UNIVERSITY OF SOUTHAMPTON

Faculty of Humanities

Department of Archaeology

Volume 1 of 1

A Bioarchaeological Approach to Men, Masculinities, and the Body in Medieval Alba Iulia, Romania

By

Ferenc Toth

Thesis for the degree of Doctor of Philosophy

October 2024

University of Southampton

<u>Abstract</u>

Faculty of Arts and Humanities

<u>Archaeology</u>

Thesis for the degree of Doctor of Philosophy

A Bioarchaeological Approach to Men, Masculinities, and the Body in Medieval Alba Iulia, Romania

Ferenc Toth

Over the past several decades, bioarchaeology has seen an increase in the interest in theoretical approaches to the archaeological body, based upon which approaches to gendered identities through the analysis of skeletal populations are explored. This thesis attempted to contribute to this body of literature by filling a gap identified in gender bioarchaeology: the exploration and theorisation of men as gender subjects in past societies through skeletal analysis.

Using a mortuary skeletal sample this thesis aimed to study men's gender identities in the medieval period, specifically in the 12^{th} to 13^{th} centuries, in the city of present-day Alba Iulia, Romania. More specific goals included analysing gendered differences in men's risk-taking and subjecting bodies to risk in connection to their health outcomes, resulting from behaviours related to the deployment of idealised forms of masculinities. Through the bioarchaeological analysis of trauma and the examination of activity-related joint modification patterns, implications for gendered behaviour were studied.

The study developed a theoretical framework based on gender performativity (Butler, 1993), which considers gender not biologically inherent, but an agential process created through corporeal action, and the body as material culture (Sofaer, 2006a), that views the archaeological body as a sedimented embodiment of past lifeways and lived experiences. The amalgamation of these approaches permitted the conceptualisation of the body as the intersection of material and discourse, resulting in material-discursive bodies.

While employing a novel explanatory framework, the study used well established, standardised, data collection methods to maintain methodological rigour. Information collected from skeletal remains included indicators which may implicate men's behaviours in health outcomes and well-being. These included data on traumatic injuries that may

indicate accidental and violence related incidents, as well as joint modification features that may indicate patterns of activity and attitudes toward using the body to perform work.

Overall, the majority of skeletal injuries from blunt force trauma, for both males and females, were considered to have resulted from accidental injuries from everyday activities or occupational hazards. The results suggested increased risk-taking behaviours in some subgroups of males. For example, males with weapon related injuries and individuals with multiple and repeat injuries, suggest that subgroups of men participated in more dangerous activities than other males or females. Violence related trauma was observed exclusively in males indicating that engagement in armed conflict was the domain of men. Injury recidivism was also exclusively observed in males and provides clues to social influences on skeletal injury. Differences in activity related patterns were not discernible through the osteological data, suggesting that either there was no difference in the activities performed between men and women, or more likely that differential activities resulted in an overall similar skeletal response with regards to the risk of developing joint modification markers.

Despite challenges, including a lack of historical context and archaeological information, the theoretical framework was useful in gaining a more nuanced understanding of men's gendered engagement in risk-taking and being at-risk. It also allowed interpretations of the interplay between biological factors and larger social and cultural influences that perpetuated and legitimised behaviours which in turn detrimentally affected men's health outcomes.

Table of Contents

List of Tables

List of Figures

Research Thesis: Declaration of Authorship

Ferenc Toth

A Bioarchaeological Approach to Men, Masculinities, and the Body in Medieval Alba Iulia, Romania

I declare that this thesis and the work presented in it is my own and has been generated by me as the result of my own original research.

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University.
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
3. Where I have consulted the published work of others, this is always clearly attributed.
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.
5. I have acknowledged all main sources of help.
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.
7. None of this work has been published before submission.

Signature: Date: October 8, 2024

Acknowledgements

The completion of this dissertation relied heavily on the love and support of many individuals, to whom I am forever indebted.

First and foremost, I wish to express my sincere gratitude to my academic supervisors Dr. Joanna Sofaer and Dr. Sonia Zakrzewski. Thank you Dr. Sofaer for your endless positivity and always inspiring me to push forward. Thank you Dr. Zakrzewski for always pushing me to think analytically and kindly nudging me to figure things out for myself.

I wish to thank my external examiners, Dr. Jo Buckberry and Dr. Anna Collar, whose insightful and creative feedback has made this thesis significantly stronger.

I would also like to thank Dr. Daniela Marcu Istrate, Director of Excavations at Alba Iulia, for providing me, and trusting me, with access to the mortuary sample. I'm also grateful for the help I received from Dr. Mihai Constantinescu, Dr. Andrei Soficaru, and Dr. Mihaela Gatej at the Fr. I. Rainer Institute of Anthropology in Bucharest, for arranging access to the collection, and supporting me in my travels and work in Romania.

A special thanks to Dr. Maria Liston for introducing me to bioarchaeology many years ago, without which I would not have aspired to do any of this.

Finally, my deepest thanks go to my family for their unwavering and endless support and patience. Thank you to my parents for teaching me to be relentlessly curious about the natural world. Thank you to my wife for not letting me give up when it felt like that may be the right thing to do, and for always pushing me to be a better person. I dedicate this thesis to my children with the hope of inspiring them to believe that with determination and hard work we can do difficult things.

Abbreviations

ACLP	Adjusted crude lifetime prevalence
ALP	Adjusted lifetime prevalence
AM	Antemortem
CLP	Crude lifetime prevalence
F	Female
FOOSH	Fall on outstretched hand
Inter	Intermediate sex category (skeletal non-dimorphic)
M	Male
MA	Middle adult
OA	Old adult
PM	Perimortem
UnA	Unknown adult (Skeletal sex or age)
YA	Young adult

Chapter 1: Introduction

Bioarchaeologists have studied men as part of their assemblages since the origins of the discipline. However, with few notable exceptions (Knüsel, 2012; Sundman, 2022; Sundman & Kjellström, 2020; Torres-Rouff, 2012; Villotte & Knüsel, 2014), men have rarely been the explicit focus of investigations, and even rarer has men's gender been critically examined. This thesis draws attention to men's gender through a bioarchaeological investigation to explore men in the past in relation to health outcomes. To achieve this, analysis was conducted on a skeletal assemblage from medieval Romania (12th and 13th centuries) from the city of Alba Iulia. The overall intent of the thesis is three-fold: (1) to make men's gender explicit in bioarchaeological studies of gender; (2) to explore theoretical approaches to studying men's gender bioarchaeologically combining embodiment and gender performativity theories; and (3) to explore discourses of masculinities and masculine performatives in the medieval period and to examine how they relate to male bodies as observable through skeletal analysis.

In the 1980s, feminist archaeologists highlighted the androcentric traditions of archaeological inquiry and interpretation, leading to narratives that render women as invisible part of history and present men as the universal subjects, representing all of humanity (Conkey & Spector, 1984). Therefore, at first glance, the current thesis' focus on men may appear to reinforce these problematic notions, trivializing decades of work by feminist archaeologists. However, I argue, as others have, that a closer examination of men's experiences in the past will reveal them as gendered individuals, distinct from any universal representation (Alberti, 2006).

Bioarchaeologists have paid increasing attention to the influence of sex and gender on the skeleton since gender studies gained wider popularity within archaeology in the 1990s (Hollimon, 2011, p. 140). Ever since, there have been numerous studies examining skeletal indicators considered to relate to gendered behaviour (see reviews by Hollimon, 2011; Sofaer, 2013; Zuckerman, 2020; Zuckerman & Crandall, 2019). Despite these endeavours, with the exception of a few recent studies (Knüsel, 2012; Redfern, 2006; Sundman, 2022; Sundman & Kjellström, 2020; Torres-Rouff, 2012; Villotte & Knüsel, 2014), bioarchaeologists have rarely focused on men's gender and its relation to skeletal markers. This is an interesting observation because, with the development of gender archaeology, one would have expected that both women's and men's gender would have been equally explored. To understand how this has taken place and establish the context for this thesis, it is useful to examine the bioarchaeological literature. Specifically, it is important to consider how the limited application of social theory concerning gender has resulted in the portrayal of men in essentialist and heteronormative ways, as universal and transhistorical subjects.

1.1. Context of the research

Early feminist archaeologists pointed out that archaeology has been androcentric because it has focused on normative male roles, activities and processes, such as hunting, war, violence, economic activity. It has also been concerned with interpretations from a male standpoint, thereby influencing which questions archaeologists find interesting to investigate and which interpretations are considered plausible (Conkey & Spector, 1984; Wylie, 1991). Furthermore, it has been argued that archaeological narratives have been created by imposing modern stereotypical ideas about gendered activities on the past, and these archetypal narratives have made men the representatives of ancient societies as a whole (Skogstrand, 2011; Wylie, 1991). Thus, archaeology has universalised men through essentialist descriptions. Essentialist descriptions highlighted key characteristics about men which are said to define them, regardless of culture, time period, or location, based on masculine qualities presumably innate to all men (Alberti, 2006, p. 407). Such qualities were based on biological determinism and were also rooted in earlier social evolutionist ideas of psychic unity (Facoetti & Gontier, 2020), according to which differences in men were due to social evolutionary stages rather than individual or cultural differences (Alberti, 2006, p. 408). Essentialised and determinist narratives of men in archaeology mostly predate the influence of feminism and the emergence of gender archaeology. However, notions of it still survived in archaeological writing, but not explicitly articulated, rather appearing as subtext.

The androcentrism in early physical anthropology is immediately apparent upon a quick scan of the table of contents of most issues prior to the 1980s of its premier journal, the *American Journal of Biological [Physical] Anthropology*. Papers commonly use the term ‘man’ to represent the human species, with titles such as: *Fetal Growth in Man* (Schultz, 1923),*Ontogenetic Aspects of Sutures In Man* (Noback, 1946), and *Bipedal Behavior and the Emergence of Erect Posture in Man* (Sigmon, 1971). Other titles include phrases like ‘races of man’, ‘ape men’, ‘fossil man’, and ‘Neanderthal man’. By the 1990s these overtly essentialist titles and descriptions of men fell out of favour. However, some subtle aspects of essentialism were slow to, and arguably never, completely disappeared from the discipline. This lagging essentialism was partly due to bioarchaeology's focus on population level studies, a preoccupation with activity reconstruction and the assumptions built into it, and the reluctance to engage in theory building especially around the sex and gender. Furthermore, bioarchaeological notions and narratives of essentialised men linger because of the dominance of some schools of thought. Bioarchaeological literature does not necessarily present essentialised notions of men's behaviour in explicit or intentional ways, but rather as a subtext of interpretations of gender roles which cast men in roles that reinforce dominant forms of masculinity. In much of the bioarchaeological literature even in which gender was explicitly discussed, it was never fully explored beyond explanations using sex role theory, which inherently carries a subtle subtext of biological determinism. Sex role explanations of gender result in men being cast as one type, as opposed to ones where men's gender is more than a passive re-enactment of socially prescribed roles. Such stereotypical representations of men render them invisible, just as they rendered women invisible.

Although, with the exception of very recent literature, in bioarchaeology men have only been studied implicitly. Certainly, men have been the subjects of many bioarchaeological investigations because sex is an ubiquitous, and frequently the first, axis of analysis. Indeed, some assemblages comprise almost entirely of males, such as those from military contexts, for example the Franklin Expedition (Keenleyside et al., 1997), or the sailors from the Mary Rose (Stirland, 2001), or monastic samples (Mays, 2006). There are also studies which focus on a specific male skeleton such as the Kennewick Man, and fossil 'men' such as 'Peking Man' or 'Kabwe Man', and case studies in which the skeleton under analysis happens to be male. These studies investigate men by default. They study men not because the researchers sought to find out something about men, but because they wanted to find out something about the study population (or individual) which happened to be entirely male.

There are several possible reasons bioarchaeology has studied men only implicitly. One may be due to a general hesitancy to study men in response to criticisms of archaeology's long history of androcentrism. Bioarchaeologists have studied women's lives in somewhat more, although limited, detail (Liston, 2012). Archaeological studies of detailed gendered lives are usually the domain of gender archaeology (Gilchrist, 1999; Nelson, 2006; Sørensen, 2000), and gendered approaches traditionally have investigated women's lives, owing to roots in feminism. Paralleling this trend of a focus on women, bioarchaeology has explored women through studies of parturition, childbirth, breastfeeding, weaning, and osteoporosis (Cox & Scott, 1992; Fogel et al., 1989; Fuller et al., 2006; Katzenberg et al., 1996; Nitsch et al., 2010; Tsutaya & Yoneda, 2015; Weaver, 1998). However, before the turn of the century bioarchaeological investigations of women have rarely been within the explicit framework of gender. In fact, most studies focussing on women explored the biological processes related to biological phenomena experienced by female bodies. This is unsurprising given bioarchaeology's historical propensity towards positivism, science, and biology (Sofaer, 2006a). It is also a reflection of contemporary trends in scientific, medical, and popular discourses, which have naturalised women as biological entities, a notion insisted upon by health systems that medicalise female (reproductive) body functions (Courtenay, 2000c; Lorber & Moore, 2002). Thus, since many bioarchaeologists are interested in pathological and health patterns, studies of 'women's issues' are simply an extension of the specious link between women and the natural world, leaving men's issues underexplored.

There is a long bioarchaeological tradition of examining the relationship between biological sex in relation to other skeletal indicators, but only limited attempts to use gender as an explanatory axes of analysis and not as an independent variable in relation to skeletal outcomes. In the early 21st century, bioarchaeology was criticised for being disengaged from wider theoretical discussions occurring in interpretive archaeology, including those surrounding gender (Sofaer, 2006a). This was argued to be due to bioarchaeology's disciplinary trajectories, which are grounded in empirical tradition, and more closely aligned with hard sciences such as chemistry, biology, and physics, than with social sciences and philosophy. Such scientific focus has rendered bioarchaeologists as specialists and lent them a sense of authority and respect, but it also established bioarchaeology as an archaeological subfield distinct and perhaps even incompatible with branches of archaeology which are more humanistic and interpretive (Sofaer, 2006a). This ostensible incompatibility has resulted in the reluctance of bioarchaeologists to engage in wider theoretical discussions in archaeology and to use concepts from interpretive archaeology to approach bioarchaeological problems, leaving concepts such as gender underexplored. Thus, for a long time bioarchaeology lacked specific theoretical frameworks that would enable the exploration of gender through the skeleton.

The methodologically focused bioarchaeology of the 20th century placed specific emphasis on exploring sex because it was essential to bioarchaeological field methods. In a great portion of bioarchaeological analyses, men were simply part of the 'male' sex category, left unexplored, undifferentiated, and unfragmented. In the majority of bioarchaeological studies, the male category was used as a variable to which other variables, for example lesion counts, were correlated. Inferences about the meaning of skeletal indicators almost always compared men and women in general, and rarely sub-groups of men or sub-groups of women. In bioarchaeology, sex was rarely considered to be anything other than a fixed biological category, owing to field and laboratory methods grounded in the apparent fixity of biology. As a result, mapping gender onto sex rendered gender as a seemingly fixed category. This led to conclusions about men in general, even in studies which have explored behaviour through a gendered approach. Therefore, in most bioarchaeological accounts, men have been represented as an undifferentiated monolithic category, where the category represented each man, and each man is represented the category.

1.2. Disciplinary history and the study of men

The way in which men have been explored is related to disciplinary trajectories of bioarchaeology and its situation in the larger context of developments in archaeology. Agarwal and Glencross (2011a) have divided the history of bioarchaeology into three general historical waves of theoretical engagement. The first wave grew out of increasing emphasis on the duality of the human skeleton which was seen as being both biologically and, more importantly, culturally influenced. Skeletal biologists in the first half of the 20th century, and even until more recently, often served as service providers of osteological data, such as age and sex, to archaeologists working in mortuary contexts (Sofaer, 2006b). Skeletal biologists became increasingly aware that the human body is a product of biology, culture and the physical environment, and contended that careful analysis of human bones can reveal many aspects of past societies beyond biology. As archaeological inquiries outside of bioarchaeology increasingly focused on gender, skeletal biologists became invaluable sources for accessing the biological sex of individuals in graves. Gender was inferred by associating patterns of grave good with biological sex (Sofaer, 2013).

The emergence of bioarchaeology was grounded on frustrations of archaeologists marginalizing the potential of archaeologically recovered human remains to contribute to our understanding of the past beyond giving archaeologist biological information (Larsen, 1997). In the 1980s bioarchaeologists increasingly recognised the extent to which culture influenced biology, and therefore the role sex related behaviours played in the biological development of the skeleton. This led to the articulation of the biocultural model which viewed skeletal indicators as responses to a system of interactions between the environment, biology, and culture (Cohen & Armelagos, 1984). The model provided a framework to tackle archaeological issues raised in mainstream archaeological discussions such as those of population transitions and to answer larger evolutionary questions. This created a movement towards the use of epidemiological principles in studies of stress indicators, with a focus on population based approaches (Armelagos, 2003). The emergence of the biocultural model was alongside a larger paradigm shift in archaeology that emphasised a systems approach (Armelagos & van Gerven, 2003; Trigger, 2006). This resulted in a distinct focus on populations as units (or sub-systems) of analysis, with the effect that in bioarchaeology sex became a unit of analysis. In early studies employing the biocultural model examining gender, and even those which did not, males and females were separated into analytical categories with each sex being a unit of analysis, or a sub-population.

The second wave of engagement according to Agarwal and Glencross (Agarwal & Glencross, 2011a) saw the increased uptake of cutting edge scientific methods along with increased awareness of the possible biases inherent in skeletal assemblages. Scientific advances in chemical analysis (Brown & Brown, 2011; Katzenberg, 2008) and genetics (Stone, 2008) opened new avenues for the analysis of archaeologically recovered human remains. Analysis of stable isotope content of human bones to reconstruct past diet, population movements, and weaning patterns (Fuller et al., 2006), quickly gained popularity, along with analysis of ancient DNA for studies of phylogenetic lineages and pathological conditions (Nieves-Colón & Stone, 2019). Reflections on epidemiological approaches of the first wave brought the realization that human remains from archaeological contexts may provide biased information about past living populations. So-called biological selectivity renders interpretations of morbidity and mortality in past populations paradoxical (Wood et al., 1992). Scientific advances in molecular bioarchaeology hoped to offer solutions to this paradox (Wright & Yoder, 2003). Bioarchaeologists focused on the promise of state-of-the-art science at the expense of theoretical developments seen in interpretive archaeology as a result of the post-processual critique. Some have even accused bioarchaeology of becoming atheoretical (Sofaer, 2006a). The lack of involvement of bioarchaeologists in archaeological theory building, and the continual embrace of the biocultural model, resulted in continuation of men's narratives seen in the first wave.

Finally, the third wave focused on the greater contextualization of bioarchaeological data, and engagement with social theory (Agarwal & Glencross, 2011b). Bioarchaeology emphasised the contextual analysis of human remains by incorporating other sources of information such as the archaeological context, and historical and ethnographic information (Buikstra & Beck, 2006; Larsen, 2015). Wave 3 bioarchaeologists still continued to use the biocultural model and state of the art scientific methods, but have also aligned themselves with a holistic approach, integrating developments from other scientific fields, such as biology, ecology, geology, and importantly, interpretive branches of archaeology which focus on the lived experience of past people. Bioarchaeologists have recently started using concepts from interpretive archaeology and social theory such as embodiment (Sofaer, 2006a; Wesp, 2013), agency (Crandall & Martin, 2014; Glencross, 2011; Tung, 2014), identity (Geller, 2009; Knudson & Stojanowski, 2009; Torres-Rouff, 2012), and personhood (Boutin, 2012, 2016), to explore the lived experiences of the people they study (Agarwal & Glencross, 2011b; Baadsgaard et al., 2012; Byrnes & Muller, 2017; Geller, 2017; Stone, 2018). Schools of thought emerged which placed increased emphasis on the lived experience of individuals (Stodder & Palkovich, 2012), employing developments in social theory.

The paths followed by the discipline reveal some of the factors that led to the essentialization of men in bioarchaeology. These include an emphasis on scientific methods aimed at developing robustness in research, which drew upon concepts from fields such as epidemiology, demography, and clinical pathology. Such approaches promoted a population level approach. This represented a move away from earlier reports on skeletal remains from archaeological contexts which often consisted of case studies of individual skeletons. Such approaches argued that studies focused on individuals lacked explanatory power for larger questions that bioarchaeolgists were starting to ask about human behaviour and evolution. The post-WWII era saw an increase in population-level studies in anthropology in general (Johnson & Mann, 1997), with a waning interest in typological classifications that were prominent in biological anthropology at the time (Zuckerman & Armelagos, 2011). This was facilitated by Washburn's (1951) ‘new physical anthropology’, which emphasised hypothesis testing from an evolutionary and adaptation perspective.

Aspirations of some biological anthropologists for the role of the discipline in answering larger historical questions led to the development of the biocultural model (Zuckerman & Armelagos, 2011). Within the biocultural model, skeletal stress indicators in human populations and individuals were viewed as adaptive responses to environmental, cultural, and biological processes (Goodman & Armelagos, 1989). The biocultural approach facilitated population level approaches in bioarchaeology because it focused on adaptive processes of past populations from a systems perspective, such as shifts in subsistence patterns (e.g., transition to agriculture) (Cohen & Armelagos, 1984), political or economic change, or change across periods of contact (Agarwal & Glencross, 2011a). Culture was seen as part of this adaptive system which buffered individuals from environmental insults. Concurrent to this approach was the uptake of epidemiological approaches to palaeopathological analyses. This approach argued that disease processes should be understood in the context of populations. Thus, individuals in bioarchaeology became mere units of diagnosis, while the unit of analysis was the population (Armelagos, 2003). Indeed, a population level approach has been declared one of the three primary components of bioarchaeology (Zuckerman & Armelagos, 2011, p. 21).

Thus, bioarchaeology, as it became defined, has traditionally had a distinct focus on macro scale phenomena. Most bioarchaeological scholars today still see population level approaches as central to the discipline; however, there is increased emphasis on returning to studying individuals as a complimentary perspective attempting to resolve the tension between the macro and micro scales of analyses (Martin et al., 2013; Stodder & Palkovich, 2012). These advancements with regards to studying gender in bioarchaeology are discussed in Chapter 4.

A specific research area in which the normalization of men’s gender is particularly salient is the activity and behaviour reconstruction literature (Jurmain, 1999; Jurmain et al., 2012). The reconstruction of activity patterns has a long history in bioarchaeology and has received much attention both methodologically and theoretically. This research area has had an interest in gendered behaviour with an emphasis on understanding sexual divisions of labour. Historically, activity reconstruction is rooted in efforts to study occupational markers of stress, by studying changes in musculoskeletal stress markers (Pearson & Buikstra, 2006). Bioarchaeologists have also attempted to reconstruct general activity levels by observing cross sectional geometry (Jurmain et al., 2012; Weiss, 2009b). It has recently been forcefully argued that a population level analysis should remain central to this branch of bioarchaeology on the basis that these indicators are found universally in human groups (Jurmain et al., 2012, p. 537). This method of inquiry has been one of the leading methods through which bioarchaeologists have studied gendered lifeways in the past, as activity differences between men and women were often the focus of hypotheses and interpretations. While the population approach has made strides in increasing the interpretive power of bioarchaeological data, it also created narratives about men in past societies which are oversimplified and heteronormative reconstructions of their social identities.

Historically, the activity reconstruction literature is replete with androcentric interpretations descriptions of men’s activities. Earlier studies attempted to view degenerative changes as occupational markers of stress by linking osteological changes to specific activities (Kennedy, 1989; Merbs, 1983). Changes seen on male skeletons were often interpreted as evidence of activities such as hunting, fishing, military activity, and carrying heavy loads; while similar changes on women's skeletons were interpreted as due to prolonged sitting, burden from childcare and household chores (Kennedy, 1989). Similar changes in males and females of the same population were interpreted to have resulted from different activities. For example, Angel (1966), in one of the earliest studies to attempt to link arthritis to activity, attributed arthritic changes in the elbow in men to spear throwing (‘atlatl elbow’), while for females he suggested the same condition was caused by seed grinding (‘metate elbow’ (Merbs, 1980). An often cited meta-analysis on osteoarthritis (Bridges, 1992) concluded that males, almost universally, show a higher levels of degenerative joint changes. This influential study considered osteoarthritis to be due to wear-and-tear, and as an indicator for activity levels in past societies. This reinforced pre-existing notions that in prehistoric societies men were more active and engaged in more strenuous activities than women. Therefore, activity-related changes in men were interpreted to result from an active and mobile lifestyle, and changes in women as due to passive, inactive, and sedentary life style. There was a general consensus that men wore down their bodies, and women's bodies just wore down.

In other research areas of bioarchaeology, it was also common to use skeletal findings to underpin androcentric and heteronormative interpretations about men’s social identities.

For example, bioarchaeological studies of violence and conflict, have predominantly featured men in violent roles. The main reason for this seemed to be that skeletal trauma, including those presumed to have been obtained from interpersonal violence, in archaeological samples are almost universally higher for males than females (Redfern, 2017b). Additionally, many researchers assumed that the trauma seen on female skeletons were a result of acts perpetrated by men (Hollimon, 2011, p. 159; Judd & Redfern, 2012, p. 367), making even studies of (violence against) women (Novak, 2006; Redfern, 2017a; Tung, 2012), implicitly about men. However, more recent interpretations are moving away from the warrior model of maleness, and “do not automatically assume that male injuries represent warriors and that female injuries represent victims” (Hollimon, 2011, p. 159). Therefore, historical studies of trauma have reified the archaeological trope that represents men as an undifferentiated dominant group with a propensity for violence.

The focus of bioarchaeology on the population approach left a palpable lack of engagement of bioarchaeological scholars in theory building, and the use of social theory around the turn of the century. The lack of interest in social theory has left gender, a domain of more theoretically driven interpretive archaeologies, bioarchaeologically undertheorised and under explored, and the link between sex and gender under-investigated. This maintained the understanding of men’s gender as fixed, and the category of men unfragmented.

Although bioarchaeologists have used the terms sex and gender for decades, these terms have, for the most part, remained under explored and under theorised within the field. In the later half of the 20th century, the term gender was increasingly used in the biomedical and social science literature, including physical (biological) anthropology. A review of this literature by Walker and Cook (1998) indicated an increase in the use, and misuse, of the term starting in the mid-1970s. The increased attention and the use of the term gender, however, was not an indicator of an increase in the interest of the social constructs of gender, it was simply conflated with and used as a synonym for sex. The authors (Walker & Collins Cook, 1998, p. 257) observed that biological anthropologists “were among the worst offenders”, with none of the articles published in the 1990s in the *American Journal of Physical Anthropology* making a useful distinction between sex and gender.

The majority of bioarchaeological publications that deal with the concepts of gender, have titles which include the phrase "sex and gender", the words always together, in that order (Grauer & Stuart-Macadam, 1998; Hollimon, 2011; Sofaer, 2006a). This impresses on the reader that in bioarchaeology two concepts are inseparably linked, and that one is the outcome of the other (i.e., gender follows from sex). Bioarchaeological studies most often defined sex as the biological identity and gender as the social, without critically examining the relationship between the two. As Armelagos (1998) has defined in the introduction to *Sex and Gender: A Paleopathological Perspective* (Grauer & Stuart-Macadam, 1998):

> "There is a consensus in anthropology that sex is defined by the biological differences between males and females determined at the moment of conception and enhanced in subsequent physiological development. … There is also agreement that gender is the cultural construct in which individuals are socially classified into categories such as male and female, or masculine and feminine in our culture" (Armelagos, 1998, p. 1).

What bioarchaeologists have done with such a definition is to assume that biological identity is determined through osteological methods of sexing, and social identity will then emerge by mapping the cultural indicators onto the sex, thus declaring gender has been discovered. However, this approach simply links sex with gender, or substitutes gender for sex, and risks explanations of men's (in this case) behaviours as biologically determined. In much of the bioarchaeological literature in the last century, men were a category of analysis anchored in the fixity of biological indicators of maleness, which are observable from skeletal remains. In twentieth century bioarchaeology biological sex was seen as unchanging and stable (Geller, 2008; Sofaer, 2006b). The fixed biological categories of male and female were often the first axes of analyses in investigations. Since the category male was based on biology, anchored in biological processes of male physiology, the differences between males and females were often considered inherent. This assumption of inherency was perpetuated, when studies that simply mapped biological sex onto a cultural gender. In other words, when the fixity of sex was mapped onto gender, gender was also considered fixed, leading to a subtext of biological determinism and interpretations which were essentialist in nature. This contributed to the idea of universality of males, where maleness or masculinity was seen as constant and unchanging through time and place, without considering the possibility that maleness, or masculinity, is contextually constructed and there may exist many types of men's genders.

More recently, scholars have critically examined the interplay between sex and gender (and sexuality) in bioarchaeology, challenging the assumption that biological sex equates to cultural gender (Agarwal, 2012; Hollimon, 2011; Sofaer, 2006a, 2006b). More precisely, with influences from outside (Butler, 1990, 1993, 2004; Fausto-Sterling, 1993, 2000, 2019), as well as within bioarchaeology (Geller, 2008; Sofaer, 2006a, 2006b), scholars in the past 20 years have recognised the diverse nature of sex and gender expression, and have stressed the non-binary expression of both. The non-dichotomous nature of sex/gender, in fact, has become a key topic for a subset of bioarchaeologists interested in the diversity of a gendered lived experiences in the past (Agarwal, 2012; Agarwal & Wesp, 2017; DeWitte & Yaussy, 2020; Geller, 2009, 2017; Hollimon, 2011, 2017; Sofaer, 2006a, 2006b, 2013; Wesp, 2017; Zuckerman, 2020; Zuckerman & Crandall, 2019; Zuckerman et al., 2023).

Humans are considered to be a sexually dimorphic species. In addition to having different male and female primary sex characteristics, the human body displays sex differences in size and shape, including the morphology of the skeleton. This is due to the fact that sex expression is immensely variable in the human body. There are variations even in chromosomal sex, and their phenotypic expressions, including manifestations in the skeleton. The work of Fausto-Sterling (1993, 2000, 2019) has been influential here in advancing the understanding of non-binary expression of biological sex. She has called attention to the fact that a range of biological sex categories exist beyond the XX and the XY chromosomal genotypes, and phenotypic expressions beyond the textbook male and female primary sex characteristics (Fausto-Sterling, 1993, 2000, 2019).

Scholars of human osteology have been keenly aware of the variation in phenotypic sex expression (Klales et al., 2020). This is precisely the reason sex assessment of skeletal remains has challenged practitioners since the beginnings of the disciplines of human osteology and biological anthropology. These notions have been the subject of many methodological investigations focused on sex assessment, which have studied the skeletal expression of sex in various age groups (Geller, 2005; Walker, 1995, 2005). Although sex may be genetically influenced, the physical expression of this genotype, is differentially expressed from individual to individual, and changes throughout the life course within individuals from adolescence, to puberty, and as the body senesces (Sofaer, 2006b). Such variation has introduced tension between osteological methods and bioarchaeological theory. Text books, and data collection and field manuals, teach bioarchaeologists to score osteological variation of anatomical sites involved in sex assessment on a continuum (Bass, 1995; Brickley & McKinley, 2004; Buikstra & Ubelaker, 1994; Mays, 1998; White et al., 2012), as the expression of all sexes contains variation. Traditionally, this variation in osteological studies has been converted to binary sex categories of male and female and the rest excluded from analysis. In recent years bioarchaeolgists aware of the non-binary nature of sex and gender expression, have grappled with the question of how to utilise this continuous variation in a way that does not involve discarding data (Wesp, 2014, 2017). The inability of practitioners to assess skeletal sex due to ambiguous skeletal sex presentation should not exclude skeletons from being part of analyses. Furthermore, retaining individuals of un-assessible sex is of interest not only because it expands datasets, but also because individuals with intermediate sex expression may represent individuals with the most interesting lived experiences (Geller, 2017). Some recent scholars have developed innovative and nuanced methods that consider the spectrum of variation instead of excluding individuals who do not fit into dichotomous sex categories. Recent approaches to the non-binary, dynamic, and contextual analysis of sex/gender are further discussed in Chapter 4.

In summary, a lack of theory building in bioarchaeology in the last century has also resulted in the category of men being a fixed category of analysis. A bioarchaeology that emphasised and encouraged analytical study designs, and eschewed description (Armelagos & van Gerven, 2003; Larsen, 2010), used both sex and gender as fixed categories of analysis. Males, or men, were treated in this way, both as biological and conceptual categories. The category of men in bioarchaeology has been traditionally an unfragmented, monolithic, category because sex has been viewed as a fixed biological category onto which a fixed cultural category of gender was mapped. With the historical backdrop of static sex and gender as unchanging and normative, and in light of new developments in bioarchaeology acknowledging that sex and gender are non-binary, contextual, dynamic, and fluid, the question becomes, how can bioarchaeologists study men as explicitly gendered subjects with fluid and dynamic identities, and maintain scientific rigour?

1.3. Research aims and objectives

The challenge for bioarchaeolgists is, how do we study men in bioarchaeology in a way that makes them explicitly gendered, not essentialised, and not heteronormativised, and considers gender as a dynamic and socially produced process rather than a fixed category? Benjamin Alberti, in his article *Archaeology, Men, and Masculinities*, the first of its sort in the discipline, argued that marking men's gender explicit in archaeology may come with its own dangers, and thus he suggests that the theoretical frameworks to study men are already in place with feminist-inspired archaeology (Alberti, 2006). He introduced the idea of studying men by exploring the concept of masculinity or masculinities. The dangers he refers to are the potential solidity of an object (*i.e.*, masculinity) that may not be a stable object of inquiry, and that it may be seen as a corrective measure to a feminist gender archaeology largely interested in women. As Alberti writes:

> "What are required, I argue, are both critical engagements with the concept of 'masculinity' and the development of the means of conceptualizing sexual difference that go beyond the assumption of fixed binary categories of identity. Both these goals can be achieved through extant conceptual and theoretical frameworks within the discipline (Alberti, 2006, p. 404)."

Alberti highlighted that feminist-inspired archaeology already provides theoretical frameworks to study men. In building on Alberti's recommendations, it is possible to move away from essentialism by employing social theories of masculinities in bioarchaeological investigations. In this thesis it is suggested that this can be explored by using Judith Butler's (1990, 1993) theory of gender performativity, which suggests that gender is not an essential characteristic but is rather an agential process performed through the repetition of social practices. This research seeks to combine this approach to gender identity with

Joanna Sofaer's (2006a) the theory of the body as material culture to understand the body as both the site and the product of men's subjective gendered life experiences, embodying both the material and the discursive realities of being male.

Interest in this research grew out of a fascination with the embodiment of gendered behaviours in contemporary men. More specifically, it grew from an interest in contemporary research linking men's health related behaviours to the deployment of 'masculinities'. As will be explored in Chapter 3, constructions of masculinities in contemporary society have been argued by social scientists to have a number of negative effects on men's bodies, specifically on their health outcomes (Robertson, 2007). In recent years, 'men's health' scholars have closely studied the relationship between the deployment of certain types of masculinities and health related outcomes. This had led to observations that implicate cultural constructions of masculinities, rather than biological differences to account for the differences in some trends in health disparities between men and women, that were long thought to be due to biological differences. For example, men today (almost universally) live shorter lives (Bonhomme, 2009) and have higher morbidity and mortality for almost all leading causes of death in the United States (Courtenay, 2000a; Pinkhasov et al., 2010). Social science research in this field showed that many health outcomes previously thought to be biological predispositions are greatly influenced by differences in gendered behaviours (Courtenay, 2000a). More precisely, behaviours that include risk-taking as a result of social ideas about masculinity that include aggression, athleticism and emotional concealment, and are often associated with dominant forms of masculinities, have been linked to increased likelihood of negative health outcomes in various areas, such as mental health, disease, injury, and death (Courtenay, 2003, 2011). These behaviours, many of which explicitly or implicitly involve risk-taking, include underutilisation or access to health care, higher rates of substance abuse, engagement in higher risk activities such as sports, higher rates of engagement in violence such as fighting or criminal activity, and engaging in employment with greater occupational hazards (Courtenay, 2000a). These behaviours, influenced by cultural or discursive constructions of masculinities, can lead to higher morbidity and mortality trends in men. Such observations in contemporary society led the author, with an already developed interest archaeological bodies, to question whether men in the past similarly engaged in gendered behaviours that affected their health outcomes. More generally, how did masculinity embody itself in the physical body? Moreover, what can embodied gendered differences reveal about past attitudes towards the body concerning risk-taking in terms of physical injuries or overuse due to activity?

In order to investigate men from archaeological remains without falling back on biological, essentialist, or universalist explanations of gendered difference, a contextual approach was required (Agarwal & Glencross, 2011a; Buikstra & Beck, 2006). This approach should consider the flexible, fluid, plural, and contextual nature of masculinities and explore how masculine discourses in the past may have been engaged with and deployed performatively, and affected men's well-being. To investigate men and the embodiment of masculinities in the medieval period, through an understanding of the body as the site of a lived experience onto which gender identity is inscribed, a case study was required. To this end, a skeletal sample from medieval Alba Iulia in Transylvania, from current-day Romania, was chosen.

This medieval sample was chosen for investigation for several reasons. By examining the life experiences of men during this time, we can gain valuable insights into the foundations of some of the discourses that still shape men's behaviour today. This enduring impact of the medieval period is evident in its literature and art, that even today, has a pervasive presence in themes and narratives within Western culture (Senior, 1994; Truesdale, 2018). Medieval discourses can be seen today, for example, in many beloved children's stories and fairy tales. These narratives often present men through various archetypes, such as princes, kings, chivalrous knights, and heroes. While these stories may be fantastical, they still promote moral lessons that reinforce cultural values and consequently influence boys', and eventually men's gendered expectations and behaviour. These, in turn, influence men's understanding of their position in society and their gender identities through what Whitehead (2002) has called 'the male heroic project'. This is the idea that cultural narratives, including myths, legends, and fairy tales, often depict men as brave, strong, and heroic. The male hero has existed throughout history as a trope of an exemplar model of masculinity (Whitehead et al., 2013). These depictions have social implication by encouraging men today to deploy traditional masculine ideals that are not passive or weak, but active, strong, brave, resolute and stoic (Whitehead et al., 2013; Whitehead, 2002). As explored below, many men's health scholars have pointed out that conformity to dominant or 'hegemonic' ideals of masculinity, negatively influences men's well-being including their physical and mental health (Addis & Mahalik, 2003; Brooks, 2001; Courtenay, 2011; Mahalik et al., 2007; Robertson, 2007). To better understand men's behaviours and their health impacts in contemporary society, it is essential to understand the historical underpinnings of discourses surrounding masculinities that may be rooted in the medieval period.

Therefore, the medieval skeletal sample from Alba Iulia, presents a relevant case study to investigate men's embodied gender from an archaeological population. This relevancy stems from the fact that skeletal remains provide direct access to biological indicators of health (Grauer, 2012; Ortner, 2003; Roberts & Manchester, 2005), and also represent embodied gendered lived experiences in the past (Agarwal & Wesp, 2017; Sofaer, 2006a, 2006b; Zuckerman et al., 2023). This offers a unique opportunity to explore the ways in which social forces in the past shaped human bodies (Agarwal & Glencross, 2011b; Cheverko et al., 2020). By studying the health-related skeletal indicators of injury and mechanical stress, this thesis seeks to explore how social forces influenced men's behaviour and consequently impacted their health outcomes.

1.3.1. Research questions

To address the aims of this study, which involve examining men as explicitly gendered subjects through the concept of masculinities and assessing the impact of these masculinities (particularly those related to risk-taking) on the skeletal remains using a bioarchaeological approach, the following research questions were formulated:

- How do patterns of blunt and sharp force trauma implicate gender differences in risk-taking or being at-risk of physical injury in Medieval Alba Iulia? How can we use these patterns of trauma to understand men's deployment of masculine discourses?
- What can patterns of activity-related joint changes tell us about gender differences in general activity levels in Medieval Alba Iulia? How do gendered differences in activity levels implicate the deployment of masculine discourses?

Men's lives can be explicitly focussed on in archaeology without reinstating them as universal subjects. Indeed, explicit focus on men will allow the removal of men as representatives of societies as a whole. As Alberti has argued, "…[m]aking past men's gender explicit reveals them as gendered subjects--rather than representing the whole of humanity, they can stand only for themselves" (Alberti, 2006, p. 403). Explicit focus on men through a gendered lens will allow the examination of men in the past through a lens other than an essentialist or heteronormative one. Exploratory studies can elucidate such things as how various constructions, and deployment of, masculinities and the relationship to health, morbidity, and mortality patterns. A gendered approach to exploring men in the past with the use of social theories of masculinity and embodiment will allow the elucidation of men's gendered performances in the past, and how these gendered lifeways made their marks on their skeletons.

Chapter 2: Background to Case Study

This chapter gives a background to the case study by describing the archaeological context of the human skeletal remains used in the study to answer the research questions introduced in Chapter 1. Some historical background is introduced about Alba Iulia, and the limited detail that is known about the archaeological excavations is given. The skeletal sample chosen for this study was selected because initial reports indicated that the sample was relatively well preserved and was and constituted a relatively sizable mortuary dataset. Additionally, the latter portion of this chapter discusses men and masculinity during the medieval period, taking into account various contextual dimensions.

2.1. Background to the site

The city of Alba Iulia (Hungarian: *Gyulafehérvár*) is located in Alba County in west-central current day Romania, in the geographical regions of Transylvania (Figure 2.1). It is situated on the banks of the Mureş river. The area has been continuously inhabited from Roman times to the present day, and was the centre of power in the region many times during this span. Although the region was inhabited since the Neolithic Period, a city was established when a Roman *castrum* (military fortification) was built on the banks of the Mureş River (Makkai, 2001). It became an important city in the Roman province of Dacia (Marcu Istrate, 2010). After the province was abandoned, the castrum was re-inhabited in the mid-10th century by a tribal chief (*gyula*) (Engel, 2001). From there on, Alba Iulia was an important place politically and played a strategic role in the extension of the Hungarian Kingdom (from A.D. 895 onwards). Historical documents mention a *Gyulafehérvár* (white fortress of the *gyula*) in the 11th (A.D. 1003) century. The city became known by its Slavic name *Bălgrad*, and the name *Alba Iulia* was adopted later on. After Christianisation of the area the city became the seat of Transylvania's Catholic Bishopric. Later it was an important military centre for the Habsburgs (Marcu Istrate, 2008). The city remains occupied until today, and the citadel serves as a tourist attraction. In this thesis the sample is sometimes referred to as Transylvanian. This strictly refers to the geographical origin of the skeletal population under study and not the ethnic constitution or origin of the individuals. Even though the Alba Iulia was part of the Hungarian Kingdom, as discussed below the cemetery likely contained an ethnically heterogenous population.

Figure 2.1 Geographical location of the city of Alba Iulia in modern day Romania

The skeletal sample used in the analysis for this research was excavated from a cemetery located on the citadel (Figure 2.2), as part of a salvage archaeology effort, during the summer season in 2011. The sample was chosen for this research because it was a relatively large sample as well as relatively well preserved. The excavations were directed by Dr. Daniela Marcu Istrate of The Romanian Academy. After excavation the skeletons were transported to the *Francisc I. Rainer Anthropological Research Centre* in Bucharest, where they were washed and stored, and where the data were collected by the author.

The cemetery was located to the west of (front) the cathedral (Figure 2.3). As an excavation report was unavailable at the time of writing of this thesis, the author only had access to excavation photographs. From the photographs available to the author, all graves appear to be articulated inhumations. A small number grave goods were discovered with the skeletons including coins and jewellery (Marcu Istrate, personal comm.). According to personal communications with the archaeological director of excavations the graves mostly date from the second half of the 12th to the beginning of the 13th centuries, based on artifact and numismatic finds such as circular belts and coins from the reign of Andrew II (1205-1235) (Marcu Istrate, 2012; Marcu Istrate et al., 2015; Marcu Istrate & Istrate, 2005). However, from earlier excavation reports in the vicinity of the cathedral, published evidence suggests that the citadel grounds outside of the cemetery under analysis were used for burials from the late 9th to the 18th centuries (Marcu Istrate, 2008, p. 107).

Figure 2.2 Present day citadel in Alba Iulia, Romania (Photo credit: Stan, 2017, licensed via Adobe Stock)

The first constructions related to the Catholic bishopric on the citadel are argued to be dated to the 11th century, with the most significant buildings, including the Cathedral of Saint Michael built in the 12th and the 13th centuries (Kovács, 2003; Marcu Istrate, 2012). It was common during this time period for churches to be surrounded by a contemporaneous cemetery (Cringaci Tiplic & Purece, 2016). Historical documents indicate that there were as many as 3 cemeteries in Alba Iulia by the middle of the 11th century, suggesting an increase in population living around the fortress. The inhabitants of the fortress buried their dead around the new cathedral from the 12th century onward (Bóna, 1994). The presence of anthropomorphic tombs suggests the cemetery included individuals not native to the area. These were tombs with the body outlined with brick or stone with a niche for the head (Marcu Istrate & Istrate, 2005). It has been suggested that these graves indicate a group temporarily living in Alba Iulia (from western Europe), or an immigrant group, possibly connected to the construction of the cathedral (Marcu Istrate et al., 2015; Marcu Istrate & Istrate, 2005). The 12th century was the time of Saxon settlement in Transylvania (Makkai, 1994), and these graves may be representative of this incoming populations (Marcu Istrate et al., 2015).

Of the 632 graves that were discovered and excavated, graves labelled M112 to M632 were available for the current research. During excavation the skeletal material was numbered, bagged, and labelled by grave. For example, skeletal material from grave 1 was bagged and labelled M001 (M standing for *mormânt*, meaning grave in Romanian), even if it contained the bones of multiple individuals. However, multiple individuals in a single grave were rare, with 15 graves containing the remains of more than one individual. For the current analysis 408 graves were available for analysis that contained the remains of 427 individuals.

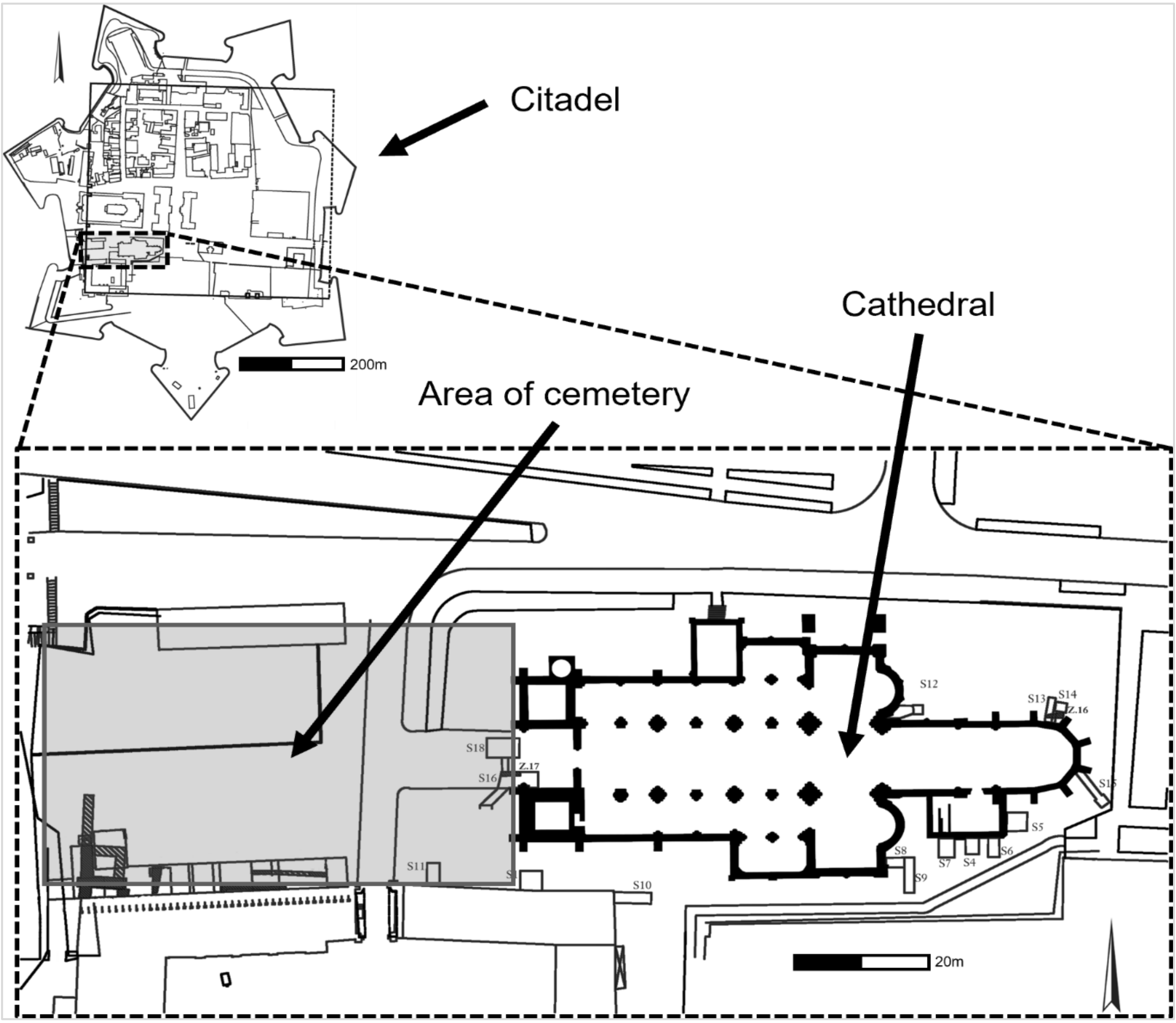

Figure 2.3 Approximate location of cemetery (grey shaded area) on citadel and in relation to the cathedral (Adapted from Marcu Istrate, 2008, pp. 231–232)

Unfortunately, no other archaeological information regarding the cemetery or the graves was available to the author at the time of writing this thesis.

2.2. Medieval masculinities

Obtaining information on men and masculinity during the Medieval period in Eastern Europe has proven to be difficult. Research into medieval men's gender identities and masculinities in general is nascent, as demonstrated by the absence of synthetic overviews of the field. The Oxford Bibliographies entry for *Masculinities and Male Sexuality in the Middle Ages*, for example, has only six entries, with almost all the sources focused on Western European context (Murray, 2018).

Historical literature on the Middle Ages in Eastern Europe tends to focus on culture history with little exploration of cultural dynamics and social relationship that would be part of past societies and everyday lives. The information presented below has been sourced from multiple context levels, including geographical areas for which sources speak about gendered expectations and experiences of men. This lack of information serves to highlight the importance of the current study of the Alba Iulia skeletal sample, which aims to shed more light on medieval men. This section examines literature on possible deployment of masculinities in the medieval period with respect to the life course, class differences, military associations, and taking physical risks and being at-risk.

Information on childhood in the middle ages throughout Europe is scant, but has been studied from various disciplines including archaeology (Hadley, 2014) and the analysis of literary text such as hagiography (Koval, 2021). Boyhood in 12th and 13th centuries in Transylvania would have been influenced by many factors including socioeconomic, political, and religious factors. Male children of the noble class, as least in Western parts of the continent were groomed for continuing family traditions and inheritance. They were often sent to live in castles where they trained for combat and learned courtly manners (Karras, 2003). In Western European contexts, boys of the noble class would begin to learn how to ride horses from an early age and by the age of 7 would undertake training to become a knight, which would be complete around the middle of their teenage years (Bennett, 1999; Knüsel, 2012). For aristocratic men, their masculine identities would have been closely tied to their abilities in combat, and therefore aggression and violence played a significant role in their conceptualisation and deployment of masculinities (Bennett, 1999). Although knighthood may not have played the same role in the medieval Hungarian Kingdom, horses played a prominent and strategic role in medieval Transylvania, especially in the lives of the nobility, as military service on horseback was common (Engel, 2001). Consequently, military training was an essential part of some men’s upbringing and therefore would have significantly influenced their gender identity expression.

Boys of the lower class were also expected to continue family traditions with expectations to contribute to the household, assist in the fields, and later seek an apprenticeship if they wished (Karras, 2003). Sources are largely absent on concepts of maturity, and whether certain rites of passage indicated transition from various life-stages to others. In Western Europe the transition from boyhood to young adulthood in some medieval cultures was seen as the onset of puberty, which has been argued to have been in the late teens (Gilchrist, 2012). However, in contemporaneous medieval Poland (11th century to 14th century), while there were some definitive turning points in a child’s life, transition from age categories, or life-stages was marked by behaviour and the fulfilment of expectations and roles, rather than chronological age or ceremonial rites (Koval, 2021). In some social contexts adolescents were considered more part of adulthood than childhood, and they were expected to take on many adult responsibilities (Newman, 2007). Boys would have been expected to begin work at a relatively earlier age, often in their early teens, regardless of the type of work they were undertaking (Newman, 2007). Agricultural, artisanal or intellectual work was all considered as valid options for young boys (Newman, 2007).

Children and adults in medieval Transylvania were part of a strict social hierarchy. Generally people belonged to two classes: 'freemen' and 'serfs' (Engel, 2001). Freemen were able to move freely, choose their residence, and choose their lord; while serfs (or bondsmen) were not able to move freely, and were confined to a lifetime of service to their hereditary lords (Engel, 2001). In the late 11th and 12th centuries, Transylvania saw a change in its ruling class as the nobility and military became the new power brokers, which was a shift away from the prior pre-Christian power structures that were organised into tribes (Bóna et al., 1994). At this time there was an increasing emphasis on militarisation and fortification, and populations protected by castles grew substantially. Castle populations consisted of freemen, who were split into two groups: professional soldiers and commoners (Bóna et al., 1994). The warrior class was bonded to a lifetime of military service, while the bondage of the commoner was manual labour (Engel, 2001). The warriors "…could be compelled to fight by their count and there was no limit to their military obligation…" (Engel, 2001, p. 72). However, commoners were often called on for military service because the number of castle warriors was insufficient to form armies (Engel, 2001), Therefore, most men would have been called upon to fulfil military obligations at some point in their lives. While Makkai (1994) identifies a 'middle' warrior class prior to the 12th century, by the 12th century this class of individuals was described as 'nobles' (Engel, 2001). The serfs constituted the lowest class of people, who served the household of their masters, and worked their fields with draught animals and ploughs. The social divide between freemen and serfs was strict, each governed by a separate set of laws (codebooks), and marriage between the two social classes was forbidden (Engel, 2001).

Military activity was a defining aspect of social identity and masculinity for young men in some social groups in most areas of medieval Europe. The western model of knighthood emphasised military prowess, bravery, expertise in the use of violence, and being skilled in arms (Karras, 2003). The training for these qualities involved assuming significant bodily risk of injury, not just during battle, but during combat training as well. This focus on military training of young men institutionalised aggressiveness and violence as key aspects of masculinity. However, Karras (2003) has argued that there was another important side to the military training young men received in the middle ages that presented a different kind of masculinity. These aspects were in tension with the traditional aspects of knighthood that emphasised gentility and courtliness. These behaviours included knowledge of behaviour appropriately in court, including appropriate conduct towards women. These chivalric values survived well after the middle ages and even inform contemporary masculine ideals (Karras, 2003).

Although constructing masculinity through miliary association was common in the middle ages, another common way through which masculinity was deployed and contested was through occupations, some of which were male dominated such as craftworkers (Newman, 2007). Urban centres in medieval Hungary were required to engage in active enterprise to bear the burdens imposed by their overlord, and many of the town occupants were engaged in the maintenance of the urban infrastructure. This included the construction and upkeep of infrastructure such defensive works, buildings, roads, water pipes, and churches (Szende, 2018). Urban workers who participated in such constructions included carpenters, masons, locksmiths, blacksmiths, and carters (Szende, 2018). In some other parts of Western Europe, occupations and crafts in the middle ages were often passed on from father to son, which reinforced the masculine nature of some of these occupations, and the masculinity discourses connected to them (Newman, 2007), although some could learn their craft from an unrelated master (Karras, 2003).

Although historical sources describing male occupation in medieval Alba Iulia were not available, men's professions can discerned from mortuary finds described in the report from the 2000 to 2002 excavation on the citadel (Marcu Istrate, 2008). Everyday use items were discovered in graves around the cathedral, dated to this period, that hint at everyday life on the citadel and the surrounding region. In addition to speaking to the everyday use of the discovered artifacts, they also speak to the presence of craftspersons who would have been responsible for manufacturing such items. Occupations suggested by mortuary artifact include stone, metal, and woodworkers. For example, stone working was indicated by the presence of iron tools discovered as part of a mason's took kit which included stone chisels, hammers, and iron wedges. Medieval metalworking is indicated by the presence of jewellers, locksmiths, and other metalworkers. These artifacts include jewellery such as rings, earrings, bracelets, made of silver and bronze; a locksmith's tools such as locks and keys, and tailors' instruments such as scissors and thimbles. In addition, the presence of other metal working professions was indicated by archaeological finds that included metal personal wear including hairpins, buckles, buttons, and household items such as knives with wooded or bone handles. Weaponry manufacturing was also revealed by archaeological discoveries included arrow tips, spear tips, crossbow bolts, daggers, swords, armour, and spurs. Lastly, the presence of woodworkers was indicated by artifacts such as axes and adzes for cutting and carving wood and iron tool for carving spoons (Marcu Istrate, 2008, pp. 657-660). These artifact discoveries attest not only to the presence of the professionals who would have used the implements, but also to the presence of craftspersons and occupations involved in the production industry who would have manufactured them.

Karras (Karras, 2003) has argued that in later medieval urban environments in Westen Europe, masculinity was constructed in relation to the occupation of craft work, which was considered a masculine pursuit. She argued that masculinity was constructed in relation to the occupation of craftwork due to the physical demands it required including strength, dexterity, and skill. This meant that discourses about men who engaged in craft work were such that they were perceived as strong and capable and were respected for their physical abilities. Additionally, craft work was considered a highly skilled and specialised occupation requiring a great deal of knowledge and training. Karras (2003) argues that adolescent boys or young men used apprenticeships to acquire this knowledge. Mastering one’s craft was tied to one’s achievement of economic independence and to masculinity. Until an apprentice mastered a craft, as they were dependent on their master and without a degree of economic success it was difficult for men to marry. Dynamics of masculinity constructions came to the fore as challenges, and competitions against other men to prove themselves as 'not boys' (Karras, 2003).

The Hungarian Kingdom in the 12th and 13th centuries was in the process of Christianization, and the Catholic Church would have been a transformative force in Alba Iulia since the 11th century when the first building complexes related to Christianity appeared on the citadel (Marcu Istrate, 2010). These included churches and other ceremonial buildings related to the administrative and ecclesiastical institutions that later served the Diocese of Transylvania (Marcu Istrate, 2010). In a different context (Western Europe), Knüsel (2012) has explored gender identities and argued that clerical masculinities formed a competing form of masculinity to that of aristocratic masculinity. These clerical masculinities were in opposition to ones deployed by aristocratic men that encouraged the use of violence; however, both knights and clergy required training from young ages. According to Knüsel’s (2012) research, the two types of masculinities were in opposition with each other, with one exemplified by military prowess and the other by its opposition to violence; however, they were both seen as competing with each other at the top of the social structure. While information about clerical identities in Alba Iulia is not available, the presence of the cathedral and associated structures related to the bishopric, indicate the presence of clergy and ecclesiastical personnel that would have implications for constructing alternate forms of masculinities in this medieval Transylvanian city. The Catholic Church emphasised the importance of chastity, purity, and spirituality and provided an alternative model of masculinity.

Even though this review of masculinities in the medieval period is a patchwork of sources from various geographic areas and time periods, it elucidates the complexities of gender performances available to men during this era which were influenced by personal factors, and social and religious affiliations. Popular narratives often present medieval men through idealised (dominant) masculine archetypes; however, an examination of historical sources reveals that multiple possibilities were indeed available to men in configuring their gendered identities. This research also shows that in the medieval period there were multiple ways to configure, deploy, negotiate, and contest manhood, which was achieved through occupational enterprise and activities with an undertone of violence such as training for battle, amongst other things. The current research is interested in how such variations in the deployments of masculinities in 12th to 13th century Alba Iulia became embodied in archaeological bodies as observed through skeletal indicators of health. To achieve this, a theoretical framework was developed which allows the interrogation of men's gendered performances through the examination of skeletal remains.

Chapter 3: Men, Masculinities and the Body

The biocultural model was described in Chapter 1, and some insights offered about how it may have contributed to essentializing men in bioarchaeology. Historically, uses of the biocultural approach are best exemplified by studies examining the impact of various stressors on populations. The biocultural model remains a very robust and flexible framework that can be modified, reconfigured, and built upon (Martin et al., 2013). Agarwal and Glencross argue that social bioarchaeology should be anchored in the biocultural model because it "emphasize[s] the synergistic relationship of social, cultural, and physical forces shaping the skeleton" (Agarwal & Glencross, 2011a, p. 1). The theoretical framework constructed below in this chapter should be considered an adaptation of the biocultural model for the current study—a modification arising from trajectories of contemporary exploration of gender in bioarchaeology (see Chapter 4). Building on the biocultural model allows to build on the biocultural syntheses, or population level studies that have come before rather than considering them as obsolete, uninformative, or essentialist. The framework proposed here will enable the study of men as gendered subjects in the past, still situated in a bio-social-environmental complex, but with in-depth exploration of the 'cultural black box' of the biocultural model using feminist-inspired social theory. This can be achieved by using recent developments in social theory including embodiment theory and gender identity theories, including masculinity theories.

3.1. The study of men and masculinities

Sociologists have critically explored men's gender, and how constructions of masculinities are implicated in men's behaviour (Carrigan et al., 1985; Connell, 1995, 2005; Whitehead, 2002). The sub-subfield of Critical Studies of Men has emerged focusing on men's health by examining men's gendered behaviours and their health outcomes (Addis & Mahalik, 2003; Courtenay, 2000b, 2000c, 2011; Mahalik et al., 2007; Robertson, 2007). The first part of this section reviews approaches to masculinity which describe it as a role situated in a male body. Such an approach equates masculinity with being biologically male, and argues that social, political, and power differentials between men and women are natural elaborations of biological sex characteristics (Connell, 1995, 2005). Next, more recent approaches are reviewed that focus on masculinity as a social construct. These theories considering masculinity as socially constructed which allows researchers to destabilise the link between sex, gender, and the relationship between male bodies and masculinity

(Whitehead, 2002; Whitehead & Barrett, 2001a, 2001b). The latter approach provides an avenue to explore the variability in the performances of masculinities in particular social settings.

3.1.1. Masculinity as a biological role

Masculinity, as studied in social sciences including anthropology, sociology, psychology, has moved through three prominent phases, largely mirroring theoretical shifts within feminist thinking, drawing on theories from functionalism, structuralism, and post-structuralism (Whitehead & Barrett, 2001b). The first wave of studies exploring masculinity heavily utilised concepts from functionalist role theory (Connell, 1995). Role theory considers gender as socially prescribed, according to which men act out roles which society sets for them due to their biological maleness. According to sex role theorists, male identity is defined by biological difference, by the male-female dichotomy. Males are identified or defined by masculine roles which are unlike the roles of females. The roles of men and women are driven by cultural norms, and male identity is understood as internalised roles of cultural values acquired through socialization (Connell, 2005, p. 5).

A central element in sex role theory is the process of socialization that produces stable adult personalities. Socialization is considered the process through which males and females are conditioned into appropriate behaviours for their sex (Haywood & Mac an Ghaill, 2003, p. 7). This process is central to a functionalist view of society as a web of interrelated parts. Men serve a role in this natural web, which is different but complementary to the roles served by women. Inequalities between men and women are considered a natural phenomenon because they are based on the doctrine of innate sex difference (Connell, 2005, p. 21). The division of labour, for example, is understood to serve the collective aims of various social groups (Whitehead, 2002, p. 18). This sexual dichotomy is justified because functionalism presents it as a natural phenomenon necessary for the natural and smooth functioning of society (Whitehead, 2002, p. 18). Functionalists would argue that a society that is harmonious and peaceful is one in which individuals carry out their normative roles that society ascribes to them. This was an attractive idea for 20th century archaeologists interested in culture because society as a web of inter-related parts held a reductive promise of understanding entire cultural systems by understanding its sub-units (Trigger, 2006). As Whitehead (2002, p. 18) writes, “The idea that women and men function as socialized beings at some subliminal but essentially biological level for the wider benefit of an 'ordered society' is, for many, a compelling and seductive notion."

The first attempts to create a social science of masculinity were built on this concept (Connell, 1995). Masculinity was considered to be an internalised (male) sex role. With relation to this definition of masculinity, polarised norms and expectations between the sexes were central. Because socialization was central to the sex role theory approach to masculinity, theorists argued that the degree of masculinity was quantifiable by measuring the level of socialization (Haywood & Mac an Ghaill, 2003). As Haywood and Mac an Ghaill (2003, p. 7) write, "…[w]ithin this perspective, masculinity is subject to objective and unproblematic measurement through an index of gender norms". Therefore, sex role theorists tended to assume that an ahistorical gender essence exists which is quantifiable and measurable. It viewed subgroups of men, such as gay and effeminate men, as not having enough masculinity. It explains this deficiency either in terms of biology (e.g., not having enough testosterone) or socialization (e.g., inadequate role models; Haywood & Mac an Ghaill, 2003).

Sex role theories in social sciences are considered by most contemporary social scientists to have fallen out of favour, due in part to articulations of gender, largely by feminist theorists, as a socially constructed. However, there remains a body of work on men and masculinities that could be labelled as ‘masculinist’. Masculinism is the dominant ideology or discourse which serves to naturalise male domination (Alexander, 2011). Masculinist studies draw on naturalizing discourses on the differences between men and women and emphasise the natural differences between them. They stand in opposition to basic feminist principles espoused by pro-feminist social constructionist masculinity theorists. Masculinist approaches share a belief in the essential nature of men and women, and argue that men and women are intrinsically different. They argue for sex specific character traits which make them suited to occupy separate positions in society (Aslop et al., 2002, p. 134).

Sociobiology and evolutionary psychology seemingly naturalise sex differences in this way. Sociobiologists posit that social organization is an extension of biological organization, and a result of evolutionary processes. They point to various biological markers to explain and justify social organization, such as genetics, and hormonal and anatomical differences. Dawkins, for example, in *The Selfish Gene* (Dawkins, 1976) argues that men's genes program their bodies to act in ways as to maximise their reproductive potential. This not only makes men more prone to philandering, adultery, and violence but justifies and naturalises such actions. Women on the other hand, due to their large investment in child rearing, are seen as more selective and limit their mate choices. Similarly, evolutionary psychologists argue that psychological and behavioural, and consequently social, differences between men and women observed, are explainable as a result of natural forces of evolutionary selection (Miller, 2000). Such accounts offer naturalizing discourses about differences in gendered behaviour and social structures resulting from gender difference, such as the division of labour. They allude to a singular notion of manhood, a universal male nature, and a male body which transcends time and space. They describe an essential maleness, an inner masculine core, and an embodied masculinity located in a biologically male body, which is irrespective of culture, time period, and personal characteristics or identity (Alberti, 2006; Aslop et al., 2002).

3.1.2. Masculinities as socially constructed

In the 1980s sex role theories came under criticism for two main reasons. First, that they were essentialist; and second, that they failed to fully grasp issues of power. Social constructionist masculinity theorists charged sex role theories as essentialist because they fixed male identity in biological maleness (Connell, 1995). Social constructionists argued that gender identity “is not fixed in advance of social interaction” (Connell, 2005, p. 25). They considered gender, masculinity, and all social identities as socially constructed. This view considers that men and women behave in certain gendered ways not because their role identities are based on biology or psychology, but because of culturally constructed ways of behaving as masculine or feminine that are learnt from culture. Social constructionism in general argues that meaning is created through social interaction, through behaviour and speech. From this perspective, identities (including gender and masculinity) does not reside in individuals, but emerge through social interactions. Thus, social constructionists consider gender not an innate fact, inherent in individuals because of their biological sex, but as something which emerges through social interaction (Connell, 2005). While sex role theories explained the plurality of masculine roles as variation between cultures, social constructionism equipped scholars to explore the variation of masculinities within cultures (Aslop et al., 2002, pp. 137-138).

Social constructionist theorists also charged gender role theories as inadequate at exploring masculinity because they failed to recognise political differences between men and women, and as Connell (2005) has argued, between various groups of men. The issue of gender power dynamic is a central tenet of feminist philosophy, and scholars studying men from a feminist perspective charged sex role theory as being politically complacent (Connell, 2005, p. 23). Feminists argued that men, as a political category, are the main beneficiaries of material and ideological inequalities. Using the concept of patriarchy, they located men’s power hierarchically, which represented the universal subordination of women. Pro-feminist scholars studying men (re)positioned the study of masculinity accordingly, to considering power differentials in gendered relations as central. Gender dynamics were explored not just between men and women but among various sub-groups of men. Thus, theories of masculinity emerged which considered the possibility of multiple *masculinities* (Connell, 1995, 2005).

The notion of multiple masculinities first explored through the concept of hegemonic masculinity (Connell, 1995). Introduced by Connell and colleagues in 1985, its main tenet was that a culturally dominant construction of masculinity exists. This in itself was not a novel concept, however, it simultaneously introduced the idea of subordinate masculinities (Connell, 1995). According to Connell (1995) hegemonic masculinity was not considered the most common form of masculinity, but an ideal type. It is the type portrayed by popularised versions of masculinity such as historical heroes and fantasy figures (Aslop et al., 2002, p. 140). The hegemonic type is not embodied by all men, or even by most men; as Connell puts it "[h]egemony is a question of relation of cultural domination, not of head-counts" (Connell 1993, cited in Aslop et al., 2002, p. 140). The idea of hegemonic masculinity allowed for the categorization of men into various masculine types, and the exploration of power relations between and among groups of men. In her later works Connell often defined gender as practices and behaviours that categorise men and women as masculine or feminine: "Gender is a social practice that constantly refers to bodies and what bodies do" (Connell, 2005, p. 71). Therefore, social constructionist conceptualizations of gender are ones in which actions, practices, and behaviours constitute gender, and it is not something that is fixed, biologically determined, or passively internalised through norms (Connell, 1995).

3.1.3. Masculinities as fluid and dynamic

Actions, practices, and behaviour are central to post-structuralist approaches to studying men that emphasise gender and masculinity as a discursive practice (Whitehead, 2002). Post-structuralist theories, especially those of Foucault (1978) and Butler (1990, 1993, 2004), offer ways to link subjective masculine identities to social action and discursive power relations. These approaches have sought to understand historically situated (dynamic) male subjects, and have moved away from meta-narratives of universal maleness and the understanding of male power as emanating from a biological essence or ideological social structures (Whitehead, 2002).

Many scholars engaged in the critical studies of men have been heavily influenced by Foucault's idea of discourse (Whitehead, 2002). Discourse, as Foucault conceptualises it, is different from that used in linguistic analysis. In post-structuralist terms, discourse "refers not only to both language *and* practice, but also signals the means by which the subject is enabled and marked as an *individual*, the individual being a product of discourse" (Whitehead, 2002, p. 102). This Foucauldian view of subject formation sees individuals as discursively produced through the constant negotiation of norms and subjectivity in contradictory processes of power (Berggren, 2014, p. 235). Thus, it also acknowledges that such subject formation is a political process but without linking power to ideological structures that are unchanging or static or which emanate from a fixed and specific source. In the case of male power, it is not seen to emanate from biological maleness, but is said to be discursively produced through public discourse and actions which produce social systems of value (Gutterman, 1994).

3.1.4. Performance of contemporary masculinities

The view of subjective formation of the male self which is dynamic and contextual, has given rise to a great number of studies that focus on the performances of masculine subjectivities (Berggren, 2014). Contemporary studies examining masculine performances have focused on athleticism, aggression, and the concealment of emotions, for example in relation to male sports activities (Messner 1992, as cited in Schrock & Schwalbe, 2009, p. 282). Historically, sports have been extremely sex segregated (Messner, 2016). Discourses surrounding male sports and masculinity involve physical and mental toughness. In these contexts researchers have observed an expectation of regulation and display of emotions, that men should not express pain but remain stoic (Sabo, 1994). Policing behaviours and emotions are common with team sports activities (Kimmel, 2008; Messner, 1992; Schrock & Schwalbe, 2009). Arguably, some of the most important discourses surrounding masculinities involve aggression and violence. Contemporary discourses about boyhood encourage boys from a young age to engage in play which involves popular warrior or hero discourses (Schrock & Schwalbe, 2009). Violence is also embedded in team sport activities where aggressive play is praised and passive play is demeaned (Messner, 1992).

A body of research on men seeks to understand the deployment of masculine performances in relation to power differences. Based on Goffman’s (1956) work on the presentation of self as a performance and Connell’s theory of multiple masculinities (Connell, 1995, 2005), these interactionist approaches focus on how some masculine performances empower some men yet simultaneously disempower others. Kimmel (2008) and Pascoe (2012) examined how masculine performances lead to power and status differences between men. They explored the construction of masculinities, especially during adolescence, through policing behaviours. Policing behaviour of one another's masculine performatives are often in the form of deploying discourses that challenge one’s masculinity using emasculating insults (Kimmel, 2008, 2009; Pascoe, 2012). These observations by Kimmel (2008, 2009) and Pascoe (2012) are not unlike those of sex role theorists’ conceptualizations of attitudes and behaviours that demonstrate masculinity such as Brannon’s (1976) summary of the main ‘rules’ of the male ‘script’: ‘no sissy stuff’, ‘be a big wheel’, ‘be a sturdy oak’, and ‘give 'em hell’ (dsicussed in Kimmel, 2008; Messner, 1998). According to this, masculinity is a rejection of behaviours considered feminine, the demonstration of power and status, the demonstration of confidence, independence and self reliance, and finally the demonstration of aggression, daring and violence. Or as Springer and Mouzon (2011) argue, the concealment emotions, success, independence, and toughness. The sections that follow discuss how such masculine performatives are deployed and examine how they create power dynamics and inequality among men, especially through their deployment through a physical body via physical acts, actions, ways of moving and ways of taking up space.

3.1.5. Masculinities and health outcomes

The exploration of men's performances of masculinities opened the door for scholars to examine the relationship between men, gender, and health in ways that were not confined to biological explanations. As more scholars studied the social construction of masculinities from a performance and interactionist perspective, it became clear that many of the performances considered 'masculine' in contemporary western societies have a great deal to do with assuming risks or being at risk—physically and socially—that potentially adversely affect health outcomes (Courtenay, 2011; Robertson, 2007; Robinson & Robertson, 2014). In the 1990s, researchers started to focus on men's health issues which were related to constructions of masculinities and the consequent risk-taking behaviour. The field of 'men's health' emerged with the goal of critically examining men's health by studying men's *gendered* behaviours in relation to health outcomes (Lloyd, 1996). Early scholars in this field opened the debate over the possibility that differing health outcomes between males and females, that were long thought to be outcomes of biological predispositions, were greatly influenced by gendered social norms, expectations, and discourses (Schofield et al., 2000). Using Connell's idea of multiple masculinities, health differences between groups of men (social class, ethnicity, *etc.*) were also investigated. Closer examination of the risk taking behaviours and the stoicism in men was linked to increased likelihood of negative health outcomes in mental health, disease, injury, and death (Courtenay, 2000a).

Extensive work by Courtney (2000a, 2000b, 2000c, 2003, 2011) has critically examined the association of men's masculine performances and their effect on health outcomes. He argues that men's masculine performances, such as the ones cited above, increase the likelihood of negative health outcomes. Courtenay (2000a) draws upon a large body of evidence and datasets to demonstrate that males of all ages engage in behaviours that increases their risk of morbidity and mortality over females in the same age groups. His data sources point out that:

> "death rates for unintentional injuries, suicides, and homicides are 2.5 to 4.5 times higher among men than women... men have higher death rates for all 15 leading

> causes of death ... The incidence of seven of 10 of the most common infectious diseases in the United States is higher among men than among women... Men are also more likely than women to suffer severe chronic conditions and fatal diseases and to suffer them at an earlier age. Under age 65, for instance, nearly three out of four persons who die from heart attacks are men" (Courtenay, 2000a, p. 82).

A more recent study by Pinkhasov and colleagues (2010) discovered the same pattern of gender disparity regardless of geography, race, or ethnicity in the United States. Their review of the data found that more men die from the leading 12 of the 15 causes of death over women. Causes of death with a mortality ratio not greater in men are cerebrovascular diseases, hypertension, and dementia. They further indicate and interesting pattern of women having higher morbidity rates for some diseases, but lower mortality rates, contributing to the gender disparity in modern mortality trends.

Courtenay (2000b) pointed out that such alarming statistics about men's health are likely linked with men's gendered behaviours. In a comprehensive study of contemporary health statistics, he reviewed 30 behaviours that men are more likely to engage in than women that make them more vulnerable to of injury, disease, and death (Courtenay, 2000a). For example, discourses about men being stoic about pain result in under-accessing healthcare which consequently increase adverse health outcomes. Cultural ideas about masculinity, amongst other things, influence unhealthy eating habits, make men more likely to abuse substances such as tobacco, alcohol, and street drugs. Males of all ages were found to be more likely to engage in activities that are risky or physically dangerous (Courtenay, 2000a, p. 98), for example, reckless driving, drinking and driving, not using safety belts and helmets, risky sexual activities, dangerous sports, engage in violence, fighting, use of weapons and criminal activity, and working dangerous jobs (Courtenay, 2000a, pp. 98-108).

Courtenay research has led others to question why men are more likely to take on risky behaviours that increase their chances of physical injury, disease, and death. While some researchers maintain that differential health outcomes in males and females result from biological predispositions (Marais et al., 2018; Regan & Partridge, 2013), others have questioned this assumption pointing out that men are not simply at greater risk of premature death solely due to genetic or physiological predispositions. For example, Bonhomme (Bonhomme, 2009) has questioned whether the gender longevity gap is due to biology or to social factors that influence men’s behaviour. The longevity gap observed in western societies—that men have a shorter life expectancy than women—has often been considered a taken for granted biomedical fact. The reasons for the observed gap are multifactorial, and possibly involve genetic (e.g., Y-chromosome) and physiological (e.g., testosterone) influences (Marais et al., 2018; Regan & Partridge, 2013). However, an increasing number of researchers are beginning to understand cultural influences affecting life expectancy, which amongst other things, includes behavioural and environmental factors (Newman & Brach, 2001; Schünemann et al., 2017). Bonhomme (2009) points to various non-biological determinants of mortality, some of which are linked to gendered activities, such as risks involved with occupational hazards and reduced-access to healthcare. He argues that a deterministic view of gendered differences in health outcomes, limits our understanding of the cultural factors that may be involved in the health disparities.

In summary, a large body of research has demonstrated that activities involving risk taking contribute to injury, disability, and death of males of all ages from boyhood to old adulthood (Courtenay, 2000a, 2011; Robertson, 2007). Masculine discourses available to men are used to assert manhood and power, and deployment of some of these idealised masculine behaviours, positions men in a way as to concurrently negatively affect their health outcomes (Courtenay, 2000c). Adherence to these types of dominant masculine ideals often means the rejection of culturally defined non-masculine, or feminine behaviours (Kimmel, 2008). In many Western societies, even with access to many alternate form of non-dominant masculinities, which are not as detrimental to health outcomes, many men may choose to avoid them for the fear of being socially ostracised, ridiculed, disgraced, or even physical hurt (Kimmel, 2009). As dominant ways of male behaviour in patriarchal Western cultures are rewarded, concurrently they serve to reinforce and reward men's unhealthy habits and behaviours. In turn, unhealthy ‘masculine’ behaviours produce and reproduce social structures that maintain gender inequality.

The challenge for bioarchaeologists is to interrogate men’s gendered behaviour from archaeological skeletal remains in ways that do not rely on universalist discourses about masculinity to explain past behaviours, but approach it as contextual and dynamic. In this thesis the definition of masculinity that is adopted is one in which masculinities are flexible, fluid, pleural, and contextual; as we cannot argue that any of the behaviours that contemporary researchers observe are universally applicable to all men in the past. We must take a multi-disciplinary approach to understand masculine discourses in the past and understand how men may have engaged with them and deployed them performatively, and how this is reflected in their health outcomes. By interrogating skeletal indicators of injury, health, and activity in the past, we may discover embodied gendered life histories. The next section will develop a framework which enables the bioarchaeological investigation of embodied gendered differences in archaeological skeletal populations using post structuralist approaches to the gender performativity and interpretive archaeological approaches to the body.

3.2. Embodiment and the body as material culture

There has been a general rise in the interest in archaeological engagement with the body and the concept of embodiment at the turn of the century (Joyce, 2005). Archaeologists became increasingly interested in bodies and how human experiences in the past could be examined by thinking about humans in the past as corporeal agents experiencing their world through physical senses (Hamilakis et al., 2002). This was an outcome of a general trend in archaeology that saw an interest in increasingly smaller scale phenomenon, including individuals and their life experiences (Dobres & Robb, 2000; Dornan, 2002; Fowler, 2004). This strand of thought was heavily influenced by the philosophy of phenomenology concerned with the body as the site of a lived experience. Within broader archaeological contexts such interest resulted in the studies of body representation, body ornamentation, and bodily practices (Joyce, 2005). Bioarchaeologists were perfectly positioned to engage with such theoretical concepts because they directly studied human ‘bodies’ belonging to individuals. However, such engagement did not happen until certain theoretical positions were set in place, namely a shift in conceptualising mortuary skeletal remains as bodies and how these bodies fit into the larger archaeological lived experience project.

Even though bioarchaeologists worked with skeletal remains, these remains were not thought of as ‘bodies’ until the beginning of the century. Epidemiological approaches in bioarchaeology considered individuals in skeletal collections as mere data points, rather than once living individuals. Consequently, the engagement with the embodiment literature in bioarchaeology was fairly delayed, compared to other subfields of archaeology. A recent rise in the interest in individuals (e.g., osteobiographies; (Robb, 2002; Saul & Saul, 1989; Stodder & Palkovich, 2012)), coupled with an interest in engagement with social theory in bioarchaeology (Agarwal & Glencross, 2011b; Sofaer, 2006a) has legitimised descriptions and discussion of individual ‘bodies’. This was catalysed by Sofaer’s (2006a) reorientation of archaeological individuals not as skeletons but as ‘body’ that belonged to a once living individual, in her book *The Body as Material Culture*.

Subsequent to this publication, the last decade has seen increased engagement with social theory and interpretive archaeologies by a growing number of bioarchaeologists (Agarwal & Glencross, 2011b; Baadsgaard et al., 2012; Geller, 2017; Sofaer, 2006a; Wesp, 2017), which has led to what Joyce (2017) has described as the consolidation of a ‘new bioarchaeology’. Bioarchaeologists are now interrogating human remains to explore theoretically sophisticated understandings of identity and difference the past (Knudson &

Stojanowski, 2009). Much of the theoretical activity has been inspired, influenced, and facilitated by Sofaer's (2006a) concept of the body as material culture. Sofaer reconfigured archaeological skeletal remains from mere skeletal elements that are subjects of scientific investigations, to artifacts that represent past individuals, bodies, and past agents. Scholars who follow Sofaer, no longer consider the archaeological human body solely a product of biological and environmental processes (including culture) acting upon the body, but consider it a result of a lived experience of a corporeal agent. This is a theoretical re-orientation from that used in prior biocultural conceptualizations which views culture as something extrasomatic or ideological. The concept of culture as extrasomatic is the idea that it is merely one aspect of the environment which shapes the patterning of skeletal indicators observable in skeletal assemblages.

The new engagements with social theory have allowed novel ways of approaching the impact of culture on the skeletal body. Particularly, engagement with embodiment theories, has led to new axes of analysis and insights into the social lives and social identities of past people (Joyce, 2005). Scholars have recognised that the body is as much a cultural artifact as other archaeological materials—its contents and form shaped and moulded by the actions of the persons who inhabited them (Sofaer, 2006a). The life histories of living bodies (trajectories of its physiological composition and its physical morphology), and their final shapes and compositions upon death, is not solely determined by a series of genetically pre-programmed biological events, nor is it shaped by cultural forces outside of individuals, but is a product of body practices including bodily gestures, comportment, habitual movements, and consumption practices of individual agents or subjects (Wesp, 2017). These gestures, comportment, and movements are influenced by subjective realties and subject positions of intersecting and fluid identities and powerful social dynamics. Thus, skeletal bodies as archaeologists discover them, contain a life history of *sedimented subject positions* recorded in bones, through an ontological process via the body's biological plasticity.

Human bodies respond to external stimuli which play an important part in its developmental trajectory. This has led to scholarship about the social construction of bodies, not only in a constructivist sense—how bodies are given meaning socially, or that bodies cannot exist outside of a social realm—but also in the realist sense, where the material make-up of the body is influenced by cultural discourses. As Sofaer argues, "[t]he skeletal body is culturally constructed – moulded by action – but this is in the most fundamental material way" (Sofaer, 2006a, p. 124). How are the final material characteristics of the body, especially the skeletal body, influenced by social norms and discourses, and specifically social agents or subjects? In other words, how does culture imprint itself on the body?

The incorporation of 'culture' into skeletal bodies has been at the forefront of recent bioarchaeological theorization. Spring boarded by Sofaer's book *The Body as Material Culture* (Sofaer, 2006a), many social bioarchaeologists (Agarwal & Glencross, 2011b) are taking seriously the influences of culture, identity, and agency on skeletal tissues. In espousing her thesis, Sofaer (2006a) explains that human bodies, including bones, are not stable tissues. All tissues of the body are living tissues, in constant turnover, remodelling and re-materializing over a lifespan. This concept is central to her idea of the body as material culture, which views it as a plastic entity shaped in large part by cultural practices. Thus, bodies become analogous to other archaeological material culture which derive their final forms through human action, based on cultural ideas about what those objects mean. Therefore, human bodies are shaped by what individuals do with them and do to them.

Sofaer argues that through biological plasticity, life-histories become sedimented in bodies, including the hard tissues. The life-histories, or rather lived-histories, or lived-experiences, of individuals, physically shape their body's materiality—its chemical, physical, and morphological properties. She refers to this process as *incorporation*: the physical incorporation of a lived experience into bodies. There are two types of incorporation acting on skeletal bodies: those that are overt and obvious and those that are covert and inconspicuous. The more obvious bioarchaeological examples include cultural practices that modify the physical appearance of the body. These are easy to recognise by bioarchaeologists because of their overt deviations from the expected forms of skeletal morphology. Examples include foot binding (Lee, 2019), head shaping (Tiesler, 2014), intentional dental modification (Burnett & Irish, 2017), to name a few. However, many other cultural practices make their mark on bodies that are less salient to bioarchaeologists, and require special scientific investigative and theoretical approaches to identify. These include changes to skeletal tissues as a result of everyday activities—repetitive, habitual, bodily movements that individuals perform over their life course. Examples include changes to skeletal chemical composition due to diet (Katzenberg, 2008) or morphological changes due to activity patterns (Jurmain, 1999). A more recently explored possibility is the incorporation of social identity, including gender identity as an aspect that may become incorporated in the body through its plasticity (Agarwal & Wesp, 2017; Sofaer, 2006b, 2013; Zuckerman, 2020).

Conceptualising gender identity as a sedimented embodied property of the body allows for novel ways of interrogating gender from archaeological bodies. It lays the groundwork for the possibility of examining gender performativity from archaeologically recovered human bodies, without falling back on gender proxies such as funerary artifacts (Sofaer, 2006b). Sofaer's approach laid the groundwork for the possibility of examining gender from archaeologically recovered human bodies, without falling back on such proxies. However, it still considered gender as a 'social institution' that impacts, or imprints itself upon the body (Sofaer, 2006a, p. 124), rather than recognizing it as a discursive process. A 'social institution' approach tends to maintain the dualism between sex and gender, in that it views gender as an ideological force that imprints itself on the sexed body, rather than viewing the social and biological aspects of sex and gender as being co-created material-discursively. Using performativity theory allows us to view gender as something that is created simultaneously as it is being deployed. Performativity links the discursive and the material. It is the link between gender and sex, it is both gender and sex. According to performativity theory, there is no gender prior to its deployment via physical movement and action, and there is no sexed body without it already not being gendered through performative discourses.

3.3. Gender performativity and the body as material culture

Sofaer opened the floor for the debate about the way culture influences the body, however little work has been undertaken on how specific identities / subjectivities / discourses materialise in the archaeological body. This section explores the usefulness of Judith Butler's (1990, 1993, 2004) concept of gender performativity in understanding how gender identity sediments in the material body. In essence, how discourse produces bodies, how it influences the materiality of the bodies and therefore produces material bodies in which discourse itself become sedimented resulting in material-discursive bodies is explored. Butler's work, described in detail below, emphasises gender as a corporeal practice. Through the concept of performativity, gender becomes a set of actions, and not something subjects possess. Accordingly, the innateness of gender does not materialise in the body, being one gender does not create a gendered body. It is the performativity of gendered discourses, or corporeal actions that have the potential to materialise in bodies. Gendered bodies come about through repeated citation of gendered discourses. Following Foucault, Butler views discourse, gender, and performativity as power laden, never separate from power relationships. Consequently, power relationships embed themselves into material or biological bodies through plasticity and material bodies are marked by power relations. Actions, movements, and postures which are performatively (discursively) enacted, produce bodies in specific ways through the biological plasticity of human tissues. Therefore, it is performativity through which gender becomes part of the ontogenic process. Moreover, because gender performativity is always a discursive deployment, gender performatives are always inscribed with power relations, and it is through this process that power relations are embedded in the ontogenic process and incorporated into the body. Such a view of the gendered body also acknowledges that the body is not simply a passive medium of external power relations. Bodies are an integral part of the gender process, and through performativity, become marked by the gender identities and power relationships.

Performativity of gender, as espoused by Butler, builds on post-structuralist ideas of discursive gendered subject formations. Through her work in numerous writings including the seminal books *Gender Trouble* (1990), and *Bodies that Matter* (1993), Butler uncouples the apparently logical and seemingly natural relationship between sex and gender. Furthermore, she questions the binary nature of gender and the way this binary mirrors biological sex categories. Her work has been instrumental in dispersing essentialist ideas about gender. Although seldom referred to by bioarchaeologists, this important idea can provide the critical link between material bodies, and discursive identities and power structures, as discussed below.

In *Bodies that Matter* and later in *Undoing Gender* (2004) Butler develops the idea that gender is not a natural out come of biological sex, but it "…is in fact a highly coded set of behaviour intended to assert sex" (Butchbinder, 2013, p. 53). Men and women are discursively compelled to act in ways appropriate for their sex in order to be seen as male or female. As Butchbinder (2013, p. 55) cogently puts it: "…one does not act in a masculine or feminine manner because one is male or female; rather, one acts in such a manner in order to be seen (by oneself as well as by others) as male or female." Butler (1993) refers to these gendered actions as the *citations* of gender, and argues that they are discursively imposed. What is imposed is a constant pressure for individuals to cite their gender which she calls *performativity*.

Gender performativity is the acts, behaviours, and speech, that are appropriated by discourses to be suitable for men and women in given situations. Butler borrows the idea of performativity from linguistic theory of speech acts (Butler, 1988). According to linguistic theory: "Performative acts are forms of authoritative speech: most performatives, for instance, are statements that, in the uttering, also perform a certain action and exercise a binding power" (Butler, 1993, p. 225). Performative speech acts are therefore declarations which call into being that which they name (Brickell, 2005, p. 26). An often used example is the performative used in western marriage ceremonies of the utterance of 'I pronounce you…'. This is a performative speech act because the act of its utterance is also an undertaking of the meaning of the words, in that the word becomes binding (Salih, 2007). To say that gender is performative means that gender becomes an undertaking through acts. Moreover, to undertake the acts or actions that which are the performatives of gender also name the thing (gender) which they are said to perform.

A phenomenological or theatrical approach to performativity allows not only speech acts to be performative but also physical acts: movement and gestures. For Butler, speech acts and physical acts are closely related because the act of speaking is a physical undertaking (Butler, 1990, p. xxv; 1997). Therefore, speech may in some ways be said to be the intersection of language and corporeal movement. However, language may be expressed fully corporeally. Words, concepts and feelings may be expressed without speaking as non-verbal communication or *body* language (gestures, postures, movement). In the paper titled *Performative Acts and Gender Constitution*, Butler (1988) took a phenomenological approach to explore the production of gendered subjects through constituting acts of subjective experience. She argued that phenomenological theory of 'acts' seeks to explain the "mundane way in which social agents *constitute* social reality through language, gesture, and all manner of symbolic social sign" (Butler, 1988, p. 519). Thus, she argues that social agents become, and are always in the process of becoming through performativity. For example, gendered identity is created over time and is enacted through a 'stylized repetition of acts' (Butler, 1988). Through this repetition, gender as set of acts, can be said to be *rehearsed*.

This rehearsal or repetition is central to Butler's idea of performativity and is a concept that originates in Victor Turner's ideas of ritual. In a structuralist sense repetition is a "reenactment and reexperiencing of a set of meanings already socially established" (Butler, 1990, p. 178). Also drawing on the Derridean notion of *iterability*, Butler sees repetition as a discursive process, in which the act informs discourse as much as discourse informs the act itself. The act produces discourse as much as discourse produces the act. Thus, with respect to the performativity of gender the constant repetition, iteration, and/or re-citation, brings gender categories into being. The acts are not simply expressions of culturally established gender categories, the acts themselves bring the categories into being. The Derridean idea of iterability "…also implies that every act is itself a recitation, the citing of a prior chain of acts which are implied in a present act" (Butler, 1993, p. 244). This is Butler's anti-essentialist position, in that "these categories are not imported into culture or society from the 'nature' outside but rather are fundamentally shaped through discourse" (Brickell, 2005, p. 26).

In *Gender Trouble* Butler (1990) argued for the social construction of not only gender but sex as well, in that sex is socially constructed as much as gender—a position which she clarifies in *Bodies that Matter*. According to Butler, human bodies are assigned gender from the moment they are born and therefore there is no sex that is not already gendered. For example, from the moment 'It's a boy!' at birth is uttered, it initiates a process of 'boying' the male subject (cf. Brickell, 2005, p. 26). In other words, for Butler there is no 'natural body' that exists prior to its cultural signification. Accordingly gender is not something one is but is "something one does, an act, or more precisely, a sequence of acts, a verb rather than a noun, a 'doing' rather than a 'being'" (Salih, 2007, p. 55). In the first chapter of *Gender Trouble* Butler (1990, pp. 43-44) states: "Gender is the repeated stylization of the body, a set of repeated acts within a highly rigid regulatory frame that congeal over time to produce the appearance of substance, of a natural sort of being." As such, performativity is the "the discursive mode by which ontological effects are installed" (Butler, 1994, p. 33).

Conceptualizing gender as a performative and discursive undertaking puts bioarchaeologists in a position, from which—first and foremost—they can think about gender as something people do rather than something people are. It also allows then for the understanding of gender as a series of habitual bodily actions, movements, comportment, and postures, that are repeatedly cited over-and-over during the life course. Traces of these gendered activities of past social agents may become sedimented in, or marked on, the skeletal bodies, through the process of biological plasticity. These traces may become observable to bioarchaeologists through scientific investigation, such as chemical, morphological, or metric analyses. This allows for gendered exploration of skeletal bodies without the need to locate gender in proxies, such as mortuary artifacts.

Moreover, the concept of gender as performative also introduces the idea of discourse to bioarchaeology which offers the potential to resolve ontological gap between culture and action. Previous conceptualizations of gender, even though they acknowledged gender as a process, asserted gender as a social institution. This gives the impression of gender as an ideological structure that somehow imprints itself on biological bodies. Alberti argued that, "[i]n such a formulation, gender is culturally and historically specific, subject to change and manipulation, while the body remains a transcultural, transhistorical common denominator—a blank slate onto which culture is inscribed" (Alberti, 2005, p. 109). This views the body is a passive medium onto which cultural meanings are inscribed. However, a performative approach to gender acknowledges that gendered body actions both deploy and simultaneously create discourses about gender in an iterative way. Therefore, the body has an equal role in creating the gender which it deploys through performativity. This grounds the concepts of agency, personhood, and subjectivity in discourse instead of thinking about them as 'free floating' or products of ideological structures. This links gender identity in the past to larger social structures that are entangled in the creation and deployment of discourses that influence and constrain gender performativity.

Using performativity to understand bioarchaeological bodies builds on Sofaer's (2006a) understanding of gender as an ontological process that is constantly created throughout the life course. Since performativity is a discursive deployment of gender identity it not only helps us understand how gender identity can be incorporated into skeletal remains, but also helps integrate analysis of social power dynamics from gendered interrogations of skeletal remains. Since discourses are always power laden and political, gendered deployments of such discourses are also always a political undertaking. Thus, the resulting gendered bodies become marked by power and politics.

3.4. Embodied masculine performatives

Based on a Butlerian approach to gender performativity, it is suggested that masculinities are then those action, movements, gestures, speech, and anything corporeal, which are part of a masculine performative repertoire. Masculinities become not something men have by virtue of being declared male or having a male body, it is something that emerges through men’s interactions with the social and physical world, including their own bodies first and foremost. Deploying aspects of this male gendered repertoire seeks to assert one's biological maleness in an effort to be seen as male, with reference to dominant cultural discourses of ‘maleness’ for specific cultures and time periods.

Discourses surrounding men's bodies create the performativity of gender by appropriating ways of acting, moving, and taking up space to those performatives which are acceptable in particular places and at particular times (Whitehead, 2002). The resulting acts, actions, movement, comportment can then be said to be ‘discursive materialities’. They are discursively informed but executed through the physical body in physical space. The movement can be considered material as it is the movement of the physical body. However, the movement is simultaneously discursive as it is permitted by and constrained by discourses. Men and women move their bodies differently which are not entirely controlled by biology (Whitehead, 2002). There are certain characteristics or styles of bodily movement which are considered masculine or feminine. These movements are not entirely a function physical differences between male and female bodies, as some have suggested (Young, 1980). Discourses about how gendered bodies should, or are allowed, to do or move, come to the fore in the performativity of gender. Discourses about masculinity shape how men move their bodies in order to be seen, or assert themselves, as male or masculine, and also to challenge other notions of masculinity (Whitehead, 2002). This includes movements which masculine discourses disallow, because they are considered unmasculine. These include how gendered bodies move in space or take up space, and also what a body is physically subjected to. That masculine performatives are physical movements in space which emerge by deploying discourses about masculinity via the animation of physical bodies makes masculinity simultaneously material and discursive or *material-discursive* (Hearn, 2012, 2014).

How such masculine performatives are deployed, and how these performatives come to the fore, are the subject of a large body of contemporary literature on masculinity. The contemporary consensus on masculinities by masculinity theorists, is that various forms of masculinities are socially constructed ways of behaving that are not anchored to, fixed in, or flow directly from biologically male bodies. Schwalbe (2005) argues that 'acts of manhood' are performed in relation to an ideal form of masculinity, akin to Connell's hegemonic masculinity. This ideal masculine type is the most valued form of manhood and is the standard against which men are judged. To live up to this ideal is to display worthiness of the privileges of men, and to fall short is to place one's self into a subordinated category of men. In Western societies the hegemonic ideal positions men to be strong (not weak), rational (not emotional), courageous (not afraid), resolute (not fickle), and heterosexual (not homosexual) (Schwalbe, 2005, p. 76). As Schwalbe (2005, p. 76) argues: "In more explicit dramaturgical terms, what this view suggests is that to be credited as deserving of full manhood status, a male must signify a masculine self. He must, in other words, act in ways that can be interpreted as signifying an essential character that includes the qualities of strength, rationality, courage, resolve, and heterosexual potency." He goes on to argue that manhood thus becomes something which is created through 'acts of signification' and used in status achievement by 'skilful impression management'. Thus, for Schwalbe men must "act in ways that can be interpreted as signifying an essential character that includes the qualities of strength, rationality, courage, resolve, and heterosexual potency" (Schwalbe, 2005, p. 76). Following Butler, Schwalbe argues that masculinity and gender is not what men are, it is what they do. He further argues that many aspects of these acts of manhood become a matter of habit—manners of posture, gesture, movement, speech, and dress. The main argument Schwalbe (2005) puts forth is that, in relation to gendered power relationships, simply by acting as men, men produce and preserve an unequal gender order in a manner which is not consciously undertaken (Schrock & Schwalbe, 2009).

3.4.1. Movement, social space, and male bodies

Bodies never exist alone, they always exist in a matrix of entangled social relations and social structures. These social structures appropriate bodies, monitor them, allow or disallow doing certain things with them. These social structures can control bodies unconsciously, such as how a body can move in certain ways, and they can also control bodies overtly, by control which bodies can access certain physical and social spaces. The body's movements are therefore shaped by social and political forces throughout the life course.

The idea that individuals move and position their bodies in culturally appropriate ways that are not entirely driven by natural impulses was introduced by Mauss (1973[1936]), who argued that the way individuals used their bodies are culturally contingent. However, it was not until feminist scholarship that bodily movement was explored in relation to gender. In

Throwing Like a Girl, Young (1980) illustrates how social ideas about body movement and how bodies occupy space constrain the physical movements of bodies. Young (1980) argues that gendered body comportment arises not from biological predispositions (such as anatomical, or physiological differences, or a feminine 'essence') but from 'structures of gendered existence'. In a post-structuralist sense, she illustrates how discourses about bodies not only inform what meaning is assigned to them, but how discourses influence gendered movement, and how this bodily movement in return creates the performativity of gender. Young specifically discusses women's bodies, and argues that their movements are influenced by such 'structures' (discourses) that exist prior to the emergence of the body into the social arena. Young discusses how women experience their bodies in the space that surround them: how they move, sit, stand, talk, and engage in physical activities and how these movements are subject to restrictions and inhibitions to culturally specific discourses.

> "There is a specific positive style of feminine body comportment and movement, which is learned as the girl comes to understand that she is a girl. The young girl acquires many subtle habits of feminine body comportment-walking like a girl, tilting her head like a girl, standing and sitting like a girl, gesturing like a girl, and so on. The girl learns actively to hamper her movements. She is told that she must be careful not to get hurt, not to get dirty, not to tear her clothes, that the things she desires to do are dangerous for her. Thus she develops a bodily timidity which increases with age" (Young, 1980, p. 153).

Whitehead (2002) suggests that that the way Young describes women experience their bodies is not commonly shared by most men. He argues that dominant masculine discourses do not position the male subject as timid, careful and restricted. Instead, they do the opposite—they position males as tough, hard, physically competent, that take up space:

> "…masculine bodily existence suggests the occupation of space, the capacity to define space, the ability to exercise control over space and a preparedness to put one's body at risk in order to achieve these expectations. The male/boy/man is expected to transcend space, or to place his body in aggressive motion within it, in so doing posturing to self and others the assuredness of his masculinity" (Whitehead, 2002, p. 189).

Thinking about the movement of men's bodies as a result of the deployment of masculine discourses positions gendered bodies, and corporeal movement, as politically charged. Young's (1980) example is a classic illustration that gender expression that is unconsciously deployed, is a result of gendered power relations. Thus, based on this observation Whitehead (2002) argued that men's bodies do not simply move in or occupy space, they are a political presence, and their movements and actions are always informed and permeated by social structures of power. This notion allows us to link embodiment and materiality with power and politics. Butlers works speak of the embodied materiality of not just of gendered dynamics but also of Foucauldian the regulatory power regimes. Her theories provide us with the understanding and the theoretical tools, to view bodies are not simply as result of natural sex distinctions, but to understand that their corporealities are enmeshed in and results from regulatory powers that manifest as discursive materiality.

For Foucault, the body is the surface upon and through which power operates (Whitehead, 2002, p. 186). Discursive deployment of subject positions is always influenced by hierarchical cultural discourses and is never outside of them (Whitehead, 2002). Culture therefore constrains agential actions and cannot be separate from it. Discourses about men, maleness, and masculinity are therefore embedded in social and political forces at the same time as they are performatively deployed. Through this process the body's materiality becomes influenced and inscribed by social and political power realities. Bodies exist in physical and social space where, through discursive forces they are monitored and controlled (Wesp, 2017). Sexual difference is often the first property of the body along which social control is exerted. It is a key dimension along which bodies are monitored and controlled in social space. This includes discourses that appropriate ways of decorating them, moving them, and accessing spaces. What certain individuals are 'allowed' to wear as clothing, perform as their occupation, or what bathrooms they are allowed to access, for example, are controlling bodies along axes of sexed differences. Discourses not only construct but serve to naturalise male heteronormativity, and a certain kind of normative male body, they serve to constrain the stylization of male bodies such as hair styles, clothing, and inform what men can do with their bodies, ways of moving and acting through the body (comportment), what men should (and should not) put into their bodies. As Reeser (2010, pp. 93-94) argues, "[c]ultural practices construct ideas on the male body by transforming actions into physical aspects of the body. Gesturing is an important way in which the male body is constructed through repeated practices as a man or boy is taught to move in a certain way".

Relevant to the current bioarchaeological investigation of men, social hierarchies that influence how bodies are moved is relevant. Social inequality produces unequal access to resources that can lead to disruption of biological homeostasis and produce observable patterns on disease, morbidity, and disability (Gallo et al., 2012; Mackenbach et al., 1997). One of the arenas where this can be investigated is how men's bodies were used to perform physical work and what political structures influenced these patterns of work

(Wesp, 2015). Activity reconstruction is a promising area in bioarchaeology that may reveal activity-related changed on skeletal populations, and individuals, and also reveal social and political relations and how these institutions made their mark on men's bodies. These may include social arrangements for delegating particular occupations to specific groups of people. For example, lower class groups often performed more physically intensive labour such as agriculture.

Other structural inequalities, not based along gendered lines, can produce unequal access to resources, that lead to observable patterns of disease, morbidity, and disability and can manifest in skeletal tissues. Access to resources for marginalised groups can result in decreased health outcomes. For example, bodily injuries resulting from structural inequalities in the clinical literature have been described in the literature on injury recidivism (Brooke et al., 2006; Cooper et al., 2000). Studies have identified an association between poor social environment and the risk of physical harm and re-injury in urban centres in America (Judd, 2017; Reiner et al., 1990). For example Judd (2017) noted in a review on contemporary injury recidivism that several studies have found that individuals admitted to hospitals with multiple injuries over a span of 5 years tended to be from lower socio-economic backgrounds, more likely to be unemployed, belong to a minority group, abuse substances, or involved in criminal activity. These studies indicated that marginalization increased the risk of bodily harm. In this way social inequalities produced by hierarchical social organization materialised in the body.

3.5. Men's embodied subjectivity

This chapter explores the relationship between performativity, masculinities, and archaeological bodies. It is argued that performativity links discourses of gender and material bodies and allows bodies to be simultaneously material and discursive, or material-discursive. However, establishing a theoretical framework using Butler's concept of performativity raises several tensions concerning the materiality of the archaeological body. Butler's first aim is to establish that the sex-gender distinction is artificial. However, materialist approached to embodiment insist on the physicality of the body.

Constructivist accounts of men's bodies emphasise their discursivity; that is, what do bodies mean and how bodies are given meaning. With respect to the male body, how does this meaning articulate with masculinity, and how does this relate to discourses about masculinity? In other words, how do biological male bodies inform a subjective experience of maleness and the performativity of such identity. Post-structuralist accounts of bodies point out that discourses about biology inform gender identity. In other words, it is not biology itself which influences gender identity, but the meanings we construct about biological difference that informs what we make of the biology (Reeser, 2010). According to this view, it is not only gender or gender identity that is socially constructed but the body itself becomes a social construct. Social constructionist theories of bodies argue that the body can never exist outside of language and culture. These theorists challenge the notion that the body is only a physical and material entity. Their arguments are not necessarily that bodies are immaterial or somehow 'made of discourse', but rather that language and culture create the understanding of the body (Thomas, 2002). According to Thomas (2002, p. 33) "we do not have access to an understanding of the body which is not already an interpretation". It is only through interpretation or discourse that the body becomes itself. As Butler (1993) has pointed out, the materiality of the body is not something that the body is, it something that the body becomes, materiality is a process.

Following from this, some scholars have argued that along with the body, sex is also a culturally constructed concept. This notion originally stems from Foucault's arguments about sex as a construct of discourse in *The History of Sexuality* (Foucault, 1978). For Foucault sex is a 'regulatory ideal'. It is "…a regulatory practice that produces the bodies it governs, that is, whose regulatory force is made clear as a kind of productive power, the power to produce--demarcate, circulate, differentiate--the bodies it controls" (Butler, 1993, pp. xi-xii). Butler argues that sex is also socially constructed through specific culturally regulated practices. In Butler's words: "…'sex' is an ideal construct which is forcibly materialised through time. It is not a simple fact of static condition of the body, but a process whereby regulatory norms materialise 'sex' and achieve this materialization through forcible reiteration of those norms" (Butler, 1993, p. xii).

Butler argues in *Gender Trouble* that the gender-sex distinction is an artifice: "…gender is not to culture as sex is to nature" (Butler, 1990, p. 11). She argues that to consider gender as the cultural interpretation of sex is to fail to recognise that "…gender is also the discursive/cultural means by which 'sexed nature' or 'a natural sex' is produced and established as 'prediscursive', prior to culture, a politically neutral surface *on which* culture acts" (Butler, 1990, p. 11; emphasis original). Therefore, according to Butler there is no prediscursive, or natural, body which is untouched by power relations. From this perspective, the body is always discursively inscribed, which does not exist outside of its cultural parameters that surround and reify it.

Post-structuralist and queer theorists question the assumption that masculinity exists only in relation to men and that masculinity is inextricably linked to the male body (Aslop et al., 2002, p. 159). Using Butler's idea of performativity some scholars have questioned the assumption that masculinity exists in relation only to a biologically male body. Halberstam (1998) for example in *Female Masculinity*, asserts that masculinity is a set of cultural acts, or performances that can be achieved by individuals regardless of the sex of their bodies. Her study of the diversity of female gender expressions of masculine women, she moves the analysis of masculinity away from the male body and argues that this reveals the constructedness and artificiality of masculinity. Thus, she argues that a male body is not a prerequisite for masculine performances.

Interrogating the relationship between masculinity and the male body are central if we wish to study the embodiment of masculinity in skeletal bodies. How can we reconcile masculinity as a performative or a discursive process, with a material (sexed) body that we touch and observe? Historically, there has been a divide between materialist and discursive approaches to studying men and men's bodies. Some scholars have offered suggestions about how to reconcile the tensions between materialist and discursive approaches by thinking about bodies as both material and discursive, or material-discursive simultaneously (Hearn, 2014). It is argued here that these approaches, which do not give primacy to either the material or the discursive aspects of bodies are appropriate and applicable to bioarchaeological theorisations of sexed and gendered bodies, and specifically for the interrogation of gender using bioarchaeological data. However, for this approach to be fruitful we must accept that the body is a physical entity, or as Wesp (2017) writes, we must "return to the body".

3.5.1. Returning to the male body

Wesp's (2017) recent theorization of the body argues that in order for bioarchaeologists to explore the body as the site of a lived experience, we cannot ignore the material basis of the human body. Bodies are physical entities as they take up physical space and are made of matter. They are conceived, are born, grow, senesce, and eventually die. Materialist theorists point to the material properties of male bodies as a basis for its maleness: Y chromosome, penis, testicles, facial hair, amongst other aspects (Reeser, 2010). Embryonic development into a male body starts during the 7th week of foetal development (Moore et al., 2016). Whether a foetus develops into a male or female is determined by the chromosomal sex established at fertilization. A XY male foetus will develop male genitalia if a sperm containing a Y chromosome fertilises the X chromosome bearing oocyte, giving the embryo a XY set of chromosomes. Gonadal sex is determined by testes-determining factor the genes for which are on the Y chromosome. Embryos with XY sex chromosomes develop into a male phenotype. This requires a functional Y chromosome which contains the SRY gene (sex determining region). The SRY region activates a gene regulatory network which causes testicular differentiation. By the eighth week of foetal development the androgenic hormones (testosterone and androstenedione) initiate differentiation of internal and external sex structures. Androgenic hormones stimulate the Wolffian ducts and prevent ovarian development in the Mullerian ducts. External genitalia in the developing foetus may be distinguishable by week 9, and can be differentiated by week 12 (Moore et al., 2016). Consequently, the bodies of boys develop differently as a result of a specific sequence of genetic instructions, which in turn become physiological consequences that result in physical differences between males and females and other sex phenotypes. For the bioarchaeological study of men it is important to recognise this ontological connection between biologically male bodies and masculinities men deploy to assert their maleness. Although the male body may be a physical entity, it is impossible to defend that it exists without cultural influence.

3.6. Masculine performativity through the body

Discourses surrounding men's bodies create the performativity of gender by appropriating ways of acting, moving, and taking up space to those performatives which are acceptable in particular places and at particular times. The resulting acts, actions, movement, comportment are discursive materialities. They are discursively informed but executed through the physical body in physical space. The movement can be considered material as it is the movement of the physical body. However, the movement is simultaneously discursive as it is permitted by and constrained by discourses. Men and women move their bodies differently which are not entirely controlled by biology. There are certain characteristics or styles of bodily movement which are considered masculine or feminine. These movements are not entirely a function physical differences between male and female bodies, as some have suggested. Discourses about how gendered bodies should, or are allowed, to do or move, come to the fore in the performativity of gender. Discourses about masculinity shape how men move their bodies in order to be seen, or assert themselves, as male or masculine, and also to challenge other notions of masculinity. This includes movements which dominant masculine discourses disallow, because they are considered unmasculine. These include how gendered bodies move in space or take up space, and also what a body is physically subjected to. That masculine performatives are physical movements in space which emerge by deploying discourses about masculinity via the animation of physical bodies makes masculinity simultaneously material and discursive or *material-discursive*.

Bodily pain, aggression, violence, and health outcomes are all corporeal experiences. Bodies feel pain and are physically altered by violent encounters. These experiences are physically linked to the body which make it impossible to defend masculinity as a purely discursive construct. Therefore, masculinity is experienced and performed in and through the body, from the body, via the body, and to the body. While some scholars have argued that a male body is not necessary for the experience and deployment of masculinities

(Halberstam, 1998), it is argued here that a body is necessary. And since a body is necessary masculinity cannot be entirely discursive, it is connected to physical realities. It cannot be a completely discursive process unattached from the material realities of the bodies through/from/via which it is being deployed.

Most importantly for the current study, Sofaer's (2006a) thesis espouses the way discursive subject positions and social identity become incorporated in the skeletal body. This enables bioarchaeologists to engage with the broader archaeological embodiment and identity projects by investigating how these concepts can be engaged with and interrogated from skeletal remains. Bioarchaeologist have used this premise to develop sophisticated understandings of skeletal changes in relation to gender identity. The basic premise here is that, as individuals deploy discursive subject positions, their subjectivities materialise in their bodies through the body's material plasticity (Wesp, 2017). The plasticity of the body means that subjectivities and identities will change the physicality of body over time. As social subjects behave socially by deploying certain discourses, this will influence the trajectory of the body's physical properties. Bioarchaeologists are equipped to explore some of the physical changes through the scientific methods. As we have seen in the contemporary masculinity literature, and which should hold true for past societies, deploying certain ways of being male impacts aspects of the skeletal body which are available for discovery through bioarchaeological inquiry. Certain masculine ways of moving, posturing, assuming risk, being at risk, consuming food, and dressing, can result in changes to skeletal tissues which could be discoverable through activity pattern reconstruction, trauma analysis, and chemical analysis. This allows the bioarchaeological exploration of differences in the gendered experience.

3.7. Framework for current study

In this chapter the position is taken that gender is something that individuals actively deploy through performativity in a Butlerian discursive manner. Performativity as the repeated citation of gender, and based on the body's plasticity, aspects of gender performativity become incorporated into it in the most fundamental, biological way. For bioarchaeologists, gendered performances make their mark and are recorded in skeletal bodies. The current study uses the concept of performativity (that is the discursive deployment of gender identities) to link gender identity and osteological markers that have sedimented in the skeletal body due to its plasticity. Although the idea of gender performativity was introduced to archaeology some time ago (Perry & Joyce, 2001), in bioarchaeology it has rarely been explicitly used to link gender and skeletal indicators (Wesp, 2014, 2017), and has not been used to interrogate men's gendered lives and bodies specifically.

Drawing on Butler's notion of gender performativity as a corporeal practice of repeated citation and repetition, bioarchaeologists are able examine osteological markers apparent on the skeleton as a result of repeated biomechanical stress. These include osseous changes that results from repeated movements, actions, gestures, postures, and comportment, that could be related to corporeal deployment of gendered performatives over the life course of individuals. Bioarchaeological investigations possibly suited for this type of examination are activity reconstruction studies that focus on the effects of repeated biomechanical stress on the skeleton in relation to habitual movement, as has been exemplified by Wesp (2014, 2017). Traditionally, activity reconstruction studies have focussed on three key osteological markers to reconstruct general activity patterns in past populations, these include entheseal changes, geometric variation, and articular modification (Weiss, 2009a).

Bioarchaeological studies of entheseal changes are based on the idea that bone remodelling at muscle insertion and origin sites on the skeleton change in morphology as a result of applied mechanical stress. According to bone remodelling theory the attachment sites become more pronounced and more robust (hypertrophy) with repetitive use and loading of the muscles that attach. Muscle attachment sites with well defined markers are thought to be the results of repetitive and continued daily use. By systematically scoring the attachment sites for robusticity and analysing the data for patterns, bioarchaeologists have sought to reconstruct past activities and lifestyles (Jurmain et al., 2012). Similarly, cross sectional bone geometry, also based on the theory of remodelling as a result of repeated mechanical stress, has been applied by bioarchaeologists to study activity-related changed in archaeological skeletal samples (Ruff et al., 2006). Various activities apply mechanical forces to bones, to which bone reacts by physiologically and physically remodelling in a way that is depended on the amount of force applied and the tissue's ability to adapt. Positive adaptation is a remodelling response in order to strengthen the skeletal tissue along lines of strain in order to mitigate the stress, and ultimately to prevent breakage. Bioarchaeologists analyse changes in the cross-sectional outlines of bones to determine the types of repeated strains and loading patterns were applied to the bones throughout life to make inferences about past activities (Jurmain et al., 2012). Lastly, bioarchaeologists have used changes to joints and articular surfaces related to osteoarthritis to infer activity-related changes in archaeological skeletal remains. The premise of this approach is similar to the first two, in that the biomechanical stress of activity is thought to cause changes to the joints that are observable archaeologically. Therefore, bioarchaeologists can study the patterning of these osseous changes to infer past activities (Jurmain, 1999; Weiss & Jurmain, 2007).

Overall, the activity reconstruction approach in bioarchaeology hangs on the theoretical premise that repeated movements in the body are inscribed or sedimented in it, due to osseous modification from mechanical stimuli. This is a seemingly logical entry point to the study of gender performance which argues that gender is the repeated deployment of acts over the life course of an individual. Such an approach, according to the author's current knowledge, has only been undertaken by Wesp (2014), who has creatively used the theory of gender performativity and bioarchaeological activity reconstruction to investigate gendered lifeways. This method allows us to identify groups of individuals (sub-populations) with shared osteological markers. Groups of individuals with similar skeletal indicators are theorised to have engaged in similar activities or *modes of performance*. We can argue that these would be *shared performances* indicating a kind of sub-population group level solidarity.

Using this approach, it is possible to gain insight into gendered lives by observing patterns and trends of shared performances that make their mark on the skeleton. Other osteological markers that can be observed on archaeological skeletons, may not be cumulative in nature. Some lesions can be a result of a single incident such as traumatic lesions. Traumatic injuries on the skeleton result from forces that exceed the skeletons ability to withstand the force (Wedel & Galloway, 2014). The force can originate from an accidental fall or injury, or an intentional act of violence (Lovell & Grauer, 2019). Both of these instances represent individual moments of performance that are precisely momentarily.

Although it is impossible to determine that a single act or action is a gendered act or performance, single acts, however, are related to a broader context of actions or performances that do relate to the deployment of gendered discourses. Reconstruction of gendered activity patterns using repeated acts described in the section above, can be said to be the accumulation of movements that over time sedimented in the skeletal tissue. On the other hand, single acts can be viewed not as accumulation but as culmination events. In other words, being exposed to certain types of stressors and risks repeatedly throughout life, finally result in the momentary incident. For example, traumatic injuries are a result of accidents or violence; however, being exposed to the risks involved with those accidents or violent encounters could be ongoing throughout the lives of individuals (Turner et al., 2004). Individuals with injuries from certain types of activities are likely not the first time they were exposed to the risks of that activity, but resulted from repeated exposure. Therefore, osteological analysis that examines single incident indictors, the repeated citation of gender lies not in the single act that produced the lesion, but in the repeated assumption of, or exposure to, the risk factors that led to the traumatic incident. Therefore, the single act can be said to be an instance of that repeated performance, or a momentary performance.

With respect to the gendered single incident indicators of performances for men, we can refer back to the contemporary literature on men's health and their risk exposure throughout life, such as occupational risks, risks from military obligations, and interpersonal violence. In archaeological samples, individuals exposed to similar risks will tend to have similar patterns of indicators. When patterning of lesions is observed such as skeletal trauma, we may see patterns that indicate, for example risks involved with certain occupational conditions (*e.g.*, working closely with livestock), or risks involved in military or interpersonal violence (*e.g.*, weapon related injuries). In the current study, these observations can be compared and contrasted using the historical record about men's lives and masculine performances in the broader context of medieval Europe, and Alba Iulia specifically. From here assessments can be made whether osteological indicators concur or contrast with those indicated in the historical literature, and what explanations can be made for congruence or divergence. Thus, using a single incident indicator such as trauma we may observe shared performances as well as individual performances.

The current thesis utilises indicators that can be approached at different scales. The different markers observed, recorded, and analysed, relate to various aspects of performance and performativity, which is the reason a range of different markers was chosen for examination. Each of the markers reflects a different aspect of the theoretical framework. On the one hand, articular modification will allow the assessment of activity patterns in the population and consequently look at intra-population differences in specific sub-groups. This will allow the examination of the deployment of shared modes performance. On the other hand, the analysis of trauma allows the examination of individual modes performances, by looking at specific instances of trauma on specific individuals, and compare and contrast these to overall patterns of injury. In such a way, the former is a top-down, and the later a bottom-up approach to interpreting the lived experience and embodies subjectivities of past individuals and groups. This allows for the exploration of the 'middle range' between the population and the individual, to examine commonalities, or shared performances, individual and group identities.

Group identities, or shared performances, can be explored by looking for data patterns suggestive of intersecting or 'cross-cutting variables', such as age, sex, socio-economic status, disability, and so on. For example, in the trauma analysis, we can look for individuals who have experienced traumatic injuries more than once in their lifetime. In the clinical literature this group is often described as belonging to a lower socio-economic status at-risk group (Tegtmeyer & Martin, 2017). The trauma analysis will also provide data for inferences about men and risk, both risk taking behaviours and being at-risk of physical harm or injury.

Chapter 4: Recent Approaches to Gender in Bioarchaeology

Over the past decade, gender has become a well established and well examined analytical concept in the rapidly growing subfield of social bioarchaeology (Agarwal & Wesp, 2017; Zuckerman, 2020). Many social bioarchaeolgists have, and remain, critically engaged in discussing theoretical and methodological issues related to the complexity of investigating gendered life in the past through the study of human skeletal remains. This has resulted in a diverse body of literature which uses varied and diverse approaches and perspectives to methods and theoretical frameworks (Zuckerman, 2020). Recent developments in bioarchaeology include: (1) doing away with gender as a category or variable of analysis to use it as an exploratory concept; (2) examination of tensions arising from the social constructivist approaches to sex and gender and the implications of this for osteological methods; (3) a move away from a population level / epidemiological approach to a focus on individuals and lived experiences.

4.1. Gender as exploratory

In the 1990s some bioarchaeologists were drawn to the rising popularity of the idea of gender highlighted by the emerging sub-field of gender archaeology. As an outcome, bioarchaeological studies and publications of ‘sex and gender’ increased in volume (Walker & Collins Cook, 1998). At the time, bioarchaeologists conceptualised sex as the domain of the biological and gender as that of the cultural, as evidenced by the first edited volume on the subject by Grauer and Stuart-Macadam (1998). This framework fitted neatly into the biocultural approach which focussed on the interaction between biology and behaviour. However, in the 2000s broader gender theories gained popularity which blurred the lines between the biological and the social (Perry & Joyce, 2001); the material and the discursive. Developments in feminist and queer theories have raised questions that challenge naturalness of both sex and gender (Butler, 2004). Within bioarchaeology, for those wishing to apply the advances in gender theory to the study of skeletal remains, resulted in tension between method and theory (Sofaer, 2006c).

At the turn of the century several bioarchaeologists critiqued the discipline for using gender as a label and simply a variable in archaeological analysis (Geller, 2008; Sofaer, 2006a), “rather than to use it as an exploratory analytical tool” (Sofaer, 2006a, p. 99). In population level studies sex and gender were often used as analytical categories or variables in the statistical analysis of skeletal data. Sex was determined from the skeleton by standard osteological methods and gender was often inferred from proxies such as grave goods (Sofaer, 2006a). Each skeleton was pigeonholed into ‘male’ or ‘female’ in these two categories, or was excluded from analysis when this was not possible to accurately determine. Critics argued that this created artificialities or biases in the data by mapping a Western heteronormative view of gender relations onto ancient remains. In bioarchaeology gender has often been thought of as something which can be ‘assigned’ (Zuckerman, 2017). However, new approaches, inspired by feminist scholarship, argued that gender should be explored not as a category but as a dynamic concept, and not to regard the body as a mere source of data, but should be thought of as a cultural concept and the site of a lived reality (Sofaer, 2006c).

Sofaer’s (2006a, 2006b) influential work provided the groundwork to shift focus away from the innateness of gender, away from gender as something that can be discovered from bodies or about bodies (for example through proxies such as grave goods), to gender process that is always ongoing throughout the life course. She did this by considering the archaeological body as a once living, changing, shifting entity. Using the concept of biological plasticity, she argued that behaviour, and specifically gendered action, has the potential to be expressed in skeletal remains, because human action sediments in the body. This allowed bioarchaeologists to conceptualise gender as a dynamic ongoing *process* rather than a static manifestation of identity. Gender that is always in process, enacted throughout life, and sedimented in the body, becomes part of the ontogenetic process (Sofaer, 2006b). Configuring the body this way, rendered gender as an exploratory and an analytical tool, rather than a way to categorise people of the past. This has led to a volley of bioarchaeological research on gender that explores the diverse dynamic ways in which past societies negotiated, deployed and entangled with gender identities (Agarwal & Wesp, 2017; Hollimon, 2011; Sofaer, 2013; Zuckerman & Crandall, 2019).

4.1.1. Social construction of the sexed and gendered body

Social constructivist approaches frequently configure gender and sex as an agential process, brought into being by deployment of discourses. Some early attempts to explore social construction fluid and dynamic sex and gender attempted to study the gender spectrum or multiple genders. Such attempts were an outcome of criticism by gender archaeologists who argued that conceptualising gender as a binary construct (male and female) will foreclose the possibility of accessing the gender spectrum (Hollimon, 2017). Responses by bioarchaeologists to a sex and gender dualism include attempts to access non-binary genders, such as third or fourth, or alternative genders. For example, Hollimon (1996) has argued to have identified possible two-spirit, or third-gender, males from a Native Californian site. Her interpretations were based on male burials with patterns of artifacts and skeletal pathology of spinal arthritis typical of females in this population.

Similarly, Perry (2004) has reasoned possible indicators of third gender individuals in an American Southwest sample, by observing musculoskeletal stress markers in biologically male skeletons which were typical of patterns seen in women. Geller (2005) has argued for the identification of a possible Mayan 'gender bending' individual from Belize. These bioarchaeologists have attempted to move beyond the gender binary however their categories consist of male, female, and 'other'. As Knapp and Meskell (1997, p. 200) have reflected, looking for third genders "…still seems to present normative categories along with the other, that is, an essence of difference which serves to consolidate them." Although these studies are exemplary for exploring gender beyond the binary and the normative, they leave out the exploration of gendered lives of individuals with heteronormative gender orientations in those ancient populations.

Critiques of the binary division of sex have called into question bioarchaeological methods of sexing the skeletons. Fausto-Sterling (1993, 2000, 2019) argues that sex cannot be understood through two categories, because even on a biological level there are genotypic and phenotypic variations which a binary sex framework does not adequately represent. The destabilization of gender as fluid, non-binary, constructed, and not biologically fixed, has caused concern in bioarchaeology about how the concept can be employed usefully given that through our osteological methods the first observations include the assessment of biological sex. Wesp (2014, 2017) examined the tension between sex and gender in bioarchaeological practice resulting from the traditional skeletal sexing methods. She argues that because skeletal sexing is based on a framework of a binary sex/gender system, bioarchaeologists are forced to fit skeletal sex into male/female categories. These then create artificialities that may or may not represent sex or gender categories in the population under study, potentially creating analytical bias. She takes issue with the common practice of excluding individuals from analysis who were not confidently sexed, for example 'probable males' or 'intermediate/ambiguous' groups. Following Fausto-Sterling (1993, 2000) Wesp argues that biological sex itself is more complex than a binary category. Fausto-Sterling (2019) has argued for sex, gender, sex/gender, and sexual orientation as an embodied dynamic system, with these individual components being part of a unified whole. Thus, in her thesis Wesp (2014) chose not to differentiate between sex and gender. In her analysis, she did not initially begin her data analysis by sex categories. Rather, she first looked at patterns of variation and groupings in the data, and then added the sex estimates of groupings after the fact to see if, and what, gendered patterns emerged.

Sofaer (2006a, 2006b, 2006c) introduced the ideas of gender being practice based, and explorable through the bioarchaeological body. Wesp (2017) later built on this using Butler's (1990, 1993) performativity theory which rejects gender to be a manifestation of a biologically determined sex and argues that sex and gender are produced discursively. The approach used by Wesp, not separating sex and gender, may offer some resolution between the cultural construction of sex as seen by feminist and queer theorists, and the physicality of sex observed on skeletal remains. Using performativity approaches, Wesp acknowledged that bodies exist in social space where they are monitored and regulated by social factors. Furthermore, using embodiment approaches, she also argued that performativity renders material consequences to social discourse. Because bodies are inherently material, developmental theory through plasticity suggest that the deployment of discursive sexed and gendered subject positions incorporates such life experiences in the materiality of the body. She referred to this approach as the embodied bioarchaeology of performativity, which was explored in detail in Chapter 3. This approach anchors gender to the materiality of the body because gendered actions are corporeal, and therefore subjective lived experiences are linked to the materiality of the body. According to Wesp (2017) the deployment of gendered subject positions sediments the subjective experience of sex and gender in the skeletal body.

Agarwal (2012, 2017) has also responded methodologically to the line of reasoning that suggests both sex and gender are discursive, using a design that, rather than presuppose gender as an important cross cutting variable, interrogates data patterns to see relationships between gender and sex. Agarwal (2012, 2017) explored data patterns first, and analysed based on sex only when statistically justified. In her study of osteoporosis, which has been associated with biological ageing in women, Agarwal (2012) studied the differences between men and women only when examining that difference was statistically justifiable. This is unlike past studies of bone loss in bioarchaeology which *a priori* divided samples by biological sex, and focused on osteoporosis in the female group, with the "… expectation that the most influential factor(s) in mediating bone loss will be closely linked to biological sex" (Agarwal, 2012, p. 331). Agarwal (2012) demonstrates that in medieval rural and urban samples, the different expectations of gendered behaviours for women affected bone maintenance in distinct ways. Women in rural England exhibited lower levels of bone mineral density than their urban counterparts, as a result of having more children, breast feeding longer, and engaging in more physically demanding activities. The study illustrates how skeletal health is not only biologically driven but also mediated by gendered social experiences.

These approaches are useful because they do not assume that gendered differences in past societies are a primary axes of identity construction. However, in studies interested in exploring the identity and health outcomes specifically of men, such approaches may not provide the most appropriate framework. In samples from contexts for which historical documents indicate strong binary sex/gendered social organization, the initial separation of the sample based on sex may be justified. Such an approach does not inherently conflate sex and gender. Instead, it prepares the data for the exploration of differences as well as commonalities in lived experiences.

4.1.2. Focus on the gendered lived experience

While still recognizing the importance of population level and epidemiological approaches to studying health and disease in the past (Martin et al., 2013), starting in the second decade of the new millennium a growing number of bioarchaeologists became interested in examining the everyday lived experience of past individuals (Agarwal & Glencross, 2011b; Torres-Rouff & Knudson, 2017). This subset of bioarchaeologists have shifted interest from studying large scale phenomenon such as population transformations, to an interest in exploring the lived experience of individuals in the past. They recognised that past individuals had agency and personhood, and that studying these aspects of their lives can reveal valuable information and more relatable stories as part of our contribution to public discourse. Recent bioarchaeological studies have focused on individuals and their intersections of experiences of health, disease, trauma, and social status.

4.1.3. Focus on individual lives

Although not a new development in biological anthropology, in recent years there has been renewed interest in the examining the skeletal remains of individuals in more detail (Stodder & Palkovich, 2012). Biological anthropologists have in the past often reported on analyses of individual skeletons as case studies, but such reports were viewed "…pejoratively by a biocultural research paradigm that prioritized population statistics" (Boutin, 2008, p. 52). Therefore, reports on individual skeletons, an alternative to population level approaches, were mostly out of necessity rather than choice, for example in situations where sample sizes are small or only single skeletons were discovered. A deliberate focus on individual skeletons was officially dubbed 'osteobiography' and aims to reconstruct life histories through life events recorded in bones (Saul & Saul, 1989). The osteobiographical approach has been interpreted in various ways, which resulted in three main sub-genres. The first is the exhaustive description of individual skeleton including, age, sex, stature, paleopathology, activity markers, and any anything else osteologically discoverable that is meaningful in the reconstruction of life (Faccia et al., 2016; Lessa & Guidon, 2002; Lovell & Dublenko, 1999; Mayes & Barber, 2008). The second, more recent, is a more humanistic approach, focused on the lived experience of the individual under study, using various theoretical backdrops such as embodiment, personhood, and life course analysis (Hawkey, 1998; Robb, 2002; Stodder & Palkovich, 2012). Finally, the most recent approach pioneered by Boutin (2012, 2016), is based on a phenomenological, lived experience approach. This method explores the construction of richly contextualised fictive narratives of past lifeways for selected individuals in the context of a larger sample under analysis. Boutin (2012) employed personhood and life course approaches using multiple voices and perspectives to acknowledge the multivocality not only of past life experiences, but also in the creation of scientific knowledge (Joyce, 2002). Such approaches hold promise for the bioarchaeology of gender because they offer the possibility of the examination of the detailed gendered lives of individuals in contrast to broader population level studies (Sofaer, 2013), and to explore difference in individual lived experience of gender (Joyce, 2017).

4.1.4. Intersecting identities

Another interesting avenue of exploring gender difference in the past by bioarchaeologists has been through the use of the concept of intersectionality. Bioarchaeologists, following recent feminist developments, have acknowledged that gender is "entangled with a variety of complex biosocial conditions" (Zuckerman, 2020, p. 33). This flows from the concept of intersectionality which explores the simultaneous intersection of an individual's social identities that create inequalities, including gender identity, sexual orientation, race, age, disability, social class, among other social identities (DeWitte & Yaussy, 2020). As Zuckerman (2020, p. 33) wrote "…these differences … are entangled with [one another] and cannot analytically be separated out into discrete factors (Brah & Phoenix, 2004). This is because individuals experience diverse aspects of their social identity and social position simultaneously." This concept is useful for bioarchaeological investigations because it addresses multiple identities that intersect in individuals and recognises that systems of power influence those identities (Yaussy, 2021). Furthermore, those systems of power, particularly in the form of systemic oppression, can interact to produce inequalities in access to resources, including access to deploy certain discourses. In the context of bioarchaeological investigations, these disparities may give rise to variations in discernible skeletal indicators, including health and survival outcomes.

A bioarchaeological approach to studying multiple and intersecting identities is presented in the research of Torres-Rouff and Knudson (2017). Using a variety of methods and lines of evidence the authors investigated individual and group level identities over time from sites in northern Chile. They stressed the importance of bringing together micro-level approaches such as osteobiography and life-history approaches, with population level analysis. This allowed them to explore multiple and dynamic social identities embodied and deployed by individuals that are impacted by the individual as well as the group. They used multiple lines of evidence from skeletal morphology (cranial vault modification, biodistance study), skeletal biochemistry (isotopic geographic origins data), and mortuary context. These lines of evidence pointed to a shift from heterogeneity to homogeneity from the Middle Horizon to the Late Horizon Period transition in the Chilean Atacama. The authors of this comprehensive multiscalar study discussed larger patterns of group identity change as well as focus on individual life histories of those interred in the graves. They demonstrate the usefulness of studying the intersection of micro-level identities with macro-level power structures.

Mant and colleagues (2021) explored individual lived experiences through intersectionality using trauma analysis. To understand intersectional identities, the authors relied on multiple strands of evidence to understand the context in which the individuals lived. For example, their osteobiography of a male from the Terry Collection used bioarchaeological data along with historical newspaper and census data to understand key intersecting factors. This individual had more than 10 fractures over the course of his life. Historical records indicate that this individual struggled with substance abuse and had died impoverished in a public hospital, his body unclaimed by relatives. In a second case study of an unclaimed older woman from the Royal London Hospital collection, no historical records were available, but the authors were able to use contextual historical data in relation to her perimortem trauma to discuss the intersections of age, sex, and social status in 19th century London. Mant and colleagues (2021, p. 586) strive to demonstrate that "skeletal trauma is an ideal way to approach intersectional theory in bioarchaeology." This is because trauma can represent a single incident or multiple repeated instances of accidental insults or injuries due to violence. Predispositions (or risk) to accidental and violent trauma are a result of the interplay of complex and multifaceted social and individual factors and behaviour that can involve multiple aspects of identity.

These recent bioarchaeological studies that explicitly employ the concept of intersectionality demonstrate of approaches to investigate the multiplicity of past identities. Here identity is understood not as single 'marker' but as an entanglement of multiple identities that cannot wholly be understood individually or be separated into individual categories for analysis. For bioarchaeological investigations of gender this means that gender identity is always interwoven with other identities, and the performance or deployment of gender is always linked with other intersectional aspects. Therefore, what this means for researchers interested in studying gender using bioarchaeological approaches is that gender cannot be studied on its own, it will always be in the context of a web of social relations and influences.

4.1.5. Bioarchaeology and masculinities

A handful of bioarchaeological scholars have explicitly explored men as gendered subjects, and some have even employed social theoretical concepts of masculinities found in the social theory literature. For example, Knüsel (2012) explored men's social identities in Medieval England through the association of a specific type of elbow injury with social status. Knüsel (2012) examined medieval burials from a number of sites with individuals who exhibited signs of humeral medial epicondylar avulsion fractures. Knüsel (2012) argued out that in the modern clinical literature this type of lesion is associated with highly physically active adolescent boys who are engaged in repeated overhand throwing, such as competitive baseball. This led Knüsel (2012) to conclude that presence of this type of injury in medieval samples suggested intense physical training of young men, presumably for military activities. Using contextual archaeological evidence Knüsel (2012) relates the occurrence of these injuries to the pursuit of idealised masculine social identities, specifically by higher status young males in knightly training.

In a Chilean El Molle sample, Torres-Rouff (2012) explored the construction of social identity and masculinity through body modification. The labret, a body ornament worn in a pierced or slit lower lip, is argued to have left traces on dental and mandibular tissues with prolonged use. Labret use in the El Molle sample was exclusive to men. Torres-Rouff (2012) employed theoretical approaches used by body scholars, such as agency and life course theory, to argue that labret use in this population "…served to emphasize a particular sort of individual masculinity…" (Torres-Rouff, 2012, p. 154). Because labret use seemed to be within a broad age group, Torres-Rouff (2012) suggested it may be linked with age, or a specific life transition event, thus representing movement through an individual's life course. Consequently, she further argues that labret use associated with one of multiple masculinities which El Molle men were able to construct or access.

These studies exemplify an approach to exploring men's gender identity that diverges from previous research that sought fixed categories of men. Instead, these scholars employ masculinity theories to conceptualise masculinities as plural, negotiated, and embodied, which can be studied through bioarchaeological analysis of human skeletal remains. This thesis expands upon the foundational work established by these scholars, striving to investigate men as explicitly gendered subjects.

In summary, as this literature review of recent developments in the bioarchaeology of gender indicates, much of the recent literature has focused not on seeking to identify gender as a category, nor seeking to identify categories of individuals belonging to a specific gendered group, but on using gender as an exploratory tool. There has been a general trend of moving away from population level analyses and a growing interest in the life experiences and life histories of individuals. This makes sense because gender is individually expressed and experienced. Recent approaches that consider gender as agential, fluid, and relational, allow us to move beyond heteronormative and essentalised explanations of past social organisation, and consider intersectional factors as well as social and political power structures of inequality in the creation of past identities and embodied subjectivities. Furthermore, this allows us to investigate health and disease as a an outcome social diversity (inequality). A general result of these approaches has been to gain insight into *difference* in the human experience (Joyce, 2017).

4.2. Principles and processes of joint modification

According to Waldron (2009) bony changes to joints are most common conditions, along with dental disease, to be observed in skeletal remains. They have been used to infer activity patterns in past populations (Jurmain et al., 2012). The underlying assumption is that the changes seen in dry bone are due to everyday activities that cause ‘wear-and-tear’ or ‘degeneration’ on the skeletal tissues around the joints due to mechanical stress (Larsen, 1997, pp. 163-164). This approach requires bioarchaeologists to diagnose osteoarthritis in joints, or to assume that changes in the features in the bones are due to the osteoarthritic process. This has led to many bioarchaeological studies seeking to reconstruct activity patterns, to concentrate on diagnosing osteoarthritis in their samples. As I argue below, the difficulties with this are two-fold. First, the palaeopathological diagnosis of osteoarthritis from dry bone is difficult, and the assumption of a direct relationship between osteoarthritis and activity, in the sense of ‘wear-and-tear’, is problematic. Consequently, it is imperative for bioarchaeologists to reevaluate their methodological and interpretive approaches joint modifications in skeletal assemblages.

The mechanical stress origin of osteoarthritis in bioarchaeology and its use in activity pattern reconstruction has a long history. Larsen's influential bioarcheology text writes: "primary contributing factor to osteoarthritis is mechanical stress and physical activity" (Larsen, 1997, p. 163). Larsen (1997), for example, cites numerous epidemiological studies in which occupation activities and weight gain is related to higher prevalence of osteoarthritis. However, the studies cited are cross-sectional in design and it is difficult to assess osteoarthritis risk using this study design. For example, osteoarthritis could lead to an overall reduction of activity, leading to weight gain, in turn increasing the risk of the disease due to activity (Felson et al., 1997, p. 729). Therefore, longitudinal studies better are suited to assess the validity of the association between physical activity and osteoarthritis.

As early as the 1970s, it was recognised that the relationship between activity and osteoarthritis was complex (Jurmain, 1977). At the turn of the century the validity of the relationship was beginning to be vehemently questioned. For example, Jurmain (1999) questioned whether activity-related changes are as straight forward as some bioarchaeological studies had presumed, considering the multifactorial aetiology of osteoarthritis, and whether the features osteoarchaeologists are recording from dry bone represent the clinical osteoarthritic process. Subsequent work by some bioarchaeologists has recognised that, in addition to the effects of mechanical loading, other factors influence the risk of and the patterns of osteoarthritis in individuals and populations. These include genetic influences, anatomical influences, and body mass index influences (Jurmain, 1999; Weiss & Jurmain, 2007). Nevertheless, other influential bioarchaeologists continued to adhere to the wear-and-tear approach (e.g., Martin (Goodman & Martin, 2002, p. 41). This is not surprising since even in clinical textbooks conceptualisation of osteoarthritis as a “degenerative joint disease of mechanical wear-and-tear” (Chai et al., 2007, p. 165) continues. The concept continues to be used because of a lack of a better model which explains joint modification processes.

Literature reviews of the evidence of correlation between overall activity levels and the prevalence of osteoarthritis are inconclusive. For example, Weiss and Jurmain’s (2007) review includes 41 epidemiological studies investigating the correlation of osteoarthritis with general levels of activity, and with specific occupational or sports activities. They conclude that “…data relating to overall increased levels of activity and prevalence of osteoarthritis show no obvious trend”, and that “…epidemiological studies focusing on specific risk groups of individuals engaged in presumably mechanically stressful activities, results are slightly more encouraging—but not overwhelmingly” (Weiss & Jurmain, 2007, p. 442). The authors report a modest trend in a range of sports and occupational activities on numerous joints (although hip and knee joints are the most widely studied and reported), with about two-thirds of the studies indicating a positive in the increased osteoarthritis prevalence. The authors argue that one thing from their review is apparent, which is that individuals working in the farming industry are at a significantly higher risk of hip osteoarthritis. A possible explanation for this trend is that individuals involved in agricultural work often begin their farming activities early in life, and this early onset of mechanical stress contributes to the later development of joint pathology (Weiss & Jurmain, 2007).

Interpretations of activity patterns from skeletal remains are at the risk of tautological reasoning. If it is presumed that an osteological marker is the outcome of certain physical activity, then if that marker is seen in skeletal remains, it is used to conclude that the physical activity is observable from the marker. For example, Angel (1966) identified the presence of osteoarthritis in the elbow. Using ethnographic evidence of the existence of atlatls he concluded that the elbow osteoarthritis was caused by atlatl throwing. To avoid tautology, it is essential that the osteological markers studied by bioarchaeologists are grounded in clinical research evidence with a relationship between activity and the osseous outcomes observed in dry bone.

4.2.1. Identifying osteoarthritis in the archaeological record

Symptoms of osteoarthritis include the progressive development of pain, stiffness and reduced functional ability (Zhang & Bierma-Zeinstra, 2023). Patients usually seek medical care for pain, aching, and stiffness, that is exacerbated by movement and relived by rest (Gujar & Mochberg, 2014). These symptoms are the result of structural changes to tissues of joints which include articular cartilage, the subchondral bone, and other surrounding tissues (Lajeunese & Reboul, 2007). The disease is often diagnosed from radiological findings of cartilage degeneration and bone remodelling (Mandl, 2007). The standard clinical model for evaluating and diagnosing radiographic osteoarthritis is the Kellgren and Lawrence System (Table 4.1). A grade 2 or above on this scale is most often used as a diagnostic indicator of osteoarthritis by radiologists (Mandl, 2007; Roach & Tilley, 2007). However, not all individuals with radiographic definitions also present with functional definitions, that is, some individuals with grade 2 or above on the Kellgren and Lawrence scale may have minimal or no symptoms of pain or disability (Holzer et al., 2015). Accordingly, the most common epidemiological definition of osteoarthritis is: “radiographic evidence of OA and pain on most days of a month within the past year” (Mandl, 2007, p. 1).

Table 4.1 Kellgren-Lawrence System for clinical radiographic grading of osteoarthritis (from Mandl, 2007, p. 2)

Grade	Radiographic Description
0	Normal
1	Possible osteophyte
2	Definite osteophytes, possible joint space narrowing
3	Moderate osteophytes, definite narrowing, some sclerosis, possible attrition
4	Large osteophytes, marked narrowing, severe sclerosis, definite attrition

Cartilage degeneration and pain presentation are impossible to observe in skeletal populations, and bioarchaeologists therefore rely on proxy criteria to diagnose osteoarthritis in dry bone specimens. Indicators used by bioarchaeologist for appendicular synovial joint sites, includes lipping (osteophyte formation), surface porosity (holes), and eburnation (polish) (Buikstra & Ubelaker, 1994). These markers are scored on the degree of expression, and the extent of the circumference or the surface affected (Buikstra & Ubelaker, 1994).

However, there is no consensus with regards to arriving at a specific diagnosis of osteoarthritis using these traits. For example, how much of the articular surface periphery needs to be covered in osteophytes for it to be considered a positive diagnosis; and what size of osteophytes is required for the diagnosis? Similarly, how much of the articular surface needs to be porous, and how much of the surface is required to be covered by the porosity? Furthermore, what combination and what degree of expression of the traits is required for a positive diagnosis? The standards for osteological data collection (Brickley & McKinley, 2004; Buikstra & Ubelaker, 1994) do not offer any guidance on this. Some guidance is offered by Waldron (2009, pp. 33-34) who suggested the following as a diagnosis of osteoarthritis in individual joints:

(1) presence of eburnation; or
(2) at least two of the following:
   i. Osteophytes
   ii. New bone on joint surface
   iii. Pitting (*i.e.*, porosity)
   iv. Alteration in joint contour

There is disagreement about what each of the markers represent and whether they are even part of the osteoarthritic process (Waldron, 2012). Even though the recording of the degree (size) extent (area covered) are routinely recorded, there is a lack of a standard for how to include or process these scores in the diagnostic process (Waldron, 2009). Therefore, diagnosing the stage or severity of osteoarthritis remains problematic. The only clear indicator of osteoarthritis (eburnation) is a late stage presentation (Weiss & Jurmain, 2007). This makes the visibility of osteoarthritis in archaeological samples low, because the sensitivity of the tools available does not allow for the detection of early stages of osteoarthritis, which makes comparisons to contemporary clinical and epidemiological studies challenging (Ortner, 2003, p. 547).

Diagnosing osteoarthritis in archaeological bone is further complicated by differential diagnosis (Ortner, 2003). Many joint modifying processes produce osteophytes, porosity, and eburnation, not just osteoarthritis. These include rheumatoid arthritis, ankylosing spondylitis, reactive arthritis, psoriatic arthritis, osteoarthritis, and diffuse idiopathic skeletal hyperostosis (Waldron, 2012). Roberts and Manchester (2005, pp. 133-134) caution against the diagnosis of osteoarthritis in individual joints arguing that "a complete skeleton is a prerequisite to even attempting a diagnosis of the different joint diseases." Other authors have also pointed out that various arthropathies affect more than one joint in the body, with an often recognizable patterning (Rogers et al., 1987). Therefore, the observation of the patterning of joint involvement within an individual skeleton can help in the differential diagnosis of the various arthropathies (Ventades et al., 2018). This process, however, requires complete (or near complete) skeletons; which, may not always be available in archaeological samples.

These complexities make the precision and the accuracy of the tools available to bioarchaeologist to identify osteoarthritis, low. As a result, some bioarchaeologists have attempted to evaluate the significance of each joint modification indicator and its relationship to activity (e.g., Sofaer, 2000). A possibly more fruitful approach, rather than to attempt the palaeopathological diagnosis of osteoarthritis—given the above mentioned difficulties involved in its diagnosis in dry bone—may be to examine the connection of the individual indicators to activity patterns. For example, rather than attempting to diagnose osteoarthritis in skeletal samples, what is the evidence for osteophytes, eburnation, or porosity as standalone indicators to be useful in the reconstruction of activity patterns in past population?

4.2.2. Joint modification indicators and their relationship to activity

In order to assess the usefulness of bony joint changes in activity reconstruction, the clinical literature was examined for the relationship between activity induced mechanical stress and the indicators bioarchaeolgists record in dry bone. The section below examines the evidence of each joint modification indicator that bioarchaeologists record as standard in their data sets (Buikstra & Ubelaker, 1994): (1) osteophytes; (2) eburnation; and (3) porosity. The current clinical evidence base is examined for each of these indicators and their relationship to mechanical stress or activity.

4.2.2.1. *Osteophytes*

It has been long debated whether osteophytes are functional adaptations or pathological phenomena. Osteophytes are ‘fibrocartilage-capped bony outgrowths’ on the periphery of joints. They arise in the periosteum overlying the bone at the junction of bone and cartilage (van der Kraan & van den Berg, 2007). They are easily identifiable both on medical imaging and in dry bone. Osteophytes grow in the non-weight bearing parts of the joint, at the junction of the periosteum and the synovium.

Osteophyte formation is thought to result from the joint’s attempt to stabilise itself (Lajeunese & Reboul, 2007; Rogers, 2000). These bony outgrowths are considered stabilizing structures that redistribute biomechanical forces (Felson et al., 2005; Menkes & Lane, 2004), however, this simultaneously limits the natural motion of the joint and can produce limited range of motion and pain (Lajeunese & Reboul, 2007). Studies have shown that osteophytes in the knee and spine potentially serve to limit instability by resisting some movement and that removing them surgically significantly increases the range of motion (Al-Rawahi et al., 2011; Colnot et al., 2012). These studies suggest that osteophyte formation, rather than being part of a degenerative process or pathological phenomena, may be part of an adaptive process serving mechanical functions in stabilizing joints.

Further evidence that osteophyte formation and joint degenerative disease are not necessarily causally related is that they do not always co-occur with cartilage alteration or joint deformity. Osteophytes have been associated with osteoarthritic changes, however, their presence is often observed without cartilage damage in otherwise seemingly health joints (van der Kraan & van den Berg, 2007). Conversely, joint have been observed with severe cartilage damage and no osteophyte formation (Alonge & Oni, 2000). Even though osteophytes are used in the clinical diagnosis of osteoarthritis, their appearance on diseased joints varies greatly, and does not necessarily indicate the stage of the disease or the presence of the disease. It is possible that both processes are initiated by the same factors, but develop independently of one anther (van Beuningen et al., 2000). Some bioarchaeology researchers have suggested that the pathophysiological mechanisms operating at the joint margins may be different from those of involved in changes at the joint surface and recommend the evaluation of the indicators used in the diagnosis of osteoarthritis separately (Weiss & Jurmain, 2007).

Osteophytes are considered an age related phenomenon, with most individuals acquiring them starting in the third decade of life (Roberts & Manchester, 2005). This has led researcher to developed age estimation techniques for forensic applications that rely on osteophyte quantities (Listi & Manhein, 2012; Praneatpolgrang et al., 2019). However, the relationship of osteophyte formation to the biological ageing process is not well understood, with recent evidence suggesting that other factors are involved in their aetiology. Mechanical loads, for example, may play a role in their initiation and subsequent development. For example, several studies have demonstrated that there is a relationship between osteophyte severity and their position on the vertebral column (Bridges, 1994; O'Neill et al., 1999; Van der Merwe et al., 2006). According to this research, osteophytes increase in severity from cervical to lumbar regions, suggesting that increased mechanical loads have a positive relationship with their development, indicating that osteophyte development maybe an adaptive process.

Other studies have also suggested that osteophyte formation is a process resulting from an adaptation to mechanical stimuli, and may be part of a response that attempts to stabilise joints. He and Xinghua (2006), for example, found vertebral osteophyte formation to be involved in the stabilization of the spine. They reported progressive changes in osteophytes as a result of changes to the mechanical environment. Their models indicated that the progression of intervertebral disc degeneration correlates with the progressive growth of osteophytes. However, when the disc degeneration reached a steady state, so did the osteophyte proliferation. Hsia and colleagues (2017) offered more evidence to support the idea that osteophyte formation is a process the body uses to stabilise joints. By studying murine models, they found similarities in the responses of fracture repair processes (early callus formation) and osteophyte development. Similarities include that both fracture calluses and osteophytes start as cartilaginous features that mineralise over time, and that both are stabilizing structures for mechanically unstable anatomical sites. These results are congruent with earlier studies that also observed similarities in the processes of osteophyte and bone fracture callus formation (Colnot et al., 2012; Schett et al., 2009). Further evidence that osteophytes can be mechanically induced are reported based on animal studies by Venne and colleagues (2020). Their study on rats indicated that, in their experiments, a single mechanical impact to the periosteum of a knee induced the proliferation of visible osteophytes by the third week after the intervention. They concluded that moderate blunt trauma to the knee periosteum plays a role on the development of osteophytes, further buttressing the notion the periosteal response in osteophyte initiation is mechanically induced. These studies suggest the periosteum of joints may be vulnerable to macro or microtrauma induced by mechanical stimuli and may contribute to the development of osteophytes without other degenerative changes.

Osteophyte formation in relation to general levels of activity has been reported in experimental studies using animals as well as using longitudinal studies in human populations. Experimental research using animals has shown that osteophyte formation may be related to general activity levels. For example, Wallace and colleagues (2022) tested whether activity is related to cartilage degeneration, synovial inflammation, and osteophyte formation in guinea pigs. Changes to the histopathology of the proximal tibia were analysed in two groups. One group was the ‘active’ group, and another ‘inactive’. The active guinea pigs were allowed free range movements, while the movements of the ‘sedentary’ group were restricted. After the experimental period, the results showed that cartilage degeneration and synovial inflammation were significantly higher in the sedentary group. Osteophyte formation was higher in the active group with 67% of the animal exhibiting the marker, compared to 53% in the sedentary group. However, the size of the osteophytes was 95% larger in the sedentary group. Thus, this study shows activity-related changes at the margins of the joints in guinea pigs.

Although it is difficult to know the relevance of animal models to human populations, high quality longitudinal studies of human participants have also indicated an increased risk of osteophyte formation from higher levels of activity. A systematic review by Urquhart et al. (2011) reported a positive association between physical activity and osteophytes on the tibia and femur at the knee. Systematic reviews are considered the gold standard, and at the top of the clinical and epidemiological evidence hierarchy. They not only consider the results and conclusions of research studies, but the quality of the study design. A quality tool is applied that filters out low quality study designs and results. Urquhart et al. (2011) reviewed 37 studies that investigated the association between physical activity and joint changes as seen on radiographs or MRI imaging at the knee. The researchers found thee high-quality longitudinal studies that indicated that there was strong correlation between physical activity and the development of osteophytes at the knee. Two of the studies were from the Framingham Study, that began in the 1940s and followed a cohort of individuals for various health risks. The third study assessed joint modification changes in runners’ radiographs at baseline and again at 2-year follow-up. Female runners showed more osteophyte formation in the knee comparted to the non-runners. These studies led Urquhart et al. (2011) to conclude that osteophyte formation is related to physical activity.

The studies conflicted in reporting the increase in risk of joint space loss. Therefore, the authors suggest that physical activity may differentially affect osteophyte development and the narrowing of the joint space.

In summary, osteophyte formation is a complex process that is associated with both ageing and mechanical stimuli. Evidence from various studies suggests that osteophyte formation is not just a part of the natural ageing process, but instead is a response to changes in the mechanical environment of joints throughout life. The formation of osteophytes may play a role in the stabilization process of joints limiting the natural motion of the joint. Studies using both animal models and human populations have indicated that higher levels mechanical stimuli or physical activity are associated with an increased risk of osteophyte formation. Furthermore, because the formation of osteophytes is cumulative in nature it is also associated with age. Based on the evidence presented above, this thesis considers osteophytes to be a standalone phenomenon separate from other ‘degenerative’ or osteoarthritic processes. This research aims to explore the relationship between osteophyte formation and physical load applied to joints.

4.2.2.2. *Eburnation*

Eburnation is the term used to describe the condition in dry bones in which the subchondral bone has developed a smooth polished appearance (Ortner, 2003, p. 547). This appearance is produced by the bone on bone contact at sites with complete cartilage volume decrease (Molnar et al., 2011). Eburnation is said to be the only pathognomic diagnostic criterion able to identify osteoarthritis in dry bone (Waldron, 2012), and is considered a late stage indicator of the disease (Ortner, 2003; Weiss & Jurmain, 2007), with considerable effects on activities of daily living and disability. Clinical studies on the relationship between activity and cartilage volume of load bearing joints have shown inconsistent results. Whether eburnation as an osteological marker is a reliable indicator of activity levels in ancient populations has been debated by bioarchaeologists for decades. However, recent evidence suggests that mechanical loads may play a significant role at least in the initiation of the cartilage degeneration process.

Mechanical stress initiates the cartilage degeneration process by causing microtrauma at the osteochondral junction. The osteochondral junction, also called the tidemark, is the zone of transition between the hard and the soft tissues of synovial joints. It is the zone where subchondral bone meets the cartilage. It is a critical tissue in mitigating stress while the joints are under load. Abnormal loading can lead to microfractures within both the tidemark and in the underlying subchondral bone (Lajeunese & Reboul, 2007). The osteochondral junction is usually a barrier to molecular pathways that have been implicated in the initiation or in the involvement of the cartilage degeneration process (Donell, 2019).

Microfractures at the osteochondral junction can alter the synthesis of cartilage proteins by chondrocytes and activate the synthesis of proteinases, both of which contribute to the degeneration of the cartilage matrix (Goldring, 2007; Heinegård, 2007). The end result is that chondrocytes are not able to maintain the balance between synthesis and degradation of the cartilage matrix. A complex of signal pathways are involved in the progression of the cartilage degeneration, including cytokines, growth factors, and other signalling molecules, produced by the various tissues of the joint, including the subchondral bone, the synovial membrane, the cartilage itself, and other tissues (Hügle & Geurts, 2017). The osteochondral junction is normally serves as barrier to prevent ‘cross-talk' in these signal pathways. When the effectiveness of this barrier is impeded due to microtrauma it affects the progression of the cartilage degeneration (Donell, 2019).

The microdamage from mechanical loads lead to lesions in the subchondral bone that have been termed bone marrow lesions (BML). If the abnormal loading continues the BML will persist, and cartilage loss will occur. At this stage if the abnormal mechanical loads are corrected it is possible for healing to occur. If the BML persists, the remodelling causes an increase in the amount of bone, but a decrease in the mineral density. This is seen as osteosclerosis on radiographs, with fewer and thicker trabeculae (Hügle & Geurts, 2017). Along with microfractures, neovascularization (formation of new blood vessels) is also seen in the subchondral bone and the osteochondral junction, which further increases the capacity of the tissues of the joint for ‘cross-talk' (Donell, 2019). Osteoblastic and osteclastic activity is disrupted and osteoclast activity is increased. Donell (2019, p. 224) has argued that "in normal bone, fractures heal back to bone, but in OA the microfractures heal with fibrous vascular tissue and undermineralised sclerotic bone, implying a similar process to delayed fracture healing." According to Donell (2019) the usual initiator of subchondral remodelling is abnormal mechanical load, which results in microfractures and to a process not unlike a fracture healing response seen in a delayed union or a non-union response by the bone. When the mechanical environment persists beyond the joint tissues' ability to recover from the stress, the cartilage degeneration response will progress (Donell, 2019).

It is clear that the degradation of cartilage in synovial joints is not a wear-and-tear process; however, it may be initiated and progressed by mechanical stress on the joint. The stress can be from two types of traumas: (1) *Low frequency-high magnitude trauma* results in an immediate injury to the joint tissues, or the cartilage itself. This can often lead to posttraumatic, or secondary, osteoarthritis, and subsequent cartilage damage that may lead to eburnation (Punzi et al., 2016). For example, knee injuries such as anterior cruciate ligament ACL tears involve a significant amount of cartilage damage, often with subsequent chondral degradation (Potter et al., 2012). The incidence of posttraumatic osteoarthritis following ACL injury has been reported to be as high as 87% (Friel & Chu, 2013). (2) *High frequency-low magnitude trauma* can cause abnormal tissue loading in joints leading to microtrauma. Microfractures are involved in the initiation of the cartilage matrix destruction pathways, and the continuation of the stress progresses the degradation. Through this progression, cartilage volume decreases which eventually leads to eburnation. This gives bioarchaeologists a potential mechanism or a pathway for activity induced stress to manifest itself in the archaeological body.

4.2.2.3. ***Porosity***

Porosity on dry bone is defined as the “[t]he state of bone tissue caused by perforating pathological lesions” (Manchester et al., 2016, p. 29). On subchondral dry bone, porosity appears as multiple holes of various sizes. Although porosity has been used as part of the palaeopathological diagnosis of osteoarthritis, direct research on the relationship between porosity and activity or mechanical stress is lacking. Rothschild (1997) has argued that the porosity as manifested in dry bone may not even be part of the osteoarthritic process as has been presumed by many biological anthropologists. He argues that there is a lack of correlation between porosity and other indicators of OA such as eburnation, and therefore the examination of porosity should not be involved in the diagnosis of osteoarthritis. The usefulness of this phenomenon as a standalone indicator of activity in the past requires epidemiological or pathophysiological observations about its prevalence, or aetiological pathways in relation to biomechanical stress. However, since porosity is not visible on medical imaging in live specimens, there is a lack of evidence regarding the relationship of this phenomenon to activity in extant populations.

With regard to the aetiology of subchondral porosity in dry bone, there are a number of processes through which ‘holes’ may appear on the articular surface. These include:

- *Neovascularization*: The formation and proliferation of blood vessels and nerves through the tidemark as part of the cellular and biomolecular response of osteochondral tissues to bone marrow lesions (Donell, 2019).
- *Osteosclerosis*: The amount of bone in the subchondral tissue increases as mineral density is reduced. This results in fewer, but thicker trabeculae that may be exposed by the thinning of the subchondral cortical plate (Hügle & Geurts, 2017).
- *Subchondral cysts*: Subchondral cysts are a common formation in osteoarthritis, due to synovial intrusion into the bone (Roach & Tilley, 2007).
- *Bone marrow intrusions*: Vascular invasion of bone marrow tissue into the subchondral plate causing subchondral bone resorption pits, are sometimes implicated in the osteoarthritic process (Shibakawa et al., 2005).

Clear protocols are lacking to aid in the identification of each of these clinical features in dry bone. Therefore, bioarchaeologists are unable to clearly identify which process created the porosity seen on dry bone in their samples using macroscopic observations (Jurmain, 1999). Further evidence is needed in order to determine what different types of porosity in dry bone are present in the clinical literature, and how they are impacted in mechanical loading. For this reason, the analysis of the porosity data which was collected as part of the standard data collection protocol, was not analysed for this thesis.

4.2.3. Mechanical stress and tissue (bone) adaptation

For close to a century, biological anthropologists and bioarchaeologists have used the long-standing perception that there is a relationship between levels of physical activity and the accumulation of ‘wear’ on joints. This wear was recognised in the form of osteophyte formation, articular surface porosity, and eburnation on the subchondral bone. These plastic changes were seen as a response to the applied stress, with a general cause and effect relationship between the mechanical stress and ‘degeneration’ of the skeleton. The persistence of this idea for so long is surprising given that bioarchaeologists in other areas of activity reconstruction have long acknowledged the plastic nature of bones, and their ability to respond to stress to strengthen. Bioarchaeologists reconstructing activity patterns using cross-sectional geometry and entheseal changes have used theory, such as Wolff's Law, that acknowledges that skeletal tissues respond positively to mechanical loading, and not in a degenerative way (Pearson & Lieberman, 2004).

Wolff’s Law states: “The form of a bone being given, the bone elements place or displace themselves in the direction of the functional pressure and increase or decrease their mass to reflect the amount of functional pressure” (Wolff, 1892). Wolff’s Law has three major tenets:

1. Bone must be strong enough for support but light enough for locomotion
2. Trabeculae in the bone align themselves along the direction of principle strain
3. This is accomplished by self-regulating mechanisms as the bone responds to mechanical loads (Pearson & Lieberman, 2004)

Wolff’s Law applies specific mathematical rules that govern the remodelling process in bone and is based on the assumption that mechanical loading of bones will cause specific osseous responses affecting bone morphology (shape). This has been argued to be based on biomechanical misconceptions, that does not consider the living nature of the bone (Cowin, 2001; Pearson & Lieberman, 2004). This theory holds that increased physical activity leads to changes in bone morphology such as cross-sectional size and bone density. The reverse has also been argued with lower levels of mechanical loads correlating with a decrease in bone size (Gilsanz et al., 1994). This suggests an upper and a lower threshold which cause changes in the bone to occur either in a positive or negative manner (Barak et al., 2011). These are the basic tenants of Frost's (1987, 2003) mechanostat model which hypothesises a homeostatic feedback loop to regulate bone remodelling. According to this model when the amount mechanical stress exceeds an upper threshold, bone formation will occur to strengthen it. If the mechanical stress remains in a customary strain zone, no bone response is elicited. When the strain is below a lower threshold below the customary strain, bone resorption occurs.

This bone remodelling theory has been used in bioarchaeological studies of activity in skeletal samples using cross-sectional geometry and musculoskeletal stress markers (Jurmain et al., 2012). However, it has not been applied in the same manner to the bone markers that bioarchaeologists record around joints. Joint modification changes are still often thought of as general indicators of a wear-and-tear mechanism without considering the qualities and quantities of the mechanical load in conjunction with and the prior adaptive state of the tissues. Since bone consists of the same tissues throughout, it should be possible to assume that mechanical loads do not ‘wear out’ some regions of the human body while strengthening others. Therefore, bioarchaeologist must consider the relationship between activity and tissue response as ‘dose’ dependant. To understand how bone, and the surrounding soft tissues respond to mechanical load that is consistent in cortical, trabecular, subchondral, and periarticular bone, a previously unused model of tissue stress and response was employed in this research. The physical stress theory model described below is useful for bioarchaeologists to understand tissue adaptation in response to mechanical loads, which is important in the study of activity related osseous changes.

4.2.3.1. *The physical stress theory model*

The physical stress theory model is a model which has seen increasing uptake in clinical practice in orthopaedic rehabilitation as well as in the quantification of training volume stress for injury prevention and management in athletic training (Paquette et al., 2020). The theory presents a framework for the body’s tissue response to physical/mechanical stress, such as load and overload, in understanding the potential for tissue injury. An often used figure to illustrate the ‘injury potential’ of a biological structure is the fatigue curve (Hreljac, 2004). The fatigue curve is a simple way to represent the amount of stress and the number of repetitions required to reach the injury potential of a particular structure (Figure 4.1). The curve illustrates the relationship between magnitude of the stress and the frequency of the stress occurrence. Larger magnitude stress needs to occur less often to cause injury, while lower magnitude stress is required to occur repeatedly for tissue injury. It also illustrates that the removal of the stress would avoid injury. A static curve, however, does not adequately cover the injury potential of biological tissues, because biological tissues of the body have the ability to adapt and the curve then changes dynamically.

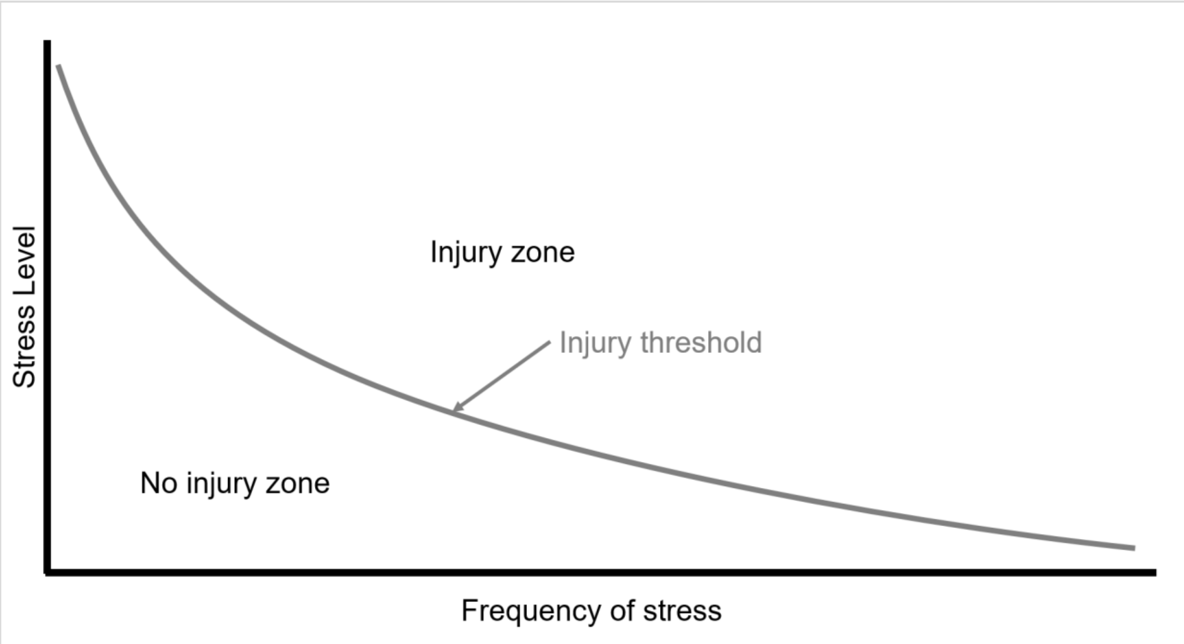

Figure 4.1 The fatigue curve - showing theoretical relationship between stress level, stress frequency, and injury threshold or injury potential. Adapted from (Hreljac, 2004).

Dye (1996, 2005) presented a more dynamic model referring to the injury threshold as the ‘envelope of function’ (Figure 4.2). This model presents thresholds or zones of adaptation, depending on the stress sustained by the biological tissues. The envelope of function represents a threshold below which is the homeostatic loading zone. Mechanical loading in this zone achieves tissue maintenance. Loading above the threshold qualifies loads as sufficiently great for the body to initiate tissue inflammation and repair process (supraphysiologic load). Dye (1996, p. 13) argues that in this supraphysiologic zone a complex biologic cascade of trauma induced inflammation occurs that is “manifested clinically by discomfort, tenderness, swelling, and warmth.” According to Dye, this pain is a phenomenon that functions as a type of negative feedback loop to warn the organism of possible damage if the load is left unchanged (2005). Dye also presents an upper and a lower threshold. The upper threshold represents forces that result in macrostructural failure such as tissue tears or fractures. The lower threshold of loading may results in loss of tissue homeostasis, for example, from disuse atrophy (Dye, 2005). When the applied stress is very low or removed completely, tissue resorption occurs, and the structure is weakened.

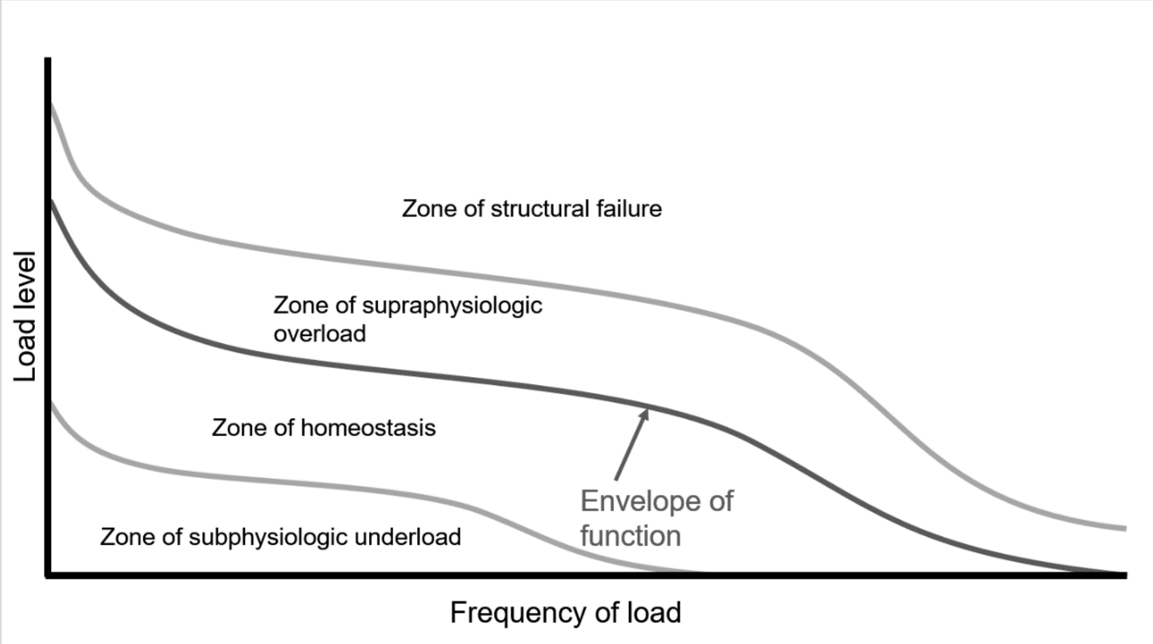

Figure 4.2 Envelope function with 4 zones of loading. Adapted from Dye (2005).

A more in-depth theory was put forward by Mueller and Maluf (2002) which presents biological tissues' ability to adapt and respond to physical stress to modulate the body's physical stress tolerance. Their 'Physical Stress Theory' more adequately addresses the temporal response of tissues to mechanical stress than other prior models. The basic premise is that "changes in the relative level of physical stress cause a predictable adaptive response in all biological tissues" (Mueller & Maluf, 2002, p. 383). Along a continuum of stress levels specific predictable responses will in specific zones of adaptation (Figure 4.3). Zones of adaptation are separated by threshold levels, defining the lower limit of one response from the upper limit of another response. Tissues respond in 5 possible ways depending on the level of stress:

1. Decreased stress tolerance
2. Maintenance
3. Increased Stress tolerance
4. Injury
5. Death

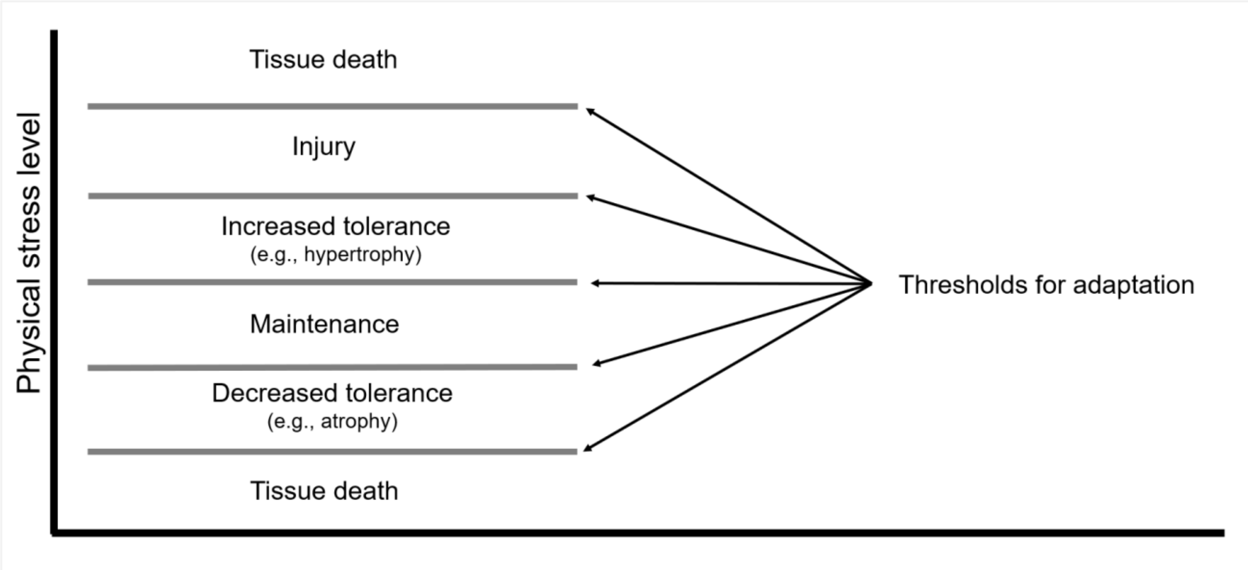

Figure 4.3 Five tissue responses according to the Physical Stress Theory. Adapted from Mueller and Maluf (2002)

Decreased tolerance: Physical stress that's lower in magnitude than what is required for tissue maintenance will decrease the tissues tolerance to successive stress episodes (Figure 4.4). Atrophy is part of this response and occurs when tissue degradation exceeds tissue production. In bone the osteoclastic activity exceeds the osteoblastic activity.

Maintenance: Physical stress levels with magnitudes reaching the maintenance range will not cause adaptive changes in the tissues. This is a homeostatic zone in which tissue degeneration equals tissue production with tissue turnover without loss or gain. This homeostatic state occurs in tissues exposed to an invariable level (in amplitude, and frequency) of physical stress.

Increased stress tolerance: Levels of physical stress magnitude that exceed the maintenance zone will elicit adaptive response that increase tissue tolerance to subsequent stresses (Figure 4.5). This results in hypertrophy which is when tissue production exceeds tissue degradation resulting in an increase in tissue cross-sectional area, density, or volume. An important factor of tissue adaptation to increased mechanical stress is recovery time between episodes of the stress. Adequate recovery time is required between the stress episodes for the adaptive response to manifest.

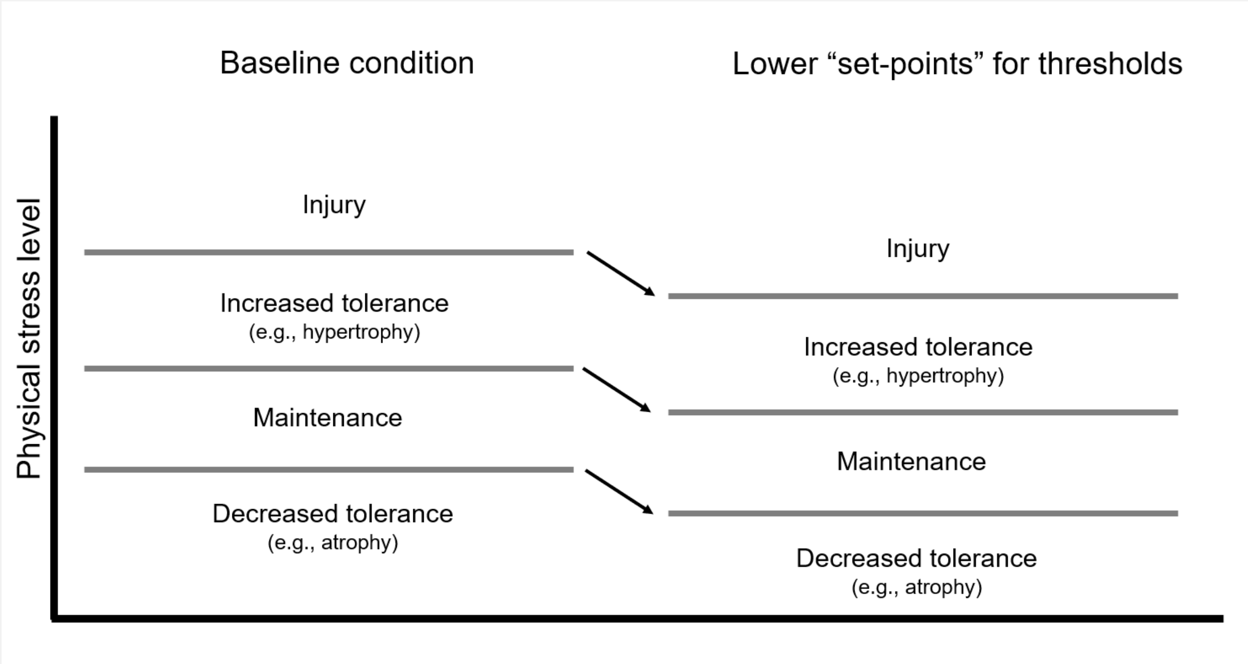

Figure 4.4 Effect of low stress. The thresholds for subsequent adaptation and injury are lowered. Adapted from Mueller and Maluf (2002)

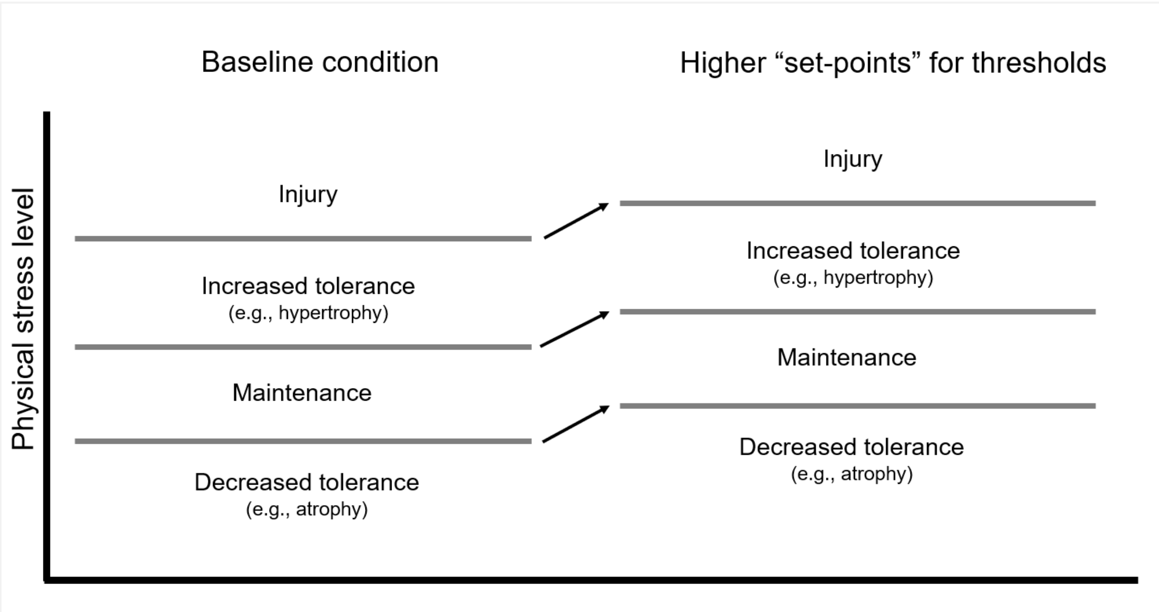

Figure 4.5 Effect of high physical stress load. The thresholds for subsequent adaptation and injury are raised. Adapted from Mueller and Maluf (2002)

Injury: High levels of physical stress will injure tissues. Mueller and Maluf (2002, p. 387) define injury as "tissue damage caused by excessive stress resulting in pain or discomfort, impaired function of the tissue, or both." However, tissue damage can occur even if it does not cause clinical symptoms. When a 'maximum stress threshold' is exceeded, injury can occur. This is the threshold at which tissue begins to fail, given it is fully recovered from previous bouts of stress. Physical stress that exceeds this threshold can cause injury in 3 ways:

1. It is high in magnitude and brief in duration
2. It is low in magnitude and long in duration
3. It is moderate in magnitude and applied frequently (*i.e.*, tissue does not recover)

The level of exposure of the tissue to physical stress is given by the combination of the magnitude (force, amplitude), time (duration, frequency), and the direction (tension, compression, shear, torsion) of the stress. Individual stress episodes combine these factors in a complex way to contribute to the overall level of stress experienced by tissues.

Tissue Death: Mechanical stress with extremely high magnitudes above the maintenance range will exceed the capacity of the tissues to adapt and result in tissue death. Tissue death may occur from exposure to extremely high or extremely low levels of physical stress, from which the tissues consequently are unable to recover. Tissue death in bone may manifest as osteonecrosis.

4.2.3.2. *Accumulation of stress responses*

Tissue response to mechanical stress has a temporal aspect. In other words, the effect of any stress will depend on prior stress applications and the adaptation or misadaptation those stresses have already caused. That is to say, the effects of stress on tissues are cumulative whether it is strengthening or weakening tissue structures. A positive adaptation requires periods of rest. If stress is applied too frequently it will decrease tolerance, and if stress is applied periodically *with sufficient recovery times* the tissue will increase tolerance to subsequent stress. Therefore, the tolerance zones and the adaptation thresholds are modular. They are constantly being modulated by ongoing stress and adapting to the application of those physical loads. Increased tissue tolerance will result in the tissue being able to withstand greater amounts of stress before injury occurs (raised thresholds, Figure 4.6). On the other hand, decreased tolerance renders the tissue more susceptible to injury (lowered thresholds, Figure 4.7). As such, the thresholds of tissues at any particular moment will depend on prior exposure to mechanical stress and the tissues current capacity to respond.

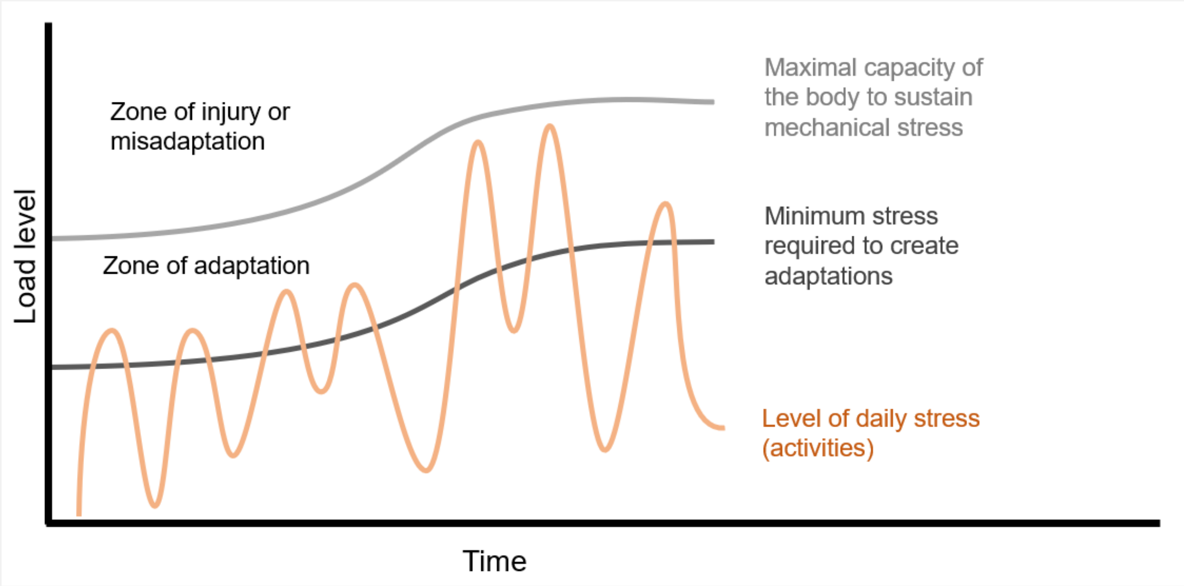

Figure 4.6 Progressive or gradual increase in mechanical stress levels will increase the body's capacity to withstand stress and prevent injury. Original concept by Dubois (2001), used with permission.

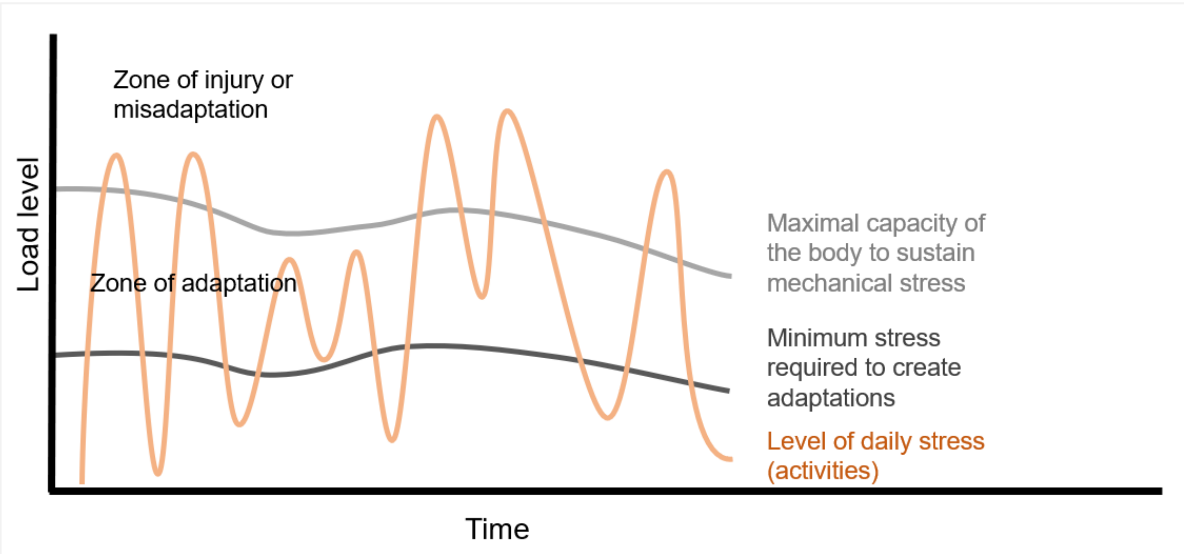

Figure 4.7 Increases in mechanical stress levels over the body's maximal capacity to adapt will decrease the capacity to withstand subsequent stress rendering it more susceptible to injury. Original concept by Dubois (2001), used with permission.

4.2.4. Adaptation response is simultaneous in all tissues

Joints are made up of many different tissues including hard tissues such as bones, connective tissues, such as ligaments, tendons, and muscular and nervous tissue. All of these tissues connect and interact with each other at mechanical and biological levels. They respond to physical stress simultaneously, to protect themselves and each other. All tissues are involved in the initial absorption of the load, and in the subsequent adaptation (increased or decreased tolerance). Therefore, mechanisms that protect joint tissues from high loads involve not only the structures of the joints themselves, but also other tissues in the body. These include muscles directly responsible for the movement of the joint, and muscles further up the kinetic chain. For example, muscles are well known to provide a dampening mechanism for the forces that place stress on the joints (Dye, 2005). The muscle-tendon unit's elastic properties give it energy absorbing properties (Magnusson et al., 2000). It has been estimated that muscles involved in the movement of the knee are able to absorb almost 4 times the energy than they are able to generate (Winter, 1983). When muscular tissue responds to stress by hypertrophy, it not only increases its ability to generate force, but also its ability to dampen mechanical stress.

The thresholds of adaptation of joint surfaces are therefore not only dependent on the bone's ability to adapt, but the entire tissue structure, including connective tissues, such as fascia, tendons, ligaments, and most importantly the muscles. The entire complex responds to the stress not just the bones, and bioarchaeologists need to remain cognizant of this when conceptualizing stress adaptation models. The risk of injury arises when the entire system, or some parts of the system are misadapted, not just the bone, not just the soft tissues of the joints, but also the dampeners, and the breaks (*i.e.*, the muscles, or muscle weakness). Dye (1996, 2005) argued that joints are biologic transmissions where loads get accepted, transferred and dissipated. All structures of the joint, and connected to the joint, play a role in what he called the 'envelope function'. Muscles play a large role within the transmission as they represent both the driving forces providing movement and a breaking and dampening system. Muscle weakness, in both strength and endurance, is a well-known risk factor for predisposition to musculoskeletal injuries (de la Motte et al., 2017).

The physical stress theory model predicts that appropriate amounts of activity and rest results in the strengthening of tissues related to a joint. Inactivity, on the other hand, weakens the tissues and muscles by returning to the zone of homeostasis for a lower level of stress, and their ability to withstand mechanical loading at higher levels diminishes. This leads to increased susceptibility when high stress activities resume. Muscles weaken after periods of inactivity or decrease in activity, by atrophy, losing mass and strength. Research shows that after a period of inactivity muscle strength is lost relatively quickly. Vigelsø and colleague's (2015) research indicates that in previously highly active individuals who undergo leg immobilization, muscle strength diminishes after two weeks by as much as 30 percent. This is a concern for high-level athletes in the off-season, who are advised to keep active between training seasons (Paquette et al., 2020). The model also predicts that higher levels of physical stress with inadequate time for recovery, also lead to misadaptation and injury.

4.2.5. Applying the physical stress theory to joint modification in bioarchaeology

The physical stress theory model in bioarchaeology is useful because it allows for the conceptualization of hard tissue joint modifications observable on dry bone, not as a result of 'wear-and-tear' but as a result of cumulative adaptive responses to ongoing and changing physical stimuli. Therefore, bodily stress responses that are determined to be resulting from a misadaptation response, or overuse injuries such as stress fractures, could be viewed not as simply a result of cumulative stress but as a result of stress that the body was not adapted to withstand, or to respond to positively to prevent injury. Periods during which the body is not 'ready' to handle specific amount of mechanical stress are following periods of inactivity or lowered levels of activity, that render the body at-risk when higher levels of activity or mechanical stress resumes. This could be lower 'off-season' activity levels during which the tissues return to a prior state of homeostasis that is required at those lower activity level. Consequently, once the activity resumes at the higher magnitudes of stress, the structures may not be 'ready' for higher mechanical loads, and lead to tissue failure (injury). This is to argue that according to the physical stress theory model, periodic, episodic, or punctuated activity is more likely to cause tissue damage than activity which is sustained. Accordingly, wear-and-tear does not occur from ongoing activity to which the body can adapt, but from activities that cause mechanical stress levels that exceed the body's ability to positively respond.

Such periodization of activity may occur in populations in which physical training or work is seasonal. Seasonal high intensity activities may have higher prevalences of these markers such as agricultural populations, where the same jobs are not being performed daily throughout the year. For example, Weiss and Jurmain's (2007) literature review provided evidence that populations involved in farming show significantly higher prevalences of some types of joint disease. The interpretation of this finding was that since farmers are involved in manual labour throughout their lives, they are at a higher risk of developing such diseases. However, using the physical stress theory model, it could be argued that this elevated risk stems not from the engagement in lifelong strenuous physical activity, but rather results from engagement in intermittent or seasonal high intensity activities. Such periodic activities would place bodies under periodic mechanical loads to which the tissues would not be adapted, resulting in a (mal)adaptive responses seen as joint modification markers. Therefore, for bioarchaeolgists examining activity through joint modification markers, the 'wear' observed may be indicative of periods of inactivity followed by periods of high intensity activity that the body is not adapted to handle, rather than continuous activity. Bioarchaeological studies should closely examinate of patterning of joint modifications indicators for distributions of stress and overload. For example, if certain joint modification indicators are found in greater prevalence in the joints of the upper body, this may suggest a greater emphasis on upper limb activities that periodically overloaded the joint structures.

It is important to keep in mind that bone adaptation is not the only mechanism in joint tissue response to activity. With respect to osseous changes to joints, it is important to consider the modulating effects of all the tissues surrounding the joint of interest as well. Connective tissues and muscle tissues involved in its movement and stabilization may mitigate or amplify the mechanical stress. Furthermore, researchers also need to consider the quality and the quantity of the activity when interpreting the patterning of skeletal joint modification indicators. The stress theory model can be helpful here in interpreting the relationship between activity and osseous changes because it allows for the consideration of activity modulation (variations in load frequency and amplitude). This highlights the importance of considering the dosage relationship between activity and its physical manifestation as evidenced on skeletal remains and embodied in archaeological bodies. This concept is aligned with recent theorisation of the archaeological body in bioarchaeology as a plastic, material-discursive, and a sedimented entity, that embodies the lived experience of once living individuals.

Chapter 5: Methods

Exploring gendered lived experiences through novel theoretical frameworks in bioarchaeology does not necessitate the use of new methodological approaches. On the contrary, theoretical bioarchaeologists should fall back on standard methods to maintain methodological rigour, while interpreting the results with a new interpretive lens. This study aimed to explore men’s performance of masculine discourses in medieval Alba Iulia, and its embodied manifestation through skeletal health outcomes. Therefore, skeletal indicators that may provide insight into risk and physical activity were examined, which were inferred from observations using skeletal trauma and through joint modification indicators. This chapter outlines the methods used in the collection of data that were employed in the inferences about risk through the analysis of blunt and implement trauma, as well as inferences about general activity patterns through the analysis of osteophytes and eburnation. For precise prevalence figures, it was necessary to compile an accurate inventory of each element preserved in the skeletal sample. Given the focus of this research on gender identity, it was important to assess sex based on preserved skeletal indicators. Furthermore, since the expression of gender is influenced by age, accurate skeletal age estimation methods were also required to be employed. Accordingly, the following sections outline the methods employed for inventory compilation (section 5.1), sex and age estimation (sections 5.2 and, 5.3 respectively), trauma analysis (section 5.4), and joint modification analysis (section 5.5).

5.1. Inventory and preservation

For an accurate inventory, data were collected from the entire sample available from the cemetery. Inventory was taken of each *bone*, *segments* of bone, *group* of bones, or *region* of the skeleton as outlined below, for each skeleton representing an individual in the Alba Iulia sample.

> *Bone*: skeletal element
>
> *Segments*: the portions of long bones including the proximal and distal ends (epiphyses, including metaphyses) and the shafts (diaphyses)
>
> *Group*: group of bones from the same anatomical region that were scored as a unit; for example, carpals, phalanges, and tarsals
>
> *Region*: a cluster of bones scored as a unit such as the calvarium, face, and mandible

During data collection if a bag/grave was determined to contain the remains of multiple individuals, the skeletons were assigned a designation of a, b, *etc*. (*e.g.*, M001a, M001b). Each bone, segment, group, or region was assigned a representation score according to the following scale (Table 5.1):

(0) missing
(1) under 50% present
(2) 50-75% present
(3) over 75% present

5.1.1. Representation and inventory of the bones of the head

Three regions of the head were recorded separately on the scale mentioned above, from 1 to 3. These regions were the calvarium, the face, and the mandible. For example, if the entire calvarium was more than 75% present, it was scored a 3. Similarly, if only one side of the face was present, therefore, less than 50%, it was scored a 1. Completeness of each cranial and facial bone was not recorded in detail.

5.1.2. Representation and inventory of long bones

Long bones were divided into 3 segments and each portion scored separately. The segments were: proximal end segment (metaphysis + epiphysis), diaphysis, and distal end segment (metaphysis + epiphysis). The clavicle was recorded in two segments, the medial (sternal) half, and the lateral (acromial) half. Segments were scored on the 1 to 3 scale for completeness. The ‘system of squares’ proposed by Müller et al (1990) and presented in Judd (2002b), was used to determine the size of the proximal and distal end segments. According to this method the size of the end segment is “delimited by a square whose sides are the same length as the widest part of the epiphysis in question” (Judd, 2002b, p. 1258). For the size of the distal and proximal ulna and fibula Judd’s recommendation was followed, which recommends that the length of the segment be increased to twice the width. Moreover, the proximal femoral segment was considered to be the portion superior to a line that transverses the inferior margin of the lesser trochanter (Figure 5.1).

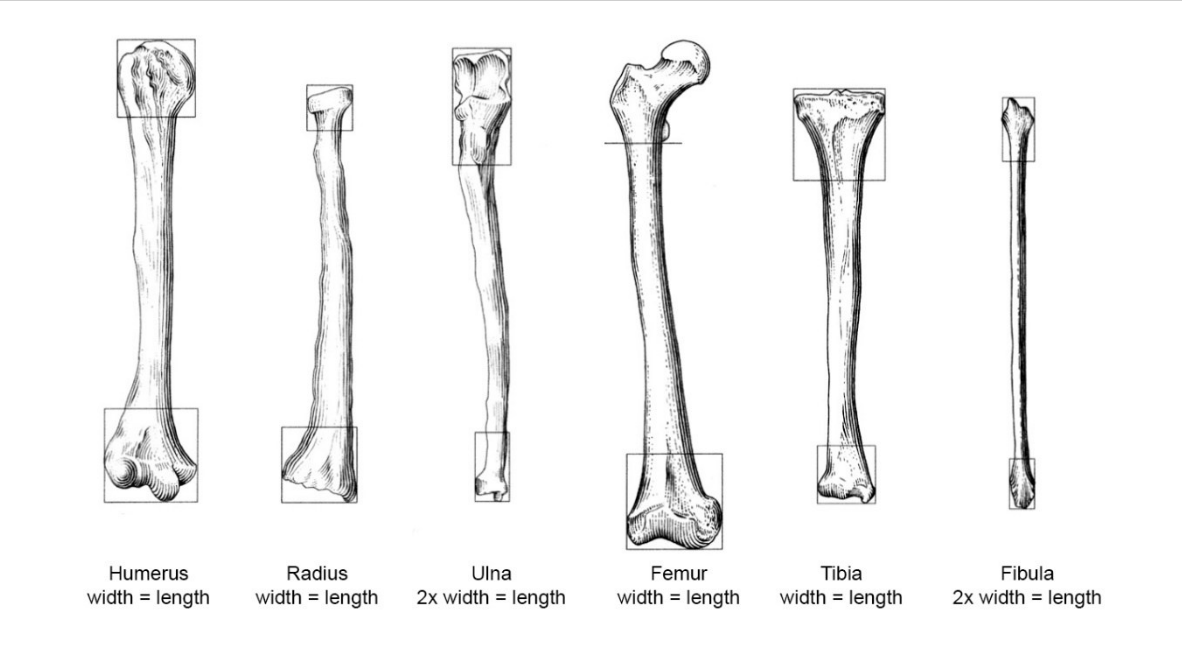

Figure 5.1 'System of squares' method used in determining size of proximal and distal segments of long bones. Figure adapted from Judd (2002b, p. 1259).

5.1.3. Representation and inventory of the axial skeleton

Vertebrae: Recorded on the same scale of completeness from 1 to 3. Cervical, thoracic, and lumbar vertebrae were scored as a group. For example, if there were 4 out of 7 complete cervical vertebrae, it was scored as a 2. Additionally, the number of vertebral bodies present were recorded.

Ribs: Representation of ribs was recorded on the 1 to 3 scoring system grouped as left and right. For example, fragments were sided as accurately as possible, and the percentage of ribs present per side was estimated. As ribs were relatively fragmentary, this was a best guess based on the number of fragments observed. When intact ribs were present the score was based on rib counts plus fragment estimates. Intact ribs were scored the following way: 1 = 1 to 6 ribs present; 2 = 6 to 8 ribs present; 3 = 9 to 12 ribs present. For example, an individual who had 6 intact ribs present for one side and some fragments was scored a 2.

Sternum: Representation of the sternum was recorded on a scale of 1 to 3 with each portion given a score of 1 if present. For example, if all bones were present including the manubrium, the body, and the xiphoid process, it received a score of 3.

Sacrum: Sacrum as a whole was scored on a scale of 1 to 3 with the alae representing 2 of the 3 points. For example, if a sacrum was intact except it was missing one of its auricular surfaces it would receive a score of 2.

Scapula: The scapula received 3 separate scores on a scale of 1 to 3. The portions scored were the body, the glenoid, and the acromion process. For example, a scapula with the body complete, the acromion missing, and the glenoid missing half of its inferior surface, received a score of 3, 0, 2.

Os Coxae: The os coxa was scored on a scale of 1 to 3 with each score representing a portion of the element. For example, a complete os coxa received a 3 for having the ilium, ischium, and the pubis present. The acetabulum was scored separately on its own 1 to 3 scale.

Table 5.1 Scoring of representation of regions, elements, and segments

Region / Element	**Scoring**
Head	
Calvarium (as whole)	1 – 3
Face (as whole)	1 – 3
Mandible (as whole)	1 – 3
Long Bones	
Clavicle – Medial half Lateral half	1 – 3 1 – 3
Humerus - Proximal Diaphysis Distal	1 – 3 1 – 3 1 – 3
Same for Ulna, Radius, Femur, Tibia, Fibula	
Axial	
Sternum	1 – 3
Ribs – Left (as group) Right (as group)	1 – 3 1 – 3
Vertebrae Cervical # of bodies Thoracic # of bodies Lumbar # of bodies	 1 – 3 # observed 1 – 3 # observed 1 – 3 # observed
Sacrum	1 – 3
Other	
Scapula - Body Glenoid Acromion	1 – 3 1 – 3 1 – 3
Os Coxae Acetabulum	1 – 3 1 – 3
Hand bones (as group)	1 – 3
Patella	1 – 3
Foot bones (as a group, excluding talus and calcaneus)	1 – 3
Talus	1 – 3
Calcaneus	1 – 3

Scoring key: 1 = under 50% is present; 2 = 50-75% is present; 3 = over 75% is present. Left and right sides were scored separately for bilateral elements.

5.1.4. Representation and inventory of other elements

Hand and foot bones: The bones of the hand (carpals, metacarpals, phalanges) and the foot (tarsals [excluding the talus and calcaneus], metatarsals, and phalanges) were scored as a group on a scale of 1 to 3. The talus and calcaneus were recorded separately and individually on a scale of 1 to 3.

Patella: The patella was scored based on the amount of bone preserved on a scale of 1 to 3.

Missing elements, portions, and groups were scored as 0.

Completeness of an individual skeleton was calculated by tallying the scores for each element, portion, and group and dividing it by the total possible score of 210.

5.2. Sex assessment

Given the research objective's focus on gender differences, it was important to determine the biological sex of individuals within the sample. Accordingly, sexually dimorphic traits were evaluated in all adult skeletal remains that had the necessary anatomical regions for standard sex assessment analyses intact. This method established a reliable basis, for exploring how gender, biology and social interactions intersected within the population under study. Adults for whom age estimates were over 20 years were then assessed for sex. Nonadults were excluded from sex assessment because of underdeveloped morphological characteristics that render sex assessment in adults possible from the pelvis and the skull. Although techniques exist to assess sex of nonadults from long bone and dental measurements, these were not used because element and tooth size are influenced by a multitude of factors other than biological sex, and therefore these techniques provide estimates with low accuracy (Mays, 1998; Mays & Cox, 2000).

Sex assessment in human skeletal remains relies on the observation that humans are a sexually dimorphic species, with males generally larger in size and more robust than females (White & Folkens, 2005). The differences in morphology between male and female adult skeletons are sufficient to allow the assessment of biological sex in many cases (Mays, 1998). The skull and the pelvis are the most sexually dimorphic regions of the skeleton with the pelvis being the more reliable area, and is given the most weight in osteological sex assessments (Mays, 1998). Because the extent of sexual dimorphism exhibited by individuals varies across distinct characteristics a number of markers were observed in the sex assessment process following traits outlined in Buikstra and Ubelaker (1994).

Using the cranial and pelvic attributes the individuals were places into the following initial sex categories:

- Definite female

- Probable female
- Definite male
- Probable male
- Unknown (intermediate)
- Unknown (unobservable)

Table 5.2 Criteria for initial sex categories

Definite	• most pelvic and cranial features and most scores indicate high probability of sex • pelvic features present and most of them indicate high probability of sex • cranial features present and glabella, mental eminence, and orbit, all have scores of 1 (female) or 5 (male)
Probable	• most pelvic and/or cranial features are present, but scores are medium probability • some (2 to 3) pelvic or cranial features present with high probability of sex
Unknown (intermediate)	• most pelvic and cranial features are present, but scores are ambiguous • most pelvic features are present but scores ambiguous • most cranial features are present but scores ambiguous
Unknown (unobservable)	• no pelvic of cranial features present, or material very fragmentary

5.2.1. Skull features used in sex assessment

Human skulls exhibit sexually dimorphic features due to size and robusticity differences between males and females (Mays, 1998). The crania of males have a more pronounced supra orbital ridge, nuchal crest, and mastoid process (Mays & Cox, 2000), and male mandibles also have characteristically broader jawlines and squarer chins (White & Folkens, 2005). Sex assessment from cranial features has been reported to be up to 80% to 90% accurate (Mays & Cox, 2000, p. 119), with some researchers reporting a 92% accuracy in some modern samples (Meindl et al., 1985).

Sexually dimorphic characteristics of the cranium and mandible were scored following the methods outlined in *Standards* (Buikstra & Ubelaker, 1994). A total of five traits were scored including the nuchal crest, the mastoid process, the supraorbital margin, the prominence of glabella, and the mental eminence. Scores were recorded on an ordinal scale from 1 to 5 following the figures in *Standards* (Buikstra & Ubelaker, 1994, p. 20).

5.2.2. Pelvic features used in sex assessment

The human pelvis is a sexually dimorphic structure of the body with observable anatomical differences in males and females (Whitehead & Barrett, 2001a). Stemming mostly from functional adaptations to childbirth, the bones, including the os coxa (ischium, pubis, and ilium) and the sacrum exhibit anatomical differences that can be used to assess the sex in skeletal remains (White & Folkens, 2005). These differences in morphological appearance make this section of the human skeleton the most reliable for sex assessment in bioarchaeological and forensic contexts (Mays, 1998). For example, regions of the pubic bone including the subpubic concavity, ventral arch, and ischiopubic ramus (Phenice, 1969), and other portions of the os coxae, including the subpubic angle, and the greater sciatic notch (Bass, 1995; Buikstra & Ubelaker, 1994), have been reported to produce reliable sex assessments. Lovell (1989), for example, has reported the traits of the pubis to be up to 83% accurate. In addition to these classically observed traits, a more recently reported sexually dimorphic feature of the pelvis is the 'composite arch' (Bruzek, 2002) as also used. This is a visual examination technique examining the relationship of the anterior margin of the sciatic notch relative to the anterior portion of the auricular surface. Lastly, the preauricular sulcus also used as it has also been reported to be an indicator of sex difference, although its usefulness in accurate identification has been questioned by Karsten (2018).

Accordingly, the following sexually dimorphic features of the os coxae were scored: subpubic concavity, subpubic angle, ventral arc, ischiopubic ramus ridge, and greater sciatic notch (Buikstra & Ubelaker, 1994; Phenice, 1969), composite arch (Bruzek, 2002), and the preauricular sulcus (Karsten, 2018). Traits were scored on an ordinal scale from 1 to 9, with the exception of the preauricular sulcus which was scored on a scale of 1 to 4. The scores from 1 to 9 represented a continuum from male features to female features (1=definite male feature; 9=definite female feature). The 9-point scale was used following established protocols at the Francisc J. Rainer Institute of Anthropology, Bucharest, Romania, at the request of its directors to standardise data collection in their facility (Soficaru & Constantinescu, 2013; following Steckel et al., 2006). The preauricular sulcus scores recorded were based on the following criteria: (1) preauricular area is smooth, no clear evidence of a sulcus; (2) small sulcus is clearly present; (3) sulcus is moderate in size; (4) large well-defined sulcus is present (Soficaru & Constantinescu, 2013). Following cautions by Karsten (2018), the preauricular sulcus was never used as standalone indicators for sex, but aways in conjunction with at least another pelvic or cranial indicator. Karsten (2018) argued that the absence of a sulcus may indicate a male, however, its presence does not necessarily indicate a female.

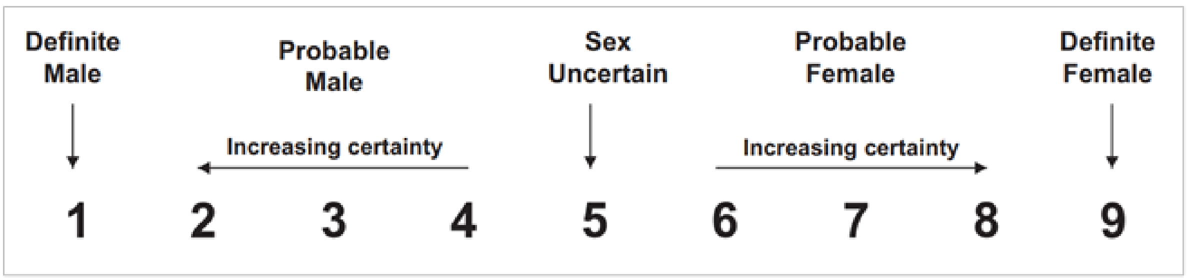

Figure 5.2 Scoring system for the pelvic sex assessment traits (from Steckel et al., 2006)

Table 5.3 Sexually dimorphic features examined on the pelvis

Pelvic feature	Reference
Subpubic concavity	(Buikstra & Ubelaker, 1994; Phenice, 1969)
Subpubic angle	(Buikstra & Ubelaker, 1994)
Ventral arch	(Buikstra & Ubelaker, 1994; Phenice, 1969)
Ischiopubic ramus ridge	(Buikstra & Ubelaker, 1994; Phenice, 1969)
Greater sciatic notch	(Buikstra & Ubelaker, 1994)
Composite arch	(Bruzek, 2002)
Preauricular sulcus	(Karsten, 2018)

5.2.3. Metric analysis to aid sex estimation

The fragmentary nature of the skeletons in the Alba Iulia sample meant that numerous skeletons were missing anatomical features required for sex assessment. Therefore, an index of sexual dimorphism was established to enable sex estimation based on long bone measurements to expand the dataset. The index of was established based on individuals whose sex was confidently estimated by standard morphological methods, that is they were categorised as 'definite male' or 'definite female'. To achieve this, the average length of long bones was calculated by averaging left and right sides when both sides were available. When only one side was available, a single measurement was used. The lengths were averaged instead of analysing only one side (*i.e.*, the non-dominant side, as some sources recommend) to maximise the size of the final dataset, for it was possible to include those individuals with only the right element preserved. For this analysis only adults estimated to be over 20 years of age and of 'definite' initial sex were in the were included to ensure confidence in sex estimation.

Long bone measurements for analysis were selected after consulting the literature on the most useful measurements that most accurately correlate with sex in known reference samples (Tomczyk et al., 2017).The bones selected for analysis are listed in Table 5.4.

Table 5.4 Measurements used in metric sexual dimorphism analysis

Element	Measurement	Measurement reference number in Standards (Buikstra & Ubelaker, 1994, pp. 80–83)
Humerus	Maximum length	40
Humerus	Vertical diameter of head	42
Ulna	Maximum length	48
Radius	Maximum length	45
Femur	Maximum length	60
Femur	Maximum diameter of head	63
Tibia	Length	69
Tibia	Maximum length	Not in standards, measured as the maximum distance from the intercondyloid eminence to the medial malleolus. Following Soficaru and Contantinescu (2013)
Fibula	Maximum length	75

Histograms of frequency distributions were created of the lengths of each long bone measurement for each sex. Means, standard deviations (1SD, 2SD), minimums, and maximums of the lengths of each element were calculated (Table 5.5). To assign an individual based on long bone measurements to a sex category, a 3 phased procedure was followed. **Phase 1:** Individuals of unknown sex who had one measurement (e.g., femur) outside of the distribution of the opposite sex were labelled that sex. For example, an element with a measurement above the maximum value for females was considered to indicate a probable male individual. Conversely, any measurements falling below of the minimum value for males were considered to indicate a probable female individual. Using this criteria, one measurement was required to fall outside of the distribution to estimate sex (*e.g.*, a femur only). **Phase 2:** Measurements that were above two standard deviations for females, were considered as probable male, and below two standard deviations for males, considered as probable female. At least two such measurements were needed to confirm the estimation of an individual into a sex category (*e.g.*, an ulna and a humerus). **Phase 3:** Any measurement for a particular sex category which was below the mean of that sex category was considered for possible inclusion in that same sex category. If an individual had measurements which was below the mean for females or above the mean for males, it was considered to be in a sex category only if they also had a measurement confirmed by phase 1 or 2 of this analysis. For shorter measurements (*i.e.*, possible females) it was ensured that the short measurement was not because of nonadult status.

Through metric analysis sex was estimated for an additional 35 individuals (18 probable females and 17 probable males, see Table 5.6) from a total of 103 individuals with unknown sex (*i.e.*, no morphological sex characteristics available for scoring).

Table 5.5 Measurements derived from metric sexual dimorphism analysis used in sex estimation of the Alba Iulia sample

<table>
<tr><th></th><th colspan="2">Humerus - max length</th><th colspan="2">Humerus head – vertical dia.</th><th colspan="2">Ulna – max length</th><th colspan="2">Radius – max length</th><th colspan="2">Femur – max length</th><th colspan="2">Femur - max head</th><th colspan="2">Tibia - length</th><th colspan="2">Tibia – max length</th><th colspan="2">Fibula – max length</th></tr>
<tr><td>Female +2SD</td><td colspan="2">>337.24</td><td colspan="2">>47.36</td><td colspan="2">>270.41</td><td colspan="2">>249.36</td><td colspan="2">>465.94</td><td colspan="2">>49.67</td><td colspan="2">>396.65</td><td colspan="2">>401.04</td><td colspan="2">>376.57</td></tr>
<tr><td>Female Max</td><td colspan="2">354.00</td><td colspan="2">51.19</td><td colspan="2">273.00</td><td colspan="2">259.50</td><td colspan="2">477.50</td><td colspan="2">51.23</td><td colspan="2">405.50</td><td colspan="2">409.00</td><td colspan="2">390.00</td></tr>
<tr><td>Female Mean</td><td colspan="2">301.64</td><td colspan="2">41.19</td><td colspan="2">245.14</td><td colspan="2">224.60</td><td colspan="2">417.58</td><td colspan="2">43.50</td><td colspan="2">349.71</td><td colspan="2">352.67</td><td colspan="2">339.81</td></tr>
<tr><td>Male -2SD</td><td colspan="2"><294.5</td><td colspan="2"><42.54</td><td colspan="2"><241.37</td><td colspan="2"><225.51</td><td colspan="2"><414.20</td><td colspan="2"><44.32</td><td colspan="2"><324.5</td><td colspan="2"><333.07</td><td colspan="2"><330.76</td></tr>
<tr><td>Male Min</td><td colspan="2">294.50</td><td colspan="2">41.42</td><td colspan="2">240.00</td><td colspan="2">225.00</td><td colspan="2">421.00</td><td colspan="2">42.22</td><td colspan="2">321.50</td><td colspan="2">333.50</td><td colspan="2">336.50</td></tr>
<tr><td>Male Mean</td><td colspan="2">325.78</td><td colspan="2">47.02</td><td colspan="2">265.33</td><td colspan="2">248.63</td><td colspan="2">456.90</td><td colspan="2">49.45</td><td colspan="2">366.50</td><td colspan="2">372.28</td><td colspan="2">360.15</td></tr>
<tr><td colspan="19">Number of individuals/elements used in the analysis</td></tr>
<tr><td></td><td>M</td><td>F</td><td>M</td><td>F</td><td>M</td><td>F</td><td>M</td><td>F</td><td>M</td><td>F</td><td>M</td><td>F</td><td>M</td><td>F</td><td>M</td><td>F</td><td>M</td><td>F</td></tr>
<tr><td>N</td><td>45</td><td>59</td><td>51</td><td>63</td><td>37</td><td>42</td><td>39</td><td>52</td><td>35</td><td>52</td><td>35</td><td>62</td><td>20</td><td>33</td><td>21</td><td>33</td><td>17</td><td>24</td></tr>
</table>

Table 5.6 Estimated sex after sexual dimorphism analysis and the measurements used in the analysis

Skeleton #	Probable Sex	Humerus -max length	Humerus head – vertical dia.	Ulna – max length	Radius – max length	Femur – max length	Femur -max head	Tibia - length	Tibia – max length	Fibula – max length
M005	M				253.00		49.14			
M112	M	326.00	47.20				50.21			
M132	F					368.00	41.86	290.50	291.50	285.00
M169	F					435.00	42.37	355.00	361.50	
M215	M					447.00	50.51	366.00	369.50	364.00
M230	M					474.00	57.35	390.00	392.50	
M235	M	328.00		276.00	252.00					
M278	M	322.50	44.40	273.50	253.00					
M279	F	292.00	39.50							
M280	F					413.00	42.65			
M285	F							325.00	327.00	
M298	M	343.00	49.48	264.00	242.50					
M308	M							401.50	411.50	383.00
M311	M			277.00	260.00					
M321	F	304.00	38.84				42.74			
M325	F									336.00
M353	M							400.00	405.00	387.00
M360	F				217.00					
M363	F		37.35							
M388	M	330.00	46.60	281.00	255.00	460.00	48.53	388.00	389.00	
M399	F							330.00	332.00	326.00
M431	F					408.50	46.10	334.50	339.00	330.00
M460	M					457.00	53.55	370.00	374.00	
M464	F		38.20		234.00	437.00	43.46	347.50	352.00	338.50
M493	M					470.00	44.48			369.00
M524	M							397.00	394.00	
M538	M					457.00	49.83	378.00	383.00	372.00
M549	M	314.50	47.55		235.00		51.14			
M552	F							326.00	329.00	
M560	F							323.00	327.50	
M563	F							327.00	331.00	316.00
M569	F					417.50	44.48	331.50	332.00	
M571	F							320.00	320.00	
M620	F					434.00	42.00	349.50	352.00	
M577	M							400.00	404.00	382.00

5.2.4. Intermediate expression of sex

The intermediate expression of sex is often encountered in bioarchaeology. The usual practice has been to exclude these individuals from analysis. However, recently scholars have stressed the importance of including individuals in the analysis that they were not able to confidently sex (e.g., Wesp, 2014, 2017). Assigning intermediate sex arises from two possibilities. One is poor preservation, when not enough datapoints are available to confidently make an assessment, and the second is the true intermediate expression of skeletal sex. The latter scenario arises when all characteristics neither lean towards male or female, or when the characteristics provide conflicting data, some leaning to male, some to female. In the current study, in instances when the skeletal remains exhibited characteristics in this manner, they were assigned to an intermediate sex group.

Poor Preservation: Individuals were assigned to an intermediate sex group when not enough data was present to confidently assess sex. For example, when only 2 or fewer data points were available for pelvic features. However, when two pelvic features were present and they were the composite arch and the greater sciatic notch, and had an expression of ≤2 or ≥8, they were assigned to the probable male and probable female category, respectively.

Intermediate Expression of Sex: Intermediate expression of sex was considered when pelvic or cranial scores were ambiguous or conflicting. For example, if all pelvic scores were between 4 and 6, or all cranial scores between 2 and 3 without leaning to one side or another, the intermediate sex category was assigned. For cranial the consideration was taken whether the site was a muscle attachment site (e.g., nuchal line and mastoid). These were given less weight because they may have a relationship to mechanical stress.

Individual skeletons that were identified as having intermediate expression of sex, were included as a third sex category, to see if there were any identifiable patterns in the trauma and joint modification data in this group of individuals, and whether those patterns were similar to the other trends in the other sex categories.

5.3. Age estimation

Age is known to influence gender expression and identity (Agarwal, 2012; Sofaer, 2006b). Therefore, the bioarchaeological analysis of skeletal indicators such as lesions from a life course perspective is valuable in understanding past social dynamics (Zuckerman, 2020). Understanding age related patterns in the Alba Iulia sample required the estimation of age for each skeleton. Nonadults were aged by growth and developmental indicators such as long bone lengths and dental eruption patterns, while in adults age was estimated by morphological changes on specific anatomical regions of the skeleton (Cox, 2000) as described below.

5.3.1. Nonadult age estimation

Nonadult age estimation was based on dental development, long bone measurements, and epiphyseal synostosis patterns. Age estimation using the development and eruption pattern of teeth was based on the diagrams developed and published by Ubelaker (1989). Age estimation based on nonadult long bone measurements followed Stloukal and Hanáková (1978), and Bernert and colleagues (2007, 2008). Both techniques are based on European populations and were deemed more appropriate for the Alba Iulia sample than methods derived from North American populations. Age estimation based on epiphyseal union and fusion pattens followed those described in *Standards* (Buikstra & Ubelaker, 1994, pp. 42-44). In many cases the final nonadult age estimate was based on a combination of these three methods.

5.3.2. Adult age estimation

Age estimation of the adult skeletons in the Alba Iulia sample was based on the following anatomical areas: pubic symphysis, auricular surface, sternal rib ends, and cranial suture closure.

5.3.2.1. *Pubic symphysis*

The pubic symphysis is the joint of the pubis where it joins the contralateral element. The pubic symphyseal face is an irregular articular surface with macroscopically observable age-related changes in the human skeleton that were first systematised and published by Todd (1920). These changes have been demonstrated to be reliable in estimating the age of adults (Bedford et al., 1993). Pubic symphysis age estimation methods provide wide age ranges with a number of methods available to assess age from the pubic symphysis. The Suchey-Brooks method (Brooks & Suchey, 1990; Katz & Suchey, 1986) was used in this research as it has been demonstrated to be more reliable than other methods (Mays, 1998). Even though the Suchey-Brooks method provides wider age estimates than other methods (*i.e.*, less precise), studies using mortuary samples with known ages at death, have shown it to be more accurate (Gillett, 1991). This method, however, has been noted to have difficulty in accurately estimating the age of older individuals in various samples (Hens et al., 2008; Saunders et al., 1992).

5.3.2.2. *Auricular surface*

The auricular surface is the joint surface on the ilium that is part of the sacroiliac joint. In the human skeleton the auricular surface undergoes age-related changes (Cox, 2000). Although some bioarchaeologists regard pubic symphysis ageing techniques to be more accurate, more precise (Jackes, 2000; Meindl & Lovejoy, 1989; Milner & Boldsen, 2012) and easier to score (Buikstra & Ubelaker, 1994, p. 24), the additional use of the auricular surface is recommended, because it is more likely to survive taphonomic insults in archaeological contexts (Wescott, 2015). The auricular surface been argued to provide more accurate estimates in the older age categories (Meindl & Lovejoy, 1989), making it a complimentary method to the pubic symphysis age estimation technique.

Adult age estimates based on the auricular surface were determined using the Lovejoy and colleagues (1985) and Meindl and Lovejoy (Meindl & Lovejoy, 1989) protocols. These methods score the regions of the auricular surface designated by the authors as demifaces (superior and inferior), apex and retroauricular area, for the following age-related changes: porosity, granularity, billowing, and density. Lovejoy *et al*. (1985) divided the age-related morphological changes into eight phases which correspond to five year intervals beginning with 20 to 25 years and ending at 60 plus years.

5.3.2.3. *Sternal rib ends*

Age data was collected using the 4th rib age estimation method developed by İşcan and colleagues (1984; 1984, 1985) using the images and descriptions in Bass (1995). Typically, based on this method individuals were assigned to one phase, or two phases if the morphology was overlapping. Phase information was recorded for any sternal end rib fragment that was available for an individual, regardless if it was 4th or otherwise. Because of the fragmentary nature of the remains, especially of the ribs. In almost all instances identifying the 4th rib was impossible. Other researchers have reported that using the İşcan et al. (1984; 1984, 1985) 4th rib technique on non-4th ribs will over or under estimate the age, as the sternal ends of other ribs develop their morphology at different rates (Alsup, 2007; Yoder et al., 2001). Because it was not possible to identify the 4th rib in many cases and therefore used available rib ends, the phasing was expanded by 1 score on either side. For example, where the available rib ends indicated a phase 4, it was expanded to include a range from phase 3 to phase 5, thus expanding the possible age range estimate. This was based on Yoder et al.'s (2001) observation that using rib ends other than the fourth will often score in the same phase or an adjacent phase. The age ranges for each phase represent 95% confidence intervals for the original reference sample.

5.3.2.4. *Cranial suture closure*

Cranial sutures that separate the bones of the cranium in children are known to fuse in adults with advancing age. The bioarchaeological process of estimation relies on the process of the suture fusion, whereby they become less obvious in dry bone and are obliterated with advanced age (Mays, 1998). Cranial suture closure data was collected, even though it has been reported that there is considerable variability in its relation to age (Ruengdit et al., 2020) and considered by some as unreliable (Mays, 1998). Consequently, in the analysis, suture closure age estimates were used only when anatomical portions required for the other age estimation methods were unavailable, or to confirm age estimates from other methods. Nevertheless, information from sutures closure scores were collected whenever crania were present. The suture fusion was scored based on the ectocranial surfaces at the following points as recommended by Buikstra and Ubelaker (1994):

1. Midlambdoid: midpoint of left lambdoid suture
2. Lambda: intersection of sagittal and lambdoid sutures
3. Obelion: at obelion
4. Anterior sagittal: one-third the distance from bregma to lambda
5. Bregma: at bregma
6. Midcoronal: midpoint of left coronal suture
7. Pterion: usually where the parietosphenoid suture meets the frontal

Each point was scored on a scale of 0 to 3, and the points for each of the 7 points were added to arrive at a composite score out of a maximum possible score of 21. The composite score was compared to figures published in Meindl and Lovejoy (1985) to arrive at estimated mean ages for each individual.

5.3.3. Age categories

Research shows that it is impossible to precisely age individuals based on macroscopic osteological observation (Cox, 2000). Because biological age is influenced by genetic factors as well as cultural and individual factors such as diet and activity, attempting to assign specific chronological ages to individuals based on osteological markers would provide inaccurate age profiles. These observations complicate the estimation of chronological age from osteological marker (Buckberry, 2015). As a result, it has become best practice in bioarchaeology to categorise individuals into broad age categories following published standards (Brickley & McKinley, 2004; Buikstra & Ubelaker, 1994). The ordinal age categories used to age adults are listed in Table 5.6.

Table 5.7 Age categories used in analysis

Age category	**Estimated age range**
Nonadult	Less than 20 years
Young adult	20 to 34 years
Middle adult	35 to 50 years
Old adult	50 years+
Unknown (Adult)	Adults of unknown age

Adults were allocated to age categories based on an experience-based assessment. Experience based assessment is practiced and taught by many bioarchaeologists and forensic anthropologists (Garvin & Passalacqua, 2012), and their use has been found to provide comparable accuracy to many high powered statistical methods for estimating skeletal age (Milner & Boldsen, 2012). Anatomical features used in the categorisation of individuals into sex categories depended on the features available for analysis. For example, if only the pubic symphysis was available for observation, the mean age of that indicator was used (Brooks & Suchey, 1990; Katz & Suchey, 1986). For example, a phase 4 female, with a mean age of 38.2 years (range 26 to 70), was categorised as middle adult. For the auricular surface the age range for the modal phase was used as described in Lovejoy and colleagues (1985) and Meindl and Lovejoy (1985). For sternal rib ends, the age ranges for phasing provided by Iscan and colleagues (1984; 1984) were used as presented in Bass (1995). When multiple anatomical features were available for observation they were prioritised in the following sequence: pubic symphysis > auricular surface > sternal rib ends > cranial sutures. For example, in individuals where both the pubic symphysis and the auricular surface were present, the pubic symphysis was given primacy and the auricular surface was used to verify or modify the age category established from the pubic symphysis. A more complex example is a male presenting a phase 5 pubic symphysis (mean age of 45.6 range of 27 to 66 years), with an auricular surface modal stage of 8 (age range of 60+ years), and a sternal rib end phase of 7 (age range of 54-64), was deemed to be older than the age provided by the mean of the pubic symphysis, and consequently categorised as an old adult.

It is important to note that the use of mean ages (pubic symphysis), or narrow modal phases (auricular surface) to allocate individuals to age categories, may not actually allocate them to the chronological age the individual was at the time of death. Osteological age estimation methods have been found to consistently under age older individuals and over age younger individuals (Buckberry & Chamberlain, 2002). Furthermore, mean age of any stage of an age estimation technique depends on the overall age distribution of the population under study (Buckberry, 2015). Since the mean age of the sample under study is unknown, the mortuary mortality curves of archaeological populations will be biased in the direction of the modern reference samples used in the establishment of the age estimation technique (Bocquet-Appel & Masset, 1982; Hoppa & Vaupel, 2002; Jackes, 2000). It is also important to note that categorisation of individuals into three adult categories of young, middle, and old, can create ‘age mimicry’ (Buckberry, 2015). Age mimicry in a mortuary mortality profile can be seen as a ‘hump’ in the middle adult category. This artifice in the data is created is because age estimation methods have a tendency to overestimate the age of young individuals and underestimate the age of older adults (Buckberry & Chamberlain, 2002). This is because some young adults biologically age faster than their counterpart, and some older adults age slower than others (Buckberry, 2015). Since bioarchaeological age estimation methods are based on biological age and not chronological age, this creates an over estimation of individuals in the middle age category.

5.4. Trauma analysis methods

This research sought to investigate aspects of men's gender in medieval Alba Iulia. More specifically it sought to understand men's deployment of masculinities and its consequent implications for risks taking and being at-risk through the analysis of health outcomes. Risk taking and being at-risk was inferred from skeletal remnants of bodily injury, namely blunt force trauma and implement, or weapon, trauma. The prevalences of these injuries served as a proxy measure for risk. The use of these proxy measures is supported by clinical evidence which has established a link between injury rates and risk behaviours in contemporary populations (Jelalian et al., 1997; Turner et al., 2004). By examining the skeletal evidence of trauma sample, this research sought to gain insight into the deployment masculinities and social forces, and power structures embedded in masculine discourses that influenced men's behaviours.

Trauma was recorded using a combination of the latest recommendations for clinical classifications combined with established bioarchaeological and forensic anthropology standards. The clinical recommendations from the *Fracture and Dislocation Classification Compendium—2018* (Meinberg et al., 2018) were used, combined with recommendations for forensic anthropology presented in *Broken Bones: Anthropological Analysis for Blunt Force Trauma* by Wedel and Galloway (2014). The Compendium recommends a systematic numbering method for fracture classification. The accuracy of this method has been shown to be questionable, and its utility for archaeological and forensic settings is debatable (Galloway et al., 2014, pp. 71-72). Therefore, the numbering system was not employed; however, the categorization terminology was used to describe fracture location, type, pattern, and associated modifiers and qualifications. Using the terminology from both the clinical and forensic anthropology sources allowed consistent fracture descriptions that are similar to clinical and the anthropological literature. Bioarchaeologists often refer to clinical studies for comparable cases, especially when investigating potential ultimate causes of certain fracture types in modern populations.

Details recorded during macroscopic observations were: (1) category of trauma (*i.e.*, blunt or sharp); (2) element, side, and location on element; (3) fracture type, pattern, modifiers, and displacement; (4) complication; (5) healing status; (6) timing of injury.

1. **Category of trauma**: The categories of trauma recorded were:
    a. *Blunt trauma*: Fracture caused by a force over a relatively large area of bone. Force may be internal loading or external pressure (Lovell & Grauer, 2019, p. 362).
    b. *Implement trauma*: Fracture caused by an external force by an implement of war or a tool to a relatively small area at relatively low velocity (*i.e.*, not a high velocity projectile or bullet)
        i. *Sharp implement trauma*: Fractures are caused by edged objects such as bladed weapons.
        ii. *Blunt implement trauma*: Fractures are caused by blunt objects such as hammers or clubs.
    c. *Dislocation*: Articular surfaces of two or more bones forming a joint are displaced from one another. Can result in tissue and ligament damage, depending on degree of separation (Lovell & Grauer, 2019).
2. **Element, side and location on element**
    a. *Element*: Name of bone on which the fracture is located.
    b. *Side*: Left of right element for bilateral elements.
    c. *Location on element*: Location of fracture on the bone. Location was determined by finding the fracture's centre according to *Fracture and Dislocation Classification Compendium—2018* (Meinberg et al., 2018, p. S5).
3. **Type, pattern, modifiers, and displacement** (see Table 5.8 for descriptions)
    a. *Type*: Simple, wedge, multifragmentary, segmental, articular, extraarticular
    b. *Pattern*: Transverse, oblique, spiral, complete, partial, avulsion, crush, torus, buckle
    c. *Modifiers*: Impaction
    d. *Displacement*: Displaced, nondisplaced. Displacement in archaeological bone can only be observed on fractures that have healed. It is impossible to know whether a fracture was displaced at acuity, if the bones were repositioned and healed in alignment, or the injury was perimortem.
4. **Complications** (see for Table 5.9 descriptions of identifications)
    a. *Infection*: Evidence of bony reaction to infection around the fracture site.
    b. *Shortening / malalignment*: Fracture united and healed in displacement
    c. *Arthropathy*: Damage to bony articular surfaces at one of the joints of the bone the fracture is on
    d. *Soft tissue damage*: Inferred by severity of fracture damage
    e. *Non-union / delayed union*: Failure of bone fragments to unite
5. ***Healing status***
    a. *Not healed*: Fresh break with no evidence of healing

   b. *Healing*: Callus formation still active with visible woven bone
   c. *Healed*: Callus is well remodelled (including healed non-union), evidence of compact bone callus

6. **Timing of injury**
   a. *Antemortem*: The fracture occurred before death as evidenced by fracture healing
   b. *Perimortem*: The fracture occurred around the time of death as evidenced by the absence of a healing response

Recording of trauma on ribs: The location of fractures was recorded following Brickley (2006). Location of rib fractures was recorded as follows:

- Fractured rib's position on thorax: (1) Superior – ribs 1-3; (2) Central – ribs 4-9; Inferior – ribs 10-12.
- Location of fracture on rib: (1) Posterior; (2) Lateral; (3) Anterior

Although clinical standards consider the costochondral cartilage to be the anterior end segment of a rib, considering the anterior end of the osseous rib to be the anterior segment produces extra resolution that may help in identifying mechanisms of injury. However, this distinction between clinical and anthropological definitions must be kept in mind when examining the clinical literature.

Terminology used in the description of trauma was based on *Fracture and Dislocation Classification Compendium—2018* (Meinberg et al., 2018), Lovell & Grauer (2019) and Galloway et al. (2014). The following terms were used to describe blunt force trauma fractures.

For specific fracture types I consulted the *AO/OTA Fracture and Dislocation Classification Compendium—2018* published by the AO Foundation and Orthopaedic Trauma Association (Meinberg et al., 2018), *Broken Bones* by Wedel and Galloway (2014), and other published medical literature. In bioarchaeology, unless the fractures are perimortem, the assessment of fracture type is often inferred based on the macroscopic appearance of healed bone. Callus formation can obfuscate the fracture pattern making the classification of fracture type difficult.

Table 5.8 Common long bone fracture recording, and fracture morphology terminology used

Type, pattern, modifier	Description	Reference
Extraarticular	Fracture line involves end segment but does not include articular surface (may be epiphyseal or metaphyseal)	(Meinberg et al., 2018)
Partial articular:	Fracture involves the articular surface while a portion of the articular surface remains connected to the metaphysis and diaphysis	(Meinberg et al., 2018)
Complete articular	Fracture through the articular surface and articular surface is separated from the diaphysis	(Meinberg et al., 2018)
Simple	Single fracture line, circumferential disruption of the diaphysis	(Meinberg et al., 2018)
Wedge (aka Butterfly)	Triangular fragment resulting on the concave side of an angulation fracture	(Galloway et al., 2014, p. 66)
Multifragmentary (aka Comminuted)	Fracture with more than two fragments generated	(Galloway et al., 2014, p. 65)
Spiral	Fracture due to rotational and longitudinal stress along the axis of a long bone	(Lovell & Grauer, 2019, p. 340)
Oblique	Fracture line greater than ≥30° to a line perpendicular to the long axis of the diaphysis	(Meinberg et al., 2018)
Transverse	Fracture line greater than <30° to a line perpendicular to the long axis of the diaphysis	(Meinberg et al., 2018)
Segmental	Two or more fracture lines produce a segment of diaphyseal bone	
Complete	Results in discontinuity between two or more bone fragments	(Galloway et al., 2014, p. 63)
Incomplete	Some continuity is maintained between the fractured bone portions	(Galloway et al., 2014, p. 59)
Bowing fracture (aka plastic deformation)	Bone appears with exaggerated curvature due to longitudinal compression	(Galloway et al., 2014, p. 61)
Greenstick	Incomplete transverse fracture with bowing on unfractured portion of bone	(Galloway et al., 2014, p. 62)
Depressed	'caving-in' of the bone's cortex or metaphyseal areas	(Galloway et al., 2014, p. 62)
Crush	Occur when large force crushing force is applied over a large area. 1. **Depression**: Crushing force on one side of bone 2. **Compression**: Crushing force on both sides of bone	(Lovell & Grauer, 2019, p. 340)
Avulsion	Fragment of bone separated from the element as a result of tension on the attached ligament or tendon	(Galloway et al., 2014, p. 69)
Torus	Bulging of the bone cortex due to longitudinal compression commonly seen in juvenile bones	(Galloway et al., 2014; Lovell & Grauer, 2019)
Buckle	A fracture in which the bone has failed at the point of compressive stress prior to failing at the point of tensile stress. (Often conflated with torus fracture)	(Love & Symes, 2004)
Displaced	Bone portions or fragments have moved from anatomical alignment	
Nondisplaced	Bone segments or fragments remain in anatomical alignment	

Table 5.9 Identification of post-traumatic fracture complications

Complication	Description of identification	Reference
Infection	Infection following fractures results from the introduction of bacteria into the injury site through an open wound or a penetrating implement. The infection can be localised or become systemic. Localised infection can be identified by periostitis, osteitis, or osteomyelitis at the fracture site, with care taken not to be confused with initial stages of callus formation. Infection was identified by the presence of reactive bone formation and/or lytic lesions around the fracture site, characteristic of bone infection.	(Lovell & Grauer, 2019; Ortner, 2003)
Shortening	Shortening is the malunion of bone in which the element loses length after healing. Shortening can occur when medical intervention is not provided, for example the bone is not reduced, or when the reduction fails. Shortening in archaeological samples can be identified by comparing the fractured bone's length to the contralateral element.	(Lovell & Grauer, 2019)
Arthropathy	Post-traumatic arthropathy can be caused by injury to the articular structures during or after a traumatic event. In archaeological cases this can be observed when an element with evidence of fracture has greater arthritic changes than other elements, or even ankylosis to articulating elements.	(Lovell & Grauer, 2019)
Soft tissue damage	Bone fractures are often accompanied by soft tissue damage including vascular and neurological damage. Major vascular damage can lead to the disruption of blood flow that can result in tissue necrosis. Nerve injuries can lead to sensory or functional impairment. Soft tissue damage is not identifiable from dry bone samples, but may be inferred based on the deduced severity of the injury.	(Lovell & Grauer, 2019; Ortner, 2003)
Nonunion	Nonunion is the failure of fracture fragments to heal and unite. Nonunion in archaeological samples can be identified by the continued presence of a fracture line with extensive callus formation and the sealing of the medullary cavity. This can result in a pseudoarthrosis.	(Lovell & Grauer, 2019; Ortner, 2003)

5.4.1. Estimation of fracture force direction

The understanding of fracture mechanics is a critical element of trauma analysis. Fracture patterns serve as an indicator of the forces implicated in the traumatic event. Specific forces create distinct fracture patterns. By closely analysing these fracture patterns bioarchaeolgists can estimate the direction and the magnitude of the forces. These observations can provide bioarchaeologists with behavioural inferences, such as potential activities or risks that may have preceded the event.

Bone fracture patterns are a result of how the bone is put under external or internal stress. Stress on skeletal tissue that can result in a fracture are tension, compression, torsion, bending, and shearing (Ortner, 2003).

Transverse fractures: The direction of force in transverse fractures is perpendicular to the long axis of the bone. The bone undergoes loading on both the concave (compression) and the convex side (tension). It is difficult to determine in dry bone which way the fracture propagated (Galloway et al., 2014).

Oblique fractures: Oblique fractures run diagonally across diaphysis and are usually a result of bending and compressive forces (Galloway et al., 2014).

Spiral fractures: Spiral fractures are a result of rotational and tensile stress. The fracture originates at the point of maximum tension and propagates along the angle of rotation. The direction of the spiral observed on dry bone indicates the direction of the twisting forces (Galloway et al., 2014).

Comminuted fractures: Comminuted or multifragmentary fractures in which there are many fragments produced by the forces. These are usually the result of relatively higher magnitude forces (Galloway et al., 2014).

Wedge fractures: Wedge or butterfly fractures are the result of transverse or oblique forces combined with compression forces. The apex of the wedge is on the side of the bone which failed in tension and indicates the direction of the force (Galloway et al., 2014), with the wider part of the wedge on the impact side (Reber & Simmons, 2015).

Segmental fracture: Segmental fractures are usually the result of the application of simultaneous forces to the bone at two points or by a large surface (Galloway et al., 2014).

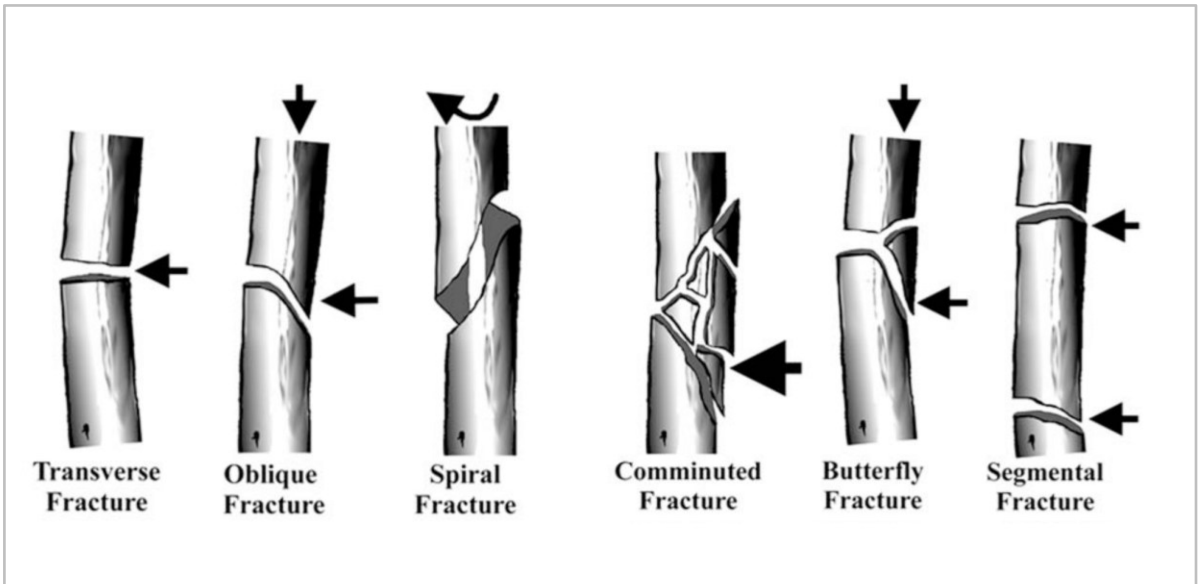

Figure 5.3 Direction of applied forces (arrows) in various fracture patterns. Illustration from Galloway et al. (2014, p. 64, used without permission).

5.5. Joint modification data collection methods

In order to assess gendered differences in activity patterns in medieval Alba Iulia that may implicate men as deploying certain types of masculinities, data were collected on joint modification. Joint modification data was collected for joint surfaces involved in articulations at major joints of the appendicular skeleton. Table 5.10 lists the anatomical sites that were scored. Scoring of the features was done by macroscopic observation of the subchondral surfaces and periphery of the articular surface. The anatomical components that were observed were changes to the joint margins and the joint surface. Marginal hypertrophic changes recorded included (1) osteophytes; and articular surface changes included (2) eburnation. The indicators were scored separately on their respective scales and no effort was made to arrive at an osteoarthritis diagnosis or score at any point in the research. This was done in order to examine the indicators individually as they relate to activity independently. All indicators were recorded independently of other joint changes.

Table 5.10 Articular surfaces examined in the collection of joint modification data

Joint	Anatomical site	Anatomical feature observed
Shoulder	Clav Dist	Acromial facet articular surface
	Scap Glen	Glenoid cavity articular surface
	Scap Acro	Acromioclavicular articular surface
	Hum Prox	Humeral head articular surface
Elbow	Hum Dist	Distal articular surface which includes trochlea and capitulum
	Ulna Prox	Proximal articular surface which includes trochlear notch and radial notch
	Rad Prox	Radus head and articular circumference
Wrist	Ulna Dist	Ulna head and articular circumference
	Rad Dist	Distal articular surface including ulnar notch and carpal articular surfaces
Hip	Acetabulum	Lunate surface of the acetabulum
	Fem Prox	Articular surface of the femoral head
Knee	Fem Dist	Inferior articular surface which includes lateral and medial condyles, intercondylar fossa and patellar surface
	Patella	Patellar articular surface which includes lateral and medial facets
	Tib Prox	Superior articular surface which includes lateral and medial condyles
	Fib Prox	Articular surface of the fibula head
Ankle	Tib Dist	Inferior articular surface for the talus
	Fib Dist	Articular surface for the talus
	Tal Prox	Superior articular surface including lateral process and facet for the medial malleolus

5.5.1. Osteophytes

Marginal osteophytes are periarticular hypertrophic changes that in dry bone present as bony outgrowths around the margins of joints (Jurmain, 1999, pp. 26-30). A recent systematic review presented strong evidence between physical activity osteophyte formation (Urquhart et al., 2011), and were therefore used in this study to assess overall activity patterns.

Osteophytes on articular surfaces were scored following the Säger (1969) system presented in Buikstra and Ubelaker (1994). Osteophytes were scored on a 5-point scale from 0 to 4. 0 = no osteophytes observed; 1 = osteophytes barely discernible; 2 = sharp ridge on the joint margin, sometime curled with spicules; 3 = extensive spicule formation on the joint margin; 4 = ankylosis of the joint. The extent of osteophytes was scored on a 3-point scale with 1 = less than 1/3 of the articular margin affected; 2 = 1/3 to 2/3 of margin affected; and 3 = more than 2/3 of the margin affected (Table 5.11).

Table 5.11 Osteophyte scoring

Degree Score	Extent Score
0 – None: absent 1 – Slight: barely discernible 2 – Moderate: sharp ridge, sometime curled with spicules 3 – Advanced: extensive spicule formation 4 – Extreme: ankylosis (bony fusion of the joint)	1 – <1/3 2 – 1/3 - 2/3 3 – >2/3

5.5.2. Eburnation

Sclerosis and eburnation are indisputable hallmarks of the osteoarthritic process (Burr & Gallant, 2012). In the current study, the original design attempted to score sclerosis as the initial stage of osteoarthritis and consequently the cartilage degeneration process. However, preliminary data analysis showed that sclerosis scoring dataset was inconsistent and unsatisfactory. This was likely because sclerosis is an increase in subchondral bone density (visible on radiographs), that is difficult to recognise externally by visual examination of dry bone. Consequently, only the eburnation was used in the analysis in this study. Some bioarchaeologists have recommended that the presence of eburnation should be the only criterion for identifying the skeletal presence cartilage degeneration (Jurmain, 1999; Waldron, 1995, 2009, 2012).

Eburnation was scored on a scale from 0 to 3 following the methods in Buikstra and Ubelaker (1994): 0 = no eburnation; 1 = sclerosis only [not used in analysis] 2 = some eburnation; 3 = moderate eburnation; 4 = extreme eburnation with grooves. The extent of eburnation was scored on a 3-point scale with 1 = less than 1/3 of the articular surface affected; 2 = 1/3 to 2/3 of surface affected; and 3 = more than 2/3 of the surface affected (Table 5.12).

Table 5.12 Sclerosis and eburnation scoring

Degree Score	Extent Score
0 – None: absent 1 – Slight: sclerosis only [not used in analysis] 2 – Moderate: sclerosis with some eburnation 3 – Advanced: eburnation more extensive than sclerosis 4 – Extreme: extreme eburnation	1 – <1/3 2 – 1/3 - 2/3 3 – >2/3

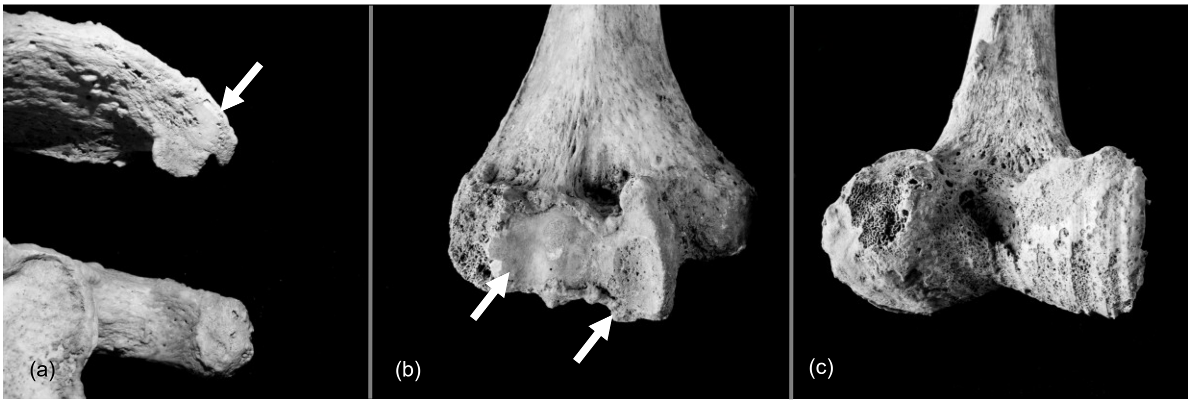

Figure 5.4 Eburnation scoring examples: (a) score of 2, some eburnation, polished surface; (b) score of 3, extensive eburnation, polished surface with shallow grooves or exposed trabecular bone; (c) score of 4, extreme eburnation, polished surface with deep grooves. (Author's photographs)

5.6. Metric data collection

Metric data was collected for postcranial elements. Specific measurements recorded are listed in Table 5.13. Measurements were taken as described in Buisktra and Ubelaker (Buikstra & Ubelaker, 1994, pp. 79-84), using sliding callipers, and a micrometre. Measurements longer than 150mm were recorded to the nearest millimetre. Measurements shorter than 150mm were recorded with a digital calliper to the nearest one-hundredth of a millimetre (calliper readout default). Circumferences of any length were recorded to the nearest millimetre using measuring tape.

Table 5.13 Measurements recorded from adult skeletal remains

Bone	**Measurement**	**Reference**
Clavicle	Maximum length	Buikstra and Ubelaker (1994)
	Vertical (superior-inferior) diameter at midshaft	Buikstra and Ubelaker (1994)
	Sagittal (anterior-posterior) diameter at midshaft	Buikstra and Ubelaker (1994)
Humerus	Maximum length	Buikstra and Ubelaker (1994)
	Epicondylar breadth	Buikstra and Ubelaker (1994)
	Maximum diameter at midshaft	Buikstra and Ubelaker (1994)
	Minimum diameter at midshaft	Buikstra and Ubelaker (1994)
	Vertical diameter of head	Buikstra and Ubelaker (1994)
Ulna	Maximum length	Buikstra and Ubelaker (1994)
	Physiological length	Buikstra and Ubelaker (1994)
	Minimum circumference	Buikstra and Ubelaker (1994)
	Anterior-posterior (dorso-volar) diameter	Buikstra and Ubelaker (1994)
	Medial-lateral (transverse) diameter	Buikstra and Ubelaker (1994)
Radius	Maximum length	Buikstra and Ubelaker (1994)
	Medial-lateral (transverse) diameter at midshaft	Buikstra and Ubelaker (1994)
	Anterior-posterior (sagittal) diameter at midshaft	Buikstra and Ubelaker (1994)
Sacrum	Anterior length	Buikstra and Ubelaker (1994)
	Anterior superior breadth	Buikstra and Ubelaker (1994)
	Maximum transverse diameter of base	Buikstra and Ubelaker (1994)
Coxae	Coxa height	Buikstra and Ubelaker (1994)
	Iliac breadth	Buikstra and Ubelaker (1994)
Femur	Maximum length	Buikstra and Ubelaker (1994)
	Bicondylar length	Buikstra and Ubelaker (1994)
	Midshaft circumference	Buikstra and Ubelaker (1994)
	Anterior-posterior (sagittal) midshaft diameter	Buikstra and Ubelaker (1994)
	Medial-lateral (transverse) midshaft diameter	Buikstra and Ubelaker (1994)
	Medial-lateral (transverse) subtrochanteric diameter	Buikstra and Ubelaker (1994)
	Anterior-posterior (sagittal) subtrochanteric diameter	Buikstra and Ubelaker (1994)
	Maximum diameter of head	Buikstra and Ubelaker (1994)
	Epicondylar breadth	Buikstra and Ubelaker (1994)
Tibia	Tibia length	Buikstra and Ubelaker (1994)
	'Maximum' length	Trotter and Gleser (1952)
	Maximum proximal epiphyseal breadth	Buikstra and Ubelaker (1994)
	Maximum distal epiphyseal breadth	
	Maximum diameter at the nutrient foramen	Buikstra and Ubelaker (1994)
	Medial-lateral (transverse) diameter at the nutrient foramen	Buikstra and Ubelaker (1994)
	Circumference at the nutrient foramen	Buikstra and Ubelaker (1994)
Fibula	Maximum length	Buikstra and Ubelaker (1994)
	Maximum diameter at midshaft	Buikstra and Ubelaker (1994)
Calcaneus	Maximum length	Buikstra and Ubelaker (1994)
	Middle breadth	Buikstra and Ubelaker (1994)

The measurements recorded for nonadult long bones were those that are useful in metric age estimation in nonadult skeletal remains. The metric age estimation of nonadults used publications with reference measurements derived from European populations (Bernert et al., 2007; Stloukal & Hanáková, 1978) which deemed more suitable for the sample under analysis than US or British standards.

5.7. Statistical analysis

The sample under analysis is cross-sectional and the fractures observed in individuals have accumulated over a life course. Therefore, they do not represent incidence rates, because incidence is the number of new cases over a certain period of time, over the population at risk over that same period of time (Bhopal, 2016) which is impossible to calculate with archaeological mortuary samples (Waldron, 2007). Following Glencross (2003, 2011), in this thesis the term 'lifetime prevalence' is used in order to indicate the prevalence of fractures that have accumulated over a lifetime in a cross-sectional sample. Lifetime prevalence reported in the trauma results section are therefore presented in one of the two following ways: (1) crude lifetime prevalence, (2) adjusted lifetime prevalence

Crude lifetime prevalence (CLP): The crude prevalence is based on the number of fractures observed over the total number of individuals in the sample or a subsample (e.g., males). The CLP assumes that none of the missing elements were affected by trauma, and therefore is not an accurate measure of trauma prevalence in the past. Crude prevalences are reported in this thesis as it was standard practice in past bioarchaeological texts, and will give the results some comparability to previously published literature. It is calculated by the total number of bones with fractures over the total number of individuals in the sample or subsample.

$$CLP = \frac{total\ \#\ of\ fractures}{total\ \#\ of\ individuals\ in\ (sub)\ sample}$$

Adjusted lifetime prevalence (ALP): The adjusted prevalence is sometimes called corrected lifetime prevalence because it corrects the assumption that the missing elements were not affected by trauma by removing those elements from the calculation. This method is considered to increase the reported prevalence accuracy by using higher resolution data. It is calculated by the total number of fractures over the total number of elements observed in the sample or subsample.

$$ALP = \frac{total\ \#\ of\ fractures}{total\ \#\ of\ elements\ in\ (sub)sample}$$

Adjusted crude lifetime prevalence (ACLP): Binary logistic regression was used in this thesis to test for statistical significance for the presence of fractures. However, because logistic regression requires categorical dependent variables to be mutually exclusive and exhaustive, the data needed to be recoded so that each case had only one data point for the presence of a lesion at an *element site*. An element site was the presence of an element from the left AND/OR the right sides. Therefore, for the recoding the left and right categories were combined, meaning that the sample numbers now represented element sites, and not individual elements. For example, a case with a fracture on left ulna but not the right, would now represent a case with fracture to the ulna. Similarly, a case with fractures to both left and right ulnae would now represent a case with fracture to the ulna.

$$ACLP = \frac{total\ \#\ of\ fractures\ at\ element\ site}{total\ \#\ of\ element\ sites\ in\ (sub)sample}$$

Prevalence in this thesis is most often reported as a percentage, however, at times it is reported as prevalence per thousand, presented as rate/10^3 (Waldron, 1994), to allow certain calculations, such as changes in magnitude of prevalence from one category to another. Changes in magnitude were calculated using the following formula (Glencross, 2003), where V_1 is the initial value and V_2 is the final value:

$$Magnitude\ of\ change = \frac{(V_2 - V_1)}{|V_1|} \times 100$$

Frequency calculations and statistical analyses were performed for each of the joint modification features. Since the study sought to investigate the impact of activity patterns on the major appendicular joints of the body, where the osseous modifications of the joint were determined to be secondary in nature (for example following a traumatic injury, due to diffuse idiopathic skeletal hyperostosis (DISH), or bone formers (Rogers et al., 1997)), these joints were excluded from analysis. Joint surfaces were unavailable for scoring due to poor preservation or other factors these were excluded from the total sample for frequency calculations and statistical analyses, except in the calculation of crude prevalence figures.

Similar to trauma reporting, joint modification prevalences were reported as adjusted prevalence (often referred to as true prevalence), which is the standard method for comparing features between groups. This is useful in bioarchaeological samples in which skeletons are incomplete. Adjusted prevalences were calculated using element or segment counts rather than population level counts (*i.e.*, number of individuals) to arrive at more accurate prevalences and avoid overestimation of prevalences (Waldron, 2007). Calculating prevalence counts using number of individuals in the sample (crude prevalence) assumes that all skeletal elements from all individuals were available for observation, which in bioarchaeological samples is not the case. Therefore crude prevalence rate calculations can misrepresent actual prevalence rates (Roberts & Cox, 2003, p. 386). The formula used was:

$$Adjusted\ prevalence = \frac{\#\ joints\ affected}{total\ \#\ of\ joints\ observable}\ x\ 100$$

For analyses that required the pooling of left and right sides, such as for regression analysis, the method used was the following: For presence-absence observations, if the indicator was present on either the left or the right size it was scored as present at the anatomical site. For example, if an individual had an osteophyte present on the proximal femur on the left but absent on the right, the case would be coded as present for an osteophyte at the proximal femur. Therefore, the results for the pooled data represent prevalences per anatomical site, for example the proximal femur, and not prevalences per element. Consequently, the adjusted prevalence for the polled data used the following formula:

$$Pooled\ adjusted\ prevalence = \frac{\#\ of\ anatomical\ sites\ affected}{total\ \#\ of\ anatomical\ sites\ observable}\ x\ 100$$

Binary logistic regression was used as the preferred method of statistical tests because it considers the interacting effects of multiple variables in a single analysis (Harris, 2021). Binary logistic regression "allows a wider variety of questions to be asked simultaneously within a single analysis" (Baker & Pearson, 2006, p. 220). For binary regression analysis of the trauma and joint modification data were recoded for presence, absence as describe above. Baker and Pearson (2006) argued that bioarchaeological studies of age related features should consider the confounding effects of age on lesions, and that comparison of age related indicators requires advanced statistical methods. In such cases, analyses are required that allow the appropriate control of differences in underlying age-structures. Baker and Pearson (2006) suggest the use of logistic regression to compare population risk. Logistic regression allows the investigation of categorical variables to simultaneously consider the effect of a number of confounding variables in addition to the effect of age, which has been exemplified by several bioarchaeological studies (Faccia & Williams, 2008; Villotte & Santos, 2022).

Consequently, statistical analysis of the trauma and joint modification data was performed using binary logistic regression to compare the risks of events happening (*e.g.*, having osteophytes) based on a number of predictor variable (*e.g.*, sex, age). This allowed the control of the effects of multiple predictor variables for, example to consider sex and age in the same model, which goes beyond simply reporting data in age specific intervals as has been previously done.

Binary logistic regression was used examine the risk of presence of trauma and joint modification features and other variables such as sex and age. Statistical analyses were performed on skeletons belonging to the following age group: young adult, middle adult, old adult. Skeletons belonging to age groups outside of these three categories (i.e., nonadults) or ones that could not be appropriately aged (i.e., adults of unknown age), were excluded from this analysis.

Prevalence figures for some lesions were low in the Alba Iulia sample, with groups often containing low frequency counts (sparse data). Consequently, the Firth procedure was applied when using binary regression modelling. The ‘Firth method’ has become the standard approach to analyse small samples using binary outcomes (Puhr et al., 2017). It is designed to reduce bias in the maximum likelihood estimates (Firth, 1989; Puhr et al., 2017). Firth logistic regression was performed using the ‘firthlogit’ function in STATA v17 statistical software application that is available as an addon package (StataCorp, 2021).

Chi-squared tests were also used in hypothesis testing to determine whether distributions of the presence of lesions were significantly different between comparison groups (Healey, 2005). The tests were calculated using IBM SPSS Statistics software package (IBM Corp, 2021). When expected values were less than 5 the Fisher’s exact test was used (Bland, 2015).

Setting the level of significance for statistical tests required some considerations for a project with multiple hypothesis tests. As noted by Sedgwick (2010), when multiple hypothesis tests are conducted the probability of type I errors occurring increases. To minimise the possibility of these errors in calculations, corrections are often used in significance tests, such as the Bonferroni correction (Sedgwick, 2012). This correction involves adjusting the significance level by the number of statistical tests performed. However, a drawback to this approach arises in projects with a large number of hypothesis tests, where the adjustment may dramatically reduce the likelihood of detecting real differences (Perneger, 1998). In other words, it increases the chances of type II errors; that is, retaining the null-hypothesis when in-fact the alternative hypothesis is true (false negative) (Kim & Bang, 2016). The level of significance for the current thesis was chosen considering the sample size and the losses from incorrect decisions (see Kim & Choi, 2021). Consequently, instead of *post-hoc* adjustment of p-values, the decision was made to set alpha to a moderate 0.01 (99% confidence level) for all statistical tests performed as the threshold for level of significance required to reject null-hypotheses. Accordingly, any p-values less than 0.01 were considered significant results.

Chapter 6: Results

This chapter presents the results of the analysis of the data from the Alba Iulia skeletal sample to answer the research questions identified in Chapter 1. After outlining the preservation and the demographics of the sample, the results of the trauma and joint modification analysis are presented. The results are presented starting with population level observations with subsequent exploration of subcategories that are either part of standard analyses (e.g., males only), or have emerged through the data analysis, for example individuals with multiple traumas or with repeat trauma (recidivism). Micro level analysis is also discussed by focussing on particular individuals.

6.1. Preservation of the sample

The Alba Iula skeletal sample material was very fragmentary in nature with many missing skeletal elements for each individual. This was due to poor preservation and post depositional influences (*i.e.*, grave inter-cutting). Figure 6.1 shows the distribution of the number of individuals in respect of the portion of their skeletal remains available for analysis. Of 427 individuals in the sample, 319 (75%) had 50% or less of their skeletal elements represented. This means that only 108 (25%) of individuals in the sample had more than half of the skeleton available for data collection and analysis. Such large amount of missing data had implications for data handling (described below) in order to avoid drawing inaccurate inferences about the data.

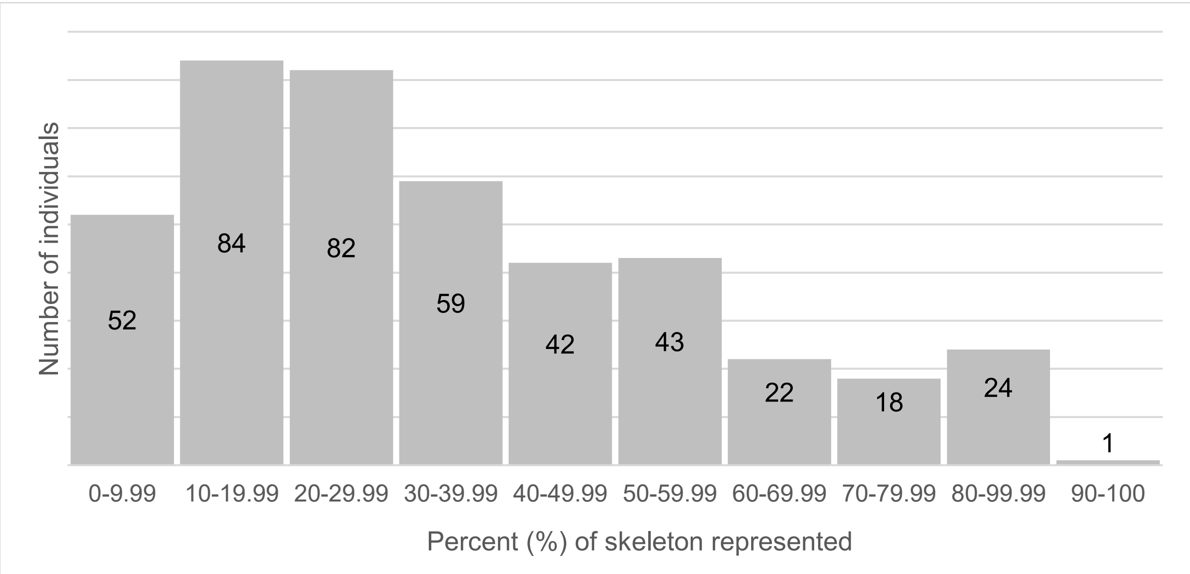

Figure 6.1 Distribution of the number of individuals in each representation category

Due to poor preservation/representation of the sample, in order to arrive at more accurate prevalences for skeletal indicators discussed below in this chapter, representation scores of skeletal elements were used in the determination of the denominator for prevalence calculations. The number of elements, or segments, with *any representation* (n_{ra}) received a score of 1 or more (see scoring in section 5.1, and details in Appendix 1). A score of 1 or more indicates an element represented by a fragment or in whole. This is a general presence-absence indicator. *Complete representation* (n_{rc}) indicates elements with complete, or near complete (>75% present) representation. This was used as a general indicator of representation or preservation of elements in sample. Appendix 1 presents the n_{ra} and n_{rc} numbers for elements (*e.g.*, Humerus - left), segments of elements (*e.g.*, Humerus - left – proximal), and regions (*e.g.*, calvarium). For long bones a complete element would be represented by the tally of all 3 segments equalling 9 (e.g., proximal portion = 3, diaphysis = 3, distal portion = 3, totalling 9). The clavicle was scored in 2 segments: proximal half and distal half, and was marked as complete if the total equalled 6.

The data indicated that, for the entire assemblage, rarely were more than half (50%) of the expected number of elements accounted for (*i.e.*, n=427), with exception of bones that were counted as a group (*e.g.*, ribs, vertebrae). This means that there are over 50% missing data for most skeletal elements or segments. Therefore, to account for missing data, when possible, the adjusted prevalences were used as described in section 5.7.

6.2. Demographics

6.2.1. Sex profile

Application of the sex assessment and estimation techniques described in the Chapter 5 permitted assignment of the sex for 257 adult skeletons, which is 78% (257/329) of the adults in the sample. Eighty-eight individuals were categorised as definite female, with 46 as probable female, and 68 were identified as definite male, with 55 as probable male (Table 6.1). For 72 skeletons the assessment of sex was not possible. Of these, it was not possible to estimate sex of 59 of these individuals due to preservation issues (lacking diagnostic skeletal elements), and were categorised as *Unknown (Adult).* The remaining 13 had sufficient elements for analysis of sex, but the result was ambiguous, and were categorised as *Unknown (Intermediate)*.

Table 6.1 Counts of individuals in initial sex categories

Definite Female	Probable Female	Unknown (Intermediate)	Probable Male	Definite Male	Unknown (Adult)	Unknown (Nonadult)	Total
88	46	13	55	68	59	98	427

In order to maximise the sample size and facilitate statistical analyses, the definite and probable sex categories were combined for each sex. This resulted in 134 females and 123 males available for analysis (Table 6.2).

Table 6.2 Counts of sexed individuals in the sample after combining definite and probable categories

	Females	Males	Unknown (Intermediate)	Unknown (Adult)	Unknown (Nonadult)	Total (N)
n	134	123	13	59	98	427
% of total number of individuals	31%	29%	3%	14%	23%	
Total sexed	257		72			
% of total sexed	52%	48%				

The Unknown Intermediate group contained individuals with ambiguous sexually dimorphic features. This was often due to preservation, for example when only few features were present which did not provide enough information (poor preservation), or when and intermediate expression of sex was observed. This group comprised 3% of the of the sample. A total of 9 individuals were not categorised into male of female due to the intermediate expression of skeletal sex. The individuals with intermediate expression of sex due to the lack of skeletal dimorphism were used in the analysis to see patterns of trauma and joint modification in this group of individuals. From here they will be referred to as the Intermediate group (n=9).

Table 6.3 Counts of Unknown Intermediate sexed individuals in the sample

	Due to Preservation	Non-Dimorphic	Subtotal (n)
n	4	9	13
% of intermediate number of individuals	31%	69%	
% of total number of individuals	0.9%	2.1%	

6.2.2. Age profile

Age profiles were constructed because it was important to assess the prevalences of skeletal markers at different ages to observe patterns of risk and activity throughout the life course in the sample, sub-samples, and individuals. Individuals were assigned into one of five age categories: young adult (YA), middle adult (MA), old adult (OA), adult (of unknown age), and nonadult. Nonadults were collapsed into as a single group. Since the discussion focuses on gendered differences it was important to establish which skeletons belonged to males and females. Nonadult sex assessment was not performed, and therefore this group was excluded from analysis of sex and gender differences. Detailed ages for the young adult group are not presented. Age assessments for adult individuals used in the analyses are detailed in Appendix 2.

Table 6.4 Counts of individuals by age category

	Males	Intermediate	Females	Unknown (Adult)	Unknown (Nonadult)	Total
Young Adult	20	1	31	4		56
Middle Adult	74	6	81	6		167
Old Adult	15		7	2		24
Unknown (Adult)	14	2	15	51		82
Unknown (Nonadult)					98	98
Total	123	9	134	63	98	427

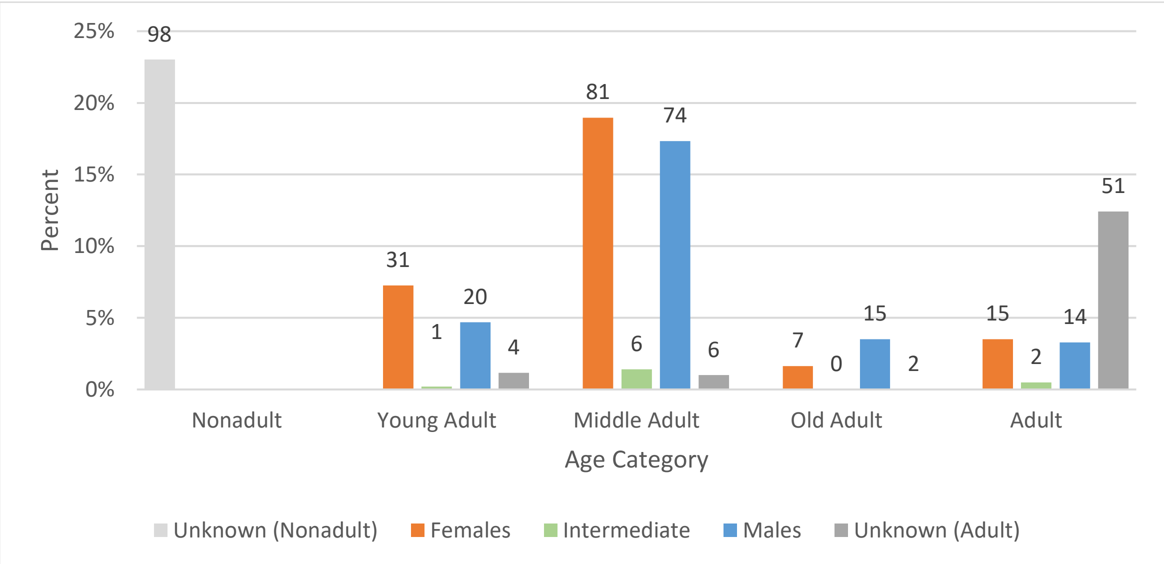

Figure 6.2 Percent of females, males, and unknown sex by age category as a percentage of the entire sample. Data labels indicate number of individuals from a total of N=427.

Table 6.4 and Figure 6.2 present the age profile of the entire sample showing the percentage of individuals in each age category. Data labels represent numbers of individuals. The figure indicates that the sample is skewed towards the middle adult age category with 39% (167/427) of individuals belonging to this category. It also shows that a large portion of individuals in the sample died as young or middle adults (52%, 223/427), with middle adult age category having the highest frequency count. When considering the demographic data, it is important to keep in mind that classifying individually aged skeletons into original ordinal categories can create ‘age mimicry’ (Buckberry, 2015). Ordinal age categories have been argued to create an over representation of middle adults because the young adults who mature faster, and old adults who age slower will be classified into the middle adult category (Buckberry, 2015). This kind of a curve is visible in the Alba Iulia skeletal data with middle adults in all sex categories having a proportionally higher number of individuals.

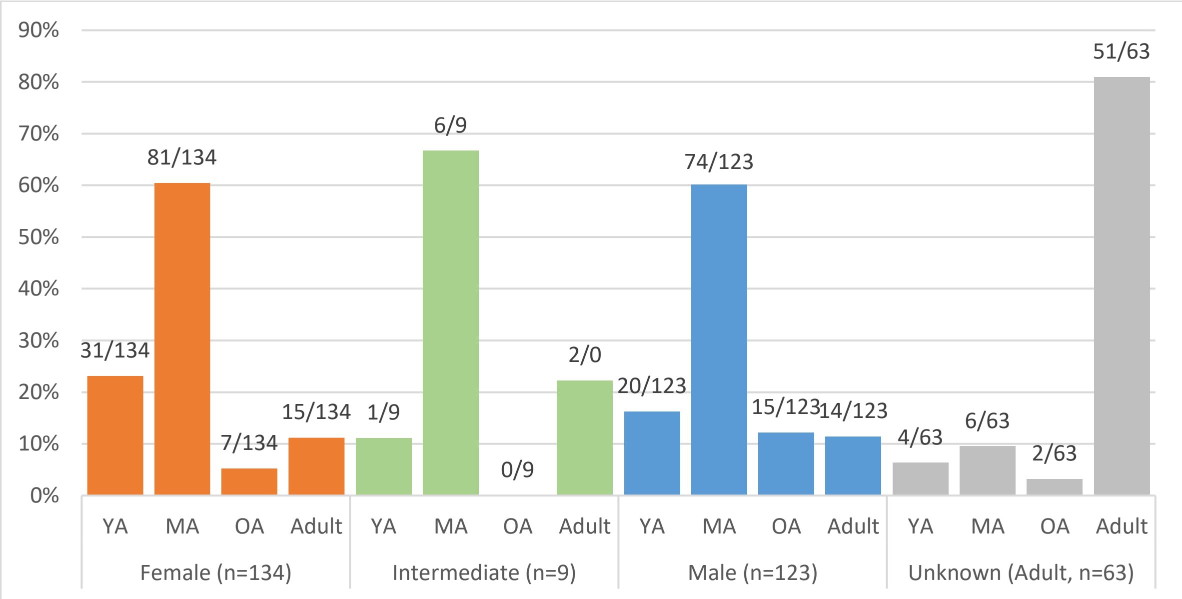

Figure 6.3 Age profile of adults within sex categories. Legend: YA = young adults; MA = middle adults; OA = old adults

Figure 6.3 presents the age profile of each sex. Most males and females died in the middle adult age category. In the young adult and middle adult categories the percentage of females and males who died at these ages were not statistically different (YA = χ^2 [1, N = 257] = 1.905, p = 0.167; MA = χ^2 [1, N = 257] = 0.002, p=0.963; OA = χ^2 [1, N=257] = 3.982, p = 0.046).

6.3. Trauma analysis results

The prevalence and patterning of traumatic injuries reflects the lifestyle of groups and individuals. Trauma analysis was carried out in an attempt to assess sex and gendered differences in both risk-taking and being at-risk in relation to severe bodily injuries that resulted in skeletal trauma. The results indicate that least 22.8% of adult males (n=28) and 14.2% of adult females (n=19), and 11.1% of the intermediate group (n=1) experienced some kind of skeletal trauma at some point in their lives. Crude lifetime prevalence of trauma by sex is presented in Table 6.5. In general, both males and females experienced trauma at about the same frequency with a slight trend towards the males; however, the difference is statistically non-significant (see Table 6.6). However, skeletal implement trauma was exclusively observed on skeletal elements belonging to males, with 6.5% of males exhibiting trauma from weapon related injuries.

Table 6.5 Crude lifetime prevalence (CLP) of trauma by sex (blunt and sharp trauma included)

	f/n	%
All trauma		
Males	28/123	22.8
Intermediate	1/9	11.1
Females	19/134	14.2
Unknown (Nonadult)	3/98	3.1
Unknown (Adult)	2/63	3.2
Total	53/427	12.4
Blunt trauma only		
Males	21/123	17.1
Intermediate	1/9	11.1
Females	19/134	14.2
Unknown (Nonadult)	2/98	2.0
Unknown (Adult)	2/63	3.2
Total	45/427	10.5
Implement trauma only		
Males	8/123	6.5
Intermediate	0/9	-
Females	0/134	-
Unknown (Nonadult)	0/98	-
Unknown (Adult)	0/63	-
Total	8/427	1.9
Multiple trauma (sharp + blunt)		
Males	16/123	13.0
Intermediate	0/9	-
Females	7/134	5.2
Unknown (Nonadult)	0/98	-
Unknown (Adult)	0/63	-
Total	23/427	5.4

f = number of individuals with trauma
n = number of individuals in sample or sub-sample (e.g., males)

Table 6.6 Results of binary logistic regression analysis for crude lifetime trauma prevalences with sex and age as predictor variables

	Predictor	Coeff (SE)	Odds ratio (99% CI)	p-value
All trauma	sex	-0.35 (0.176)	0.705 (0.44, 1.109)	0.047
	age	0.335 (0.313)	1.398 (0.624, 3.133)	0.284
Blunt trauma	sex	-0.17 (0.184)	0.843 (0.525, 1.354)	0.354
	age	0.567 (0.337)	1.763 (0.741, 4.196)	0.092
Implement trauma	sex	-1.599 (0.775)	0.202 (0.027, 1.487)	0.039
	age	-1.262 (0.7)	0.283 (0.047, 1.717)	0.071
Multiple trauma	sex	-0.366 (0.242)	0.694 (0.372, 1.294)	0.131
	age	0.718 (0.429)	2.051 (0.679, 6.197)	0.094

Coding: Sex: 1 = male, 2 = intermediate, 3 = female; Age: 1 = YA, 2 = MA, 3 = OA

The results of the blunt trauma analysis are presented below, followed by the results of the sharp and weapons trauma.

6.3.1. Blunt trauma

Blunt trauma analysis provides a view of serious bodily injuries that led to broken bones sustained by individuals the Alba Iulia skeletal assemblage. Analysing blunt trauma provides a view to risk exposure among the sample population, subgroups, and individuals. Even though most blunt trauma can be argued to be accidental, accidents do not randomly occur to individuals. Accidents causing bodily harm, especially accidents causing severe harm such as broken bones, are a result of bodies being subject to risks of physical injury (Turner et al., 2004). A closer examination of the nature and patterning of trauma may reveal the nature of the risks assumed by different groups or individuals in the sample that lead to the various traumatic outcomes observed. Since the thesis seeks to discuss gendered patterns of risk to bodily harm, the analysis below compares blunt trauma prevalences between males and females. The prevalences are also presented for the adult age categories to ascertain trends in risk throughout the life course.

6.3.1.1. *Sample level fracture prevalence*

Antemortem blunt trauma was observed in 20 males and 17 females. Prevalence was proportionally higher in males with 17.5% of males and 12.7% of females having had broken bones at some point in their lives. Perimortem blunt trauma prevalence based on CLP appeared to be low in both males and females, at 2.4% and 1.5%, respectively.

Table 6.7 Crude prevalence in sex categories by timing of blunt trauma

	Antemortem		**Perimortem**	
	f/n	**%**	**f/n**	**%**
Males	20/123	16.3	3/123	2.4
Inter	1/9	11.1	0/9	-
Females	17/134	12.7	2/134	1.5
Unknown (Adult)	2/72	2.8	0/72	-
Unknown (Nonadult)	0/98	0.0	3/98	3.1

f = number of individuals with trauma
n = number of individuals in sub-sample

Crude lifetime prevalence figures indicated a general increase with age. Table 6.8 indicates an overall increase in antemortem blunt trauma prevalence from young to old age categories (NA = 2.4%, YA = 5.5%, MA = 16.8%, OA = 20.8%). Within the sex categories, this remains true for females (YA = 6.5%, MA = 14.8%, OA = 28.6%), however, in males there is a slight decrease in old adult age cohort from the middle adult cohort (YA = 10.0%, MA = 21.6%, OA = 20.0%).

Table 6.8 Crude lifetime prevalence for blunt trauma (antemortem + perimortem) presented as rate/10^3

	Males			**Inter**			**Females**			**All**		
	f	**n**	**rate/10^3**	**f**	**n**	**rate/10^3**	**f**	**n**	**rate/10^3**	**f**	**n**	**rate/10^3**
Nonadult										2	82	24.4
Young Adult	2	20	100.0	0	1	-	2	31	64.5	4	73	54.8
Middle Adult	16	74	216.22	0	6	-	12	81	148.1	28	167	167.7
Old Adult	3	15	200.0	0	0	-	2	7	285.7	5	24	208.3
Unknown (Adult)				1	2	x	3	14	x	5	81	61.7
Total										44	427	103.0

f = number of individuals with trauma
n = number of individuals in subsample
x = not calculated

Crude lifetime prevalence showed an overall increase from one age category to the next (young to old). Table 6.6 presents CLP rates per thousand for each age group. However, when examining the magnitude change (increase or decrease) of the prevalence (Table 6.9) from one age category to the next (124.7% > 206.0% > 24.3%), overall there is increase from nonadult hood to young adulthood and from young adulthood to middle adulthood in the magnitude of the rise. This suggests that the highest rates of fractures occurred during young and middle adulthood and decreased with age.

Table 6.9 Magnitude of increase (↑) or decrease (↓) in crude lifetime prevalence of blunt trauma from one age category to next expressed as a percentage (%)

	Nonadult to YA	**YA to MA**	**MA to OA**
Male		116.2 ↑	7.5 ↓
Intermediate	-	-	-
Female		129.6 ↑	92.9 ↑
All	124.7 ↑	206.0 ↑	24.3 ↑

Table 6.10 Crude lifetime prevalence (CLP) of antemortem and perimortem blunt trauma by age category

		All		Females		Intermediate		Males	
		Antemort	**Perimort**	**Antemort**	**Perimort**	**Antemort**	**Perimort**	**Antemort**	**Perimort**
Nonadult	**f/n**	0/98	3/98						
	%	0	3.1						
Young Adult	**f/n**	5/56	3/56	2/31	0/31	0/1	0/1	2/20	3/20
	%	8.9	5.4	6.5	-	-	-	10.0	15.0
Middle Adult	**f/n**	28/167	6/167	11/81	1/81	0/6	0/6	17/74	5/74
	%	16.8	3.6	13.6	1.2	-	-	23.0	6.8
Old Adult	**f/n**	5/24	0/24	2/7	0/7	0/0	0/0	3/15	0/15
	%	20.8	0	28.6	0.0	-	-	20.0	0.0
Unknown (Adult)	**f/n**	4/82	2/82	2/15	1/15	1/2	0/3	0/14	1/14
	%	4.9	2.4	13.3	6.7	50.0	-	0.0	7.1
Total	**f/n**	42/427	14/427						
	%	9.8	3.3						

f = number of individuals with trauma
n = number of individuals in sub-sample

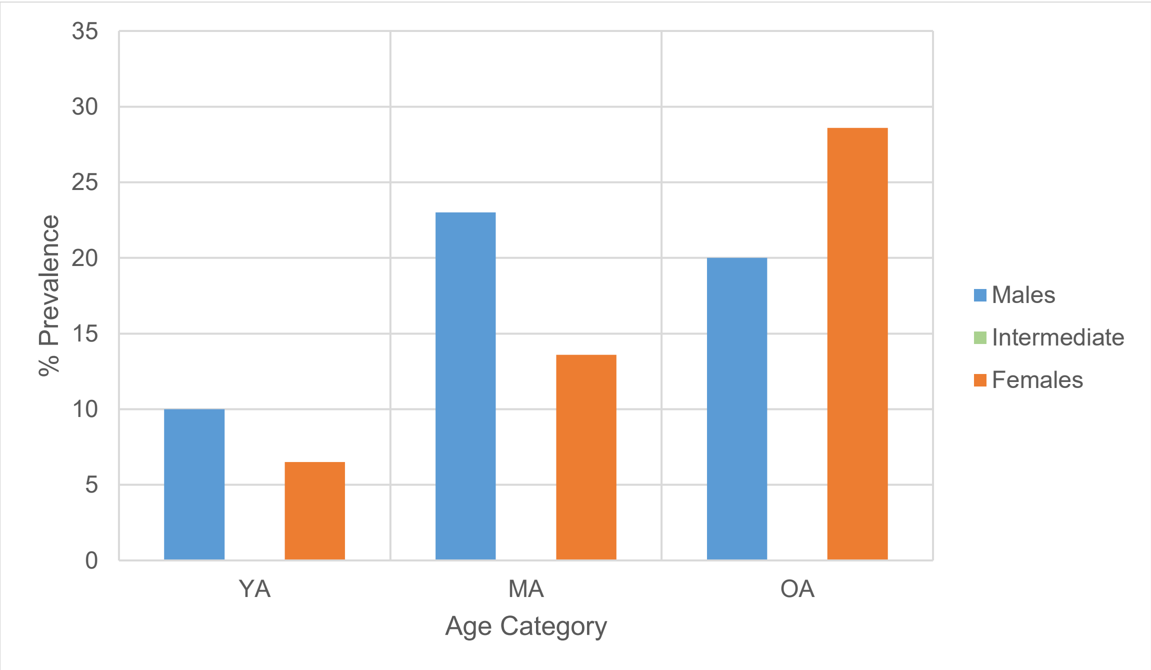

Figure 6.4 Cumulative lifetime prevalence (CLP) of antemortem blunt trauma in sex categories by age category

Next, the crude perimortem trauma prevalence was compared to see if there are any implications of the magnitude of the risk involved in blunt trauma. It was assumed that perimortem trauma indicated a greater magnitude of risk of bodily harm in subpopulations because perimortem trauma may be connected to, or involved in, the death of those individuals. It may speak to the magnitude of the risk of the activities that can lead to cause bodily harm performed by each subgroup of individuals.

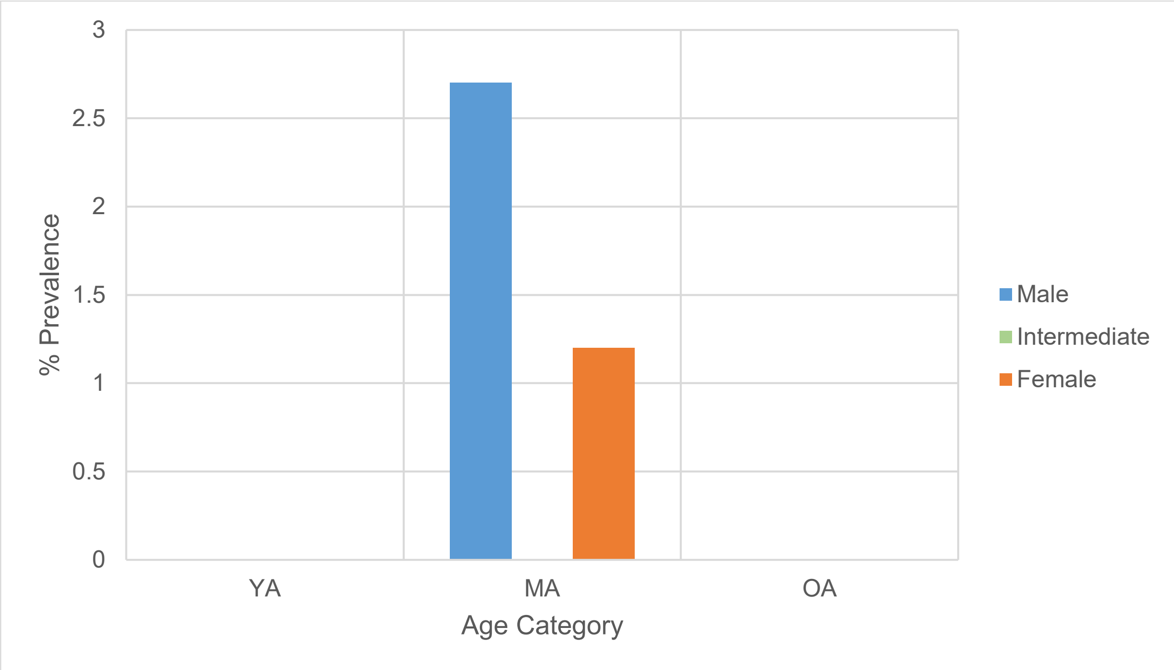

Figure 6.5 Cumulative lifetime prevalence (CLP) of perimortem blunt trauma in sex categories by age category

The CLP of perimortem blunt trauma indicates that middle adult males had a higher prevalence of trauma (2.7%) around the time of their deaths compared to females (1.2%) in the same age categories. This indicates difference was, however, not statistically significant (p=0.606, Fisher's exact test)

Table 6.11 Comparison of male and female CLP of perimortem blunt trauma by age group

	Young Adult			**Middle Adult**			**Old Adult**		
	f/n	%	p-value	f/n	%	p-value	f/n	%	p-value
Male	0/20	-	n/a	2/74	2.7	0.606*	0/15	-	n/a
Female	0/31	-		1/81	1.2		0/7	-	

f = number of individuals with perimortem trauma
n = number of individuals in subsample
*result of Fisher’s exact test

Table 6.12 Trauma locations and descriptions in males by age category

Age category	**Skeleton No.**	**Element, side, location**
Young Adult	M544	• Humerus, right, distal
	M625	• Rib (lower 10-12), left, lateral
Middle Adult	M125	• 2 Ribs (middle 4-9), lateral
	M161	• Rib, right, anterior
	M208	• Ulna, right, diaphysis
	M239	• Radius, left, distal
	M324	• Rib, right, lateral
	M385	• 6 ribs, left, anterior and lateral
	M421	• Phalanx, right, distal
	M478	• Rib (middle 4-9), anterior
	M484	• Ulna, right, diaphysis • 1st metacarpal, left, proximal
	M486	• Ulna, right, diaphysis
	M500	• 2nd and 3rd metacarpals, right, diaphysis • 2 ribs (lower, and middle), left, anterior
	M526	• Tibia, left, proximal
	M554	• Radius, left, diaphysis • 2 ribs (middle), right, posterior
	M570	• 8 rib fractures (middle and lower), left and right, lateral
	M573	• 3 ribs, left, anterior and lateral
	M585	• 6 ribs (middle, and unknown), left, anterior, lateral, posterior
	M597	• Phalanx (foot), unknown, diaphysis • 2 ribs (middle), right, lateral
Old Adult	M235	• Radius, right, distal • Ulna, right distal
	M511	• 4 ribs (middle), left and right, anterior, and lateral
	M555	• Clavicle, right, diaphysis • Rib, unknown, lateral

Table 6.13 Trauma locations and descriptions in females by age category

Age category	**Skeleton No.**	**Element, side, location**
Young Adult	M245	• 2 ribs, unknown side,
	M535	• Radius, left, distal (plastic deformity)
Middle Adult	M117	• Clavicle, left, diaphysis
	M132	• Radius, right, distal
	M212	• Radius, right, distal • Ulna, right distal
	M266	• 2nd metatarsal, left, diaphysis
	M268	• Rib, unknown side, lateral
	M322	• Rib, right, unknown location
	M346	• Rib (middle rib 4-9), right, anterior
	M360	• Radis, left, distal • Ulna, left distal • 8 rib fractures (all locations), both sides, lateral and posterior
	M381	• Rib (middle rib 4-9), right, lateral
	M492	• Radius, right, distal • 5th metacarpal, left, diaphysis • 2 ribs (middle 4-9), right, anterior and lateral
	M533	• Rib (lower 10-12), right, posterior
	M591	• Humerus, left, diaphysis
Old Adult	M138	• 2 ribs (one is middle 4-9), left and unknown, posterior and lateral
	M453	• 2 ribs (middle 4-9), one is left one is right, both posterior

6.3.1.2. *Blunt trauma in long bones*

Blunt trauma prevalences in long bones based on element counts were calculated next, to increase the accuracy of the prevalence figures for long bones by accounting for missing elements, using the adjusted lifetime prevalence formula described in section 5.4.

A total of 1399 adult long bones were identified as complete in the entire Alba Iulia sample of which 27 had evidence of blunt trauma (1.9%). Ten of the 535 (1.9%) identified as belonging to males had signs of blunt trauma and 13 of the 658 (2.0%) of female bones (Table 6.14). No long bone blunt trauma was identified in the Intermediate sex category. The overall patterning between males and females was statistically non-significant (χ^2 [1, N = 1193] = 0.100, p = 0.752). In males the ulna was the most frequently fractured long bone (5.1%) and in females the radius (5.0%). Femur injuries were absent from both male and female samples and the fibula from the male sample.

Table 6.14 Adjusted lifetime prevalence (ALP) in long bones by sex category

	Males		**Inter**		**Females**		**Unknown (Adult)**		**Unknown (Nonadult)**	
	f/n	**%**	**f/n**	**%**	**f/n**	**%**	**f/n**	**%**	**f/n**	**%**
Clavicle	1/103	1.0	0/4	-	1/116	0.9	0/9	-	0/53	-
Humerus	1/82	1.2	0/5	-	1/101	1.0	0/5	-	1/10	10.0
Ulna	4/78	5.1	0/0	-	2/87	2.3	1/2	50.0	0/5	-
Radius	3/77	3.9	0/0	-	5/100	5.0	0/4	-	0/4	-
Femur	0/89	-	0/2	-	0/106	-	0/8	-	0/16	-
Tibia	1/63	1.6	0/2	-	2/93	2.2	0/35	-	0/15	-
Fibula	0/43	-	0/2	-	2/55	3.6	2/24	8.3	0/1	-
Total	**10/535**	**1.9**	**0/15**	**-**	**13/658**	**2.0**	**3/87**	**3.4**	**1/104**	**0**
								Sample total:	**27/1399**	1.9

f = number of long bones with blunt trauma
n = number of complete long bones in (sub)sample

Table 6.15 Adjusted lifetime prevalence (ALP) in long bones in male and female sex by age category

	Males		**Inter**		**Females**	
	f/n	**%**	**f/n**	**%**	**f/n**	**%**
Young Adult	1/77	1.3	0/4	-	1/196	0.5
Middle Adult	6/373	1.6	0/5	-	9/401	2.0
Old Adult	3/56	5.4	0/0	-	0/33	-
Unknown (Adult)	0/29	-	0/6	-	4/28	14.3

f = number of long bones with blunt trauma
n = number of complete long bones in (sub)sample

6.3.1.2.1. Side specific prevalence

Long bone fracture prevalences were examined to detect if overall fracture patterns on the left side of the body were different from the right, as these may have implications in behaviour reconstruction and risk profiles. The results indicate that, overall, the ALP of trauma (Figure 6.6) was higher on the right compared to the left in both sexes, but statistical test indicated this to be a non-significant finding ($\chi2$ [1, N = 1193] = 1.541, p = 0.214). Comparison of overall ALP by side between males and females (left: males 1.1%, females 1.8%; right: males 2.6%, females 2.5%) also revealed statistically non-significant results sexes (Table 6.16).

Table 6.16 Comparison of ALP in long bone trauma prevalences by side across male and female elements

	Left				**Right**			
	f	**n**	**%**	**p-value**	**f**	**n**	**%**	**p-value**
Males	3	265	1.1	0.316*	7	270	2.6	0.914**
Females	6	332	1.8		8	326	2.5	
Total	9	597	1.5		15	596	2.5	

f = number of long bones with blunt trauma
n = number of complete long bones in (sub)sample
*result of Fisher's exact test
** result of Chi-square test $\chi2$ [1, N = 596] = 0.012

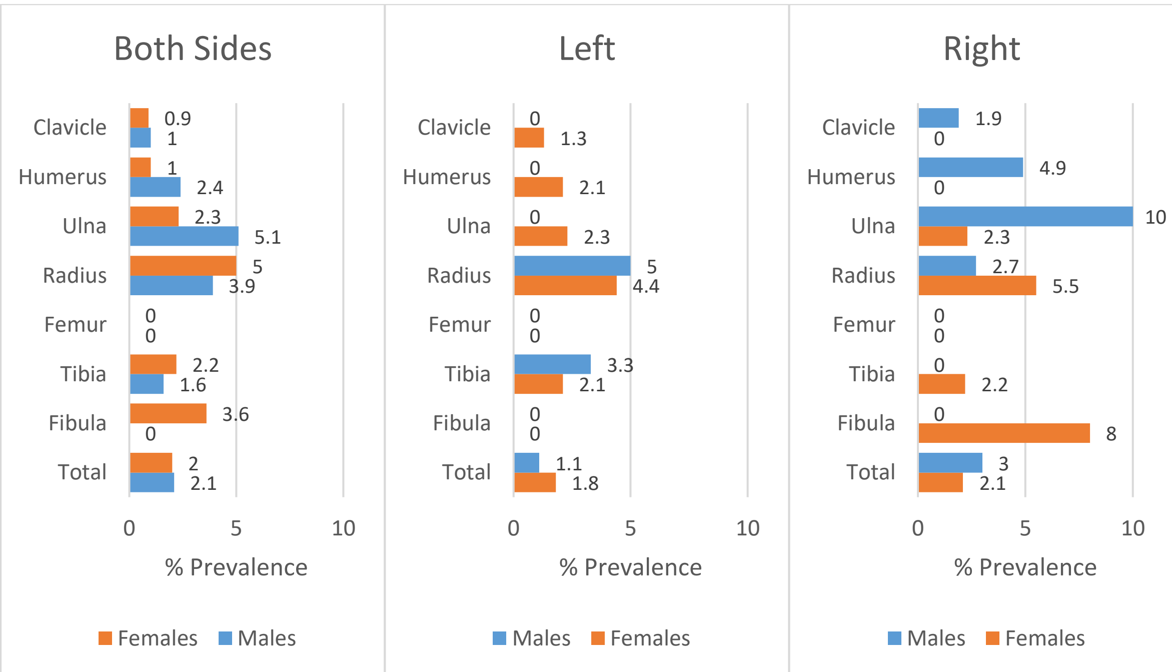

Figure 6.6 Cumulative ALP patterning of long bone blunt trauma in males and females

The tables below (Table 6.17 and Table 6.18) detail the adjusted lifetime prevalences of blunt trauma at the element segment location on long bones in males and females.

Table 6.17 Adjusted lifetime prevalence (ALP) of blunt trauma by segment and element in males

		Proximal		**Diaphysis**		**Distal**		**Element**	
		f/n	**%**	**f/n**	**%**	**f/n**	**%**	**f/N**	**%**
Clavicle	Left			0/na	-			0/51	-
	Right			1/na	-			1/52	1.9
	Both			1/na	-			1/103	1.0
Humerus	Left	0/46	-	0/54	-	0/54	-	0/41	-
	Right	0/46	-	0/58	-	1/59	1.7	1/41	2.4
	Both	0/92	-	0/112	-	1/113	0.9	1/82	1.2
Ulna	Left	0/61	-	0/51	-	0/50	-	0/38	-
	Right	0/52	-	3/51	5.9	1/48	2.1	4/40	10.0
	Both	0/113	-	3/102	2.9	1/98	1.0	4/78	5.1
Radius	Left	0/55	-	1/54	1.9	1/53	1.9	2/40	5.0
	Right	0/50	-	0/51	-	1/49	2.0	1/37	2.7
	Both	0/105	-	1/105	1.0	2/102	2.0	3/77	3.9
Femur	Left	0/57	-	0/58	-	0/55	-	0/47	-
	Right	0/56	-	0/56	-	0/53	-	0/42	-
	Both	0/113	-	0/114	-	0/108	-	0/89	-
Tibia	Left	1/36	-	0/45	-	0/39	-	1/30	3.3
	Right	0/43	-	0/46	-	0/38	-	0/33	-
	Both	1/79	-	0/91	-	0/77	-	1/63	1.6
Fibula	Left	0/26	-	0/38	-	0/35	-	0/18	-
	Right	0/28	-	0/44	-	0/43	-	0/25	-
	Both	0/54	-	0/82	-	0/78	-	0/43	-
Total	**Left**							**3/265**	**1.1**
	Right							**7/270**	**2.6**
	Both							**10/535**	**1.9**

f = number of segments or elements affected
n = total number of segments observable
N = total number of elements observable
na = not available

Table 6.18 Adjusted lifetime prevalence (ALP) of blunt trauma by portion and element in females

		Proximal		Diaphysis		Distal		Element	
		f/n	%	f/n	%	f/n	%	f/N	%
Clavicle	Left			1/na	-			1/60	1.7
	Right			0/na	-			0/56	-
	Both			1/na	-			1/116	0.9
Humerus	Left	0/58	-	1/68	1.5	0/64	-	1/48	2.1
	Right	0/63	-	0/69	-	0/69	-	0/53	-
	Both	0/121	-	1/137	0.7	0/133	-	1/101	1.0
Ulna	Left	0/64	-	0/62	-	1/49	2.0	1/44	2.3
	Right	0/67	-	0/60	-	1/47	2.1	1/43	2.3
	Both	0/131	-	0/122	-	2/96	2.1	2/87	2.3
Radius	Left	0/55	-	0/63	-	2/56	3.6	2/45	4.4
	Right	0/63	-	0/59	-	3/62	4.8	3/55	5.5
	Both	0/118	-	0/122	-	5/118	4.2	5/100	5.0
Femur	Left	0/68	-	0/71	-	0/66	-	0/57	-
	Right	0/64	-	0/62	-	0/54	-	0/49	-
	Both	0/132	-	0/133	-	0/120	-	0/106	-
Tibia	Left	0/54	-	0/58	-	1/60	1.7	1/48	2.1
	Right	0/51	-	1/59	1.7	0/54	0.0	1/45	2.2
	Both	0/105	-	1/117	0.9	1/114	0.9	2/93	2.2
Fibula	Left	0/33	-	0/53	-	0/49	-	0/30	-
	Right	0/32	-	2/45	4.4	0/46	-	2/25	8.0
	Both	0/65	-	2/98	2.0	0/95	-	2/55	3.6
Total	**Left**							**6/332**	**1.8**
	Right							**7/326**	**2.1**
	Both							**13/658**	**2.0**

f = number of segments or elements affected
n = number of segments observable
N = number of elements observable
na = not available

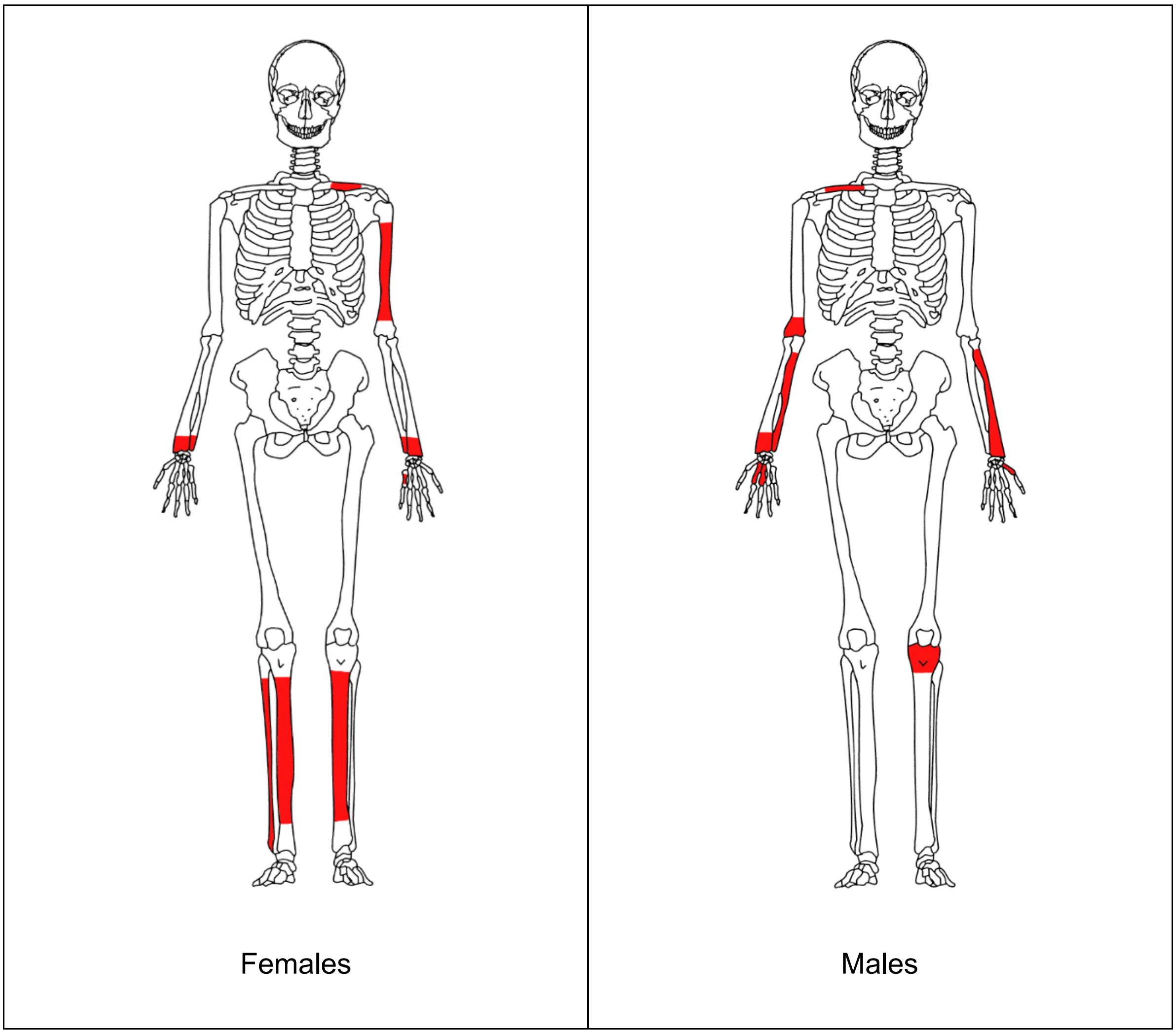

Figure 6.7 Cumulative patterning of post cranial appendicular blunt trauma in females and males. Illustration from Buikstra and Ubelaker (1994: Attachment 3a) modified by author.

Table 6.19 Long bone fracture type as a proportion of fractured elements

Males							
	Multifrag-mentary	**Partial**	**Complete**	**Oblique**	**Spiral**	**Transverse**	**Plastic Defor-mation**
	f/n	**f/n**	**f/n**	**f/n**	**f/n**	**f/n**	**f/n**
Clavicle				1/1			
Humerus		1/1					
Ulna						4/4	
Radius		1/3		1/3	1/3		
Femur							
Tibia							
Fibula				1/1			
Total	0/10	2/10	0/10	3/10	1/10	4/10	0/10
Females							
	Multifrag-mentary	**Partial**	**Complete**	**Oblique**	**Spiral**	**Transverse**	**Plastic Defor-mation**
	f/n	**f/n**	**f/n**	**f/n**	**f/n**	**f/n**	**f/n**
Clavicle				1/1			
Humerus						1/1	
Ulna		1/2		1/2			
Radius		1/5		3/5			1/5
Femur							
Tibia	1/2					1/2	
Fibula						2/2	
Total	1/13	2/13	0/13	5/13		4/13	1/13

f = number of elements with fracture type
n = number of elements fractured

Long bone blunt trauma was examined in detail in order to assess trauma patterns that may indicate risk. Closer examination of long bone trauma, for example, element or portion (proximal, midshaft, distal), anatomical features involved, fracture line patterns, and callus formation, sometimes enabled the identification of specific fracture types. These patterns provided valuable insights into the mechanisms and causes of injuries, as well as differences in susceptibility between subgroups. Findings are presented below for the following long bones: clavicle, humerus, ulna, radius, femur, tibia, and fibula. Trauma in certain individuals is described in detail, to discuss the implications of the location, fracture type and pattern, for possible causes and consequences of the fractures.

6.3.1.3. *Statistical analysis of blunt trauma in long bones*

The interpretation of sex specific blunt trauma prevalences, since it is a cumulative process, needed to consider the interacting or confounding effects of age. Following published methods (Baker & Pearson, 2006; Faccia & Williams, 2008; Villotte & Santos, 2022), binary logistic regression analysis was used to consider the effects of multiple variables on a single outcome. The results below presented adjusted-crude lifetime prevalences after pooling the left and right sides.

The following are the results of the analysis of the presence of blunt trauma in the population with left and right side data recoded for adjusted-crude lifetime prevalences. Table 6.20 displays the results of prevalence blunt trauma for sex categories after left and right samples were combined using the steps described above. The most affected body site was the forearm in both males and females (4.9% ulna in males; 5.8% radius in females, based on ACLP).

Table 6.20 Adjusted-crude lifetime prevalence (ACLP) in long bones by sex category

	Males		**Inter**		**Females**		**Combined**	
	f/n	**%**	**f/n**	**%**	**f/n**	**%**	**f/n**	**%**
Clavicle	1/79	1.3	0/2	-	1/88	1.1	2/169	1.2
Humerus	1/86	1.2	0/4	-	2/100	2.0	3/190	1.6
Ulna	4/82	4.9	0/1	-	2/91	2.2	6/174	3.4
Radius	3/78	3.8	0/1	-	5/86	5.8	8/165	4.8
Femur	0/71	-	0/1	-	0/86	-	0/158	-
Tibia	1/52	1.9	0/0	-	0/60	-	1/122	0.8
Fibula	0/50	-	0/0	-	0/58	-	0/108	

f = number of long bones with blunt trauma
n = number of individuals with long bones in (sub)sample

Table 6.21 Adjusted-crude lifetime prevalence (ACLP) in long bones by age category

	Young Adult		**Middle Adult**		**Old Adult**	
	f/n	**%**	**f/n**	**%**	**f/n**	**%**
Clavicle	0/41	-	1/110	0.9	1/18	5.6
Humerus	1/36	2.8	2/128	1.6	0/18	-
Ulna	0/41	-	5/120	4.2	1/13	7.7
Radius	1/41	2.4	6/112	5.4	1/13	7.7
Femur	0/37	-	0/112	-	0/9	-
Tibia	0/27	-	1/76	1.3	0/9	-
Fibula	0/26	-	0/73	-	0/9	-
Total	**2/249**	**0.8**	**15/731**	**2.1**	**3/89**	**3.4**

f = number of long bones with blunt trauma
n = number of individuals with long bones in (sub)sample

Table 6.22 Results of binary logistic regression analysis for the presence of blunt trauma on long bones using age and sex as predictor variables

		Predictor	Coeff (SE)	Odds ratio (99% CI)	p-Value
Upper Body	Clavicle	Sex	0.144 (0.605)	1.155 (0.243, 5.483))	0.811
		Age	1.831 (1.187)	6.241 (0.293, 132.819)	0.123
	Humerus	Sex	0.137 (0.534)	1.146 (0.289, 4.541)	0.798
		Age	-0.560 (1.003)	0.571 (0.043, 7.558)	0.577
	Ulna	Sex	-0.274 (0.407)	0.760 (0.267, 2.167)	0.500
		Age	1.125 (0.802)	3.081 (0.391, 24.302)	0.161
	Radius	Sex	0.242 (0.356)	1.274 (0.509, 3.186)	0.497
		Age	0.638 (0.676)	1.893 (0.332, 10.799)	0.345
Lower Body	Femur	Sex	-0.163 (1.056)	0.850 (.056, 12.914)	0.877
		Age	-0.815 (2.638)	0.442 (0.000, 395.383)	0.757
	Tibia	Sex	-0.596 (0.825)	0.551 (0.066, 4.611)	0.470
		Age	0.269(1.949)	1.309 (0.009, 198.326)	0.890
	Fibula	Sex	-0.082 (1.071)	0.921 (0.058, 14.529)	0.939
		Age	-0.284 (4.095)	0.753 (0.000, 28701.63)	0.945

Coding: Sex: 1 = male, 2 = intermediate, 3 = female; Age: 1 = YA, 2 = MA, 3 = OA

6.3.1.3.1. Clavicle

A total of two blunt force fractures to the clavicle were observed in the sample. One belonged to a male and the other to a female. The prevalence in males was 0.8% based on CLP, 1.0% based on ALP, and 1.3% based on ACLP, and for females 0.7% CLP, 0.9% ALP, 1.1% ACLP. The difference in prevalences was non-significant (Table 6.22). Both fractures were at midshafts of the clavicles.

Table 6.23 Clavicle fracture prevalences based on CLP, ALP, and ACLP

	CLP		ALP		ACLP	
	f/N	%	f/n	%	f/N_2	%
Males	1/123	0.8	1/103	1.0	1/79	1.3
Inter	0/9	-	0/4	-	0/2	-
Females	1/134	0.7	1/116	0.9	1/88	1.1

f = number of segments or elements affected
n = total number of elements observable
N = total number of individuals in sub-group
N_2 = total number of individuals with element preserved

Table 6.24 Summary of blunt trauma fractures of the clavicle

Skeleton No.	Sex	Age	Side	Portion	Type	Facture Pattern	Complication	Timing
M117	F	MA	L	Diaphysis	Simple	Oblique	Shortening and angulation	AM
M555	M	OA	R	Diaphysis	Simple	Oblique	Angulation	AM

F = female; M = male; MA = middle adult; OA = old adult; L = left; R = right; AM = antemortem

M117: This was a female in the middle adult age category with a fracture to the midshaft of the left clavicle (Figure 6.8). A well remodelled callus was observable indicating the incident causing the injury occurred long before the death of this individual probably during childhood.

Figure 6.8 Blunt trauma to left clavicle in M117. (Author’s photograph)

M555: This old adult male presented with an angular deformation to the right clavicle (Figure 6.9). The distal half of the clavicle was angled inferiorly between 20 and 25 degrees compared to the contralateral element. The almost complete remodelling or the lack of a callus indicates that this injury was sustained a long time ago, most likely in childhood.

In children, clavicular midshaft fractures are often greenstick or bowing fractures (Lovell & Grauer, 2019). Most common causes of midshaft fracture of the clavicle are falls onto the shoulder from a moderate height, falls onto an outstretched arm, or direct trauma to the bone (Galloway, 2014b). The angulation on this clavicle may have caused a slight (if any) inhibition to the range of motion of the right shoulder, but was likely symptom free. Malalignment of a clavicular fracture is not an indicator of the lack of medical treatment (Lovell & Grauer, 2019).

Figure 6.9 Blunt trauma to right clavicle of M555. (Author's photograph)

6.3.1.3.2. Humerus

Three humeri had evidence of fracture in the sample. One fracture was a perimortem fracture in a nonadult between 6 months to 1 year of age. The other two were in adults, one male (0.8% CLP, 1.2% ALP, 1.2 ACLP), the other female (0.7% CLP, 1.0% ALP, 2.0 ACLP). The prevalences calculated were statistically non-significant when using sex and age as predictor variables in the binary logistic regression models.

Table 6.25 Humerus fracture prevalences based on CLP, ALP, and ACLP

	CLP		**ALP**		**ACLP**	
	f/N	**%**	**f/n**	**%**	**f/N$_2$**	**%**
Males	1/123	0.8	1/82	1.2	1/86	1.2
Inter	0/9	-	0/4	-	0/4	-
Females	1/134	0.7	1/101	1.0	2/100	2.0

f = number of segments or elements affected
n = total number of elements observable
N = total number of individuals in sub-group
N_2 = total number of individuals with element preserved

Individual fractures location, facture type, fracture, location, and observable complications are detailed in Table 6.21.

Table 6.26 Summary of blunt trauma fractures of the humerus

Skeleton No.	Sex	Age	Side	Portion	Type	Facture Pattern	Complication	Timing
M369	Un	NA	R	Diaphysis	Simple	Oblique		PM
M544	M	YA	R	Distal	Articular	Partial	Non-union, pseudoarthrosis	AM
M591	F	MA	L	Diaphysis	Simple	Transverse	Slight angulation medially, shortening	AM

F = female; M = male; Un = unknown sex; NA = nonadult; YA = young adult; MA = middle adult; L = left; R = right; AM = antemortem; PM = perimortem

M369: This individual was a nonadult in its first year of life. A simple oblique fracture was present midshaft on the diaphysis of the right humerus (Figure 6.10). The humerus received direct trauma from a levering or bending force that bent the bone posteriorly resulting in the fracture. The young bone bent posteriorly resulting in a complete fracture, implying considerable indirect force (Lovell, 1997). Reconstruction of the two pieces indicated that the bone was bent 52 degrees posteriorly. It is possible that initially this was a green stick fracture and an attempt was made to set the distal portion back into alignment, either after the incident or postmortem. The lack of evidence of any new bone formation indicates that the fracture was sustained perimortem, and the plastic deformation of the bone spurs around the fracture site indicate that it was not postmortem. Force seems to have been applied from the posterior direction of the humerus. A possible scenario for this facture is a child being grabbed forcefully by the arm with the index finger of the caregiver acting as the fulcrum at the midshaft of the humerus. Humeral midshaft fractures in children have been recorded in the forensic literature on child abuse (Love et al., 2011); however, intentionality cannot be established on fracture type alone (Love et al., 2011).

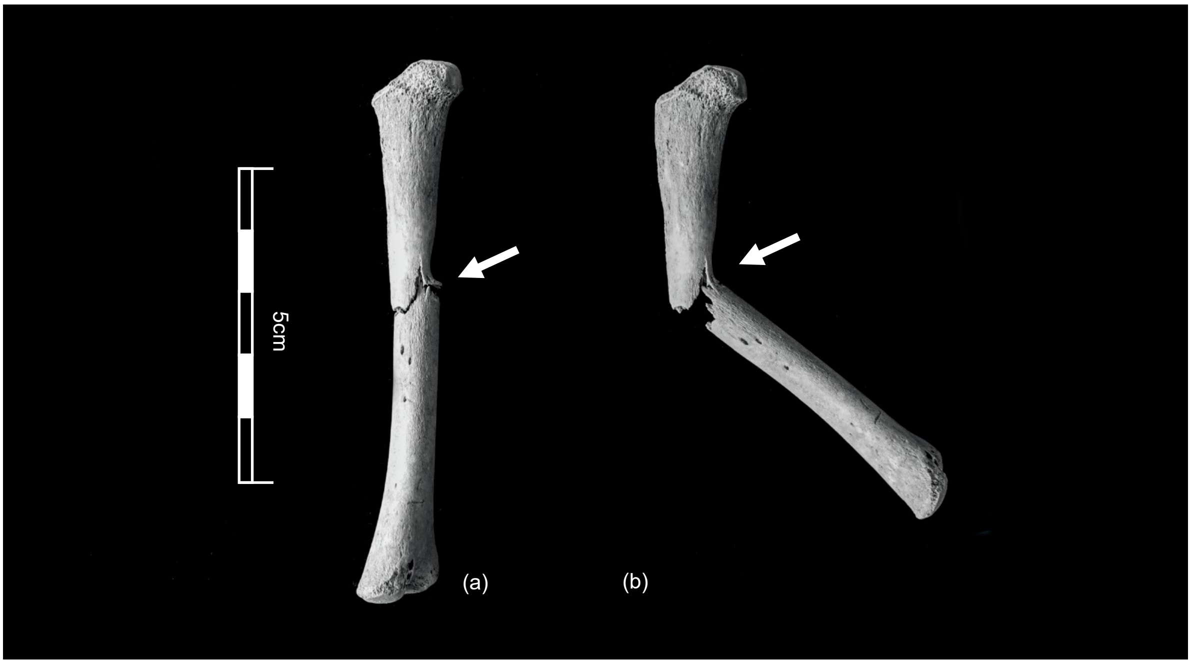

Figure 6.10 Blunt trauma on right humerus of M369. (a) showing fracture pattern, (b) indicating reconstructed bending. Both a and b are the same element. (Author’s photograph)

M544: This individual was a young adult male with disfigurement to the distal lateral portion of the left humerus (Figure 6.11). The lateral condyle was involved in a complete fracture which subsequently resulted in non-union or a pseudo arthrosis. This appears to be a single column fracture, although the lateral portion was not recovered. The well remodelled bone around the injury site indicates the injury was sustained many years prior to death possibly in childhood. Clinical literature indicates that simple transtrochlear fractures, such as this one, are most common in boys between the ages of 5 and 10 (Galloway et al., 2014). This type of fracture pattern is usually seen in instances of falls onto a flexed elbow with force going through the olecranon superiorly between the trochlea and the capitulum (Galloway, 2014b). Based on dry bone reconstruction of the elbow limited range of motion was ascertained between 30 and 60 degrees of flexion. With such a limited range of motion this individual would have had difficulty performing activities of daily living, even more so if the individual was left handed.

Figure 6.11 Blunt trauma to distal left humerus in M544. (Author's photograph)

6.3.1.3.3. Ulna and radius

The results of the ulna and radius are presented together because in a few cases the ulna and radius appear to be injured from a single incident. Four males (3.3% CLP; 5.1% ALP) and 2 females (1.5% CLP; 2.3% ALP) exhibited fractured ulnae. The prevalences compared between the male and female sex were statistically non-significant for both CLP and ALP. Furthermore, 3 males (2.4% CLP; 3.91% ALP) and 5 females (3.7% CLP; 5.0% ALP) exhibited fractured ulnae. The prevalences compared between the male and female sex were statistically non-significant for both CLP and ALP.

Table 6.27 Radius and ulna fracture prevalences based on CLP, ALP, and ACLP

Ulna						
	CLP		**ALP**		**ACLP**	
	f/N	**%**	**f/n**	**%**	**f/N2**	**%**
Males	4/123	3.3	4/78	5.1	4/82	4.9
Inter	0/9	-	0/0	-	0/1	-
Females	2/134	1.5	2/87	2.3	2/91	2.2
Radius						
	f/N	**%**	**f/n**	**%**	**f/N2**	**%**
Males	2/123	2.4	3/77	3.9	3/78	3.8
Inter	0/9	-	0/0	-	0/1	-
Females	5/134	3.7	5/100	5.0	5/86	5.8

f = number of segments or elements affected
n = total number of elements observable
N = total number of individuals in sub-group
N_2 = total number of individuals with element preserved

Table 6.28 Summary of blunt trauma fractures of the ulna

Skeleton No.	**Sex**	**Age**	**Side**	**Portion**	**Type**	**Facture Pattern**	**Complication**	**Timing**
M208	M	MA	R	Diaphysis	Simple	Transverse	Distal articular surface arthropathy	AM
M212	F	MA	R	Distal	Extra-articular	Oblique	Styloid process not united (missing)	AM
M235	M	OA	R	Distal	Simple	Transverse	New bone formation on both the ulna and the radius. Severe arthrosis humeral head, glenoid, and acromion.	AM
M360	F	MA	L	Distal	Articular	Partial	Osteoarthritis (eburnation)	AM
M484	M	MA	R	Diaphysis	Simple	Transverse	Arthropathy at right elbow possibly related to the trauma	AM
M486	M	MA	R	Diaphysis	Simple	Transverse		AM
M556	UnA	UnA	L	Diaphysis	Simple	Oblique	Malunion, malalignment, shortening	AM

F = female; M = male; UnA = unknown; MA = middle adult; OA = old adult; L = left; R = right; AM = antemortem

Table 6.29 Summary of blunt trauma fractures of the radius

Skeleton No.	Sex	Age	Side	Portion	Type	Facture Pattern	Complication	Timing
M132	F	MA	R	Distal	Articular	Partial		AM
M212	F	MA	R	Distal	Extraarticular	Oblique	Malalignment (dorsal angulation)	AM
M235	M	OA	R	Distal	Simple	Oblique		AM
M239	M	MA	L	Distal	Articular	Partial	Angulation	AM
M360	F	MA	L	Distal	Simple	Oblique	Subsequent arthritis on distal joint of radius	AM
M492	F	MA	R	Distal	Simple	Oblique	Dorsal angulation of distal end of radius (between 5 and 15 degrees), possible shortening	AM
M535	F	YA	L	Distal	Bow fracture		Dorsal angulation	AM
M554	M	MA	L	Diaphysis	Simple	Spiral	Displacement with subsequent malunion, resulting in angulation and shortening	AM

F = female; M = male; YA = young adult; MA = middle adult; OA = old adult; L = left; R = right; AM = antemortem

M132: The right radius of this middle adult female exhibited a fracture callus located at the distal end, approximately 4 cm from the articular surface (Figure 6.12). The direction of the fracture force was difficult to determine due to the well-remodelled callus, but it is likely from dorsal to ventral force, thus making it a Smith's fracture (Galloway, 2014b). Additionally, a thin fracture line (gap) was observed on the medial posterior articular surface that is most likely related to the fracture of the metaphysis. The well-remodelled callus suggests that the fracture had occurred more than a year prior to death. Smith's fractures are typically sustained from falling on the back of the hand or onto a dorsiflexed hand in supination that is rotating into pronation (Galloway, 2014b), and are common occurrence in older women (Dóczi & Renner, 1994; Galloway, 2014b). The fracture of the shaft appears to have healed well and may have had little impact on activities of daily living; however, the fracture of the articular surface likely resulted in subsequent joint pain and mobility issues.

Figure 6.12 Blunt trauma to distal right radius in M132 (anterio-distal view). (Author's photograph)

M208: This middle adult male sustained a transverse mid-shaft fracture in their right ulna (Figure 6.13). The timing of the injury was estimated to have occurred long before death based on the well-remodelled appearance of the callus. Direct or indirect trauma were identified as potential causes of the fracture. The distal articular surface of this right ulna showed signs of arthropathy, possibly post-traumatic.

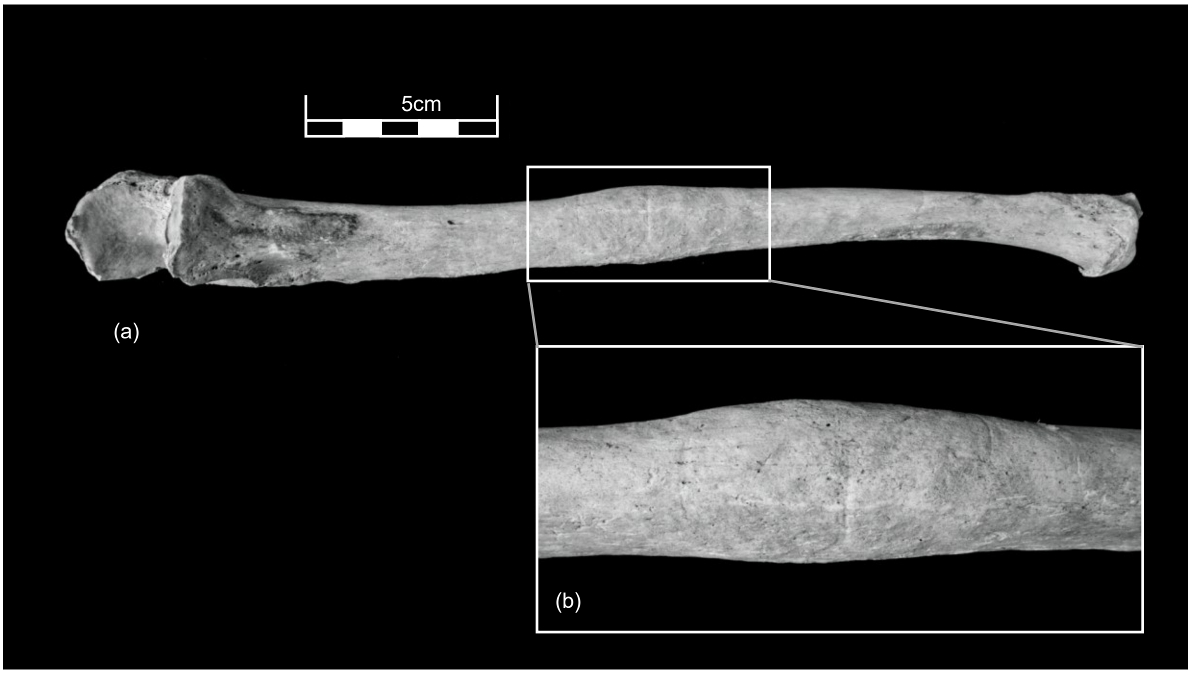

Figure 6.13 Blunt trauma on right ulna of M208. (a) showing location on element, (b) close-up of fracture callus. (Author's photographs)

M212: This middle adult female had fractures to the distal right radius (Figure 6.14) and ulna. The healing stage of both calluses indicated that the two fractures were most likely a result of a single event. The oblique radial fracture healed in malalignment that resulted in angulation of the distal portion. The dorsal angulation was between 15 and 20 degrees. The fracture on the ulna was a styloid process fracture. The angulation may have interfered with the normal mobility and range of motion of the hand, and may have given an appearance of slight disfigurement of the arm. The clinical, or quality of life implications were reduced range of motion and possible pain upon movement of the wrist. This may have limited some activities that involved fine motor movement or precision. The angulation also implies that medical services to set the bone after the injury were not available to this woman. The fracture of the styloid process of the ulna indicates that the impact was considerable. During a traumatic event the distal ulna and the carpals come in contact only under extreme loading (which causes the styloid process fracture), and such a fracture may indicate a fall from a height (Galloway, 2014b).

Figure 6.14 Blunt trauma on the distal portion of the right radius (bottom) in M212, showing angulation compared to the left radius (top). (Author's photograph)

M235: This old adult male had fractures to both distal right radius and ulna (Figure 6.15). The individual has a fractured right distal ulna with complications. The radius exhibited new bone formation and may have been fractured as well. It is difficult to observe the possible fracture site because of the new bone formation (i.e., *myositis ossificans*) that is attached to the bone at this location. The likely cause of this injury was some type of trauma that completely fractured the ulna and possibly incompletely fractured the radius. This type of injury frequently occurs by receiving a weapon injury while shielding the head with the forearms in a defensive position. The density and well-remodelled nature of the bone formations around the fracture sites suggest that the injury occurred a considerable time before death.

Figure 6.15 Blunt trauma to right ulna (top) and right radius (bottom) in M235. (Author's photograph)

M360: This middle adult female exhibited evidence of blunt force trauma at the distal left ulna and radius (Figure 6.16). The radius fracture is consistent with a Colles' type fracture (Lovell & Grauer, 2019). The trauma is well healed but exhibits malalignment resulting in dorsal angulation. The distal ulna also sustained trauma, with a compaction fracture affecting the head and styloid process. The fracture calluses are well-remodelled and subsequent post-traumatic osteoarthritic changes were observed at the distal radio-ulnar joint, indicating the timing of incident was many years prior to death. The evidence suggests that this was most likely a fall on an outstretched hand (FOOSH) type of injury, but the disfigurement to the distal ulna suggests a high degree of force and loading was involved (Galloway, 2014b). The clinical or quality of life implications include significant disfigurement of the distal ulna and impaired function of the left hand due to joint pain.

Figure 6.16 Blunt trauma to the distal left radius of M360 exhibiting angulation and osteoarthritic changes. (Author's photograph)

M492: This middle adult female had a simple oblique fracture to the distal right radius (Figure 6.17). The fracture pattern is consistent with a Smith's fracture, characterised by a force that travelled dorsal side superiorly to the ventral, so that the fracture on the ventral side is more proximally located (Galloway, 2014b). The most likely cause of Smith's fractures according to the clinical literature is a fall on the back of the hand, or on the forearm in supination which is rotating into pronation with a dorsiflexed hand (Galloway, 2014b). There is potential for shortening as a complication of this fracture, evidenced by the 6mm difference in length between the left and the right radii in this individual. Although this could potentially be attributed to normal anatomical variation, the observation that all other upper extremity long bone measurements for this individual are greater on the right than the left, indicate that it was most likely a result of shortening due to trauma. This deviation in length suggests that the bone was displaced upon injury and healed in malalignment.

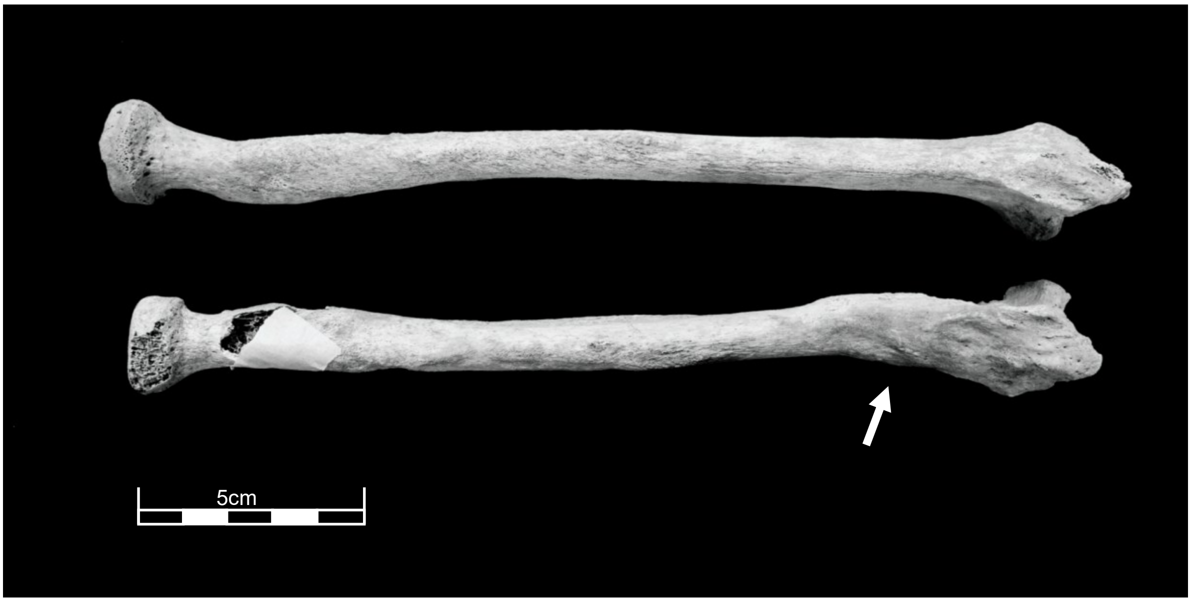

Figure 6.17 Blunt trauma to the distal right ulna (bottom) of M492, compared to the right ulna (top). (Author's photograph)

M535: This young adult female presented with a bowing or plastic deformation fracture (Figure 6.18). This is evidenced by angulation of the distal left radius to an angle between 15 and 20 degrees. Bowing fractures are a childhood injury (more rarely in adolescents) and occur most often on the radius and ulna (Mabery & Fitch, 1989). The cause of these types of injuries is typically a fall onto the outstretched hand, from a height such as when climbing furniture, playground equipment, and trees (Lovell & Grauer, 2019). These types of falls often result in significant force being applied to the arm, causing the soft (lower mineral content) bones of children and adolescents to deformation or bow instead of fracture (Redfern, 2017b). These fractures do not exhibit the typical features of a healed fracture, such as callus formation, but instead present as a permanent bowing of the affected bone (Mabery & Fitch, 1989).

Figure 6.18 Plastic deformation fracture on distal left radius of M535. (Author’s photograph)

6.3.1.3.4. Femur

No blunt trauma fractures were observed in femora in the sample.

6.3.1.3.5. Tibia and fibula

Three individuals had sustained fractures to their tibiae in the sample, one male (0.8% CLP; 1.6% ALP) and two females (1.5% CLP; 1.1% ALP). The prevalences compared between the male and female sex were statistically non-significant for both CLP and ALP.

Table 6.30 Tibia and fibula fracture prevalences based on CLP, ALP, and ACLP

Tibia						
	CLP		**ALP**		**ACLP**	
	f/N	**%**	**f/n**	**%**	**f/N₂**	**%**
Males	1/123	0.8	1/63	1.6	1/52	1.9
Inter	0/9	-	0/2	-	0/0	-
Females	2/134	1.5	2/93	2.2	0/60	-
Fibula						
	f/N	**%**	**f/n**	**%**	**f/N₂**	**%**
Males	0/123	0.8	0/43	-	0/50	-
Inter	0/9	-	0/2	-	0/0	-
Females	2/134	1.5	2/55	3.6	0/58	-

f = number of segments or elements affected
n = total number of elements observable
N = total number of individuals in sub-group
N_2 = total number of individuals with element preserved

Table 6.31 Summary of blunt trauma fractures of the tibia

Skeleton No.	**Sex**	**Age**	**Side**	**Portion**	**Type**	**Facture Pattern**	**Complication**	**Timing**
M270	F	UnA	L	Distal	Articular	Partial	Fusion of talus to tibia. Arthropathy on distal left fibula.	AM
M431	F	UnA	R	Diaphysis	Simple	Transverse		PM
M526	M	MA	L	Proximal	Simple	Oblique	Slight malalignment, tibia bit angled and twisted Proximal end of fibula fused to tibia	AM

F = female; M = male; UnA = unknown; MA = middle adult; L = left; R = right; AM = antemortem; PM = perimortem

Two skeletons presented with fractures to fibulae in the sample, both of them were female. Therefore, the male prevalence of fibular fractures was 0%, with females having a prevalence of 1.5% based on CLP or 2.6% based on ALP (**Error! Reference source not found.**). The prevalences compared between the male and female sex were statistically non-significant for both CLP and ALP. A detailed summary of the fractures to fibulae is presented in Table 6.32.

Table 6.32 Summary of blunt trauma fractures of the fibula

Skeleton No.	Sex	Age	Side	Portion	Type	Facture Pattern	Complication	Timing
M431	F	UnA	R	Diaphysis	Wedge	Butterfly	None	PM
M569	F	UnA	R	Diaphysis	Simple	Transverse(?)	None	AM

F = female; UnA = unknown; L = left; R = right; AM = antemortem; PM = perimortem

M270: This female of unknown adult age exhibited a distal articular fracture of the left tibia (Figure 6.19). A well-remodelled callus on the distal third of the left tibia indicated a fracture in an oblique orientation suggesting a compacted or spiral fracture. The distal portion of the tibia showed slight displacement, and the talus was ankylosed to the tibia, suggesting involvement in the same traumatic event. This ankylosis may have resulted from severe dislocation or comminution of the articular facets of both the tibia and the talus and is accompanied by evidence of ligament damage at the ankle joint in the form of ossification of soft tissue on the distal fibula (Lovell, 1997). The well-remodelled callus on the shaft, observable by only a slight deformity on the cortical surface, suggests the traumatic event likely occurred during childhood. The ankylosis at the distal joint and the obliquely displaced fracture on the distal shaft point towards vertical compression, such as a hard landing on the foot from a height (Galloway, 2014a). The ankylosis of the distal tibio-talar joint results in a loss of range of motion at the left ankle, and has social implications in the form of a lifetime of post-traumatic disability, limiting mobility and physical activity.

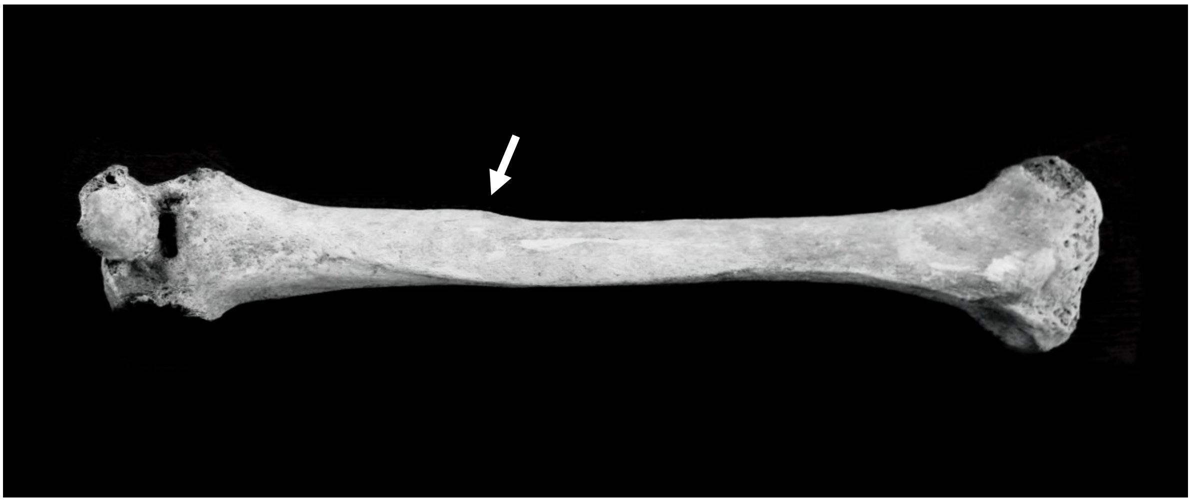

Figure 6.19 Blunt trauma to left tibia (arrow) of M270 with ankylosis of talus. (Author's photograph)

M431: This female of unknown adult age exhibited a midshaft perimortem fracture of the right tibia and fibula (Figure 6.20). Both bones exhibited transverse fractures with slight obliquity, with the fibula showing a butterfly fracture pattern. On the tibia the fracture was more distal than on the fibula (11cm and 13cm from the distal end, respectively) indicating that the direction of the force was either slightly oblique or there was a slight rotational component to the injury mechanism. The nature of the fracture (tib-fib) indicates that it was caused by considerable forces. The butterfly fracture on the fibula indicates that the force originated on the lateral side of the leg on the fibula and propagated through the tibia. This is evidenced by the wide portion of the wedge oriented on the lateral side of the fibula, with the wide aspect of the wedge usually being on the side of impact (Reber & Simmons, 2015). Such fractures are most common in lower extremities that are weight bearing at the time of impact by an extraneous object (Galloway et al., 2014).

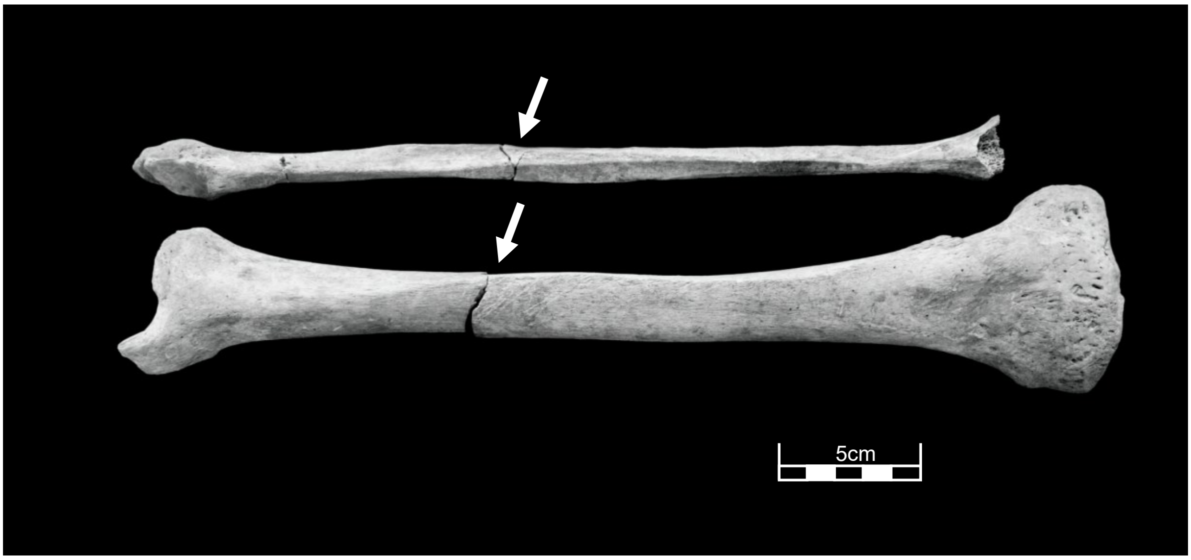

Figure 6.20 Blunt trauma on right tibia and fibula of M431. (Author's photograph)

M526: This middle adult presented with an oblique tibial plateau (metaphyseal) fracture of left tibia with metaphysio-diaphyseal displacement (Figure 6.21). The proximal tibia exhibits a healed oblique fracture line with no articular involvement. The fracture line runs obliquely from the proximal dorsal surface just distal the epiphyseal plate, descending inferiorly to the anterior surface, exiting slightly distal to the tibial tuberosity. This type of tibial plateau fracture is more specifically defined by Bono and colleagues (2001) as an anterior oblique extraarticular tibial fracture. In M526, there is slight superio-posterior displacement of the distal fragment. The articular surface does not seem to be involved. Timing of the injury is indicated by a well remodelled fracture callus with no woven bone present, indicating that the traumatic event occurred more than a year before the death of this individual. These type of injuries are common in young adults, and often a result of high energy impact such as falls from a considerable height, or sports related injuries (Galloway, 2014a).The resulting malalignment of the tibial plateau, with medial angulation may have led to complications and quality of life implications for this individual, including reduction in joint mobility and gait interference.

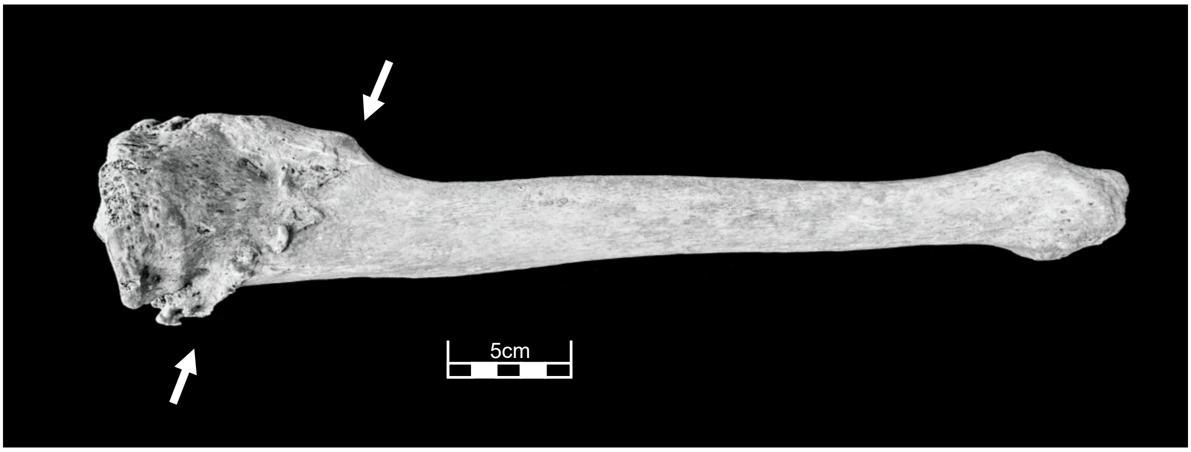

Figure 6.21 Blunt trauma to the proximal tibia of M526. (Authors photograph)

M569: This female of unknown adult age exhibited a midshaft antemortem fracture of the right fibula (Figure 6.22). The fracture is evidenced by the presence of a callus, which is well remodelled, indicating considerable time between the injury and death, but obscures any fracture lines or indications to the fracture pattern. The nature of the fracture suggests it possibly resulted from a direct blow to the lateral lower leg. This simple fracture was in alignment and no displacement was noted.

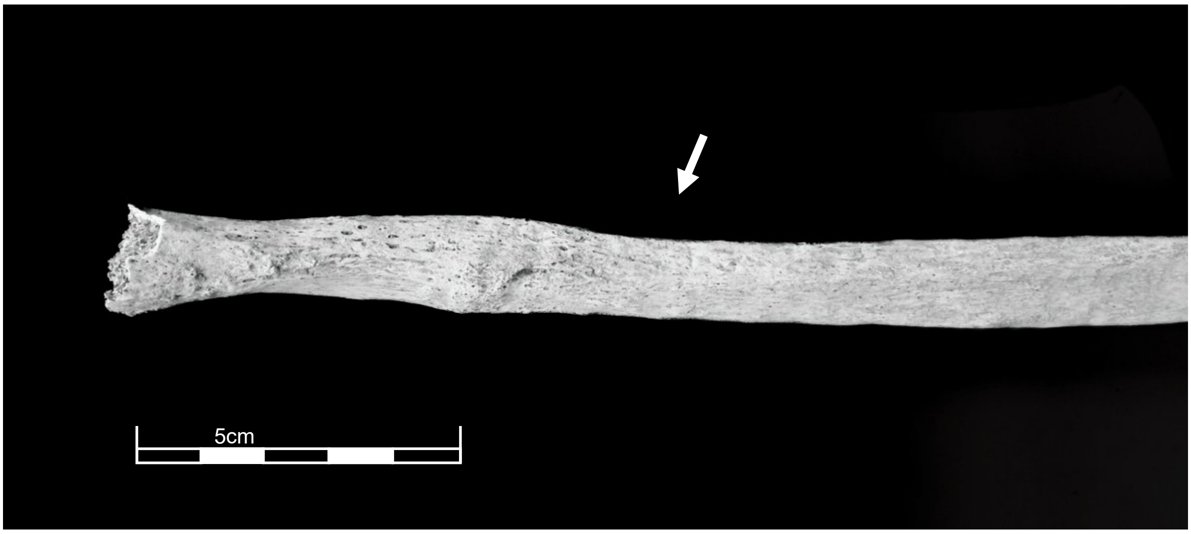

Figure 6.22 Blunt trauma to the right fibula of M569. (Author's photograph)

6.3.1.4. *Blunt trauma in ribs*

Rib fractures are one of the most common skeletal injuries found in historical archaeological samples (Brickley, 2006; Roberts & Cox, 2003) and including some medieval samples (Agnew & Justus, 2014; Burrell et al., 2018; Dittmar et al., 2021) and can result from both blunt and penetrating trauma to the chest (Caragounis et al., 2021). During the medieval period blunt force trauma, such as that experienced from falls, crush injuries, or assault would have been the major causes of fractured ribs. However, medical conditions such as osteoporosis, and bone tumours can increase the likelihood of rib fractures, especially in the elderly (Wuermser et al., 2011). Bioarchaeological studies often overlook the analysis of rib fracture patterns in detail (Brickley, 2006). However, such an analysis can reveal important information about interactions and lifestyles of past populations. Rib fractures are explored below to examine the risks involved in the patterning of blunt force trauma to the thorax. The patterning of the location of the fracture on the thorax and within the ribs was also analysed for indications of injury mechanisms.

Overall, CLP rates indicate that 26 individuals in the sample had rib fractures (26/427, 6.1%) in their lifetime. Fourteen males (11.4%) and 10 females (7.5%) had at least one of their ribs fractured, the difference was statistically non-significant (Table 6.33). No rib fractures were identified in the Intermediate sex category, and therefore are not included in any of the tables below.

Table 6.33 Crude lifetime prevalence (CLP) of rib fractures

	f/n	%	p-value
Males	14/123	11.4	0.281
Females	10/134	7.5	
Intermediate	0/9	-	
Unknown Sex (Adult)	1/63	1.6	
Unknown Sex (Nonadult)	1/98	1.0	
Total	26/427	6.1%	

f = number of individuals with rib blunt trauma
n = number of individuals in subsample

The 26 individuals had 63 fractured ribs with a total of 67 fractures (4 ribs had two fractures, i.e., multifragmentary). Fourteen (14) individuals had multiple ribs fractured, 9 of them male and 5 female.

Of the individuals for whom age could be estimated, the CLP of rib fractures shows a rise in prevalence in from Young Adults to Middle Adults for both females and males, then a drop from Middle Adults to Old Adult in males, but a rise in females (Table 6.34). In the Middle Adult category males have a higher prevalence (almost double) of rib fractures; however, this difference is not statistically significant.

Table 6.34 Crude lifetime prevalence (CLP) of rib fractures by age categories for males and females

	Males		Females	
	f/n	%	f/n	%
Young Adult	1/20	5.0	1/31	3.2
Middle Adult	11/74	14.9	7/81	8.6
Old Adult	2/15	13.3	2/7	28.6
Total	14/123	11.4	10/134	7.5

f = number of individuals with rib blunt trauma
n = number of individuals in subsample

To get a better understanding of rib fracture prevalence patterns the subgroup of individuals with rib trauma was explored further. Within the subsample of individuals-with-rib-fractures (n=26), 10 of 26 (38.4%) were female and 14 (53.8%) were male, 1 (3.9%) was an adult of unknown sex, and 1 (3.9%) was a nonadult. Fourteen individuals had multiple ribs fractured, and 12 had a single rib fractured (Table 6.35). Of the individuals who had multiple ribs fractured, 9 were male and 5 were female.

Table 6.35 Counts and prevalence of individuals with single and multiple fractured ribs within the subsample of individuals-with-rib-fractures

	Number of ribs fractured in individual							**Prevalence within the subcategory**					
	Single	**Multiple**						**Single Rib**		**Multiple Ribs**		**Grand Total**	
	1	**2**	**3**	**4**	**5**	**6**	**8**	**f/n**	**%**	**f/n**	**%**	**f/n**	**%**
Males	5	4	1	1	1	2		5/14	35.7	9/14	64.3	14/26	53.8
Females	5	4					1	5/10	50.0	5/10	50.0	10/26	38.4
Unknown (Adult)	1							1/1				1/26	3.9
Unknown (Nonadult)	1							1/1				1/26	3.9
Total	12	8	1	1	1	2	1	12/26	46.2	14/26	53.8	26	

f = number of individuals with rib blunt trauma
n = number of individuals in subsample (e.g., males with rib fractures)

Within the subsample of females with rib fractures, half (50.0%) had a single fractured rib, with the remaining half having multiple (two or more) ribs fractured. Conversely, among males 35.7% had a single rib fractured, and 64.3% having multiple ribs fractured. This points to a possible trend of males having more severe incidents, or higher risk situations, in which ribs were fractured. Alternatively, since it was not possible to tell the timing of such multiple trauma, it may be possible that males who sustained a rib fracture are at a higher risk of sustaining subsequent rib fractures.

Next, the age distribution rib fractures was analysed to observe the patterning within the subgroup of individuals-with-rib-fractures. Table 6.36 presents the age distribution patterning of single and multiple rib fractures, and combined statistics. In the subsample of males with rib fractures, 7.1% were young adult, 78.6% were middle adult, and 14.3% were old adult; and females were 10.0% young adult, 70.0% middle adult, and 20.0% old adult Figure 6.23. This suggests that the majority of rib fractures occurred in young or middle adulthood. It also suggests have having rib fractures may be an indicator of decreased survivorship into old adulthood.

Table 6.36 Count and percentage of females and males with single and multiple fractured ribs by Age Category

	Males						Females					
	Single		Multiple		Subtotal		Single		Multiple		Subtotal	
	f/n	%	f/n	%	f/n	%	f/n	%	f/n	%	f/n	%
Young Adult	1/1	100			1/14	7.1			1/1	100.0	1/10	10.0
Middle Adult	3/11	27.3	8/11	72.7	11/14	78.6	5/7	71.4	2/7	28.6	7/10	70.0
Old Adult	1/2	50	1/2	50	2/14	14.3			2/2	100.0	2/10	20.0

f = number of individuals with rib blunt trauma
n = number of individuals in subsample

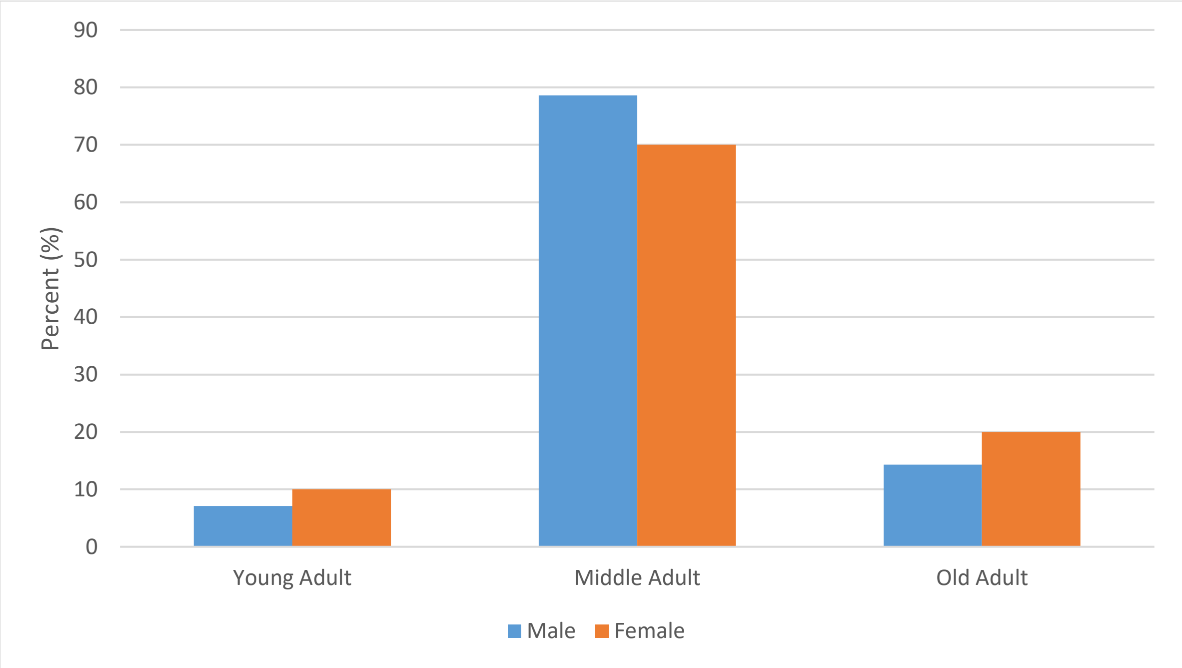

Figure 6.23 Percentage of individuals with rib fractures by age category in the subcategory of individuals-with-rib-fractures.

The patterning of the location of the rib fractures was analysed to see if the location of the fractures on the thorax and on the ribs themselves could indicate injury mechanisms.

When sidedness was analysed, it was discovered that, of the ribs that were fractured in the sample, 45.9% were from the left side and 38% from the right (16% unknown side). Interestingly, the pattering in males and females was opposite. In males the left side had a higher proportion of ribs fractured, while in females the right side was greater. In males 55% of the fractured ribs were from the left side, 35% from the right; and in females 29% from the left and 41% on the right.

Table 6.37 Proportion of fractured ribs by sex and side

	Male		Female		Total	
	f/n	**%**	**f/n**	**%**	**f/n**	**%**
Left	22/40	55.0	6/21	28.6	28/61	45.9
Right	12/40	30.0	11/21	52.3	23/61	37.7
Unknown	6/40	15.0	4/21	19.1	10/61	16.4
Grand Total	40/40	100	21/21	100	61/61	100

f = number of fractured ribs in subcategory
n = total number of fractured ribs in subcategory

Table 6.38 Prevalence of rib fracture in females and males (excludes, Intermediate, Unknown Adults and Nonadult, n=61 ribs, n=65 fractures)

Side (ribs)						
	Female		**Male**		**Total**	
Left	6	29%	22	55%	28	46%
Right	11	41%	12	35%	23	38%
Unknown	4	30%	6	6%	10	16%
Total	21	100%	40	100%	61	100%
Anatomical location (fractures)						
Anterior	3	12%	16	40%	19	30%
Lateral	14	56%	18	45%	32	49%
Posterior	8	32%	4	10%	12	18%
Unknown			2	5%	2	3%
Total	25	100%	40	100%	65	100%
Healing status (fractures)						
Healed	25	100%	27	68%	48	80%
Healing	0	0%	10	25%	10	15%
Unknown		0%	3	8%	3	5%
Total	25	100.00%	40	100.00%	67	100.00%
Number of ribs fractured in injury recidivists vs non-recidivists (ribs)						
Non-recidivist	21	100%	23	58%	44	72%
Recidivist	0	0%	17	43%	17	28%
Total	21	100%	40	100%	61	100%
Location on thorax (ribs)						
Upper (1-3)	1	5%	1	3%	2	3%
Middle (4-9)	13	62%	22	55%	35	57%
Lower (10-12)	2	10%	4	10%	6	10%
Unknown	5	24%	13	33%	18	30%
Total	21	100%	40	100%	61	100%

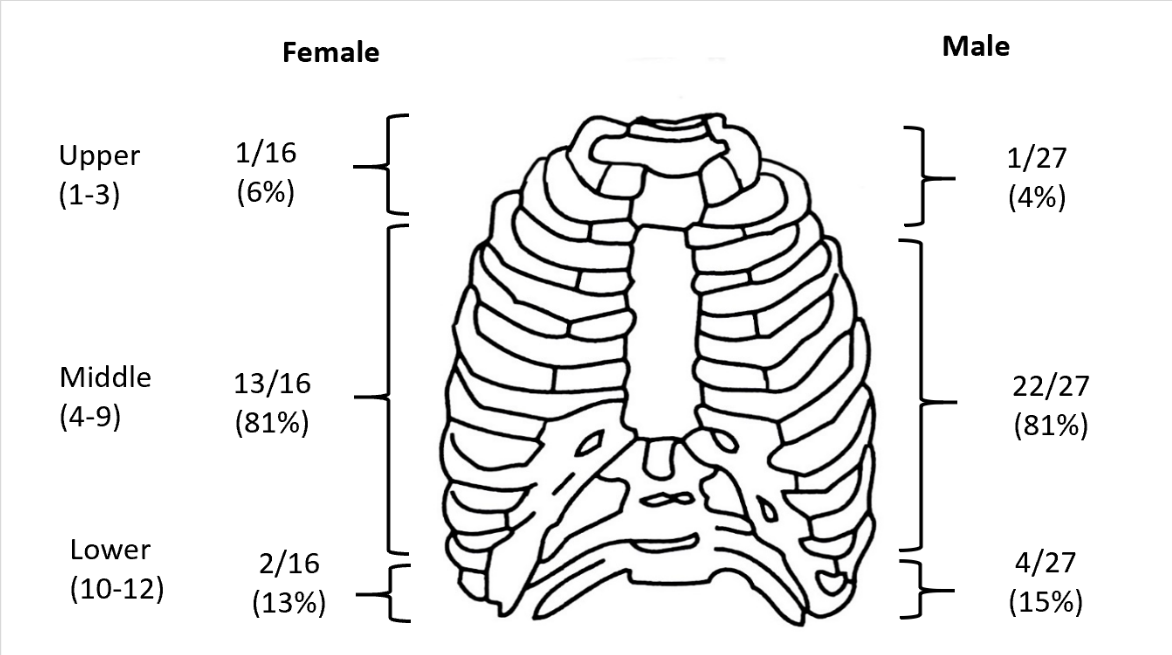

Figure 6.24 Location of fractured ribs on thorax in females and males (excludes ribs of unknown location). Illustration from Buikstra and Ubelaker (1994: Attachment 3a) modified by author.

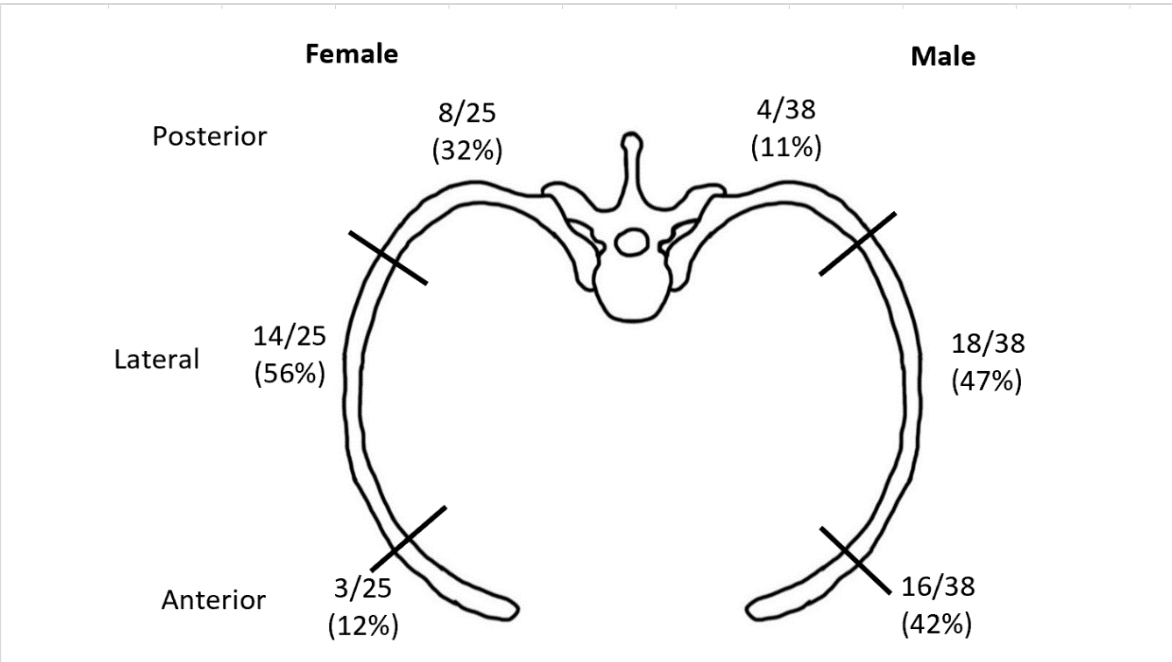

Figure 6.25 Anatomical location of fractures on ribs for females and males (excludes fractures of unknown anatomical location). Illustration by author.

Adjusted lifetime prevalences were unavailable for rib fractures due to the fragmentary nature of the Alba Iulia skeletal sample. In many cases, it was impossible to determine which rib was being investigated, other than placing it in the upper, middle, or lower section of the rib cage. Statistical analyses indicated the rib fracture patterns did not significantly differ between males and females (Table 6.39).

Table 6.39 Results of statistical tests (χ2) comparing males to females for fracture location on thorax and location on rib

	Males		Females			
	f/n	%	f/n	%	χ^2	p-value
Location on Thorax						
Upper (ribs 1-3)	1/27	3.7	1/16	6.3	-	1.000*
Middle (ribs 4-9)	22/27	81.5	13/16	81.1	-	1.000*
Lower (ribs 10-12)	4/27	14.8	2/16	12.5	-	1.000*
Location on rib						
Anterior	16/38	42.1	3/25	12.0	6.488, df=1, n=63	0.011
Lateral	18/38	47.4	14/25	56.0	0.450, df=1, n=63	0.503
Posterior	4/38	10.5	8/25	32.0	-	0.050*

f = number of fractures at site
n = total number of ribs with fractures
*result of Fisher's exact test

Rib fracture patterns were analysed because they hold important information about the injury mechanism. The results of the fracture pattern analysis are presented in Table 6.40. Analyses did not reveal any significant differences in patterns between males and females..

Table 6.40 Results of statistical tests (χ^2) comparing males to females for rib fracture patterns

	Transverse			Oblique			Unknown	
	f/n	%	p-value	f/n	%	p-value	f/n	%
Male	21/40	52.5	0.153 (2.037, df=1, n=61)	14/40	35.0	0.018 (5.561, df=1, n=61)	5/40	12.5
Female	7/21	33.3		14/21	66.7		0/21	
Unknown	2/2							

f = number of fractured ribs with specific pattern sex subcategory
n = total number of fractured ribs in sex subcategory
() = χ^2 statistics

6.3.2. Implement trauma

Implement trauma provides a unique opportunity to study interpersonal violence in the Alba Iulia sample as sharp force trauma in the medieval period, before the hazards of modern machinery, was more often than not a result of weapon injuries. Weapon injuries are usually not a result of accidents and can often be attributed to intentional perpetration of a violent act, whether from interpersonal conflict or larger social conflicts such as warfare. Individuals afflicted by implement or sharp force trauma may represent a certain sub-group or at-risk individuals such as military personnel.

Nine individuals in the total sample had sustained skeletal implement trauma. Eight of the individuals were adult males (8/123; 6.5% of males), and one individual was a nonadult of unknown sex. A total of 20 implement injuries were observed, with 4 individuals having multiple injuries. In multiple implement injury cases, the injuries were sustained concurrently in each individual and very likely involved in, or led to, the cause of death. Figure 6.26 presents a cumulative patterning (all individuals combined) of the location of all implement trauma found in the sample. It was apparent that individuals sustained implement trauma on all parts of their bodies including the head, arms, pelvis, and legs. The head was the most frequent site of with 7 of the 9 individuals with implement trauma having these types of injuries to the head, suggesting lethal intent by another individual in most cases, rather than occupational accidents (for example).

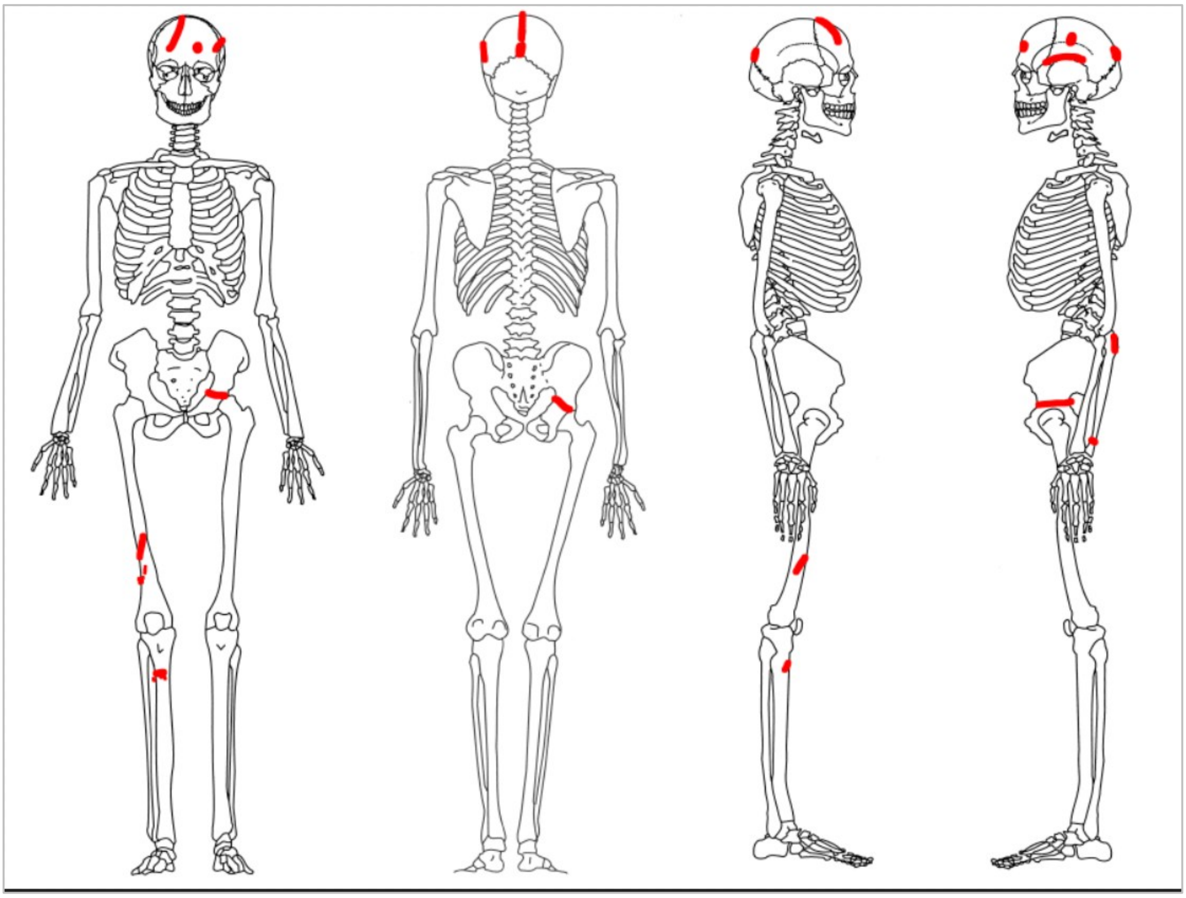

Figure 6.26 Location of (marked in red) all cumulative combined implement trauma. Illustration from Buikstra and Ubelaker (1994: Attachments 3a, 3b, 4a, and 4b) modified by author.

Table 6.41 Crude lifetime prevalence (CLP) of implement trauma

	Males		Inter		Females		Unknown		Total	
	f/n	%	f/n	%	f/n	%	f/n	%	f/n	%
Nonadult							0/98	-	0/98	-
Young Adult	3/20	15.0	0/1	-	0/31	-	0/4	-	3/56	5.4
Middle Adult	4/74	5.4	0/6	-	0/81	-	0/6	-	4/167	2.4
Old Adult	0/15	-	0/0	-	0/7	-	0/2	-	0/24	0
Unknown (Adult)	1/14	7.1	0/2	-	0/15	-	0/51	-	1/82	1.2
Total	8/123	6.5	0/9	-	0/134	-	0/170	-	8/427	1.9

f = number of individuals with implement trauma
n = number of individuals in sub-sample

Antemortem implement trauma was observed in two individuals (M543 and M614) indicated by the presence of well remodelled bone on the margins of the traumatic lesion (Figure 6.27).

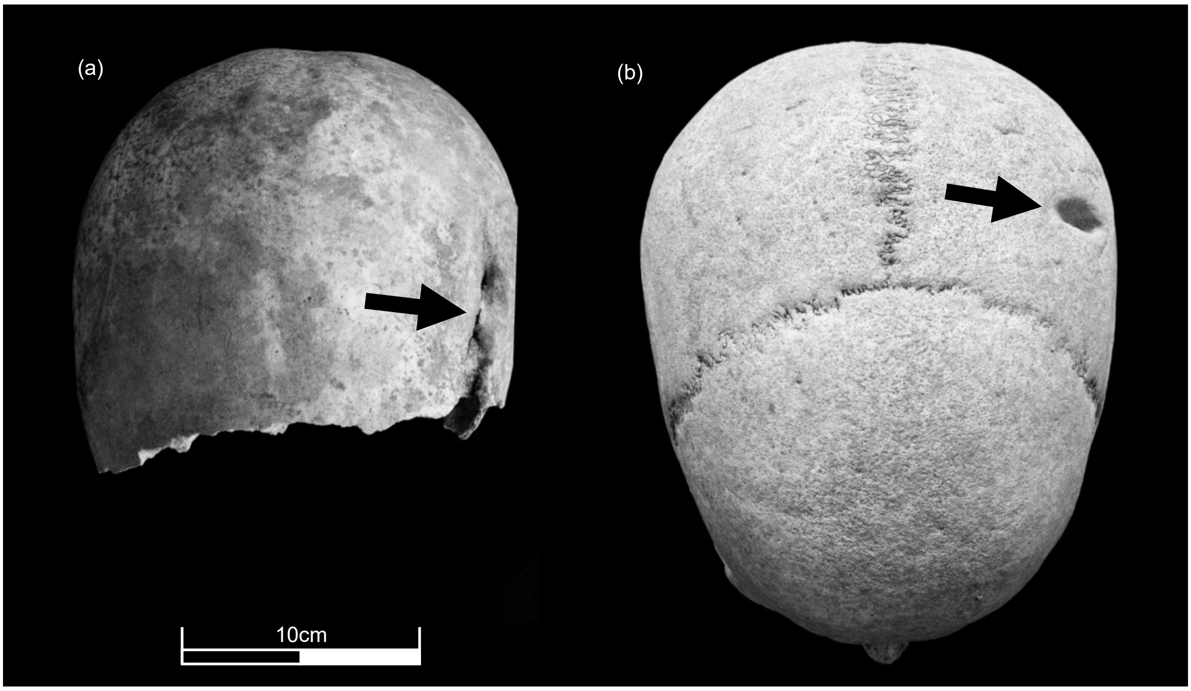

Figure 6.27 Antemortem sharp trauma on crania of M543 (a) and M614 (b) with evidence of healing. (Author's photograph)

6.3.2.1. *Sub-Group*

The subgroup of individuals with implement trauma were all male (n=7). This may indicate that personal engagement in armed violence in medieval Alba Iulia was exclusively reserved for males. There were no old adults in this sub-sample of individuals, indicating that perhaps individuals engaged in weapon violence, or armed combat, may have had shorter life expectancies, and that older people may not have engaged in combat. Implement trauma was a mixture of cranial and post-cranial injuries. Overall, the proportion of individuals with perimortem implement injuries was 71.4% of the total implement injuries observed (5 out of 7).

Table 6.42 Number of individuals with sharp trauma by location (cranial vs post-cranial) and age category

	Cranial	Post Cranial	Cranial + Post cranial	Total
Nonadult				
Young Adult	2		1	3
Middle Adult	3*	1		4
Old Adult				0
Unknown (Adult)	0			0
Total	5	1	1	7

* Two middle adults had healed cranial sharp trauma

Table 6.43 Number of males with antemortem and perimortem implement trauma by age category

	Antemortem	Perimortem	Total
Nonadult			
Young Adult		3	3
Middle Adult	2	2	4
Old Adult			0
Unknown (Adult)		0	0
Total	2	5	7

6.3.2.2. *Individuals with implement trauma*

M001 is a middle adult male with multiple perimortem lower body sharp trauma. This individual died a violent death as a consequence of weapon blows to his lower and upper legs (left and right femora, left and right fibulae, and right tibia), as well as his lower abdomen or pelvic area. Left os coxae exhibited sharp trauma at the greater sciatic notch (Figure 6.28). A consequent fracture line propagated through the acetabulum with complete separation the os coxae into two fragments. The nature of the cut marks indicates that the trauma was inflicted by a blade weapon, most likely a sword.

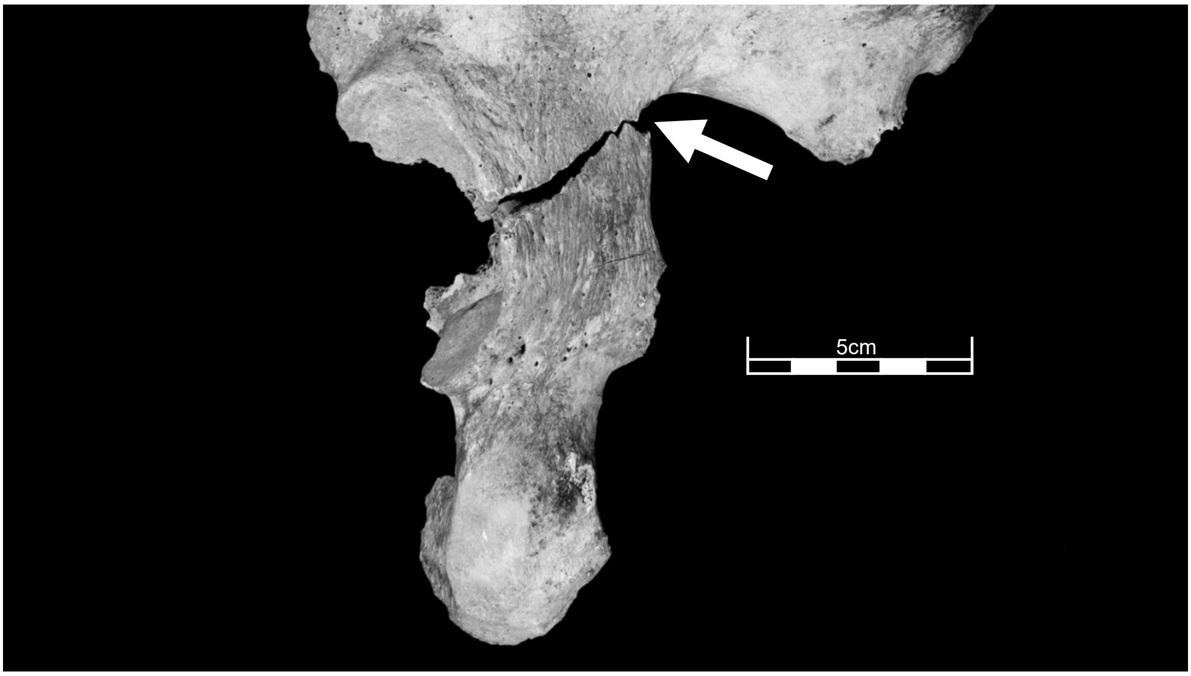

Figure 6.28 Implement (sharp) trauma at the greater sciatic notch in M001 with fracture line propagating through to the acetabulum (arrow indicates location of sharp trauma). (Author's photograph)

M207 is a middle adult male with implement trauma (blunt) of a depressed fracture on the frontal bone (Figure 6.29) located about 3cm above the medial margin of the left orbit. The depression is slightly oval with dimensions of 1.1cm by 1.3cm, with concentric fracture lines within the impact site. The fracture has penetrated through the skull with failure of the endocranial surface. The endocranial surface had only slight internal bevelling. The apparent cause is an impact by a round cylindrical object with a flat face, such as a rod or a hammer with a circular face. There was no evidence of healing, and therefore the blow is assumed to have been fatal, or somehow involved in the fatality.

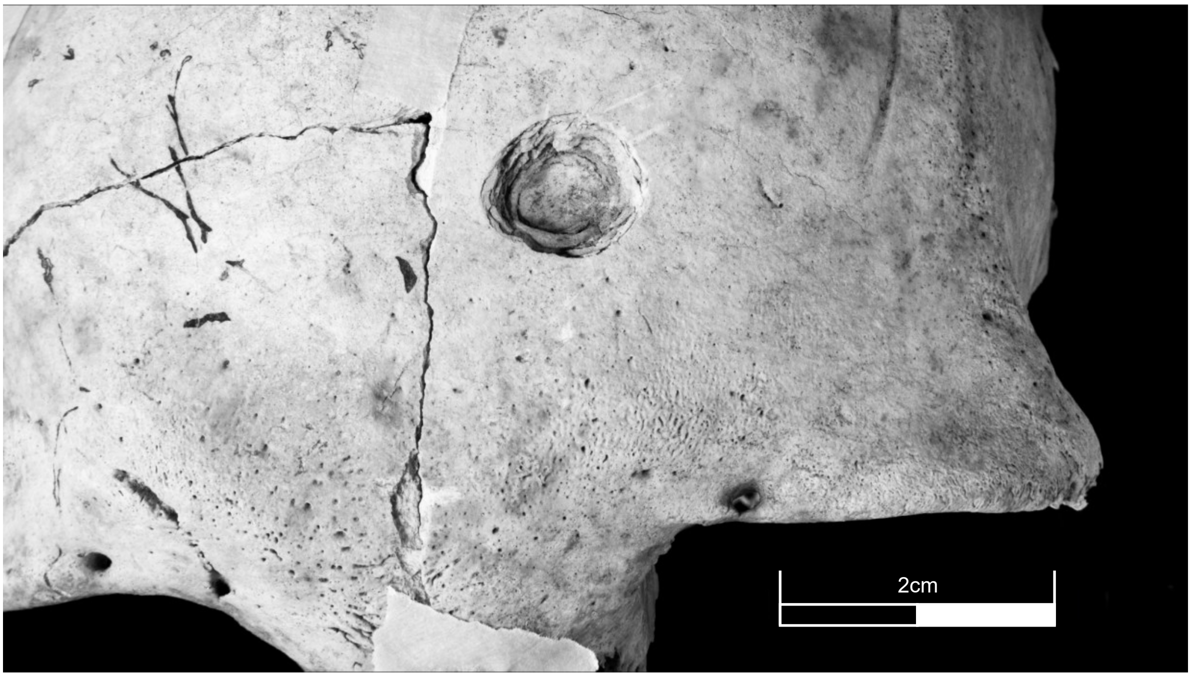

Figure 6.29 Implement (blunt) trauma, depressed fracture on frontal bone of M207. (Author's photograph)

M225 is a young adult male with perimortem sharp trauma to the cranium. A single blade cut is located on the frontal and right parietal bones. The cut dissected the frontal bone slightly offset to right of the sagittal line. The angle of the cut indicates that the blade was travelling from the anterio-superior left side of the body when it impacted the skull. This evidence suggests that someone swung a right-handed weapon downward and slightly across the body when it made contact with the victim’s skull.

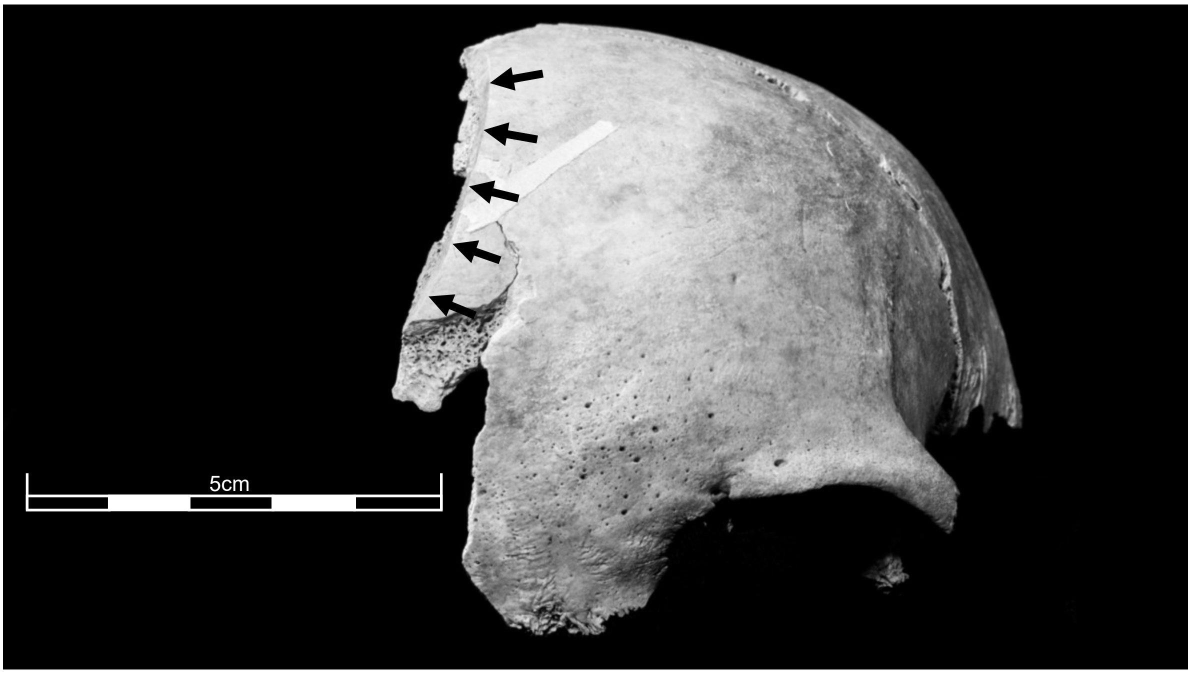

Figure 6.30 Blade injury to frontal and parietal bones in M225. (Author's photograph)

M390 is an adult male with multiple implement trauma to the head (Figure 6.31). Four instances of sharp trauma were observed on the cranium of this individual: one on the frontal, two on the right parietal, and one on the occipital condyle. The marks were most likely caused by a lager blade instrument, such as a sword. The frontal bone had a blade slice mark on the sagittal line. The blade entered at roughly 45° clockwise of sagittal plane, at an angle to the surface of the bone, forming a groove. The cut was 4cm long with a fracture line running near the sagittal line to the top of the cranium to the coronal suture. A second cut on the superior portion of the right parietal is observable. This was a complete slice through the bone at an angle almost perpendicular to the surface. The angle of the cut was about 45° counterclockwise from the sagittal line. A third blade cut was located on the lateral side of the right parietal bone. The ectocranial surface was shaved off with the endocranial surface intact, leaving the diploe exposed. Some grooving was observed on the bone indicating a serrated instrument (Figure 6.31b), or perhaps defects in the blade. The fourth blade mark was on the left occipital condyle (Figure 6.32), indicating a decapitation or an attempt to decapitate. Since no post crania were recovered during the excavation for this individual, it is possible that this cranium was buried as a severed head.

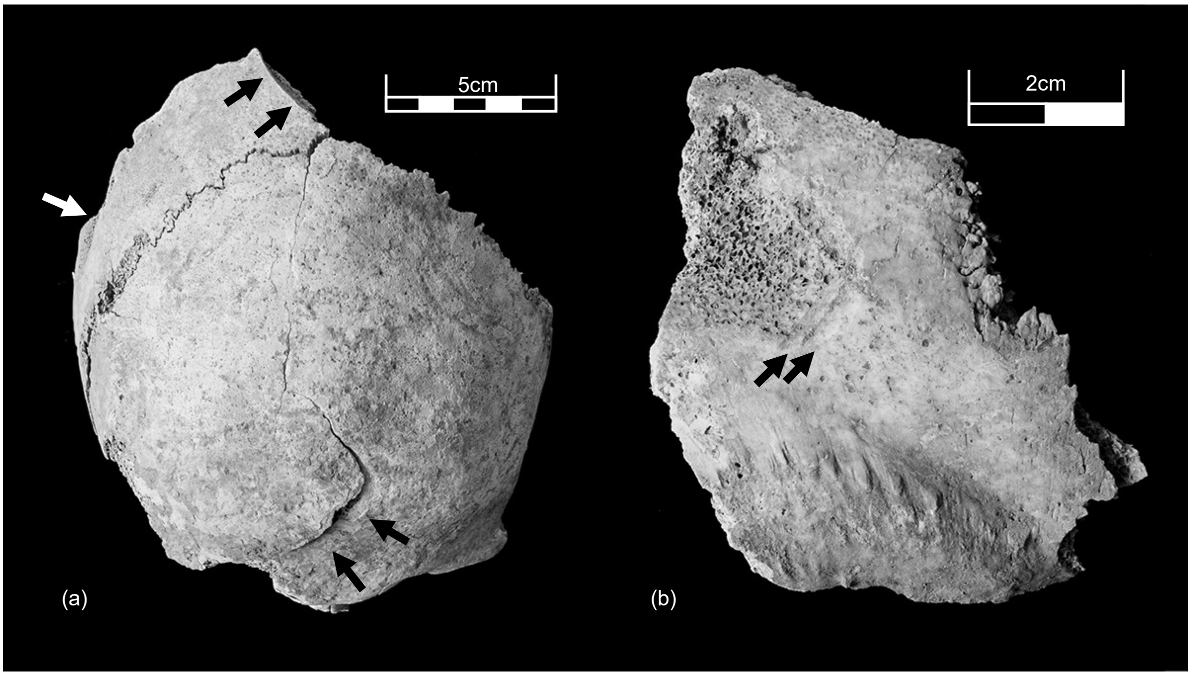

Figure 6.31 Perimortem sharp trauma on M390; (a) location of blade injuries on cranium; (b) close-up of sliced ectocranial blade trauma on right parietal, arrows showing serration marks. (Author's photograph)

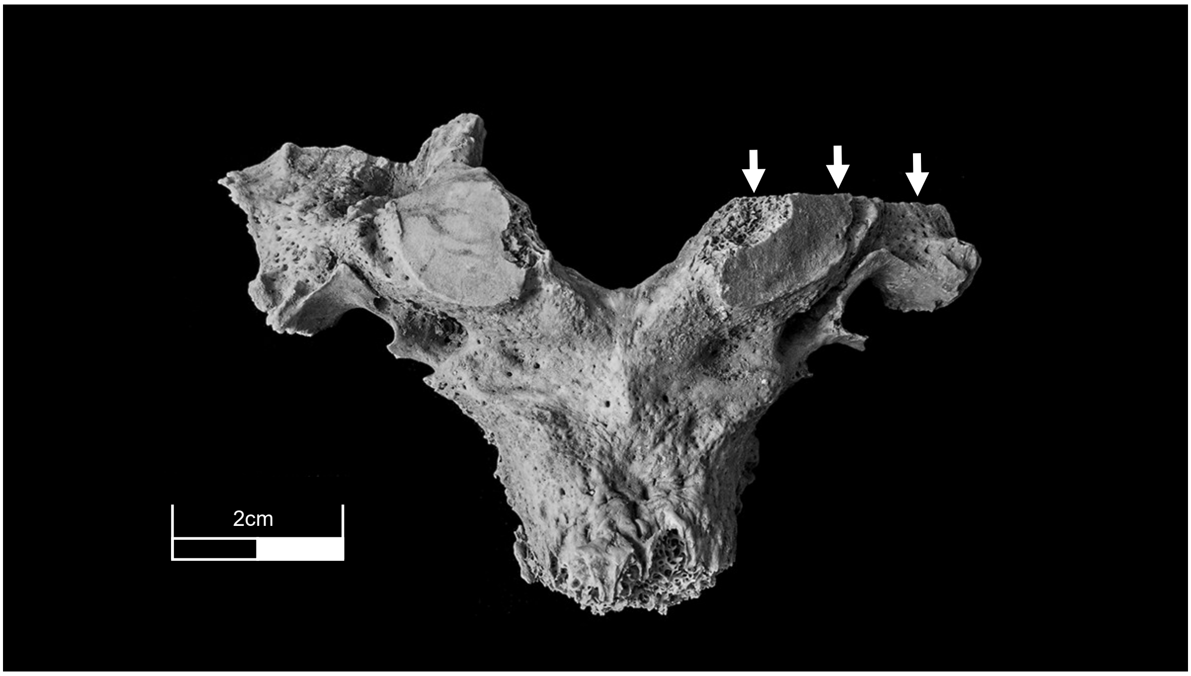

Figure 6.32 Perimortem sharp trauma on occipital condyle of M390, likely a decapitation. (Author’s photograph)

M543 was a middle adult male with trauma to the left parietal located laterally near and along the superior temporal line in the sagittal plane (Figure 6.27a). Sharp trauma is assumed because the elongated nature of the fault line seems to imply a blade weapon injury; however, the margins of the bone are very well remodelled and healed, and fresh cutmarks cannot be observed. The injury exposed the brain cavity which upon healing the cranium is still perforated. Possible complications of such severe trauma include brain injury.

M551 is a young adult male with sharp trauma to the back of his cranium. There is puncture type wound on the sagittal suture 1.5cm superior to lambda (Figure 6.33a). The opening is 4mm by 5mm, somewhat rectangular in shape. An elongated bone fragment is displaced internally but remains attached to endocranium (Figure 6.33b). The injury was likely obtained from a piercing tool or a projectile, such as a spike, weapon with spikes on it, spear, or arrow.

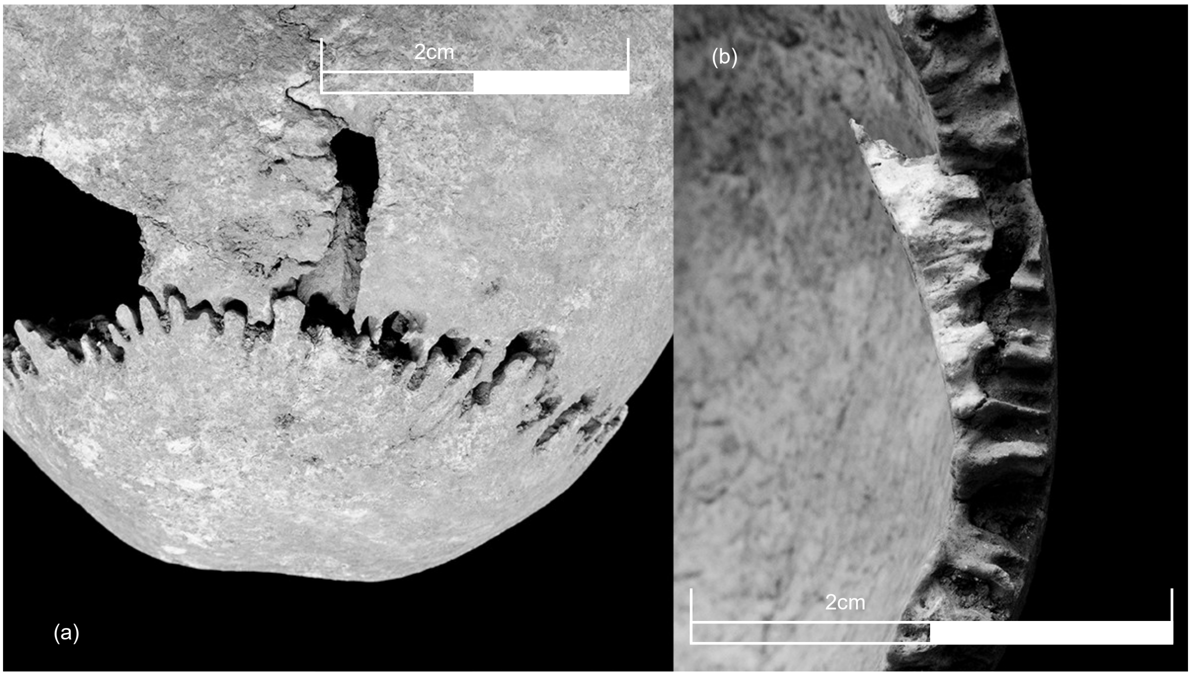

Figure 6.33 Perimortem sharp trauma on M511 cranium. (Author's photograph)

M614 was a middle adult male with antemortem penetrating sharp trauma to his left parietal. A penetrating lesion is observed on the left parietal bone. A well remodelled round hole is visible on the ectocranium, with perforation reaching the intracranial space. The injury was caused by a perforating object moving in the inferior direction, possibly a mace with spikes, a war hammer (see Figure 7.1), or another spiked implement, being swung in a downward direction by a person wielding it in the right hand.

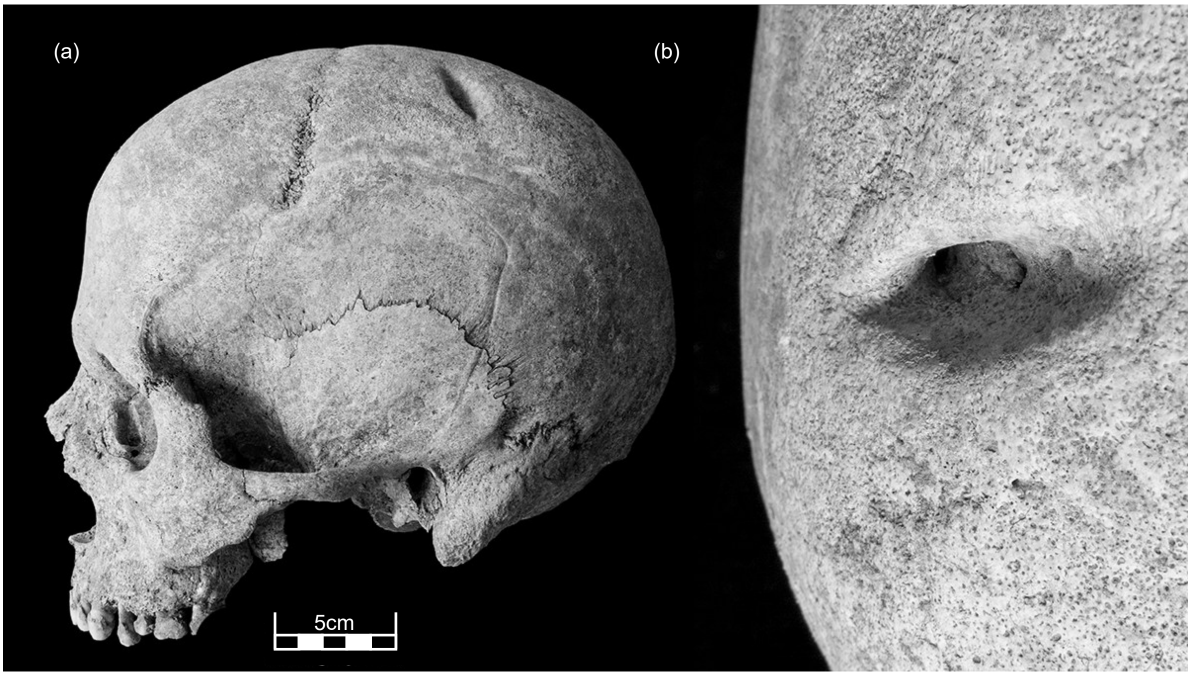

Figure 6.34 Antemortem sharp trauma to left parietal on M614. (b) close-up of sharp trauma, superior view (scale unavailable). (Author's photograph)

M625 was a young adult male with sharp trauma on the top of his cranium. This individual has a blade injury located on the sagittal suture. Sharp force trauma is also present on the medial aspect of the left ulnar proximal epiphysis. This portion of the bone was cut off with a blade weapon. This suggests the blow was received in a defensive posture with the arm shielding the head. Both of these implement injuries were perimortem with no evidence of healing.

6.3.3. Individuals with multiple injuries

Individuals with multiple injuries were analysed because this group has been discussed in bioarchaeological literature to represent a high-risk group. The Alba Iulia skeletal sample contained 23 individuals (5.4% of the population) exhibiting multiple fractures (2 or more) due to blunt and/or implement trauma (Table 6.45). This includes both healed (antemortem) or unhealed (perimortem) fractures. Seven females (5.2% of females) and 16 males (13% of males), and no individuals categorised as Intermediate sex had multiple fractures. When looking at injuries caused exclusively by blunt trauma the difference between males and females (9.8% vs 5.2%, respectively) was not statistically significant (p=0.165). When implement trauma was considered as part of multiple injuries the difference was also not significant (p=0.029).

Table 6.44 Tests of significance of multiple injuries for blunt multiple trauma and for combined blunt and sharp multiple trauma between males and females based on CLP

	Blunt trauma only			Blunt and implement trauma combined		
	f/n	**%**	**p-value**	**f/n**	**%**	**p-value**
Males	12/123	9.8	0.165*	16/123	13.0%	0.029**
Females	7/134	5.2		7/134	5.2%	
Inter	0/9			0/9	-	

f = number of individuals in with fractures (single or multiple)
n = total number of individuals with single or multiple injuries
* χ^2 = 1.924, df = 1, p <0.165
** χ^2 = 4.769, df = 1, p <0.029

Table 6.45 and Figures 6.35 and 6.36 below indicate that the CLP of trauma (both blunt and sharp) higher in females in the old adult age category compared to the middle adult category. While there is an increase for males from the middle adult to the old adult category, the rise is not as drastic. There were no females in the sample with implement trauma. The old adult female blunt trauma category is the only age category for which the prevalence of multiple fractures is higher than that of males. It should be noted that none of the females with multiple blunt force trauma were considered recidivists (discussed in section 6.3.4). This suggested that that multiple injuries sustained by women in this age category were all sustained during a single event with multiple bones broken at once.

Table 6.45 Crude lifetime prevalence (CLP) of individuals with multiple trauma (blunt and sharp combined)

		Males			Females			All		
		Blunt	**Sharp**	**Combined**	**Blunt**	**Sharp**	**Combined**	**Blunt**	**Sharp**	**Combined**
Young Adult	**f/n**	-	2/20	2/20	1/31	-	1/31	1/73	2/73	3/73
	%	-	*10.0*	*10.0*	*3.2*	-	*3.2*	*1.4*	*2.7*	*4.1*
Middle Adult	**f/n**	9/74	1/74	10/74	3/81	-	3/81	12/167	1/167	13/167
	%	*12.2*	*1.4*	*13.5*	*3.7*	-	*3.7*	*7.2*	*0.6*	*7.8*
Old Adult	**f/n**	3/15	-	3/15	2/7	-	2/7	5/24	0/24	5/24
	%	*20.0*	-	*20.0*	*28.6*	-	*28.6*	*20.8%*	*0.0*	*20.8*
Unknown (Adult)	**f/n**	-	1/14	1/14	1/15	-	1/15	1/82	1/82	2/82
	%	-	*7.1*	*7.1*	*6.7*	-	*6.7*	*1.2*	*1.2*	*2.4*
Totals	**f/n**	12/123	4/123	16/123	7/134	0/134	7/134	19/427	4/427	23/427
	%	*9.8*	*3.3*	*13.0*	*5.2*	-	*5.2*	*4.4*	*0.9*	*5.4*

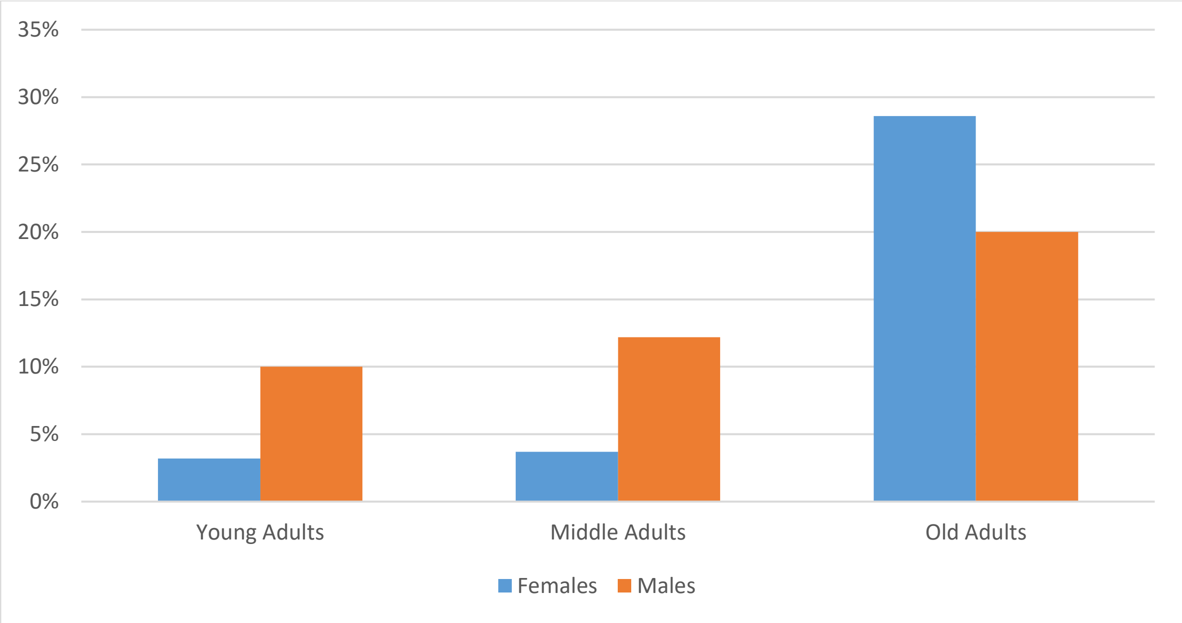

Figure 6.35 Crude lifetime prevalence (CLP) of individuals with multiple fractures by age category (blunt and sharp trauma combined)

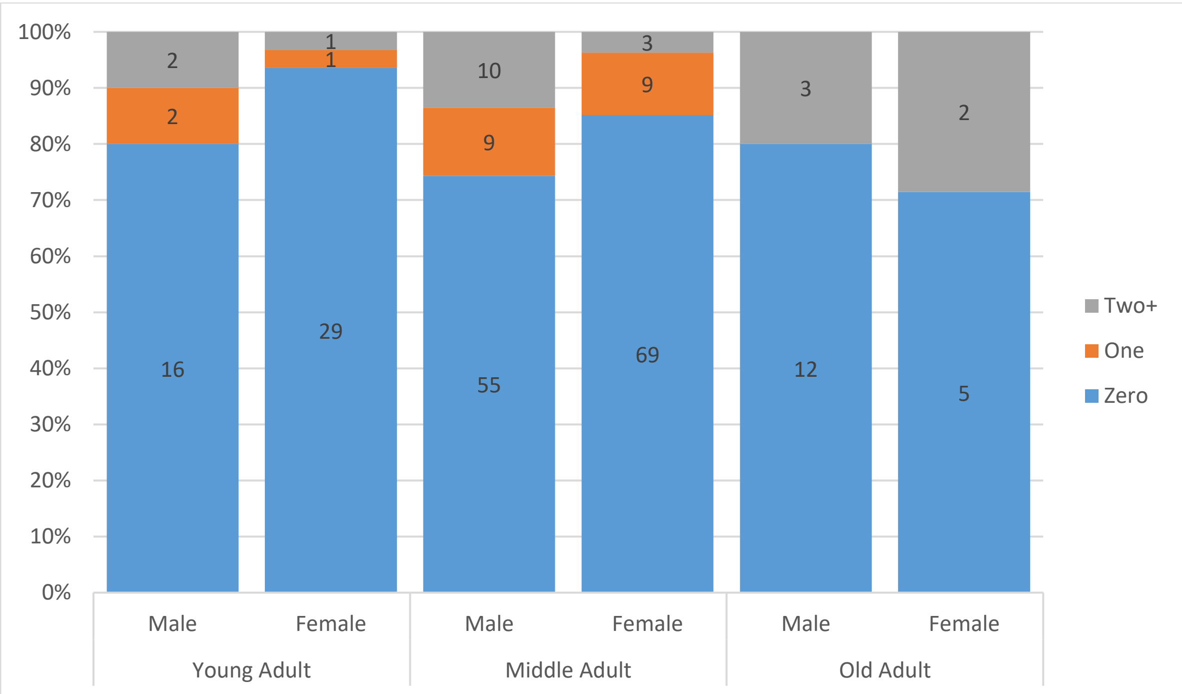

Figure 6.36 Distribution of males and females by number of injuries and age category. Data labels indicate number of individuals.

Next was examined the sub-group of individuals with multiple fractures. Table 6.46 indicates that of the individuals with traumatic injuries, 43.4% had more than one injury. Having more than one trauma on skeletal remains belonging to a single individual can be due to multiple injuries in a single incident, or repeated incidents during the life course. Individuals for whom repeated incidents were identifiable are presented below in section 6.3.4 on injury recidivism. Binary logistic regression did not indicate any significant differences in the distribution of multiple injuries (blunt and implement combined) with using sex and age categories as predictor variable (Table 6.48).

Table 6.46 Proportion of males and females with single and multiple fractures (blunt and sharp combined)

	Single		Multiple	
	f/n	**%**	**f/n**	**%**
Males	12/28	42.9	16/28	57.1
Females	12/19	63.2	7/19	36.8
Inter	0/0	-	0/0	-
Unknown (Adult)	3/3	100.0	0/3	0.0
Unknown (Nonadult)	3/3	100.0	0/3	0.0
Grand Total	30/53	56.6	23/53	43.4

f = number of individuals in with fractures (single or multiple)
n = total number of individuals with single or multiple injuries

Table 6.47 Proportion of individuals with single and multiple fractures (blunt and sharp) by sex and age group

	Young Adult		Middle Adult		Old Adult	
	f/n	**%**	**f/n**	**%**	**f/n**	**%**
Females						
Single	1/10	10.0	9/10	90.0		
Multiple	1/6	16.7	3/6	50.0	2/6	33.3%
Males						
Single	2/12	16.7	10/12	83.3		
Multiple	2/15	13.3	10/15	66.7%	3/15	20.0%

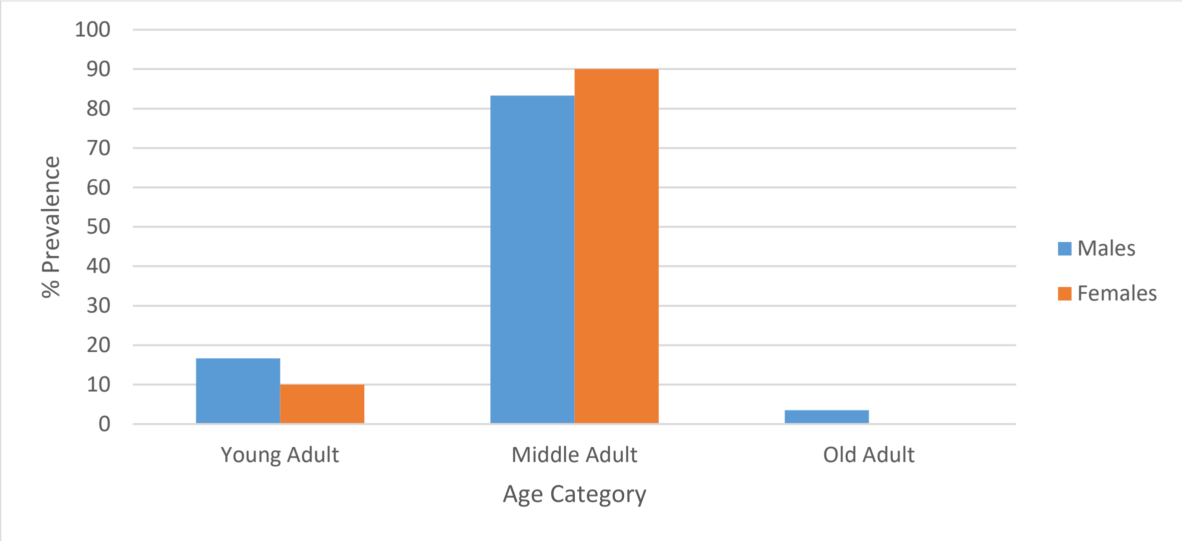

Figure 6.37 Age distribution of individuals with single fracture within the persons with fractures sub-category

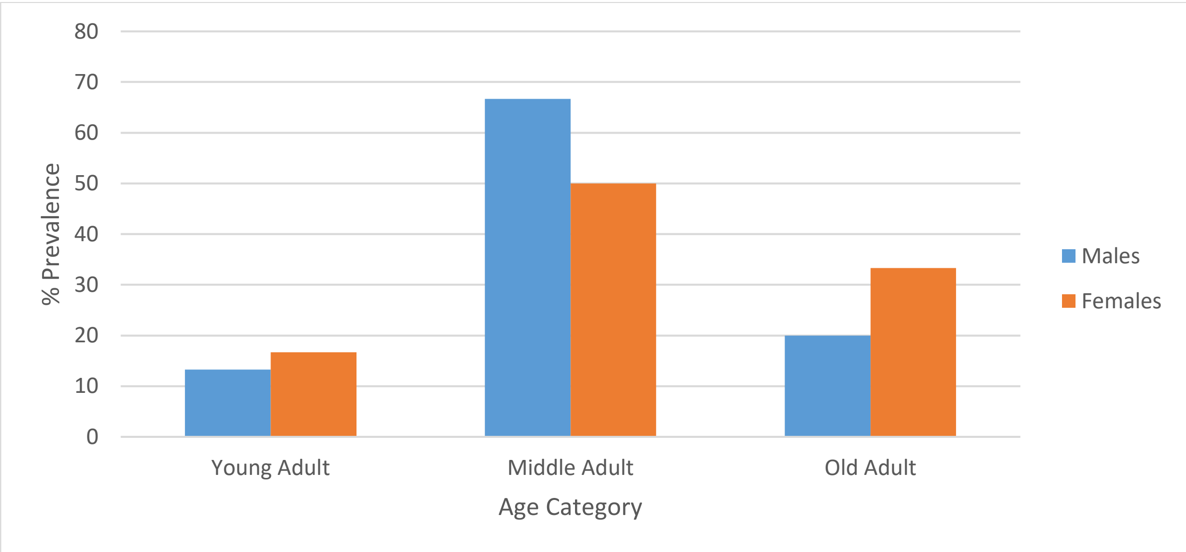

Figure 6.38 Age distribution of individuals with multiple fractures within the persons with multiple fractures sub-category

Table 6.48 Results of binary logistic regression analysis for crude lifetime prevalences for multiple trauma with sex and age as predictor variables.

	Predictor	Coeff (SE)	Odds ratio (99% CI)	p-value
Multiple trauma	sex	-0.175 (0.315)	0.839 (0.373, 1.887)	0.578
	age	0.867 (0.627)	2.382 (0.474, 11.974)	0.166

Coding: Sex: 1 = male, 2 = intermediate, 3 = female; Age: 1 = YA, 2 = MA, 3 = OA

A summary of the individuals with multiple trauma and their injuries are detailed in Table 6.49

Table 6.49 List of individuals with multiple trauma (blunt and sharp combined) in the sample

Grave No.	Age category	Multiple trauma description
Females		
M138	Old Adult	• 2 ribs
M212	Middle Adult	• Right distal radius and ulna
M245	Young Adult	• 2 ribs
M360	Middle Adult	• Left distal radius and ulna • 8 ribs
M431	Unknown Age (Adult)	• Right tibia and fibula
M453	Old Adult	• 2 ribs
M492	Middle Adult	• Distal right radius • Left 5th metacarpal • 2 ribs
Males		
M001	Middle Adult	• Weapon trauma: pelvis, left femur, right femur, left fibula, right fibula, right tibia (perimortem)
M125	Middle Adult	• 2 ribs
M225	Young Adult	• Weapon trauma: frontal parietal (perimortem)
M235	Old Adult	• Right distal radius and ulna
M385	Middle Adult	• 6 rib fractures
M390	Unknown Age (Adult)	• Weapon trauma: 2 parietals, frontal, occipital
M484	Middle Adult	• Right diaphysis ulna • 1st left metacarpal
M500	Middle Adult	• 1st and 2nd right metacarpals • 2 ribs
M511	Old Adult	• 4 ribs
M554	Middle Adult	• Radius diaphysis left • 2 ribs
M555	Old Adult	• Right clavicle • 1 rib
M570	Middle Adult	• 8 ribs
M573	Middle Adult	• 3 ribs
M585	Middle Adult	• 6 ribs
M597	Middle Adult	• Phalanx (foot)
M625	Young Adult	• 1 rib • Weapon trauma: 2 parietals, ulna

6.3.4. Injury recidivists

Injury recidivism was investigated in the sample by identifying individuals with repeat trauma. Injury recidivism was defined as individuals with trauma who sustained their injuries on two or more separate occasions. The identification of this relied on the presence of two or more antemortem injuries with clear indicator of non-concurrent timing (i.e., different stages of healing), or a mixture of antemortem and perimortem trauma (Mant, 2019; Redfern et al., 2017). This is an updated definition from earlier bioarchaeological studies which recommend that there must be at least one violence related antemortem injury in addition to one or more ante- or perimortem injuries (Judd, 2002a). The injuries clearly had to have occurred during two or more separate events during the life of the individual. Consequently, the next phase of the study sought to identify individuals who had sustained traumatic injuries on multiple occasions.

Five recidivists were identified in total in the Alba Iulia skeletal sample. All recidivists were male and comprised 4.1% of the male subsample (Table 6.50).

Table 6.50 Crude lifetime prevalence (CRP) of injury recidivism in the Alba Iulia sample

	f/n	%
Males	5/123	4.1
Intermediate	0/9	-
Females	0/134	-
Unknown (Adult)	0/63	-
Unknown (Nonadult)	0/98	-

f = total number of recidivists
n = total number of individuals in sex category

Within the sub-category of injury recidivists, of the five males that were identified as such, 1 belonged to the young adult age category while the remaining 4 were in the middle adult category (Table 6.51). Interestingly, there were no injury recidivists in the old adult age category, which may indicate that individuals exposed to this level of risk to physical injury perhaps had a shorter life expectancy, and were possibly part of a disadvantaged or disenfranchised group. Conversely, it is also possible that individuals who sustained skeletal fractures early in life had their fracture calluses well remodelled by old adulthood leading to underestimated prevalences in the old adult age category.

Table 6.51 Age profile of injury recidivists

	Males		Intermediate		Females	
	f/n	%	f/n	%	f/n	%
Young Adult	1/5	20.0	0/0	-	0/0	-
Middle Adult	4/5	80.0	0/0	-	0/0	-
Old Adult	0/5	-	0/0	-	0/0	-

f = number of recidivists in age category
n = total number of recidivists in sample

Table 6.52 Results of binary logistic regression analysis for crude lifetime prevalences for recidivism with sex and age as predictor variables

	Predictor	Coeff (SE)	Odds ratio (99% CI)	p-value
Recidivism	sex	-1.365 (0.779)	0.256 (0.034, 1.899)	0.080
	age	0.494 (0.794)	0.610 (0.079, 4.724)	0.534

Coding: Sex: 1 = male, 2 = intermediate, 3 = female; Age: 1 = YA, 2 = MA, 3 = OA; significant results in bold

More detail on the five individuals who were identified as recidivists is provided in Table 6.53. Three were categorised as recidivists because of a mixture of both ante- and perimortem fractures. One individual (M585) was categorised as recidivist due to one antemortem fracture in a different stage of remodelling from the rest, indicating the fracture was more recent and not contemporaneous with the others. Individual M597 was also identified as a recidivist based on antemortem fractures that were clearly in different stages of remodelling.

Table 6.53 Details of the 5 males identified as injury recidivists

Skeleton No.	Sex	Age	# of fractures	Type of trauma	Timing of trauma
M385	Male	Middle Adult	6	Blunt trauma	Ante & Perimortem
M500	Male	Middle Adult	4	Blunt trauma	Ante & Perimortem
M585	Male	Middle Adult	6	Blunt trauma	Antemortem
M597	Male	Middle Adult	3	Blunt trauma	Antemortem
M625	Male	Young Adult	4	Blunt & Sharp trauma	Ante & Perimortem

M385 was a middle adult male with antemortem and perimortem blunt trauma. This individual sustained 6 skeletal fractures over his lifetime. All fractures were on ribs and on the left side. One lateral fracture on the lower ribs is well healed while the other 5 fractures on the anterior portions of the upper and middle ribs were actively healing as indicated by the presence of woven bone.

M500 was a male in the middle adult age category with 4 identified lifetime accumulated fractures. Two avulsion fractures were on his right hand—dorsal aspect of 2^{nd} and 3^{rd} metacarpals. These fractures were healed, and the bone is well remodelled. Two unhealed fractures (indicated by woven bone) are present on two separate ribs on the left side of the thorax. One is a middle and the other a lower rib, with both fractures located on the anterior portions of the ribs.

M585 was a male in the middle adult age category with 6 rib fractures. Five of the ribs were fractured antemortem while one was perimortem in the healing stage. The fracture with active healing was on the anterior portion of a rib from an unknown side (fragment too small to assign side with confidence).

M597 was a male in the middle adult age category who had once broken a toe and has had two fractured ribs. A foot phalanx of unknown side exhibited a healed callus on its diaphysis. The two ribs, both middle ribs from the right side, had calluses that were remodelling at the time of death. One rib exhibited a hairline crack over the remodelled callus indicating a re-injury or delayed union.

M625 was a young adult male, and the only recidivist identified with weapon related injuries. His non weapon injury was a well remodelled a rib fracture. The perimortem injuries were from a blade injury affecting the left proximal ulna, and on the top of the head along the sagittal suture line. It is possible the blade injuries represent one blade swing, being received in a defensive position of protecting the head with folded arms over the head.

In summary, the analysis of blunt and sharp force fractures in the Alba Iulia skeletal sample revealed a prevalence of trauma among males, specifically among younger males, compared to their female counterparts. The fractures were seemingly caused by a mix of accidental mechanisms, such as falls and occupational hazards, and inter-personal violence. The risk of trauma in medieval Alba Iulia seems to have been influenced by factors such as age, sex and gender identity, and other lifestyle hazards.

6.4. Joint modification analysis results

To explore gendered differences in general activity levels within and between sex categories, the next phase of data analysis explored differences in patterns of joint modification indicators, the presence of which are related to activity and mechanical stress levels. Explored below are patterns of osteophyte and eburnation presentation in the Alba Iulia sample to examine differences related to activity patterns. The analysis results are reported separately for each indicator (osteophytes and eburnation). First, the osteophytes analysis results are presented, followed by results of the eburnation analysis. The results are presented for each body site based on the number of elements observable.

The analysis for each indicator starts with an examination of overall population prevalences at the various anatomical sites and articular surfaces. Differences in the prevalences comparing males and females are also presented. The analysis examined activity-related changes within the male and female sex groups to examine whether patterns at various anatomical sites exist that may reveal something about the subjection of bodies to physical movement and physical stress.

A total of 228 individuals from the sample were included in the analysis of osteophytes and eburnation. Inclusion criteria included individuals that were sexed as either male or female and were categorised into one of the age categories of Young Adult (YA), Middle Adult (MA), or Old Adult (OA). A total of 109 females and 119 males were included in the analysis. However, the analyses and prevalences reported are based on anatomical site and element counts and not individual counts (except in some sections discussing eburnation) as described in section 5.5, therefore, the number of individuals that is included in the prevalence count at each anatomical location varies due to preservation. Abbreviations used in this section are listed again in Table 6.54.

Table 6.54 Abbreviations used in this section

Abbreviation	Description
Clav Dist	Clavicle Distal
Scap Glen	Scapula Glenoid
Scap Acro	Scapula Acromion
Hum Prox	Humerus Proximal
Hum Dist	Humerus Distal
Ulna Prox	Ulna Proximal
Rad Prox	Radius Proximal
Ulna Dist	Ulna Distal
Rad Dist	Radius Distal
Fem Prox	Femur Proximal
Fem Dist	Femur Distal
Tib Prox	Tibia Proximal
Fib Prox	Fibula Proximal
Tib Dist	Tibia Distal
Fib Dist	Fibula Distal
Tal Prox	Talus Proximal

6.4.1. Osteophytes

6.4.1.1. *Analysis of osteophytes in sample*

Table 6.55 displays the prevalences for the articular surface analysis for osteophytes in the entire sample for individuals that were skeletally sexed as male, female, or intermediate. A total of 3562 articular surfaces were available for this analysis; 454 of which had osteophytes present (12.7%). The prevalence for male joints was 16.3% and female 9.7%, a 6.6% difference which was statistically significant using Chi-squared analysis (χ^2= 13.210, df=1, p<0.001). Of the 17 joints that belonged to intermediate skeletal sex individuals none had osteophytes present. Since osteophytes were absent from all intermediate joints, they are not presented in the tables below. The most affected surface in both males and females was the proximal ulna. The articular surfaces of the clavicle and scapula at the shoulder also had high prevalence in both sexes, as well as the acetabular lunate articular surface. An initial glance at Figure 6.39 presenting the prevalences for each joint surface, indicated possible higher prevalences in the upper body compared to the lower body in both male and female sexes.

Table 6.55 Adjusted lifetime prevalence (ALP) of osteophytes for joint surface observed

	Male		Intermediate		Female		Combined	
	f/n	%	f/n	%	f/n	%	f/n	%
Clav Dist	32/105	30.5	0/4	-	22/122	18.0	54/227	23.8
Scap Glen	20/75	26.7	0/5	-	13/82	15.9	33/157	21.0
Scap Acro	34/107	31.8	0/5	-	22/118	18.6	56/225	24.9
Hum Prox	8/108	7.4	0/6	-	4/124	3.2	12/232	5.2
Hum Dist	15/114	13.2	0/5	-	17/133	12.8	32/247	13.0
Ulna Prox	39/110	35.5	0/1	-	31/129	24.0	70/239	29.3
Rad Prox	5/107	4.7	0/1	-	1/114	0.9	6/221	2.7
Ulna Dist	14/91	15.4	0/0	-	7/92	7.6	21/183	11.5
Rad Dist	22/104	21.2	0/0	-	14/113	12.4	36/217	16.6
Acetabulum	37/114	32.5	0/1	-	21/121	17.4	58/235	24.7
Fem Prox	2/125	1.6	0/3	-	4/137	2.9	6/262	2.3
Fem Dist	11/110	10.0	0/2	-	12/122	9.8	23/232	9.9
Patella	4/43	9.3	0/1	-	5/49	10.2	9/92	9.8
Tib Prox	6/80	7.5	0/2	-	1/105	1.0	7/185	3.8
Fib Prox	1/45	2.2	0/2	-	0/47	-	1/92	1.1
Tib Dist	12/85	14.1	0/2	-	5/110	4.5	17/195	8.7
Fib Dist	6/74	8.1	0/2	-	2/84	2.4	8/158	5.1
Tal Prox	3/62	4.8	0/2	-	2/84	2.4	5/146	3.4
Total	271/1659	16.3	0/17	-	183/1886	9.7	454/3562	12.7

f = number of joint surfaces with osteophytes present
n = number of joint surfaces available for observation

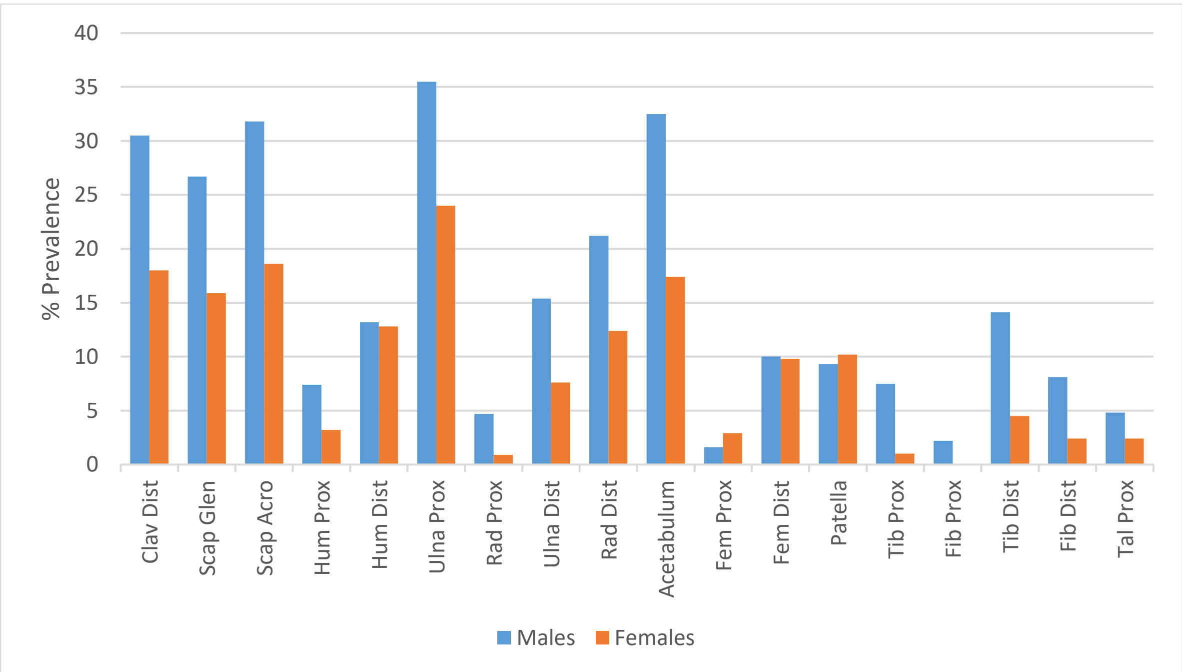

Figure 6.39 Prevalence of osteophytes across sex categories per articular surface observed

Figure 6.40 presents the compares osteophytes per observable joint by side, to examine mechanical stress levels in the sample affecting each side of the body. Generally, the prevalence of osteophytes was higher on the right side for most of the elements except for Scap Acro at the shoulder, and Ulna Dist and Rad Dist at the wrist, at which locations they were higher on the left. Statistical testing indicated the overall difference in osteophyte prevalence by side were not significant Table 6.56.

Table 6.56 Total number of articular surfaces observed and affected by osteophytes by side

	f/n	%	χ^2	p-value
Left	227/1960	11.6	1.531, df = 1	0.216
Right	251/1949	12.9		

f = number of joint surfaces with osteophytes present
n = number of joint surfaces available for observation

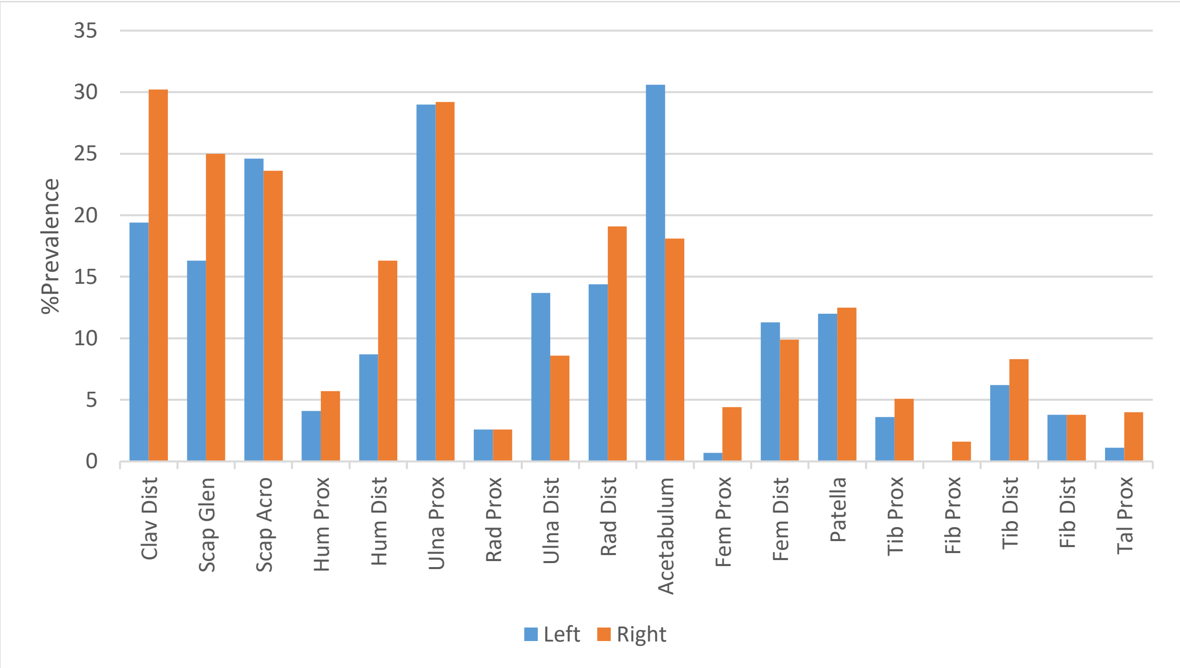

Figure 6.40 Prevalence of osteophytes per observable joint in sample by side

To explore whether males and females exerted physical stress on their joints differentially, left and right side osteophyte prevalences within each sex category were compared and analysed. Table 6.57 presents the results of each side being compared within the sex categories (i.e., male left compared to male right, female left compared to female right. The side comparisons were not statistically significant.

Table 6.57 Overall osteophyte prevalence by side within male and female sex categories, and statistical test (χ^2) results

	Male			Female		
	f/n	**%**	**p-value**	**f/n**	**%**	**p-value**
Left	125/583	21.4	0.052*	90/952	9.5	0.712**
Right	146/842	17.3		93/934	10.0	

f = number of joint surfaces with osteophytes present
n = number of joint surfaces available for observation
* χ^2 = 3.762, df = 1, p <0.052
** χ^2 = 0.136, df = 1, p <0.712

Table 6.58 provides the results of the analysis of comparison of each side across the male and female sex categories. The prevalence figures indicate that overall osteophyte prevalence was higher in males on each side, an observation that was statistically significant.

Table 6.58 Overall osteophyte prevalence by side across male and female sex categories, and statistical test (χ^2) results

	Left	Right				
	f/n	**%**	**p-value**	**f/n**	**%**	**p-value**
Male	125/817	15.3	**<0.001***	146/842	17.3	**<0.001****
Female	90/952	9.5		93/934	10.0	

f = number of joint surfaces with osteophytes present
n = number of joint surfaces available for observation
* χ^2 = 14.074, df = 1, p <0.001
** χ^2 = 20.722, df = 1, p <0.001

Next, the differences in osteophytes prevalences were compared between the upper and lower body sites, with the body sites grouped into single variables. The results of the analysis (see Table 6.59 and Table 6.60) indicated that, in general, there was a difference between use of the upper and lower body joints with the upper body exhibiting significantly more osteophytes overall in the sample (males and females combined) as well as within the sex categories (males 20.5% upper body, 11.1% lower body; females 12.8% upper body, 8.4% lower body). When male and female data was combined the results also showed a statistically significantly difference between the upper and lower body (16.4% vs 8.4%) indicating more load or overload from mechanical stimuli using the arms compared to the legs.

Table 6.59 Intra-sex comparison of overall osteophytes prevalences between upper and lower body sites

	Males			Females			Total		
	f/n	**%**	**p-value**	**f/n**	**%**	**p-value**	**f/n**	**%**	**p-value**
Upper body	189/921	20.5	**<0.001***	131/1027	12.8	**0.014****	320/1948	16.4	**<0.001*****
Lower body	82/738	11.1		52/859	6.1		134/1897	8.4	

f = number of joint surfaces with osteophytes present
n = number of joint surfaces available for observation
* χ^2 = 26.545, df = 1, p <0.001
** χ^2 = 23.980, df = 1, p <0.001
*** χ^2 = 80.915, df = 1, p <0.001

The data were next reoriented for a comparison between the sexes. The comparison indicated a statistical difference in prevalence of osteophytes found in the appendicular joints of upper body (males 20.5%, females 12.8%) compared to the lower body (males 11.1%, females 6.1%) between males and females (Table 6.60).

Table 6.60 Inter-sex comparison of overall osteophytes prevalences between upper and lower body sites

	Upper body			Lower body		
	f/n	**%**	**p-value**	**f/n**	**%**	**p-value**
Male	189/921	20.5	**<0.001***	82/738	11.1	**<0.001****
Female	131/1027	12.8		52/859	6.1	

f = number of joint surfaces with osteophytes present
n = number of joint surfaces available for observation
* χ^2 = 21.329, df = 1, p <0.001
** χ^2 = 13.210, df = 1, p <0.001

The results using overall sample and sex category level osteophyte prevalences indicate that overall, there was a significant difference in the distribution of osteophytes on male and female joints. The distributions did not differ significantly between the left and right side surfaces, or within sex categories. The side differences were, however, significant when comparing male left to female left, and male right to female right, indicating that males generally had more osteophyte development on both sides.

6.4.1.2. *Results of logistic regression analysis*

To examine the interaction of sex and age in the presentation of osteophytes, data from the left and right sides needed to be combined. Following published methods (Baker & Pearson, 2006; Villotte & Santos, 2022) logistic regression analysis was used for a more robust articular surface by articular surface comparison, while taking into account the interacting effects of sex and age. Because logistic regression requires categorical depended variables to be mutually exclusive and exhaustive, the data were recoded so that each case had only one data point for the presence of osteophytes at a location. Therefore, left and right categories were combined for presence-absence meaning that the sample numbers, now represented articular sites *in individuals*, and not individual joint surfaces. For example, a case with osteophytes on left distal clavicle but not on the right, now represented a case with osteophyte present at distal clavicle (e.g., case with variables ClavLDistOst=1 and ClavRDistOst=0 was recoded to ClavDistOst=1).

Furthermore, only adults with known sex (male, intermediate, or female) and age (young adult, middle adult, old adult) were included in the analysis; that is, nonadults and adults with unknown age were excluded (N=235).

The following are the results of the analysis of the presence of osteophytes in the population with left and right side data combined. Table 6.61 displays the results of prevalence analysis of osteophytes in the entire Alba Iulia sample. Overall, the most affected surface was the distal clavicular articular surface of the shoulder (34.9%) followed by the proximal ulnar articular surfaces (32.2%).

Table 6.61 Osteophyte presence frequency by sex in entire sample (left and right sides combined per individual)

		Male		**Intermediate**		**Female**		**Sample**	
		f/n	**%**	**f/n**	**%**	**f/n**	**%**	**f/n**	**%**
Shoulder	Clav Dist	31/66	47.0	0/2	-	20/78	25.6	51/146	34.9
	Scap Glen	23/69	33.3	0/3	-	15/81	18.5	38/153	24.8
	Scap Acro	17/56	30.4	0/4	-	10/59	16.9	27/119	22.7
	Hum Prox	8/75	10.7	0/4	-	4/86	4.7	12/165	7.3
Elbow	Hum Dist	12/76	17.1	0/4	-	12/87	13.8	25/166	14.4
	Ulna Prox	28/69	40.6	0/1	-	21/83	25.3	49/153	32.2
	Rad Prox	5/69	7.2	0/0	-	1/76	1.3	6/145	4.1
Wrist	Ulna Dist	14/63	22.2	0/0	-	6/66	9.1	20/129	15.5
	Rad Dist	17/69	24.6	0/0	-	11/74	14.9	28/143	19.6
Hip	Acetabulum	28/70	40.0	0/1	-	16/80	20.0	44/151	29.1
	Fem Prox	2/28	2.9	0/1	-	3/78	3.8	5/107	4.7
Knee	Fem Dist	6/58	10.3	0/0	-	10/72	13.9	16/130	12.3
	Patella	4/27	14.8	0/0	-	3/33	9.1	7/60	11.7
	Tib Prox	4/41	9.8	0/0	-	1/54	1.9	5/95	5.3
	Fib Prox	1/28	3.6	0/0	-	0/32	0.0	1/60	1.7
Ankle	Tib Dist	7/45	15.6	0/0	-	3/52	5.8	10/97	10.3
	Fib Dist	4/42	9.5	0/0	-	2/45	4.4	6/87	6.9
	Tal Prox	2/35	5.7	0/0	-	1/44	2.3	3/79	3.8

f = number of joints with osteophytes present on either left of right side
n = number of individuals with observable surfaces on either left or right side

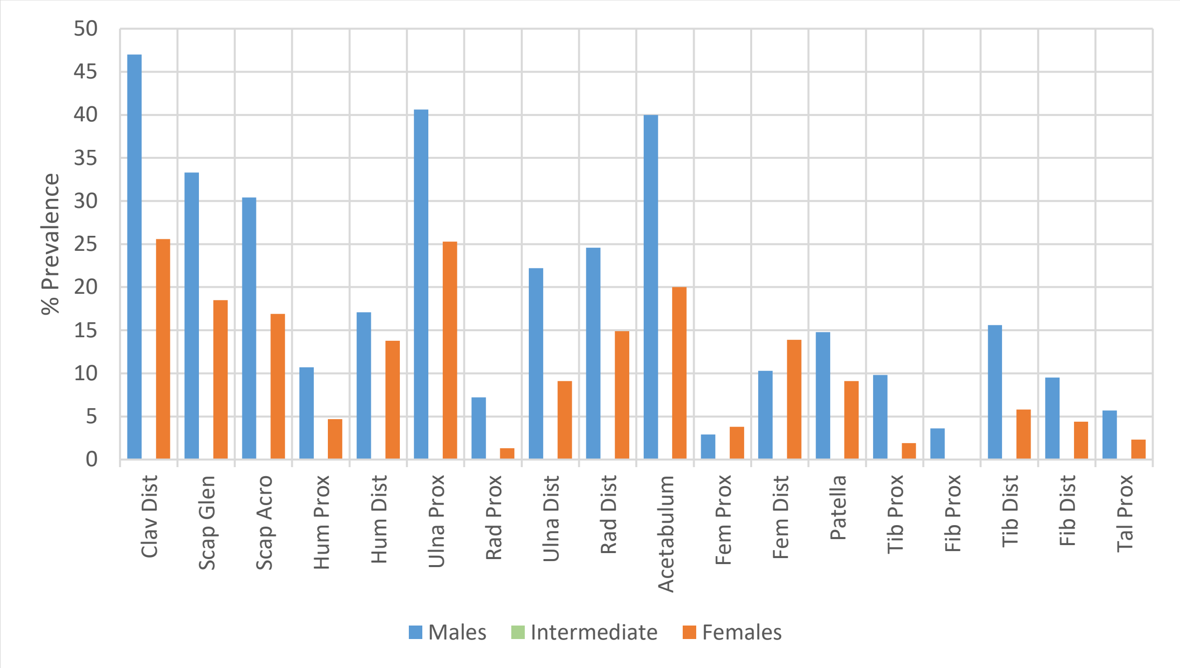

Figure 6.41 Osteophyte prevalence in sex categories by site (left and right combined per individual)

Table 6.62 Total number of articular surfaces (per individual, left and right sides combined) observed and affected by osteophytes by age category

		YA		MA		OA	
		f/n	%	f/n	%	f/n	%
Shoulder	Clav Dist	2/35	5.7	39/95	41.1	10/16	62.5
	Scap Glen	0/35	-	27/103	26.2	11/15	73.3
	Scap Acro	1/24	4.2	17/82	20.7	9/13	69.2
	Hum Prox	0/35	-	6/112	5.4	6/18	33.3
Elbow	Hum Dist	0/36	-	16/115	13.9	9/16	56.3
	Ulna Prox	2/34	5.9	37/106	34.9	10/13	76.9
	Rad Prox	0/32	-	4/102	3.9	2/12	16.7
Wrist	Ulna Dist	0/33	-	15/85	17.6	5/11	45.5
	Rad Dist	1/32	3.1	23/101	22.8	4/10	40
Hip	Acetabulum	2/32	6.3	35/110	31.8	7/9	77.8
	Fem Prox	1/30	3.3	3/108	2.8	1/9	11.1
Knee	Fem Dist	1/29	3.4	13/92	14.1	2/9	22.2
	Patella	0/13	-	5/43	11.6	2/4	50
	Tib Prox	0/24	-	3/67	4.5	2/4	50
	Fib Prox	0/14	-	1/43	2.3	0/3	-
Ankle	Tib Dist	0/21	-	7/68	10.3	3/8	37.5
	Fib Dist	0/16	-	5/64	7.8	1/7	14.3
	Tal Prox	0/16	-	2/54	3.7	1/9	11.1

		Male			Intermediate			Female		
		YA	MA	OA	YA	MA	OA	YA	MA	OA
Shoulder	Clav Dist	7	29	50	0	0	0	5	20	45
	Scap Glen	0	25	55	0	0	0	5	13	71
	Scap Acro	0	29	79	0	0	0	0	22	63
	Hum Prox	0	5	21	0	0	0	0	2	22
Elbow	Hum Dist	0	10	39	0	0	0	0	14	50
	Ulna Prox	0	34	71	0	0	0	5	27	88
	Rad Prox	0	5	7	0	0	0	0	0	17
Wrist	Ulna Dist	0	16	40	0	0	0	0	11	20
	Rad Dist	12	23	27	0	0	0	0	16	50
Hip	Acetabulum	0	35	78	0	0	0	9	18	80
	Fem Prox	6	1	0	0	0	0	0	2	40
Knee	Fem Dist	6	8	11	0	0	0	0	14	25
	Patella	0	13	0	0	0	0	0	6	75
	Tib Prox	0	8	33	0	0	0	0	0	25
	Fib Prox	0	3	0	0	0	0	0	0	0
Ankle	Tib Dist	0	13	33	0	0	0	0	4	25
	Fib Dist	0	6	50	0	0	0	0	4	0
	Tal Prox	0	3	14	0	0	0	0	4	0

Figure 6.42 Heat map of osteophyte prevalence distribution by age and sex categories at articular surfaces observed. Percentages represent prevalence in each age category. Darker colours indicate higher prevalences.

Table 6.63 presents the results of the statistical analysis of the osteophytes in the population. Binary regression analysis was used to predict the presence of osteophytes with sex and age as predictor variables. When interpreting the results the coding of the categories must be kept in mind. For example, sex is coded as male = 1 and female = 2. This is important to know when looking at the coefficients (b). A positive coefficient indicates an increasing relationship in the female direction and a negative coefficient indicates an increasing relationship in the male direction. For example, a negative coefficient indicates that the predicted probability of a osteophytes being present in females is decreasing; therefore, more likely to be present in males.

The odds ratios reflect the multiplitive change in odds per unit increase of the predictor variables. Odds ratios less than one indicate the odds are decreasing per unit of increase on the predictor variable. For example, for sex, this would mean the odds are decreasing for females (or increasing for males). For age, this means the odds are decreasing for every increase in age category (not chronological age in years). Odds ratios greater than 1 means the odds are increasing for each unit of increase on the predictor variables. Odds ratios are significant when the confidence interval does not cross 1 (both values greater than 1, or both values less than 1).

The results for each body site are presented in detail below.

Table 6.63 Results of binary logistic regression analysis for the presence of osteophytes.

		Predictor	Coeff (SE)	Odds ratio (99% CI)	p-value
Shoulder	Clavicle - distal	Sex	-0.400 (0.189)	0.670 (0.412, 1.090)	0.034
		Age	1.443 (0.384)	**4.233 (1.572, 11.395)**	**<0.001**
	Scapula - glenoid	Sex	-0.290 (0.212)	0.748 (0.433, 1.291)	0.171
		Age	2.283 (0.528)	**9.808 (2.514, 38.263)**	**<0.001**
	Scapula - acromion	Sex	-0.290 (0.243)	0.749 (0.400, 1.399)	0.233
		Age	1.899 (0.528)	**6.677 (1.714, 26.016)**	**<0.001**
	Humerus - proximal	Sex	-0.252 (0.325)	0.777 (0.337, 1.794)	0.438
		Age	2.115 (0.598)	**8.289 (1.775, 38.699)**	**<0.001**
Elbow	Humerus – Distal	Sex	0.038 (0.239)	1.038 (0.561, 1.921)	0.874
		Age	2.211 (0.507)	**9.122 (2.468, 33.713)**	**<0.001**
	Ulna – proximal	Sex	-0.254 (0.188)	0.776 (0.478, 1.26)	0.177
		Age	1.825 (0.464)	**6.203 (1.878, 20.482)**	**<0.001**
	Radius - proximal	Sex	-0.607 (0.476)	0.545 (0.160, 1.859)	0.203
		Age	1.566 (0.805)	4.787 (0.603, 38.027)	0.052
Wrist	Ulna – distal	Sex	-0.370 (0.267)	0.691 (0.347, 1.376)	0.167
		Age	1.646 (0.530)	**5.185 (1.322, 20.332)**	**0.002**
	Radius – distal	Sex	-0.210 (0.219)	0.811 (0.462, 1.424)	0.337
		Age	1.219 (0.468)	**3.385 (1.013, 11.303)**	**0.009**
Hip	Os coxa - acetabulum	Sex	-0.427 (0.195)	0.652 (0.395, 1.077)	0.028
		Age	1.810 (0.521)	**6.110 (1.595, 23.402)**	**0.001**
	Femur - proximal	Sex	0.155 (0.429)	1.167 (0.387, 3.523)	0.718
		Age	0.640 (0.979)	1.896 (0.152, 23.635)	0.514
Knee	Femur – distal	Sex	0.249 (0.275)	1.283 (0.632, 2.604)	0.365
		Age	1.020 (0.554)	2.774 (0.666, 11.566)	0.066
	Patella	Sex	-0.188 (0.401)	0.829 (0.295, 2.327)	0.640
		Age	1.994 (0.919)	7.346 (0.689, 78.322)	0.030
	Tibia – proximal	Sex	-0.758 (0.526)	0.468 (0.121, 1.818)	0.150
		Age	2.989 (1.121)	**19.862 (1.107, 356.437)**	**0.008**
	Fibula – proximal	Sex	-0.628 (0.823)	0.534 (0.064, 4.442)	0.445
		Age	0.293 (1.946)	1.340 (0.009, 201.654)	0.880
Ankle	Tibia – distal	Sex	-0.474 (0.355)	0.623 (0.250, 1.554)	0.182
		Age	1.829 (0.725)	6.228 (0.961, 40.351)	0.012
	Fibula – distal	Sex	-0.335 (0.410)	0.715 (0.249, 2.058)	0.414
		Age	1.149 (0.875)	3.155 (0.331, 30.064)	0.189
	Talus – proximal	Sex	-0.316 (0.532)	0.729 (0.185, 2.869)	0.552
		Age	1.252 (1.028)	3.496 (0.248, 49.315)	0.223

Coding: Sex: 1 = male, 2 = intermediate, 3 = female; Age: 1 = YA, 2 = MA, 3 = OA; significant results in bold

6.4.1.2.1. Shoulder

The overall prevalence of osteophytes at the shoulder was higher for males at all the articular surfaces observed compared to females. (Clav Dist: 47.0% males, 25.6% females; Scap Arco: 33.3% males, 18.5% females; Scap Glen: 30.4% males, 16.9% females; Hum Prox: 10.7% males, 4.7% females). There were not osteophytes at the shoulder articular surfaces in the Intermediate sex category.

The age related prevalences of osteophytes at articular surfaces at the shoulder are presented in Figure 6.43. From the graph it is apparent that all of the joint surfaces exhibit greater prevalence of osteophytes from one age category to the next. This ranges in prevalence from 0.0% to 5.7% in young adults, increasing to 5.4% to 41.1% in middle adults, and 33.3% to 73.3% in old adults.

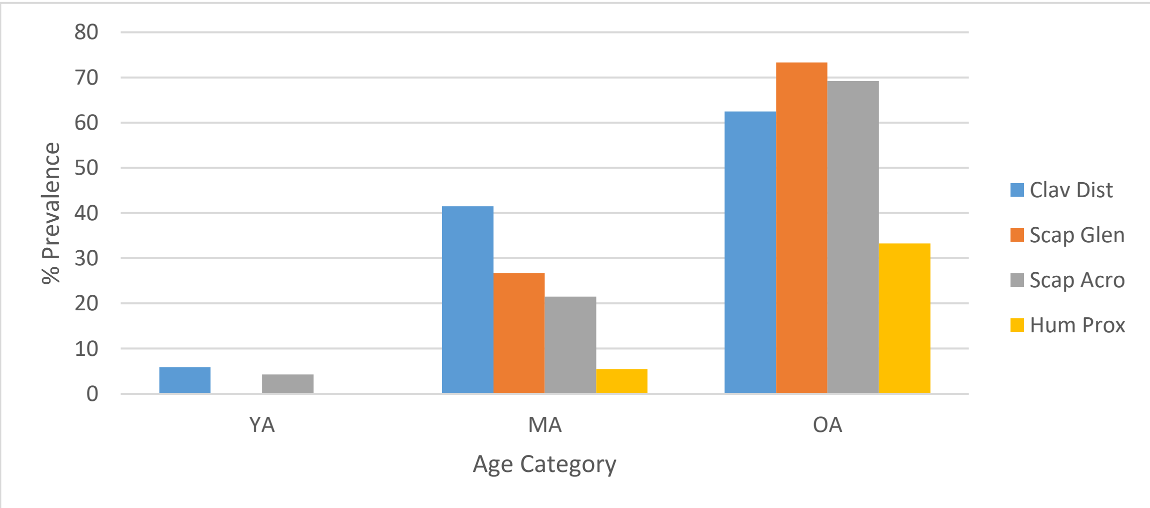

Figure 6.43 Osteophyte prevalence in population at joint surfaces of the shoulder (left and right combined)

Clav Dist: Fifty-one (34.9%) individuals had distal clavicle articular surfaces affected by osteophytes. Clav Dist were affected in 47% males and in 25.6% of females. The logistic regression model represented a significant improvement in fit over a null or unconditional model (Wald χ^2=18.84, p<0.001). Logistic regression model indicates that sex was a not a significant (b=-0.400, s.e.=0.189, p=0.034) predictor of the likelihood of a clavicle presenting osteophytes at the Clav Dist site. Age was a positive and significant (b=1.433, s.e.=0.384, p<0.001) predictor of the likelihood of a person developing osteophytes at the distal clavicle. The odds ratio indicates for every unit of increase in age, the odds of developing osteophytes were significant, indicating an increased by a factor of 4.233 (CI=1.572, 11.395). This means that for every increase in age category the predicted odds of having osteophytes were significant and increased by a factor of 4.233.

Scap Glen: Thirty-eight (24.8%) individuals had osteophytes present on the glenoid articular surfaces. Scap Glen were affected in 33.3% of males and in 18.5% of females. The logistic regression model represented a significant improvement in fit over a null or unconditional model (Wald χ^2=21.000, p<0.001). The model indicated that sex was not a significant (b=-0.290, s.e.=0.212, p=0.171) predictor of the likelihood of a glenoid presenting osteophytes. Age was a positive and significant (b=2.283, s.e.=0.528, p<0.001) predictor of the likelihood of a person having osteophytes present at the glenoid surface. The odds ratio indicates for every unit of increase in age, the odds ratio for developing osteophytes were significant indicating an increased by a factor of 9.808 (CI=2.514, 38.263). For every increase in age category the predicted odds of having osteophytes were significant and increased by a factor of 9.808.

Scap Acro: Twenty-seven (22.7%) individuals had osteophytes present on the acromial articular surface of the scapula. Scap Acro were affected in 30.4% of males and in 16.9% of females. The logistic regression model represented a significant improvement in fit over a null or unconditional model (Wald χ^2=14.470, p<0.001). The model indicated that sex was a non-significant (b=-0.290, s.e.= 0.243, p=0.233) predictor of the likelihood of an acromion presenting osteophytes. Age was a positive and significant (b=1.899, s.e.=0.528, p<0.001) predictor of the likelihood of a person developing osteophytes at the acromion. The odds ratio indicates for every unit of increase in age, the odds of developing osteophytes were significant indicating an increased by a factor of 6.677 (CI=1.714, 26.016). This means that for every increase in age category the predicted odds of having osteophytes were significant and increased by a factor of 6.677.

Hum Prox: Twelve (7.3%) individuals had osteophytes present on the proximal humeral articular surface. Hum Prox were affected in 10.7% of males in 4.7% of females. The logistic regression model represented a significant improvement in fit over a null or unconditional model (Wald χ^2=14.13, p=0.001). The model indicated that sex was a non-significant (b=-0.252, s.e.= 0.325, p=0.438) predictor of the likelihood of a humerus presenting osteophytes at the proximal articular surface. Age was a positive and significant (b=2.115, s.e.= 0.598, p<0.001) predictor of the likelihood of a person developing osteophytes at the proximal humerus. The odds ratio indicates for every unit of increase in age, the odds of developing osteophytes were significant, indicating an increased by a factor of 8.289 (CI=1.775, 38.699) Meaning that for every increase in age category the predicted odds of having osteophytes increased by a factor of 8.289.

6.4.1.2.2. Elbow

The overall prevalence of osteophytes at the elbow was higher for males at all articular surfaces observed when compared with females. (Hum Dist: 17.1% males vs. 13.8% females; Ulna Prox: 40.6% males, 25.3% females; and Rad Prox: 7.2% males, 1.3% females). There were not osteophytes at the elbow articular surfaces in the Intermediate sex category.

The age related prevalences of osteophytes at articular surfaces at the elbow are presented in Figure 6.44. The graph indicates that all joint surfaces exhibit greater prevalence of osteophytes from one age category to the next. This ranges from a prevalence of 0.0% to 5.9% in young adults, increasing to 3.9% to 34.9% in middle adults, and finally 16.7% to 76.9% in old adults. The prevalence of osteophytes is highest in the proximal ulna in all age categories.

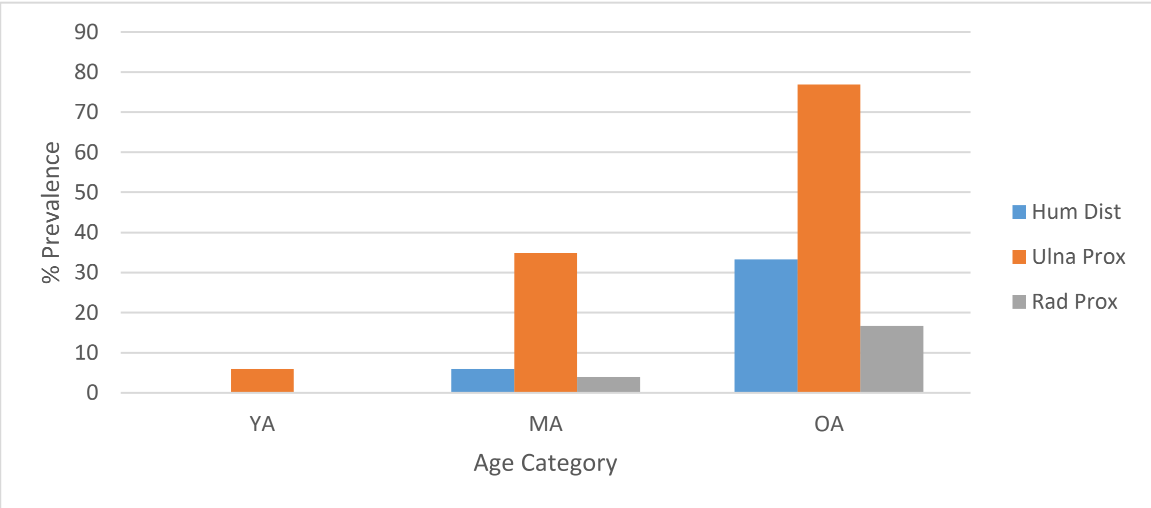

Figure 6.44 Osteophyte prevalence in population at joint surfaces of the elbow (left and right combined)

Hum Dist: Twenty-five (14.4%) individuals had osteophytes present on the distal humeral articular surface. Hum Dist were affected in 17.1% of males and in 13.8%. females. The logistic regression model represented a significant improvement in fit over a null or unconditional model (Wald χ^2=19.210, p<0.001). Logistic regression model indicates that sex was a non-significant (b=0.038, s.e.= 0.239, p=0.874) predictor of the likelihood of a humerus presenting osteophytes at the Hum Dist site. Age was a positive and significant (b=2.211, s.e.= 0.507, p<0.001) predictor of the likelihood of a person developing osteophytes at the distal humerus. The odds ratio indicates that for every unit of increase in age, the odds of developing osteophytes were significant indicating an increased by a factor of 9.122 (CI=2.468, 33.713). Therefore, for every increase in age category the predicted odds of having osteophytes were significant and increased by a factor of 9.122.

Ulna Prox: Forty-nine (32.2%) individuals had osteophytes present on the proximal ulnar articular surface. Ulna Prox were affected in 40.6% of males and in 25.3% of females. The logistic regression model represented a significant improvement in fit over a null or unconditional model (Wald χ^2=17.86, p<0.001). The model indicated that sex was a non-significant (b=-0.254, s.e.= 0.188, p=0.177) predictor of the likelihood of an ulna presenting osteophytes at the Ulna Prox site. Age was a positive and significant (b=1.825, s.e.=0.464, p<0.001) predictor of the likelihood of a person developing osteophytes at the proximal ulna. The odds ratio indicates for every unit of increase in age, the odds of developing osteophytes were significant indicating an increased by a factor of 6.203 (CI=1.878, 20.482). This means that for every increase in age category the predicted odds of having osteophytes were significant and increased by a factor of 6.203.

Rad Prox: Six (4.1%) individuals had osteophytes present on the proximal radial articular surface. Rad Prox were affected in 7.2% of males and in 1.3% of females. The logistic regression model was not a significant improvement in fit over a null or unconditional model (Wald χ^2=6.01, p=0.050). Neither sex (b=-0.607, s.e.= 0.476, p=0.203) nor age (b=1.566, s.e.= 0.805, p=0.052) was significant predictors for the presence of osteophytes at this site.

6.4.1.2.3. Wrist

The overall prevalence of osteophytes at the wrist was higher for males at all articular surfaces observed when compared with females. (Ulna Dist: 22.2% males, 9.1% females; Rad Dist: 24.6% males, 14.9% females). No osteophytes were observed at wrist articular surfaces in the Intermediate sex category.

The age related prevalences of osteophytes at articular surfaces at the wrist are presented in Figure 6.45. The graph indicates that all joint surfaces exhibit greater prevalence of osteophytes from one age category to the next. This ranges a prevalence of 0.0% to 3.1% in young adults, increasing to 17.6% to 22.8% in middle adults, and finally 40.0% to 45.5% in old adults.

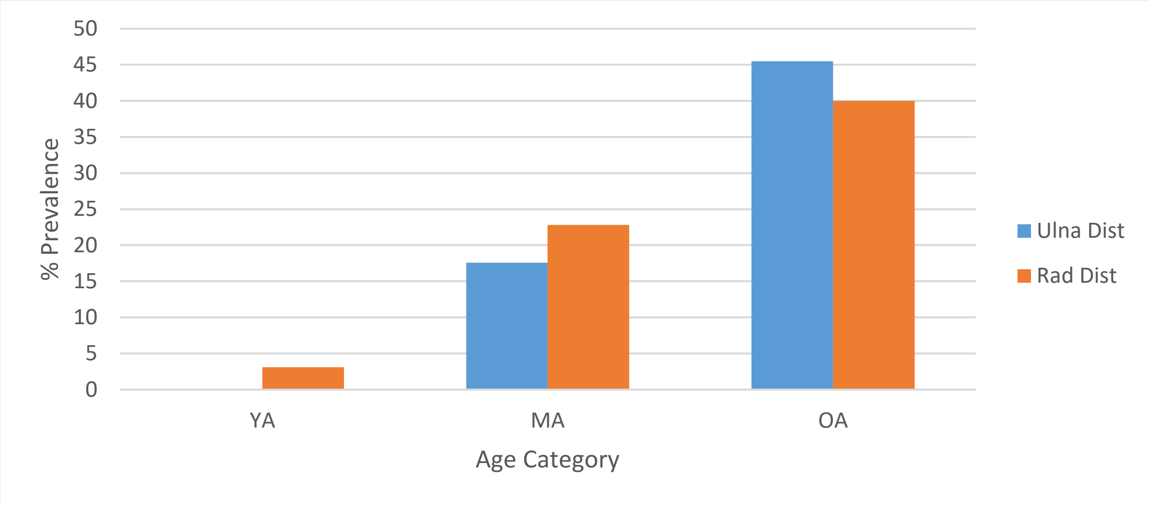

Figure 6.45 Osteophyte prevalence in population at joint surfaces of the wrist (left and right combined)

Ulna Dist: Twenty (15.5%) individuals had osteophytes present on the distal ulnar articular surface. Ulna Dist were affected in 22.2% of males and in 9.1% of females. The logistic regression model represented a significant improvement in fit over a null or unconditional model (Wald χ^2=12.50, p=0.002). The regression model indicates that sex was a non-significant (b=-0.370, s.e.= 0.267, p=0.167) predictor of the likelihood of a distal ulna presenting osteophytes. Age was a positive and significant (b=1.646, s.e.=0.530, p=0.002) predictor of the likelihood of a person exhibiting osteophytes at the distal ulna. The odds ratio indicates for every unit of increase in age, the predicted odds of having osteophytes present were significant and increased by a factor of 5.185 (CI=1.322, 20.332).

Rad Dist: Twenty-eight (19.6%) individuals had osteophytes present on the distal radial articular surface. Rad Dist were affected in 24.6% of males in 14.9% of females. The logistic regression model represented a significant improvement in fit over a null or unconditional model (Wald χ^2=8.48, p=0.014). Logistic regression model indicates that sex was a non-significant (b=-0.210, s.e.=0.219, p=0.337) predictor of the likelihood of a radius presenting osteophytes at the Rad Dist site. Age was a positive and significant (b=1.219, s.e.=0.468, p=0.009) predictor of the likelihood of a person developing osteophytes at the distal radius. The odds ratio indicates for every unit of increase in age, the predicted odds of having osteophytes present were significant and increased by a factor of 3.385 (CI=1.013, 11.303).

6.4.1.2.4. Hip

The overall prevalence of osteophytes at the hip was higher for males at the acetabulum (40.0% males, 20.0% females), and higher for females at the head of the femur (2.9% males, 3.8% females).

The age related prevalences of osteophytes at articular surfaces at the hip are presented in Figure 6.46. From the graph it is apparent that the joint surfaces exhibit greater prevalence of osteophytes from one age category to the next, with the exception of the femoral head which is lower in the middle adult category compared to the young adult category by 0.5%. The prevalence on the acetabulum ranges from a relatively low of 6.3% in young adults, to 32.1% in middle adults, to the highest reported prevalence for osteophytes at any site in the sample at 77.8%.

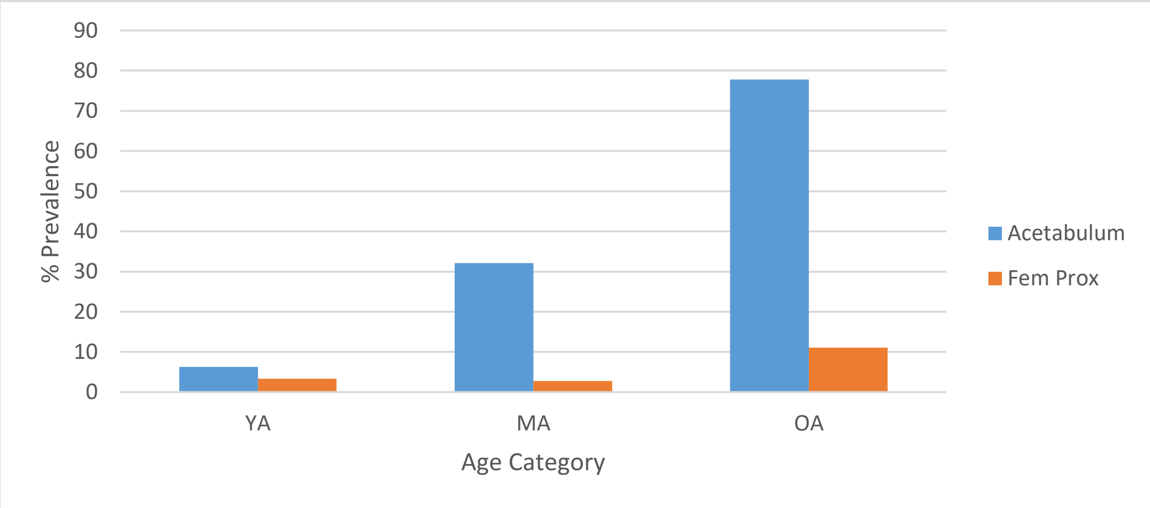

Figure 6.46 Osteophyte prevalence in population at joint surfaces of the hip (left and right combined)

Acetabulum: Forty-four (29.1%) individuals had osteophytes present on the acetabular lunar articular surface. Acetabula were affected in 40.0% of males and in 20.0% of females. The logistic regression model represented a significant improvement in fit over a null or unconditional model (Wald χ^2=16.64, p<0.001). The model indicated that sex was not a significant (b=-0.427, s.e.= 0.195, p=0.028) predictor of the likelihood of an acetabulum presenting osteophytes. Age was a positive and significant (b=1.810, s.e.=0.521, p=0.001) predictor of the likelihood of a person developing osteophytes at the acetabulum. The odds ratio indicates for every unit of increase in age, the predicted odds of having osteophytes present were significant and increased by a factor of 6.110 (1.595, 23.402).

Fem Prox: Five (4.7%) individuals had osteophytes present on the proximal femoral articular surface. Fem Prox were affected in 2.9% of males and in 3.8% of females. The logistic regression model represented a non-significant improvement in fit over a null or unconditional model (Wald χ^2=0.49, p=0.781). Logistic regression model indicates that sex was a non-significant (b=0.155, s.e.= 0.429, p=0.718) predictor of the likelihood of a femur presenting osteophyte, as was age (b=0.640, s.e.=0.979, p=0.514).

6.4.1.2.5. Knee

The overall prevalence of osteophytes at the knee was higher for males at all articular surfaces except for the distal femur, where it was higher in females (Fem Dist: 10.3% males, 13.9% females; Patella: 14.8% males, 9.1% females; Tib Prox: 9.8% males, 1.9% females; Fib Prox: 3.6% males; 0.0% females).

Figure 6.47 presents the prevalence of osteophytes at the knee in the sample in each age category. The prevalence of osteophytes increases at the knee on each articular surface with the exception of the proximal fibula.

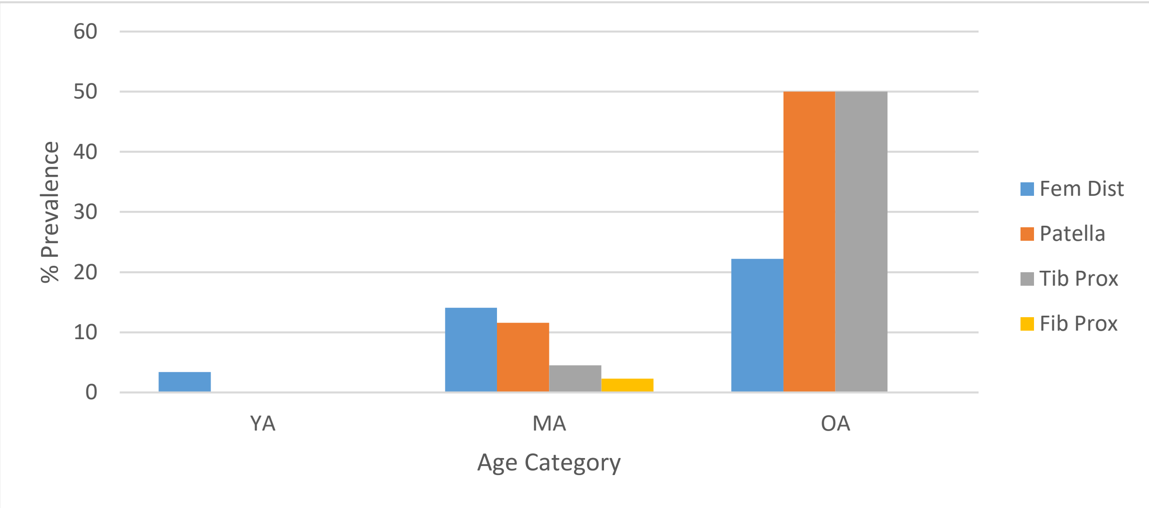

Figure 6.47 Osteophyte prevalence in population at joint surfaces of the knee (left and right combined)

Fem Dist: Sixteen (12.3%) individuals had osteophytes present at the distal femoral articular surface. Fem Dist were affected in 2.9% of males and in 3.8% of females. This was one of the two sites where female prevalence was higher than male. The logistic regression model represented a non-significant improvement in fit over a null or unconditional model (Wald χ^2=3.69, p=0.158). The regression model indicates that sex was a non-significant (b=0.249, s.e.= 0.275, p=0.365) predictor of the likelihood of a femur presenting osteophytes at the Fem Dist site. Age was also a non-significant (b=1.020, s.e.= 0.554, p=0.066) predictor.

Patella: Seven (11.7%) individuals had osteophytes present at the patellar articular surface of the knee. Patellae were affected in 14.8% of males and in 9.1% of females. The logistic regression model represented a non-significant improvement in fit over a null or unconditional model (Wald χ^2=4.89, p=0.087). The model indicated that sex (b=-0.188, s.e.= 0.401, p=0.640) and age (b=1.994, s.e.= 0.919, p=0.030) were non-significant predictor of the likelihood of a patella presenting osteophytes.

Tib Prox: Five (5.3%) individuals had osteophytes present at the proximal tibial articular surface of the knee. Tib Prox were affected in 9.8% of males and in 1.9% of females. The logistic regression model represented a non-significant improvement in fit over a null or unconditional model (Wald χ^2=7.78, p=0.020). The model indicated that sex was a non-significant (b=-0.758, s.e.= 0.526, p=0.150) predictor of the likelihood of a proximal tibia presenting osteophytes. Age was a positive and significant (b=2.989, s.e.=1.121, p=0.008) predictor of the likelihood of a person developing osteophytes at the proximal tibia. The odds ratio indicates for every unit of increase in age, the predicted odds of having osteophytes present were significant and increased by a factor of 19.862 (CI=1.107, 356.437).

Fib Prox: One (1.7%) individual had osteophytes present at the proximal fibular articular surface of the knee. Fib Prox were affected in 3.6% of males and in 0.0% of females. The logistic regression model represented a non-significant improvement in fit over a null or unconditional model (Wald χ^2=0.62, p=0.732). The model indicated that sex was a non-significant (b=-,0.628 s.e.= 0.823, p=0.445) predictor of the likelihood of a proximal fibula presenting osteophytes. Age was also a non-significant (b=0.293, s.e.=1.946, p=0.880 predictor.

6.4.1.2.6. Ankle

The overall prevalence of osteophytes at the ankle was higher for males at all articular surfaces (Tib Dist: 15.6% males, 5.8% females; Fib Dist: 9.5% males, 4.4% females; Tal Prox: 5.7% males, 2.3% females).

Figure 6.48 presents the prevalence of osteophytes at the ankle in the sample in each age category. The figure indicates that the prevalence of osteophytes increases at the ankle on each articular surface from one age category to the next.

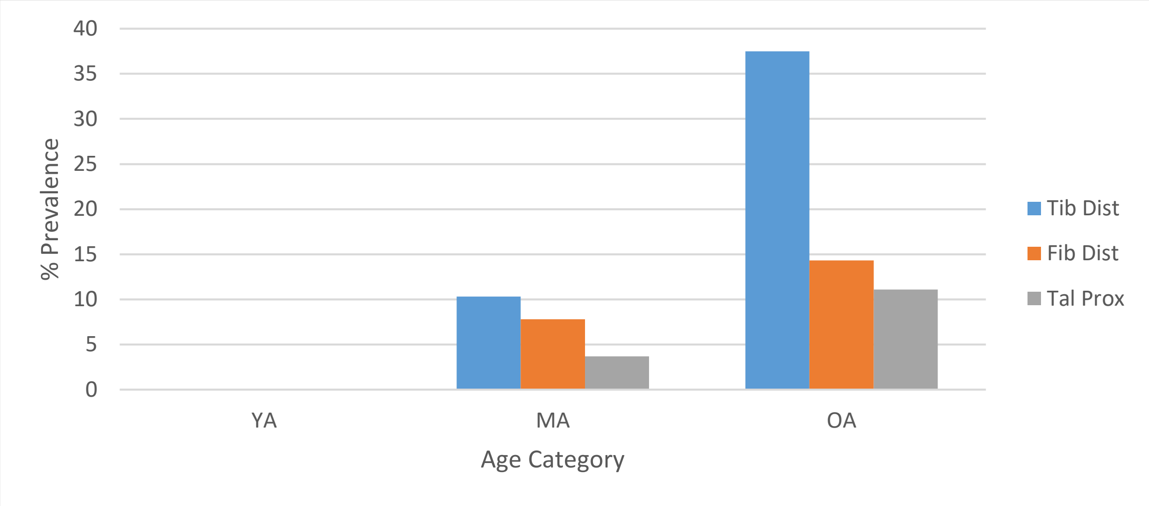

Figure 6.48 Osteophyte prevalence in population at joint surfaces of the ankle (left and right combined)

Tib Dist: Ten (10.3%) individuals had osteophytes present at the distal tibial articular surface of the ankle. Tib Dist were affected in 15.6% of males and in 5.8% of females. The logistic regression model represented a non-significant improvement in fit over a null or unconditional model (Wald χ^2=7.59, p=0.022). The regression model indicates that sex was a negative and non-significant (b=-0.474, s.e.= 0.355, p=0.182) predictor of the likelihood of a distal tibia presenting osteophytes. Age was also a non-significant (b=1.829, s.e.= 0.725, p=0.012) predictor.

Fib Dist: Six (6.9%) individuals had osteophytes present at the distal fibular articular surface of the ankle. Fib Dist were affected in 9.5% of males and in 4.4% of females. The logistic regression model represented a non-significant improvement in fit over a null or unconditional model (Wald χ^2=2.28, p=0.320). Sex was a non-significant (b=-0.335, s.e.=0.410, p=0.414) predictor of the likelihood of osteophytes, as was age (b=1.149, s.e.=0.875, p=0.189).

Tal Prox: Three (3.8%) individuals had osteophytes present at the superior talar articular surface of the ankle. Tal Prox were affected in 5.7% of males and in 2.3% of females. The logistic regression model represented a non-significant improvement in fit over a null or unconditional model (Wald χ^2=2.00, p=0.369). The regression model indicates that sex was a non-significant (b=-0.316, s.e.= 0.532, p=0.522) predictor of the likelihood of osteophytes at the proximal talus. Age was also a non-significant (b=1.252, s.e.=1.028, p=0.223) predictor.

In summary, the wide confidence intervals for many of the analyses, and large standards of error for many of the coefficients, indicated that the analyses lacked power due to small case counts in some of the categories. Even though the overall sample size for the joint modification analysis is fairly large (n=235), the representation issues presented in section 6.1 render the sample with much missing data.

In the overall sample, the prevalence counts for the presence of osteophytes were higher in males for all but 2 of the anatomical sites observed. However, in the logistic regression models, sex was not a significant predictor for the presence of osteophytes at any of the anatomical sites tested. Moreover, the prevalence of osteophytes in the age groups increased from YA to MA, and to OA, with the exception of proximal fibula, for which the prevalence remained low for all age categories. In the logistic regression models, age was a significant predictor for the presence of osteophytes at the following articular surfaces at the shoulder (distal clavicle, glenoid surface of scapula, acromion of scapula, proximal humerus), elbow (distal humerus, proximal ulna) wrist (distal ulna, distal radius), hip (acetabulum) and knee (proximal tibia). Odd ratios for significant predictors ranged from 3.385, to 19.862.

6.4.2. Eburnation

Eburnation was examined in the sample as it was considered to represent cartilage degeneration and a proxy indicator for general levels of activity. Because eburnation has been reported as a separate indicator in previously published literature (unlike osteophytes), crude prevalences were first calculated, to compare to this previously published data. Crude prevalence of eburnation in the Alba Iulia sample of the appendicular skeleton is presented in Table 6.64. The CP of eburnation in the entire adult sample was 2.4%, and slightly higher in males than females (4.1% and 2.2%, respectively); however, the difference was not statistically significant.

Table 6.64 Crude prevalence of eburnation in the adult sample

	f/n	%
Male	5/123	4.1
Intermediate	0/9	-
Female	3/134	2.2
Unknown (Adult)	0/63	-
Total Adult	8/329	2.4

f = number of individuals with eburnation
n = number of individuals in subsample

After the male and female sex categories were separated by age groups, an age related pattern was observed. No eburnation was observed at any joints in young adults. In the overall sample the crude rate from middle adults was 2.4%, and was greater multiple-fold in old adults at 16.7%. This increase was more pronounced in the female subsample with a middle adult prevalence of 1.2% and 28.6% in the old adult age category, while in males it was 4.0% in middle adults and 13.3% in old adults.

Table 6.65 Crude lifetime prevalence (CLP) of eburnation by age group in sex categories

	Males		Intermediate		Females		Total	
	f/n	%	f/n	%	f	%	f	%
Young Adult	0/20	-	0/1	-	0/31	-	0/52	-
Middle Adult	3/74	4.0	0/6	-	1/81	1.2	4/161	2.5
Old Adult	2/15	13.3	0/0	-	2/7	28.6	4/22	18.2

f = number of individuals with eburnation
n = number of individuals in subsample

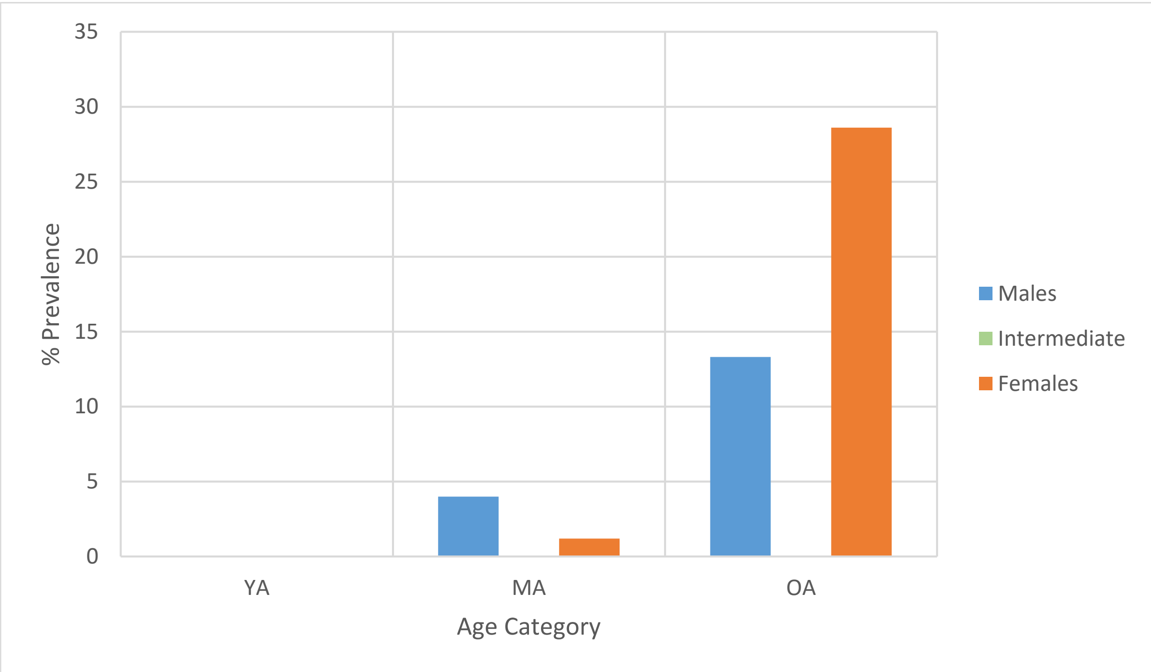

Figure 6.49 Crude lifetime prevalence (CLP) of eburnation by age category within the sex categories

The crude prevalences provided information on general trends between males and females and between age categories. The patterning of eburnation was next analysed to see which joints were more affected to allow the assessment of joint load patterns. The results indicated that, overall, male joints had almost twice the prevalence of the female joints; however, this result was not statistically significant (Table 6.66). The data showed the eburnation in males was seen at the shoulder (3.7%) and elbow (2.2%), while in females it was seen in the wrist (1.3%), hip (1.1%), and knee (1.4%) (Figure 6.50). The patterning initially indicated differences in upper and lower body prevalence between males and females, which was examined next.

In order to identify differences in the patterns of eburnation that may be related to joint loading or physical stress between males and females, the joint surfaces were pooled together as functional body sites. Eburnation was recoded as present if one or more of the articular surfaces was affected. Upper body sites included the shoulder, elbow and wrist, and the lower body the hip, knee and ankle.

All eburnation in males was confined to the upper body joints (2.0%). In females the prevalence of lower body eburnation (0.9%) was more than double that observed in the upper body (0.4%). Intra and inter sex differences were not statistically significant (Table 6.67).

Table 6.66 Adjusted prevalence of eburnation by body site and sex category

	Male		Intermediate		Female		All	
	f/n	%	f/n	%	f/n	%	f/n	%
Shoulder	3/81	3.7	0/5	-	0/94	-	3/175	1.7
Elbow	2/90	2.2	0/4	-	0/93	-	2/183	1.1
Wrist	0/77	-	0/0	-	1/79	1.3	1/156	0.6
Hip	0/76	-	0/2	-	1/92	1.1	1/168	0.6
Knee	0/63	-	0/1	-	1/74	1.4	1/137	0.7
Ankle	0/50	-	0/1	-	0/55	-	0/105	0.0
Total	5/437	1.1	0/13	-	3/487	0.6	8/924	0.9

f = number of body sites with eburnation present
n = number of body sites available for observation

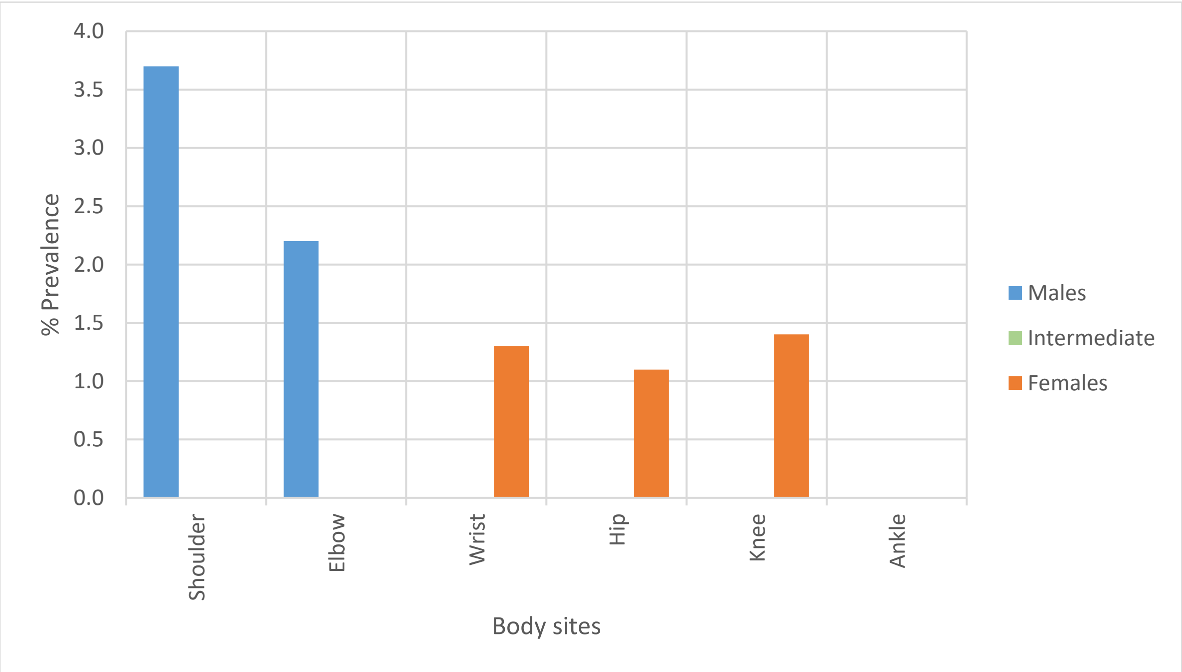

Figure 6.50 Prevalence of eburnation based on number of body sites observed in males and females

Table 6.67 Intra-sex upper and lower body joint eburnation comparison

	Male			Female		
	f/n	**%**	**p-value**	**f/n**	**%**	**p-value**
Upper body	5/248	2.0	0.071*	1/266	0.4	0.593*
Lower body	0/189	-		2/221	0.9	

f = number of body sites with eburnation present
n = number of body sites available for observation
*result of Fisher's exact test

Table 6.68 Inter-sex upper and lower body joint eburnation comparison

	Upper body			Lower body		
	f/n	**%**	**p-value**	**f/n**	**%**	**p-value**
Male	5/248	2.0	0.108*	0/189	-	0.152*
Female	1/266	0.4		2/221	0.9	

f = number of body sites with eburnation present
n = number of body sites available for observation
*result of Fisher's exact test

To analyse if activity patterns differed by side the left and right sides eburnation prevalence patterns were compared between and across sexes. The analysis indicated that with the exception of 1 shoulder all eburnation was on the right side (0.9% right, 0.1% left). Although some intra- and inter-sex differences in sidedness were observed in the prevalences rates, none proved to be statistically significant (Table 6.69, Table 6.70, and Table 6.71) . These results indicates that although differences between the left and right side eburnation prevalences were observed, they did not implicate any differences in activity levels between the sides.

Table 6.69 Comparison of left and right body sites affected by eburnation in total sample

	Left		Right		
	f/n	**%**	**f/n**	**%**	**p-value**
Shoulder	1/134	0.7	2/158	1.3	1.000*
Elbow	0/156	-	2/162	1.2	0.499*
Wrist	0/124	-	1/124	0.8	1.000*
Hip	0/136	-	1/140	0.7	1.000*
Knee	0/110	-	1/118	0.8	1.000*
Ankle	0/84	-	0/94	-	-
Total	1/744	0.1	7/796	0.9	0.070*

f = number of body sites with eburnation present
n = number of body sites available for observation
*result of Fisher's exact test

Table 6.70 Intra-sex comparison of left and right body sites affected by eburnation

	Males					Females				
	Left		Right		p-value	Left		Right		p-value
	f/n	%	f/n	%		f/n	%	f/n	%	
Shoulder	1/67	1.5	2/75	2.7	1.000*	0/81	-	0/79	-	-
Elbow	0/78	-	2/73	2.7	0.232*	0/75	-	0/81	-	-
Wrist	0/62	-	0/60	-	-	0/65	-	1/62	1.6	1.000*
Hip	0/68	-	0/72	-	-	0/88	-	1/70	1.4	1.000*
Knee	0/55	-	0/62	-	-	0/77	-	1/59	1.7	1.000*
Ankle	0/42	-	0/53	-	-	0/62	-	0/47	-	-
Total	1/372	0.3	4/395	1.0	0.374*	0/448	-	3/398	0.8	0.049*

f = number of body sites with eburnation present
n = number of body sites available for observation
*result of Fisher's exact test

Table 6.71 Inter-sex comparison of left and right body sites affected by eburnation

	Left					Right				
	Males		Females		p-value	Males		Females		p-value
	f/n	%	f/n	%		f/n	%	f/n	%	
Shoulder	1/67	1.5	0/81	-	1.000*	2/75	2.7	0/79	-	0.236*
Elbow	0/78	-	0/75	-		2/73	2.7	0/81	-	0.223*
Wrist	0/62	-	0/65	-		0/60	-	1/62	1.6	1.000*
Hip	4	-	0/88	-		0/72	-	1/70	1.4	1.000*
Knee	0/55	-	0/77	-		0/62	-	1/59	1.7	1.000*
Ankle	0/42	-	0/62	-		0/53	-	0/47	-	-
Total	1/372	0.3	0/448	1.0		4/395	1.0	3/398	0.8	

f = number of body sites with eburnation present
n = number of body sites available for observation
*result of Fisher's exact test

Age related patterns of eburnation were next analysed. Table 6.72 presents the adjusted prevalence of the eburnation data by sex and age group. The results indicate that the joints that have eburnation in males (shoulder and elbow) display an age related curve with the frequency increasing from middle adults to old adults. On the other hand, the age related patterning of eburnation in female joints is not as obvious with some joints only presenting in middle adults and others only in old adults. More specifically, the presence of female hip and knee eburnation was present only in old adult females, with a sharp difference in prevalence compared to prevalences in old adults in the male group, with quarter of the females in the old adult category having hip eburnation, and a third having knee eburnation.

Table 6.72 Prevalence of eburnation by age categories in males and females

	Males						Females					
	YA		MA		OA		YA		MA		OA	
	f/n	%	f/n	%	f/n	%	f/n	%	f/n	%	f/n	%
Shoulder	0/15	-	2/54	3.7	1/12	8.3	0/24	-	0/64	-	0/6	-
Elbow	0/15	-	1/65	1.5	1/10	10.0	0/23	-	0/64	-	0/6	-
Wrist	0/14	-	0/55	-	0/8	-	0/24	-	1/51	2.0	0/4	-
Hip	0/12	-	0/58	-	0/6	-	0/24	-	0/64	-	1/4	25.0
Knee	0/11	-	0/45	-	0/7	-	0/20	-	0/51	-	1/3	33.3
Ankle	0/7	-	0/38	-	0/5	-	0/14	-	0/37	-	0/4	-
Total	0/74	-	3/315	1.0	2/48	4.2	0/129	-	1/331	0.3	2/27	7.4

f = number of joint surfaces with eburnation present
n = number of joint surfaces available for observation

	Male			Intermediate			Female		
	YA	MA	OA	YA	MA	OA	YA	MA	OA
Shoulder	0	3.7	8.3	0	0	0	0	0	0.0
Elbow	0	1.5	10	0	0	0	0	0	0.0
Wrist	0	0	0	0	0	0	0	2.0	0.0
Hip	0	0	0	0	0	0	0	0	25.0
Knee	0	0	0	0	0	0	0	0	33.3
Ankle	0	0	0	0	0	0	0	0	0.0

Figure 6.51 Heat map of eburnation prevalence distribution by age category in males and females. Percentages represent prevalence in each age category.

The examination of prevalences based on articular surface counts was conducted for an understanding of eburnation patterning using a higher resolution dataset. This analysis gave more accurate prevalences by accounting for missing elements, and also allowed to observe patterning of eburnation at joints and articular surfaces. The adjusted prevalences indicated that overall in the sample eburnation was rare with 0.3% of articular surfaces affected (Table 6.73). The overall prevalence was slightly higher in males than females (0.5% and 0.3%, respectively), with no eburnation recorded for the intermediate skeletal sex category. The difference in the male and female prevalences was statistically non-significant (χ^2 [1, N = 3543] = 2.973, p = 0.085).

Table 6.73 Adjusted lifetime prevalence (ALP) of eburnation for joint surface observed

		Male		**Female**		**Total**	
		f/n	**%**	**f/n**	**%**	**f/n**	**%**
Shoulder	Clav Dist	0/105	-	0/122	-	0/227	-
	Scap Glen	1/75	1.3	0/82	-	1/157	0.6
	Scap Acro	2/107	1.9	0/118	-	2/225	0.9
	Hum Prox	2/108	1.9	0/124	-	2/232	0.9
Elbow	Hum Dist	2/114	1.8	0/133	-	2/247	0.8
	Ulna Prox	0/110	-	0/129	-	0/239	-
	Rad Prox	1/107	0.9	0/114	-	1/221	0.5
Wrist	Ulna Dist	0/91	-	1/92	1.1	1/183	0.5
	Rad Dist	0/104	-	0/113	-	0/217	-
Hip	Acetabulum	0/114	-	1/121	0.8	1/235	0.4
	Fem Prox	0/125	-	0/136	-	0/261	-
Knee	Fem Dist	0/110	-	0/122	-	0/232	-
	Patella	0/43	-	1/49	2.0	1/92	1.1
	Tib Prox	0/80	-	0/105	-	0/185	-
	Fib Prox	0/45	-	0/47	-	0/92	-
Ankle	Tib Dist	0/85	-	0/110	-	0/195	-
	Fib Dist	0/74	-	0/83	-	0/157	-
	Tal Prox	0/62	-	0/84	-	0/146	-
	Total	*8/1659*	*0.5*	*3/1884*	*0.2*	*11/3543*	*0.3*

f = number of joint surfaces with eburnation present
n = number of joint surfaces available for observation

Figure 6.52 indicated a general pattern of eburnation with male articular surfaces having higher frequencies in the upper body (no eburnation in lower body), and females with higher frequencies in the lower body. Only 1 female articular surface exhibited eburnation in the upper body.

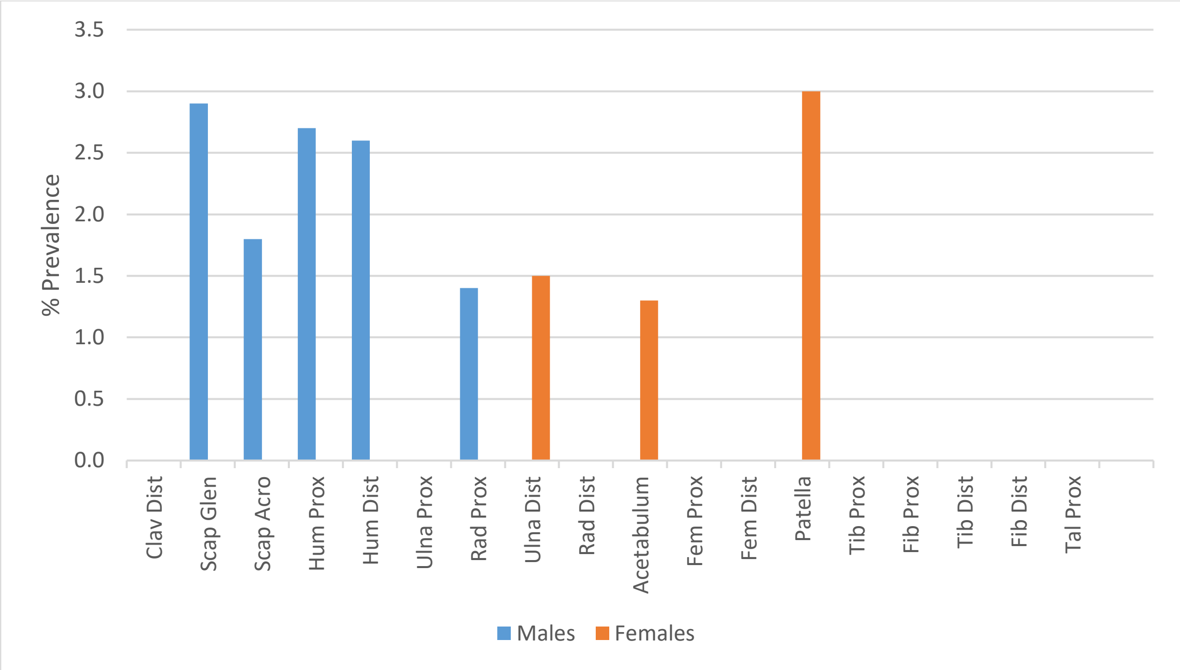

Figure 6.52 Prevalence of eburnation across sex categories per articular surface observed

Next, the age related patterning was analysed. The heatmap in Figure 6.53 shows the age related prevalence of eburnation at the various articular surfaces that were observed. Upon visual inspection a relationship with age was apparent. It was also apparent that eburnation was almost exclusively observed in older adults in the female sex, with the exception of 1 articular surface at the distal ulna. In males, eburnation affected upper body joint surfaces belonging to middle adults, with progressively higher prevalence of some of those surfaces in the older adult age category. This suggests that conditions, activity, and movements, that induced cartilage degeneration in the upper body in males, started early in adulthood.

		Male			Intermediate			Female		
		YA	MA	OA	YA	MA	OA	YA	MA	OA
Shoulder	Clav Dist	0	0	0	0	0	0	0	0	0
	Scap Glen	0	2	0	0	0	0	0	0	0
	Scap Acro	0	1	7	0	0	0	0	0	0
	Hum Prox	0	1	5	0	0	0	0	0	0
Elbow	Hum Dist	0	1	6	0	0	0	0	0	0
	Ulna Prox	0	0	0	0	0	0	0	0	0
	Rad Prox	0	1	0	0	0	0	0	0	0
Wrist	Ulna Dist	0	0	0	0	0	0	0	2	0
	Rad Dist	0	0	0	0	0	0	0	0	0
Hip	Acetabulum	0	0	0	0	0	0	0	0	20
	Fem Prox	0	0	0	0	0	0	0	0	0
Knee	Fem Dist	0	0	0	0	0	0	0	0	0
	Patella	0	0	0	0	0	0	0	0	25
	Tib Prox	0	0	0	0	0	0	0	0	0
	Fib Prox	0	0	0	0	0	0	0	0	0
Ankle	Tib Dist	0	0	0	0	0	0	0	0	0
	Fib Dist	0	0	0	0	0	0	0	0	0
	Tal Prox	0	0	0	0	0	0	0	0	0

Figure 6.53 Heat map of eburnation prevalence (%) distribution by age category in males and females. Percentages represent prevalence within each age category.

The interacting effects of sex and age in the presentation of eburnation were examined using binary logistic regression analysis. As described in the methods chapter, the left and right data were pooled for this analysis, with sex and age categories used as predictor variables. Upon analysis, the results indicated that none of the models showed an improvement in fit over a null or unconditional models (Table 6.74). This indicated that the categorical variables of age and sex were collectively not statistically significant for predicting the risk of the presence of eburnation in the skeletal sample at any of the anatomical sites.

Table 6.74 Results of Wald χ^2 tests for logistic regression analysis on eburnation

		Wald χ^2	p-value
Shoulder	Clav Dist	0.01	0.996
	Scap Glen	3.11	0.211
	Scap Acro	0.48	0.786
	Hum Prox	2.88	0.237
Elbow	Hum Dist	3.23	0.199
	Ulna Prox	0.03	0.984
	Rad Prox	0.53	0.765
Wrist	Ulna Dist	0.58	0.747
	Rad Dist	0.07	0.965
Hip	Acetabulum	4.79	0.091
	Fem Prox	0.41	0.817
Knee	Fem Dist	0.15	0.928
	Patella	0.08	0.960
	Tib Prox	3.89	0.143
	Fib Prox	0.03	0.987
Ankle	Tib Dist	0.11	0.947
	Fib Dist	0.10	0.949
	Tal Prox	0.11	0.949

Eburnation presented at various body sites in the Alba Iulia skeletal sample with overall prevalences at joint surfaces ranging from 0.0% to 1.7%. Anatomical sites that were affected were the shoulder, elbow, wrist, hip, and the knee. While some trends were observed in the data, such as males having higher prevalence in males at the shoulder and elbow, and eburnation being exclusive to females at the wrist, hip, and knee joints, the distributions were not statistically significant. This indicated that neither age nor sex were a significant predictor for the risk of the presence of eburnation at appendicular synovial joints. These observations suggested that, based on the presence of eburnation, males and females did not place differential mechanical stimuli or loads on their joint surfaces as a result of activity related stress.

Chapter 7: Discussion

This chapter synthesises and discusses the key findings of the current case study of the analysis of the skeletal indicators used to implicate embodied masculinities in the medieval period skeletal sample from Alba Iulia. The analysis focused on two primary objectives: (1) to examine blunt force and implement trauma as proxy indicators for risk and being at-risk, and (2) to investigate joint modification changes and their relationship to gendered differences in activity levels, and how both of these observed skeletal manifestations of past lifeways implicate men's gendered behaviours and their health outcomes. This chapter discusses insights gained into the lived experiences of medieval men in Alba Iulia, and the social factors that compelled men to deploy certain masculinities. A close examination and synthesis of the data emphasises the connection between the theoretical framework of the study and the results of the osteological analysis. It situates the finding in a broader historical context and highlights the role bioarchaeology can play in a more nuanced understanding of past gendered lived experiences.

7.1. Bodily injury and masculinity

A key aim of this thesis was to employ trauma analysis to examine risk taking and being at-risk of physical injury associated with gendered behaviours, particularly those arising from men's deployment of medieval masculine discourses. During the medieval period an individual’s or group’s risk of injury was influenced by a multitude of intersecting factors including among them their social status, gender, and age (Turner & Lee, 2018). Injury patterns as revealed by skeletal trauma may shed light on aspects risk of individuals and groups (Glencross, 2011). According to Dittmar and colleagues (2021) trauma may reflect several risk factors:

- Accidental injures associated with occupations and working conditions. This implies a higher risk of injury for manual labourers compared to a crafts persons or skilled workers.
- A buffering system (socioeconomic or institutional) from incidental risks of daily life. This implies a lowered risk of physical injury for higher status individuals, and a higher risk of injury for the lower class.
- The general level of aggressive or violent interactions (interpersonal or institutional) individuals or groups were expected to experience. For a medieval setting this implies a higher level or risk for males than for females.

Different groups may exhibit distinct levels and patterns of trauma and injury (Redfern, 2017b). Given that in the medieval period men and women occupied different social spheres and engaged in diverse types of work (Karras, 2003), it is reasonable to expect their skeletal remains to exhibit different patterns of skeletal trauma. Specifically, men's injuries may be influenced by constructions of acceptable gendered behaviours and expectations within society, including masculine discourses about engaging in physical activity and confrontational behaviour (Courtenay, 2011). Furthermore, variations in injury patterns may also exist among men living and working in different ways, or occupying different levels of society, such as warriors and commoners. The medieval mortuary sample from Alba Iulia was analysed for skeletal trauma using osteological data collection methods to assess risk factors for blunt and implement trauma and their implications for gendered behaviour with a specific interest in the consequences of men's risk taking behaviour to their health outcomes.

In general, the demographic analysis of the Alba Iulia skeletal sample indicated that the mortality distribution was weighted toward the middle adult age category, as can be seen in Figure 6.2 (pg. 116). The distribution indicated that 13% of individuals died in young adulthood, with 39% dying in middle adulthood, and 5.6% in old adulthood. An interesting trend discovered in the data was that a higher proportion of males (with known ages) survived into old adulthood compared to females (13.7% versus 5.9%, respectively). These figures are similar to other medieval mortuary mortality data from Transylvania such as the 12th to 16th century sample from modern day Sibiu (Marcu Istrate et al., 2015). However, this is unlike the demographic data from some sites from other areas of medieval Europe (Agnew & Justus, 2014; Dittmar et al., 2021), where male survivorship did not exceed females in the old age categories. As mentioned before, it is important to consider potential data bias due to osteological methods, which have a tendency to create a peek in the middle adult age group (Buckberry, 2015; Chamberlain, 2000), and sex assessment methods that have the tendency to categorise older female skeletal remains as male (Walker, 2005; Walker et al., 1988). These methodological deficiencies may create artifacting in the data to create demographic profiles that indicate that life expectancy for males was greater compared to females. Nonetheless, the data seem to indicate that being male in medieval Alba Iulia afforded *some* males with privileges that allowed them to live longer lives.

To interrogate masculine gender performances as linked to health outcomes in the sample under analysis, the risks of bodily injuries were separated into unintentional and intentional injuries. Unintentional injuries were considered those in which the perpetration of violence could not be determined, and fracture mechanics indicated aetiologies due to non-violent incidents, such as slips and falls or other accidents. Intentionality was established based on blunt or implement trauma presenting with fracture location, type or patterning that has been established in bioarchaeological and forensic literature as indicative of assaults (Brink et al., 1998; Galloway & Wedel, 2014b; Redfern, 2017b).

7.1.1. Unintentional and multiple injuries

The analysis of the skeletal trauma found that more males in the sample exhibited more evidence for skeletal injuries than females, with an overall crude lifetime prevalence of non-weapon trauma of 17.9% for males and 14.1% for females (Table 6.7). This is consistent with findings from other medieval period samples from throughout Europe (Agnew & Justus, 2014; Dittmar et al., 2021; Grauer & Miller, 2017; Kjellström, 2015; Marcu Istrate et al., 2015), which report a similar pattern. Overall, in the sample the prevalence of blunt trauma increased with each successive age category with the following frequencies: nonadults 4.9%, young adults 10.9%, middle adults 20.3%, and old adults 20.9%. This is expected from a mortuary sample for an indicator that is cumulative in nature. The female sub-sample demonstrated this age-related pattern (YA = 6.5%, MA = 14.8%, OA = 28.6%), however, the male sub-sample showed a decline in the old age category (YA = 20.0%, MA = 29.7%, OA = 20.0%), a finding which was unexpected in a cumulative sample, especially for one in which male survivorship was relatively higher for the old age category. This contradicts bioarchaeological models of trauma which predict that the frequency of cumulative trauma increases with age (Judd, 2002a). A possible explanation for this is that there was a negative relationship between male survivorship into old adulthood and the experience of blunt trauma. Possible reasons the experience of trauma predisposed men to an earlier death are: (1) the severity of the injuries was greater compared to females; (2) the kinds of activities men undertook that led to the trauma were of higher risk to physical injury, and (3) because the subgroup of men who experienced skeletal injury were part of an at-risk group with shortened life expectancies.

A clue to the injury severity hypothesis is that males in the middle adult age category had more than 3 times the prevalence of multiple blunt trauma compared to females (males 12.2%, females 3.7%). Multiple trauma is an indicator that an individual either sustained significant injuries in one high-energy incident that broke multiple bones, or that an individual had sustained broken bone on more than one occasion throughout his or her life (Judd, 2017). The data suggest that males were at risk for more severe injuries from single incidents, and from sustaining multiple skeletal injuries during their lives. Furthermore, the observation that the prevalence of perimortem blunt trauma in males was almost three times the frequency seen in females, indicates that the intensity of the events that precipitated the trauma was comparatively higher for males, rendering them more prone to fatality resulting from the occurrence. These observations suggest that males assumed risks or were at-risk from activities that had the potential to cause more severe injuries were repeatedly subject to such risks.

The analysis of the long bone blunt force trauma fracture patterns is often a good indicator of the nature of general mechanisms involved in the incident and assessment of risks in a population whether due to accidental or interpersonal incidents (Lovell & Grauer, 2019; Wedel & Galloway, 2014). Long bone trauma prevalence was calculated based on long bone counts rather than crude prevalence to provide higher resolution data (Judd, 2002b). From a total of 1399 long bones 24 had traces of skeletal injury (1.7%). Males experienced about the same level of elemental fractures as females. Overall, the data did not present any significant differences between males and females, elements affected, side differences, and differences between upper and lower body prevalences in long bone injuries. However, the analysis of fracture patterning did present a better understanding of injury mechanisms involved in the trauma. The data indicated that most long bone injuries were caused by accidental or non-intentional incidents, such as falls, some of which were from high energy and direct impacts. These injuries include two oblique fractures to the clavicles of a male and a female. These are commonly observed in clinical cases of falls onto the shoulder from a moderate height, falls onto an outstretched arm, or direct trauma to the bone (Galloway, 2014b). Fractures on humeri were observed on 3 elements, their presentations (e.g., oblique, distal articular, shortening) suggested accidental mechanisms such as falling and landing on the elbow or direct trauma (Galloway, 2014b; Humbyrd et al., 2012). The most common long bones to fracture were the ulna and radius (prevalence 5.0%). Most of the fractures to these elements also presented evidence of accidental causes, with some exceptions discussed below. These included simple oblique fractures, and other distal end fractures generally considered Colles' and Smith's fractures which are usually fractures obtained from an attempt to mitigate the impact of a fall with an outstretched hand (Humbyrd et al., 2012; Lovell & Grauer, 2019). Fractures of the distal portions of both the ulna and radius in two individuals (M360 a middle adult female, and M235 old adult male) suggested relatively higher-impact trauma in these individuals. Lower limb injuries were not common with 4 individuals exhibiting fractures to their tibia and/or fibula. Some fractures to the tibia and fibula show patterns of being a result of direct blows indicated by simple transverse fractures to the right tibia (M431, female, UnA) and fibula (M569, female, UnA). Individual M431 also had a wedge type, butterfly pattern fracture of the right fibula indicating a tib-fib fracture from a significant impact. Overall, the long bone trauma patterns indicated that both males and females were subject to high energy impact blunt trauma, such as significant blows to the skeletal elements, or falls from significant heights, but many were likely a result of accidental incidents. A few fractures in males were suggestive of violence related injuries.

Rib fractures may have a variety of causes, including accidental falls, or direct blows to the chest from assaults (Caragounis et al., 2021; Galloway, 2014b). Rib fracture patterning analysis indicated some differences between males and females. Overall, in the sample, 11.4 percent of males and 7.5 percent of females had at least one rib fractured during their life time, a difference that was not statistically significant. The sub-sample of individuals who sustained rib fractures consisted of the remains of 26 people, or 6.1 percent of individuals. The prevalence of rib fractures increased with age from young adult to middle adult age categories for both males and females. However, the pattern diverged for middle adult and old adults. For males, the prevalence declined slightly from 14.9% (MA) to 13.3% (OA), and for females it increased more than three-fold from 8.6% (MA) to 28.6% (OA). This pattern indicates that males with rib trauma may have had a decreased survivorship into old adulthood. More than half of the subsample with rib fractures had multiple ribs fractures. Although it was impossible to determine if the ribs, in case of multiple rib fractures, were a result of multiple incidents, this observation does indicate that in these cases, either the single incidents were more severe, or they were at a higher risk for multiple injuries to the thorax throughout their lives. Multiple rib fractures were observed at higher prevalence in males (64.3%) compared to females (50%). This indicated that males may have been at a greater risk of higher intensity trauma, or repeated trauma to the rib cage.

Analysis of the fracture pattern often helps in the determination of the underlying cause of rib fractures (Brickley, 2006; Redfern, 2017b). For example, transverse fractures are usually caused by direct blows to the rib cage, while oblique fracture patterns are caused by crushing or bending forces (Galloway & Wedel, 2014a). In the Alba Iulia sample the prevalence of transverse fractures were proportionally higher in males, with 52.5% of transverse fractures observed on male ribs, compared to 33.3% on female. This means that about half of the rib fractures in males were transverse and half oblique, and in females a third were transverse and two-thirds were oblique, suggesting that perhaps trauma that resulted in rib fractures was more often caused by direct blows to the thorax in males. Oblique fractures are more often the result of forces that are relatively slow, such as falls, rather than direct blows by objects, weapons, or body parts (Galloway & Wedel, 2014a). If the force is directed anteriorly the breaking point is more likely to be along the spine and sternum (Galloway & Wedel, 2014a). Further analysis of fracture positions indicated that the direct blows in males were most likely a result of interpersonal violence as a significantly greater number of ribs fractures occurred on the anterior aspect in males (males 42%, females 12%). Furthermore, in males more left sided anterior rib fractures were observed than right sided (77% left, 23% right), suggesting blows from right-handed perpetrators. However, the rib fracture types and patterns were not used in the identification of specific individuals as victims of violence because in the absence of other indicators this could not be done with a high level of confidence.

The data indicate that the majority of blunt trauma in males occurred in the young adult and the middle adult age categories. This is not an unsurprising observation as other bioarchaeological studies have observed this 'accident hump' in young males in various populations (Glencross, 2011; Mant, 2019; Redfern, 2017b). Glencross (2011) for example, used a life course analysis for long bone trauma distribution in the Indian Knoll skeletal sample (Kentucky, USA). The frequency of traumatic lesions differed in distribution for males and females. In males it peaked in adolescence after which it declined and then rose with age. In females no adolescent peak was observed, instead it rose steadily in relation to age. Males with multiple fractures have also been observed as part of the 'accident hump' in various clinical and bioarchaeological samples. Mant (2019) for example, in a post-medieval sample points to an increase in multiple fractures in males between 18 and 35 years of age in her sample from eighteenth-century London. This pattern is also reported in several other bioarchaeological populations from various time periods and geographical locations as well as modern clinical literature (Caufeild et al., 2004; Judd, 2002a; Redfern et al., 2017). Redfern has hypothesised this pattern in males to be due to "the extent to which they adopt adult masculine behaviours and engage in risk-taking activities" (Redfern, 2017b, p. 88). Increased level of risk-taking activity in young males is has been documented in the modern clinical literature (Courtenay, 2000a; Robertson, 2007).

7.1.1.1. *Injury recidivism and individuals with multiple fractures*

The analysis of the data suggested that the subgroup of individuals with rib fractures may represent a group with increased risks to physical bodily harm. This is suggested by the observation that all 5 individuals who were identified to have experienced skeletal trauma at least twice in their lives, all had rib fractures. This group of injury recidivists consisted of 5 adult males, 4 of them middle adults, and 1 young adult. The pattern of high proportion of rib fractures being part of recidivists skeletal injuries is a common observation in bioarchaeological and forensic literature on injury recidivism (Mant, 2019; Prince-Buitenhuys et al., 2017; Schrader & Smith), and speaks to the importance of including ribs in trauma analysis (Brickley, 2006). The injury recidivists were identifiable based on a mixture of antemortem and perimortem blunt trauma fractures (M385, M500), antemortem blunt fractures in different stages of healing (M585, M597), and antemortem blunt trauma and perimortem sharp trauma (M625). Although the skeletal evidence was only able to establish two time signatures of injury, all individuals had sustained more than two injuries, raising the possibility these individuals experienced the trauma of broken bones more than twice in their life. The number of fractures in individuals with multiple trauma ranged from 3 broken elements in individual M597 to 6 elements in M385.

The injury recidivists were part of a larger group of individuals with multiple injuries who experienced skeletal trauma of multiple bones. The 'individuals with multiple injuries' group included injury recidivists in addition to individuals with multiple fractures for whom the sequencing of traumata lacked evidence. This larger group consisted of 23 individuals, which was 5.4% of the total Alba Iulia sample, with two-thirds of this group consisting of males (n=16, 70%) and one-third female (n=7, 30.0%). In relation to the sex categories, the 16 males represented 13.0% of the males in the sample and the 7 females represented 5.2% of the females. This indicates a higher proportion of males with multiple bones broken compared to females, suggesting that either men sustain more severe injuries in single incidents, or sustained more traumatic incidents over their lives. The age distribution of multiple trauma victims showed an accumulative curve for both males and females. In males the prevalence in young adults was 10.0% and increased to 13.5% in middle adulthood and to 20% in old adulthood. In females the prevalence in young adults and middle adults was lower than in males, at 3.2% and 3.7% respectively, however, it rose sharply in old adults to 28.6%. This indicates that either survivorship of males with multiple injuries into old age was lower, or that women in the old adult category were at higher risk of bodily injury from blunt force trauma. A closer examination of the types of injuries indicated that the majority of the female multiple trauma could be attributed to accidental injuries such as falls, with 3 of the 7 women having FOOSH type injuries, 3 with only rib fractures (common in falls in older individuals), and 1 with a tib-fib fracture that was likely caused by an outside force that may or may not be violence related. Men also display accidental injury mechanisms, with 7 of the individuals' multiple injuries caused by accidents or falls as seen by FOOSH fractures of clavicle and ulna and rib fractures (although see above discussion on patterning within rib fractures). However, men's injury patterns of multiple trauma also displayed indicators of intentional injuries by weapons (sharp trauma), or in defence of an attack (Parry fracture), or as a perpetrator of an attack (e.g., right metacarpal trauma). This indicates that the higher prevalence in males could possibly be due to their engagement in violence and combat.

Recent bioarchaeological studies have revealed how social forces influence health outcomes in past populations (Judd, 2002a, 2017; Mant, 2019; Redfern et al., 2017; Tegtmeyer & Martin, 2017). These studies of skeletal indicators of injury recidivism build upon contemporary clinical research, which has identified underlying social commonalities in individuals with repeated severe bodily injuries throughout their life course. One of the earliest published clinical studies on recidivism focused on hospital readmissions for trauma. In this study, Reiner and colleagues (1990) found that injury recidivists were most commonly young men, with an average age of 26 at readmission, but with an average age of 20 at first admission. This observation has been supported by other studies, with the additional observation that these younger males tend to be from vulnerable, at-risk, populations (Brooke et al., 2006; Cooper et al., 2000; Judd, 2017; Redfern et al., 2017; Reiner et al., 1990), and were also more likely to be visiting the hospital for assault related injuries than non-repeat patients (Judd, 2017; Redfern et al., 2017). More recent literature on recidivism research indicated that individuals with repeated visits to hospitals for trauma related injuries represented a group of individuals with increased-risks due to lifestyle factors. These individuals were more likely to be single men, from disadvantaged socioeconomic conditions, be involved in criminal activity, and have had a history of substance abuse (Judd, 2017; Redfern, 2017b). Furthermore, a recent study found that trauma recidivists represented an at-risk group with significantly higher post discharge mortality in all age groups, compared to non-recidivists (Gerrish et al., 2019). These commonalities suggest that injury recidivism is not only a result of individual behavioural factors but involves a complex interplay of intersectional social factors that place individuals at higher risk of physical bodily harm.

Bioarchaeological studies that heavily rely on contextual information have suggested that injury recidivist groups may represent disadvantaged groups. Bioarchaeological studies of injury recidivism and individuals with multiple fractures have generally supported this clinical model. For example, Judd's (2002a) results from a study of adult skeletal remains from the Kerma Period of Sudanese Nubia, supported an injury recidivism profile. Correspondence between the modern clinical profiles and multiple injuries in the archaeological sample included: (1) most individuals with multiple injuries were middle adult males, (2) rural and urban samples showed no significant difference in violence- or accident-related multiple injury patterns, and (3) a high number of adults with multiple injuries exhibited one or more skeletal markers of nonfatal violence. In a larger expanded study Redfern and colleagues (2017) combined samples from 5 additional populations to the Kerma sample from Europe and Asia to investigate demographic patterns and general health of people with multiple injuries. This study revealed that, irrespective of the temporal and cultural context, adult males were more likely to be injury recidivists, have multiple injuries, and die during young adulthood. Interestingly, the study found no significant relationship between general poor health and multiple trauma (Redfern et al., 2017). In another study of 5 post-medieval London cemeteries, Mant (2019) also found a similar pattern in a sample of 721 individuals, with males exhibiting a higher prevalence of multiple fractures in the young and middle adult age categories. In a follow-up study, Mant and colleagues (2021) presented two case studies, one from the Royal London Hospital collection and one from the Terry collection, for whom extensive contextual historical information was available. Both individuals were injury recidivists with multiple healed and perimortem trauma. This osteobiographical approach demonstrated the intersectional connections between adverse health outcomes and sociocultural and behavioural factors of these two marginalised individuals. These bioarchaeological studies of injury recidivism and individuals with multiple fractures have supported the clinical model, demonstrating that adult young males are more likely to be injury recidivists, have multiple fractures, and experience premature mortality during young adulthood, irrespective of the temporal and cultural context of the investigation.

Interpreting multiple trauma and injury recidivism is a challenging task for bioarchaeologists that requires careful consideration of the osteological data and the historical context. In the sociological literature, subgroups of males with these types of injuries have been identified to belong to vulnerable and disenfranchised populations (Brooke et al., 2006; Cooper et al., 2000; Reiner et al., 1990). Disadvantaged individuals and groups have higher risk of serious illness and mortality (van Lenthe & Mackenbach, 2021; WHO, 2022). These can be attributed to limited access to resources such as nutrition and medical treatment. Poor living conditions and nutrition allow the spread of infectious and metabolic diseases. Furthermore, an individual's health status during childhood can have a significant effect on adult health (Judd, 2017). However, with the lack of archaeological and historical information regarding medieval Alba Iulia, the current study was unable to reach firm conclusions about the group of individuals in the mortuary sample represented by multiple and recurring injuries. Nonetheless, situating the current study in broader bioarchaeological literature and understanding the nature of cumulative trauma (Judd, 2002a, 2017; Mant, 2019; Redfern et al., 2017; Tegtmeyer & Martin, 2017), it is suggestive of a category of individuals with less social capital, lower access to resources, and experiences of similar risks throughout their lives based on similar intersectional circumstances. This is suggested by the demographic and injury patterns of these individuals who were primarily younger males involved in high risk activities.

7.1.1.2. *Living with the consequences of injury*

The effects of physical injuries in the medieval period went beyond immediate pain and disability. They often had physical or cognitive outcomes that may have led to lasting social consequences (Byrnes & Muller, 2017). In the Alba Iulia skeletal sample, there were several examples of injuries with post-incident quality of life implications. With regards to men, a large body of contemporary health research focuses on the negative mental health outcomes of some men subscribing to and deploying hegemonic masculinity (Addis & Cohane, 2005; Brooks, 2001; Courtenay, 2000b; WHO, 2020). Although it is impossible to know the effect of trauma on individuals' mental health outcomes in the Alba Iulia skeletal collection, some educated conjectures may be presented based on known clinical outcomes of specific traumatic injuries. Seven individuals in the sample suffered cranial weapon trauma (M207, M225, M390, M543, M551, M614, M625), all of whom were male. Cranial trauma in an eighth individual, a male (M405), was not classified as weapon trauma because it was not possible to specifically diagnose as such. This was a depression fracture over the left orbit, the location of which indicated suspected interpersonal violence. Three of the individuals had survived the weapon trauma to the head. Survivors of weapon trauma in the Alba Iulia sample likely suffered from concussion or more severe brain damage (Lawrence, 2000), and the repercussions of the lasting effects of mild to severe brain injuries such as cognitive, psychological and behavioural symptoms (June et al., 2020). Such symptoms include physical ones such as chronic headaches, dizziness, imbalance, vertigo, as well as cognitive and phycological ones such as decreased cognitive performance, anxiety, difficulty concentrating (Moser et al., 2005; Teo et al., 2020). Other symptoms of concussion can include loss of consciousness, periods of memory loss, disturbances in vision, and periods of confusion (Moser et al., 2005). These symptoms may have been long-lasting and could have significantly impacted their ability to function in society after the traumatic event, leading to further mental health issues.

Some authors have attempted to study mental health issues of ancient warriors based on written sources. For example, Melchior (2011) studied post-traumatic stress disorder (PTSD) in Ancient Roman soldiers based on historical and literary evidence. She concluded that the prevalence of PTSD in Roman soldiers was likely less than in modern combatants for several reasons. First, is that violence in ancient societies was an everyday occurrence and soldiers would be accustomed to it; and second, that PTSD in modern societies is in large part caused by explosion induced concussions (Melchior, 2011). However, in response to Melchior's conclusions, Heebøll-Holm (2014) has argued that while violence was prevalent in pre-modern times, in the medieval period life was indeed violent, it was not characterised by everyday acts of extreme violence, and that there is reason to doubt that concussion is the major cause of PTSD. Heebøll-Holm (2014) also suspected that extreme close combat violence experienced in medieval soldiers had lasting impression on their mental health. There are several male individuals in the Alba Iulia sample who were possible combatants and suffered severe weapon trauma to the head. These individuals possibly suffered both concussions and were witness to, and subject of, extreme violent acts, making them susceptible to mental health issues as an outcome of their participation in war.

Overall, in the Alba Iulia skeletal sample the analysis of fracture patterns, injury recidivism and multiple trauma indicated a higher prevalence of skeletal injuries in males compared to females, with males being at a higher risk for severe or repeated injuries in certain age groups and sub-populations. The closer examination of the types of injuries also revealed that while both sexes displayed accidental injury mechanisms, men's injury patterns also showed signs of intentional interpersonal aggression as either recipients or perpetrators. The decreased survivorship of a group of males with trauma, especially those with who engaged in weapon combat, possibly indicated a shorter life expectancy in this subgroup, which the next section explores.

7.1.2. Intentional Injuries, violence and social structures

The World Health Organization (WHO, 2002) provides a useful typology for understanding the complexities of intentional injuries in the bioarchaeological record, because the framework allows researchers to focus on and examine multiple levels of violence (2017b). The World Health Organization defines violence as "the intentional use of physical force or power, threatened or actual, against oneself, another person, or against a group or community, that either results in or has a high likelihood of resulting in injury, death, psychological harm, maldevelopment, or deprivation" (WHO, 2002, p. 5). The framework identifies three levels of violence which span from individual to broader social levels, namely: (1) self-directed, (2) interpersonal, and (3) collective violence (WHO, 2002). *Self-directed violence* refers to suicidal behaviours and self-abuse (WHO, 2002). This type of violence has not been studied using bioarchaeological samples, according to the author's knowledge, most likely because this requires the identification of intent to self-harm, which is difficult to ascertain from skeletal remains. *Interpersonal violence* refers to two types of violence that includes 'family violence' including intimate partner, child, or elderly abuse, and 'community violence' that involves altercations between unrelated individuals (WHO, 2002). The archaeological record contains abundant evidence of interpersonal violence during the medieval period, including wounds from blunt force and weapon trauma (Gilchrist, 2012; Turner & Lee, 2018). The ubiquitous nature of skeletal injuries suggesting interpersonal conflict in medieval skeletal assemblages indicate that violence was common and the threat of violence was a part of many individual's daily lives across the Europe (Caufeild et al., 2004; Judd, 2002a; Mant, 2019; Redfern et al., 2017; Tegtmeyer & Martin, 2017). *Collective violence* refers to social, political, and economic violence, and includes violence committed by larger groups of individuals such as special interest groups or states. Acts can include mob violence, terrorist acts, and war. Collective violence may be identified in the bioarchaeological record through skeletal assemblages that include a large number of casualties such as war or massacre related cemeteries or mass graves (Anderson & Martin, 2018). This framework also recognises that violence is a discursive result of social and structural forces including poverty, social inequality, and discrimination (WHO, 2002). Structures of violence may not immediately be obvious in the skeletal record; however, the right interpretive frameworks and historical documentation can lead to the understanding of social structures that produced violence in the past. Notable examples are bioarchaeological studies that have attempted to investigate indicators of inequality through injury recidivism. Studies of individuals with multiple and reoccurring skeletal injuries have been linked to lower socioeconomic status and disadvantaged groups (Caufeild et al., 2004; Judd, 2002a; Mant, 2019; Redfern et al., 2017; Tegtmeyer & Martin, 2017). In summary, a multiscalar framework for understanding violence is valuable in understanding the complexities involved in the perpetration of violent acts evidenced in skeletal assemblages. To fully understand violent behaviour in the past an interpretive framework is required that considers violence as both individually perpetrated while simultaneously situating it within, and compelled by, social forces that institutionalise violence at various levels of society.

The perpetuation of violence is inextricably linked to social discourses. To effectively study violence, it is essential for bioarchaeologists to recognise not only its transformative nature upon individual and collective lives, but also the social structures implicated in its performance, taking into consideration that most forms of violence always originate from a broader discursive cultural forces (Klaus, 2012; Martin et al., 2012). The bioarchaeological study of violence, in addition to focusing on individual and group health outcomes, should also investigate the transformative processes involved that unfold within a social context (Martin & Harrod, 2015; Martin et al., 2013). In this research, violence, examined from a discursive perspective, is viewed as the deployment of behavioural patterns compelled by social institutions and power structures, behaviours which simultaneously inform and co-create those very same social structures that inform its deployment in the first place. This iterative process of deployment of violence serves a legitimising effect for men's aggressive behaviours. Studies of violence in bioarchaeological contexts using such a performative view, in addition to understanding the deployment of violence and men's aggressive behaviour, are also positioned examine the cultural means used to normalise, legitimise, and perpetuate it.

Upon the analysis of trauma in the Alba Iulia sample, it became apparent that intentional injuries were most commonly perpetrated by men and inflicted onto other men. Weapon related injuries, that almost always indicate intentional use of force, were exclusively observed on adult male skeletal remains (Table 6.41). Although most long bone fractures had evidence of accidental mechanisms, there were a few possible fractures potentially indicating interpersonal violence, such as midshaft transverse fractures of the ulna, which are commonly interpreted as 'Parry' fractures caused by interpersonal aggression resulting from a direct blow to a forearm shielding the head or body (Judd, 2008; Smith, 1996). These types of fractures were observed in four individuals (M208, M484, M486, and M556), all of whom were middle adult males, except for one adult of unknown sex and age. These individuals represent possible victims of violent encounters.

A further indicator that can reveal information about violence related acts are injuries to the cranium, mandible, and dentition, as the head is often the target in interpersonal physical confrontations (Goulart et al., 2014). Non-sharp trauma on the cranium was observed in one adult individual of unknown sex. The depression fracture located on the left frontal bone of M405 (just above the left orbit), suggested an injury sustained in an altercation with a right-handed individual (Kremer et al., 2008).

A total of 8 individuals had implement trauma injuries, all of which were estimated to be intentional in nature. The 8 males represented 6.5% of the adult male sub-sample (crude prevalence). Seven out of the 8 individuals were in the young adult and middle adult age categories, suggesting that younger men were more likely to be involved in armed combat. However, it is plausible that older adult individuals who had sustained and survived antemortem sharp trauma earlier in life, had their injuries healed over by the time of their deaths. In such cases, the identification of sharp trauma specifically would be impossible because the injury sites appear as non-specific fracture calluses. However, the observation that perimortem trauma is seen in the young adult and middle adult group (Table 6.43) may indicate that old adult individuals were less likely to engage in armed confrontations, indicating changing societal attitudes toward armed combat through the life course. It may also suggest that life expectancy in the sub-population that engaged in armed combat was reduced, with most individuals dying before reaching old adulthood. The observation that sharp trauma or weapon violence was exclusive to males, is not an unusual observation for a medieval period sample. Marcu Istrate *et al.* (2015) also found a similar pattern in the medieval sample from the Sibiu, Romania, churchyard cemetery active during the 12th to 16th centuries, roughly about 80 kilometres southwest of Alba Iulia. The researchers observed at least 5 males and no females exhibiting weapon related skeletal trauma. However, in some medieval societies in the broader European context, it is not uncommon to observe weapon related trauma in females as well (Sundman, 2022; Sundman & Kjellström, 2020).

Identifying the perpetrators of violent acts in the bioarchaeological record is a more complex task because it is less obvious than the identification of the victims. In most cases skeletal injury is a result of receiving violence and not the delivery of the assault. However, committing interpersonal violence can also lead to certain traumatic skeletal injuries (Redfern, 2017b). For example, individual M500 sustained 2nd and 3rd right metacarpal fractures, which often result from a poorly delivered intentional blows (Galloway, 2014b). Regardless of the relative absence of skeletal indicators for the intent to harm, it is reasonable to suggest that, in this medieval society, individuals with combat injuries, especially individuals in certain demographic groups such as young males, sustained injuries because they themselves engaged in combat.

Figure 7.1 Medieval weapons exhibited in The National Museum of the Union, Alba Iulia, Romania (Photo credit: Davazno1, 2021)

The Alba Iulia data suggest that the deployment of male violence was influenced by social factors at various levels. The observation that being a victim of sharp trauma, and therefore engaging in armed combat, was exclusively reserved for men, indicates that being male—or having a male body—was a significantly influential factor, or risk factor, for sustaining weapon injuries at some point during the lifecourse, at least for certain subgroups of men. The result that most skeletal injuries indicative of interpersonal violence were those caused by weapons, suggests that weapons were perhaps a common personal property of many men. There is a distinct absence of skeletal fracture patterns that would implicate interpersonal violence without weapons such as such as nasal, mandibular, or zygomal fractures (Redfern, 2017b, citing Brink et al., 1998).

The results of the analysis of the Alba Iula skeletal sample may also provide a window into how institutionalised violence predicated itself on everyday individual bodies, not in forms of violent acts themselves, but as embodied in health outcomes. The exclusivity of weapon injuries in males illustrates how social institutions of violence can leave enduring marks on the male body. Given Alba Iulia's historical significance as a fortified settlement, the ubiquitous presence of military personnel and organisations was a pervasive force at all social levels. The current bioarchaeological examination of the male body exemplifies how such discursive regimes of violence inscribe themselves onto the bodies of individuals. A subset of the population of medieval Alba Iulia would have belonged to a social class that was defined by its readiness for armed combat. These individuals were considered to form an upper class and ruled over the population living in the town and surrounding areas (Engel, 2001). Paradoxically, this elevated social status also predisposed them to obligatory engagement in activities that placed them at higher risk of sustaining physical injuries. Contrary to the hypothesis that high social status can often act as a buffer or protective system against physical insults and adverse health outcomes (Dittmar et al., 2021), the results of the current analysis suggest that some deployment of masculine gender identities may have a dualistic double-edged nature conferring social advantages, with the risk of disadvantages due to bodily harm and consequent detrimental health outcomes.

In summary, by examining the intersection of trauma, violence, male bodies, and masculinities, this research has attempted to link the discursive power structures implicated in the deployment of masculinities in medieval Alba Iulia to male bodies. Some medieval political and power structures simultaneously gave men higher social status, while simultaneously having a detrimental impact on their health outcomes. Traditional expectations of men’s behaviour placed men in positions that increased their risk of living shorter lives and severe bodily harm through military obligations and hazardous occupations. Furthermore, the injuries sustained, combined with continued social expectations may have had lasting effects on their mental and psychological well being.

7.2. Activity analysis interpretations

In addition to exploring relationships between male gendered behaviours and risk through trauma analysis, this thesis also aimed to examine general gendered activity patterns, particularly those related to men's deployment of medieval masculine discourses, through the analysis of joint modification skeletal indicators. Bioarchaeological studies that have attempted to study general gendered activity differences have relied on three primary joint modification markers that are identifiable on dry bone: osteophytes, sclerosis/eburnation, and porosity (Waldron, 2012). These markers have been used in various combinations to arrive at palaeopathological diagnoses of osteoarthritis (Jurmain et al., 2012; Rogers, 2000; Waldron, 2009), which in turn were interpreted in a framework that considers osteoarthritis as a wear-and-tear disease resulting from prolonged joint use (Jurmain, 1999). However, as discussed in section 4.2.2, the diagnosis of osteoarthritis in bioarchaeological samples through some combination of these skeletal markers as diagnostic criteria has not provided clear answers (Waldron, 2012). Some scholars have contended that the diagnosis of osteoarthritis as an ultimate goal may not be possible in dry bone, as only eburnation is the unequivocal indicator of the process (Rogers, 2000; Waldron, 2009), and should be the only indicator used in the diagnosis (Waldron, 2012). Consequently, the methodology in this thesis adopted an approach from bioarchaeologists who have examined individual osseous joint modification markers separately in relation to activity (Sofaer, 2000).

As a result of the challenges involved in diagnosing osteoarthritis in skeletal remains, the current research relied on the identification and presence of osteophytes and eburnation on or around articular surfaces at major appendicular diarthrodial joints. Porosity was excluded, due to its ambiguous macroscopic manifestation (see section 4.2.2.3). The position in this thesis of using the presence of osteophytes as an activity indicator is supported by an emerging body of clinical evidence suggesting they may function as an adaptive response contributing to joint stabilization in reaction to changing mechanical environments (Colnot et al., 2012; He & Xinghua, 2006; Hsia et al., 2017; Schett et al., 2009; Venne et al., 2020). Contrary to the long-held view that osteophytes are part of an osteoblastic disease process (Roberts & Manchester, 2005), this study posited that they are adaptive tissues produced in response to varying degrees of mechanical stress, in accordance with the body's capacity for adaptation. Eburnation, on the other hand, was regarded as an integral component of cartilage thinning, and the sole indication of the osteoarthritic process. The distribution of osteophytes and eburnation was interpreted through the physical stress theory model framework, which characterises all bodily tissues as adaptive entities that can respond and adapt to mechanical stimuli (Dubois, 2001; Dye, 1996, 2005; Hreljac, 2004; Mueller & Maluf, 2002). The use of the physical stress theory implies that osteophytes and eburnation are not seen as a result of everyday wear-and-tear or use, but as a tissue response to loads or mechanical stresses, in a dose-response relationship, always depending on prior adaptive levels.

The hypothesis in this thesis with regards to activity patterns, given the medieval context of Alba Iula, was that men generally subjected their bodies to more significant physical stress and mechanical loads. Medieval gendered expectations would have positioned men to assume greater physical risks and put greater loads on their bodies compared to females (Karras, 2003; Knüsel, 2012; Sundman & Kjellström, 2020). Consequently, it was anticipated that men would often push past their pain thresholds and physical limitations, disregarding their body’s natural signalling mechanisms that may indicate potential tissue damage. Using the physical stress theory model it was predicted that such deployment of masculinities, in some groups of men, would lead to higher joint modification prevalences in the male sex category, especially those in the young adult category.

7.2.1. Overall activity patterns

The examination of the osteophyte and eburnation data provided some patterns possibly attributable to differences in mechanical loading on joints used in the body to perform work and everyday activities. Overall, a higher prevalence of osteophytes was observed in males (16.3%) compared to females (9.7%), indicated by a statistically significant difference. Sample level differences between left and right sides for the distribution of osteophyte was not significant, indicating an equal amount of stress on both sides of the skeleton. Statistical differences were observed when comparing sided prevalences between males and females. Osteophytes on the left side of the body were higher in males (15.3%) than in females (9.5%), as well as on the right side (males = 17.3%; females = 10.0%). This indicates that males possibly placed higher mechanical loads on their appendicular joints in general (both sides of the body), compared to females. Binary logistic regression analysis that considered the interacting effects of age and sex for the distribution of osteophytes did not reveal any significant differences in the sex categories. However, it revealed differences for the predictor category of age as a risk factor for the presence of osteophytes. At 10 of the 18 articular surfaces observed, most of which were in the upper body (8 out of the 10) age was a significant predictor. The analysis of the eburnation data did not reveal any statistical differences between the sex categories.

One interesting observation in the joint modification data was that different articular surfaces at the same joint had drastically different prevalence rates. For example, at the acetabulum osteophyte presence prevalence of 29.3% was observed while at the proximal femur (femoral head) the prevalence was 3.4%. This pattern held true for both males and females, when the intra sex categories prevalences were compared. The figures indicate a large difference in the prevalence of the same indicator at the same joint on different subchondral surfaces. Therefore, it could be argued that the same mechanical stimuli responsible for the formation of osteophytes have a different effect, or elicits a different response, on the two articular surfaces. Alternatively, the same activity places different loads on the tissues that are connected to articular surfaces on the two bones. Whatever the case, the important thing this indicates is that data from multiple joint surfaces of the same anatomical joint should not be combined because the indicators may not represent the same information on the various articular surfaces. Each joint surface should be examined separately. Further research is needed to determine the implications of joint changes at each articular surface in relation to activity patterns.

Upper and lower body differences in the prevalences of both osteophytes and eburnation were observed in the sample, with Figure 6.39 and Figure 6.50 indicating a general trend of higher prevalences in the upper body for males compared to females. Statistical analysis confirmed this pattern and indicated a significant relationship between upper and lower body overall osteophyte prevalence within male as well as female categories. The relationship was also significant when upper body and lower body differences were compared between the sex categories. This indicated that higher (over)loads were experienced in the upper limbs of males and females compared to the lower limbs. Loads were also more pronounced in the upper body of males compared to females, and also in the lower body. Although the same pattern was observed in the osteoarthritis data, the statistical tests were not significant and did not allow population level inferences. In summary, a more detailed examination of osteophyte prevalences by sex implied differences in upper body lower body use in both males and females, and intra-sex differences in upper and lower body use, inferring both sex-specific activities and differences in the degree of loading or overload based on this sample population.

7.2.2. Problems with interpretation

The interpretation of osteophyte and eburnation patterning to draw conclusions about past activity from bioarchaeological datasets can be challenging due to the multifactorial (and latent) underlying aetiologies of each indicator (Jurmain, 1999; Jurmain et al., 2012; Lajeunese & Reboul, 2007; Roach & Tilley, 2007; Weiss & Jurmain, 2007). Moreover, their development in relation to the biological ageing process is also inadequately understood. With regards to osteophyte development, some confounding factors include non-mechanical factors of biological ageing that may exponentially accelerate their development. Specific to joints, one of these changes may include the waning of the protective mechanisms muscles provide in mitigating mechanical stress on joint structures. Furthermore, comparisons to other published case studies are complicated by the use of numerous theoretical and methodological approaches to data collection and analysis among studies. Such differences in research methods make it difficult to draw meaningful connections between activity levels between various past populations. Consequently, bioarchaeologists must exercise caution when drawing conclusions about the activity patterns in past populations based on joint modification changes.

The novel approach taken in this research, to discern activity patterns from osteophyte distributions, relies on a bioarchaeological theoretical approach that is not new. The conceptualisation of osteophyte proliferation as a microtrauma induced reaction, is similar in concept to the approach taken in bioarchaeology to infer activity-related patterns using entheseal changes. Entheseal changes have long been understood as activity markers predicated upon the notion that bone remodelling at muscle insertion and origin sites is a skeletal response related to mechanical stimuli (Jurmain et al., 2012; Villotte & Knüsel, 2013). The appearance of muscle attachments sites dynamically changes the morphology with differential loads placed on specific muscles. The added advantage of this approach over the observation of osteophytes to infer activity, is that bioarchaeologists have the advantage of knowing which muscles attach at specific anatomical sites and therefore know what body movements are implicated. In a similar process to osteophyte development, microtrauma (in addition to other factors), had been argued to elicit entheseal changes through a fibrocartilaginous ossification process (Villotte & Knüsel, 2013). Villotte and Santos (2022) investigated the relationship between age and entheseal changes and observed that in older individuals the changes do not necessarily seem to correlate with activity, unlike in younger individuals. The researchers observed that the frequency of late-stage entheseal changes increased drastically in older adults, and seems to develop quickly from previously healthy entheses. The authors suggested that the 'muscle use' theory does not seem to apply to these entheses, and suggest that changes seen in older adults are likely not attributable to physical activity or microtrauma (Villotte & Santos, 2022). However, minor changes in younger adult skeletons could indicate past microtrauma. The relationship between the processes involved in entheseal changes and osteophyte development requires closer examination to understand if age related changes are analogous; however, this research implies that structures at fibrocartilage-to-bone interfaces may have propensities that allow the induction of morphological changes due to mechanical stimuli.

Age (age category) was the only explanatory factor in the logistic regression models for the risk of osteophyte presence, significant at 10 out of the 18 articular surfaces. Age related changes are consistent with observations of previous studies of joint modification changes in bioarchaeology, forensics, and clinical literature (Listi & Manhein, 2012; Molnar et al., 2011; Praneatpolgrang et al., 2019; Weiss & Jurmain, 2007; Wong et al., 2016), that universally associate the increase in osteophyte prevalence with age. However, the specific relationship between biological ageing and the proliferation of osteophytes at various joints is not well understood. Their development may be influenced by a host of changing biomolecular factors in older adults (Lajeunese & Reboul, 2007) that may affect joint stability, with biomechanical factors also playing a role. As discussed in section 4.2.2, the initial phases of osteophyte formation may be closely related to mechanical stimuli and microtraumatic processes because of their similarities in development to the initial stages of bone fracture healing processes. Joint stability is the result of the close interaction of tissues surrounding the joint, including ligaments, tendons, sensory receptors and musculature (Riemann & Lephart, 2002; Sell & Lephart, 2010), in which the dynamic viscoelastic (fluid and elastic) properties of muscles play a significant role (Solomonow & Krogsgaard, 2001). Consequently, tissues involved in the movement and stabilisation of joints enable them to move through a range of motion in proper alignment and without displacement (Sell & Lephart, 2010). Proper biomechanics rely on the strength and capacity of the muscles involved in joint movement. When muscles are diminished in effectiveness resulting in less stable movements, the mechanical loads are redistributed to other joint structures such as ligaments, tendons, cartilage, and bones. These abnormal loads may become mechanical stimuli that initiate mechanisms that signal joint instability, and consequently initiate a physiological response that results in the formation of osteophytes in an attempt to maintain joint stability.

Extensive research has documented the phenomenon of the decline of muscle function and strength with advancing age (Wiedmer et al., 2021). This decline, a process known as sarcopenia, typically starts in the third and fourth decades of life and progressively declines with age (Janssen et al., 2000). Muscle function and strength decrease in older individuals poses increased vulnerability to body structures, due to reduced mobility and agility (Grosicki et al., 2022). Volpi and colleagues (2004) noted that muscle mass begins to decline as early as the third decade of life and can accelerate after the age of 60. The scientific consensus around muscle mass decrease is that after middle adulthood it diminishes by 0.5 to 1 percent per year, with muscle strength declining by 1 to 3 percent, and muscle power by 3 to 4 percent for each year of age (Grosicki et al., 2022; Wilkinson et al., 2018). In addition to providing movement to the body, muscles also function as energy and shock absorbers protecting joints and bones from impact and physical stress damage (Grosicki et al., 2022; Wilkinson et al., 2018). With a decline in muscle performance, such protective properties of muscles would be reduced, rendering bones and joints more susceptible to damages from mechanical loads. Therefore, it can be surmised that even if activity levels remain at a constant level throughout life, the vulnerability of the joints to mechanical loads and stimuli increases because tissue tolerance decreases. If osteophytes are indeed a mechanically induced response as joint stabilising processes their development will progress with advancing age even if the loads remain stable throughout an individual's life.

Initially, based on the results, the development of osteophytes may appear to be directly linked to the biological ageing processes. However, by interpreting their distribution in the framework of the physical stress theory model, culturally mediated factors in their development may become evident. For example, cultural discourses around ageing bodies may position individuals to sustain physical exertion as bodies age, which can contribute to, or exacerbate the development of osteophytes. In relation to men's bodies, discourses centred around strength and physical ability embedded in dominant or idealised discourses of masculinities, can compel men to push their bodies beyond their physical limits, or beyond the thresholds that allow their bodies to positively adapt. The individual or collective deployment of such discourses, impacts the level of physical stress to which men's bodies are exposed to throughout the lifecourse. As joint tissues are consistently loaded with mechanical stimuli that land in the zone of misadaptation, (mal)adaptive responses, such as osteophyte formation, may develop. The observation in the Alba Iulia sample that osteophyte prevalences increased for most joint surfaces from one age group to the next (for both males and females), may be indicative of an attitude of exertion of continued physical load, combined with biologically ageing bodies. This process possibly could have resulted in the observation that in the Alba Iulia sample, significantly higher prevalences of osteophytes at 9 out of the 18 appendicular anatomical sites that were found to have significant differences in the age category predictor. Utilising the physiological stress theory model highlights the importance of examining the complexities between cultural and biological factors influencing joint modification features used to examine activity patterns in archaeological populations. Seemingly age-related processes may not always be explained by a relationship to the biological ageing process, but may also have cultural implications.

Statistical analysis of overall prevalences indicated a difference between upper and lower body osteophyte distributions, within and between male and female sex categories. This suggests that overall there may have been load differences experienced in the upper limbs compared to the lower limbs. These results possibly suggest the existence of gendered activity differences that differentially loaded the upper body and the lower body. However, closer examination of the patterning of osteophytes at anatomical sites, was not able to bring more resolution to these differences, as no statistically significant results were observed. However, the lack of difference in the skeletal markers between men and women in the Alba Iulia sample could mean that they equally engaged in strenuous activities, when it comes to individual joint use, however, it does not necessarily mean that they engaged in the same activities, only that the relative mechanical stress on their joint tissues was similar. Since general activity analysis through osteological markers is not sensitive to specific activities, it may be that men and women performed different activities, but had similar attitudes about performing work with their bodies, and periodically subjected them to loads they were not adapted for. Because tissues respond according to their prior adaptive states, it could be that women also participated in periodic or seasonal activities to which their articular tissues were not adapted. The loads would not have had to be as high in magnitude as those in men, but only high enough to cross the adaptive thresholds. For this reason, the stress theory model is not able to compare absolute loads, only relative loads, which is likely the reason the statistical tests did not detect differences in the sex predictor. In essence, the stress theory does not test for activity patterns, but for overload or exertional patterns. Additionally, bioarchaeological analysis works best when combined with archaeological data. Such information would have provided possible access to socioeconomic status, religious affiliation, class distinction, and chronological groupings based on stratigraphy. However, the archaeological data was inaccessible, and the analysis relied on categories and subgroups that emerged from the skeletal analysis.

7.3. Men, masculinity, risk taking, health and attitudes towards the body in medieval Alba Iulia

While it is important to acknowledge the limitations, some observations from this case study can be made concerning men's behaviour and their implications in the deployment of masculinities and consequent health outcomes in medieval Alba Iulia. Contemporary studies of medieval masculinities describe a multitude of ways to configure manhood in various cultural and social levels (Karras, 2003; Lees, 1994). Karras (2003), for example, has identified a pervasive theme in Western European medieval societies of male competition and aggression across at all levels of society deployed through competitiveness in craftsmanship for the working class and combat training for the aristocratic class. Through this research, two factors of such expression of masculinities were identified in 12th and 13th century Alba Iulia both relating to military presence. First, Alba Iulia, as a frontier town and was a significant military fortification and centre (Marcu Istrate, 2008); second, among the inhabitants of the fortification would have been a class of men who by birthright were required to fulfil military obligations (Engel, 2001; Makkai, 1994). Consequently, a large portion of individuals inhabiting the citadel and the surrounding region were men whose military obligations crucially influenced their gender identity starting from childhood. The pervasive presence of military structures infused at all social levels during this time period provided certain types of idealised masculinities, which, while conferred specific privileges, simultaneously put men at risk and impacted their health outcomes negatively.

The analysis of trauma of in the skeletal sample revealed some intriguing findings from a life course perspective when examining the prevalences in the age categories. While initial observations suggested higher prevalences of injuries in younger males, the statistical analyses did not support the hypothesis of a difference in distribution in the sex and age categories. Overall, the data suggest that the majority of injuries were a result of accidents rather than intentional assaults as a result of interpersonal violence. However, both injury recidivists and individuals with weapon trauma were exclusively male, suggesting that some groups of males were at higher risk of physical injury than females or other groups of males. This is in contrast to some interpretive frameworks that propose that social privilege acts as a buffer against physical injury risk (Dittmar et al., 2021). In the Alba Iulia sample, the data indicated some connection between the risk of injury and being male. Consequently, the privileges of being male in this medieval patriarchal society did not necessarily provide protection from harm. However, where the association between men and specific injuries became apparent is the through the examination of injuries through the analysis of trauma caused by weapons; in other words, injuries related to violence.

The most common forms of violence in medieval Transylvania, as indicated by the current analysis, seems to have been interpersonal violence as a result of hand-to-hand combat with weapons. Whether they occurred on an interpersonal or collective level is difficult to establish from the current bioarchaeological data. However, what is clear is that, due to the overarching power structures of institutionalised violence, in forms of the ubiquitous presence of social institutions related to warfare, violence in medieval Transylvanian life was a pervasive and ever-present force. These institutions included social classes whose entire existence was predicated on being trained for combat and ready to engage in warfare and violence.

Male violence embodies both the discursive and the material, as it is entrenched within discursive social structures that mediate its expression (Martin, 2021) while simultaneously being predicated upon corporeal bodies (Torres-Rouff & King, 2014). The archaeological body serves as a direct source of evidence for acts of violence (Walker, 2001), as aggressive and violent actions leave lasting marks on physical tissues (Torres-Rouff & King, 2014). Bioarchaeological evidence of violence can be interpreted in a multi-layered framework of expanding levels of influence from the individual to the collective (Redfern, 2017b; WHO, 2002). This allows the examination of both micro- (personal) and macro-level (societal) implications. The observation in the skeletal data that weapon related injuries were exclusively observed in males, suggested that violent altercations with weapons were predominantly a social transaction reserved for men. This very activity was most likely used as a power-play that positioned some men as different from others, and also positioned all men as different from women (Courtenay, 2011; Whitehead, 2002). On an individual level, acts of violence can be seen as a resource for men to utilise in deployment of masculine behaviours to negotiate their masculinities. However, it is important to recognise the plurality of the expression of masculinities, and that the subsample of men osteological data presenting with weapon trauma, does not represent nor speak for all men in the larger population.

Bioarchaeological interest in examining the social influences of violence has grown over the past decade (Martin & Harrod, 2015; Martin et al., 2012; Redfern, 2017b; Tegtmeyer & Martin, 2017). Scholars have made strides in recognising that male violence is inextricably linked to broader social and cultural contexts rather than an outcome of biological predispositions (Martin & Harrod, 2015). Martin (2021), has examined the relationship between cultural contexts through archaeological and ethnographic case studies of ritualised production of violence, and argues that violence serves as a ritualised means to produce certain discourses about masculinities. Thus, she positions male violence as both destructive and productive, both creating and deploying social structures that inform men’s behaviours. Although ritualised forms of violence, like the ethnographic examples described by Martin (2021), are not apparent in the archaeological and historical context available for Alba Iulia in the 12th and 13th centuries, it is evident that violence had a pervasive influence due to the ongoing military presence at this fortified city. Therefore, in the framework of violence, both deploying and producing discourses about men's behaviour, it is possible to argue that the presence of military activities, along with the social classes associated with it, created institutionalised and cultural discourses surrounding masculinities which were consequently deployed through corporeal actions and subsequently became embodied in the archaeological bodies analyses in this research.

In the Alba Iulia sample, it was not possible to assign individuals to social classes. However, historical records do indicate that there were different classes present at this historical military fortification. Without more archaeological contextual data to indicate socioeconomic status, it is impossible to draw class distinctions based on skeletal (biological) observations alone. As noted in the above discussion, individuals with sharp trauma and multiple recurring trauma (recidivism) may be indicative of the social class of two different groups based on prior bioarchaeological and epidemiological observations. One group could be an upper warrior class with hereditary military obligations, and the other a lower, disadvantaged, class with increased risk of injury, predisposed by their socioeconomic positioning. In the skeletal data, there was overlap between the subgroup of individuals with implement trauma and the subgroup with injury recidivism. One young adult individual (M625) had both antemortem blunt trauma and perimortem sharp trauma. The information available currently does not conclude that the group with weapon trauma represent warriors, and injury recidivists represent a disenfranchised group. Not all individuals with weapon injuries necessarily belonged to the warrior class, because as noted by historians, commoners were often called upon to take up arms for military obligations (Engel, 2001). Furthermore, not all individuals with multiple recurring injuries in modern populations are young males and part of vulnerable populations. Therefore, even though the biological data is indicative of certain classifications or grouping of people, it cannot solely be used to assign individuals to social groups. However, their presence does suggest that men from various social strata engaged in activities and behaviours that put them at risk of severe bodily harm and even death.

Male violence seems to be a paradoxical feature of engagement with idealistic masculine discourses. Discourses surrounding masculinity that encourage men to participate in competition and violence are of a double-edged nature. On the one hand, discourses about interpersonal and institutionalised violence positioned these acts as noble, righteous, and patriotic (Brooks & Silberstein, 1995), with the fearless warrior being the ultimate man (Karras, 2003). On the other hand, because of the immense destructive nature of violence, it represented one of the greatest impediments to physical and mental health (Brooks & Silberstein, 1995). Risk taking as a central feature in constructions of some forms of idealised masculinities, leads to disregard for personal safety and needs, and is often seen as noble and altruistic. Conforming to ‘hero’ narratives gave men access to the political and social advantages afforded by these discourses (Courtenay, 2011; Whitehead, 2002). Yet as the embodiment of violence on the skeletal remains of men in the Alba Iulia sample suggests, men often suffered the physical and mental consequences of engaging in armed combat.

The analysis of the Alba Iulia skeletal sample implicated exclusively men as individuals who engaged in violence, with weapon related injuries observable only on male remains. However, it is crucial to recognise that not all men in this medieval population were violent, engaged in combat, or perpetrated acts of physical assault. This is because injuries due to violence are not always recorded on skeletal tissues, and therefore the sample is not fully representative of all individuals upon whom violence was inflicted. Furthermore, weapon related injuries represent victims of assault and not the perpetrators. However, the fact the sharp trauma was observed exclusively in males suggests that male bodies were politically positioned as different from female bodies. Such positioning, that simultaneously constructed and perpetuated social inequalities, for example, though access to weapons (and power), emphasised roles for males and females within the social framework. Despite skeletal data indicating a deeply interwoven relationship between violence and maleness, it must be recognised that in all societies exist plural and complex expressions of masculinities, that are shaped by biological and cultural factors that go beyond the expression of aggression. Bioarchaeological exploration of masculinities cannot be understood through frameworks for violence alone, but it may serve as one useful means through which to understand male competition and systems of power that produce systems of inequality.

7.4. Limitations of the study

During the current study, several limitations became apparent, including the recognition of the sensitivity of the osseous indicators used, well as knowledge gaps in the theoretical background to the osseous indicators to assess risk and general activity patterns. In addition the potential for sample biasing of bioarchaeological datasets including cultural, excavation, and mortality biases were recognised.

The observation of the lack of statistical difference between many of the sample distributions compared, indicates that, even though men and women in Alba Iulia may have engaged in different behavioural patterns, the data was unable to distinguish between gendered activities. Considering the strong gender roles in the medieval Hungarian

Kingdom, the lack of detectable differences in the analysis of trauma and joint modifications may also suggest that the proxies used in this analysis to examine risk and activity were not sensitive enough. The sensitivity of osseous traumatic lesions may not be enough to ascertain risk in target populations from sample populations. Furthermore, the sensitivity of the osseous changes for which data was recorded at the joints may not be enough to detect activity levels. Therefore, even though in the clinical literature bodily injuries are correlated with risk taking activities (Turner et al., 2004), with skeletal remains it is not possible to examine the full range of injuries over the lifecourse of an individual only the ones that left their mark on the skeleton. Modern clinical data gathered from injury rates that rely on accessing modern health care, may not be transferable to archaeological populations (Waldron, 1994). This raises important questions on the applicability of clinical observations to bioarchaeological samples.

The observation that the clinical data on injuries may not be transferable to archaeological samples to indicate risk, raises the important considerations of bias in mortuary samples. Patterns of lesions observed in the mortuary samples may not be fully representative of the patterns of illness in the once living medieval population. Several factors complicate the interpretation of osteological indicators of morbidity and mortality from skeletal samples. Potential biasing factors of skeletal data include environmental, cultural, and biological mortality biases (Saunders & Hoppa, 1993). *Environmental mortality bias* acknowledges that archaeological samples can be altered by taphonomic processes and can result in poor preservation (Guy et al., 1997) (Walker, 1995), post-depositional alteration, (Jackes, 2000; Walker et al., 1988), obscure pathological conditions (Roberts & Manchester, 2005), or lead to pseudopathology (Lovell, 2008). These preservation issues may bias a skeletal sample by under-representing certain age groups or the frequency of pathological conditions. *Cultural mortality bias* can arise from the differential burial practices for individuals or groups. For example, cemeteries, or sections of cemeteries, may be reserved for certain age, class, religious groups, or even gender identities (Saunders & Hoppa, 1993). Since entire cemeteries are rarely excavated, this non-random sampling may introduce bias. *Biological mortality bias* is another important issue to consider in palaeopathological analysis. A seemingly paradoxical approach in palaeopathology is the attempt to study the health of once living populations by studying their dead (Wood et al., 1992). Cemetery populations are composed of non-survivors who died for a reason, making skeletal samples by nature biased samples of living populations. Furthermore, skeletal samples only represent those who died at a given age and not all individuals who were at risk at that age. Therefore, the sample of individuals within a given age group is highly selective for lesions that increase the chances of dying at that age. Additionally, because a sample does not represent the entire population at risk, the population prevalences estimated from skeletal lesions are, therefore, selectively biased (Wood et al., 1992). Consequently, the observed frequency of lesions in skeletal samples may overestimate the true prevalence of the condition in the living population.

This study piloted the idea that osteophytes may be used as activity-related joint modification indicators in bioarchaeological analyses. This approach was met with limited success, and the future usefulness of the approach relies on establishing further clinical evidence base for the link between activity related mechanical stimuli and osteophyte development. However, as the clinical knowledge base grows, it is becoming increasingly more evident that mechanical stimuli play a role in the initiation and proliferation of synovial joint osteophyte formation. However, caution must be taken when analysing osteophytes on a presence/absence basis, as their development and proliferation may be more complex. Osteophyte development is undoubtedly multifactorial with additional factors at play in addition to mechanical stimuli, including localised (micro)trauma, and systemic disease processes affecting synovial joints (Ortner, 2003; Waldron, 2009, 2012). Furthermore, anatomical differences between male and female skeletal morphology (Sizer & James, 2008) could influence the development of joint modification indicators. Therefore, future research should investigate which aspects of osteophyte formation involve mechanical stimuli and which are part of other processes, and whether these can be successfully studied from the archaeological record.

In conclusion, this study was initially conceptualised by becoming increasingly aware of the way in which men have been historically characterised in bioarchaeology (Chapter 1). With recent developments in bioarchaeology that view gender as an agential process embodied in skeletal remains (Chapter 4), a research framework was developed to explicitly interrogate men's gender from mortuary assemblages (Chapter 3). This research aimed to study men's gender from the archaeological record without falling back on essentialist or heteronormative explanations of their behaviour, that explain masculinities as biologically informed constructs. Using social theory that draws on constructivist approaches to men's gender that conceptualises it as dynamic and fluid, an agential and contextually dependent perspective on male deployment of masculinities was taken. By combining theories of the performativity of gender identities (Butler, 1990, 1993, 2004), and the bioarchaeological conceptualisations of the body as a culturally informed sedimented entity (Sofaer, 2006a), it was posited that various discursively informed deployments of masculinities in past societies would be observable through the contextual analysis of human skeletal remains in the medieval town of Alba Iulia.

The implementation of the theoretical framework developed for this project for the interrogation of men’s gendered performances as sedimented in the archaeological body proved more challenging than anticipated. The reasons for the challenges included the paucity of historical resources from the time period for the geographical area of Alba Iulia, as well as the absence of archaeological information from the excavations of the cemetery. The archaeological information would possibly have enabled access to social categories for analysis, such as access to socioeconomic status, through the examination of mortuary data such as artifacts or grave orientation, as well as temporal sequencing of the cemetery, enabling the investigation of patterns through time. Despite the emergence of data patterns that were seemingly heteronormative—mainly that males were at a higher risk of bodily injury from confrontations, indicating that they more readily engaged in aggressive and violent behaviour—the framework allowed for nuanced explanations of men's behaviours that did not tie such actions strictly to biological predispositions. Rather, the framework which considered the body as a material-discursive construct, conceptualised the body as the product of both biological and social forces. This enabled the view of the resulting skeletal traces of violence as a response to broader social and cultural pressures to perform and deploy certain kinds of dominant masculine discourses. However, the framework conceptualises the deployment of masculinities not as originating from ideological power structures that compelled men to act in certain ways, but from discursive structures which are created by the very performances of gender they informed. It is through the iterative process of gender performativity that the male body is physically transformed and comes to embody the social and political structural forces that constrain and inform the subjective realities of men.

Chapter 8: Conclusions

The primary aim of this thesis was to explore men's past lived experiences from an explicitly gendered viewpoint, using bioarchaeological data collected from a mortuary skeletal sample. This research sought to contribute to a small but growing body of bioarchaeological literature interested in exploring men as gendered subjects in past societies. The study developed a novel theoretical framework based on the theories of gender performativity (Butler, 1988, 1990, 1993, 2004), and the body as material culture (Sofaer, 2006a), in combination with social constructivist theories of dynamic and contextual masculinities (Connell, 2005; Courtenay, 2011; Whitehead, 2002). Employing a new theoretical lens allowed for an original perspective in the interpretation of skeletal data collected through standard osteological methods. Specific aims of the research were two-fold; first, it was sought to understand how patterns of skeletal trauma implicate gendered differences in risk; and second, how patterns of joint modification changes implicate gendered differences in general activity levels. An understanding of both of these skeletal outcomes was sought through an approach that interprets men's deployment of various masculinities—as influenced by social factors—in relation to health outcomes (Courtenay, 2011; Robertson, 2007). Despite limitations in the availability of historical and archaeological contextual data, this research provides valuable insights into the complex interplay between gender and historical social structures.

This research adds to the small but exciting body of bioarchaeological research revealing the potential of osteological syntheses to contribute to discussions about men and masculinity in past populations. These studies posit that historical gender identities can be conceptualised as fluid and dynamic social constructs, rather than inherent, unchanging, and biologically determined. The current thesis contributed to this body of literature by demonstrating that exploratory frameworks are already in place through feminist inspired archaeology and sociology (Alberti, 2006) that views the body as being at the intersection of material and discursive realities, creating material-discursive bodies. More specifically, conceptualising gender using Butler's theory of gender performativity, allowed for the investigation of gender identity not as a result of specifically sexed bodies, but as a series of corporeal movements compelled by gendered discourses. Furthermore, using Sofaer's (Sofaer, 2006a) approach to the body as material culture, such gendered actions, movements, and comportments were considered to incorporate into skeletal bodies through the body's plasticity. The combination of these approaches was viewed through a social constructionist lens of multiple masculinities as they manifest through men's health outcomes.

In the specific case study of the 12th to 13th century skeletal collection from Alba Iulia, some observations surrounding medieval masculinities were possible. The research findings suggested that the deployment of masculinities was informed by various individual and social factors. Masculinities were deployed through the corporeal actions embodied in certain masculine behaviours, including those that subject male bodies to physical injury from occupational hazards or violence related risks. With Alba Iulia being a military fortification and having a social class of individuals who by birthright were obligated to perform military duties, the deployment of these idealised forms of masculinities was compelled by the presence of a medieval cultural milieu and social organisation in which military and combat themes were ubiquitous, endorsing and legitimising risk taking and aggression in certain subgroups of men. The iterative relationship between male risk and the social institutions that sanctioned it, served to further perpetuate such behaviours with negative impacts on men's health outcomes, by normalising male violence. This reinforced and sustained an already existing hierarchical gender organisation.

The approach to investigating masculinity used in the research resulted in the lack of observation of statistical differences between men and women that would have allowed the inferences interrogation of differential deployment of gender identities. There are two possible explanations for this. One is that the skeletal features used as proxies for risk and activity differences were not sensitive enough measures of gendered differences, or that differences between sample distributions did not actually exist. While the population level statistical analysis revealed patterns in blunt trauma prevalence distributions between the sexes were not significant, a closer examination of the fracture types by zooming in on individual skeletons revealed the value of closely examining individuals. This supports the value of combining both population and individual level analyses in bioarchaeological studies of past populations. Analysis at the individual level, and the close examination of fracture patterns, timing, and possible causes, revealed that most of the blunt trauma observed in men and women was due to accidental everyday injuries such as falls. While the ultimate cause of accidental injuries is not known, the pattern of blunt trauma did not suggest that assaults were involved. Violence, however, was suggested by examining the blunt and implement trauma patterns. All trauma which was identified as having been inflicted by weapons, suggestive of a violent encounter, whether prior to death or around the time of death, was solely confined to male skeletons. Even though the subsample of individuals with evidence of violence was small, it suggests that violent encounters with weapons were mostly in the domain of men. Unfortunately, with osteophyte and eburnation datasets it was not possible to zoom in on individuals to access possible causes in a similar manner to the trauma analysis. Therefore, for the joint modification investigation further analysis was unavailable that would provide a higher resolution understanding of the osteophyte and eburnation formation patterns observed at a population level.

The pilot study in this thesis that used the distribution of osteophytes as an indicator for activity, was initially encouraged by clinical publications on the relationship between the development of osteophytes and mechanical stimuli. Recently published research in the clinical literature has provided some links between osteophytes as a consequence of a physiological response to changing mechanical environments of joint structures. Applying this research to archaeological skeletal samples should be of interest to bioarchaeologists seeking to understand the relationship between activity and osseous modifications to joint structures. However, further research is needed before a full understand the relationship between osteophytes to activity can be confidently discerned in past population. A more comprehensive understanding is required of other confounding factors such as the biological ageing process and pathological processes involved in diarthrodial joint tissues, such as that of osteoarthritis. It is hoped that the continued efforts of clinical researches will identify specific mechanical stimuli that induce specific patterns of osteophyte development at various joints. Longitudinal studies would also offer high quality confirmation of the relationship between joint changes and general or specific activity levels. While recent clinical studies are promising much remains to be learned about how activity produces responses in the tissues at appendicular synovial joints, and their implications for reconstructing activity and load patterns from their presence on dry bone in archaeological samples.

Having critiqued, at the beginning of this thesis, the biological anthropology and bioarchaeological literature on men, and arguing that it treated men in a theoretically unsophisticated manner using heteronormativised and essentialised tropes, it was initially sought to avoid discussions of men in the context of violence. However, upon data analysis it become increasingly evident that violence was part of many men's everyday lives in the medieval period. Violence was deployed on multiple levels and served various purposes, among them being one avenue through which men deployed, expressed and negotiated their masculine identities. At the same time, it was observed that medieval social organisation, with a heavy and pervasive presence of military themes, influenced everyday life and promoted violent and aggressive behaviours in men (Karras, 2003). In Alba Iulia, engaging in armed combat seemed to have been exclusively reserved for men, and served to distinguish men from women, thereby accentuating the masculine nature of such activities (Whitehead, 2002). Social institutions related to warfare present in medieval Alba Iulia regulated access to military discourses, and in turn regulated access to the means of expression particular masculinities. This emphasises the complex relationship between gender, violence, and social dynamics. Such an understanding of men's gender, which is influenced by, and deployed through, cultural power structures, understands masculinities not as a result of biological propensities, but as contextual and dynamic constructs. Therefore, using sophisticated theoretical frameworks allows bioarchaeologists to conceptualise men's gendered performances in the past, which include the deployment of violent masculine discourses, not as essentialised biological predispositions, but as outcomes of historically and culturally situated gender identity dynamics.

The approach taken in this thesis raises many possibilities for future bioarchaeological research on men and masculinities in the past. This thesis has provided insights on men, masculinities, and gendered life experiences in that past, and at the same time it has also raised historical and methodological questions that remain unexplored. It is important for bioarchaeologists to continue to explore the intersections of gender and health in relation to men’s bodies with theoretical backdrops that position them as active agents in their own gendered performances. Further development of theoretical models and the explorations of indicators that may be relevant to the analysis of risk and activity patterns are needed. It would be worthwhile to undertake research to compare the Alba Iulia mortuary skeletal sample to other contemporaneous collections from Transylvania. It would also be valuable to compare the patterns of trauma and joint modifications to samples from other time periods to observe temporal trends in the performance of gender identities and attitudes towards gendered bodies in various social and political spheres. Furthermore, analysis of other health outcomes, such as palaeopathological indicators for nutritional status, infections, and developmental disorders, may also provide important intersectional information on gendered access to economic, social, and political resources. Most importantly, however, future approaches are needed that have abundant archaeological and historical contextual information to augment the interpretations of the patterns observed in the osteological data.

Through the amalgamation of social theoretical frameworks of the performances of gender identity, social determinants of health, and embodiment of gender in human archaeological bodies, this thesis demonstrated the potential for such theoretically informed approaches to further our understanding of men's gender deployment in the past. The usefulness of this approach can be seen in the interpretation of gendered patterns of the observed skeletal indicators not as a result of inherent biological differences between men and women, but as consequences of social discourses and power dynamics that inform and constrain gender performances. Furthermore, conceptualising the discursive nature of gender performances as an iterative process that simultaneously creates the discursive processes it deploys, allows for the examination of individual and social processes in the creation of social inequality. Such an interpretive framework applies not only to this specific medieval skeletal sample from Alba Iulia, but may be used to examine gendered lifeways from other assemblages from other historical periods and geographic locations. Through uniting strands of scholarship from gender theory, sociology, clinical science, and archaeological theories, this thesis has offered insights into the dynamic lifeways of men in 12th to 13th

century Alba Iulia, and their deployment, contestation, and negotiation of their dynamic, fluid, and contextual gender identities.

Appendices

Appendix 1: Representation and preservation of sample

Number of elements with any representation (n_{ra}) and complete (n_{rc}) representation and the percentage of individuals represented by each count.

	All				Females				Males				Unknown (Adult)				Nonadult			
	n_{ra}	%	n_{rc}	%	n_{ra}	%	n_{rc}	%	n_{ra}	%	n_{rc}	%	n_{ra}	%	n_{rc}	%	n_{ra}	%	n_{rc}	%
Calvarium	215	50	159	37	73	54	60	45	77	63	59	48	13	18	9	13	52	53	31	32
Face	200	47	94	22	70	52	40	30	69	56	40	33	9	13	5	7	52	53	9	9
Mandible	206	48	164	38	76	57	61	46	69	56	62	50	4	6	4	6	57	58	37	38
Clavicle - left - medial	191	45	170	40	76	57	68	51	64	52	56	46	9	13	7	10	42	43	39	40
Clavicle - left - lateral	195	46	163	38	76	57	67	50	68	55	59	48	9	13	7	10	42	43	30	31
Clavicle Left	201	47	144	34	77	57	60	45	69	56	51	41	10	14	6	8	45	46	27	28
Clavicle - right - medial	186	44	171	40	68	51	64	48	69	56	63	51	8	11	8	11	41	42	36	37
Clavicle - right - lateral	186	44	157	37	74	55	64	48	65	53	57	46	8	11	7	10	39	40	29	30
Clavicle Right	200	47	141	33	76	57	56	42	71	58	52	42	8	11	7	10	45	46	26	27
Scapula - left	209	49	56	13	81	60	16	12	70	57	24	20	13	18	4	6	44	45	12	12
Scapula - left - glenoid	159	37	116	27	74	55	50	37	57	46	44	36	11	15	8	11	17	17	14	14
Scapula - left - acromion	143	33	102	24	63	47	40	30	54	44	42	34	10	14	9	13	16	16	11	11
Scapula - right	216	51	48	11	84	63	16	12	76	62	22	18	9	13	2	3	47	48	8	8
Scapula - right - glenoid	168	39	128	30	75	56	58	43	67	54	53	43	8	11	4	6	18	18	13	13
Scapula - right - acromion	141	33	93	22	65	49	45	34	53	43	34	28	7	10	4	6	16	16	10	10
Sternum	191	45	76	18	72	54	32	24	71	58	35	28	7	10	2	3	41	42	7	7
Ribs - left	289	68	85	20	101	75	35	26	103	84	33	27	19	26	1	1	66	67	16	16
Ribs - right	280	66	83	19	99	74	33	25	98	80	33	27	18	25	2	3	65	66	15	15
Ribs both sides	293	69	70	16	102	76	28	21	104	85	28	23	20	28	1	1	67	68	13	13
Vertebrae - cervical	225	53	110	26	80	60	37	28	76	62	50	41	15	21	4	6	54	55	19	19
Vertebrae - thoracic	275	64	133	31	97	72	51	38	96	78	54	44	21	29	10	14	61	62	18	18
Vertebrae - lumbar	232	54	133	31	86	64	53	40	80	65	56	46	11	15	5	7	54	55	19	19
Humerus - left - proximal	166	39	123	29	66	49	58	43	56	46	46	37	9	13	9	13	35	36	10	10
Humerus - left - diaphysis	202	47	163	38	79	59	68	51	65	53	54	44	10	14	7	10	48	49	34	35
Humerus - left - distal	180	42	134	31	70	52	64	48	62	50	54	44	8	11	8	11	40	41	8	8
Humerus - left	209	49	99	23	79	59	48	36	68	55	41	33	11	15	6	8	51	52	4	4
Humerus - right - proximal	176	41	129	30	71	53	63	47	58	47	46	37	6	8	5	7	41	42	15	15
Humerus - right - diaphysis	206	48	171	40	77	57	69	51	70	57	58	47	7	10	5	7	52	53	39	40
Humerus - right - distal	194	45	143	33	76	57	69	51	67	54	59	48	7	10	6	8	44	45	9	9
Humerus - right	214	50	104	24	82	61	53	40	72	59	41	33	8	11	4	6	52	53	6	6
Ulna - left - proximal	181	42	134	31	68	51	64	48	65	53	61	50	5	7	3	4	43	44	6	6
Ulna - left - diaphysis	192	45	151	35	73	54	62	46	71	58	51	41	5	7	4	6	43	44	34	35
Ulna - left - distal	149	35	106	25	57	43	49	37	56	46	50	41	4	6	4	6	32	33	3	3
Ulna - left	199	47	85	20	74	55	44	33	73	59	38	31	6	8	1	1	46	47	2	2
Ulna - right - proximal	169	40	126	30	70	52	67	50	59	48	52	42	2	3	1	1	38	39	6	6
Ulna - right - diaphysis	183	43	147	34	74	55	60	45	63	51	51	41	4	6	1	1	41	42	35	36

Ulna - right - distal	134	31	100	23	52	39	47	35	52	42	48	39	1	1	1	1	29	30	4	4
Ulna - right	189	44	87	20	77	57	43	32	66	54	40	33	4	6	1	1	41	42	3	3
Radis - left - proximal	155	36	120	28	57	43	55	41	59	48	55	45	5	7	5	7	34	35	5	5
Radis - left - diaphysis	182	43	150	35	70	52	63	47	67	54	54	44	10	14	5	7	35	36	28	29
Radis - left - distal	165	39	118	28	65	49	56	42	62	50	53	43	6	8	5	7	32	33	4	4
Radis - left	190	44	89	21	73	54	45	34	70	57	40	33	10	14	2	3	37	38	2	2
Radis - right - proximal	154	36	122	29	63	47	63	47	56	46	50	41	3	4	3	4	32	33	6	6
Radis - right - diaphysis	185	43	141	33	70	52	59	44	64	52	51	41	7	10	2	3	44	45	29	30
Radis - right - distal	159	37	121	28	64	48	62	46	56	46	49	40	5	7	5	7	34	35	5	5
Radis - right	191	45	96	22	73	54	55	41	67	54	37	30	7	10	2	3	44	45	2	2
Hand bones - left	199	47	15	4	81	60	7	5	79	64	6	5	12	17	1	1	27	28	1	1
Hand bones - right	190	44	14	3	81	60	9	7	72	59	3	2	8	11	1	1	28	29	1	1
Coxa - left	216	51	74	17	87	65	25	19	75	61	32	26	4	6	0	0	50	51	17	17
Coxa - left - acetabulum	153	36	105	25	77	57	51	38	65	53	47	38	3	4	1	1	8	8	6	6
Coxa - right	214	50	77	18	86	64	33	25	74	60	30	24	5	7	0	0	48	49	14	14
Coxa - right - acetabulum	154	36	112	26	79	59	60	45	63	51	46	37	3	4	1	1	8	8	5	5
Sacrum	199	47	87	20	81	60	37	28	71	58	40	33	4	6	2	3	43	44	8	8
Femur - left - proximal	203	48	146	34	79	59	68	51	67	54	57	46	9	13	6	8	48	49	15	15
Femur - left - diaphysis	213	50	176	41	83	62	71	53	65	53	58	47	12	17	8	11	53	54	39	40
Femur - left - distal	193	45	151	35	74	55	66	49	62	50	55	45	11	15	10	14	46	47	20	20
Femur - left	229	54	118	28	84	63	57	43	71	58	47	38	14	19	5	7	60	61	9	9
Femur - right - proximal	193	45	146	34	70	52	64	48	66	54	56	46	9	13	8	11	47	48	17	17
Femur - right - diaphysis	200	47	162	38	76	57	62	46	64	52	56	46	13	18	8	11	46	47	35	36
Femur - right - distal	186	44	135	32	64	48	54	40	57	46	53	43	16	22	12	17	48	49	16	16
Femur - right	220	52	103	24	77	57	49	37	69	56	42	34	16	22	5	7	57	58	7	7
Patella - left	65	15	65	15	26	19	26	19	21	17	21	17	10	14	10	14	8	8	8	8
Patella - right	69	16	66	15	26	19	26	19	27	22	27	22	8	11	7	10	7	7	5	5
Tibia - left - proximal	184	43	128	30	62	46	54	40	47	38	36	29	26	36	22	31	49	50	16	16
Tibia - left - diaphysis	198	46	168	39	67	50	58	43	52	42	45	37	31	43	26	36	48	49	39	40
Tibia - left - distal	169	40	136	32	63	47	60	45	45	37	39	32	28	39	25	35	33	34	12	12
Tibia - left	204	48	103	24	68	51	48	36	53	43	30	24	31	43	19	26	52	53	6	6
Tibia - right - proximal	181	42	133	31	57	43	51	38	50	41	43	35	30	42	22	31	43	44	17	17
Tibia - right - diaphysis	194	45	165	39	64	48	59	44	52	42	46	37	32	44	28	39	45	46	31	32
Tibia - right - distal	168	39	128	30	58	43	54	40	44	36	38	31	30	42	24	33	35	36	11	11
Tibia - right	200	47	105	25	65	49	45	34	52	42	33	27	34	47	18	25	48	49	9	9
Fibula - left - proximal	123	29	73	17	40	30	33	25	31	25	26	21	21	29	13	18	31	32	1	1
Fibula - left - diaphysis	177	41	145	34	61	46	53	40	44	36	38	31	30	42	22	31	42	43	32	33
Fibula - left - distal	145	34	108	25	52	39	49	37	36	29	35	28	26	36	23	32	31	32	1	1
Fibula - left	183	43	59	14	61	46	30	22	46	37	18	15	31	43	11	15	45	46	0	0
Fibula - right - proximal	115	27	81	19	37	28	32	24	31	25	28	23	20	28	20	28	26	27	1	1
Fibula - right - diaphysis	174	41	141	33	56	42	45	34	47	38	44	36	29	40	23	32	41	42	28	29
Fibula - right - distal	149	35	119	28	47	35	46	34	43	35	43	35	27	38	25	35	31	32	4	4
Fibula - right	179	42	66	15	58	43	25	19	47	38	25	20	32	44	15	21	41	42	1	1
Talus - left	112	26	109	26	44	33	43	32	29	24	28	23	20	28	20	28	19	19	18	18
Talus - right	134	31	133	31	47	35	46	34	40	33	40	33	25	35	25	35	21	21	21	21
Calcaneus - left	130	30	119	28	49	37	45	34	33	27	32	26	30	42	27	38	18	18	15	15
Calcaneus - right	141	33	133	31	48	36	46	34	42	34	41	33	30	42	29	40	20	20	17	17
Foot bones - left	128	30	6	1	45	34	2	1	37	30	0	0	26	36	4	6	20	20	0	0
Foot bones - right	139	33	8	2	49	37	2	1	42	34	1	1	26	36	5	7	21	21	0	0

Appendix 2: Sex and age category of each skeleton

	Skeleton no.	Sex Category	Age Category
1	M001	M	Middle Adult
2	M001B	F	Middle Adult
3	M001C	Nonadult	Nonadult
4	M002	Nonadult	Nonadult
5	M002B	F	Middle Adult
6	M002C	M	Middle Adult
7	M003A	Inter	Middle Adult
8	M003B	F	Middle Adult
9	M004	F	Young Adult
10	M005	M	Unknown (Adult)
11	M005B	Unknown (Adult)	Unknown (Adult)
12	M006	M	Middle Adult
13	M007A	F	Young Adult
14	M007B	Nonadult	Nonadult
15	M007C	F	Middle Adult
16	M008	M	Middle Adult
17	M008B	F	Old Adult
18	M112	M	Young Adult
19	M116	Unknown (Adult)	Unknown (Adult)
20	M117	F	Middle Adult
21	M125	M	Middle Adult
22	M131	M	Middle Adult
23	M132	F	Middle Adult
24	M134	Inter	Middle Adult
25	M138	F	Old Adult
26	M142	F	Young Adult
27	M144	M	Middle Adult
28	M149	F	Middle Adult
29	M150	F	Middle Adult
30	M152	F	Middle Adult
31	M153	F	Young Adult
32	M155	Nonadult	Nonadult
33	M156	F	Middle Adult
34	M159	M	Middle Adult
35	M160	Unknown (Adult)	Unknown (Adult)
36	M161	M	Middle Adult
37	M162	F	Middle Adult
38	M164	M	Middle Adult
39	M166	F	Middle Adult
40	M167	Nonadult	Nonadult
41	M169	F	Unknown (Adult)
42	M170	F	Middle Adult
43	M171	F	Middle Adult
44	M175	F	Middle Adult
45	M200	Nonadult	Nonadult
46	M201	Nonadult	Nonadult
47	M202	Inter	Unknown (Adult)
48	M203	F	Young Adult
49	M204	Nonadult	Nonadult
50	M205	M	Middle Adult
51	M206	Unknown (Adult)	Old Adult
52	M207	M	Middle Adult
53	M208	M	Middle Adult
54	M209	Unknown (Adult)	Unknown (Adult)
55	M210	Unknown (Adult)	Unknown (Adult)
56	M211	F	Middle Adult
57	M212	F	Middle Adult
58	M214	F	Middle Adult
59	M215	M	Unknown (Adult)
60	M218	Unknown (Adult)	Middle Adult
61	M221	F	Middle Adult
62	M222	M	Middle Adult
63	M223	Unknown (Adult)	Unknown (Adult)

64	M224	F	Middle Adult
65	M225	M	Young Adult
66	M227	Nonadult	Nonadult
67	M228	M	Unknown (Adult)
68	M230	M	Unknown (Adult)
69	M232	Nonadult	Nonadult
70	M233	Unknown (Adult)	Unknown (Adult)
71	M234	Inter	Middle Adult
72	M235	M	Old Adult
73	M236	Unknown (Adult)	Young Adult
74	M237	Nonadult	Nonadult
75	M238	M	Middle Adult
76	M239	M	Middle Adult
77	M240	F	Middle Adult
78	M241	F	Young Adult
79	M242	Unknown (Adult)	Unknown (Adult)
80	M243	F	Young Adult
81	M244	F	Young Adult
82	M245	F	Young Adult
83	M246	Unknown (Adult)	Unknown (Adult)
84	M247	M	Old Adult
85	M257	Unknown (Adult)	Unknown (Adult)
86	M258	Nonadult	Nonadult
87	M259	M	Middle Adult
88	M260	Unknown (Adult)	Unknown (Adult)
89	M262	F	Middle Adult
90	M263	Nonadult	Nonadult
91	M266	F	Middle Adult
92	M267	F	Young Adult
93	M268	F	Middle Adult
94	M269	Unknown (Adult)	Unknown (Adult)
95	M270	F	Unknown (Adult)
96	M271	F	Young Adult
97	M272	M	Old Adult
98	M273	F	Middle Adult
99	M274	F	Middle Adult
100	M275	F	Middle Adult
101	M276	Nonadult	Nonadult
102	M277	M	Middle Adult
103	M278	M	Middle Adult
104	M279	F	Middle Adult
105	M280	F	Unknown (Adult)
106	M281	Unknown (Adult)	Unknown (Adult)
107	M282	F	Young Adult
108	M283	Nonadult	Nonadult
109	M284	Nonadult	Nonadult
110	M285	F	Unknown (Adult)
111	M287	Inter	Middle Adult
112	M288	Unknown (Adult)	Unknown (Adult)
113	M289	M	Old Adult
114	M290	Unknown (Adult)	Unknown (Adult)
115	M292	Nonadult	Nonadult
116	M293	M	Middle Adult
117	M294	F	Middle Adult
118	M295	F	Middle Adult
119	M296	F	Young Adult
120	M297	F	Middle Adult
121	M298	M	Old Adult
122	M300	Unknown (Adult)	Unknown (Adult)
123	M301A	Intermediate (Pres)	Unknown (Adult)
124	M301B	Nonadult	Nonadult
125	M301C	Unknown (Adult)	Unknown (Adult)
126	M303	M	Middle Adult
127	M304	Nonadult	Nonadult
128	M305	Nonadult	Nonadult
129	M306	Nonadult	Nonadult
130	M307	Unknown (Adult)	Unknown (Adult)

131	M308	M	Unknown (Adult)
132	M309	Unknown (Adult)	Unknown (Adult)
133	M310	Nonadult	Nonadult
134	M311	M	Unknown (Adult)
135	M312	M	Old Adult
136	M313	Unknown (Adult)	Middle Adult
137	M314	F	Middle Adult
138	M315	F	Middle Adult
139	M316	M	Middle Adult
140	M317	Nonadult	Nonadult
141	M320	Nonadult	Nonadult
142	M321	F	Middle Adult
143	M322	F	Middle Adult
144	M323	M	Young Adult
145	M324	M	Middle Adult
146	M325	Unknown (Adult)	Unknown (Adult)
147	M326	Unknown (Adult)	Unknown (Adult)
148	M327	F	Middle Adult
149	M328	F	Middle Adult
150	M329	Unknown (Adult)	Unknown (Adult)
151	M330	Unknown (Adult)	Unknown (Adult)
152	M331	Unknown (Adult)	Unknown (Adult)
153	M332	Nonadult	Nonadult
154	M333	M	Middle Adult
155	M334	F	Middle Adult
156	M335	F	Middle Adult
157	M336	M	Young Adult
158	M337	F	Middle Adult
159	M339	F	Young Adult
160	M340	M	Middle Adult
161	M341	M	Young Adult
162	M342	Nonadult	Nonadult
163	M343	Unknown (Adult)	Unknown (Adult)
164	M344	Nonadult	Nonadult
165	M345	Unknown (Adult)	Middle Adult
166	M346	F	Middle Adult
167	M347	Unknown (Adult)	Old Adult
168	M348	Nonadult	Nonadult
169	M350	F	Middle Adult
170	M351	Nonadult	Nonadult
171	M352	Nonadult	Nonadult
172	M353	M	Young Adult
173	M354	F	Middle Adult
174	M355	M	Middle Adult
175	M356	M	Middle Adult
176	M358	Nonadult	Nonadult
177	M359	Nonadult	Nonadult
178	M360	F	Middle Adult
179	M362	Nonadult	Nonadult
180	M363	F	Unknown (Adult)
181	M364	Nonadult	Nonadult
182	M365	Intermediate (Pres)	Middle Adult
183	M366	M	Young Adult
184	M367	F	Middle Adult
185	M368	M	Middle Adult
186	M369	Nonadult	Nonadult
187	M370	F	Middle Adult
188	M370A	F	Middle Adult
189	M371	M	Middle Adult
190	M372	Nonadult	Nonadult
191	M373	Nonadult	Nonadult
192	M374	M	Old Adult
193	M375	Nonadult	Nonadult
194	M376A	Nonadult	Nonadult
195	M376B	M	Young Adult
196	M377	Nonadult	Nonadult
197	M378	F	Old Adult

198	M380	M	Old Adult
199	M381	F	Middle Adult
200	M382	F	Middle Adult
201	M383	F	Middle Adult
202	M383b	F	Old Adult
203	M384	M	Middle Adult
204	M385	M	Middle Adult
205	M386	Nonadult	Nonadult
206	M387	F	Young Adult
207	M388	M	Unknown (Adult)
208	M389	M	Middle Adult
209	M390	M	Unknown (Adult)
210	M391	F	Middle Adult
211	M392	Unknown (Adult)	Middle Adult
212	M393	F	Young Adult
213	M394	Nonadult	Nonadult
214	M395	F	Young Adult
215	M396	Nonadult	Nonadult
216	M397	Nonadult	Nonadult
217	M398	Unknown (Adult)	Unknown (Adult)
218	M399	F	Unknown (Adult)
219	M400	F	Middle Adult
220	M401	F	Young Adult
221	M402	Unknown (Adult)	Young Adult
222	M403	F	Middle Adult
223	M404	F	Young Adult
224	M405	Inter	Unknown (Adult)
225	M406	Nonadult	Nonadult
226	M407	M	Young Adult
227	M408	F	Middle Adult
228	M409	M	Old Adult
229	M410	Nonadult	Nonadult
230	M413	Nonadult	Nonadult
231	M414	Nonadult	Nonadult
232	M415	Nonadult	Nonadult
233	M416	F	Middle Adult
234	M418A	F	Middle Adult
235	M418B	M	Middle Adult
236	M419	M	Middle Adult
237	M420	Inter	Middle Adult
238	M421	M	Middle Adult
239	M422	Nonadult	Nonadult
240	M423	Unknown (Adult)	Unknown (Adult)
241	M424	Unknown (Adult)	Unknown (Adult)
242	M425	M	Unknown (Adult)
243	M426	Nonadult	Nonadult
244	M427	Nonadult	Nonadult
245	M428	Nonadult	Nonadult
246	M429A	M	Young Adult
247	M429B	M	Young Adult
248	M430	M	Middle Adult
249	M431	F	Unknown (Adult)
250	M432	Unknown (Adult)	Unknown (Adult)
251	M433	Unknown (Adult)	Unknown (Adult)
252	M435	M	Young Adult
253	M436	F	Young Adult
254	M437	Nonadult	Nonadult
255	M438	M	Old Adult
256	M439	Unknown (Adult)	Unknown (Adult)
257	M440	F	Middle Adult
258	M441	Unknown (Adult)	Unknown (Adult)
259	M442	F	Middle Adult
260	M443	M	Young Adult
261	M444	Nonadult	Nonadult
262	M445	Nonadult	Nonadult
263	M446	Unknown (Adult)	Unknown (Adult)
264	M447	F	Middle Adult

265	M448	F	Middle Adult
266	M449	M	Old Adult
267	M450	M	Middle Adult
268	M451	M	Middle Adult
269	M452	Unknown (Adult)	Unknown (Adult)
270	M453	F	Old Adult
271	M454	Nonadult	Nonadult
272	M455	M	Middle Adult
273	M456	F	Old Adult
274	M457	F	Old Adult
275	M458	Unknown (Adult)	Unknown (Adult)
276	M459	M	Middle Adult
277	M460	M	Unknown (Adult)
278	M461	Nonadult	Nonadult
279	M462	M	Middle Adult
280	M463	Nonadult	Nonadult
281	M464	F	Young Adult
282	M465	Nonadult	Nonadult
283	M468	Unknown (Adult)	Unknown (Adult)
284	M469	Nonadult	Nonadult
285	M472	Nonadult	Nonadult
286	M473	F	Young Adult
287	M474	Unknown (Adult)	Young Adult
288	M476	Unknown (Adult)	Unknown (Adult)
289	M477	F	Middle Adult
290	M478	M	Middle Adult
291	M479	F	Middle Adult
292	M480	M	Unknown (Adult)
293	M481	F	Middle Adult
294	M482	M	Middle Adult
295	M483	M	Middle Adult
296	M484	M	Middle Adult
297	M485	Intermediate (Pres)	Unknown (Adult)
298	M486	M	Middle Adult
299	M487	F	Middle Adult
300	M488	Nonadult	Nonadult
301	M489	Intermediate (Pres)	Unknown (Adult)
302	M490	F	Middle Adult
303	M491	M	Old Adult
304	M492	F	Middle Adult
305	M493	M	Unknown (Adult)
306	M495	Nonadult	Nonadult
307	M496	Nonadult	Nonadult
308	M497	F	Unknown (Adult)
309	M500	M	Middle Adult
310	M501	M	Middle Adult
311	M502	Nonadult	Nonadult
312	M503	Unknown (Adult)	Unknown (Adult)
313	M504	Nonadult	Nonadult
314	M505	Unknown (Adult)	Unknown (Adult)
315	M506	F	Middle Adult
316	M507	Inter	Young Adult
317	M508	M	Middle Adult
318	M509	M	Young Adult
319	M511	M	Old Adult
320	M512	Nonadult	Nonadult
321	M513	F	Young Adult
322	M514	F	Middle Adult
323	M515	Nonadult	Nonadult
324	M516	M	Middle Adult
325	M517	Nonadult	Nonadult
326	M518	Nonadult	Nonadult
327	M519	F	Middle Adult
328	M520	F	Young Adult
329	M521	Nonadult	Nonadult
330	M522	Nonadult	Nonadult
331	M524	M	Young Adult

332	M525	Nonadult	Nonadult
333	M526	M	Middle Adult
334	M528	F	Unknown (Adult)
335	M529	F	Middle Adult
336	M531	F	Young Adult
337	M532	M	Middle Adult
338	M533	F	Middle Adult
339	M534	Nonadult	Nonadult
340	M535	F	Young Adult
341	M536	Nonadult	Nonadult
342	M537	M	Middle Adult
343	M538	M	Unknown (Adult)
344	M540	F	Middle Adult
345	M541	M	Middle Adult
346	M542	Unknown (Adult)	Young Adult
347	M543	M	Middle Adult
348	M544	M	Young Adult
349	M545	F	Middle Adult
350	M546	M	Young Adult
351	M547	M	Middle Adult
352	M548	M	Young Adult
353	M549	M	Middle Adult
354	M550	Unknown (Adult)	Unknown (Adult)
355	M551	M	Young Adult
356	M552	F	Unknown (Adult)
357	M553	Nonadult	Nonadult
358	M554	M	Middle Adult
359	M555	M	Old Adult
360	M556	Unknown (Adult)	Unknown (Adult)
361	M557	Nonadult	Nonadult
362	M558	F	Middle Adult
363	M559	Nonadult	Nonadult
364	M560	F	Unknown (Adult)
365	M561	Unknown (Adult)	Unknown (Adult)
366	M561b	F	Middle Adult
367	M562	F	Young Adult
368	M563	F	Unknown (Adult)
369	M565	Nonadult	Nonadult
370	M566	M	Middle Adult
371	M568	Nonadult	Nonadult
372	M569	F	Unknown (Adult)
373	M570	M	Middle Adult
374	M571	F	Unknown (Adult)
375	M572	Unknown (Adult)	Unknown (Adult)
376	M573	M	Middle Adult
377	M574	F	Middle Adult
378	M575	M	Middle Adult
379	M577	M	Unknown (Adult)
380	M578	M	Middle Adult
381	M579	Unknown (Adult)	Unknown (Adult)
382	M580	Unknown (Adult)	Unknown (Adult)
383	M581	Nonadult	Nonadult
384	M582	Unknown (Adult)	Unknown (Adult)
385	M583	M	Middle Adult
386	M584	Unknown (Adult)	Unknown (Adult)
387	M585	M	Middle Adult
388	M586	Nonadult	Nonadult
389	M587	M	Middle Adult
390	M588	F	Middle Adult
391	M589	F	Middle Adult
392	M590	F	Middle Adult
393	M591	F	Middle Adult
394	M592	Nonadult	Nonadult
395	M593	Nonadult	Nonadult
396	M594	Nonadult	Nonadult
397	M595	F	Young Adult
398	M596	Nonadult	Nonadult

399	M597	M	Middle Adult
400	M598	M	Middle Adult
401	M599	M	Middle Adult
402	M600	Nonadult	Nonadult
403	M602	Nonadult	Nonadult
404	M604	F	Young Adult
405	M605	F	Middle Adult
406	M606	M	Middle Adult
407	M609	Inter	Middle Adult
408	M611	Nonadult	Nonadult
409	M613	Unknown (Adult)	Middle Adult
410	M614	M	Middle Adult
411	M615A	Nonadult	Nonadult
412	M615B	Nonadult	Nonadult
413	M616	Nonadult	Nonadult
414	M618	M	Old Adult
415	M619	Nonadult	Nonadult
416	M620	F	Unknown (Adult)
417	M621	Unknown (Adult)	Unknown (Adult)
418	M622	Nonadult	Nonadult
419	M623	F	Young Adult
420	M625	M	Young Adult
421	M627	Nonadult	Nonadult
422	M629	Nonadult	Nonadult
423	M630	F	Young Adult
424	M631	M	Middle Adult
425	M632	Nonadult	Nonadult
426	MXXX	M	Middle Adult
427	MXXXB	M	Middle Adult

List of References

Addis, M.E., & Cohane, G.H. (2005). Social scientific paradigms of masculinity and their implications for research and practice in men's mental health. *Journal of Clinical Psychology, 61*(6), 633-647. doi:10.1002/jclp.20099

Addis, M.E., & Mahalik, J.R. (2003). Men, masculinity, and the contexts of help seeking. *American Psychologist, 58*(1), 5-14. doi:10.1037/0003-066X.58.1.5

Agarwal, S.C. (2012). The past of sex, gender, and health: Bioarchaeology of the aging skeleton. *American Anthropologist, 114*(2), 322-335. doi:10.1111/j.1548-1433.2012.01428.x

Agarwal, S.C. (2017). Understanding sex- and gender-related patterns of bone loss and health in the past: A case study from the Neolithic community of Çatalhöyük. In Agarwal, S.C. & Wesp, J.K. (Eds.), *Exploring Sex and Gender in Bioarchaeology*, (pp. 165-188). Albuquerque, NM: University of New Mexico Press.

Agarwal, S.C., & Glencross, B.A. (2011a). Building a social bioarchaeology. In Agarwal, S.C. & Glencross, B.A. (Eds.), *Social Bioarchaeology*, (pp. 1-11). Malden, MA: Wiley-Blackwell.

Agarwal, S.C., & Glencross, B.A. (Eds.). (2011b). *Social Bioarchaeology*. Malden, MA: Wiley-Blackwell.

Agarwal, S.C., & Wesp, J.K. (Eds.). (2017). *Exploring Sex and Gender in Bioarchaeology*. Albuquerque, NM: University of New Mexico Press.

Agnew, A.M., & Justus, H.M. (2014). Preliminary investigations of the bioarchaeology of medieval Giecz (XI-XII C.): Examples of trauma and stress. *Anthropological Review, 77*(2), 189-203. doi:10.2478/anre-2014-0015

Al-Rawahi, M., Luo, J., Pollintine, P., Dolan, P., & Adams, M.A. (2011). Mechanical function of vertebral body osteophytes, as revealed by experiments on cadaveric spines. *Spine, 36*(10), 770-777. doi:10.1097/BRS.0b013e3181df1a70

Alberti, B. (2005). Bodies in prehistory: Beyong the sex/gender split. In Funari, P.P. & Zarankin, A. (Eds.), *Global Archaeological Theory: Contextual Voices and Contemporary Thoughts*. New York, NW: Kluwer Academic/Plenum Publishers.

Alberti, B. (2006). Archaeology men and masculinities. In Milledge Nelson, S. (Ed.), *Handbook of Gender in Archaeology*, (pp. 401-434). Lanham, MD: AltaMira Press.

Alexander, B.K. (2011). Queer(y)ing Masculinities. In Jackson, R.L. & Balaji, M. (Eds.), *Global Masculinities and Manhood*, (pp. 52-74): University of Illinois Press.

Alonge, T.O., & Oni, O.O. (2000). An investigation of the frequency of co-existence of osteophytes and circumscribed full thickness articular surface defects in the knee joint. *African Journal of Medicine and Medical Sciences, 29*(2), 151-153.

Alsup, B.K. (2007). *Investigation of the Second, Fourth, and Eighth Sternal Rib End Variation Related to Age Estimation.* Masters Thesis, University of Tennessee, Knoxville, TN.

Anderson, C.P., & Martin, L.D. (Eds.). (2018). *Massacres: Bioarchaeology and Forensic Anthropology Approaches*. Gainseville, FL: University of Florida Press.

Angel, J.L. (1966). Early skeletons from Tranquility, California. *Smithsonian Contributions to Anthropology, 2*, 1-19.

Armelagos, G.J. (1998). Introduction: Sex, gender, and health status in prehistoric and contemporary populations. In Grauer, A.L. & Stuart-Macadam, P. (Eds.), *Sex and Gender in Paleopathological Perspective*, (pp. 1-10). Cambridge: Cambridge University Press.

Armelagos, G.J. (2003). Bioarchaeology as anthropology. *Archeological Papers of the American Anthropological Association, 13*(1), 27-40. doi:10.1525/ap3a.2003.13.1.27

Armelagos, G.J., & van Gerven, D.P. (2003). A century of skeletal biology and paleopathology: Contrasts, contradictions, and conflicts. *American Anthropologist, 105*(1), 51-62. doi:10.1525/aa.2003.105.1.53

Aslop, R., Fitzsimons, A., & Lennon, K. (2002). Theorizing men and masculinities. In *Theorizing Gender*, (pp. 130-164). Cambridge, UK: Polity.

Baadsgaard, A., Boutin, A.T., & Buikstra, J.E. (2012). *Breathing New Life into the Evidence of Death: Contemporary Approaches to Bioarchaeology*. Santa Fe, NM: SAR Press.

Baker, J., & Pearson, O.M. (2006). Statistical methods for bioarchaeology: Applications of age-adjustment and logistic regression to comparisons of skeletal populations with differing age-structures. *Journal of Archaeological Science, 33*(2), 218-226. doi:10.1016/J.JAS.2005.07.019

Barak, M.M., Lieberman, D.E., & Hublin, J.J. (2011). A Wolff in sheep's clothing: Trabecular bone adaptation in response to changes in joint loading orientation. *Bone, 49*(6), 1141-1151. doi:10.1016/j.bone.2011.08.020

Bass, W.M. (1995). *Human Osteology: A Laboratory and Field Manual of Human Skeleton*. Columbia, MO: Missouri Archaeological Society.

Bedford, M.E., Russell, K.F., Lovejoy, C.O., Meindl, R.S., Simpson, S.W., & Stuart-Macadam, P.L. (1993). Test of the multifactorial aging method using skeletons with known ages-at-death from the Grant Collection. *American Journal of Physical Anthropology, 91*(3), 287-297. doi:10.1002/ajpa.1330910304

Bennett, M. (1999). Military masculinity in England and northern France, c. 105O-c. 1225. In Hadley, D. (Ed.), *Masculinity in Medieval Europe*, (pp. 71-88). New York, NY: Addison Wesley Longman.

Berggren, K. (2014). Sticky masculinity: Post-structuralism, phenomenology and subjectivity in critical studies on men. *Men and Masculinities, 17*(3), 231-252. doi:10.1177/1097184X14539510

Bernert, Z., Évinger, S., & Hajdú, T. (2007). New data on the biological age estimation of children using bone measurements based on historical populations from the Carpathian Basin. *Annales Historico-Naturales Musei Nationalis Hungarici, 99*, 199-206.

Bernert, Z., Évinger, S., & Hajdú, T. (2008). Adatok gyermekek életkorbecsléséhez a Kárpát-medencei történetei népességek gyermekhalottainak csontméretei alapján. *Anthropologiai Közelmények, 49*, 43-50.

Bhopal, R.S. (2016). *Concepts of Epidemiology: Integrating the Ideas, Theories, Principles, and Methods of Epidemiology* (3rd ed.). Oxford, UK: Oxford University Press.

Bland, M. (2015). *An Introduction to Medical Statistics*. Oxford, UK: Oxford University Press.

Bocquet-Appel, J.-P., & Masset, C. (1982). Farewell to paleodemography. *Journal of Human Evolution, 11*(4), 321-333. doi:10.1016/S0047-2484(82)80023-7

Bóna, I. (1994). The Hungarian-Slav Period (895-1172). In Bóna, I., Kopereczi, B., & Makkai, L. (Eds.), *History of Transylvania*, (pp. 109-177). Budapest, Hungary: Adadémiai Kiadó.

Bóna, I., Kopereczi, B., & Makkai, L. (1994). *History of Transylvania*. Budapest, Hungary: Akadémiai Kiadó.

Bonhomme, J. (2009). The gender longevity gap: Is it really biology? *Journal of Men's Health, 6*(3), 151-154. doi:10.1016/j.jomh.2009.08.072

Bono, C.M., Levine, R.G., Rao, J.P., & Behrens, F.F. (2001). Nonarticular proximal tibia fractures: treatment options and decision making. *The Journal of the American Academy of Orthopaedic Surgeons, 9*(3), 176-186. doi:10.5435/00124635-200105000-00004

Boutin, A.T. (2008). *Embodying life and death: Osteobiographyical narratives from Alalakh.* PhD Thesis, University of Pennsylvania, Philadelphia, PA.

Boutin, A.T. (2012). Crafting a bioarchaeology of personhood: Osteobiographical narratives from Alalakh. In *Breathing New Life into the Evidence of Death: Contemporary Approaches to Bioarchaeology*, (pp. 109-133). Santa Fe, NM: School for Advanced Research Press.

Boutin, A.T. (2016). Exploring the social construction of disability: An application of the bioarchaeology of personhood model to a pathological skeleton from ancient Bahrain. *International Journal of Paleopathology, 12*, 17-28. doi:10.1016/j.ijpp.2015.10.005

Brah, A., & Phoenix, A. (2004). Ain't I a woman? Revisiting intersectionality. *Journal of International Women's Studies, 5*(3), 75-86.

Brannon, R. (1976). The male sex role: Our culture's blueprint for manhood, what it's done for us lately. In David, D. & Brannon, R. (Eds.), *The Forty-Nine Percent Majority: The Male Sex Role*. Reading, MA: Addison-Wesley.

Brickell, C. (2005). Masculinities, performativity, and subversion: A sociological reappraisal. *Men and Masculinities, 8*(1), 24-43. doi:10.1177/1097184X03257515

Brickley, M. (2006). Rib fractures in the archaeological record: A useful source of sociocultural information? *International Journal of Osteoarchaeology, 16*(1), 61-75. doi:10.1002/oa.809

Brickley, M., & McKinley, J.I. (2004). *Guidelines to the Standards for Recording Human Remains*. Southampton, UK: BABAO.

Bridges, P.S. (1992). Prehistoric arthritis in the Americas. *Annual Review of Anthropology, 21*, 67-91. doi:annurev.an.21.100192.000435

Bridges, P.S. (1994). Vertebral arthritis and physical activities in the prehistoric southeastern United States. *American Journal of Physical Anthropology, 93*(1), 83-93.

Brink, O., Vesterby, A., & Jensen, J. (1998). Patterns of injuries due to interpersonal violence. *Injury, 29*(9), 705-709.

Brooke, B.S., Efron, D.T., Chang, D.C., Haut, E.R., & Cornwell, E.E. (2006). Patterns and outcomes among penetrating trauma recidivists: it only gets worse. *The Journal of Trauma: Injury, Infection, and Critical Care, 61*(1), 16-20. doi:10.1097/01.ta.0000224143.15498.bb

Brooks, G.R. (2001). Masculinity and men's mental health. *Journal of American College Health, 49*(6), 285-297.

Brooks, G.R., & Silberstein, L.B. (1995). Understanding the side of masculinity: An integrative systems model. In Levant, R.F. & Pollack, W.S. (Eds.), *A New Psychology of Men*, (pp. 280-333). New York, NY: Basic Books.

Brooks, S., & Suchey, J.M. (1990). Skeletal age determination based on the os pubis: A comparison of the Acsfidi Nemesk6ri and Suchey-Brooks methods. *Human Evolution, 5*(3), 227-238.

Brown, T., & Brown, K. (2011). *Biomolecular Archaeology: An Introduction*. Malden, MA: Wiley-Blackwell.

Bruzek, J. (2002). A method for visual determination of sex, using the human hip bone. *American Journal of Physical Anthropology, 117*(2), 157-168. doi:10.1002/ajpa.10012

Buckberry, J. (2015). The (mis)use of adult age estimates in osteology. *Annals of Human Biology, 42*(4), 323-331. doi:10.3109/03014460.2015.1046926

Buckberry, J., & Chamberlain, A. (2002). Age Estimation from the Auricular Surface of the Ilium: A Revised Method. *American Journal of Physical Anthropology, 119*(3), 231-239.

Buikstra, J.E., & Beck, L.A. (2006). *Bioarchaeology: The Contextual Analysis of Human Remains*. Boston, MA: Academic Press.

Buikstra, J.E., & Ubelaker, D.H. (1994). *Standards for Data Collection from Human Skeletal Remains*. Fayetteville, AR: Arkansas Archaeological Survey Research Series No. 44.

Burnett, S.E., & Irish, J.D. (Eds.). (2017). *A World View of Bioculturally Modified Teeth*. Gainseville, FL: University Press of Florida.

Burr, D.B., & Gallant, M.A. (2012). Bone remodelling in osteoarthritis. *Nature Reviews Rheumatology, 8*, 665-673. doi:10.1038/nrrheum.2012.130

Burrell, C.L., Emery, M.M., Canavan, S.M., & Ohman, J.C. (2018). Broken bones: Trauma analysis on a medieval population from Poulton, Cheshire. In Turner, W.J. & Lee, C. (Eds.), *Trauma in Medieval Society*, (pp. 71-91). Boston, MA: Brill.

Butchbinder, D. (2013). *Studying Men and Masculinities*. New York: Routledge.

Butler, J. (1988). Performative acts and gender constitution: An essay in phenomenology and feminist theory. *Theatre Journal, 40*(4), 519-531. doi:10.2307/3207893

Butler, J. (1990). *Gender Trouble: Feminism and the Subversion of Identity*. New York: Routledge.

Butler, J. (1993). *Bodies That Matter: On the Discursive Limits of "Sex"*. New York: Routledge.

Butler, J. (1994). Gender as performance: An interview with Judith Butler. *Radical Philosphy, Summer*, 32-39.

Butler, J. (1997). *Excitable Speech: A Politics of the Performative*. New York: Routledge.

Butler, J. (2004). *Undoing Gender*. New York: Routledge.

Byrnes, J.F., & Muller, J.L. (Eds.). (2017). *Bioarchaeology of Impairment and Disability: Theoretical, Ethnohistorical, and Methodological Perspectives*. Cham, Switzerland: Springer.

Caragounis, E.-C., Xiao, Y., & Granhed, H. (2021). Mechanism of injury, injury patterns and associated injuries in patients operated for chest wall trauma. *European Journal of Trauma and Emergency Surgery, 47*(4), 929-938. doi:10.1007/s00068-019-01119-z

Carrigan, T., Connell, B., & Lee, J. (1985). Toward a new sociology of masculinity. *Theory and Society, 14*(5), 551-604. doi:10.1007/BF00160017

Caufeild, J., Singhal, A., Moulton, R., Brenneman, F., Redelmeier, D., & Baker, A.J. (2004). Trauma recidivism in a large urban canadian population. *Journal of Trauma and Acute Care Surgery, 57*(4), 872-876. doi:10.1097/01.ta.0000135350.06670.60

Chai, D.H., Stevens, A.L., & Grodzinsky, A.J. (2007). Biomechanical aspects: Joint injury and osteoarthritis. In Bronner, F. & Farach-Carson, M.C. (Eds.), *Bone and Osteoarthritis*, (pp. 165-179). London, UK: Springer.

Chamberlain, A. (2000). Problems and prospects in palaeodemography. In Cox, M. & Mays, S. (Eds.), *Human Osteology: In Archaeology and Forensic Science*, (pp. 101-116). Cambridge: Cambridge University Press.

Cheverko, C.M., Prince-Buitenhuys, J.R., & Hubbe, M. (2020). *Theoretical Approaches in Bioarchaeology*. London, UK: Taylor and Francis.

Cohen, M.N., & Armelagos, G.J. (1984). *Paleopathology at the Origins of Agriculture*. Orlando, FL: Academic Press.

Colnot, C., Zhang, X., & Knothe Tate, M.L. (2012). Current insights on the regenerative potential of the periosteum: Molecular, cellular, and endogenous engineering approaches. *Journal of Orthopedic Research, 30*(12), 1869-1878. doi:10.1002/jor.22181

Conkey, M.W., & Spector, J.D. (1984). Archaeology and the study of gender. *Advances in Archaeological Method and Theory, 7*, 1-38.

Connell, R.W. (1995). *Masculinities* (1st ed.). Berkley, CA: University of California Press.

Connell, R.W. (2005). *Masculinities* (2nd ed.). Los Angeles, CA: University of California Press.

Cooper, C., Eslinger, D., Nash, D., al-Zawahri, J., & Stolley, P. (2000). Repeat victims of violence: Report of a large concurrent case-control study. *Archives of Surgery, 135*(7), 837-843. doi:10.1001/archsurg.135.7.837

Courtenay, W.H. (2000a). Behavioral factors associated with disease, injury, and death among men: Evidence and implications for prevention. *Journal of Men's Studies, 9*(1), 81-142. doi:10.3149/jms.0901.81

Courtenay, W.H. (2000b). Constructions of masculinity and their influence on men's well-being: A theory of gender and health. *Social Science and Medicine, 50*(10), 1385-1401. doi:10.1016/S0277-9536(99)00390-1

Courtenay, W.H. (2000c). Engendering health: A social constructionist examination of men's health beliefs and behaviors. *Psychology of Men & Masculinity, 1*(1), 4-15. doi:10.1037//1524-9220.1.1.4

Courtenay, W.H. (2003). Key determinants of the health and well-being of men and boys. *International Journal of Men's Health, 2*(1), 1-30. doi:10.3149/jmh.0201.1

Courtenay, W.H. (2011). *Dying to be Men: Psychosocial, Environmental, and Biobehavioral Directions in Promoting the Health of Men and Boys*. New York, NY: Routledge.

Cowin, S.C. (2001). Mechanics of materials. In Cowin, S.C. (Ed.), *Bone Biomechanics Handbook*, (pp. 6-24). Boca Ratonm FL: CRC Press.

Cox, M. (2000). Ageing adults from the skeleton. In Cox, M. & Mays, S. (Eds.), *Human Osteology: In Archaeology and Forensic Science*, (pp. 61-82). Cambridge: Cambridge University Press.

Cox, M., & Scott, A. (1992). Evaluation of the obstetric significance of some pelvic characters in an 18th century British sample of known parity status. *American Journal of Physical Anthropology, 89*(992), 431-440. doi:10.1002/ajpa.1330890404

Crandall, J., & Martin, D.L. (2014). The Bioarchaeology of Postmortem Agency: Integrating Archaeological Theory with Human Skeletal Remains. *Cambridge Archaeological Journal, 24*(3), 429-435. doi:10.1017/S0959774314000584

Cringaci Tiplic, M., & Purece, S.I. (2016). Medieval Churches and Cemeteries in Transylvania in the Light of Coin Discoveries (second half of the 11th century–13th century). *Revista Transilvania, 10*, 33-53.

Davazno1. (2021). Photos of National Museum of Union, Alba Iulia, Romania. Retrieved from https://dynamic-media-cdn.tripadvisor.com/media/photo-o/1e/4a/3a/04/weapons.jpg. Accessed on March 16, 2023.

Dawkins, R. (1976). *The Selfish Gene*. Oxford, UK: Oxford Univeristy Press.

de la Motte, S.J., Gribbin, T.C., Lisman, P., Murphy, K., & Deuster, P.A. (2017). Systematic review of the association between physical fitness and musculoskeletal injury risk: Part 2—Muscular endurance and muscular strength. *The Journal of Strength and Conditioning Research, 31*(11), 3218-3234.

DeWitte, S.N., & Yaussy, S.L. (2020). Bioarchaeological applications of intersectionality. In Cheverko, C.M. & Hubbe, M. (Eds.), *Theoretical Approaches in Bioarchaeology*, (pp. 45-58): Routledge.

Dittmar, J.M., Mitchell, P.D., Cessford, C., Inskip, S.A., & Robb, J.E. (2021). Medieval injuries: Skeletal trauma as an indicator of past living conditions and hazard risk in Cambridge, England. *American Journal of Physical Anthropology, 175*(3), 626-645. doi:10.1002/ajpa.24225

Dobres, M.-A., & Robb, J. (2000). *Agency in Archaeology*. New York, NY: Routledge.

Dóczi, J., & Renner, A. (1994). Epidemiology of distal radius fractures in Budapest. A retrospective study of 2,241 cases in 1989. *Acta Orthopaedica Scandinavica, 65*(4), 432-433.

Donell, S. (2019). Subchondral bone remodelling in osteoarthritis. *EFORT Open Reviews, 4*(6), 221-229. doi:10.1302/2058-5241.4.180102

Dornan, J.L. (2002). Agency and archaeology: Past, present, and future directions. *Journal of Archaeological Method and Theory, 9*(4), 303-330.

Dubois, B. (2001). *New Trends in the Prevention of Running Injuries*. Lac-Beauport, QC, Canada: The Running Clinic.

Dye, S.F. (1996). The knee as a biologic transmission with an envelope of function: A theory. *Clinical Orthopaedics and Related Research, 325*, 10-18.

Dye, S.F. (2005). The pathophysiology of patellofemoral pain - A tissue homeostasis perspective. *Clinical Orthopaedics and Related Research, 436*, 100-110. doi:10.1097/01.blo.0000172303.74414.7d

Engel, P. (2001). *The Realm of St. Stephen: A History of Medieval Hungary, 895-1526*. New York, NY: I.B.Tauris.

Faccia, K., Waters-Rist, A.L., Lieverse, A.R., Bazaliiskii, V.I., Stock, J.T., & Katzenberg, M.A. (2016). Diffuse idiopathic skeletal hyperostosis (DISH) in a middle Holocene forager from Lake Baikal, Russia: Potential causes and the effect on quality of life. *Quaternary International, 405*, 66-79. doi:10.1016/j.quaint.2015.10.011

Faccia, K.J., & Williams, R.C. (2008). Schmorl's Nodes: Clinical significance and implications for the bioarchaeological record. *International Journal of Osteoarchaeology, 18*, 28-44. doi:10.1002/oa.924

Facoetti, M., & Gontier, N. (2020). Psychic Unity. In *Encyclopedia of Evolutionary Psychological Science*, (pp. 1-9): Springer International Publishing.

Fausto-Sterling, A. (1993). The five sexes: Why male and female are not enough. *Sciences, 33*, 20-24.

Fausto-Sterling, A. (2000). *Sexing the Body: Gender Politics and the Construction of Sexuality*. New York: Basic.

Fausto-Sterling, A. (2019). Gender/sex, sexual orientation, and identity are in the body: How did they get there? *The Journal of Sex Research, 56*(4-5), 529-555. doi:10.1080/00224499.2019.1581883

Felson, D.T., Gale, D.R., Elon Gale, M., Niu, J., Hunter, D.J., Goggins, J., & Lavalley, M.P. (2005). Osteophytes and progression of knee osteoarthritis. *Rheumatology, 44*(1), 100-104. doi:10.1093/rheumatology/keh411

Felson, D.T., Zhang, Y., hannan, M.T., Naimark, A., Weissman, B., Aliabadi, P., & Levy, D. (1997). Risk facors for incident radiographic knee osteoarthritis in the elderly. *Arthritis Rheum, 40*(4), 728-733.

Firth, D. (1989). Bias reduction of maximum likelihood estimates. *Biometrika, 80*(1), 27-38.

Fogel, M.L., Tuross, N., & Owsley, D.W. (1989). Nitrogen isotope tracers of human lactation in modern and archaeological populations. In *Annual Report of the Director*, (pp. 111–117): Carnegie Institution of Washington.

Foucault, M. (1978). *The History of Sexuality: Introduction Vol 1*. New York: Vintage Books.

Fowler, C. (2004). The Archaeology of Personhood: An Anthropological Aproach.

Friel, N.A., & Chu, C.R. (2013). The role of ACL injury in the development of posttraumatic knee osteoarthritis. *Clinical Sports Medicine, 32*(1), 1-12. doi:10.1016/j.csm.2012.08.017

Frost, H.M. (1987). Bone "mass" and the "mechanostat": A proposal. *Anatomical Record, 219*(1), 1-9.

Frost, H.M. (2003). Bone's mechanostat: A 2003 update. *Anatomical Record, 275A*(2), 1081-1101.

Fuller, B.T., Fuller, J.L., Harris, D.A., & Hedges, R.E.M. (2006). Detection of breastfeeding and weaning in modern human infants with carbon and nitrogen stable isotope ratios. *American Journal of Physical Anthropology, 129*(2), 279-293. doi:10.1002/ajpa.20249

Gallo, V., Mackenbach, J.P., Ezzati, M., Menvielle, G., Kunst, A.E., Rohrmann, S., Kaaks, R., Teucher, B., Boeing, H., Bergmann, M.M., Tjonneland, A., Dalton, S.O., Overvad, K., Redondo, M.L., Agudo, A., Daponte, A., Arriola, L., Navarro, C., Gurrea, A.B., Khaw, K.T., Wareham, N., Key, T., Naska, A., Trichopoulou, A., Trichopoulos, D., Masala, G., Panico, S., Contiero, P., Tumino, R., Bueno-de-Mesquita, H.B., Siersema, P.D., Peeters, P.P., Zackrisson, S., Almquist, M., Eriksson, S., Hallmans, G., Skeie, G., Braaten, T., Lund, E., Illner, A.K., Mouw, T., Riboli, E., & Vineis, P. (2012). Social inequalities and mortality in Europe--results from a large multi-national cohort. *PLoS ONE, 7*(7), e39013. doi:10.1371/journal.pone.0039013

Galloway, A. (2014a). The lower extremity. In Wedel, V.L. & Galloway, A. (Eds.), *Broken Bones: Anthropological Analysis of Blunt Force Trauma*, (pp. 245-308). Springfield, IL: Charles C. Thomas.

Galloway, A. (2014b). The upper extremity. In Wedel, V.L. & Galloway, A. (Eds.), *Broken Bones: Anthropological Analysis of Blunt Force Trauma*, (pp. 195-243). Springfield, IL: Charles C. Thomas.

Galloway, A., & Wedel, V. (2014a). The axial skeleton. In Wedel, V.L. & Galloway, A. (Eds.), *Broken Bones: Anthropological Analysis of Blunt Force Trauma*, (pp. 195-243). Springfield, IL: Charles C. Thomas.

Galloway, A., & Wedel, V. (2014b). Common circumstances of blunt force trauma. In Wedel, V.L. & Galloway, A. (Eds.), *Broken Bones: Anthropological Analysis of Blunt Force Trauma*, (pp. 91-130). Springfield, IL: Charles C. Thomas.

Galloway, A., Zephro, L., & Wedel, V. (2014). Classification of fractures. In Wedel, V.L. & Galloway, A. (Eds.), *Broken Bones: Anthropological Analysis of Blunt Force Trauma*, (2nd ed., pp. 59-72). Springfield: Charls C. Thomas.

Garvin, H.M., & Passalacqua, N.V. (2012). Current practices by forensic anthropologists in adult skeletal age estimation. *Journal of Forensic Sciences, 57*(2), 427-433. doi:10.1111/j.1556-4029.2011.01979.x

Geller, P.L. (2005). Skeletal analysis and theoretical complications. *World Archaeology, 37*(4), 597-609. doi:10.1080/00438240500404391

Geller, P.L. (2008). Conceiving sex: Fomenting a feminist bioarchaeology. *Journal of Social Archaeology, 8*(1), 113-138. doi:10.1177/1469605307086080

Geller, P.L. (2009). Identity and Difference: Complicating Gender in Archaeology. *Annual Review of Anthropology, 38*(1), 65-81. doi:10.1146/annurev-anthro-091908-164414

Geller, P.L. (2017). *The Bioarchaeology of Socio-Sexual Lives: Queering Common Sense About Sex, Gender, and Sexuality*. Switzerland: Springer.

Gerrish, A.W., Hamill, M.E., Locklear, T.M., Bower, K.L., Lollar, D.I., Faulks, E.R., Matos, M., Nussbaum, M.S., & Collier, B.R. (2019). Trauma recidivism postdischarge mortality: Important differences exist between the adult and geriatric populations. *American Surgeon, 85*(7), 685-689. doi:10.1177/000313481908500723

Gilchrist, R. (1999). *Gender and Archaeology: Contesting the Past*. London: Routledge.

Gilchrist, R. (2012). *Medieval Life: Archaeology and the Life Course*: Boydell Press.

Gillett, R.M. (1991). Determination of age at death in human skeletal remains: A comparison of two techniques. *International Journal of Anthropology, 6*(2), 179-189. doi:10.1007/BF02443951

Gilsanz, V., Boechat, M.I., Roe, T.F., Loro, M.L., Sayre, J.W., & Goodman, W.G. (1994). Gender differences in vertebral body sizes in children and adolescents. *Radiology, 190*(3), 673-677. doi:10.1148/radiology.190.3.8115609

Glencross, B.A. (2003). *An Approach to the Palaeoepidemiology of Bone Factures: Methods and Techniques Applied to Long Bones from the Indian Knoll Seletal Sample, Kentucky.* PhD Thesis, University of Toronto, Toronto, ON.

Glencross, B.A. (2011). Skeletal injury across the life course: Towards understanding social agency. In Agarwal, S.C. & Glencross, B.A. (Eds.), *Social Bioarchaeology*, (pp. 390-409). Malden, MA: Wiley-Blackwell.

Goffman, E. (1956). *The Presentation of Self in Everyday Life*. Edingburgh, UK: The University of Edinburgh Social Sciences Research Centre.

Goldring, M.B. (2007). Cytokines, growth factors, and bone-derived factors in cartilage. In Bronner, F. & Farach-Carson, M.C. (Eds.), *Bone and Osteoarthritis*, (pp. 41-63). London, UK: Springer.

Goodman, A.H., & Armelagos, G.J. (1989). Infant and childhood morbidity and mortality risks in archaeological populations. *World Archaeology, 21*(2), 225-243.

Goodman, A.H., & Martin, D.L. (2002). Reconstructing health profiles from skeletal remains. In Sackel, R.H. & Rose, J.C. (Eds.), *The Backbone of History: Health and Nutrition in the Western Hemisphere*, (pp. 11-60). Cambridge, UK: Calbridge University Press.

Goulart, D.R., Colombo Ldo, A., de Moraes, M., & Asprino, L. (2014). What is expected from a facial trauma caused by violence? *Journal of Oral and Maxillofacial Research, 5*(4), e4. doi:10.5037/jomr.2014.5404

Grauer, A.L. (Ed.) (2012). *A Companion to Paleopathology*. Malden, MA: Wiley Blackwell.

Grauer, A.L., & Miller, A.G. (2017). Flesh on the Bones: A Historical and Bioarchaeological Exploration of Violence, Trauma, Sex, and Gender in Medieval England. *Fragments, 6*, 38-79.

Grauer, A.L., & Stuart-Macadam, P. (1998). *Sex and Gender in Paleopathological Perspective*. Cambridge: Cambridge University Press.

Grosicki, G.J., Zepeda, C.S., & Sundberg, C.W. (2022). Single muscle fibre contractile function with ageing. *Journal of Physiology, 600*(23), 5005-5026. doi:10.1113/JP282298

Gujar, B., & Mochberg, M. (2014). Osteoarthritis and Other Joint Involvement. In Shapiro, J.R. (Ed.), *Osteogenesis Imperfecta*, (pp. 353-358). London, UK: Academic Press.

Gutterman, D.S. (1994). Postmodernism and the interrogation of masculinity. In Brod, H. & Kauffman, M.W. (Eds.), *Theorizing Masculinities*, (pp. 219-238). Thousand Oaks, CA: Sage.

Guy, H., Masset, C., & Baud, C.-A. (1997). Infant taphonomy. *International Journal of Osteoarchaeology, 7*(3), 221-229. doi:10.1002/(SICI)1099-1212(199705)7:3<221::AID-OA338>3.0.CO;2-Z

Hadley, D.M. (Ed.) (2014). *Medieval Childhood: Archaeological Approaches*. Philadelphia, pA: Oxbow Books.

Halberstam, J. (1998). *Female Masculinity*. London: Duke University Press.

Hamilakis, Y., Pluciennik, M., & Tarlow, S. (2002). *Thinking Through the Body: The Archaeologies of Corporeality*. New York: Kluwer Academic / Plenum.

Harris, J.K. (2021). Primer on binary logistic regression. *Family Medicine and Community Health, 9*(S1), e001290. doi:10.1136/fmch-2021-001290

Hawkey, D.E. (1998). Disability, compassion and the skeletal record: using musculoskeletal stress markers (MSM) to construct an osteobiography from early New Mexico. *International Journal of Osteoarchaeology, 8*(5), 326-340.

Haywood, C., & Mac an Ghaill, M. (2003). *Men and Masculinities: Theory, Research and Social Practice*. Philadelphia: Open University Press.

He, G., & Xinghua, Z. (2006). The numerical simulation of osteophyte formation on the edge of the vertebral body using quantitative bone remodeling theory. *Joint Bone Spine, 73*(1), 95-101. doi:10.1016/j.jbspin.2005.03.019

Healey, J.F. (2005). *Statistics: A Tool for Social Research* (7th ed.). Belmont, CA: Thomson Wadsworth.

Hearn, J. (2012). Male bodies, masculine bodies, men's bodies: The need for a concept of gex. *Routledge Handbook of Body Studies*, 307-320.

Hearn, J. (2014). Men, masculinities and the material(-)discursive. *NORMA: International Journal For Masculinity Studies, 9*, 5-17.

Heebøll-Holm, T.K. (2014). Apocalypse Then? The First Crusade, Traumas of War and Thomas de Marle. In Hundahl, K., Kjær, L., & Lund, N. (Eds.), *Denmark and Europe in the Middle Ages, c.1000–1525*. Surrey, UK: Ashgate Publishing.

Heinegård, D. (2007). Cartilage matrix destruction. In Bronner, F. & Farach-Carson, M.C. (Eds.), *Bone and Osteoarthritis*, (pp. 81-95). London, UK: Springer.

Hens, S.M., Rastelli, E., & Belcastro, G. (2008). Age estimation from the human os coxa: A test on a documented Italian collection. *Journal of Forensic Sciences, 53*(5), 1040-1043. doi:10.1111/j.1556-4029.2008.00818.x

Hollimon, S.E. (1996). Sex, gender and health among the Chumash: An archaeological examination of prehistoric gender roles. *Proceedings of the Society for California Archaeology, 9*, 205-208.

Hollimon, S.E. (2011). Sex and gender in bioarchaeological research: Theory, method, and interpretation. In Agarwal, S.C. & Glencross, B.A. (Eds.), *Social Bioarchaeology*, (pp. 149-182). Chichester, UK: Wiley-Blackwell.

Hollimon, S.E. (2017). Bioarchaeological approaches to nonbinary genders: Case studies from Native North America. In Agarwal, S.C. & Wesp, J.K. (Eds.), *Exploring Sex and Gender in Bioarchaeology*, (pp. 51-69). Albuquerque, NM: Albuquerque, NM.

Holzer, N., Salvo, D., Marijnissen, A.C., Vincken, K.L., Ahmad, A.C., Serra, E., Hoffmeyer, P., Stern, R., Lubbeke, A., & Assal, M. (2015). Radiographic evaluation of posttraumatic osteoarthritis of the ankle: The Kellgren-Lawrence scale is reliable and correlates with clinical symptoms. *Osteoarthritis Cartilage, 23*(3), 363-369. doi:10.1016/j.joca.2014.11.010

Hoppa, R.D., & Vaupel, J.W. (Eds.). (2002). *Paleodemography: Age distributions from skeletal samples*. Cambridge, UK: Cambridge University Press.

Hreljac, A. (2004). Impact and overuse injuries in runners. *Medicine and Science in Sports and Exercise, 36*(5), 845-849. doi:10.1249/01.Mss.0000126803.66636.Dd

Hsia, A.W., Collette, N.M., & Christiansen, B.A. (2017). *Osteophyte formation and the effect of mechanical loading: Comparisons to fracture healing*. Paper presented at the Osteoarthritis Research Society International, Las Vegas, NV.

Hügle, T., & Geurts, J. (2017). What drives osteoarthritis? Synovial versus subchondral bone pathology. *Rheumatology, 56*(9), 1461-1471. doi:10.1093/rheumatology/kew389

Humbyrd, C.J., Petre, B., Chanmugam, A.S., & Laporte, D.M. (2012). *Orthopaedic Emergencies*. Oxford, UK: Oxford University Press.

IBM Corp. (2021). *IBM SPSS Statistics for Windows, Version 28.0*. Armonk, NY: IBM Corp.

Işcan, Y.M., Loth, S.R., & Wright, R.K. (1984). Age estimation from the rib by phase analysis: white males. *Journal of Forensic Sciences, 29*(4), 1094-1104.

İşcan, Y.M., Loth, S.R., & Wright, R.K. (1984). Metamorphosis at the sternal rib end: A new method to estimate age at death in white males. *American Journal of Physical Anthropology, 65*, 147-156.

İşcan, Y.M., Loth, S.R., & Wright, R.K. (1985). Age estimation from the rib by phase analysis: White females. *Journal of Forensic Sciences, 30*(3), 853-863. doi:10.1520/JFS11018J

Jackes, M. (2000). Building the bases for paleodemographic analysis: Adult age determination. In Saunders, S.R. & Katzenberg, M.A. (Eds.), *Biological Anthropology of the Human Skeleton*, (2nd ed., pp. 417-466). Toronto: Wiley-Liss.

Janssen, I., Heymsfield, S.B., Wang, Z.M., & Ross, R. (2000). Skeletal muscle mass and distribution in 468 men and women aged 18-88 yr. *Journal of Applied Physiology, 89*(1), 81-88. doi:10.1152/jappl.2000.89.1.81

Jelalian, E., Spirito, A., Rasile, D., Vinnick, L., Rohrbeck, C., & Arrigan, M. (1997). Risk taking, reported injury, and perception of future injury among adolescents. *Journal of Pediatric Psychology, 22*(4), 513-531. doi:10.1093/jpepsy/22.4.513

Johnson, F.E., & Mann, A. (1997). United States of America. In *History of Physical Anthropology: An Encyclopedia* (pp. 1069-1081): Garland Publishing.

Joyce, R.A. (2002). *The Languages of Archaeology: Dialogue, Narrative, and Writing*. Oxford: Wiley-Blackwell.

Joyce, R.A. (2005). Archaeology of the Body. *Annual Review of Anthropology, 34*(1), 139-158. doi:10.1146/annurev.anthro.33.070203.143729

Joyce, R.A. (2017). Sex, gender, and anthropology: Moving bioarchaeology outside the subdiscipline. In Agarwal, S.C. & Wesp, J.K. (Eds.), *Exploring Sex and Gender in Bioarchaeology*, (pp. 1-12). Albuquerque, NM: University of New Mexico Press.

Judd, M.A. (2002a). Ancient injury recidivism: an example from the Kerma period of ancient Nubia. *International Journal of Osteoarchaeology, 12*(2), 89-106. doi:10.1002/oa.587

Judd, M.A. (2002b). Comparison of Long Bone Trauma Recording Methods. *Journal of Archaeological Science, 29*(11), 1255-1265. doi:10.1006/jasc.2001.0763

Judd, M.A. (2008). The parry problem. *Journal of Archaeological Science, 35*(6), 1658-1666. doi:10.1016/j.jas.2007.11.005

Judd, M.A. (2017). Injury recidivism revisited: Clinical research, limitations, and implications for bioarchaeology. In Tegtmeyer, C.E. & Martin, D.L. (Eds.), *Broken Bones, Broken Bodies: Bioarchaeological and Forensic Approaches for Accumulative Trauma and Violence*, (pp. 1-23). Lanham: Lexington Books.

Judd, M.A., & Redfern, R.C. (2012). Trauma. In Grauer, A.L. (Ed.), *A Companion to Paleopathology*, (pp. 359-379). Malden, MA: Wiley-Blackwell.

June, D., Williams, O.A., Huang, C.W., An, Y., Landman, B.A., Davatzikos, C., Bilgel, M., Resnick, S.M., & Beason-Held, L.L. (2020). Lasting consequences of concussion on the aging brain: Findings from the Baltimore Longitudinal Study of Aging. *Neuroimage, 221*, Article Number: 117182. doi:10.1016/j.neuroimage.2020.117182

Jurmain, R.D. (1977). Stress and the etiology of osteoarthritis. *American Journal of Physical Anthropology, 46*(2), 353-365.

Jurmain, R.D. (1999). *Stories from the Skeleton: Behavioral Reconstruction in Human Osteology*. Amsteldijk, The Netherlands: Gordon and Breach Publisher.

Jurmain, R.D., Cardoso, F.A., Henderson, C., & Villotte, S. (2012). Bioarchaeology's Holy Grail: The reconstruction of activity. In Grauer, A.L. (Ed.), *A Companion to Paleopathology*, (pp. 531-552). Malden, MA: Wiley-Blackwell.

Karras, R.M. (2003). *From Boys to Men: Formations of Masculinity in Late Medieval Europe*. Philadelphia, PA: University of Pennsylvania Press.

Karsten, J.K. (2018). A test of the preauricular sulcus as an indicator of sex. *American Journal of Physical Anthropology, 165*(3), 604-608. doi:10.1002/ajpa.23372

Katz, D., & Suchey, J.M. (1986). Age determination of the male os pubis. *American Journal of Physical Anthropology, 69*(4), 427-435. doi:10.1002/ajpa.1330690402

Katzenberg, M.A. (2008). Stable isotope analysis: A tool for studying past diet, demography, and life history. In Katzenberg, M.A. & Saunders, S.R. (Eds.), *Biological Anthropology of the Human Skeleton*, (2nd ed., pp. 413-441). Hoboken, NJ: Wiley-Liss.

Katzenberg, M.A., Herring, A., & Saunders, S.R. (1996). Weaning and infant mortality: Evaluating the skeletal evidence. *Yearbook of Physical Anthropology, 39*, 177-199. doi:10.1002/(SICI)1096-8644(1996)23+<177::AID-AJPA7>3.0.CO;2-2

Keenleyside, A., Bertulli, M., & Fricke, H.C. (1997). The final days of the Franklin Expedition: New skeletal evidence. *Arctic, 50*(1), 36-46.

Kennedy, K.A.R. (1989). Skeletal markers of occupational stress. In Iscan, Y.M. & Kennedy, K.A.R. (Eds.), *Reconstruction of Life from the Skeleton*, (pp. 129-160). New York: Alan R Liss.

Kim, J., & Bang, H. (2016). Three common misuses of P values. *Dental Hypotheses, 7*(3), 73-80. doi:10.4103/2155-8213.190481

Kim, J.H., & Choi, I. (2021). Choosing the level of significance: A decision-theoretic approach. *ABACUS, 57*(1), 27-71. doi:10.1111/abac.12172

Kimmel, M. (2008). *Guyland: The Perilous World Where Boys Become Men*. New York, NY: Harper Collins.

Kimmel, M. (2009). Masculinity as homophobia. In Disch, E. (Ed.), *Reconstructing Gender: A Multicultural Anthology*. Boston, MA: Mc-Graw-Hill.

Kjellström, A. (2015). Interpreting violence: a bioarchaeological perspective of violence from medieval central Sweden. In Knüsel, C. & Smith, M.J. (Eds.), *The Routledge Handbook of the Bioarchaeology of Human Conflict*, (pp. 237-250). New York, NY: Routledge.

Klales, A.R., Long, H., & Willsey, C. (2020). A history of sex estimation of human skeletal remains. In Klales, A.R. (Ed.), *Sex Estimation of the Human Skeleton: History, Methods, and Emerging Techniques*, (pp. 3-10). London, UK: Academic Press.

Klaus, H.D. (2012). The bioarchaeology of structural violence: A theoretical model. In Martin, D.L., Harrod, R.P., & Pérez, V.R. (Eds.), *The Bioarchaeology of Violence*. Gainseville, FL: University Press of Florida.

Knapp, A.B., & Meskell, L. (1997). Bodies of evidence on prehistoric Cyprus. *Cambridge Archaeological Journal, 7*(2), 183-204. doi:10.1017/S0959774300001931

Knudson, K.J., & Stojanowski, C.M. (2009). *Bioarchaeology and Identity in the Americas*. Tallahassee, FL: University Press of Florida.

Knüsel, C.J. (2012). Men take up arms for war: Sex and status distinctions of humeral medial epicondylar avulsion fractures in the archaeological record. In Baadsgaard, A., Boutin, A.T., & Buikstra, J.E. (Eds.), *Breathing New Life into the Evidence of Death: Contemporary Approaches to Bioarchaeology*, (pp. 221-249). Santa Fe, NM: School for Advanced Resaearch Press.

Kovács, A. (2003). Gyulafehérvár, az erdélyi Püspökök Középkori Székhelye. In Baroti, L.S. (Ed.), *A Gyulafehérvári Gróf Majláth Gusztáv Líceumi Szeminárium Évkönyve*, (pp. 7-18). Cluj-Napoca, Romania: Státus Kiadó.

Koval, M. (2021). *Childhood in Medieval Poland (1050-1300): Constructions and Realities in a European Context*. Leiden, Netherlands: Brill.

Kremer, C., Racette, S., Dionne, C.A., & Sauvageau, A. (2008). Discrimination of falls and blows in blunt head trauma: Systematic study of the hat brim line rule in relation to skull fractures. *Journal of Forensic Sciences, 53*(3), 716-719. doi:10.1111/j.1556-4029.2008.00725.x

Lajeunese, D., & Reboul, P. (2007). The role of bone in the development of osteoarthritis. In Bronner, F. & Farach-Carson, M.C. (Eds.), *Bone and Osteoarthritis*, (pp. 19-39). London, UK: Springer.

Larsen, C.S. (1997). *Bioarchaeology: Interpreting Behavior from the Human Skeleton*. Cambridge, UK: Cambridge University Press.

Larsen, C.S. (2010). *A Companion to Biological Anthropology*. Oxford, UK: Wiley-Blackwell.

Larsen, C.S. (2015). *Bioarchaeology: Interpreting Behaviour from the Human Skeleton* (2nd ed.). Cambridge, UK: Cambridge University Press.

Lawrence, M. (2000). Head injury: Recent past, present, and future. *Neurosurgery, 47*(3), 546-561.

Lee, C. (2019). A bioarchaeological and biocultural investigation of Chinese footbinding at the Xuecun archaeological site, Henan Province, China. *International Journal of Paleopathology, 25*, 9-19. doi:10.1016/J.IJPP.2019.03.001

Lees, C.A. (1994). *Medieval Masculinities: Regarding Men in the Middle Ages*. Minneapolis, MN: University of Minnesota Press.

Lessa, A., & Guidon, N. (2002). Osteobiographic analysis of skeleton I, Sítio Toca dos Coqueiros, Serra da Capivara National Park, Brazil, 11,060 BP: First results. *American Journal of Physical Anthropology, 118*(2), 99-110. doi:10.1002/ajpa.10084

Listi, G.A., & Manhein, M.H. (2012). The use of vertebral osteoarthritis and osteophytosis in age estimation. *Journal of Forensic Sciences, 57*(6), 1537-1540. doi:10.1111/j.1556-4029.2012.02152.x

Liston, M.A. (2012). Reading the bones: Interpreting the skeletal evidence for women's lives in ancient Greece. *A Companion to Women in the Ancient World*, 125-140.

Lloyd, T. (1996). *Men's Health Review*. London: Men's Health Forum.

Lorber, J., & Moore, L.J. (2002). *Gender and the Social Construction of Illness* (2nd ed.). Walnut Creek, CA: AltaMira Press.

Love, J.C., Derrick, S.M., & Wiersema, J.M. (2011). *Skeletal Atlas of Child Abuse*. New York, NY: Humana Press.

Love, J.C., & Symes, S.A. (2004). Understanding Rib Fracture Patterns: Incomplete and Buckle Fractures. *Journal of Forensic Sciences*. doi:10.1520/jfs2004175

Lovejoy, C.O., Meindl, R.S., Pryzbeck, T.R., & Mensforth, R.P. (1985). Chronological metamorphosis of the auricular surface of the ilium: a new method for the determination of adult skeletal age at death. *American Journal of Physical Anthropology, 68*(1), 15-28. doi:10.1002/ajpa.1330680103

Lovell, N.C. (1989). Test of Phenice's technique for determining sex from the os pubis. *American Journal of Physical Anthropology, 79*(1), 117-120. doi:10.1002/ajpa.1330790112

Lovell, N.C. (1997). Trauma analysis in paleopathology. *Yearbook of Physical Anthropology, 40*, 139-170.

Lovell, N.C. (2008). Analysis and interpretation of skeletal trauma. In Katzenberg, M.A. & Saunders, S.R. (Eds.), *Biological Anthropology of the Human Skeleton*, (2nd ed., pp. 341-368). Hoboken, NJ: Wiley-Liss.

Lovell, N.C., & Dublenko, A. (1999). Further aspects of fur trade life depicted in the skeleton. *International Journal of Osteoarchaeology, 9*(4), 248-256. doi:10.1002/(SICI)1099-1212(199907/08)9:4<248::AID-OA484>3.0.CO;2-P

Lovell, N.C., & Grauer, A.L. (2019). Analysis and interpretation of trauma in skeletal remains. In Katzenberg, M.A. & Grauer, A.L. (Eds.), *Biological Anthropology of the Human Skeleton*, (3rd ed., pp. 335-383). Oxford, UK: Wiley Blackwell.

Mabery, J.D., & Fitch, R.D. (1989). Plastic deformation in pediatric fractures: Mechanism and treatment. *Journal of Pediatric Orthopaedics, 9*(3), 310-314.

Mackenbach, J.P., Kunst, A.E., Cavelaars, A.E., Groenhof, F., & Geurts, J.J. (1997). Socioeconomic inequalities in morbidity and mortality in western Europe. The EU Working Group on Socioeconomic Inequalities in Health. *Lancet, 349*(9066), 1655-1659. doi:10.1016/s0140-6736(96)07226-1

Magnusson, S.P., Aagaard, P., Larsson, B., & Kjaer, M. (2000). Passive energy absorption by human muscle-tendon unit is unaffected by increase in intramuscular temperature. *Journal of Applied Physiology*, 1215-1220.

Mahalik, J.R., Burns, S.M., & Syzdek, M. (2007). Masculinity and perceived normative health behaviors as predictors of men's health behaviors. *Social Science and Medicine, 64*(11), 2201-2209. doi:10.1016/j.socscimed.2007.02.035

Makkai, L. (1994). The emergence of the estates (1172-1526). In Bóna, I., Kopereczi, B., & Makkai, L. (Eds.), *History of Transylvania*, (pp. 178-244). Budapest, Hungary: Adadémiai Kiadó.

Makkai, L. (2001). Transylvania in the medieval Hungarian Kingdom (896-1526). In Makkai, L. & Móchy, A. (Eds.), *History of Transylvania, Volume I: From the Beginnings to 1606*. New York, NY: Columbia University Press.

Manchester, K., Ogden, A., & Storm, R. (2016). *Nomenclature in Palaeopathology*. University of Bradford.

Mandl, L.A. (2007). Epidemiology of Osteoarthritis. In Sharma, L. & Berenbaum, F. (Eds.), *Osteoarthritis: A Companion to Rheumatology*, (pp. 1-14). Philadelphia, PA: Mosby Inc.

Mant, M. (2019). Time after time: individuals with multiple fractures and injury recidivists in long eighteenth-century (c. 1666–1837) London. *International Journal of Paleopathology, 24*, 7-18. doi:10.1016/J.IJPP.2018.08.003

Mant, M., de la Cova, C., & Brickley, M. (2021). Intersectionality and trauma analysis in bioarchaeology. *American Journal of Physical Anthropology, 174*(4), 583-594. doi:10.1002/ajpa.24226

Marais, G.A.B., Gaillard, J.M., Vieira, C., Plotton, I., Sanlaville, D., Gueyffier, F., & Lemaitre, J.F. (2018). Sex gap in aging and longevity: can sex chromosomes play a role? *Biology of Sex Difference, 9*, Article number 33. doi:10.1186/s13293-018-0181-y

Marcu Istrate, D. (2008). *A Gyulafehérvári Római Katolikus Székesegyház és Püspöki palota régészeti kutatása (2000–2002)*. Budpest, Hungary: Teleki László Alapítvány.

Marcu Istrate, D. (2010). *Erdély Ezeréves Püspöksége*. Budapest, Hungary: Teleki László Alapítvány.

Marcu Istrate, D. (2012). Régészeti adalékok a gyulafehérvári Szent Mihály-székesegyház főszentélyének és sekrestyéjének történetéhez. In Papp, S. (Ed.), *A Gyulafehérvári Székesegyház Főszentélyse*, (pp. 21-41). Budpest, Hungary: Teleki László Alapítvány.

Marcu Istrate, D., Constantinescu, M., & Soficaru, A. (2015). *The Medieval Cemetery from Sibiu (Hermannstadt) Huet Square*. Büchenbach, Germany: Verlag Dr. Faustus.

Marcu Istrate, D., & Istrate, A. (2005). Morminte cu nișă cefalică descoperite la Alba Iulia (sec. XII-XIII). Contribuții privind istoria oaspeților occidentali în Transilvania / Graves with head niches uncovered in Alba Iulia (12th-13th c.). Contributions to the history of the western guests of Transylvania. In Pinter, Z.K., Țiplic, I.M., & Țiplic, M.E. (Eds.), *Relaţii interetnice în Transilvania (sec. VI-XIII)*, (pp. 229-244). Sibiu, Romania: Economică.

Martin, D.L. (2021). Violence and masculinity in small-scale societies. *Current Anthropology, 62*(Suppl 23), S169-S181.

Martin, D.L., & Harrod, R.P. (2015). Bioarchaeological contributions to the study of violence. *American Journal of Physical Anthropology, 156*(S59), 116-145. doi:10.1002/ajpa.22662

Martin, D.L., Harrod, R.P., & Perez, V.R. (2012). *The Bioarchaeology of Violence*. Gainesville: University Press of Florida.

Martin, D.L., Harrod, R.P., & Pérez, V.R. (2013). *Bioarchaeology: An Integrated Approach to Working with Human Remains*. New York, NY: Springer.

Mauss, M. (1973[1936]). Techniques of the Body. *Economy and Society, 2*(1), 70-88. doi:10.1080/03085147300000003

Mayes, A.T., & Barber, S.B. (2008). Osteobiography of a High-status Burials from the Lower Rio Verde Valley of Oaxaca, Mexico. *International Journal of Osteoarchaeology, 18*, 573-588. doi:10.1002/oa

Mays, S.A. (1998). *The Archaeology of Human Bones*. New York, NY: Routledge.

Mays, S.A. (2006). The osteology of monasticism in medieval England. In Gowland, R. & Knüsel, C.J. (Eds.), *Social Archaeology of Funerary Remains*, (pp. 179-189). Oxford: Oxbow Books.

Mays, S.A., & Cox, M. (2000). Sex determination in skeletal remains. In Cox, M. & Mays, S. (Eds.), *Human Osteology: In Archaeology and Forensic Science*, (pp. 61-82). Cambridge: Cambridge University Press.

Meinberg, E.G., Agel, J., Roberts, C.S., Karam, M.D., & Kellam, J.F. (2018). Fracture and Disloation Classification Compendium-2018. *Journal of Orthopaedic Trauma, 32*(1).

Meindl, R.S., & Lovejoy, C.O. (1985). Ectocranial suture closure: A revised method for the determination of skeletal age at death based on the lateral-anterior sutures. *American Journal of Physical Anthropology, 68*(1), 57-66. doi:10.1002/ajpa.1330680106

Meindl, R.S., & Lovejoy, C.O. (1989). Age changes in the pelvis: Implications for paleodemography. In İşcan, Y.M. (Ed.), *Age Markers in the Human Skeleton*, (pp. 137-168). Illinois: Charles C. Thomas.

Meindl, R.S., Lovejoy, C.O., Mensforth, R.P., & Don Carlos, L. (1985). Accuracy and direction of error in the sexing of the skeleton: implications for paleodemography. *American Journal of Physical Anthropology, 68*(1), 79-85. doi:10.1002/ajpa.1330680108

Melchior, A. (2011). Caesar in Vietnam: Did Roman soldiers suffer from Post-Traumatic Stress Disorder? *Greece and Rome, 58*(2), 209-223. doi:10.1017/s0017383511000052

Menkes, C.J., & Lane, N.E. (2004). Are osteophytes good or bad? *Osteoarthritis and Cartilage, 12 Suppl A*, S53-S54. doi:10.1016/j.joca.2003.09.003

Merbs, C.F. (1980). Pathology of a La Jollan skeleton from Punta Minitas, Baja California. *Pacific Coast Archaeological Society Quarterly, 16*(4), 37-43.

Merbs, C.F. (1983). *Patterns of activity-induced pathology in a Canadian Inuit population*. Ottawa, Canada: University of Ottawa Press.

Messner, M.A. (1992). *Power at Play: Sports and the Problem of Masculinity*. Boston, MA: Beacom.

Messner, M.A. (1998). The limits of "the male sex role": An analysis of the men's liberation and men's rights movements' discourse. *Gender and Society, 12*(3), 255-276. doi:doi.org/10.1177/089124329801200300

Messner, M.A. (2016). Masculinities and athletic careers. *Gender and Society, 3*(1), 71-88. doi:10.1177/089124389003001005

Miller, G.F. (2000). *The Mating Mind: How Sexual Selection Shaped the Evolution of Human Nature*. London: William Hienemann.

Milner, G.R., & Boldsen, J.L. (2012). Transition analysis: a validation study with known-age modern American skeletons. *American Journal of Physical Anthropology, 148*(1), 98-110. doi:10.1002/ajpa.22047

Molnar, P., Ahlstrom, T.P., & Leden, I. (2011). Osteoarthritis and activity—an analysis of the relationship between eburnation, Musculoskeletal Stress Markers (MSM) and age in two Neolithic hunter–gatherer populations from Gotland, Sweden. *International Journal of Osteoarchaeology, 21*(3), 283-291.

Moore, K.L., Persaud, T.V.N., & Torchia, M.G. (2016). *The Developing Human: Clinically Oriented Embryology* (10th ed.): Elsevier.

Moser, R.S., Schatz, P., & Jordan, B.D. (2005). Prolonged effects of concussion in high school athletes. *Neurosurgery, 57*(2), 300-306. doi:10.1227/01.neu.0000166663.98616.e4

Mueller, M.J., & Maluf, K.S. (2002). Tissue adaptation to physical stress: A proposed "physical stress theory" to guide physical therapist practice, education, and research. *Physical Therapy, 82*(4), 383-403. doi:DOI 10.1093/ptj/82.4.383

Müller, M., Nazarian, S., Koch, P., & Schatzker, J. (1990). *The Comprehensive Classification of Fractures of Long Bones*. New York: Springer-Verlag.

Murray, J. (2018). Masculinity and male sexuality in the Middle Ages. *Oxford Bibliographies.* Retrieved from https://www.oxfordbibliographies.com/display/document/obo-9780195396584/obo-9780195396584-0251.xml. Accessed on March 3, 2023.

Nelson, S.M. (2006). *Handbook of Gender in Archaeology*. Lanham, MD: AltaMira Press.

Newman, A.B., & Brach, J.S. (2001). Gender gap in longevity and disability in older persons. *Epidemiologic Reviews, 23*(2), 343-350. doi:10.1093/oxfordjournals.epirev.a000810

Newman, P.B. (2007). *Growing Up in the Middle Ages*. Jefferson, NC: McFarland.

Nieves-Colón, M.A., & Stone, A.C. (2019). Ancient DNA analysis of archaeological remains. In Katzenberg, M.A. & Grauer, A.L. (Eds.), *Biological Anthropology of the Human Skeleton*, (3rd ed., pp. 515-544). Oxford, UK: Wiley Blackwell.

Nitsch, E.K., Humphrey, L.T., & Hedges, R.E.M. (2010). The effect of parity status on δ15N: looking for the "pregnancy effect" in 18th and 19th century London. *Journal of Archaeological Science, 37*(12), 3191-3199. doi:10.1016/j.jas.2010.07.019

Noback, C.R. (1946). Ontogenetic aspects of sutures in man. *American Journal of Physical Anthropology, 4*, 264-264.

Novak, S.A. (2006). Beneath the facade: A skeletal model of dotnestic violence. In Gowland, R. & Knüsel, C.J. (Eds.), *Social Archaeology of Funerary Remains*, (pp. 238-252). Oxford: Oxbow Books.

O'Neill, T.W., McCloskey, E.V., Kanis, J.A., Bhalla, A.K., Reeve, J., Reid, D.M., Todd, C., Woolf, A.D., & Silman, A.J. (1999). The distribution, determinants, and clinical correlates of vertebral osteophytosis: a population based survey. *The Journal of Rheumatology, 26*(4), 842-848.

Ortner, D.J. (2003). *Identification of Pathological Conditions in Human Skeletal Remains* (2nd ed.). Boston, MA: Academic Press.

Paquette, M.R., Napier, C., Willy, R.W., & Stellingwerff, T. (2020). Moving Beyond Weekly "Distance": Optimizing Quantification of Training Load in Runners. *Journal of Orthopaedic and Sports Physical Therapy, 50*(10), 564-569. doi:10.2519/jospt.2020.9533

Pascoe, C.J. (2012). *Dude, You're a Fag: Masculinity and Sexuality in High School*. Berkley, CA: University of California Press.

Pearson, O.M., & Buikstra, J.E. (2006). Behavior and the bones. In Buikstra, J.E. & Beck, L.A. (Eds.), *Bioarchaeology: The Contextual Analysis of Human Remains*, (pp. 207-225). Boston, MA: Academic Press.

Pearson, O.M., & Lieberman, D.E. (2004). The aging of Wolff's "Law": Ontogeny and responses to mechanical loading in cortical bone. *Yearbook of Physical Anthropology, 47*, 63-99. doi:10.1002/ajpa.20155

Perneger, T.V. (1998). What's wrong with Bonferroni adjustments. *British Medical Journal, 316*, 1236-1238.

Perry, E.M. (2004). *Bioarchaeology of labor and gender in the prehispanic American Southwest.* PhD Thesis, University of Arizona, Tucson, AZ.

Perry, E.M., & Joyce, R.A. (2001). Providing a Past for "Bodies That Matter": Judith Butler's Impact on the Archaeology of Gender. *International Journal of Sexuality and Gender Studies, 6*(1/2), 63-76. doi:10.1023/A:1010142023744

Phenice, T.W. (1969). A newly developed visual method of sexing the os pubis. *American Journal of Physical Anthropology, 30*(2), 297-301. doi:10.1002/ajpa.1330300214

Pinkhasov, R.M., Shteynshlyuger, A., Hakimian, P., Lindsay, G.K., Samadi, D.B., & Shabsigh, R. (2010). Are men shortchanged on health? Perspective on life expectancy, morbidity, and mortality in men and women in the United States. *International Journal of Clinical Practice, 64*(4), 465-474. doi:10.1111/j.1742-1241.2009.02289.x

Potter, H.G., Jain, S.K., Ma, Y., Black, B.R., Fung, S., & Lyman, S. (2012). Cartilage injury after acute, isolated anterior cruciate ligament tear: Immediate and longitudinal effect with clinical/MRI follow-up. *American Journal of Sports Medicine, 40*(2), 276-285. doi:10.1177/0363546511423380

Praneatpolgrang, S., Prasitwattanaseree, S., & Mahakkanukrauh, P. (2019). Age estimation equations using vertebral osteophyte formation in a Thai population: comparison and modified osteophyte scoring method. *Anatomy and Cell Biology, 52*(2), 149-160.

Prince-Buitenhuys, J.R., L. MacInnes, H.L., Milligan, C.F., & Bartelink, E.J. (2017). An exploration of skeletal evidence of injury recidivism in cases of transients and homelessness from Northern California. In Tegtmeyer, C.E. & Martin, D.L. (Eds.), *Broken Bones, Broken Bodies: Bioarchaeological and Forensic Approaches for Accumulative Trauma and Violence*, (pp. 183-200). New York, NY: Lexington Books.

Puhr, R., Heinze, G., Nold, M., Lusa, L., & Geroldinger, A. (2017). Firth's logistic regression with rare events: Accurate effect estimates and predictions? *Statistics in Medicine, 36*, 2302-2317.

Punzi, L., Galozzi, P., Luisetto, R., Favero, M., Ramonda, R., Oliviero, F., & Scanu, A. (2016). Post-traumatic arthritis: Overview on pathogenic mechanisms and role of inflammation. *RMD Open, 2*(2), e000279. doi:10.1136/rmdopen-2016-000279

Reber, S.L., & Simmons, T. (2015). Interpreting injury mechanisms of blunt force trauma from butterfly fracture formation. *Journal of Forensic Sciences, 60*(6), 1401-1411. doi:10.1111/1556-4029.12797

Redfern, R.C. (2006). *A gendered analysis of health from the iron age to the end of the Romano-British period in Dorset, England.* PhD Thesis, University of Birmingham, Birmingham, UK.

Redfern, R.C. (2017a). Identifying and Interpreting Domestic Violence in Archaeological Human Remains: A Critical Review of the Evidence. *International Journal of Osteoarchaeology, 27*(1), 13-34. doi:10.1002/oa.2461

Redfern, R.C. (2017b). *Injury and Trauma in Bioarchaeology: Interpreting Violence in Past Lives*. Cambridge, UK: Cambridge University Press.

Redfern, R.C., Judd, M.A., & DeWitte, S.N. (2017). Multiple injury and health in past societies: An analysis of concepts and approaches, and insights from a multi-period study. *International Journal of Osteoarchaeology, 27*(3), 418-429. doi:10.1002/oa.2565

Reeser, T.W. (2010). *Masculinities in Theory: An Introduction*. Malden, MA: Wiley-Blackwell.

Regan, J.C., & Partridge, L. (2013). Gender and longevity: Why do men die earlier than women? Comparative and experimental evidence. *Best Practice and Research Clinical Endocrinology and Metabolism, 27*(4), 467-479. doi:10.1016/j.beem.2013.05.016

Reiner, D.S., Pastena, J.A., Swan, K.G., Lindenthal, J.J., & Tischler, C.D. (1990). Trauma recidivism. *The American Surgeon, 56*(9), 556-560.

Riemann, R.L., & Lephart, S.M. (2002). The sensorimotor system, Part I: The physiologic basis of functional joint stability. *Journal of Athletic Training, 37*(1), 71-79.

Roach, H.I., & Tilley, S. (2007). The Pathogenesis of Osteoarthritis. In Bronner, F. & Farach-Carson, M.C. (Eds.), *Bone and Osteoarthritis*, (pp. 165-179). London, UK: Springer.

Robb, J. (2002). Time and Biography: Osteobiography of the Italian Neolithic Lifespan. In Hamilakis, F. & Pluciennik, M. (Eds.), *Thinking through the body: Archaeologies of corporeality*, (pp. 153-172). London: Kluwer Academic.

Roberts, C.A., & Cox, M. (2003). *Health And Disease In Britain: From Prehistory To The Present Day*. Gloucester, UK: Sutton Publishing.

Roberts, C.A., & Manchester, K. (2005). *The Archaeology of Disease* (3rd ed.). Ithaca, NY: Cornell University Press.

Robertson, S. (2007). *Understanding Men and Health: Masculinities, Identity, and Well-being*. New York, NY: McGraw-Hill.

Robinson, M., & Robertson, S. (2014). Challenging the field: Bourdieu and men's health. *Social Theory & Health*. doi:10.1057/sth.2014.8

Rogers, J. (2000). The palaeopathology of joint disease. In Cox, M. & Mays, S.A. (Eds.), *Human Osteology*, (pp. 163-182). London: Greenwich Medical Media.

Rogers, J., Shepstone, L., & Dieppe, P. (1997). Bone formers: Osteophyte and enthesophyte formation are positively associated. *Annals of the Rheumatic Diseases, 56*(2), 85-90. doi:10.1136/ard.56.2.85

Rogers, J., Waldron, T., Dieppe, P., & Watt, I. (1987). Arthropathies in Paleopathology - the Basis of Classification According to Most Probable Cause. *Journal of Archaeological Science, 14*(2), 179-193. doi:Doi 10.1016/0305-4403(87)90005-7

Rothschild, B.M. (1997). Porosity: A curiosity without diagnostic significance. *American Journal of Physical Anthropology, 104*(4), 529-533. doi:10.1002/(SICI)1096-8644(199712)104:4<529::AID-AJPA7>3.0.CO;2-M

Ruengdit, S., Troy Case, D., & Mahakkanukrauh, P. (2020). Cranial suture closure as an age indicator: A review. *Forensic Science International, 307*, 110111. doi:10.1016/j.forsciint.2019.110111

Ruff, C., Holt, B., & Trinkaus, E. (2006). Who's afraid of the big bad Wolff?: “Wolff's law” and bone functional adaptation. *American Journal of Physical Anthropology, 129*(4), 484-498. doi:10.1002/ajpa.20371

Sabo, D. (1994). Pigskin, patriarchy, and pain. In Messner, M.A. & Sabo, D. (Eds.), *Sex, Violence and Power in Sports: Rethinking Masculinities*. Freedom, CA: The Crossing Press.

Säger, P. (1969). *Spondylosis cervicalis. A pathological and osteoarchaeological study of osteochondrosis invertebralis cervicalis, arthrosis uncovertebralis and spondylarthrosis cervicalis*. Copenhagen, Denmark: Munksgaard.

Salih, S. (2007). On Judith Butler and performativity. In *Sexualities and Communication in Everyday Life: A Reader*, (pp. 55-68). Thousand Oaks, CA: SAGE.

Saul, F.P., & Saul, J.M. (1989). Osteobiography: A Maya example. In Iscan, M.Y. & Kennedy, K.A.R. (Eds.), *Reconstruction of Life from the Skeleton*, (pp. 287-302). New York: Alan R Liss.

Saunders, S.R., Fitzgerald, C., Rogers, T., Dudar, C., & McKillop, H. (1992). A Test of Several Methods of Skeletal Age Estimation using a Documented Archaeological Sample. *Canadian Society of Forensic Science Journal, 25*(2), 97-118. doi:10.1080/00085030.1992.10757005

Saunders, S.R., & Hoppa, R.D. (1993). Growth deficit in survivors and non-survivors: Biological mortality bias in subadult skeletal samples. *Yearbook of Physical Anthropology, 36*(S17), 127-151. doi:10.1002/ajpa.1330360608

Schett, G., Stolina, M., Dwyer, D., Zack, D., Uderhardt, S., Kronke, G., Kostenuik, P., & Feige, U. (2009). Tumor necrosis factor alpha and RANKL blockade cannot halt bony spur formation in experimental inflammatory arthritis. *Arthritis Rheum, 60*(9), 2644-2654. doi:10.1002/art.24767

Schofield, T., Connell, R.W., Walker, L., Wood, J.F., & Butland, D.L. (2000). Understanding men's health and illness: a gender-relations approach to policy, research, and practice. *Journal of American College Health, 48*(6), 247-256. doi:10.1080/07448480009596266

Schrader, S.A., & Smith, S.T. (2017). Socializing violence: Interpersonal violence recidivism at Abu Fatima (Sudan). In Tegtmeyer, C.E. & Martin, D.L. (Eds.), *Broken Bones, Broken Bodies: Bioarchaeological and Forensic Approaches for Accumulative Trauma and Violence*, (pp. 27-42). New York, NY: Lexington Books.

Schrock, D., & Schwalbe, M. (2009). Men, masculinity, and manhood acts. *Annual Review of Sociology, 35*(1), 277-295. doi:10.1146/annurev-soc-070308-115933

Schultz, A.H. (1923). Fetal growth in man. *American Journal of Physical Anthropology, 6*(4), 389-399. doi:10.1002/ajpa.1330060404

Schünemann, J., Strulik, H., & Trimborn, T. (2017). The gender gap in mortality: How much is explained by behavior? *Journal of Health Economics, 54*, 79-90. doi:10.1016/j.jhealeco.2017.04.002

Schwalbe, M. (2005). Identity stakes, manhood acts, and the dynamics of accountability. *Studies in Symbolic Interaction, 28*, 65-81. doi:10.1016/S0163-2396(04)28010-3

Sedgwick, P. (2010). Multiple significance tests. *British Medical Journal, 340*, c2963. doi:10.1136/bmj.c2963

Sedgwick, P. (2012). Multiple significance tests: The Bonferroni correction. *British Medical Journal, 344*, e509. doi:10.1136/bmj.e509

Sell, T., & Lephart, S. (2010). Differences in neuromuscular characteristics between male and female athletes. In Noyes, F.R. (Ed.), *Knee Disorders: Surgery, Rehabilitation, Clinical Outcomes*, (pp. 404-414). Philadelphia, PA: Elsevier.

Senior, W.A. (1994). Medieval Literature and Modern Fantasy: Toward a Common Metaphysic. *Journal of the Fantastic in the Arts, 3*(3.4), 32-49.

Shibakawa, A., Yudoh, K., Masuko-Hongo, K., Kato, T., Nishioka, K., & Nakamura, H. (2005). The role of subchondral bone resorption pits in osteoarthritis: MMP production by cells derived from bone marrow. *Osteoarthritis Cartilage, 13*(8), 679-687. doi:10.1016/j.joca.2005.04.010

Sigmon, B.A. (1971). Bipedal behavior and the emergence of erect posture in man. *American Journal of Physical Anthropology, 34*(1), 55-60. doi:10.1002/ajpa.1330340105

Sizer, P.S., & James, C.R. (2008). Considerations of sex differences in musculoskeletal anatomy. In Robert-McComb, J.J., Norman, R., & Zumwalt, M. (Eds.), *The Active Female*, (pp. 25-54). New York, NY: Springer.

Skogstrand, L. (2011). Is Androcentric Archaeology Really About Men? *Archaeologies, 7*(1), 56-74. doi:10.1007/s11759-010-9149-1

Smith, M.O. (1996). 'Parry' fractures and female-directed interpersonal violence: Implications from the Late Archaic Period of west Tennessee. *International Journal of Osteoarchaeology, 6*(1), 84-91. doi:10.1002/(sici)1099-1212(199601)6:1<84::Aid-oa262>3.0.Co;2-g

Sofaer, J.R. (2000). Sex differences in activity-related osseous change in the spine and the gendered division of labor at Ensay and Wharram Percy, UK. *American Journal of Physical Anthropology, 111*(3), 333-354. doi:10.1002/(SICI)1096-8644(200003)111:3<333::AID-AJPA4>3.0.CO;2-K

Sofaer, J.R. (2006a). *The Body as Material Culture: A Theoretical Osteoarchaeology*. Cambridge: Cambridge University Press.

Sofaer, J.R. (2006b). Gender bioarchaeology and human ontogeny. In Gowland, R. & Knüsel, C.J. (Eds.), *Social Archaeology of Funerary Remains*, (pp. 155-167). Oxford: Oxbow Books.

Sofaer, J.R. (2006c). Sex and gender. In *The Body as Material Culture: A Theoretical Osteoarchaeology*, (pp. 89-116). Cambridge: University of Cambridge Press.

Sofaer, J.R. (2013). Bioarchaeological approaches to the gendered body. In Bolger, D. (Ed.), *A Companion to Gender Prehistory*, (pp. 226-243). Malden, MA: Wiley & Sons.

Soficaru, A., & Constantinescu, M. (2013). *Codebook for Anthropological Analysis*. Francisc J. Rainer Institute of Anthropology, Romanian Academy.

Solomonow, M., & Krogsgaard, M. (2001). Sensorimotor control of knee stability. A review. *Scandinavian Journal of Medicine and Science in Sports, 11*(2), 64-80. doi:10.1034/j.1600-0838.2001.011002064.x

Sørensen, M.L.S. (2000). *Gender Archaeology*. Malden, MA: Blackwell.

Springer, K., & Mouzon, D. (2011). "Macho men" and preventive health care: Implications for older men in different social classes. *Journal of Health and Social Behaviour, 52*(2), 212-227.

Stan, C. (2017). Alba Iulia medieval fortress aerial view at sunset. In *Adobe Stock*.

StataCorp. (2021). *Stata Statistical Software: Release 17.* College Station, TX: StataCorp LLC.

Steckel, R.H., Spencer Larsen, C., Sciulli, P.W., & Walker, P.L. (2006). *Data Collection Codebook*. Global History of Health Project. Ohio State University.

Stirland, A.J. (2001). *Raising the Dead the Skeleton Crew of King Henry VIII's Great Ship, the Mary Rose*. Chichester, UK: Wiley.

Stloukal, M., & Hanáková, H. (1978). Die Länge der Längsknochen altslawischer Bevölkerungen – Unter besonderer Berücksichtigung von Washstumsfragen. *Homo, 29*(59), 69-69.

Stodder, A.L.W., & Palkovich, A.M. (2012). *The Bioarchaeology of Individuals*. Gainseville, FL: University Press of Florida.

Stone, A.C. (2008). DNA analysis of archaeological remains. In Katzenberg, M.A. & Saunders, S.R. (Eds.), *Biological Anthropology of the Human Skeleton*, (2nd ed., pp. 461-483). Hoboken, NJ: Wiley-Liss.

Stone, P.K. (Ed.) (2018). *Bioarchaeological Analyses and Bodies: New Ways of Knowing Anatomical and Archaeological Skeletal Collections*. Cham, Switzerland: Springer.

Sundman, E.A. (2022). Diverse masculinities in violence and warfare: A case study of individuals with perimortem weapon-related trauma buried at a Dominican Priory in Västerås, Sweden. *Norwegian Archaeological Review, 55*(1), 1-20. doi:10.1080/00293652.2021.2010798

Sundman, E.A., & Kjellström, A. (2020). Medieval masculinities and violence: Weapon-related trauma in skeletal assemblages from two religious houses in Iceland and Sweden. *European Journal of Archaeology, 23*(4), 567-584. doi:10.1017/eaa.2020.20

Szende, K. (2018). The urban economy of Medieval Hungary. In Laszlovszky, B., Nagy, P., Szabó, P., & Vadas, A. (Eds.), *The Economy of Medieval Hungary*, (pp. 335-358). Leiden, The Netherlands: Brill.

Tegtmeyer, C.E., & Martin, D.L. (Eds.). (2017). *Broken Bones, Broken Bodies: Bioarchaeological and Forensic Approaches for Accumulative Trauma and Violence*. London, UK: Lexington Books.

Teo, S.H., Fong, K.N.K., Chen, Z., & Chung, R.C.K. (2020). Cognitive and psychological interventions for the reduction of post-concussion symptoms in patients with mild traumatic brain injury: a systematic review. *Brain Injury, 34*(10), 1305-1321. doi:10.1080/02699052.2020.1802668

Thomas, J. (2002). Archaeology's humanism and the materiality of the body. In Hamilakis, Y., Pluciennik, M., & Tarlow, S. (Eds.), *Thinking Through the Body: Archaeologies of Corporeality*, (pp. 29-46). New York: Kluwer Academic / Plenum.

Tiesler, V. (2014). *The Bioarchaeology of Artificial Cranial Modifications*. New York, NY: Springer.

Todd, T.W. (1920). Age changes in the pubic bone I. The male white pubis. *American Journal of Physical Anthropology, 3*(3), 285-334.

Tomczyk, J., Nieczuja-Dwojacka, J., Zalewska, M., Niemiro, W., & Olczyk, W. (2017). Sex estimation of upper long bones by selected measurements in a Radom (Poland) population from the 18th and 19th centuries AD. *Anthropological Review, 80*(3), 287-300. doi:10.1515/anre-2017-0019

Torres-Rouff, C. (2012). Piercing the body: Labret use, identity, and masculinity in prehistoric chile. In Baadsgaard, A., Boutin, A.T., & Buikstra, J.E. (Eds.), *Breathing New Life into the Evidence of Death: Contemporary Approaches to Bioarchaeology*, (pp. 153-178). Santa Fe, NM: School for Advanced Resaearch Press.

Torres-Rouff, C., & King, L.M. (2014). Face me like a man! (or, like a woman): Antemortem nasal fractures in pre-Columbian San Pedro de Atacama. In Martin, D.L. & Anderson, C.P. (Eds.), *Bioarchaeological and Forensic Perspectives on Violence*, (pp. 134-147). Cambridge, UK: Cambridge University Press.

Torres-Rouff, C., & Knudson, K.J. (2017). Integrating Identities: An Innovative Bioarchaeological and Biogeochemical Approach to Analyzing the Multiplicity of Identities in the Mortuary Record. *Current Anthropology, 58*(3), 381-409. doi:10.1086/692026

Trigger, B.G. (2006). *A History of Archaeological Thought* (2nd ed.). Cambridge, UK: Cambridge University Press.

Trotter, M., & Gleser, G.C. (1952). Estimation of stature from long bones of American Whites and Negroes. *American Journal of Physical Anthropology, 10*(4), 463-514. doi:10.1002/ajpa.1330100407

Truesdale, M. (2018). *The Kind and Commoner Tradition: Carnivalesque Politics in Medieval and Early Modern Literature*. New York, NY: Routledge.

Tsutaya, T., & Yoneda, M. (2015). Reconstruction of breastfeeding and weaning practices using stable isotope and trace element analyses: A review. *Yearbook of Physical Anthropology, 156*, 2-21. doi:10.1002/ajpa.22657

Tung, T.A. (2012). Violence against women: Differential treatment of local vs. foreign females in the heartland of the Wari empire, Peru. In Martin, D.L., Harrod, R.P., Pérez, & Ventura, R. (Eds.), *The Bioarchaeology of Violence*, (pp. 180-198). Gainseville, FL: University Press of Florida.

Tung, T.A. (2014). Agency, 'til death do us part? Inquiring about the agency of dead bodies from the ancient Andes. *Cambridge Archaeological Journal, 24*(November 2014), 437-452. doi:10.1017/S0959774314000614

Turner, C., McClure, R., & Pirozzo, S. (2004). Injury and risk-taking behavior—A systematic review. *Accident Analysis and Prevention, 36*(1), 93-101. doi:10.1016/S0001-4575(02)00131-8

Turner, W.J., & Lee, C. (2018). *Trauma in Medieval Society*. Boston, MA: Brill.

Ubelaker, D.H. (1989). *Human skeletal remains: Excavation, analysis, interpretation* (2nd ed.). Washington, DC: Taraxacum.

Urquhart, D.M., Tobing, J.F.L., Hanna, F.S., Berry, P., Wluka, A.E., Ding, C., & Cicuttini, F.M. (2011). What Is the effect of physical activity on the knee joint? A systematic review. *Medicine and Science in Sports and Exercise, 43*(3), 432-442. doi:10.1249/MSS.0b013e3181ef5bf8

van Beuningen, H.M., Glansbeek, H.L., van der Kraan, P.M., & van den Berg, W.B. (2000). Osteoarthritis-like changes in the murine knee joint resulting from intra-articular transforming growth factor-beta injections. *Osteoarthritis and Cartilage, 8*(1), 25-33. doi:10.1053/joca.1999.0267

van der Kraan, P.M., & van den Berg, W.B. (2007). Osteophytes: relevance and biology. *Osteoarthritis and Cartilage, 15*(3), 237-244. doi:10.1016/j.joca.2006.11.006

Van der Merwe, A.E., Işcan, M.Y., & L'Abbè, E.N. (2006). The pattern of vertebral osteophyte development in a South African population. *International Journal of Osteoarchaeology, 16*(5), 459-464. doi:10.1002/oa.841

van Lenthe, F., & Mackenbach, J.P. (2021). Socioeconomic inequalities in health in high-income countries: The facts and the options. In Detels, R., Karim, Q.A., Baum, F., Li, L., & Leyland, A.H. (Eds.), *Oxford Textbook of Global Public Health*. Oxford, UK: Oxford University Press.

Venne, G., Tse, M.Y., Pang, S.C., & Ellis, R.E. (2020). Mechanically-induced osteophyte in the rat knee. *Osteoarthritis Cartilage, 28*(6), 853-864. doi:10.1016/j.joca.2020.02.834

Ventades, N.G., Laza, I.M., Hervella, M., & de-la-Rúa, C. (2018). A recording form for differential diagnosis of arthropathies. *International Journal of Paleopathology, 20*, 45-49. doi:10.1016/j.ijpp.2018.01.004

Vigelsø, A., Gram, M., Wiuff, C., Andersen, J.L., Helge, J.W., & Dela, F. (2015). Six weeks' aerobic retraining after two weeks' immobilization restores leg lean mass and aerobic capacity but does not fully rehabilitate leg strenght in young and older men. *Journal of Rehabilitation Medicine, 47*(6), 552–560.

Villotte, S., & Knüsel, C.J. (2013). Understanding entheseal changes: Definition and life course changes. *International Journal of Osteoarchaeology, 23*(2), 135-146. doi:10.1002/oa.2289

Villotte, S., & Knüsel, C.J. (2014). “I sing of arms and of a man…”: medial epicondylosis and the sexual division of labour in prehistoric Europe. *Journal of Archaeological Science, 43*, 168-174. doi:10.1016/j.jas.2013.12.009

Villotte, S., & Santos, F. (2022). The effect of age on entheseal changes: A study of modifications at appendicular attachment sites in a large sample of identified human skeletons. *International Journal of Osteoarchaeology*, 1-13.

Volpi, E., Nazemi, R., & Fujita, S. (2004). Muscle tissue changes with aging. *Current Opinions on Clincal Nutriton and Metabolic Care, 7*(4), 405-410. doi:10.1097/01.mco.0000134362.76653.b2

Waldron, T. (1994). *Counting the Dead: The Epidemiology of Skeletal Populations*. Chichester, UK: John Wiley and Sons.

Waldron, T. (1995). Changes in the distribution of osteoarthritis over historical time. *International Journal of Osteoarchaeology, 5*(4), 385-389. doi:10.1002/oa.1390050409

Waldron, T. (2007). *Palaeoepidemiology: The Epidemiology of Human Remains*. Left Coast Press: Walnut Creek, CA.

Waldron, T. (2009). *Palaeopathology*. Cambridge, UK: Cambridge University Press.

Waldron, T. (2012). Joint disease. In Grauer, A.L. (Ed.), *A Companion to Paleopathology*, (pp. 513-530). Malden, MA: Wiley-Blackwell.

Walker, P.L. (1995). Problems of preservation and sexism in sexing: some lessons from historical collections for palaeodemographers. In Saunders, S.R. & Herring, A. (Eds.), *Grave Reflections: Portraying the Past Through Cemetery Studies*, (Vol. 18, pp. 31-48). Toronto: Canadian Scholars" Press.

Walker, P.L. (2001). A bioarchaeological perspective on the history of violence. *Annual Review of Anthropology, 30*, 573-596.

Walker, P.L. (2005). Greater sciatic notch morphology: Sex, age, and population differences. *American Journal of Physical Anthropology, 127*(4), 385-391. doi:10.1002/ajpa.10422

Walker, P.L., & Collins Cook, D. (1998). Gender and sex: Vive la difference. *American Journal of Physical Anthropology, 106*(2), 255-259. doi:10.1002/(sici)1096-8644(199806)106:2<255::aid-ajpa11>3.0.co;2-#

Walker, P.L., Johnson, J.R., & Lambert, P.M. (1988). Age and sex biases in the preservation of human skeletal remains. *American Journal of Physical Anthropology, 76*(2), 183-188. doi:10.1002/ajpa.1330760206

Wallace, I.J., Riew, G.J., Landau, R., Bendele, A.M., Holowka, N.B., Hedrick, T.L., Konow, N., Brooks, D.J., & Lieberman, D.E. (2022). Experimental evidence that physical activity inhibits osteoarthritis: Implications for inferring activity patterns from osteoarthritis in archeological human skeletons. *American Journal of Biological Anthropology, 177*(2), 223-231. doi:10.1002/AJPA.24429

Washburn, S.L. (1951). The new physical anthropology. *Transactions of the New York Academy of Sciences, 13*(7 Series II), 298-304.

Weaver, D.S. (1998). Osteoporosis in the bioarchaeology of women. In Grauer, A.L. & Stuart-Macadam, P. (Eds.), *Sex and Gender in Paleopathological Perspective*, (pp. 27-44). Cambridge, UK: Cambridge University Press.

Wedel, V., & Galloway, A. (2014). *Broken Bones: Anthropological Analysis of Blunt Force Trauma* (2nd ed.). Springfield, IL: Charls C. Thomas.

Weiss, E. (2009a). *Bioarchaeological Science: What We Have Learned from Human Skeletal Remains*. New York: Nova Science Publishers.

Weiss, E. (2009b). Reconstructing activity patterns: Making dead people move. In *Bioarchaeological Science: What we have Learned from Human Skeletal Remains*, (pp. 9-36). New York: Nova Science Publishers.

Weiss, E., & Jurmain, R.D. (2007). Osteoarthritis Revisited: A Contemporary Review of Aetiology. *International Journal of Osteoarchaeology, 17*(8), 437-450. doi:10.1002/oa

Wescott, D.J. (2015). Sexual dimorphism in auricular surface projection and postauricular sulcus morphology. *Journal of Forensic Sciences, 60*(3), 679-685. doi:10.1111/1556-4029.12737

Wesp, J.K. (2013). Embodied subjectivities within bioarchaeological research in colonial Mexico. In Rodríguez-Shadow, D.R.M. & Kellogg, S. (Eds.), *Género y Arqueología en Mesoamérica: Homenaje a Rosemary A. Joyce*, (pp. 191-206). Mexico: Centro de Estudios de Antropología de la Mujer.

Wesp, J.K. (2014). *Bodies of Work: Organization of Everyday Life Activities in Urban New Spain.* PhD Thesis, University of California, Berkeley, CA.

Wesp, J.K. (2015). Bioarchaeological perspectives on the materiality of everyday life activities. *Archeological Papers of the American Anthropological Association, 26*(1), 139-148. doi:10.1111/apaa.12067

Wesp, J.K. (2017). Embodying sex/gender systems in bioarchaeological research. In Agarwal, S.C. & Wesp, J.K. (Eds.), *Exploring Sex and Gender in Bioarchaeology*, (pp. 99-126). Albuquerque, NM: University of New Mexico Press.

White, T.D., Black, M.T., & Folkens, P.A. (2012). *Human Osteology*. New York, USA: Elsevier Academic Press.

White, T.D., & Folkens, P.A. (2005). *The Human Bone Manual*. Amsterdam: Elsevier.

Whitehead, S., Talahite-Moodley, A., & Moodley, R. (2013). *Gender and Identity: Key Themes and New Directions*. Oxford, UK: Oxford University Press.

Whitehead, S.M. (2002). *Men and Masculinities: Key Themes and New Directions*. Cambridge: Polity.

Whitehead, S.M., & Barrett, F.J. (2001a). *The Masculinities Reader*. Cambridge: Polity.

Whitehead, S.M., & Barrett, F.J. (2001b). The sociology of masculinity. In Whitehead, S.M. & Barrett, F.J. (Eds.), *The Masculinities Reader*, (pp. 1-26). Cambridge: Polity.

WHO. (2002). *World Report on Violence and Health*. Geneva: World Health Organization.

WHO. (2020). *Mental health, men and culture: how do sociocultural constructions of masculinities relate to men's mental health help-seeking behaviour in the WHO European Region?* Copenhagen, Denmark: World Health Organization.

WHO. (2022). Social Determinants of Health. Retrieved from https://www.who.int/health-topics/social-determinants-of-health. Accessed on March 24, 2024.

Wiedmer, P., Jung, T., Castro, J.P., Pomatto, L.C.D., Sun, P.Y., Davies, K.J.A., & Grune, T. (2021). Sarcopenia - Molecular mechanisms and open questions. *Ageing Research Reviews, 65*, 101200. doi:10.1016/j.arr.2020.101200

Wilkinson, D.J., Piasecki, M., & Atherton, P.J. (2018). The age-related loss of skeletal muscle mass and function: Measurement and physiology of muscle fibre atrophy and muscle fibre loss in humans. *Ageing Research Reviews, 47*, 123-132. doi:10.1016/j.arr.2018.07.005

Winter, D.A. (1983). Energy generation and absorption at the ankle and knee during fast, natural and slow cadences. *Clinical Orthopaedics and Related Research, 175*, 147-154.

Wong, S.H., Chiu, K.Y., & Yan, C.H. (2016). Review Article: Osteophytes. *Journal of Orthopedic Surgery (Hong Kong), 24*(3), 403-410. doi:10.1177/1602400327

Wood, J.W., Milner, G.R., Harpending, H.C., & Weiss, K.M. (1992). The Osteological Paradox: Problems of inferring prehistoric health from skeletal samples. *Current Anthropology, 33*(4), 343-370.

Wright, L.E., & Yoder, C.J. (2003). Recent progress in bioarchaeology: Approaches to the osteological paradox. *Journal of Archaeological Research, 11*(1), 43-70. doi:10.1023/A:1021200925063

Wuermser, L.A., Achenbach, S.J., Amin, S., Khosla, S., & Melton, L.J., 3rd. (2011). What accounts for rib fractures in older adults? *Journal of Osteoporosis, 2011*, 457591. doi:10.4061/2011/457591

Wylie, A. (1991). Gender theory and the archaeological record: Why is there no archaeology of gender. In *Engendering Archaeology: Women and Prehistory*, (pp. 31-54). Oxford: Blackwell.

Yaussy, S.L. (2021). Intersectionality and the interpretation of past pandemics. *Bioarchaeology International, 6*(1-2), 58-76.

Yoder, C.J., Ubelaker, D.H., & Powel, J.F. (2001). Examination of variation in sternal rib end morphology relevant to age assessment. *Journal of Forensic Sciences, 46*(2), 223-227.

Young, I.M. (1980). Throwing like a girl: A phenomenology of feminine body comportment motility and spatiality. *Human Studies, 3*(2), 137-156.

Zhang, Y., & Bierma-Zeinstra, S.M.A. (2023). Diagnosis, risk factors for OA development and progression, OA prevention, and recognizing comorbidities. In Hunter, D.J. & Eyles, J.P. (Eds.), *Osteoarthritis Health Professional Training Manual*, (pp. 39-53). London, UK: Academic Press.

Zuckerman, M.K. (2017). Mercury in the midst of Mars and Venus: Reconstructing gender, sexuality, and socioeconomic status in relation to mercury treatment for syphilis in seventeenth- to nineteenth-century London. In Agarwal, S.C. & Wesp, J.K. (Eds.), *Exploring Sex and Gender in Bioarchaeology*, (pp. 223-261). Albuquerque, NM: University of New Mexico Press.

Zuckerman, M.K. (2020). Gender in bioarchaeology. In Cheverko, C.M., Prince-Buitenhuys, J.R., & Hubbe, M. (Eds.), *Theoretical Approaches in Bioarchaeology*, (pp. 28-44). New York, NY: Routledge.

Zuckerman, M.K., & Armelagos, G.J. (2011). The origins of the biocultural dimensions in bioarchaeology. In Agarwal, S.C. & Glencross, B.A. (Eds.), *Social Bioarchaeology*, (pp. 15-43). Malden, MA: Wiley-Blackwell.

Zuckerman, M.K., & Crandall, J. (2019). Reconsidering sex and gender in relation to health and disease in bioarchaeology. *Journal of Anthropological Archaeology, 54*, 161-171. doi:10.1016/j.jaa.2019.04.001

Zuckerman, M.K., Malis, S.W., Dillon, D.D., Widrick, K.J., Adams, E.J., Hill, M.E., McKenna, M.K., Baumgartel, O.C., & Willis, H.D. (2023). Sex, gender, and sexuality in paleopathology: Select current developments and pathways forward. *International Journal of Paleopathology, 41*, 8-21. doi:10.1016/j.ijpp.2023.02.002