University of Southampton

Faculty of Environmental and Life Sciences

Geography and Environmental Science

Understanding Smoking Behaviour in LGB Populations Across Great Britain: Quantitative Analyses Using Secondary Data

by

Megan Davies

Thesis for the degree of Doctor of Philosophy (PhD)

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Abstract

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This thesis is the first to examine the associations between sexuality and smoking behaviour in Great Britain, using quantitative analyses of secondary data sources. Drawing on previous literature from geography, psychology and epidemiology, the thesis aims to understand the factors associated with greater smoking prevalence in lesbian, gay and bisexual (LGB) populations, how LGB smoking has changed over time, and whether different measures of sexuality impact smoking and co-behaviour likelihood. Whilst recent calls to reduce smoking prevalence in Great Britain have acknowledged inequalities between LGB and heterosexual populations, few studies in Great Britain have examined smoking trends and patterns in this population beyond prevalence rates. Much of the previous research looking at sexuality and smoking behaviour has been carried out in the United States, where contextual differences mean findings cannot be generalised. This thesis uses multilevel modelling to examine individual and environmental factors in smoking behaviour and patterns to draw comparisons across Great Britain between LGB and heterosexual populations. Findings suggest that, in Great Britain, inequalities in smoking persist between LGB people and heterosexual populations, and also within LGB groups. Across Great Britain, LGB people in certain areas may be more affected by smoking inequalities, and sexual minority women are amongst the most affected. Anti-smoking policies should address these inequalities by taking into account variations by place and recognising that sexual minority populations are more vulnerable.

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Research Thesis: Declaration of Authorship

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

Title of thesis: Understanding Smoking Behaviour in LGB populations Across Great Britain: Quantitative Analysis Using Secondary Data

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. Parts of this work have been published as:-
   Davies, M., Lewis, N. & Moon, G. (2018). Sexuality, space, gender, and health: Renewing geographical approaches to well-being in lesbian, gay, bisexual, transgender and queer populations. Geography Compass, 12(5), 1-11. https://doi.org/10.1111/gec3.12369
   Davies, M., Lewis, N. & Moon, G. (2019) Differential pathways into smoking among sexual orientation and social class groups in England: A structural equation model. Drug and Alcohol Dependence, 201, 1-7. https://doi.org/10.1016/j.drugalcdep.2019.04.012
8. I confirm that the papers cited above were co-authored by myself and my supervisors Nathaniel Lewis and Graham Moon. These papers were developed by myself after discussing the structure and research ideas for this thesis. Nathaniel and Graham gave advice on structure of the papers and gave feedback on drafts of the paper before submission. All empirical analysis was undertaken by myself.

Signature: ..... Date: .....

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Definitions and Abbreviations

BHPS	British Household Panel Survey
HSE	Health Survey for England
LGB	Lesbian, gay and bisexual
GB	Great Britain
MQL	Marginal Quasi-Likelihood
MCMC	Markov Chain Monte Carlo
MLM	Multilevel modelling
MSM	Men who have sex with men
NATSAL	National Survey of Sexual Attitudes and Lifestyles
NHS	National Health Service
PQL	Penalised Quasi-Likelihood
SEM	Structural equation modelling
SM	Sexual minority
TCP	Tobacco control plan
UK	United Kingdom
US	Understanding Society
USA	United States of America
WSW	Women who have sex with women

Chapter 1 Introduction

Lesbian, gay and bisexual (LGB) individuals disproportionately experience health inequalities compared to their heterosexual counterparts (Meads et al., 2009; Zeeman et al., 2018). Poorer health outcomes, including both physical and mental health outcomes, have been associated with identifying as LGB. Engaging in 'risky' health behaviours is also associated with sexuality, including hazardous alcohol use, illicit drug use and smoking (Kerr et al., 2014; Reisner et al., 2013). The persistent prevalence of health risk behaviours and inequalities between LGB and heterosexual individuals suggests more research is needed to understand why LGB individuals are unequally affected.

In 2017, 1.1 million individuals aged 16 and over identified as LGB in the UK (Office for National Statistics, 2019a). Due to years of previous oppressive legislations and marginalisation, LGB populations remain vulnerable to stigma and prejudice. Despite improved equality for LGB populations through changes in recent policies, for example the Marriage (Same Sex Couples) Act which passed in 2013 (Government Equalities Office, 2014), discrimination persists, which may be associated with poorer mental wellbeing and a higher prevalence of engaging in risky health behaviours than for heterosexual individuals. However, the link between sexuality, or identifying as LGB, and engaging in health risk behaviours is complex, and includes factors such as the influence of individual's environment, their mental wellbeing and social norms within communities.

Engaging in health risk behaviours has implications for both individuals and health systems, in terms of the negative health effects associated that can lead to poor health outcomes and place a significant strain on the National Health Service (NHS). Smoking tobacco has been found to be the largest risk factor for developing cancer in the United Kingdom (UK), and alcohol use is also linked to certain cancers (Parkin et al., 2011). Smoking also increases the risk of chronic obstructive pulmonary disease and cardiovascular disease (World Health Organization, 2012), and long term smoking is associated with a life expectancy of an estimated 10 years less than non-smokers. Alcohol use is also a risk factor in developing cancer and other diseases such as heart disease and stroke (Scarborough et al., 2011). The use of alcohol and other substances such as illicit drugs can also have short term implications, such as affecting cognitive processes and increasing the likelihood of engaging in unsafe sexual behaviours (Bellis et al., 2008), and increasing the risk of harm and injury from alcohol or drug related accidents (Borges et al., 2006). Smoking tobacco is estimated to cost the NHS £2.7 billion annually, which includes hospital admissions, GP visits and prescriptions, but costs to society including loss of productivity and the effects of passive smoking

are estimated to be much higher (Csikar et al., 2016; Snowdon & Tovey, 2017). These costs, coupled with the individual risks and reduction in quality of life, demonstrates the importance of focusing on improving health and reducing the prevalence of risky health behaviours, particularly smoking, in a population that faces significant health inequalities.

This thesis focuses on smoking for several reasons. Firstly, the implications involved with smoking demonstrate the huge burden smoking places on health systems and individuals. Smoking is the biggest preventable cause of early death and disease in high-income countries, and has a strong association with inequality and use in vulnerable groups (Garner & Ratschen, 2013). Secondly, light or social smoking still carries significant health risks. Even the effects of passive smoking have been found to be associated with as many health risks, such as cardiovascular diseases and cancer, as active smoking (Shane et al., 2010). Smoking is therefore unlike some other health risk behaviours such as alcohol use which can be consumed in moderation to mitigate health implications. Finally, evidence suggests smoking may facilitate engaging in other health damaging behaviours, such as risky alcohol use and cannabis use (Garner & Ratschen, 2013).

This thesis aims to untangle how sexuality is associated with inequality in terms of engaging in health risk behaviours, particularly focussing on smoking. The aim is to better understand why LGB individuals may be more likely to smoke and engage in health-damaging behaviours and how smoking patterns vary compared to heterosexual individuals, in the context of Great Britain (GB). Understanding how smoking in this population has changed over time and space, particularly in light of changing smoking policies that have been implemented in GB over the past three decades, is important in determining if trends exist across GB that might suggest certain places play a role in increased prevalence of smoking in this population.

This chapter discusses the rationale for investigating smoking behaviour in LGB populations in this thesis, and the importance and novelty of using a geographical approach when addressing the research gaps in this area. The structure of this thesis is also discussed in this chapter.

1.1 Health inequalities in LGB populations

LGB individuals are amongst some of the most marginalised populations in GB, at risk of several types of inequalities. Social inequalities due to being part of a marginalised group are evident in this population, with LGB individuals at greater risk of bullying in schools and higher education, discrimination in employment which limits the possibility for progression, and an increased likelihood of being a victim of a hate crime (Hudson-Sharp & Metcalf, 2016). In addition, research has identified a link between sexuality and health inequalities, with those identifying as LGB more vulnerable to communicable and non-communicable diseases. For example, men who have sex

with men (MSM) are at greater risk of sexually transmitted infections (STIs) including HIV infection, and other infections including gonorrhoea, syphilis and hepatitis. For women identifying as lesbian or bisexual, an increased risk of cancers such as breast and ovarian cancers have been reported, which is suggested to be related to fewer pregnancies (Boehmer et al., 2007; Hafeez et al., 2017). Sexual minority women may also be at an increased risk of cervical cancer, as they are often informed screening is unnecessary, despite sexual activity being higher risk in this population in terms of previous sexual partners, unsafe sex and lower age of first time sexual intercourse (Meads et al., 2012).

In addition to poorer physical health outcomes, LGB individuals are at greater risk of experiencing adverse mental health conditions, such as anxiety and depression (Lewis, 2009). Suicide ideation in the UK has been found to be between 42-48% in LGB populations compared to 14.9% in the general population (Meads et al., 2009), and LGB individuals are more likely to self-harm than heterosexual individuals (Taylor et al., 2018). Research in this area has particularly focused on LGB youths who appear to be at a heightened risk of self-harm (Hughes et al., 2018). Other mental health issues in this population include a greater risk of eating disorders (Meads et al., 2012), and older LGB adults may be more likely to experience social isolation (Fredriksen-Goldsen et al., 2015). Increased prevalence and reporting of mental health issues in LGB populations has been suggested to largely stem from societal and internalised stigma and homophobia, as well as acts of discrimination and prejudice (Meyer, 2003).

1.2 Smoking and other health risk behaviours

LGB individuals are also more likely than heterosexual individuals to report engaging in health risk behaviours, including higher rates of risky alcohol use, illicit drug use and tobacco consumption. Research has drawn attention to inequalities in smoking rates particularly between LGB and heterosexual individuals, as studies have consistently shown that smoking prevalence is higher in LGB populations (Fallin et al., 2015a; Fish et al., 2019b; Shahab et al., 2017) and they are less likely to be successful in quitting smoking (Matthews et al., 2013). In addition, whilst smoking rates are generally declining since the introduction of tobacco control policies, the prevalence in LGB populations appears to remain higher (Office for National Statistics, 2018). However, with the majority of research around this topic being carried out in the United States, there is a less clear picture of how sexuality is implicated in smoking inequalities in the context of GB. Some research indicates that common factors such as stress and poorer mental wellbeing might be driving smoking rates in GB similarly to in the United States, but there is a need for more studies in GB in this area.

Reducing initiation of smoking and increasing cessation rates amongst current smokers is a priority for public health in the UK, as current estimates of smoking prevalence show 15% of the adult population smoke in the UK (Department of Health, 2017). GB has some of the best anti-smoking policies worldwide, implemented to reduce public smoking, reduce the effects of second-hand smoking, and improve cessation (Brown et al., 2014). Higher smoking rates are particularly concentrated in certain populations including ethnic minority groups, low social class groups, and LGB populations. Whilst health education and smoking campaigns have been largely targeted towards reducing smoking in the general population, now is the time to focus smoking interventions and gain a better understanding of the groups affected by smoking inequalities. The Tobacco Control Plan (TCP), released in 2017, aims to reduce smoking rates to 12% by 2022 (Department of Health, 2017). The document addresses and acknowledges the inequalities between different populations in England, including LGB individuals. Yet, whilst the plan is heavy on acknowledging these inequalities and implementing objectives for reducing smoking in lower social class groups, it is light on aims and measures for reducing smoking specifically in LGB populations, despite them being one of the most at-risk groups.

Other health risk behaviours have also been associated with identifying as LGB. Risky alcohol use, which includes binge drinking and heavier alcohol consumption, has been found to be higher amongst LGB individuals compared to heterosexual individuals (Ebersole et al., 2012). Sexual minority youths particularly have been found to be more likely to binge drink than their heterosexual peers, with lesbian and bisexual females at greater risk (Fish et al., 2019a). Additionally, illicit drug use such as cannabis use is also higher in the LGB population, which has been found to be linked to other risk behaviours including a greater number of sexual partners in LGB youths, which can increase the risk of unsafe sex and STIs (Zhang & Wu, 2017). Evidence also suggests there may be a link between mental health risks in younger individuals and smoking cannabis (Copeland et al., 2013). Research in Canada examining cannabis use in bisexual women who had higher rates than other sexuality groups found a link between cannabis use and depression (Robinson et al., 2016), suggesting mental health issues can co-occur with illicit drug use in LGB individuals.

1.3 Language and focus on sexuality

The acronym LGB is part of a larger acronym and community, which varies from LGBT, that is, lesbian (women attracted to women), gay (man or woman attracted to the same gender), bisexual (man or woman attracted to both genders) and trans (person who identifies as a different gender to which they were born), to lesbian, gay, bisexual, trans, queer, plus and asexual (LGBTQ+A) (Byne, 2014). Other letters have been added over the years to include other non-

heterosexual individuals or those who wish to show their support towards sexual or gender minorities, and more recently two-spirited has been included, particularly in North America, to reflect indigenous populations who express minority sexual or gender identities (Robinson, 2017).

Whilst we acknowledge that many of the inequalities and poorer health outcomes experienced by LGB individuals may extend to other individuals in these communities, this thesis focuses only on LGB sexuality and the link with smoking and co-behaviours. This is due partially to the availability, or lack, of survey data that mainly include questions pertaining to LGB sexuality only. Sexuality in survey data is most often captured through sexual identity or orientation, which is often categorised as 'heterosexual', 'gay/lesbian' or 'bisexual'. Although there is often an option to identify as 'other', there are generally no opportunities to elaborate further than this. Additionally, whilst we recognise that trans and gender minority populations are also at greater risk of health inequalities, including higher tobacco use (Buchting et al., 2017), this thesis aims to explore the inequalities of smoking according to sexuality, not gender identity. Further research is needed in this area due to the unique pressures and life events these individuals experience, but that is beyond the scope of this thesis.

Throughout this thesis, sexuality is used as an umbrella term to refer to different measures of sexuality which includes sexual identity or orientation, sexual attraction and sexual behaviours. LGB is used as a term to describe individuals who identify as lesbian, gay or bisexual. Sexual minority is also a term that will be used throughout, which includes those who may identify as non-heterosexual but not necessarily gay or lesbian or bisexual, such as those who identify as other. As some chapters in this thesis compare smoking behaviours between men and women, the terms sexual minority (SM) men and SM women are used. SM men includes men who identify as gay or bisexual or other, and SM women includes women who identify as lesbian or bisexual or other. SM also includes individuals who report some level of same sex attraction. The terms used in each chapter reflect the wording of questions and categories used in previous literature and in the surveys that were analysed in this thesis.

1.4 Using a multilevel geographical approach

Research has shown there is a strong association between where an individual lives and health inequalities, outcomes and risk behaviours (Duncan et al., 1998, 1993). Two concepts have sought to explain differences in population level health outcomes; context versus composition effects (Macintyre, 1986; Macintyre et al., 1993). Composition effects means individual level effects, suggesting that health outcomes and differences across regions and places are due to individual characteristics that might vary in different areas. Conversely, context effects, meaning higher or

environmental level effects, suggest the characteristics of an area itself contribute to health outcomes and inequalities (Duncan et al., 1998). In epidemiology and geography research, looking only at context effects can lead to the ecological fallacy, whereby making assumptions about individual health outcomes and risk behaviours based on aggregated data can lead to unreliable findings and interpretations (Pearce, 2000). Aggregating data can lose information about an individual, leading to drawing conclusions based on findings at only a population level. Equally, research that does not consider the importance of the environment, for example some areas of psychological research, tend to make assumptions leading to the atomistic fallacy, which places emphasis at the individual level whilst ignoring the context within which that individual sits (Jones & Duncan, 1995). Much of the research that focuses on LGB health inequalities and smoking prevalence has looked at composition effects of smoking *or* context variations. Advances in modelling techniques however now allow researchers to study both and to consider the area level effects alongside individual characteristics that may be associated with different health outcomes or behaviours.

Some of the research that has looked at environmental factors in LGB health behaviours has focused particularly on 'gay environments'; that is, arguing that LGB communities and neighbourhoods with concentrated populations of LGB individuals are risky in and of themselves, due to facilitating risky health-damaging behaviours within LGB communities (Buttram & Kurtz, 2012; Carpiano et al., 2011). In the United States, whilst areas with higher LGB populations are often deemed as 'gay neighbourhoods', this focus tends to ignore other environmental factors and contexts and does not explain elevated risk behaviours such as smoking and substance use in areas with low concentrated LGB populations. A health geography perspective enables the importance of contextual factors to be considered, whilst exploring key individual factors. Particularly in health geography and epidemiology research, investigating the influence of both the environment and individual determinants is necessary to gain a clear understanding of what is related to some individuals experiencing poorer health outcomes, health inequalities and what might drive them to engage in risk behaviours more than others.

1.5 Rationale

This thesis aims to explore how LGB individuals experience inequalities in smoking and other co-behaviours compared to heterosexual individuals, from a health geography perspective. The majority of research on LGB health has been carried out in the United States, with very few studies looking at smoking inequalities in LGB individuals in GB. In line with recent policies to reduce smoking in key at-risk groups, this thesis aims to address the gaps in LGB health research, focussing on smoking in this population. This thesis explores individual level psycho-social

determinants using secondary data from GB and examines if there are any place-specific patterns that might be also driving these inequalities. Understanding why these inequalities exist is imperative to tackling high smoking rates in this population, and ultimately can help with targeting smoking cessation and anti-smoking campaigns towards LGB and sexual minority populations.

GB is used as a case study in this thesis for several reasons. Firstly, whilst there is literature looking at smoking inequalities in LGB populations and discussing the role of an individual's environment, this has been done mostly from a North American perspective. The problem with using only these examples to inform research into inequalities in GB and anti-smoking policies relates to the context of the United States, whereby there are differing advertising policies towards tobacco and smoking. Much of the literature acknowledges that less strict advertising regulations and indeed targeted advertising towards LGB populations is a major factor in driving smoking inequalities (Fallin & Davis, 2016; Stevens et al., 2004). This then leads to questions about why smoking rates are still higher in GB in LGB populations if we have stricter tobacco policies, and therefore justifies why more examination is needed to draw conclusions based on individual determinants and environmental factors in GB. The second reason for using GB and not the UK as a whole relates to data availability, with some surveys using only GB and not including Northern Ireland. This is discussed further in later chapters in this thesis.

1.6 Organisation of thesis

This thesis adopts a three-paper-thesis approach: three empirical papers, contextualised by a set of review chapters. The review element of the thesis begins with chapter two looking at the literature on smoking in LGB populations, divided into three substantive sections, and a fourth section on the gaps and research aims. The first section focuses on LGB health research, how it has changed and evolved in geography and other disciplines, whilst also highlighting current gaps that need to be addressed. The second section looks at the literature on smoking, why smoking is important to focus on as a health risk behaviour, and the research behind increasing smoking rates and prevalence in LGB populations. The third section covers the context and composition factors that may be associated with smoking prevalence and sexuality. This chapter as a whole is used to identify gaps in knowledge that will form the subject matter for the three empirical chapters. The third chapter of the thesis, and the second element to the review material, is a data landscape review chapter. This outlines how appropriate surveys for secondary analysis were sourced in line with the research questions.

The second, empirical, section of the thesis begins with a fourth chapter, outlining the contributions made in the empirical analysis chapters, and gives a brief synopsis of each empirical chapter and the methodology adopted in each chapter. The fifth chapter is the first empirical analysis paper, which looks at the psychosocial determinants of smoking in LGB individuals compared to heterosexual individuals, taking into account the known confounding factor of social class that is strongly associated with smoking inequalities in GB. The sixth chapter is the second empirical paper, which looks at the geographical distribution of smoking prevalence in LGB compared to heterosexual individuals across GB at Local Authority (LA) level using longitudinal data from Understanding Society and the British Household Panel Survey. The seventh chapter looks at smoking and other co-behaviours, comparing models between using sexual identity and sexual attraction as a measure for sexuality. Finally, a conclusion chapter pulls together the three papers, summarising the overall findings of each, the limitations, policy implications, and what is needed next to advance this field of research.

Whilst this thesis sits within the field of health geography, understanding smoking behaviours in LGB populations requires drawing upon literature from psychology, epidemiology, public health and geography. To understand the link between individual and environmental level impacts, engaging in smoking and co-behaviours in LGB populations is considered from a multidisciplinary perspective.

PART ONE: REVIEW CHAPTERS

Chapter 2 Literature review

This chapter discusses the literature and existing work on LGB health and on smoking, within geography, epidemiology and psychology. The first section of this chapter is a review paper, which summarises the work within LGB health research, the evolution of LGB health research within geography, and the shift from primarily qualitative with a strong focus on HIV/AIDS research to current sexuality research using more epidemiological approaches. The need for new approaches within health geography are also discussed, as well as gaps in LGB research that can be addressed using health geography perspectives. This review paper also discusses quantitative methods that are appropriate for modelling health inequalities, and which methods are most commonly used within epidemiology and health geography. The second section of this chapter introduces the global burden of smoking and its manifestation in GB, and discusses the literature on smoking within LGB populations, the geographies of smoking, and outlines existing UK smoking policies. Co-behaviours associated with LGB identity are also discussed. The third section addresses the importance of context versus compositional factors in smoking research in LGB populations, and particularly why taking a geographical research approach is necessary in understanding smoking inequalities. The gaps in sexuality and smoking research are then highlighted, leading to the research aims that will be addressed in this thesis in the empirical analysis chapters.

2.1 Sexuality, Society, and Wellbeing: Renewing Geographical Approaches to Sexual Minority Health

A modified version of this review has been published as: Davies, M., Lewis, N. & Moon, G. (2018). Sexuality, space, gender and health: Renewing geographical approaches to well-being in lesbian, gay, bisexual, transgender and queer populations. Geography Compass, 12(5), 1-11.

2.1.1 Introduction

Geographers have long been concerned with how place mediates inequalities between the health of the general populations and that of specific groups based on ethnicity, race, sex, immigrant status, and other characteristics. Sexual orientation, in contrast, remains under-researched in geographic studies of health inequalities (Parr, 2004). In 2007, Del Casino suggested that health geographers have been loath to study the sites, situations, and dynamics of sexual encounters and associated behaviours such as drug use (Del Casino, 2007a). He also suggested that sexualities

geographers have only occasionally studied health outcomes among those identified as LGB, despite a strong tradition of research on the regulation of public health and the construction of sexual identities and communities (Del Casino, 2007b). More than a decade onward from Del Casino's observations, we consider the degree to which these dual lacunae in health geography and sexualities geographies has persisted, assess recent theoretical and analytical developments, and set out an agenda for future work.

LGB populations experience many adverse health outcomes more frequently than their heterosexual counterparts (Conron et al., 2010) in many cases and these inequalities have persisted or worsened over time (Gonzales et al., 2016; Jones, 2016). Lesbian and bisexual women, for example, are at greater risk for breast cancer than heterosexual women (Boehmer, 2002; Case et al., 2004). Gay, bisexual, and other MSM face higher risk of HIV and other sexually transmitted infections (STIs) (Cochran & Mays, 2007). Depression and anxiety are two to three times more likely to occur in gay, lesbian, and bisexual individuals compared with heterosexuals (Alessi, 2014; Lewis, 2009). Although a great deal of research is now devoted to explaining these outcomes, much more focuses on individual characteristics and behaviours rather than geographic determinants and patterns. The following review outlines the trajectory of health and place research concerning LGB populations, emergent geographies of mental health and substance use, and the distinct contributions that geographers can make to this growing field of study.

2.1.2 The beginnings of sexuality, health, and place research

Understandings of the relationship between health, sexual orientation, and gender identity beyond frameworks of deviance and illness were limited for much of the 20th century. Although homosexuality was decriminalised in countries such as the UK and Canada by the end of the 1960s, it remained illegal in many USA states until 2003. The removal of homosexuality from the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders in 1973 marked the initial de-pathologization of non-heteronormative sex and sexualities in medical research. Social stigma affecting LGB populations, however, has persisted. Despite some early research on mental health among gay men and lesbian women (see, for example D'Augelli, 1989; D'Augelli & Hart, 1987), HIV/AIDS tended to dominate the next decade of health research on sexuality and health.

Medical geographers in the 1980s and 1990s were concerned largely with opportunities to model the spatial diffusion of a rapidly expanding HIV/AIDS epidemic. Studies of HIV diffusion patterns (e.g. Cliff & Haggett, 1988; Gould, 1993), for example, accounted for the geographic locations of

gay men only to the extent that they were a correlate of infection rates. Similarly, work addressing AIDS-related migration (Cohn et al., 1994; Ellis & Muschkin, 1996; Findlay, 1993) was interested largely in the potential for HIV-positive gay men to overwhelm local and regional public health systems as they returned home for care. Although these studies helped to uncover the spatial epidemiology of HIV/AIDS at a time when relatively little was known about the subject, they addressed the sexual subjectivities and experiences of these men only tangentially. Early medical geography, then, may have inadvertently re-pathologized homosexuality by positioning gay and bisexual men as dangerous vectors of disease rather than vulnerable individuals (Brown, 1995).

The 1990s and 2000s were watershed decades for research on the broader health outcomes of LGB populations. As societal norms shifted in North America and Western Europe, voices of diverse sexual orientation and gender identity groups gained greater legitimacy and media attention (Smith, 2008; Weeks, 2007). Psychologists and psychiatrists, for example, developed minority stress theory (Meyer, 2003, 1995) to explain that chronic, often internalised social stigma and consequently elevated levels of stress were the primary causes of high depression, anxiety, and suicide rates within LGB populations. Psychologists have also now begun to examine the specific role of microaggressions (i.e., common and often daily verbal and behavioural insults towards marginalised groups) as a vehicle of minority stress (Nadal et al., 2011). To align with these new theories, health scientists began to expand their work on the social determinants of health beyond income and poverty. Medical sociologists in particular (e.g., Graham, 2007; Graham & Kelly, 2004) were instrumental in introducing sexual orientation as an aspect of social identity or position that could, in tandem with particular social environments, contribute to unequal health outcomes. Academic researchers had thus begun to recognise sexuality as an axis of social difference and not just a predictor of disease.

2.1.3 Sexuality, gender, and health in geography's qualitiative turn

Medical geography in the 1990s experienced its own tranformation into a 'new' health geography that adopted more flexible approaches to the place-health relationship (Rosenberg, 1998). This "reformed" medical geography was inspired by a cultural turn in human geography that shifted the discipline's focus from uncovering spatial patterns to elaborating flexible and subjective experiences of place (Kearns, 1993). Qualitative health geographers began to examine everyday spaces of well-being such as the home and the doctor's office, using life history interviews and storytelling to understand health outcomes (Dyck, 2003). Some of the earliest work in this vein counteracted the medicalising tendencies of HIV/AIDS diffusion studies by focusing on implications of the epidemic for gay men's individual life-worlds (Wilton, 1996) and community

advocacy strategies (Brown, 1997). This vein of health geography has continued apace, with a new generation of researchers examining how HIV-positive gay and bisexual men negotiate their place in the world following diagnosis (Myers, 2010).

Many have examined the regulation of LGB populations through public health institutions using critical social theory and especially Foucauldian theories of biopolitics and governmentality. Both Michael Brown (2006) and Tim Brown (2000) have examined the use of HIV/STI prevention campaigns in the 1970s, 1980s, and 1990s as tools to circumscribe definitions of "normality" and "responsibility" for gay and bisexual men. More recently, Kesby and Sothern (2014) have observed that public health authorities knowingly commit ecological fallacies by projecting their knowledge of population-level HIV prevalence data onto the supposed 'riskiness' of blood donations from individual MSM. In Canada and the UK, MSM are deemed a high-risk group that must report a 12-month abstention from same-sex contact to donate, whereas men having sex only with women are presumed fit to donate. Kesby and Sothern suggest that this group-based categorisation of risk masks individual risk profiles within each group (e.g., MSM in monogamous relationships engaging in safer sex vs. heterosexual men having unprotected sex with multiple female partners) and is rooted in fear and stigma rather than sound scientific evidence. Others have provided a counterpoint to these biopolitical and regulatory approaches by examining care and resilience in LGB populations. Using the concept of the therapeutic landscape (Gesler, 1992), many have examined the role that social spaces (e.g., bars and bath houses) play in facilitating care and well-being among gay and lesbian populations (Andrews & Holmes, 2007; Brown et al., 2014).

Sexualities geographers have also examined aspects of social exclusion among those identified as LGB. Valentine (1998) offered a personal account of fear, anxiety, and depression as a lesbian woman in a hostile academic workplace. Employing the concept of sexual citizenship, Binnie (1997) considered the ways in which sexual identity affected the political and social inclusion of LGB populations in and beyond their respective countries. Others have since debated the ways in which existing power structures privilege middle-class gay men and lesbians who also become complicit in those structures (Nast, 2002; Oswin, 2008; Sothern, 2004). Although power and exclusion certainly have implications for health and wellbeing, few sexualities geographers studying these topics have focused explicitly on health outcomes.

Research on sexual and gender diversity has meanwhile remained somewhat marginalised in applied health geography (Del Casino, 2007a; Dyck, 2003; Parr, 2004). While geographers have uncovered spatially mediated processes of exclusion, regulation, and coping that would likely influence health in LGB populations, few have developed models to predict ill health in these

populations or interventions to improve health outcomes. There are undoubtedly methodological challenges to integrating sexual and gender subjectivities into more traditional models that analyse socio-spatial determinants of health from a quantitative perspective. Although national health and social surveys (e.g., Health Survey for England) are beginning to include sexual orientation questions in select waves and years, few include consistent year-to-year data, and sample sizes are often small. Analysis of these surveys also requires accepting pre-given sexual behaviour or identity categories, which runs counter to the growing emphasis on "queer" and other more fluid sexual identities in human geography (see Oswin, 2008). Finally, critical geographers may be hesitant to study sexualities and health outcomes as related phenomena lest they reinforce the notion that "risky" behaviours (e.g., substance use, unprotected sex) are somehow simply embedded culturally in certain LGB communities. Explicitly contextual and spatial work has, however, emerged in two key areas of LGB health research: mental health and substance use.

2.1.4 Emerging geographies of mental health and substance use in LGB populations

Poor mental health is an area of stark inequality between LGB and heterosexual/cisgender populations as well as a potential contributor to other health inequalities between these groups. Research that explains these inequalities, however, has long been limited largely to psycho-behavioural models. These frameworks link the prevalence of adverse mental health outcomes with sexual practices, health knowledge, or sense of attachment to the gay community (Stall et al., 2001). While many studies employ minority stress theory to contextualise these factors, they perhaps overstate the importance of individual-level factors rather than place factors in the mediation of minority stress (Gruskin et al., 2001).

The connection between place and mental health for LGB populations is now becoming clearer (Hatzenbuehler et al., 2013; Lewis, 2009) as researchers are increasingly able to use secondary data from health and social surveys to study the relationships between laws, social norms, and mental health outcomes (Bourne et al., 2014; Conron et al., 2010; Gruskin et al., 2007). Structural prejudice levied by political jurisdictions (e.g., lack of rights or protections for LGB groups) is now considered an important determinant of mental health among LGB populations in Europe and North America. For example, individuals from more politically conservative Eastern European countries report greater levels of internalised stigma than those from Western European countries (Berg et al., 2013). Mental health outcomes may be even worse beyond the Euro–American context, as studies in Asian and Middle Eastern countries (see, for example, Regmi & Van Teijlingen, 2015) have shown that individuals identifying as LGB often face significant discrimination due to cultural and familial expectations of a heteronormative life course including

heterosexual marriage and childbirth. Research in Turkey, for example, has found that most LGB people choose not to disclose their sexual orientation in employment, education, and health care settings (Göçmen & Yılmaz, 2017).

Others have investigated differences in the mental health of LGB populations between urban and rural regions within countries (Berg et al., 2013; Poon & Saewyc, 2009). Younger people identifying as LGB and living in rural areas have reported more substance use, binge drinking, isolation, and suicidal feelings compared with those in urban areas (Poon & Saewyc, 2009). Some have suggested, however that the effect of rural environments on LGB mental health has been overstated and that larger cities are actually associated with poorer well-being outcomes (Wienke & Hill, 2013). Studies at the regional and local levels also link stigma-related factors (e.g., laws and religiosity) to health outcomes. For example, the previous prohibition of same-sex marriage in most USA states has been linked to poorer mental health outcomes (Herdt & Kertzner, 2006). Similarly, living in states that lack policies to protect LGB populations are associated with feelings of hopelessness and expectations of violence and victimisation among those individuals (Everett, 2014; Hatzenbuehler, 2010). Informal social environments (e.g., churches and communities), whose characteristics cannot be measured easily but are still mediated geographically can also contribute to minority stress (Lewis, 2014).

The epidemiological research on substance use in LGB populations traditionally has connected drug use to individual beliefs and intention to use specific drugs rather than location or drug availability (Ramchand et al., 2013). While the use of some substances (e.g., tobacco) tends to be higher across LGB groups compared to their heterosexual counterparts (Gruskin et al., 2007; Lee et al., 2009; Tang et al., 2004) specific substance use patterns vary by sub-population. Tobacco use and associated risk factors are consistently higher across sexual minority groups compared to heterosexual populations (Gruskin et al., 2007; Lee et al., 2009; Tang et al., 2004), while inequalities in alcohol consumption tend to be much greater between lesbian and heterosexual women than those between gay and heterosexual men (Drabble et al., 2005). Younger lesbian and bisexual women are also more likely to report heavy alcohol intake than both heterosexual women and older lesbians (Gruskin et al., 2001).

Researchers are now also beginning to recognise the implications of place for substance use in LGB populations. Several studies have noted differences in the frequency of drug use and type of drugs among MSM across different regions of the United States (Stall et al., 2001; Thiede et al., 2003), with one finding an additional association with higher frequencies of unprotected anal sex (Hirshfield et al., 2004). In contrast to the existing mental health research, substance use studies have found religious areas to be associated with less engagement in alcohol use, and tobacco

consumption, and unprotected sex, provided that those areas also have laws supporting those who identify as LGB (Hatzenbuehler et al., 2012). A few studies have focused specifically on the neighbourhood scale (Carpiano et al., 2011; Egan et al., 2011; Everett, 2014). While some have found that living in a "gay neighbourhood" is correlated with higher levels of drug use and unprotected sex among gay men (Carpiano et al., 2011; Egan et al., 2011), others have observed that living in an urban, liberal neighbourhood has a protective effect against depression and anxiety (Everett, 2014).

There is also a growing body of research looking at drug use among gay men and other MSM in specific settings such as clubs and sex parties. "Chemsex" refers to MSM who use drugs before or during sex and has received both significant media and research attention in recent years (Bourne et al., 2014). Most of the research surrounding chemsex focuses on the link between drug use, unprotected sex, and HIV infection within individuals (Petersson et al., 2016). Bourne et al. (2014) used data from the European Men who have sex with men Internet Survey (EMIS) to identify drug use in the context of chemsex across three locations in the UK. While the study notes potential geographical differences in chemsex practices, they are not discussed in relation to differences in outcomes across the three study locations. Additional studies have suggested, however, that permissive social norms and other stimuli located in specific cities, neighbourhoods, and venues may increase drug use (Theodore et al., 2014).

The emerging research on mental health and substance use in LGB populations attends to the role of both physical and social environments in shaping risk and therefore has the potential to advance understandings of the relationships between health and place in these populations. At the same time, there are theoretical and methodological limitations in this work that risk reinforcing some of the problems observed in the earlier geographic studies of sexuality and health. The ongoing focus on individual psycho-social correlates such as self-esteem, depression, and childhood abuse in LGB mental health research can reinforce the stigmatisation and marginalisation of LGB populations. Similarly, the ongoing measurement of individual substance use without attending to environmental factors can reinforce the problematic notion of LGB "lifestyles" in which substance use is ostensibly normalised (Lewis, 2017).

Work that attends to more contextual factors can still stigmatise and even pathologize the places that intersect with LGB lives. Quantitative studies examining gay neighbourhood residence, substance use, and sexual health (e.g., Buttram & Kurtz, 2012; Carpiano et al., 2011), for example, tend to imply that certain locations somehow create "risky" lives. They measure the degree to which gay neighbourhoods and nightlife districts might alternately support LGB identities or facilitate risk behaviours (Egan et al., 2011; Stall et al., 2001) but they do not necessarily reveal

how these places intersect with broader LGB life-worlds. While neighbourhood-focused research therefore provides a signpost for health promoters looking to "target" LGB populations for substance use and HIV prevention interventions, it often implicitly pathologizes urban gay neighbourhoods as unhealthy places.

2.1.5 Modelling health behaviours in LGB populations

Whilst qualitative work has its merits in gaining rich information about an individual's experience, quantitative modelling techniques have emerged in health geography and LGB health research to support existing qualitative work, and to analyse associations and health issues at a population level. Qualitative work has also set a lot of the groundwork for theories and theoretical frameworks that can be used within quantitative modelling (Kearns & Moon, 2002), and the shift in health geography to model health behaviours in LGB populations quantitatively has certainly used existing frameworks in this context. Minority stress theory for example, stemmed from several social and psychological theories (Meyer, 1995), and is now cited frequently as a major determinant in quantitative LGB health research to explain health behaviours and both mental and physical health outcomes (Lick et al., 2013).

Health behaviours and risks have also been increasingly modelled using regression models, identifying the likelihood of being at risk or engaging in health risk behaviours compared to a baseline, 'less risky' population. In terms of LGB research, much of this compares being LGB and thus a higher risk category to that of being heterosexual, with numerous research looking at social determinants and factors of health behaviour in LGB populations compared to heterosexual (Pelster et al., 2014). Regression analysis has also been utilised to study the impact of stigma and stress on psychological distress in LGBTQ individuals (Kelleher, 2009). These methods and examples showcase how quantitative modelling can utilise data to compare two populations, yet the lack of an environmental element in many studies in LGB health research often makes the argument of contextual factors versus compositional factors. Simply using regression techniques may ignore the role of context, and making inferences about populations for individuals can increase the risk of ecological fallacy. In addition, the rise of the distinction of 'risk factor epidemiology' highlights the approach of comparing groups and populations and their corresponding risk factors, which could include gender, social status, ethnicity and sexual orientation (Evans et al., 2018).

Multilevel modelling (MLM) in other health research has been used successfully. MLM utilises natural clustering of data, whereby individuals (level one) are clustered within geographic units (level two), although levels can vary depending on the data e.g. time points in longitudinal surveys

(level one) nested within individuals (level two) (Jones & Duncan, 1995). Medical geographers and epidemiologists have established the link between examining the interrelated effects of place and health. MLM has its place for research purposes, to examine both individual and area level factors that are important when considering health outcomes and behaviours, but is also important in modelling terms. Even when exploring data at the individual level, it is important to take into account the natural hierarchy in which that data occurs, to correctly estimate standard errors and variance (Goldstein et al., 2002).

The emergence of multilevel modelling in the study of LGB health represents an area in which health geographers can make a significant contribution. Bauermeister et al. (2015), for example, have used multilevel modelling to map HIV risk in MSM according to both individual and neighbourhood characteristics. Other studies have looked at emotional distress stemming from perceived stigma in LGBT adolescents nested within schools (Almeida et al., 2009). This technique allowed the authors to draw inferences from both individual factors such as ethnicity, substance use, relationship status, and from neighbourhood-level factors such as proximity to community support centres, community-based stigma, and area-level socioeconomic status. In addition, data linkage may provide an avenue for joining large-scale social survey data on political and social attitudes to (usually smaller) health surveys that include a sexual orientation variable. This would allow geographers to begin studying the connections between levels of social acceptance and spatially variable stress-related health outcomes in LGB populations. Given the strong tradition of research in the geographic determinants of substance use (Duncan et al., 1998; Pearce et al., 2009), health geographers might also choose to look more closely at the spatial interactions of sexual orientation and the use of alcohol, tobacco, and illicit drugs. Such strategies may help bring the study of LGB health further ‘upstream’ to assess whether area-level determinants have different effects on the health outcomes of different sexual orientation and gender identity groups.

2.1.6 Sexual identity, attraction or behaviour: Different measures of sexuality

Sexual identity or orientation has been most commonly used in health and social surveys to measure sexuality (Geary et al., 2018). Whilst using sexual identity as a measure is important to capture inequalities between those who identify as LGB and heterosexual populations, it could also ignore those who either do not wish to disclose their identity, or do not categorise themselves within the LGB acronym. Some surveys include the option for ‘other’, but these numbers are often very small and prevent comparisons between groups. Research also suggests that individuals questioning their sexuality might be at greater risk of health inequalities and face barriers to health care services (Birkett et al., 2009; MacApagal et al., 2016). When examining

health inequalities between sexual minority and heterosexual populations, geographers and epidemiologists might consider using differing measures of sexuality, such as sexual attraction or behaviour as a proxy to identity, to gain a better understanding of which groups appear to be most at risk of inequalities and engaging in health damaging behaviours.

2.1.7 What can health geographers contribute now?

There is clearly still a need for research that acknowledges the interplay of individual and spatial factors contributing to LGB health outcomes. Health geographers that are now well positioned address sexual difference as an important mediator of place-health relationships while avoiding the pathologization of places and groups that characterised earlier medical geography.

Health geographers might also investigate the dynamics between individual life-worlds and "risky" venues by following the cues of medical anthropologists who explain health inequalities through cultural models rather than behavioural ones (Silenzio, 2003). Extending the excellent geographic work on gay and lesbian life-worlds and spatial attachments (Brown & Knopp, 2008; Wilton, 1996) qualitative health geographers could begin investigating some of the more socially controversial spaces (e.g., sex parties) that intersect the lives of some LGB people. While research of this nature requires careful consideration of safety and positionality (see Bain & Nash, 2006), it also serves to deconstruct risk behaviours as more than just irresponsible hedonism (see Andersson, 2011). Using concepts from feminist geography such as embodiment and emotion, qualitative studies might explore the linkages between, for example, social stress, the use of different venues as therapeutic spaces, and the potential for health risks within them. Such studies would begin to illustrate the internal dynamics of places and events that are sometimes categorised more flatly as 'risky' or risk-associated in the epidemiological literature.

Geographers interested in health services could also investigate whether higher geographic concentrations of services earmarked specifically for LGB populations are associated with better health outcomes in those populations. They might also examine issues of area-level access and stigmatisation to different levels of engagement with health promotion activities such as HIV testing (Berg et al., 2013). Both types of efforts may require the formulation of new databases and datasets from the group up through community-based participatory research.

Health geographers must also attend to the various structures and events that have recently been "queered" by scholars in sexualities and trans geographies. Like other groups (e.g., newcomer populations) that health geographers have studied, those who identify as LGB may have family forms that diverge from the mainstream (Gorman-Murray, 2008). Much like extended families may provide resilience against health risks such as work-related stress among immigrants (Dean &

Wilson, 2010), supportive families and same-sex partners may guard against place-rooted stressors, whilst less supportive or abusive families and partners may exacerbate these stressors. For trans-identified populations, it will be important to examine the health impact of urban spaces that, because of heteronormative planning procedures, remain unsafe for people who are trans or who express a non-normative gender representation (Doan, 2010, 2007). Migration itself is another area of study in which health geographers can track the relationships between displacement, movement, and health. For young and under-resourced LGB individuals who move away from home (Bruce & Harper, 2011), the destination and environment may have a therapeutic effect in some respects but also introduce social and sexual scenes that are unfamiliar and therefore distressing (Lewis, 2016, 2014).

There is also a need for work on intersectional identities in LGB health, another area in which medical anthropologists have spearheaded new lines of research. Recent studies have argued that developing appropriate interventions for HIV prevention requires a contextual understanding of the norms that may lead to transmission among gay and bisexual men in diverse cultural communities (Janes & Corbett, 2009; Silenzio, 2003). Geographers have already begun to extend this research by differentiating risk factors for gay and bisexual ethnic minority men who are new immigrants versus those who are second generation (Lewis, 2016; Lewis & Wilson, 2017).

Finally, geographers can illuminate persistent areas of inequality as the social landscape of inclusion for LGB populations continues to change. Geographers have been instrumental in drawing attention to flashpoints of exclusion amidst these new equalities (see, for example, Browne and Nash's 2014 work on social resistance towards LGB rights recognition). The inclusivity of sex education in schools has also become a lightning rod for homophobic discourse in an era of new legal equalities (McCarty-Caplan, 2013; Tracy, 2015). The ongoing heteronormativity of sex education may be a key factor perpetuating health inequalities among different sexual orientation and gender identity groups (Buston & Hart, 2001). Recent work has outlined the different 'socio-geographies' of health education and health services for LGB populations, noting both measurable and perceived differences in access to care across large cities, smaller towns, and rural areas (Baker & Beagan, 2016). There is increasing evidence to suggest that less inclusive health education in socially conservative environments can create a sexual health disadvantage for those who identify as LGB (Lewis, 2015).

This section has attempted to advance Del Casino's original call for a more theoretically engaged, comprehensive integration of sexualities and gender identity into health geography. As this review suggests, many of the gaps observed in 2007 (e.g., the lack of spatial and contextual studies of sexual health) have been addressed at least partially. Geographical research on sexual

orientation and health has moved beyond responding to the global crisis of HIV/AIDS through spatial science and now addresses the experiences of LGB people more fully. Through renewed theoretical approaches and methodological applications, researchers interested in LGB health can extend geography's rich tradition in using theories of social disadvantage to identify well-being inequalities, trajectories, and interventions.

2.2 Smoking behaviour

2.2.1 The Global epidemic of tobacco use

Tobacco consumption and smoking are a major public health concern globally. Worldwide, an estimated 1.1 billion individuals smoked tobacco in 2015, and in 2017, tobacco consumption was associated with roughly 7 million deaths (World Health Organization, 2019). Smoking tobacco grew in popularity during the 19th century in industrialised countries, initially by men but later taken up by women as well (Proctor, 2004). In developing countries, smoking is mostly associated with men, although recently rates are also increasing amongst women. Smoking is now prevalent worldwide, with health organisations and individual countries aiming to reduce smoking mortality significantly within the next few years. Whilst smoking has generally declined in developed countries, rates are higher in developing countries and contribute towards levels of household poverty. In 2011, the World Health Organization (WHO) estimated that tobacco use kills more individuals than malaria, HIV and TB combined (World Health Organization, 2012).

2.2.2 Smoking in Great Britain

In England there were an estimated 78 thousand deaths and 474 thousand hospital admissions in 2015. Smoking prevalence in GB still remains at roughly 15% of the adult population, and is the biggest cause of preventable deaths (Department of Health, 2017). Smokers in GB are more likely to be from routine and manual professions compared to managerial professions, with rates of 1 in 4 compared to 1 in 10, respectively (Office for National Statistics, 2018). Despite statistics demonstrating the decline in smoking over time, recent years have seen an increase in the use of e-cigarettes. The health implications of using e-cigarettes are largely undetermined currently, but research in the UK has found that use of e-cigarettes in adolescents is associated with initiation in smoking (Conner et al., 2018). Therefore, the importance of researching smoking behaviours and preventing initiation and how to improve cessation amongst current smokers remains.

Smoking in England has halved over the past three decades, and the government have recently set a goal to make England smoke-free by 2030. This goal, set out by the ‘Advancing our health:

prevention in the 2020s' document presented to Parliament in 2019, acknowledges that smoking unequally affects certain groups in society, such as those living in poorer areas and individuals in routine or manual professions, individuals with poor mental wellbeing and individuals who identify as LGB (Department of Health and Social Care, 2019; Office for National Statistics, 2019b). Despite acknowledgement of LGB individuals being at greater risk of smoking in England, there are currently no agendas set on how to improve cessation amongst this population.

2.2.3 The health implications of smoking

The impact on health from smoking and tobacco consumption comes from the vast array of chemicals an individual is exposed to during cigarette smoking. The short-term effects of smoking and tobacco use include nicotine addiction, short-term respiratory symptoms including coughing and wheezing, and overall poorer health status. Impaired lung functioning and an increase in the risk of developing infectious diseases such as pneumonia can happen after an individual has smoked for some time. Smoking can also exacerbate pre-existing conditions such as asthma, whereby symptoms can persist due to chronic inflammation (Bonnie et al., 2015). In developing countries, smoking is associated with poorer health outcomes for individuals with TB and HIV infections (Van Zyl Smit et al., 2010).

The long term implications of smoking have been established for many years, when Doll and Hill first reported the link between smoking and lung cancer in 1950 (Doll & Hill, 1950). Smoking is the biggest preventable cause of cancer in the UK, and can be attributed to at least 13 different types of cancer, including lung, oesophagus, bowel, stomach, ovarian and cervical cancer (Gandini et al., 2008). Smoking is also strongly related to cardiovascular diseases, increased risk of stroke, and chronic obstructive pulmonary diseases. In the United States in 2010, an estimated 28.7% of cancer deaths could be attributed to smoking (Jacobs et al., 2015).

2.2.4 Smoking in LGB populations

The link between sexuality and smoking inequalities have been demonstrated repeatedly and consistently, finding that LGB individuals are at greater risk of being current smokers, heavier smokers and more likely to start smoking earlier than their heterosexual counterparts (Gruskin et al., 2007; Lee et al., 2014; Tang et al., 2004). The implications and health outcomes of smoking are well documented, and despite figures of smoking in the general population decreasing, levels in LGB individuals remain higher (Sivadon et al., 2014). The Office for National Statistics (2019b) highlighted the smoking inequalities between LGB and heterosexual individuals in the UK from 2015-17, with smoking prevalence 1.5 times higher in LGB individuals (figure 2.1). As discussed in

the first section of this chapter, reasons attributed to this include theories that suggest stress and poorer mental wellbeing stem from stigma and discrimination, including minority stress theory and experience of microaggressions (Meyer, 2003; Nadal et al., 2011), whilst others have implicated the role of an individual's environment. Additionally, variations in smoking exist not only between LGB and heterosexual populations, but within sexual minority groups. For example, whilst LGB as a group have higher rates of smoking than their heterosexual counterparts, bisexual individuals may have higher rates of smoking than gay or lesbian individuals (Smalley et al., 2016). This may be due in part to experiences of 'bi-phobia' and discrimination experienced in both heterosexual and LGB communities (Weiss, 2003; Welzer-Lang, 2008), but may also be due to multiple psycho-social determinants.

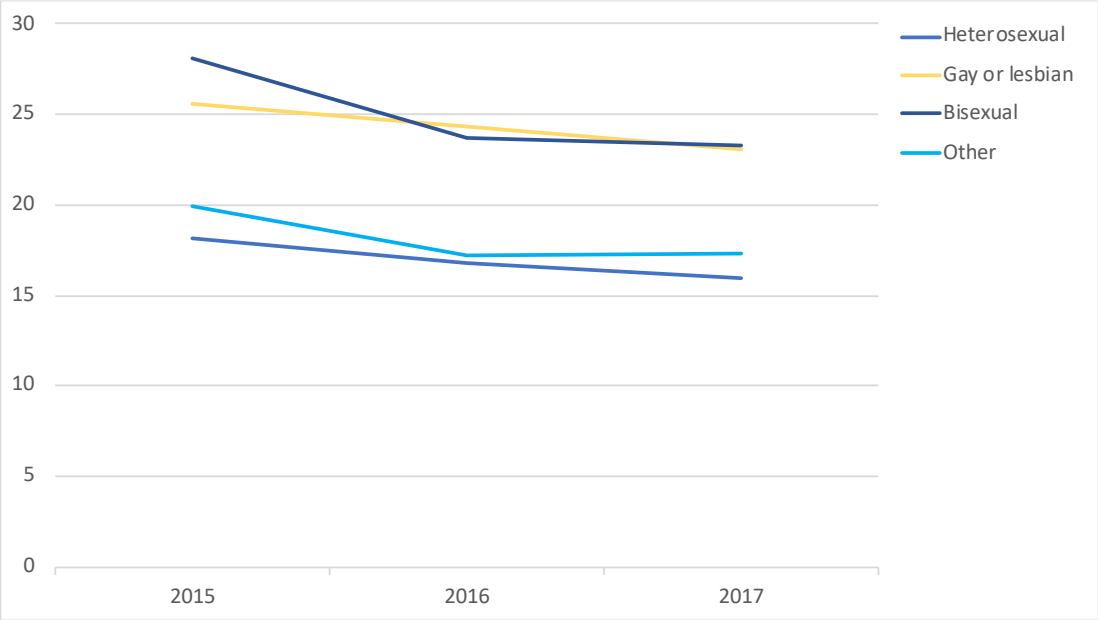

Figure 2.1. Percentage of smoking prevalence by sexual orientation 2015-2017 in the UK
Source: Office for National Statistics, Adult smoking Habits in the UK: 2018

In addition, research has demonstrated that whilst the intention to quit smoking is similar between LGB and heterosexual individuals, smokers in the LGB population are less successful in quitting (Burkhalter et al., 2009; Eliason et al., 2012; Matthews et al., 2013). Public health research has called for the need of LGB specific smoking cessation programmes, as sexual minority groups have expressed an interest in LGB-specific or LGB friendly cessation services (Matthews et al., 2013; Schwappach, 2008). These programmes are tailored to LGB individuals and are culturally sensitive and appropriate, which may increase cessation rates amongst this group. In addition, the need for anti-smoking policies in LGB specific spaces has been highlighted

in the United States (Lee et al., 2014).

Health research concerning smoking has evolved from observing mainly prevalence rates in LGB populations, to endeavouring to understand smoking characteristics, such as cessation rates and smoking heaviness (Eliason et al., 2012; Gruskin et al., 2001). In LGB populations, smoking research in a spatial context is less common, with much of the research focusing on psycho-social determinants of smoking. Some studies have focused on location in terms of policy research to explain the inequalities, such as research in the United States finding that regions that have more comprehensive tobacco control programmes, and better funded programmes, have lower sales of cigarettes than those with less emphasis on such programmes (King et al., 2012). The role of the social environment has also been acknowledged, suggesting more LGB-friendly environments have lower rates of smoking amongst LGB youths (Hatzenbuehler et al., 2011).

2.2.5 Smoking policies in the UK

The UK government has taken large steps forward in attempting to reduce smoking in the past decade, including public smoking bans, increasing the age of legality for smoking, anti-smoking campaigns and, following in the footsteps of Australia, becoming the second country in the world to sell plain packaged cigarettes (Arie, 2017). Tobacco point of sale displays have also been banned in large shops since 2012 and smaller shops and bars and pubs since 2015. In 2017, the Department for Health released a new TCP, which had previously expired in 2015. The report states the aims to reduce smoking prevalence rates down to 12% by 2022 (Department of Health, 2017). The plan states a priority of 'prevention first', aiming to reduce initiation of smoking, yet one of the key ways to successfully reduce this is to target prevention to those most at risk, which the plan does not address. Further, objectives are included which aim to support cessation in those with mental health problems, another key at-risk group.

LGB individuals are disproportionately affected by mental health conditions such as depression and anxiety (Nadal et al., 2011), yet may not be seeking mental health support services due to fear of discrimination or stigma. Thus, whilst it is essential to support those with mental health conditions in quitting, LGB individuals may be a hidden population within this group, despite being high risk for mental health issues. Finally, the plan acknowledges the health inequalities and variation in smoking prevalence, yet does not have any specific aims and objectives in targeting LGB populations. The plan makes an important point about LAs across the UK needing to know which groups have the highest rates in their communities, and how to target these groups. Knowledge of areas that might have higher prevalence rates of smoking in LGB populations is therefore needed.

2.2.6 Smoking and co-behaviours

There is some evidence that suggests smoking may be associated with engaging in other health risk behaviours. The co-occurrence of smoking and illicit drug use such as cannabis consumption has been demonstrated in some studies (Richter et al., 2017; VanderVeen et al., 2013), whereby those that smoke tobacco are also more likely to smoke cannabis and have a decreased likelihood of smoking cessation (Amos et al., 2003). The reverse relationship has also been found, suggesting that cannabis consumption might actually reinforce and maintain smoking behaviour (Agrawal & Lynskey, 2009). Similarly, binge drinking and other hazardous alcohol use has been found to be higher in adolescents who smoke, and again research suggests that alcohol use and smoking mutually reinforce each other (Johnson et al., 2000). Other associations between smoking and illicit drug use also suggest a link between smoking and cocaine and heroin use (Lai et al., 2000). Studies in the UK have acknowledged several risk factors for engaging in multiple risk behaviours including socio-economic status, ethnicity and gender (King et al., 2015; Meader et al., 2016), but few have addressed sexual minorities as an at-risk group for co-occurring behaviours.

A growing body of research, as previously mentioned, has identified the risks of engaging in chemsex (Giorgetti et al., 2017). Whilst using drugs to enhance sexual activity has predominantly been explored in MSM populations, it is also increasingly being seen in women who have sex with women (WSW). Recent research has found higher reported levels of drugs such as cocaine and ketamine in WSW during sexual activity, associated with an increased number of sexual partners (Hibbert et al., 2019). Recreational drug use for non-sexual activities are also higher than in heterosexual populations, with research particularly focusing on cannabis use (Kerr et al., 2015; Watson et al., 2018a; Zhang & Wu, 2017). A study by Kerr et al. (2014) found that gay and bisexual men were twice as likely to report cannabis use in the past year than heterosexual men, and lesbian and bisexual women reported even higher likelihoods compared to heterosexual women. Interestingly, cannabis use in bisexual women has been found to be associated with depression but not anxiety or suicide ideation (Robinson et al., 2016). The same study found that cannabis use was associated with involvement in an LGBTQ community, though there have been mixed findings in other studies about the role of the environment, finding that living in a gay neighbourhood facilitated some drug use, but was protective of others (Buttram & Kurtz, 2012; Carpiano et al., 2011).

Despite research finding that risky alcohol behaviours are elevated in LGB populations, the link between sexuality and alcohol use appears to be weaker than for other substances such as tobacco or some illicit drugs, particularly for sexual minority youths (Hagger-Johnson et al., 2013a; Talley et al., 2019). Still, other studies have found that binge drinking and other risky alcohol

behaviours remain greater than in heterosexual populations (Shahab et al., 2017). LGB individuals have also reported drinking being a key feature of the 'gay scene' (Emslie et al., 2017) and other research has found alcohol related issues such as dependence and social issues arising from alcohol misuse to be greater amongst sexual minority women (Drabble et al., 2005). The co-occurring relationship between alcohol and tobacco may amplify health implications associated with engaging in both health damaging behaviours simultaneously (Wetzels et al., 2003). Finally, the emphasis placed on LGBT nightlife spaces and venues may facilitate the association between alcohol and smoking (Emslie et al., 2017; Washington, 2002).

2.2.7 Discrepancies in quitting between LGB and heterosexual individuals

Despite intention to quit being similar between LGB and heterosexual individuals, the discrepancies in successful cessation may reflect individual level differences. In women, motivation for smoking cessation often correlates with planned or unexpected pregnancies, whereby there is strong evidence that highlights the importance of giving up smoking (Cooper et al., 2017; DiClemente et al., 2000). Despite research suggesting some of these women who quit smoking during their pregnancy relapse after giving birth, many will continue cessation postpartum. Some men might also quit smoking during the partners pregnancy and after birth, to prevent the risks of second-hand smoke (Bottorff et al., 2009). Research has suggested that lesbian and bisexual women are less likely to become pregnant than heterosexual women (Hodson et al., 2017). LGB individuals might then have less incentive and motivation to quit than heterosexuals trying to conceive, and may explain higher current smoking rates in LGB individuals through the life course compared to heterosexual individuals.

2.3 Context versus composition: Why they matter in smoking research

The factors that are associated with an increased likelihood of smoking are numerous, complex and intertwined. To understand smoking better, it is important to understand the contribution both composition (individual-level factors) and context (environmental level factors) have towards tobacco consumption. In psychology research, studies often cite smoking as a cause of learned behaviour, related individual class status, and as a result of stress, coping mechanisms and social norms (O'Callaghan et al., 2006; Rhodes & Ewoldsen, 2009). In studies such as these, smoking is generally explored at the individual level, yet many of these explanations and characteristics can also be attributed to the environment. For example, smoking as a learned behaviour implies that individuals learn smoking from exposure to smoke amongst peers, family, and within communities. Psychological theories such as the social learning theory argue that young people are likely to be susceptible to smoking initiation smoke due to social interactions

with smokers within families, schools and neighbourhoods (Ennett et al., 2010). This suggests rather than considering 'learning' smoking as an individual characteristic the role of an individuals' environment cannot be dismissed in this context.

The following section discusses factors that might be associated with increased smoking rates in LGB populations that are considered contextual or compositional. Whilst some studies have noted the role of factors such as tobacco outlets, whereby greater density is associated with increased smoking prevalence (Pearce et al., 2012; Shortt et al., 2016), this thesis does not address tobacco outlet density. Therefore, whilst we acknowledge the importance this might play in smoking prevalence, this area is not discussed further. Other environmental determinants that have emerged from research in LGB populations in the United States include the role of LGB specific environments that might facilitate social norms in this group, and the role of advertising from tobacco companies. Compositional factors that have been associated with LGB smoking prevalence include stress and poorer mental wellbeing related to being part of a marginalised population.

2.3.1 Social norms

The role of an individual's community or social network can impact how smoking is perceived and may play a key role in the initiation or indeed smoking cessation. The smoking ban in 2007 in the UK put an end to smoking in public spaces, and studies since then have showed that attitudes towards smoking have changed, and there have been increased restrictions amongst families in private spaces such as homes and cars (Moore et al., 2012). These environmental and area level policies may then filter down towards individual attitudes, and change the way individuals perceive smoking. How such policies have impacted attitudes in LGB individuals is unknown, and whether the knock-on effect of smoking policies have affected smoking prevalence in LGB individuals. Pearce et al. (2012) also note that areas of deprivation which have higher smoking rates might reinforce smoking as normal within the neighbourhood (Thompson et al., 2007). Research in Scotland found that high levels of non-heterosexual individuals were reported in some of the most deprived areas of Scotland (Matthews & Besemer, 2015). This link between neighbourhood deprivation and high concentrations of LGB individuals living in these areas might suggest smoking rates are being driven by a complex relationship between deprivation, sexuality and neighbourhood social norms.

Attitudes towards sexuality within LGB communities can also facilitate norms around smoking, as Smith et al. (2018) found that LGB individuals who felt positive about their sexuality were more likely to be dependent on smoking. This may be due to LGB individuals who feel positively about

their identity more likely to be engaged in the LGB wider community, where higher smoking rates are more common and thus might be reinforcing smoking as a social norm.

2.3.2 LGB specific environments

In LGB research, so called 'gay-neighbourhoods' documented in the United States have been associated with risk behaviours including substance use and unsafe sex (Buttran & Kurtz, 2012). These areas and other gay social venues may facilitate social norms around risk behaviours including smoking, which highlights the importance of researching sexual minority health in the context of 'neighbourhood effects' (Carpiano et al., 2011). It is however dangerous to coin areas as facilitators of risk behaviours and not to acknowledge the unique stressors that LGB individuals might face, which could also drive higher rates of smoking. For example, studies have found an association between increased rates of cannabis use in areas with higher rates of LGBT hate crimes and violence (Duncan et al., 2014). This suggests that increased stigma and discrimination, whilst higher in some areas, may be factor of substance use inequalities in marginalised populations.

2.3.3 Targeted smoking advertising

As discussed earlier, tobacco advertising has been found to be a large driver of smoking inequalities between LGB and heterosexual individuals in the United States. Tobacco companies have long been known to target LGB venues and use advertising spaces across the United States, in which some states have less stringent advertising policies than the UK (Stevens et al., 2004). This was initially discovered through documents shared regarding project 'Subculture Urban Marketing' known as SCUM. Tobacco companies purposefully aimed to target LGB individuals, through advertising, free samples and sponsorship of LGB events and funding LGB organisations (Fallin et al., 2015b; Washington, 2002). Pro-smoking advertisements have also been viewed as more appealing than smoking cessation adverts (Dilley et al., 2008). However, since the advertising ban in 2002 in the UK, which prohibits the promoting of smoking and tobacco through all media outlets such as television, radio and billboards, the explanation of tobacco targeting cannot be applied in a GB context. This suggests that the relationship between smoking, sexuality and composition and contextual factors might be more complicated.

Conversely, anti-smoking campaigns advertised within the same venues have been found to be effective. These findings have been replicated in other socially disadvantaged groups and those with increased smoking rates, such as individuals from low socio-economic backgrounds and ethnicity minority groups. One study looked at targeting smoking cessation in the media to these

groups, by helping them think about their triggers from smoking. The EX campaign was delivered over 6 months to participants through several medias including radio, internet and television, and targeted ethnic minority groups through radio programmes with a high listening percentage from African-Americans. For those from low socio-economic backgrounds, adverts included relatable characters with routine and manual jobs. The results of the study found an increase in cessation-related cognitions and attempts to quit (Vallone et al., 2011). This suggests applying these methods to LGB populations might be an effective way to increase cessation in this group, and calls for LGB specific tailored intervention programmes.

2.3.4 Global research on smoking in LGB populations

Whilst the majority of research into smoking in LGB populations has been carried out in the United States, several studies in other countries have also examined smoking prevalence in these groups. In Canada, LGBTQ populations are more likely to report being daily smokers than the general population, and greater smoking prevalence is seen in bisexual men and women compared to other groups (Clarke & Coughlin, 2012), and in MSM populations depressive symptoms have been linked to higher smoking rates (Lampinen et al., 2006). In Australia, higher prevalence of smoking has particularly been noted in sexual minority women, suggested to be linked to minority stress theory and pro-smoking norms in LGB-specific nightlife venues (Deacon & Mooney-Somers, 2017; Meyer, 2003; Praeger et al., 2019). Whilst most of the research on sexuality and smoking has been carried out in the Western world, some countries in the Global South have also started examining LGB health inequalities. Nguyen et al. (2016) found that smoking and other poor health outcomes in sexual minority women in Vietnam were associated with lack of familial support and rejection. A study by Manalastas (2012) looking at smoking in LGBT Filipino young adults found that whilst sexual minority women smoked more than heterosexual women, the highest smoking rates were seen in gay and bisexual men. The global literature on smoking in LGB populations highlights how important context is when considering smoking inequalities in this group, as factors driving smoking rates in different countries might differ between places. Therefore, to understand smoking behaviour and differences between sexual minority groups in GB more research is needed, as generalising current research from the United States and other countries risks ignoring potential context specific factors to LGB populations in GB.

2.3.5 The role of stress

Composition factors such as stress and poorer mental wellbeing have been found to be a major factor in smoking prevalence rates. In addition to stress driving smoking and other health risk

behaviour use in the LGB population as a whole, differences within sexuality groups have also been observed (Shahab et al., 2017). Younger lesbians are more likely to be heavier smokers than older lesbians, suggesting there is a complex relationship between sexual identity, age and gender (Gruskin & Gordon, 2006). These differences may reflect changing societal views of sexual minority groups and changing pressures. Many studies have linked stress to smoking, whereby increased stress acts as a predictor for smoking, and individuals report lower levels of perceived stress when smoking heavier (Lawless et al., 2015). Smokers who perceive themselves to be in good health are also less likely to attempt to quit, which suggests that in some individuals, the known health impacts of smoking are not motivation enough to quit smoking. Perceived health may also explain higher rates in LGB individuals, whereby higher rates of minority stress from stigma are reported (Meyer, 2003). Smoking may therefore in this population act as a coping mechanism, and reinforces the theory of syndemics which suggest engaging in substance use such as smoking is used as a tool for coping with stress and poorer mental wellbeing (Stall et al., 2008). This theory can also be applied to other health risk behaviours, such as risky alcohol use and illicit drug use, where engaging in them is seen as lowering stress, but may actually exacerbate poorer mental wellbeing symptoms such as depressive and anxiety symptoms (Goldbach et al., 2014).

2.4 Gaps in LGB smoking research

The examples above considering context and composition effects highlight the complexity of smoking in LGB populations. Whilst stress and discrimination might be perceived as individual level factors that may drive smoking rates, these experiences can be diminished or heightened according to an individual's environment. Similarly, factors such as socio-economic status and education level are largely related to regional effects. When examining smoking determinants in LGB compared to heterosexual individuals, it is important to consider the influence of an individual's environment, and in the context of anti-smoking policies in the UK, as understanding where smoking inequalities persist and the characteristics of those environments is essential.

The evidence on composition and context factors around smoking and LGB individuals points to a need for a sound understanding of why increased rates exist in GB. Whilst previous research has highlighted significant factors that might explain smoking prevalence in this population, differences in the United States environment, such as different tobacco regulations, suggests more research is needed to understand what is driving inequalities in GB. Several studies have established the existence of increased rates (Hagger-Johnson et al., 2013b; Office for National Statistics, 2019b; Shahab et al., 2017), yet more research needs to be done to investigate the complex link between environment, stress, sexual identity and smoking. The measurement of sexuality and smoking has also yet to be examined, as current research focuses on those who

clearly identify as LGB, rather than looking at other indicators of sexuality such as attraction. Excluding these measures might mean there are hidden populations of individuals at risk but due to not identifying as LGB they are currently unknown. It is also unclear how smoking in LGB populations might have evolved over time in line with changes to policies in GB that have been developed to reduce smoking across the general population. Finally, whilst research has drawn some conclusions about different areas across GB with higher smoking prevalence, these patterns are undetermined in LGB populations. Understanding these associations will provide stronger evidence and validation for LGB-specific aims and objectives to reduce smoking initiation and increase cessation rates. There is a strong justification for this research project to investigate these gaps and determine the ways in which smoking inequalities still impact sexual minority groups.

2.4.1 Research aims

Based on the previous research identified in this literature review, three research questions were developed to address the gaps that exist in the literature on sexuality and smoking behaviour. Each question will be addressed in the empirical analytical chapters in this thesis;

(1) What are the determinants of smoking in LGB individuals in Great Britain?
(2) Has there been change over time and space in smoking prevalence in LGB populations across Great Britain?
(3) How does smoking behaviour co-vary with other behaviours and how is it affected by measurement of sexuality?

The literature reviewed in this chapter underpins the theories and explanations for inequalities that are seen in LGB populations compared to heterosexual populations, and highlights explanations that are context dependent, for example tobacco advertising in the United States. This chapter summarises the research currently known regarding LGB individuals engaging in the use of health risk behaviours and the implications for health that they pose, and what previous research has demonstrated in terms of inequalities across sexual minority groups. The evolution of sexuality research has led to health geographers drawing on public health and psychology to explain inequalities at the individual level whilst highlighting the importance of acknowledging the role of the environment. The research summarised has led to three research aims which will be addressed in three empirical chapters in this thesis, and which will address gaps in sexuality and health risk behaviour research, whilst extending current studies in this area.

Chapter 3 Data landscape review

The purpose of this chapter is to discuss how the data were assessed and considered for use in the empirical analysis chapters in this thesis. Much of the research on sexuality and smoking has been carried out in North America and has used national surveys either from secondary data sources or primary data surveys. As UK Census data does not include sexuality questions, this narrowed the options down to using secondary survey data only (Office for National Statistics, 2014). GB has a wealth of surveys collecting data on health behaviours available and has increasingly started to include sexuality questions. These surveys are available to access through platforms such as the UK Data Service (UKDS).

Based on the gaps identified in the literature review, this chapter discusses the search and review process for identifying suitable health and social surveys in the context of the research aims that will be addressed in this thesis. Surveys were searched for via the UKDS search engine and analysed to filter out those that did not include questions on sexuality and smoking or co-behaviours such as alcohol use or illicit drug use. The search yielded a number of surveys for potential use, and the list was further refined based on the depth of the questions about smoking or co-behaviours, survey recency, and spatial indicators included in each survey. Those surveys that remained were analysed in further detail and discussed in the context of the three research aims.

3.1 Background of health and social surveys

Health and social surveys in GB are increasingly including questions in surveys regarding sexuality, most commonly looking at sexual identity (Geary et al., 2018). This inclusion allows researchers in health geography, and other disciplines such as epidemiology or psychology, to extend previous investigations into health outcomes and health risk behaviours in sexual minority groups, which can then be compared to heterosexual populations. Despite this, previous sexuality research has been dominated by studies carried out the in the United States, as the relative recency of the inclusion of sexuality in GB surveys has prevented the analysis of secondary data and has led to a reliance on primary data sources, which can be costly and time consuming.

Secondary data is an important tool to be utilised in health research, as it allows us to extend previous research and apply complex methodologies to data sources capturing a large sample of individuals. Differences in the type of data, such as cross-sectional compared to longitudinal also

allows for variation in the types of analysis and enables researchers to draw comparisons between cohorts and change over time.

3.1.1 Advantages of survey data and secondary analysis

Secondary data is a valuable tool for researchers, and in GB there is a wealth of secondary data available. There are several advantages of using secondary data. Using secondary data is often associated with a low cost for researchers compared to greater costs that are often incurred when collecting primary data. Secondary data is also much more time efficient in comparison, and often includes relatively large sample sizes which increases statistical power. Whilst primary online data collection has been associated with low response rate overall and to particular questions (Lefever et al., 2007), most funded surveys in the UK are captured face-to-face, which has been found to improve response rate (Schröder, 2016). In most cases, there is an initial data cleaning process completed before the data is made available for researchers to access, which may include deriving variables, and also ensures participant anonymity is done before access is granted. Finally, many secondary data surveys are part of a series using multiple waves collected at different time intervals, which can be either cross-sectional or longitudinal in nature, and this provides the ability to cross link different survey data to examine changes over time (Cheng & Phillips, 2014). This type of analysis would be more difficult and time consuming for primary data collection.

3.1.2 Limitations of survey data and secondary analysis

There are some limitations however to using secondary data that are important to note. High levels of non-response, whilst mitigated through face-to-face survey completion, can often be an issue in secondary data, and so ensuring missing data is handled correctly is an important issue for researchers to consider. Survey weights, or methods used to handle complex sampling designs, such as multilevel modelling can address the issue of non-response, or using different ways of handling missing data, such as comparing the benefits of listwise versus pairwise deletion (Dales et al., 2008).

Secondly, whilst longitudinal studies enable us to monitor change over time of certain behaviours or health outcomes in the same individuals, research suggests that some individuals can change their answers to questions about behaviours or attitudes due to taking part in previous survey waves (Warren & Halpern-Manners, 2012). Research has found some individuals increase their reporting of risky behaviours over time (Fitzsimons & Moore, 2008), whilst others have found individuals state they have never used substances, such as illicit recreational drugs, despite

reporting they had in a previous wave (Fendrich & Rosenbaum, 2003). Given the context of questions used in this thesis, and with the second question addressing change over time, this effect is important to note. Change in reporting use of substances over time may be attributed to reasons such as how comfortable individuals feel with an interviewer based on their perceived trust or experience, changes to behaviours or attitudes over time based on maturation of the respondent, or changes based on the perceived stigma attached to reporting certain behaviours (Warren & Halpern-Manners, 2012).

3.2 Survey selection process

The selection process we used to find appropriate surveys for use in this thesis is discussed in the following section. Surveys were searched for via the UKDS discovery search engine (www.UKdataservice.ac.uk), which holds major UK surveys, census data and government sponsored surveys accessible for current researchers. The specific terms used to search for surveys are listed in figure 3.1, in which separate searches were initially conducted for surveys containing sexuality questions and smoking or drug/alcohol use via the UKDS. Sexuality was searched for using synonyms including 'sexual orientation OR LGBT OR MSM OR sexuality, LGB, gay, lesbian, bisexual', which returned 589 surveys. Surveys returned from the search included a mix of health surveys, specific sexual lifestyle surveys, household surveys and general council surveys. The titles of the surveys were initially assessed for suitability. Many titles represented a different wave of the same survey and were thus considered a duplicate.

Surveys containing smoking and drug use questions were also searched for using search terms including 'smoking OR drug use OR tobacco OR drug misuse OR drug abuse OR drinking OR alcohol' resulting in 325 surveys. Many surveys overlapped with the sexual orientation search. Again, duplicate surveys and those deemed irrelevant were excluded. Search terms for surveys that include both sexuality and smoking or drug use used a combination of (sexual orientation OR synonyms) AND (smok* OR cigarettes OR tobacco) OR (drug abuse OR drug misuse OR substance use). This search yielded 211 results (see figure 3.1).

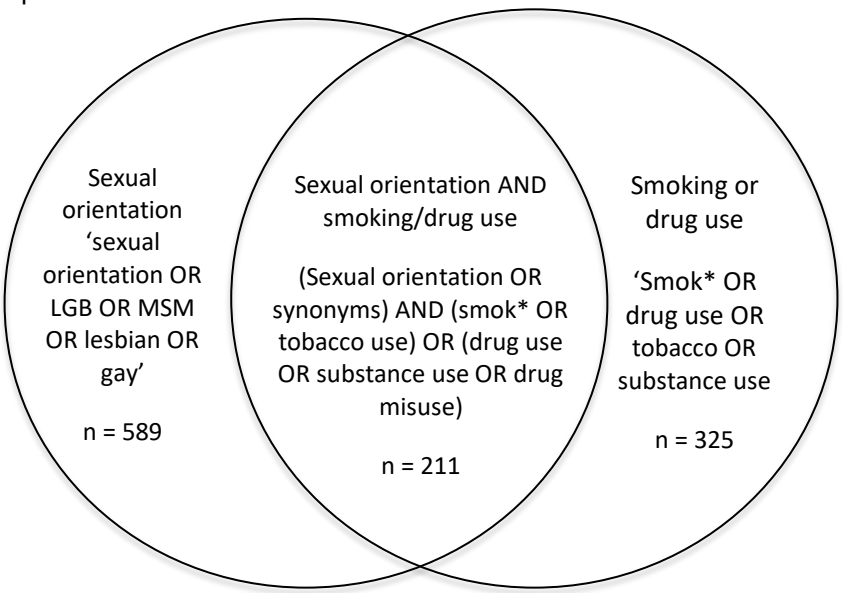

Figure 3.1. Wording used in survey search and numbers returned

From the review of the literature, one other survey was highlighted and retrieved from a general search engine (figure 3.2). Survey titles were read for suitability, and those surveys that had a specialised population focus, were not carried out in GB, or were out-dated were excluded. Duplicates were also excluded. In total, 14 candidate surveys, that either appeared on both searches or the combined search, were retained for analysis to determine their suitability and inclusion of sexual orientation and smoking questions.

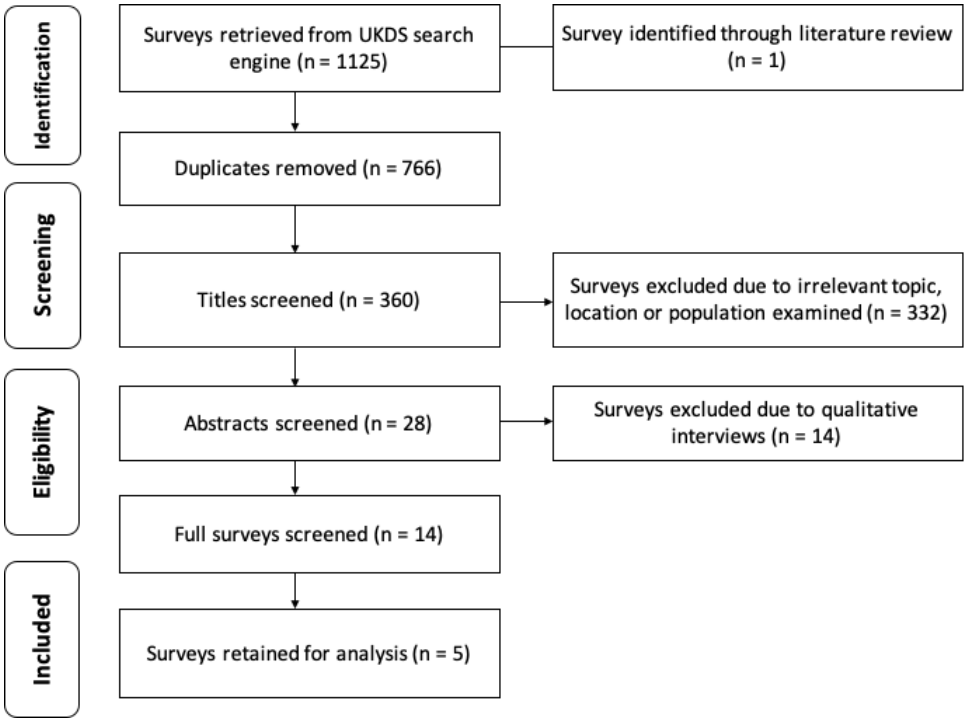

Figure 3.2. Flow chart of survey retrieval process

3.3 Surveys selected

3.3.1 Inclusion criteria

After reviewing titles and abstracts for suitability, 14 surveys were selected for further analysis to determine their suitability to use as data for empirical analysis for this thesis. Table 3.1 shows the surveys retained for analysis and their sample size and the year they and subsequent waves were collected. Further inclusion criteria for survey suitability for this thesis were based on the research questions. In order to determine how suitable surveys would be in addressing the research questions in the empirical analysis section, three inclusion criteria were developed. These inclusion criteria were set to assess the suitability of (1) appropriate sexuality data, (2) appropriate smoking and co-behaviour data, and (3) survey recency. To be considered for use in the empirical analysis part of this thesis, all three inclusion criteria had to be met. Appropriate sexuality data refers to surveys including questions that ask about an individual's sexuality, which may refer to sexual identity or orientation, or other measures of sexuality including sexual attraction or sexual behaviours. Appropriate health risk behaviour data refers to surveys that must include questions related to smoking and co-behaviours including alcohol use and illicit drug use. Finally, survey recency was decided upon based on recent public policies in smoking in the UK, the meaning of which is clarified below.

Table 3.1. Sample size and frequency for retained surveys

Survey	**Sample size**	**Year**
Adult psychiatric morbidity survey	7403	2007
The Opinions and Lifestyle Survey	100 households	Monthly waves since 2005
Scottish Crime and Justice Survey	~12,000	Frequent waves since 1993
The Crime Survey for England and Wales	30,000-50,000	Annual waves since 2011
Metropolitan Police Public Attitudes Survey	~12,000	Frequent waves since 2005
Place Survey	518,722	2008
English Housing Survey	13,174	Frequent waves since 2008
Quarterly Labour Force Survey	95,000	Quarterly waves

Integrated Household Survey	300,000	Frequent waves since 2009
Scottish Health Survey	4000	Frequent waves since 2008
Health Survey for England	8000	Frequent waves since 1991
British Household Panel Survey/Understanding Society	~49,000	Frequent waves since 1991
National Survey of Sexual Attitudes and Lifestyle 3	~15,000	Three waves from 1990-2010
European Men who have sex with men Internet Survey	17,656	2010

3.3.1 Surveys excluded

After assessing the surveys in greater detail based on the three inclusion criteria, a further nine surveys were excluded, as shown in table 3.2. The following section discusses in more detail how these surveys did not meet the inclusion criteria.

Table 3.2. Assessment of survey criteria for retained surveys

Survey	**Survey recency**	**Appropriate sexuality data?**	**Appropriate smoking data?**
Adult psychiatric morbidity survey	✗	✓	✓
Opinions and lifestyle survey	✓	✗	✓
Scottish Crime and Justice Survey	✓	✗	✗
Crime Survey for England and Wales	✓	✗	✗
Metropolitan Police Public Attitudes Survey	✓	✓	✗
Place Survey	✓	✓	✗
Quarterly Labour Force Survey	✓	✓	✗
English Housing Survey	✓	✓	✗
Integrated Household Survey	✓	✓	✗

3.3.2 Survey recency

To ensure this research is up to date with current smoking trends, surveys that were considered 'out-dated' were excluded from further analysis. Surveys were considered 'recent' if they were carried out after the 2007 UK smoking ban. As part of the Health Act in 2006, public spaces, which refer to premises open to the public, such as restaurants, bus stops and bars, were made smoke-free (NHS, 2007). The ban came into effect in 2007, and has seen a drop in smoking prevalence in the adult population from 21% in 2007 to 15% in 2017 (Office for National Statistics, 2019b). Though some surveys will have started earlier than 2007, their suitability was assessed if the latest wave of the survey was after 2007.

The Adult Psychiatric Morbidity Survey was designed to assess changes in mental health amongst the population and was administered in 2007. The survey is part of a series of mental health surveys, which look at mental health in adults over 16 in private households. The survey addressed substance use including alcohol intake and illicit drug use, and also addressed smoking behaviours. Additionally, sexuality was addressed through self-identification and sexual behaviours. As the survey was carried out in 2007 however, and the subsequent wave was not released via the UKDS until 2018 after which the empirical analysis of this thesis would be underway, this survey was excluded.

3.3.3 Appropriateness of sexuality data

Despite surveys appearing to include questions about sexuality, upon further analysis, the questions did not necessarily refer to asking about identity. The Opinions and Lifestyle Survey was returned through the sexual orientation and smoking/drug use search, which covers a range of topics including health and wellbeing and tobacco consumption. The survey series started in 1990 and since 2005 runs monthly surveys. Smoking questions were comprehensive and covered in an individual module, however although marital status included options such as cohabiting in a same-sex relationship, self-identification of sexuality itself was not addressed.

The Scottish Crime and Justice Survey started in 1993 with frequent subsequent waves. The main focus of the survey is victimisation and individual experiences of crime. Sexuality was addressed but focused on victimisation as a result of sexual preferences and did not ask directly an individual's sexual orientation, and whilst questions about illicit drug use were included, the survey did not include questions on smoking. The Crime Survey for England and Wales, previously known as the British Crime Survey, addressed sexual orientation in a similar way to the Scottish Crime and Justice Survey and whilst asked about illicit drug use, did also not include questions on

smoking tobacco. Therefore, these surveys were excluded due to a lack of sexuality data that would make it possible to address the research questions in this thesis.

3.3.4 Appropriateness of smoking and health risk behaviours data

As with sexuality, some surveys looked at issues surrounding smoking and drug use rather than asking directly about individual behaviours. The Metropolitan Police Public Attitudes Survey for example, has had frequent waves since 2005, with similar surveys dating back before then. Sexual orientation is measured through self-identification, but the survey does not ask questions about health behaviours. Rather, questions are asked about drug use but in relation to how people feel about drug use in their neighbourhood, and not individual substance use. Similarly, the Place Survey by the Department for Communities and Local Government appeared on both searches, and again included sexual orientation through self-identification. The survey was carried out in 2008 and does not address health behaviours, but rather focused on satisfaction with neighbourhoods and local community services and governments. The English Housing Survey has had frequent waves since 2008, and whilst sexual orientation and smoking habits were asked in the first two waves they were removed in subsequent waves.

The Quarterly Labour Force Survey, part of the Labour Force Survey series, has had quarterly waves each year since 1992. Whilst this survey asks about sexual orientation and smoking, smoking questions are limited addressing smoking prevalence rather than habits and behaviours. Other surveys that included questions on both sexual orientation and health behaviours were general household and work surveys. The Integrated Household Survey, which has had frequent waves since 2009, contains surveys including the Quarterly Labour Force and the English Housing Survey as well as other surveys, and overall asked about both sexual orientation and smoking habits, but does not asks any questions about drug use. The scope of the smoking questions were limited, again looking at smoking prevalence rather than habits and frequency of smoking. These surveys were therefore excluded from further analysis due to a lack of appropriate data for smoking and co-behaviours.

3.3.5 Surveys retained for further analysis

Five surveys (NATSAL, BHPS/US, SHS, HSE, EMIS) met the inclusion criteria based on the three categories. Table 3.3 lists the sample size, year and latest available wave and survey design for each survey. Although they are independent surveys, as Understanding Society (US) was an extension to the British Household Panel Survey (BHPS) series with the same individuals, these surveys were analysed and considered as one survey.

Table 3.3. Survey information for surveys considered for analysis

Survey	**Sample size**	**Year(s)**	**Latest year available**	**Survey design**
Health Survey for England	~8000	1991-2016	2014	Repeated cross-sectional
Scottish Health Survey	~4000	1995-2016	2014	Repeated cross-sectional
British Household Panel Survey	~10000	1991-2008	2008	Longitudinal
Understanding Society	_~49000	2009-2017	2017	Longitudinal
National Survey of Sexual Attitudes and Lifestyles 3	~15000	1990-2012	2012	Repeated cross-sectional
European Men who have sex with men Internet Survey	17656	2010	2010	Repeated cross-sectional

3.4 Surveys' wording and information

Table 3.4 shows the information included in each survey. Sexuality in each survey was measured through self-identification, although some surveys such as European Men who have sex with men Internet Survey (EMIS) and the National Survey of Sexual Attitudes and Lifestyle (NATSAL) went further by asking questions about sexual behaviour and sexual attraction. The level of detail about smoking and drug use varied between surveys, but all contained enough detail to examine smoking and co-behaviour prevalence. In line with the aims of this thesis, we are interested in current smoking status, rather than smoking habits of previous smokers. Although some of these surveys have more comprehensive sexuality and health risk behaviour data than the BHPS/US, they have the advantage of being panel surveys, allowing individuals to be traced back and monitor changes in smoking prevalence over time. Additionally, the BHPS/US have detailed spatial indicators that can allow for complex analysis of place-effects in smoking behaviours in sexual minority populations.

Survey	**Sexual orientation question**	**Smoking question(s)**	**Co-behaviours**
Health Survey for England	Which of the following options best describes how you think of yourself?	Have you ever smoked a cigarette, cigar or pipe? Do you smoke cigarettes at all nowadays? About how many cigarettes do you smoke in a day?	Alcohol use
Scottish Health Survey	Which of the following options best describes how you think of yourself?	Have you ever smoked a cigarette, a cigar or pipe? Do you smoke cigarettes nowadays? About how many cigarettes do you smoke in a day?	Alcohol use
BHPS	N/A	Do you smoke cigarettes nowadays?	None
Understanding Society	Which of the following options best describes how you think of yourself?	Do you ever smoke cigarettes at all? Do you smoke cigarettes at all nowadays? Approximately how many cigarettes a day do you usually smoke including those you roll yourself?	Alcohol use, cannabis use, other drug use, frequency of past drug use
EMIS	Who are you sexually attracted to? Which of the following best describes how you think of yourself?	When was the last time you consumed tobacco products?	Alcohol use, drug use, frequency of drug use
NATSAL-3	Which of the following best describes how you think of yourself? I have felt sexually attracted to…	Do you ever smoke cigarettes at all nowadays?	Alcohol use, cannabis use, other illicit substances

Table 3.4. Sexuality, smoking and co-behaviour questions in retained surveys

3.5 National Survey for Sexual Attitudes and Lifestyles

For analysis in this thesis, only the third wave of NATSAL, which was carried out in 2010-2012, is considered, as previous waves were carried out in 1990 and 2000, and were both repeated cross sectional surveys. Whilst analysing cohort effects and changes could be interesting with these data, the BHPS/US would be best placed to be considered for looking at change over time as these surveys have the benefit of being longitudinal and thus changes in the same people can be traced. NATSAL addresses sexuality with questions looking at sexual attraction, sexual behaviours and contraception and attitudes towards sexual health, as well as other health behaviours including smoking and illicit drug use. The aim of the survey is to give detailed information on sexual behaviours and risk factors, sexuality, sexual health and reproductive health and sexual behaviour over the life course in GB.

3.5.1 Survey design and sample

NATSAL used multi-stage, clustered and stratified probability design whereby an individual was selected at random from addresses that were selected within primary sampling units. 15162 interviews were completed. There was a boost sample included of 16-34 year olds, which was included to increase statistical power when exploring sexual risk behaviours in higher risk age categories (Erens et al., 2014).

3.5.2 Sexuality

Sexual orientation in NATSAL was measured through self-identification (table 3.4). The question was 'which of the options on this card best describes how you think of yourself?' with the options being gay/lesbian, heterosexual/straight, bisexual or other. Sexual attraction and experiences were included in the survey, asking how often an individual has felt sexually attracted to males and/or females. Sexual experience was defined as any contact an individual felt was sexual, including kissing, and the same options were available as sexual attraction (see details of questions asked in NATSAL in appendix A.1).

3.5.3 Smoking

Smoking was addressed in brief detail, asking whether participants are current smokers. Further questions asked about regularity of smoking and how many cigarettes they smoke per day. The smoking questions were included in the section about general health along with questions about other health conditions and self-perception of heath.

3.5.4 Substance use

NATSAL asked about illicit drug use by asking if participants had ever tried illicit drugs with a list of options given, excluding injected drugs. For those that have ever taken cannabis, the use of cannabis in the past 12 months and 4 weeks was asked about, and then for all other drugs this was asked in the same way. Injecting drug use was then asked about, and for those that had injected drugs they were asked about the last time they injected themselves, age when first injected drugs and if they have ever shared a needle. The use of other substances to improve sexual performance, such as Viagra, was also included in the survey, although in a separate section to the illicit drug questions.

3.5.5 Alcohol

Alcohol intake was also discussed, asking initially 'do you ever drink alcohol nowadays?' then continuing to ask about drinking habits such as regularity of drinking over the weekly recommended limit of alcohol and how many units usually drank.

3.5.6 Spatial indicators

NATSAL measured geographical differences across GB using Government Regional Offices (GOR) to identify the region a participant lives in. NATSAL included urban and rural indicators, with one variable looking at England and Wales and another Scotland only. In addition, NATSAL contains ONS urban/rural indicator variables and Output Area Classification codes. Area-level deprivation is also provided by the Index of Multiple Deprivation (IMD) quintiles. The 2011 Area Classifications cover output areas and LA districts. The End User version of the survey uses GOR as unit of analyses, whilst a Secure Access version contains LA districts, Area Classification for Output Areas Subgroups and IMD quintiles.

3.5.7 Other questions

Questions about both heterosexual and same-sex sexual activity were asked, including incidences of unsafe sex in the past year. Other questions included information about sexually transmitted diseases and HIV testing, attitudes to sex and self-perceived risk of HIV. In addition, questions about risk perception of HIV in different groups of people were included. The inclusion of sexual risk behaviours such as unprotected intercourse allows the exploration of the link between both smoking and drug use.

3.5.8 Filters

In NATSAL, sexuality questions are asked to all participants in the survey. Smoking again was initially asked to all participants, but only those that smoke now were asked about frequency of smoking, and those that do not smoke now were asked about previous regularity of smoking. Drug use was also asked to everyone and then filtered to specific questions applicable for those that answered that they have taken any type of drug at some point. The mode of delivery for NATSAL was face-to-face and self-completion for some questions. Computer-assisted personal delivery was used as well as computer-assisted self-interview for more sensitive questions.

3.6 The Health Survey for England and the Scottish Health Survey

The Health Survey for England (HSE) and Scottish Health Survey (SHS) are commissioned by NHS England and the Scottish Government Health Department, respectively(NatCen Social Research, 2018; ScotCen Social Research, 2019)(NatCen Social Research, 2018; ScotCen Social Research, 2019)(NatCen Social Research, 2018; ScotCen Social Research, 2019). Both surveys address the same topics about health and perceptions of health in England and Scotland, and thus the topics, wording and scope of the questions for each module may allow them to be linked to increase sample size and investigate smoking behaviours in both England and Scotland. The use of HSE 2013 and 2014, and SHS 2013 and 2014 were considered for analysis in this thesis, due to later waves not including sexuality in the End User licence version of the survey.

3.6.1 Sample design

HSE used a multi-stage stratified probability sampling design. Primary sampling units (PSU) based on postcode sectors were first selected, followed by a random sample of addresses. In each PSU 16 addresses were selected, and all adults in the household were interviewed. 8795 interviews were carried out in HSE 2013 survey, with 8077 interviews in the 2014 survey. SHS also used a multistage stratified design, selected at random, with all adults eligible to be interviewed in a household (Mindell et al., 2012). The sample size for SHS in 2013 was 4894 interviews, and 4659 in 2014, which includes a boost which was optional for Health Boards to choose in order to boost the number of adults in that area.

3.6.2 Sexuality

The HSE and SHS both measure sexual orientation through self-identification and the question was worded the same in both surveys, ‘which of the following options best describes how you

think of yourself?' with the same options given; gay or lesbian, heterosexual or straight, bisexual, other, prefer not to say (see appendix A.2 and A.3 for further question details in this survey).

3.6.3 Smoking

Whether participants smoked was initially measured by the following question, 'May I just check, have you ever smoked a cigarette, a cigar or a pipe?, which was again the same wording in both surveys. Further, more comprehensive questions about smoking are asked, such as if participants answered that they do not smoke nowadays, why did they decide to quit, with answers such as advice, advertisements, financial reasons, smoking bans, family or friends, motivation or health problems. The type of cigarettes smoked are also asked about, if hand rolled cigarettes are smoked with or without a filter, and those that smoke hand-rolled cigarettes are asked the amount of tobacco smoked each day, both on weekdays and at weekends. Other questions include the intention to quit smoking, reasons for quitting for ex-smokers, use and experience of nicotine replacement products and exposure to smoke from friends, family or the public. The HSE and SHS address smoking using most of the same questions, with the SHS going further by asking about support received for those who have tried to quit smoking. The depth of smoking questions is valuable in both surveys, as they allow for the exploration of not only smoking prevalence but smoking habits, for example age of initiation when smoking.

3.6.4 Alcohol use

Whilst illicit drug use was not addressed in the survey, alcohol intake was addressed in detail. The survey asked about various drinking habits and frequency of drinking, different types of alcohol consumed and how amount of intake of alcohol. In addition, in the self-completion booklet for adults, participants were asked how much they drink and how often they drink more than six drinks in a day, and how often in the past three weeks they have been drunk.

3.6.5 Spatial indicators

Both the SHS and HSE provide an End User Licence version of the surveys, containing GORs as the spatial indicator for HSE and Health Boards for the SHS. The 2011 Output Area Classification is available from the 2014 wave onwards. Whilst spatial indicators below regional level, such as at the LA level, are not available as the sample size for HSE and SHS are not large enough, the surveys both give IMD quintiles for lower layer super output areas (LSOA). Survey clusters are available from selecting areas and assigning anonymised numbers for each cluster.

3.6.6 Filters

In SHS and HSE, sexual orientation was asked to everyone. The SHS asked 16 and 17 year olds as part of the self-completion module, and 18 and 19 year olds were asked either as part of the main interview, or as part of the self-completion section for young people. This was decided at the interviewer's discretion, depending on whether they felt answers might not be honest if asked in front of other household members. Smoking was asked as part of the main questionnaire to all those over 20. In HSE, smoking was asked to all those over 16. After the initial smoking question, those that either currently smoked or had previously been a smoker were asked about frequency, regularity, efforts to quit and reasons for quitting. Some questions were applicable to only current smokers and some for only ex-smokers. Some questions asked about certain types of cigarettes such as hand-rolled ones, and thus only those that smoked that type of cigarette were asked further detailed questions regarding their use. Both SHS and HSE were completed face-to-face using computer-assisted personal interviewing.

3.7 Understanding Society and British Household Panel Survey

The BHPS asks general demographic questions but does not ask about sexual orientation in any wave. However, the survey does ask questions about smoking behaviours and a general question on drug and alcohol problems under a health module. US was then examined, which included both sexual orientation and smoking behaviours, in addition to questions about illicit drug use. The survey interviews the same households each year and addresses different themes including health and wellbeing, political views, education and employment (Knies, 2017).

3.7.1 Sample design

The sample design for BHPS used a stratified cluster design, with 250 PSUs in GB, with all adults interviewed in a household. More households and boost samples were added in later waves. The first wave of BHPS in 1991 was 9092 adults interviewed within households. The former BHPS sample was included from wave two of US, with those who were still part of BHPS at wave 18 and gave consent to being contacted for taking part in US. US also had a general population sample, which again used postcode sectors as PSUs, where addresses then selected from these. In wave two, 50389 individuals were interviewed which included the general population sample, former BHPS sample and an Ethnic Minority Boost Sample (Fumagalli et al., 2017).

3.7.2 Sexuality

US asks about both sexual orientation and smoking in wave three in 2012 and wave five in 2014. Sexual orientation was measured through self-identification with the question 'which of the following options best describes how you think of yourself?' with the answers heterosexual, gay or lesbian, bisexual, other or prefer not to say (for further detail of questions see appendix A.4). Although sexual orientation was not included in BHPS itself, the shift of participants from the BHPS to US allows individuals smoking habits to be traced back through the BHPS according to their sexual orientation answered in US.

3.7.3 Smoking

Smoking questions were included in all waves of US except wave one, which was excluded anyway as BHPS participants were only included from wave two onwards. Wave two, five and six asked smoking questions are part of the main questionnaire asked to all participants, whilst wave three and four smoking questions were included only as part of the youth self-completion questionnaire for participants aged 16-21. Wave three, four and six asked if participants have ever smoked and frequency of smoking, whilst wave two and five asked more detailed questions such as age when first started smoking, if they have ever quit and asked about frequency of smoking and were addressed briefly in wave three, measuring if participants smoke or not by asking 'Do you ever smoke cigarettes at all?' and then if they smoke nowadays, whilst wave fived expands on these questions asking about frequency of smoking, how many per day, if they have tried to quit and age when last quit. Smoking questions were also included in all waves of the BHPS, asking if participants have ever tried a cigarette and if they are current smokers.

3.7.4 Other substance use

Drug use in the past 12 months was addressed in all waves except wave one, and was asked only as part of the youth self-completion questionnaire for 16-21 year olds. The questions asked about drug use by type of drug such as cannabis, solvents and other illegal drugs and frequency of drug use. Alcohol intake in US was measured by asking questions such as age of first alcoholic drink, frequency of drinking and how many times in the last four weeks has a participant been intoxicated.

3.7.5 Spatial indicators

GORs are used as the spatial indicator for the standard End User License of both US and the BHPS. However, a Special License version is also available that contains finer detailed country coding and

medium-level and low-level spatial indicators such as LA level data. Under Secure Access conditions, there is a version containing British National Grid postcode grid references at 1m resolution, derived from the ONS National Statistics Postcode Directory. Northern Ireland was only included in 2001, with earlier surveys including only GB.

3.7.6 Other questions

Other questions in US were more general socio-demographic questions such as employment status and type, education qualifications, ethnicity, general health and diagnosed conditions. In the BHPS, smoking was asked both as part of the main survey and in the youth questionnaire.

3.7.7 Filters

Sexual orientation was asked in wave three of US in the main individual survey. Sexual orientation was part of the self-completion module, in that participants answered this question if they were the individual answering the survey i.e. not a proxy and had agreed to self-completion. In wave five of US, sexual orientation was part of the mainstage questionnaire in a Young Adult self-completion module. The age range was 16-21 years, and the question could be completed face-to-face and if the individual has agreed to self-completion, or via telephone or web. The question and possible answers were the same as in previous waves. Smoking questions in wave three were part of the mainstage questionnaire in the youth self-completion module. Individuals could answer this if they were face-to-face and were between 16-21 years. Those who answered 'yes' were asked about frequency of smoking. Wave five of US went into more depth for smoking questions as part of the main questionnaire, asking the same initial question and then continued asking questions regarding frequency, regularity of smoking, how many cigarettes smoked in the past, age when last stopped smoking and age when first started. Several filters were used for smoking questions in wave five. After the initial question of 'have you ever smoked cigarettes', those that answered yes went on to be asked if they smoke now, and those current smokers were asked about frequency. Ex-smokers were asked about past regularity and age when they quit. In the BHPS, smoking was asked to all, and frequency of smoking was then filtered to only those who have ever smoked. In a young adult module more in depth questions about smoking were asked for those who have ever tried it, as well as some questions about drug use.

3.8 European Men who have sex with men Internet Survey

EMIS was found through a prior literature search, and is a sexuality survey for MSM, and addresses research priorities for MSM according to the European Centre for Disease Prevention

and Control. The questions focus on four main categories; levels of HIV/STI exposure, levels of unmet needs of MSM, population coverage and biases of prevention interventions and what information is needed to compare samples and target interventions. Questions are structured to address behavioural surveillance and other issues such as knowledge regarding safe sex, alcohol and recreational drug use, relationships, access to testing and experience of homophobia. EMIS has a sample size of 17,656 across the UK.

3.8.1 Sample design

EMIS was an online administered survey, translated into 25 languages. EMIS was accessible in 38 countries, though the UK only data was made accessible from the data owner at London School of Hygiene and Tropical Medicine. EMIS was promoted through social networking sites, blogs, NGO websites and via posters in gay venues. Promotion through website were either paid or unpaid depending on the agreement (The EMIS Network, 2013).

3.8.2 Sexual orientation

Sexual orientation in EMIS was again measured by self-identification asking 'which of the following options best describes how you think of yourself?', with the options being gay or homosexual, bisexual, straight or heterosexual, any other terms or I don't usually use a term. The survey also asked about sexual behaviour and attraction (see appendix A.5 for more detailed survey questions).

3.8.3 Smoking

Smoking was briefly addressed under a section titled 'about using various substances', and included just one question about tobacco use in general rather than smoking specifically 'when was the last time you used tobacco products'.

3.8.4 Substance use

Drug use was more comprehensive, initially stating 'please say when you last did something, even if this was not typical for you' and then asking about specific drugs such as nitrate inhalants, anabolic steroids, cannabis, amphetamines, heroin and others. In addition to illicit drugs, the use of drugs for enhancing sexual performance was included in the same section, as well as legal highs. The survey also asked about when they were last used. Alcohol intake was asked in the same way as tobacco use was, asking 'when was the last time you consumed alcohol?' and had no further related questions.

3.8.5 Spatial indicators

Spatial indicators in EMIS start at the European Country level and then the subregions of Europe. Then within each country the location is refined further to county areas. In addition, area typologies are asked in the survey, asking participants to describe the place they live in with population sizes attributed to the type of area. For example, very big cities or town were described as having a population of a million or more people, whilst a village or an area in the countryside included a population size of less than 10,000 people. in total, five options were given for the participant to choose according to how they would describe where they live.

3.8.6 Other questions

Other general questions included education qualifications, occupation status and country of birth. EMIS asked similar questions to NATSAL, including sexual risk behaviours such as unprotected anal sex, visits to gay clubs, sex parties and gay saunas. Knowledge of HIV and HIV testing was included, as well as knowledge about condom safety. Other sexually transmitted diseases were also addressed.

Similar to NATSAL, EMIS allows the investigation of drug use and smoking associated with risk behaviours such as unprotected anal intercourse. Whilst EMIS includes only MSM, the survey may be able to be paired with NATSAL looking at questions that are the same, thus MSM data can then be compared with heterosexual and other sexual minority groups.

3.8.7 Filters

EMIS used sexual orientation as a screening process to ensure only men having sex or attracted to other men carried out the questionnaire. Use of tobacco was asked to everyone, and as there were no further questions no filters were used. Drug use was also asked to everyone, although there was no initial question asking about previous drug use. Thus, questions about the last time a specific drug type was used was asked to everyone. As the survey was an internet survey, that was the only mode of delivery used.

3.9 Final surveys used in empirical chapters

Whilst the five surveys identified meet the initial inclusion criteria, there are limitations to some of the surveys and their potential use for empirical analysis in this thesis. The following section looks at each survey in context with the research questions. After assessing each survey in detail, three surveys were selected to be used for the empirical analysis in this thesis; HSE, BHPS/US, and

NATSAL. The reason EMIS and SHS were excluded was due to the limitations of merging the surveys with NATSAL and HSE, respectively, which is discussed in more detail below.

3.9.1 Feasibility of merging surveys

Whilst theoretically HSE and SHS could be merged together to create a larger data set and used to address the first research question due to broader smoking questions than in other surveys, in practicality this was not feasible. Merging these data together based on similarly worded questions could be possible, but versions considered for use in this thesis from the SHS have questions worded differently to the HSE. Based on the research question and previous literature, the first empirical paper will use only HSE, as that has a greater sample size than SHS, and also fits in with the TCP for England released in 2017. Additionally, using only HSE prevents exclusion of some variables that are not present in both surveys.

The second research question could be addressed using longitudinal data that has more refined spatial indicators, and can allow smoking to be investigated over time *and* space. As the only suitable longitudinal data are BHPS and US, these could be merged to trace back individuals based on their sexual orientation and see how smoking has changed. How smoking has changed across LAs over time can also be looked at, using the Special Licence version of these data.

The third research question could be addressed using data from NATSAL and EMIS, as they have a higher number of LGB individuals in the surveys, which would allow the groups to be analysed and separated by sex and sexual identity. However, whilst initially it appeared these surveys could be merged together for analysis, EMIS is missing a number of questions that would be difficult to justify excluding (e.g. ethnicity), and the tobacco use question differs from NATSAL in that it is about daily tobacco consumption, which could include chewing tobacco or pipe smoking, rather than just current cigarette smoking status. There are also no alcohol use questions in EMIS, which limits smoking and co-behaviours to illicit substance use only. Therefore, the final empirical research paper will use NATSAL data only. Table 3.5 lists the surveys used to address each of the research questions in the three empirical chapters in this thesis.

Table 3.5. Research questions addressed by each survey

	HSE	BHPS/US	NATSAL	Chapter
Research question				
What are the determinants of smoking in LGB people across Great Britain?	✓			5
Has there been change over time and space in smoking prevalence in LGB population?		✓		6
How does smoking behaviour co-vary with other behaviours and how is it affected by measurement of sexuality?			✓	7

3.10 Conclusion

This chapter highlights the decision process for selecting appropriate surveys for analysis in this thesis. Searching for both sexuality and smoking or drug use returned a large number of surveys, but after examining titles and abstracts few surveys that appeared appropriate were retained. After reviewing all candidate surveys and excluding those unsuitable, three surveys have been retained for analysis as part of the project that included appropriate sexuality data, smoking and co-behaviour data, and the latest wave was carried out after 2007.

In addition to these surveys covering both sexuality and smoking in sufficient detail, each survey offers opportunities for complex analysis in line with the research questions and prior literature. HSE offers the opportunity to look beyond prevalence rates and examine smoking heaviness in LGB compared to heterosexual populations, and offers several other smoking variables that allows more in depth analysis of smoking behaviour to be analysed. The survey design of HSE also allows us to use multilevel modelling techniques which, although may not provide specific place information, will give correct standard errors and improve estimates of smoking behaviour in this population. The BHPS and US longitudinal nature allows us to trace individuals back to 1991 to observe if there are trends in change over time that might have occurred in the LGB population compared to heterosexual population. The inclusion of finer spatial indicators also means these changes can be mapped across GB. Finally, using NATSAL can allow for the examination of differences between different measures for sexuality and test for multiple health risk behaviours simultaneously, whilst also observing trends in different types of LAs according to each health risk behaviour.

PART TWO: EMPIRICAL ANALYSIS

Chapter 4 Overview and intended contribution

To address the gaps in health geography research on sexuality and smoking that emerged from the literature review and available data sources, three empirical papers were written in response. The data sourced for each research question was accessed, cleaned and analysed by myself, along with the writing of the empirical papers. Nathaniel Lewis and Graham Moon provided feedback on analysis, methodology and the structure of the papers, as well as supporting the ethical approval form from Southampton Ethics Committee. Special Licence approval for data access from UKDS for the BHPS and US was granted for all of the research team (see appendix B).

In the literature review, the use of quantitative methods to address gaps in sexuality research was discussed, which found that univariate regression models have been increasingly used in health research to examine health risk behaviours in LGB populations. The use of more sophisticated modelling techniques, such as multilevel modelling, has been used in fields such as educational research and health geography for some time, but its application to sexuality research has been relatively infrequent until recently. No known studies to date have applied multilevel modelling to consider the impact of both contextual and compositional factors in smoking behaviour in sexual minority populations.

4.1 Multilevel modelling

Multilevel models, also referred to as hierarchical linear models or mixed effects models, take into account data that is nested within higher levels, for example individuals nested within areas or communities (Snijders & Bosker, 2012). Social science research has previously placed more emphasis on individual level determinants of outcomes or behaviours whilst ignoring the context in which an individual sits (Duncan et al., 1998). Multilevel models therefore allow us to estimate individual level factors associated with an outcome as well as higher level factors, in a single model. This thesis contributes to previous literature looking at smoking in LGB populations by using methodologies that consider the importance of both individual and environmental level influences on smoking behaviour.

The basic structure of a multilevel model is shown in figure 4.1, where individuals are nested within a community. This can be extended in a number of ways, including adding higher levels (for example communities nested within regions), by using repeated measures data in which level one becomes a ‘time’ level nested within individuals, or multiple outcomes which represent level one

nested within individuals. Each of these structures are employed in each of the empirical chapters in this thesis, and are discussed further below.

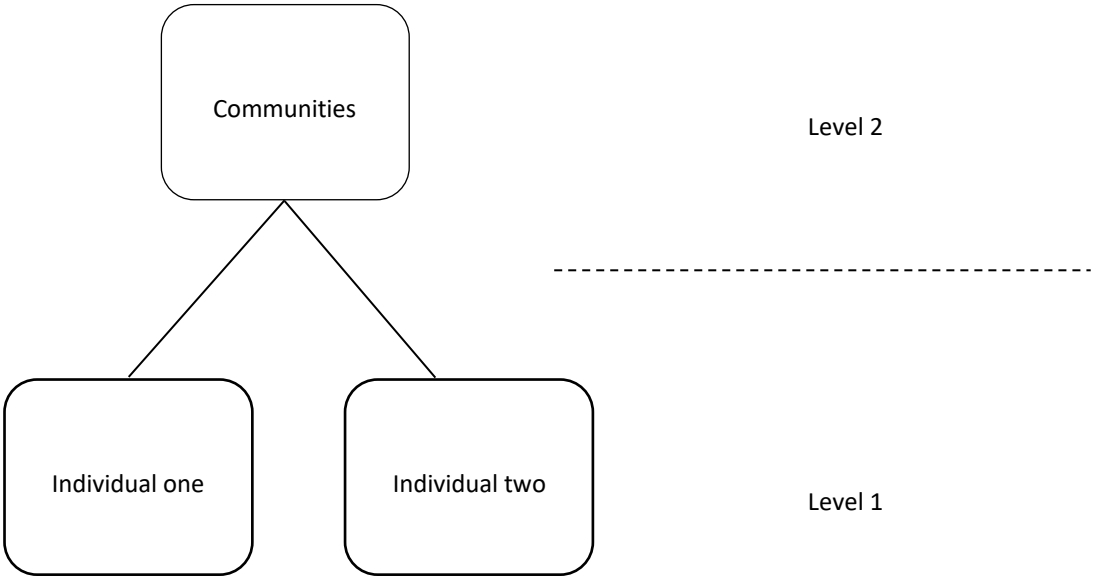

Figure 4.1. Basic multilevel structure

4.1.1 Missing data

Where possible, to account for small LGB sample sizes in each survey, Markov Chain Monte Carlo (MCMC) estimation was used. MCMC is a method of sampling that estimates posterior distributions. The advantages of using MCMC sampling is that it provides a more robust and powerful estimation method, which is useful when working with unbalanced sample sizes (van Ravenzwaaij et al., 2018). Missing data was handled in a way to minimise loss where possible; chapter five used pairwise deletion to minimise data loss, in chapter six some variables with missing data were declared as categories to prevent loss, however in chapter seven listwise deletion was used due to software requirements for multivariate modelling (Rasbash et al., 2019). These efforts ensured as much data was retained as possible for analysis.

4.2 Chapter 5: Determinants of smoking

Chapter five addresses the research aim in this thesis: 'What are the determinants of smoking in LGB populations in Great Britain?' using data from HSE. Structural equation modelling (SEM) is used to look at hypothesised pathways based on previous literature on smoking, comparing LGB individuals to heterosexual individuals. This chapter also compares these pathways for social class groups in England, which previous research shows are a large driver of current smoking rates

(Hiscock et al., 2012). The data for this chapter was accessed through the UKDS without needing special permission, as geographical indicators in this survey are only available at GOR level. This paper was published as Davies, M., Lewis, N. M. & Moon, G. (2019). Differential pathways into smoking among sexual orientation and social class groups in England: A structural equation model. *Drug and Alcohol Dependence*, *201*, 1–7. https://doi.org/10.1016/j.drugalcdep.2019.04.012

4.2.1 Methodological contributions

The methodology chosen for this chapter reflected the need to examine determinants that are associated with sexuality and smoking, beyond examining prevalence rates using models that focus on only individual level determinants (Fallin et al., 2015a; Fish et al., 2019b; Shahab et al., 2017). Whilst studies into how sexuality is implicated in smoking likelihood compared to heterosexual populations give us insight into the inequalities in these groups, they do not address the *sequence* in which smoking behaviour might occur. SEM, or path analysis, is often used to uncover latent variables, but is also useful is establishing the order in which associations may occur in observed variables, and has been found to be a particularly useful method in social sciences (Hooper et al., 2008). The use of SEM in sexuality research and smoking behaviour has not previously been employed, however given its use in social science research and previous studies that have looked at smoking behaviour in other populations (Honjo et al., 2006), this method can aim to address some fundamental questions regarding determinants of smoking in this population.

The decision to use the HSE for this chapter meant that additional access for survey data with finer geographic details required for other chapters could be applied for whilst analysis was taking place for this chapter. HSE itself does not contain finer geographic details, which means analysis at LA level is not possible and the PSUs were also kept anonymous. This also meant however that although there is a smaller LGB sample size than other surveys, there was less concern about having small numbers of LGB individuals in geographic units. HSE contained more refined smoking variables which meant path analysis could untangle aspects of smoking behaviour beyond prevalence rates between LGB and heterosexual individuals. Despite the lack of finer spatial indicators, the nested design of the survey meant multilevel modelling was still appropriate to use to obtain correct standard errors and more accurate coefficients, and still gave information about the unobserved residual variance at the PSU and GOR level.

For this chapter, a continuous outcome variable was used, as were continuous mediator variables. There were several reasons for these decisions. Firstly this paper sought to extend analyses of the

prevalence of smoking in LGB populations by having a continuous outcome variable, thus looking at smoking 'heaviness' and not simply its binary presence/absence. Secondly, categorical outcomes and mediators in a three-level model in Mplus do not give model fit indices. Limited estimation methods are available in Mplus when a three level model is fitted, and using categorical predictors adds to the complexity and makes interpretation more difficult (Muthén & Muthén, 2017). Finally, the mediators selected were reported as continuous variables and it was logical to keep them rather than manipulate them to categorical variables, for example hours of exposure to smoke per week.

Given the continuous outcome, the model at its simplest form follows that of a simple three-level multilevel model. A simplified equation for a two level model with a continuous outcome can be written as:

$$y_{ij} = \beta_{0ij} x_0$$
$$\beta_{0ij} = \beta_0 + u_{0j} + e_{0ij}$$

Where y is the continuous outcome, the subscript i refers to the level 1 (i.e. individual), j refers to the level 2 (i.e. region), $\beta_{0ij} x_0$ is the constant with a random intercept term varying at level one and two, u_{0j} and e_{0ij} are the random terms for level two and one, respectively. Path analysis extends this by regressing an outcome onto another outcome. The basic model for path analysis is shown in figure 4.2, which shows a two-level simple path model with observed variables. The outcome y3 refers to the main outcome of interest, i.e. smoking heaviness, where y1 and y2 are dependant variables that also mediate the effects of the covariates x1, x2 and x3, on the dependent variable y3. In chapter five, this is extended by adding the third level GOR, and more predictor variables and a third mediator variable.

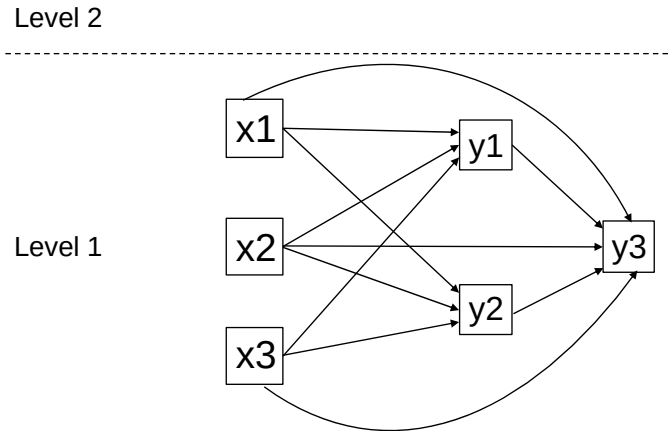

Figure 4.2. Basic two-level SEM diagram

4.3 Chapter 6: Changes in smoking over time and space

Chapter six addresses the research question: 'Has there been change over time and space in smoking prevalence in LGB populations across Great Britain?' This paper uses data from the BHPS and US merged together to trace back individuals based on sexual identity reported in US to early waves of the BHPS. The data were accessed using Special Licence access that was granted, as it contained LA data. The conditions were that this data was only accessed by myself on a personal computer using a personal or secure network. This chapter uses multilevel repeated measures modelling to look at how smoking has changed over time for LGB individuals compared to heterosexual individuals, with separate models for men and women to test for gender effects. This chapter is currently under review at *Health and Place*.

4.3.1 Methodological contributions

The nature of the second research aim looking at change over time in smoking requires the use of longitudinal multilevel analysis to look at these effects. The smoking variables in BHPS/US were less detailed than in other surveys, so the analysis was limited to using a binary current smoker question and therefore a categorical outcome. When using a multilevel repeated measures model with a categorical outcome, variation at level one cannot be estimated due to the inability to estimate random level effects at this level with a dichotomous outcome. Instead, this chapter observed the change in effects over time by including a 'time' term in the model for each wave of the survey. The multilevel structure was a three-level model, whereby each wave (time point) is nested within individuals, who were nested in LAs (figure 4.3).

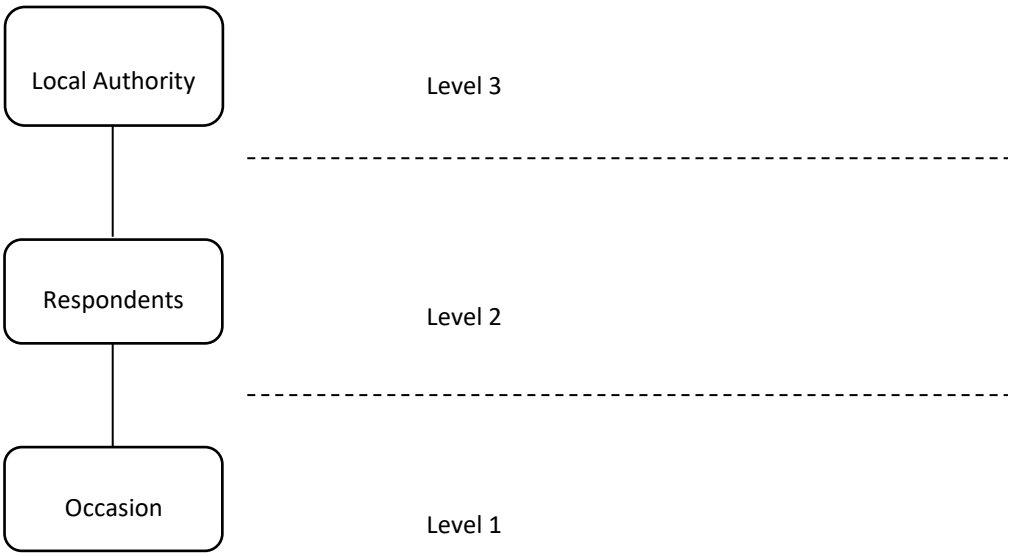

Figure 4.3. Multilevel repeated measures model structure

As the smoking outcome was measured as a binary variable in BHPS/US, this model used a logistic multilevel repeated measures model. Logistic models are used for dichotomous outcomes, which give the conditional probability that the outcome (i.e. smoking) equals one at a certain value for a covariate or independent variable (Sommet & Morselli, 2017). A simple two-level random intercept logistic model can be expressed as the following equation:

$$logit\left(p_{ij}\right) = \beta_0 x_{0ij} + \beta_1 x_1$$
$$\beta_{0j} = \beta_0 + u_{0j}$$

Where β_0 refers to the fixed constant, i refers to the individual level one i.e. time, j refers to level two i.e. individual. $\beta_1 x_1$ is a fixed covariate, u_{0j} is the random level two effect.

The variables selected were based on previous research and chosen to ensure known determinants of smoking were controlled for, such as education and employment status. The analysis included a random slope term for sexuality and fixed terms for all other covariates. To look at the predicted probability of smoking across different areas, the residual intercept and slope of each level three LA was calculated from the model, along with the fixed terms for sexual orientation and change over time. These were calculated for 1991 and 2017, and the difference was then mapped using ArcMap version 10.6.1 to draw comparisons across GB for each group. The LAs with the greatest change from 1991-2017 i.e. those that have experienced the greatest decline in smoking prevalence were shown on a map of GB, and grouped together by LA type using a box and whisker plot.

4.4 Chapter 7

Chapter seven addresses the research question: 'How does smoking behaviour co-vary with other behaviours and how is it affected by measurement of sexuality?'. This chapter used data from the third and latest wave of NATSAL, and LA data was sent separately from the data owner to link with the main survey that was accessed from the UKDS (see appendix C). This chapter used multilevel multivariate modelling, which looked at cannabis use, current smoking and alcohol use simultaneously, to give better estimates of risk behaviours and also to determine the association between each outcome at LA level. This study used both sexual attraction and sexual identity to determine if there are differences as using sexual identity only might exclude some individuals who might be vulnerable in engaging in risk behaviours, with again separate models for men and women to test for gender effects. This chapter was prepared for submission to *Social Science and Medicine*.

4.4.1 Methodological contributions

As this chapter aims to look at other health risk behaviours related to smoking in sexual minority groups, multilevel multivariate analysis was selected. This chapter used data from NATSAL, which used two different measures of sexuality; sexual attraction and sexual identity. NATSAL contains multiple questions on substance use, and based on previous research, three variables were selected as outcomes; regularly going over the weekly limit of alcohol, current smoking, and history of cannabis use. These three outcome variables were all binary variables. To extend previous literature that has compared these outcomes in separate models, this chapter used multivariate modelling to analyse the outcomes simultaneously. There are several benefits to this analysis, firstly, looking at the outcomes together 'controls' for each other, in that the effect of smoking takes into control the effect of alcohol and cannabis use. Secondly, outcomes can be correlated with each other to determine the relationship between smoking, alcohol, and cannabis use, at the LA level (Mohan et al., 2011; Subramanian et al., 2005). The structure of the model is shown in figure 4.4, whereby each outcome is level one, the respondent is level two, and LA is level three.

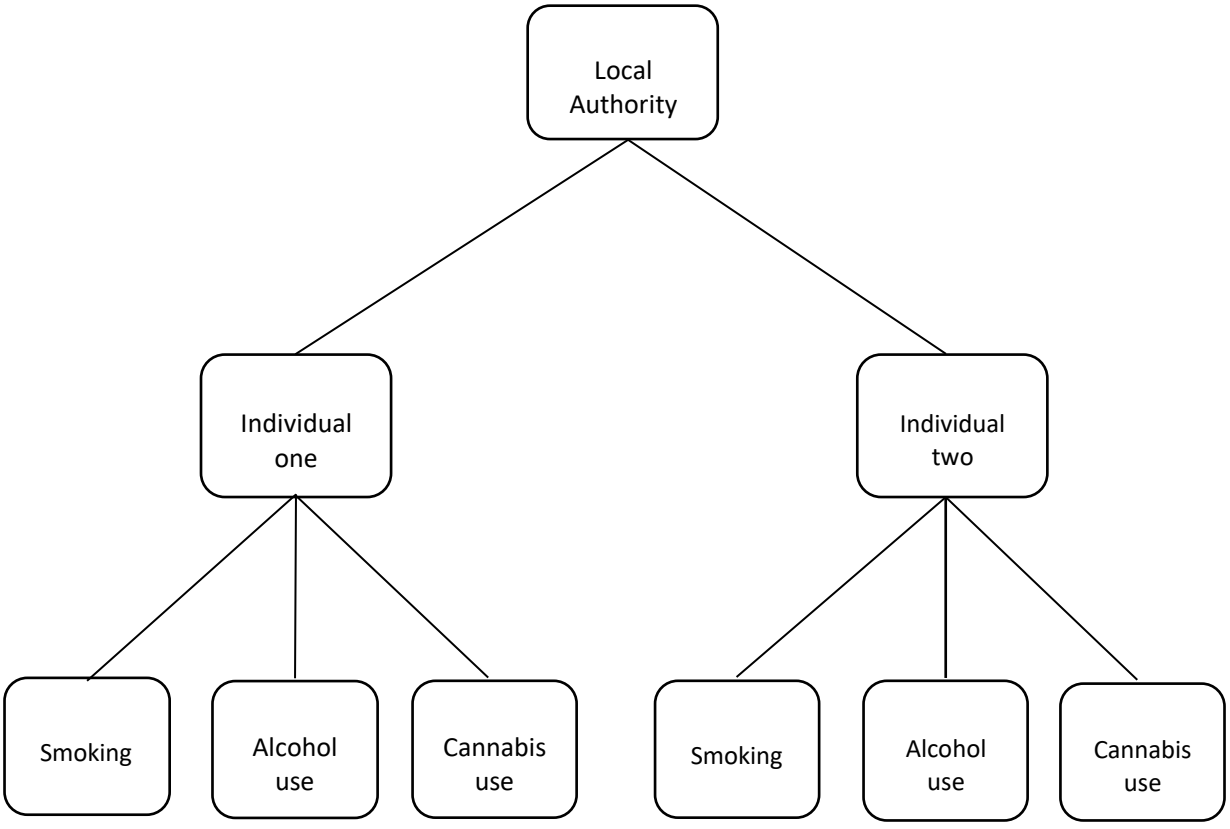

Figure 4.4. Multilevel multivariate model structure

A simple three-level logit multivariate model with only two outcomes can be expressed in the following equation:

$$logit\left(p_{1jk}\right) = \beta_{0k}x_{0ijk}$$
$$\beta_{0k} = \beta_0 + v_{0k}$$
$$logit\left(p_{2jk}\right) = \beta_{1k}x_{1ijk}$$
$$\beta_{1k} = \beta_1 + v_{1k}$$
$$\begin{bmatrix} v_{0k} \\ v_{1k} \\ v_{2k} \end{bmatrix} \sim \mathrm{N}\left(0, \Omega_v\right) : \Omega_v = \begin{bmatrix} \sigma_{v0}^2 & & \\ \sigma_{v01} & \sigma_{v1}^2 & \\ \sigma_{v02} & \sigma_{v12} & \sigma_{v2}^2 \end{bmatrix}$$

where p_{1jk} is the probability of an outcome when a covariate is 1, $\beta_{0k}x_{0ijk}$ is the constant for the first outcome, varying at each level and $\beta_{1k}x_{1ijk}$ is the constant for the second outcome. v_{0k} and v_{1k} refer to the random effects at LA level. The σ_v^2 matrix represents the variance between groups and between outcomes, which are assumed to come from a mean of zero and joint normal distribution. We extended this model in chapter seven to include fixed predictor variables and a third outcome variable. Only the intercepts were random in this model, and no random slopes were included. The outcomes and variables were chosen based on previous literature that suggests an association between sexuality, smoking and co-behaviours, and predictor variables were selected as known determinants of health outcomes, including measures of social class and positive scores for depression. LAs with fewer than 10 observations were excluded from the analysis. The random intercept term included meant that we could estimate residual terms for LA level variance, which we then compared with LA type as in chapter six.

4.5 Conclusion

This chapter addresses the methodology used in the empirical chapters in this thesis and the rationale for selecting them. Multilevel modelling was chosen as the underpinning methodology to analyse smoking behaviour in LGB populations in GB, due to the ability to examine both the effects of individual factors and the environment. Each chapter used an extension of multilevel modelling to address the gaps and research aims in sexuality and smoking research, to examine the determinants of smoking, changes over time and space, and other co-behaviours. The methods chosen aim to advance this research field using secondary data in the context of GB. The following three chapters are the empirical analysis chapters for this thesis that address each of the research questions.

Chapter 5 Differential pathways into smoking among sexual orientation and social class groups in England: A structural equation model

This paper has been published as Davies, M., Lewis, N. M. & Moon, G. (2019). Differential pathways into smoking among sexual orientation and social class groups in England: A structural equation model. *Drug and Alcohol Dependence*, *201*, 1–7.

5.1 Abstract

Previous research has shown that LGB populations smoke more than their heterosexual counterparts. Little is known about the pathways into smoking among LGB populations in England relative to the lower social class populations that are the focus of the current Tobacco Control Plan (TCP). Using the 2013/2014 waves of the Health Survey for England (HSE), we created a structural equation model to analyse pathways and interactions between sexual orientation, social class, and the number of cigarettes smoked daily. The path analysis assessed whether three intervening factors—age of initiation, mental wellbeing score, and exposure to smoke—are implicated similarly in smoking among LGB and lower social class populations, and whether interaction between sexual orientation and class is further associated with smoking. Bivariate analysis showed that LGB-identified individuals and individuals in lower occupational classes smoke more cigarettes daily, respectively, than heterosexual individuals and those in professional/managerial class populations. Path analysis showed that the number of cigarettes smoked daily was mediated by age of initiation, mental wellbeing score and weekly exposure to smoke among routine and manual workers; by mental wellbeing score and exposure to smoke among intermediate class workers, and by mental wellbeing score in the LGB population. Interactions between sexual orientation and social class were not significant. The differential nature of pathways into smoking for lower social classes and LGB populations in England suggests the need for tailored prevention and cessation efforts, with programming for LGB populations focused on the distinct stressors they face.

5.2 Introduction

Lesbian, gay, or bisexual (LGB) individuals in England are more likely to smoke than their heterosexual counterparts. A recent large scale English study found that smoking prevalence for

gay men (26%) and bisexual men (31%) exceeded that of heterosexual men (20%) while prevalence for lesbian women (25%) and bisexual women (32%) exceeded that of heterosexual women (18%), but that these differences were attenuated after controlling for sociodemographic factors (Shahab et al., 2017). Other English studies suggest that sexual orientation inequalities in smoking have persisted, particularly among men (Bourne et al., 2017) and adolescents (Hagger-Johnson et al., 2013), despite smoking rates for all populations in England (including LGB) decreasing during the past decade (see King & Nazareth, 2006).

England represents a distinct socio-historical context for LGB health and social inequalities. The UK (comprising England, Wales, Scotland, and Northern Ireland) began the process of decriminalising homosexuality in 1967, almost forty years earlier than the United States in 2003 (Hildebrandt, 2014). Despite this early advancement, LGB individuals in England experienced regressive policies in the 1980s and 1990s (e.g., Section 28 outlawing the public 'promotion' of homosexuality) and continue to experience stigma, bullying, and discrimination in homes, schools, and communities (Formby, 2017, 2013; Roberts et al., 2017; Scourfield et al., 2008).

The high smoking rates among LGB individuals in England, then, may owe to minority stress, or the chronic social stigma and stress faced by sexual and gender minority populations (Meyer, 2003; Semlyen et al., 2016). Minority stress may be exacerbated by structural factors, such as the absence of protective policies (Hatzenbuehler et al., 2014; Lewis, 2009; Pachankis et al., 2014), or by micro-level factors such as verbal slights and slurs known as microaggressions (Nadal et al., 2011). A recent review of smoking predictors in LGB populations (Blosnich et al., 2013) found that elevated levels of smoking are associated both with minority stressors related directly to sexual orientation and with other health outcomes (e.g., depression, alcohol use) experienced at higher rates in LGB populations. Internalised homophobia, sexual orientation related victimisation, negative coming out experiences, and other aspects of minority stress may all contribute to smoking or to other outcomes associated with smoking (Blosnich et al., 2013; Balsam et al., 2012).

The gravity of the smoking epidemic affecting the LGB population in England may not be fully captured in England's current public health policies and interventions. The TCP released in 2017 by the English Department of Health and Social Care aims to by 2022 reduce overall smoking prevalence in the general population from 15.5% to less than 12% and in 15-year olds (i.e., early initiators) from 8% to 3% (Department for Health, 2017, p.5). The TCP stresses the need to reduce smoking rates in individuals with diagnosed mental health conditions (pp. 13–14) and to limit exposure to smoke, particularly among 16–24-year olds (p.22). The TCP also indicates that those in the manual and routine occupational class are twice as likely to smoke as those in managerial professions (p.19). Previous research suggests that smoking among lower social class groups is

associated with initiating smoking earlier in life (Green et al., 2016), having poorer mental wellbeing (Stewart-Brown et al., 2015), and being more exposed to smoke (Katainen, 2010; Sims et al., 2012).

The TCP acknowledges that individuals from the LGB community 'remain far more likely to smoke than the general population' (p.19). The only stated target for reducing population-level inequalities, however, is 'to reduce the regional and socio-economic variations in smoking rates' (p. 6), particularly by targeting routine and manual workers through local stop smoking services (p.19). Existing research suggests, however, that many of the risk pathways into smoking outlined in the TCP, including early age of initiation, lower mental wellbeing, and exposure to smoke, may also be experienced among LGB individuals.

LGB individuals, especially lesbian and bisexual women, tend to initiate smoking earlier in life (Corliss et al., 2013; Fallin et al., 2015a). Earlier initiation for LGB individuals may occur due to low self-esteem, social isolation, early recognition of stigmatisation, or experiences with bullying at school (Rosario et al., 2011; Watson et al., 2018b). Regardless of their sexual orientation, early initiators are more likely to become daily smokers (Lenk et al., 2009) and less likely to quit (Wilkinson et al., 2007).

LGB individuals experience higher rates of adverse mental health outcomes (e.g., anxiety, depression) due to minority stress (Hatzenbuehler et al., 2014; Meyer, 2003; Pachankis et al., 2014; Semlyen et al., 2016). Mental wellbeing, which is associated with a larger range of indicators (e.g., happiness, life satisfaction, self-esteem) beyond the presence or absence of a mental disorder, also varies by sexual orientation. Low wellbeing is 1.5–2.5 times more likely in LGB individuals (Semlyen et al., 2016) and the odds for low-wellbeing tend to increase in a linear fashion alongside higher volumes of smoking (Stranges et al., 2014). Smoking among LGB individuals can reflect a strategy to cope with lower levels of wellbeing or disinterest in other sources of pleasure, which is sometimes associated with depression (Leventhal & Zvolensky, 2015). The conditions of stress, lower mental wellbeing and smoking may therefore become syndemic (i.e., co-occurring and mutually reinforcing) within LGB populations (Stall et al., 2008) and may persist across the LGB life course (Boehmer et al., 2012; Fredriksen-Goldsen et al., 2013).

As a historically marginalised population excluded from mainstream spaces and events, LGB individuals have often socialised in and around nightlife venues (e.g., gay bars and clubs) where smoking is common. LGB individuals therefore may be more exposed to smoking as a social practice (Fallin et al., 2014; Max et al., 2016) compared to heterosexual individuals. Frequent exposure to smoke in social settings can increase the likelihood of smoking through both negative mechanisms (e.g., the amplification of social distress from second-hand smoke) and positive ones,

such as smoking-tolerant environments and smoking as a form of social belonging (Bandiera et al., 2011; Hamer et al., 2010).

Health agencies in England must weigh the needs of multiple, intersecting vulnerable groups and distribute resources accordingly. Most existing research, however, focuses on inequalities between two counterpart groups (e.g., between LGB and heterosexual individuals or between the managerial class and manual-level workers) rather than differences or interactions between pathways into smoking for these various groups. Lower social class status, for example, could further mediate the associations between sexual orientation and various pathways into smoking by exacerbating or compounding experiences of stigma (Keogh et al., 2004; McDermott, 2011). Research therefore also needs to understand the influence of sexual orientation on smoking independently of and in relation to social class. We address three key research aims: (1) to test the significance of sexual orientation differences in smoking and associated pathways, with social class as a potential confounder (and vice versa), (2) to identify interactions between sexual orientation and social class in shaping smoking pathways, and (3) to identify potential differences in these pathways for LGB and lower social class individuals.

5.3 Methods

5.3.1 Data source

The current study used data from the Health Survey for England (HSE), an annual cross-sectional survey that collects household and individual-level data on health conditions, treatments, medications, and behaviours (NHS, 2018). As a population level survey including smoking-related variables, HSE offers an opportunity to better understand how differing vulnerabilities might influence pathways into smoking. HSE uses a hierarchical design where individuals are nested within primary sampling units (PSUs) represented by postcodes that are located within government office regions (GORs). All individuals in each included household are captured in the survey.

5.3.2 Sample

We analysed data from the 2013 and 2014 waves of HSE (NHS, 2014, 2013). The 2013 wave incorporates 564 postcodes while the 2014 wave incorporates 588. These two waves were the most recent to contain both sexual orientation and smoking related variables. The two waves were combined, resulting in an initial sample size of 21,060. Children under 16 and non-responses

were excluded, resulting in a final sample size of 14,481 including 269 LGB respondents (see Table 5.1).

5.3.3 Measures

The variables for the study were selected based on the pathways into smoking suggested by existing studies and England's TCP (i.e., age of initiation, mental wellbeing, and exposure), as well as availability within the HSE. We use cigarettes smoked daily as a refined measure of smoking designed to capture the differentials in the frequency and volume of smoking. Previous studies have found, for example, that LGB individuals smoke higher volumes of cigarettes than their heterosexual counterparts in addition to being more likely to smoke (see Corliss et al., 2013; Fallin et al., 2015a; Hatzenbuehler et al., 2014; Watson et al., 2018b).

5.3.3.1 Sexual orientation

Sexual orientation was self-reported by participants over the age of 16. The response categories were 'heterosexual or straight', 'gay or lesbian', 'bisexual', 'prefer not to say' and 'other'. We created a new binary variable collapsing 'gay or lesbian' and 'bisexual' into 'LGB' and excluded 'prefer not to say' or 'other'.

5.3.3.2 Social class

Social class was determined using the National Statistics Socio-Economic Classification (NS-SEC) and refined by HSE into three categories that reflect income, social position, and occupational prestige: 'managerial or professional occupation', 'intermediate occupation' and 'routine or manual workers'. Dummy variables were created with 'managerial or professional occupation' as the referent category.

5.3.3.3 Age and sex

Age and sex were included as covariates, with age included as a continuous variable, and sex as a binary variable. Sex was coded as '1' for male and as '2' for female.

5.3.3.4 Race

Race was included as a control variable with 'white', 'black' 'Asian' and 'mixed/other' as the categories.

5.3.3.5 Index of multiple deprivation (IMD)

IMD is an indicator of socioeconomic status at the area level, comprising income, employment, health, education, housing, crime and living environment. IMD is grouped into quintiles, with 1 indicating residence in area within the least deprived quintile and 5 indicating residence in an area within the most deprived quintile. We use the 2015 index, which uses data mostly from 2012 and 2013 and is included here as a control variable.

5.3.3.6 Number of cigarettes smoked daily

This outcome is derived from two questions. Participants were asked 'About how many cigarettes do you usually smoke on weekdays?', with the same question asked for weekends. These responses were aggregated into an average number of cigarettes smoked daily based on weekday and weekend amounts. Non-smokers were also included in this derived variable, coded as smoking zero cigarettes per day.

5.3.3.7 Ever smoking

Ever smoking, used as a descriptive variable only, was measured by the question, 'May I just check, have you every smoked a cigarette, cigar or pipe?', with 'yes' or 'no' as the response options.

5.3.3.8 Current smoking

Current smoking, also a descriptive variable, was measured by asking 'do you smoke cigarettes nowadays at all?', with 'yes' or 'no' as the options.

5.3.3.9 Age of initiating smoking

The age of initiating smoking was determined by asking those who currently smoke regularly about the age at which they began smoking.

5.3.3.10 Mental wellbeing score

Mental wellbeing was measured by a score calculated from the Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS), which measures mental wellbeing in the general population (Tennant et al., 2007). This is a validated scale with 14 items, with scores ranging from 14–70. Scores below 40 indicate possibly poorer than average mental well- being and scores below 32 are defined as low wellbeing scores.

5.3.3.11 Hours of exposure to smoke per week

Weekly hours of exposure to tobacco smoke were self-reported by both smokers and non-smokers. Exposure was measured by asking, 'Now, in most weeks, how many hours a week are you exposed to other people's tobacco smoke?', with hours recorded on a continuous scale.

5.3.4 Analysis

5.3.4.1 Bivariate analysis

Data were prepared using SPSS. A Welch's t-test was used to test for significant difference between LGB and heterosexual individuals in the number of cigarettes smoked daily, age of initiating smoking, mental wellbeing score, and weekly exposure to smoke. A one-way analysis of variance (ANOVA) was used to test for significant difference between social class groups for the same four variables.

5.3.4.2 Multilevel analysis

We used multilevel path analysis to examine the associations between two predictor variables (sexual orientation and social class), three mediating variables (age of initiation, mental wellbeing score, and weekly exposure to smoke), and the outcome variable of amount of cigarettes smoked daily. We first tested the model using only main effects, and then ran a separate model to examine effects of the interaction between sexual orientation and social class on cigarettes smoked daily. A multilevel path analysis using Mplus version 8 was employed to determine associations between the predictor, mediator, and outcome variables (Muthén & Muthén, 2017). Missing data were handled using pairwise deletions. As a structural equation modelling technique, path analysis aims to predict the sequential pathways leading to health behaviours and outcomes and has been used previously to explain both smoking uptake (Tickle et al., 2006) and smoking cessation (Businelle et al., 2010). We used a multilevel model design to obtain and control for correct standard errors as HSE data are structured in a geographic hierarchy of individuals within PSUs based on postcode sectors nested within GORs. We used only individual level variables in our model but specified PSU as level two and GOR as level three to reflect the HSE sample design. We estimated our model using a Bayesian approach with Markov Chain Monte Carlo (MCMC) to accommodate the small size of the LGB sample relative to the larger heterosexual sample. This approach ensured that we had robust results using simulations given the sparse nature of LGB sexual orientation relative to the outcome. A posterior predictive p (PPP) value was used to determine model fit, with values greater than 0.05 indicating good fit (Asparaouhov & Muthén, 2010).

5.4 Results

5.4.1 Differences in smoking by sexual orientation and social class

The prevalence of both smoking history and current smoking were higher in the LGB population compared to the heterosexual population (see Table 5.1). The rate of current smoking for the LGB population (29%) mirrored recent English studies and was higher than that for any social class group. LGB individuals smoked more cigarettes daily than heterosexual individuals [t (274.29) = -2.91, $p < .01$], had lower mental wellbeing scores [t (276.01)=4.04, $p < .01$], and were exposed to more hours of smoke per week [t (272.16) = -2.44, $p < .05$]. The age of initiating smoking did not differ between LGB and heterosexual individuals [t (139.84)=.81, p=.419]. One-way ANOVA showed significant difference across social class groups for the number of cigarettes smoked daily [F (2, 15665)=211.20, $p < .01$], age of initiation [F (2, 7216)=29.61, $p < .01$], mental wellbeing score [F (2, 13860)=161.25 $p < .01$], and weekly exposure to smoke [F (2, 15608)=80.83, $p < .01$]. As suggested by recent studies, the managerial class had the most desirable outcomes in terms of mean values (i.e., fewest cigarettes daily, oldest age of initiation, highest mental wellbeing score, and fewest weekly hours of exposure to smoke) while manual and routine workers had the least desirable outcomes. There was no significant difference in the social class composition of the LGB sample versus the heterosexual sample.

Table 5.1. Smoking characteristics by sexual orientation and social class, Health Survey for England 2013-2014

	Sexual orientation				Social class					
	Heterosexual		**LGB**		**Managerial**		**Intermediate**		**Routine**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Ever smoked (yes)	7854	*55*	174	*65*	2914	*52*	2122	*54*	3785	*62*
Current smoker (yes)	2615	*33*	78	*45*	713	*25*	625	*30*	1617	*43*
Number of cigarettes smoked per day										
0	11643	*82*	192	*72*	4912	*88*	3302	*85*	4564	*75*
1-5	535	*4*	17	*6*	186	*3*	129	*3*	252	*4*
6-10	780	*6*	24	*9*	219	*4*	192	*5*	456	*7*
11-20	1013	*7*	28	*10*	219	*4*	219	*6*	676	*11*
20+	198	*1*	7	*3*	37	*0.7*	42	*1*	141	*2*
Mean weekly exposure to smoke (hours)	2.28		3.74[a]**		1.15		1.91		3.19[b]**	
Mean age of initiation	17.33		16.94[a]		18.03		17.87		16.83[b]**	
Mean number of cigarettes smoked per day	2.15		3.35[a]**		1.26		1.77		3.34[b]**	
Mean mental wellbeing score	51.21		48.87[a]**		52.64		51.33		49.60[b]**	

[a] Bivariate analysis using Welches t-test

[b] Bivariate analysis using one-way ANOVA

* significant at p < .05, ** significant at p < .001

5.4.2 Pathways into smoking by sexual orientation and social class

Fig. 5.1 shows the standardised path coefficients in our model. Solid lines indicate paths that were statistically significant [p <.05] while broken lines indicate paths that were not significant [p >.05]. Control variables age, sex, ethnicity and IMD quintiles were included in the model but not reported in the figure. The PPP fit index for the path analysis indicated that the model was a good fit (0.242). The unexplained residual variance for number of cigarettes smoked daily was 26.34 [p

< .001] at the individual level, 0.12 [p < .001] at the PSU level, and 0.53 [p < .001] at the GOR level. As the household level is excluded from this model the variance goes to the next lowest level, which is individual, resulting in a large variance at this level. The estimated model is based on residual normality assumptions at each level, but the distribution is in fact strongly positively skewed with a spike of zero which represents non-smokers. Consequently, the estimated mean for those who smoke will be higher than 2.5. Moreover, the large variance at the lowest level (individual (incorporating household)) reflects the skewness around the mean value, and that the observed values cannot go below zero. A form of the multivariate model in Chapter 7 can be used to simultaneously model occurrence (do you smoke?) and quantity (how many smoke?) (see Jones & Duncan, 1996), though this mixed multivariate model is not available in Mplus.

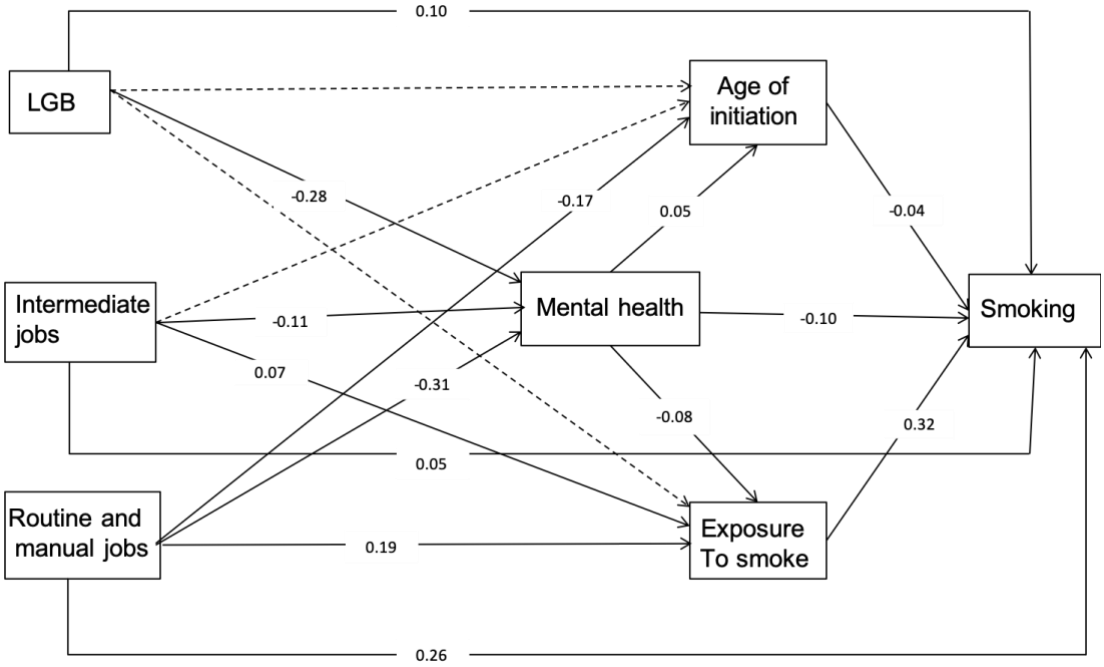

Figure 5.1. Path model showing standardised estimates of path coefficients of daily cigarettes smoked.

5.4.2.1 Number of cigarettes smoked daily

Three predictors were associated with the number of cigarettes smoked daily: identifying as LGB (β=0.10, SD=0.058, p < .05), having an intermediate job versus a professional or managerial job (β=0.05, SD=0.020, p < .01), and having a routine or manual job versus a professional or managerial job (β=0.26, SE=0.018, p < .01). Age of initiation was associated negatively with number of cigarettes smoked daily (β = -0.04, SD=0.009, p < .001), with more cigarettes smoked daily among those who began smoking younger. Lower mental wellbeing scores were also associated with more cigarettes smoked daily (β = -0.10, SD=0.007, p < .001). Finally, those who were exposed to more hours of smoke per week smoked more cigarettes daily (β=0.32, SD=0.008,

p < .001). The interaction effect of LGB orientation and having a manual or routine occupation was not associated with cigarettes smoked daily (β=0.14, SD=0.13, p=0.141), nor was the interaction between LGB orientation and having an intermediate occupation (β = -1.52, SD=0.06, p=0.06).

Males smoked more cigarettes daily than women (β = -0.08, SD=0.02, p < .001). Age was associated negatively with the number of cigarettes smoked daily, with younger individuals smoking more (β = -0.06, SD=0.01, p < .001). White individuals smoked more cigarettes daily than black individuals (β = -0.22, SD=0.05, p < .001) and Asian individuals (β = -0.25, SD=0.04, p < .001), but not individuals of mixed or other races (β = -0.05, SD=0.06, p=0.19). Across IMD categories, the number of cigarettes smoked daily did not vary between those in the first (least deprived) and second, third, or fourth quintiles, but those in the fifth (most deprived) quintile smoked fewer cigarettes per day than those in the first (β = -0.05, SD=0.03, p < .05).

5.4.2.2 Age of initiating smoking

Those who worked in routine and manual jobs had tended to start smoking younger than those in professional or managerial positions (β = -0.17, SD=0.029, p < .001). Mental wellbeing was associated positively with age of initiation (β=0.05, SD=0.012, p < .001); those who had better mental wellbeing scores had initiated smoking later in life. Males initiated smoking younger than females (β=0.17, SD=0.02, p < . 001) and white individuals initiated smoking younger than black individuals (β=0.44, SD=0.11, p < . 001), Asian individuals (β=0.55, SD=0.09, p < .001), and individuals of mixed or other races (β=0.15, SD=0.09, p < 0.05). Age of initiation was not associated with identifying as LGB (β = -0.007, SD=0.085, p=.465) or with working in an intermediate position rather than a professional or managerial position (β = -0.02, SD=0.033 p=.279).

5.4.2.3 Mental wellbeing

Identifying as LGB was associated negatively with mental wellbeing score (β = -0.28, SD=0.060, p < .001). Compared to those in professional or managerial positions, mental wellbeing scores were lower among those with manual or routine jobs (β = -0.31 SE=0.019, p < .001) or intermediate jobs (β = -0.11, SD=0.022, p < .001). Age was associated positively with mental wellbeing score (β=0.03, SD=0.01, p < .01); older individuals reported better mental wellbeing. Black individuals reported better mental wellbeing than white individuals (β=0.20, SD=0.06, p < .001), as did Asian individuals (β=0.12, SD=0.04, p < .01). Wellbeing score was not associated with being mixed race or another race rather than white (β=0.10, SD=0.06, p=0.059), nor was sex (β = -0.02, SD=0.02, p=0.142).

5.4.2.4 Exposure to smoke

Greater weekly exposure to smoke was associated both with working in an intermediate job (β=0.07, SD=0.021, p < .01) and working in a routine or manual job (β=0.19, SD=0.018, p < .01), as compared to working in a professional or managerial job. Mental wellbeing score was associated negatively with exposure to smoke, (β = -0.08, SD=0.008, p < .01), those with lower wellbeing scores were exposed to more smoke weekly. Age was associated negatively with exposure to smoke, with younger individuals exposed to more smoke weekly (β = -0.12, SD=0.01, p < .001). Males were exposed to more smoke than females (β = -0.07, SD=0.02, p < .001). White individuals were exposed to more smoke than Asian individuals (β = -0.14, SD=0.04, p < . 001), and black individuals (β = -0.09, SD=0.06, p < .05) but not mixed race or other race individuals (β = -0.01, SD – 0.06, p=.447). LGB orientation was not associated with exposure to smoke (β=0.07, SD=0.061, p=0.103) despite a significant sexual orientation difference observed in the bivariate analysis.

5.5 Discussion

Both LGB-identified individuals and those in lower social classes in England smoke significantly more cigarettes daily than their respective referent populations. In their analysis of the Smoking and Alcohol Toolkit Studies in England, Shahab et al. (2017) found that the independent effect of sexual orientation on smoking was erased after controlling for other sociodemographic factors. Our model, in contrast, retained a modest but significant sexual orientation effect on smoking after incorporating (and thus controlling for) age, sex, ethnicity, and social class.

The pathways mediating smoking, however, appear to differ across sexual orientation and social class groups. Smoking is mediated by all three intervening variables (mental wellbeing score, age of initiation, and exposure to smoke) among manual and routine workers, by two (mental wellbeing score and exposure to smoke) among intermediate social class individuals, and by one (mental wellbeing score) among LGB individuals. The significance of the path between LGB orientation, mental wellbeing score, and cigarettes smoked daily within our model confirms findings from previous studies that LGB individuals may turn to smoking as a coping mechanism to deal with minority stress and associated mental health and wellbeing outcomes (Blosnich et al., 2013; Johns et al., 2013). Although the mean wellbeing score for the LGB population (48.87) is above the cut-off scores of 40 and 32 for below average and poor wellbeing, respectively, it is the lowest among all sexual orientation and social class groups and suggests that there are likely more LGB individuals below these cut-offs compared to heterosexual individuals. Our findings also lend support to the theory that poor mental health and smoking are potentially syndemic within English LGB populations.

We did not find an association between LGB orientation and age of initiating smoking or amount of exposure to smoke despite the results of past studies suggesting that LGB individuals may share these vulnerabilities with lower social class populations. This distinction may owe to possible commonalities of experience based on lower social class, such as spending less time in education, observing parents and friends who smoke, and smoking at work (Green et al., 2016; Katainen, 2010), which are less consistent among LGB individuals with diverse class backgrounds. The absence of an expected exposure pathway may also reflect cultural differences between England and the more frequently researched United States, where smoking has long been associated with purposeful advertising in gay and lesbian nightlife spaces (Max et al., 2016) and the successful cultivation of a gay and lesbian market segment for tobacco and alcohol products (Smith et al., 2008). The ban on most forms of tobacco advertising in England since 2002 (Government of the UK, 2002) may have therefore also reduced sexual orientation inequalities in exposure to smoke, or the degree to which they influence the onward uptake or volume of smoking among LGB individuals.

We applied interactions between sexual orientation and each of the lower two social class categories to assess whether LGB orientation and lower social class status together might further influence the number of cigarettes smoked daily. Past research has suggested that working-class LGB individuals face distinct stressors that could lead to smoking, such as workplace bullying and feeling inferior in both heterosexual working-class environments and gay or lesbian environments (Keogh et al., 2004; McDermott, 2011). The interaction of LGB orientation and having a manual or routine occupation was not associated with more cigarettes smoked daily nor was the interaction of LGB orientation and having an intermediate occupation, but this second interaction approached significance (p=.06). The implication that sexual orientation could have more of an association with smoking within intermediate class populations compared to working class populations merits further research (see also Katainen, 2010). The non-significance of the interaction effects also suggests that there are distinct factors driving smoking in LGB populations that would not be captured by interventions targeting lower social class groups alone.

5.6 Conclusions

Our findings must be considered within the context of some limitations that could be addressed in future research. First, about 1.0% of HSE respondents identified as LGB compared to the 1.9% national average (Office for National Statistics, 2019a). As sexual orientation was self-reported rather than assessed through a question on sexual attraction or behaviour, it could be that some respondents did not ascribe to an LGB identity or feel comfortable in declaring one. Our selection of other variables was also limited by HSE's definitions of smoking and associated factors. More

pathways might therefore be illuminated in a larger or more representative survey, or one with more variables.

Second, we used an aggregate LGB sample rather than groups disaggregated by sex or sexual orientation to ensure good fit within a model comprising a small LGB sample and a much larger heterosexual sample. Differences across LGB subgroups, however, could weaken associations in an aggregate LGB sample or reveal new associations when subgroups are analysed separately. For example, an early age of smoking initiation may be more prominent in lesbian and bisexual women than gay and bisexual men (Corliss et al., 2013, 2014; Fallin et al., 2015a; Watson et al., 2018b) and exposure to smoke at home may be more common among bisexual women than their heterosexual or lesbian counterparts (Pizacani et al., 2009). Our descriptive results also showed that bisexual individuals, as compared to gay and lesbian individuals, started smoking earlier in life (15.1 vs. 17.8, respectively), were exposed to smoke more hours per week (5.6 vs. 2.7), smoked more cigarettes per day (3.43 vs. 3.19) and had poorer mental wellbeing scores (46.7 vs. 50.1). These trends mirror past studies showing potentially higher smoking rates among bisexual individuals (Balsam et al., 2012) and emerging work on distinct stressors they face, including peer rejection of bisexual identity and the need to escape uncomfortable social environments (McQuoid et al., 2018). Differences between these subgroups within England's LGB population should be further investigated using alternative models or data sources.

Finally, the smoking-related variables tested in our model do not reflect an exhaustive list of factors influencing smoking in LGB populations. Rather, they were selected based on previous population-based studies, availability in HSE, and the potential they offered to understand whether the pathways into smoking suggested in England's TCP were associated with sexual orientation. Further studies tailored to the LGB population in England will be important for understanding how smoking rates in this population are affected by homophobia, biphobia, bullying, discrimination, community connectedness, and other factors.

This study is one of the first to examine pathways between sexual orientation and smoking in the English context. Our use of a multilevel structural equation model, which considers LGB individuals in the context of the broader English population, offers a novel opportunity to think for the first time about the relative importance of pathways into smoking for different vulnerable groups. Although the rates of current smoking in LGB individuals are at least as high as those in manual and routine workers, socioeconomically deprived populations have emerged as the main targets for smoking prevention and cessation interventions in England. Continued work is also needed to understand the root causes of smoking among LGB individuals in this country as their pathways into smoking are likely somewhat distinct.

The significance of poorer mental wellbeing as a potential pathway into smoking for LGB individuals suggests both a need for targeted interventions focused on reducing stigma, managing stress, and reducing the use of smoking as a coping mechanism. The observed strength of the link between wellbeing and smoking in England's LGB population also suggests that counsellors, psychologists, and psychiatrists serving LGB individuals must be familiar with the links between smoking and minority stress, as well as referral processes for cessation programs. The use of LGB-specific venues for smoking cessation campaigns has been effective in decreasing smoking rates in the United States (Leibel et al., 2011) and gay and lesbian pubs may be useful sites for reaching LGB individuals in areas of England, particularly in regions less exposed to national LGB health campaigns (Taylor & Falconer, 2015). Continued research comparing the factors driving high smoking rates in LGB and other vulnerable populations within the same geographic context may also better guide public health interventions to ensure that sexual orientation inequalities are not overlooked.

Chapter 6 Trends in smoking prevalence over time and space: a comparison between sexual minority and heterosexual populations

This paper was prepared for submission and is currently under review at *Health and Place*.

6.1 Abstract

Research has suggested that lesbian, gay and bisexual (LGB) individuals are more likely to smoke tobacco than heterosexual individuals, but specific place patterns are often not examined. We looked at change in smoking prevalence over time across GB for LGB and heterosexual populations, comparing models for men and women. Smoking prevalence remained greater for sexual minority women over time than other groups. Across GB, decreases in smoking prevalence in urban areas were more pronounced for sexual minority men. Future anti-smoking policies need to consider sexuality and its association with place in order to eradicate smoking inequalities.

6.2 Introduction

Since the introduction of national tobacco control policies and increased awareness of the health implications of smoking, there has been a decrease in smoking over time (Islami et al., 2015)**.** Whilst smoking has steadily declined in the general population, inequalities persist for different social groups including those from low socioeconomic backgrounds and individuals from marginalised groups, such as LGB individuals (Hagger-Johnson et al., 2013b; Shahab et al., 2017). Studies suggest that LGB individuals have a higher prevalence and smoke more heavily than heterosexual individuals (Davies et al., 2019; Fallin et al., 2015a). Higher smoking prevalence in LGB populations may be associated with minority stress, whereby experiences of stigma and discrimination may lead to maladaptive behaviours, such as smoking, being used as a coping mechanism (Meyer, 1995).

More detailed differences between sexual orientation groups have been observed in recent research, with lesbian and bisexual women smoking both more than their heterosexual counterparts and more than gay and bisexual men (Watson et al., 2018b; Wheldon et al., 2018). Other research has found that sexual minority (SM) women have an earlier age of initiation of smoking than SM men (Watson et al., 2018b). These differences may stem from greater stigma and less support among SM women compared to SM men (Watson et al., 2018a), as well as the

double marginalisation that bisexual women might experience in both heterosexual and lesbian and gay communities (Homma et al., 2016). Several studies have suggested that mental health status also predicts heavier smoking by LGB people (Davies et al., 2019; Drescher et al., 2018).

Whilst the social determinants of smoking in LGB populations now has been examined widely, especially as related to have been to changing and stricter state-level tobacco policies (Hatzenbuehler et al., 2014; Max et al., 2016), longitudinal changes in smoking behaviours among LGB groups have been explored only rarely. Most available studies examine short time periods (≤15 years), usually cross-sectionally. For example, Watson et al. (2018a) found that smoking increased for SM youths, particularly between heterosexual women and lesbians, compared to heterosexual youths. Mitchell and Ozminkowski (2016) found that over a four-year period, smoking decreased more among gay men and heterosexual men and women than in lesbian women and bisexual men and women. Max et al. (2016) found smoking rates to be consistently higher in LGB individuals, with SM women more likely to be light smokers than their heterosexual counterparts and SM men more likely to be daily smokers than their heterosexual counterparts. The change in smoking prevalence over time in GB is unknown in different sexual orientation groups, as access to longitudinal data that include sexual orientation measures are limited (Uhrig, 2015).

Findings on the effects of place on health outcomes in SM populations have been contradictory, with some studies demonstrating that urban areas likely play a role in the initiation and frequency of substance use (Buttram & Kurtz, 2012) whereas others have shown a link between rural areas and substance use (Poon & Saewyc, 2009; Wienke & Hill, 2013). Little is known, however, about the effect of these areas on smoking specifically. These discrepancies might reflect the provision or absence of support from families and communities. Findings from North American studies may also reflect differences in policies and social attitudes between regions. Work by Hatzenbuehler et al. (2009) for example, has found that state-level policies favouring LGB rights are associated with better mental health outcomes for LGB individuals residing in those jurisdictions.

Elevated smoking rates may be seen in areas with a greater concentration of individuals living and socialising within LGB communities; i.e., a ‘gay village’ effect (Fish, 2010). In the United States, such effects are usually observed among SM men rather than SM women (Buttram & Kurtz, 2012; Carpiano et al., 2011). In 2013, interviews with LGB individuals about their experiences of coming out and social acceptance revealed that gay men were more likely than lesbians to have lived in what would be considered an ‘LGB neighbourhood’, though bisexual women were more likely than bisexual men to report having lived in one (Pew Research Center, 2013). Several theories and contextual factors have endeavoured to explain the factors associated with elevated rates of

smoking in gay neighbourhoods, including potentially increased stress and poorer mental health, increased exposure to smoke, and more permissive social norms within LGB communities (Meyer, 2003).

Other determinants of smoking in the general population can make it difficult to disentangle the effects of sexual orientation on smoking. In GB, known predictors of smoking, such as employment and education level, are associated largely with socioeconomic status. Individuals from lower social class backgrounds are more likely to smoke which may be due to living in areas of deprivation and using smoking as a coping mechanism (Hiscock et al., 2012; Office for National Statistics, 2018). Some studies have found that including measures of education and employment can mute the effect of sexual orientation on the likelihood of smoking (Shahab et al., 2017), whereas others have found that sexual orientation predicts a higher volume of smoking even when considering social class (Davies et al., 2019; Shahab et al., 2017). It is therefore important to consider the confounding effects of social class and other contextual factors beyond sexual orientation when exploring smoking behaviours in LGB populations.

With a current focus on reducing smoking prevalence to below 12% in GB by 2022 (Department of Health, 2017), and particularly reducing inequalities between different social groups, it is important to know how smoking rates have changed between heterosexual and LGB individuals. The aims of this study are to (1) examine differences in smoking rates between SM men and heterosexual men and SM women and heterosexual women, (2) examine changes in smoking rates from 1991 to 2017, comparing heterosexual and SM groups and (3) examine variations in the geographic patterning of smoking probability over time for SM and heterosexual individuals. Efforts to reduce smoking have highlighted the need to tackle inequality and shed light on LAs with elevated smoking rates, but little research parses the overall declining trend by either sexual orientation groups or geographic locations.

6.3 Methods

6.3.1 Data source

This study uses the BHPS waves 1–18 and US waves 2–7. The BHPS and US are longitudinal panel surveys collecting household and individual level data on multiple topics including day-to-day activities, socio-demographic information such as sex, age and ethnicity, health information and access and use of healthcare facilities, and behaviours such as smoking and alcohol intake. Households were selected and individuals from each household interviewed each year if they consented, and new individuals were also added to each wave. The BHPS started in 1991 and was

succeeded by US in 2007. Participants in the BHPS were asked if they wanted to continue in US from wave two. Data were retrieved through the UKDS, and Special Licence access was granted for LA data for BHPS and US.

We analysed and merged data from all 18 waves of BHPS, and waves two, five, six and seven from US to create a harmonised data set. The excluded US waves did not contain information about smoking. Sexual orientation did not appear in any BHPS waves and only appeared in the main questionnaire of US in wave three. We merged sexual orientation according to participant ID number and assumed that sexual orientation was consistent over time. Waves five and six of US contained further sexual orientation data, but only as part of the youth survey for individuals aged 16–21 (see Figure 6.1). We included individuals from this sample if they did not appear in wave three and their sexual orientation would otherwise not be known. Other variables were derived from each wave of BHPS and US. BHPS waves were yearly whereas US collected data over a two-year period for each wave. We chose the last year US data was collected as the final year in our data set. Northern Ireland was excluded from the dataset as it was only added in 2001, and recent Office for National Statistics figures show LGB figures are the lowest reported compared to in England, Wales and Scotland (Office for National Statistics, 2019a).

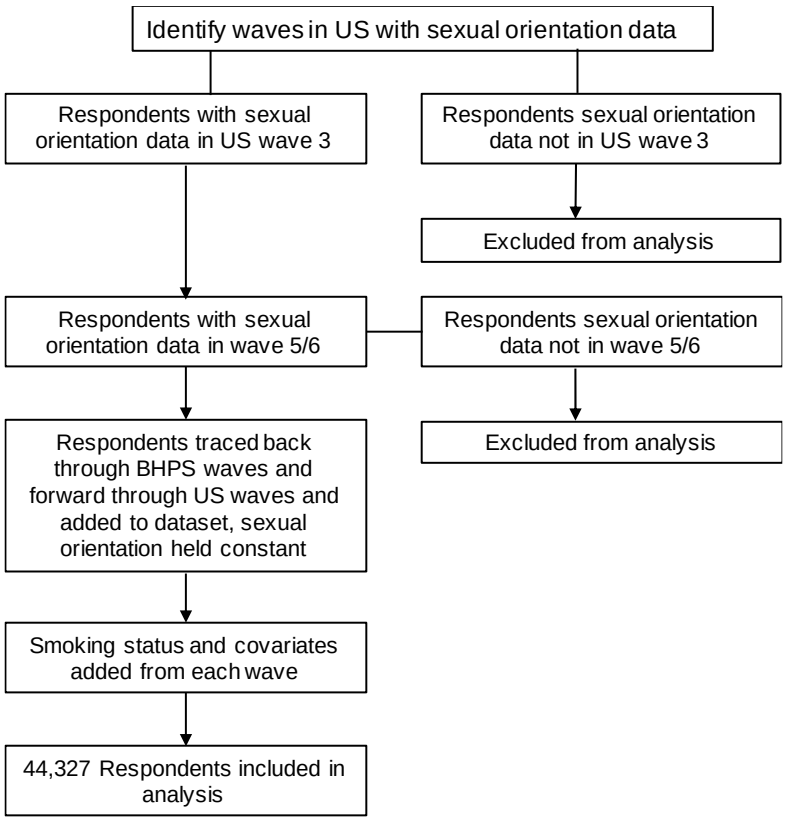

Figure 6.1. Inclusion criteria for respondents in BHPS and US

6.3.2 Measures

6.3.2.1 Smoking

Individuals were asked if they were current smokers, which was captured by a binary variable of (0) no, (1) yes.

6.3.2.2 Sexual orientation

Sexual orientation was measured with the question, which of the following best describes your sexual orientation? Answers were categorised as 'heterosexual or straight', 'gay or lesbian', 'bisexual', 'other' or 'prefer not to say'. For this analysis, we combined bisexual and lesbian women into one category referred to as sexual minority women for a model comparing them with heterosexual women, and gay and bisexual men into another for a model comparing sexual minority men and heterosexual men.

6.3.2.3 Demographic and socio-economic variables

Age was recoded into 10-year interval groups, starting with 15–24-year olds. Socio-economic status was captured using a categorical education variable recoded to a binary variable using 'post-16 qualifications', which included those with qualifications above GSCE level, and 'no post-16 qualifications', which included GSCE qualifications only and no qualifications. An employment status variable was also included, using the categories 'employed' 'unemployed' 'other' 'economically inactive' and 'full time student or apprenticeship'. Individuals indicated their ethnicity as 'White' 'Black' 'Chinese/other/mixed race' or 'Indian, Pakistani or Bangladeshi'.

6.3.2.4 Other variables

We included wave as a polynomial term and an interaction effect between wave and sexual orientation, which allowed us to estimate how smoking has changed over time in different sexual orientation groups. The polynomial term also allows us to estimate this as a curved rather than linear effect.

6.4 Analysis

The data were cleaned and prepared using SPSS version 22, and all 22 waves from BHPS and US were merged and reformatted to long-form response datasets before analysis. Data were analysed using MLWin version 3.02 (Rasbash et al., 2019). A repeated measures multilevel model with a binary outcome was used to test changes in smoking status between sexual orientation groups over time. This model allows us to test the overall effect of sexual orientation, with

separate models for men and women, on smoking status alongside other covariates. Stratification by sex was done in order to reduce subsequent model complexity, and also allowed us to examine smoking status over time separately for SM men and SM women compared to their heterosexual counterparts. Continuous outcomes for smoking, such as daily consumption rates, may be biased as individuals may underreport how much they smoke (Cowling et al., 2003). We used a three-level model, structured by year (level one), participant (level two) and LA (level three). The fixed effects of smoking over time were modelled, with a random intercept and random slope for LGB for men and women**.** The residuals were then examined for variations in the probability of smoking for SM men, SM women and heterosexual individuals across LAs and LA types (e.g., metropolitan, rural). LA type came from the supergroup for the 2011 Area classifications for LAs, which has eight supergroups (Office for National Statistics, 2015).

6.4.1 Model

Smoking status was modelled for both men and women over time through the equation;

$$Smoker(\pi_{ijk}) = \beta_{0jk} + \beta_1 sexual\ orientation + \beta_2 education + \beta_3 employment\ status + \beta_4 age + \beta_5 ethnicity + \beta_6 region + \beta_7 wave + \beta_8 wave\text{^} + \beta_9 LGB * wave$$

$$\beta_{0jk} = \beta_0 + v_{0k} + u_{0jk}$$

$$\beta_1 = \beta_1 + v_{1k}$$

$$\begin{bmatrix} v_{0k} \\ v_{1k} \end{bmatrix} \sim \text{N}\ (0, \Omega_v) : \ \Omega_v = \begin{bmatrix} \sigma_{v0}^2 & \\ \sigma_{v01} & \sigma_{v1}^2 \end{bmatrix}$$

$$[u_{0k}] \sim \text{N}\ (0, \Omega_v) : \ \Omega_v = [\sigma_{u0}^2]$$

Where $Smoker$ refers to the binary current smoking status, β_0 refers to the fixed intercept assuming all explanatory variables are 0, the subscript i refers to changes at each wave, at participant level j, and at LA level k. Sexual orientation, education, employment status, region, year, age, and ethnicity all refer to the fixed coefficients for individuals from all 22 time points. Wave^ refers to the polynomial term that allows smoking probability to be estimated on a curved line. Wave*LGB refers to the interaction between identifying as LGB and the continuous effect of year. u_{0jk} and v_{0k} refer to the random intercept at participant and LA level, respectively. v_{1k}refers to the random slope for LGB identifying individuals at LA level, and the matrixes refer to the covariance.

We transformed logistic coefficients into odds ratios. 95% credible intervals (CIs) were calculated from the transformed odds ratios and standard errors provided by MLwiN; variables with CIs that did not span 1 were considered significant. Parameters were estimated initially in MQL to obtain starting values, which then were used as informative priors for MCMC Bayesian estimation

(Browne et al., 2019). MCMC is recommended for robust results when estimating binary outcome models, and to account for unequal sample sizes. We used 350,000 MCMC chains, a figure chosen based on the Raftery-Lewis criteria. Deviance Information Criteria (DIC) were used to assess model fit information in nested models (Li et al., 2013). We compared the initial DIC for the null model with the DIC from more complex models to assess the model fit, with DIC values reducing more than 10 points indicating better fit than the null model.

6.4.2 Missing data

MLwiN imputes missing data using listwise deletions. To minimise data loss, we declared missing as a category in variables with missing survey responses for more than 1% of responses, which prevented us from losing these cases. Some variables used response options that were not applicable for some participants; to minimise data loss we declared these responses as 'inapplicable' or 'proxy' if a proxy was used to answer the survey. These categories are included in the model but not reported.

6.5 Results

6.5.1 Descriptive data

Table 6.1 shows the count and percentage of sexual orientation groups by sex in the sample. SM men and SM women made up 2.3% and 1.9% of the sample, respectively.

Table 6.1. Sample sizes and percentages by sex

	Men (n 17191)	**Women** (n 21094)
Sexual orientation		
Heterosexual	13273 (77.2%)	17334 (82.3%)
Gay/lesbian or bisexual	394 (2.3%)	406 (1.9%)
Other	125 (0.7%)	182 (0.9%)
Prefer not to say	398 (2.3%)	555 (2.6%)
Inapplicable/missing	3001 (17.4%)	2597 (12.3%)

Figure. 6.2 shows that smoking prevalence has been consistently higher for SM men than for heterosexual men, starting at 38% prevalence in 1991 and decreasing to 22% in 2017. Heterosexual men started with a prevalence of 26% which has decreased to 15% in 2017. For

those identifying as prefer not to say or other, changes in smoking were seen peaking and dropping over all time points, particularly for those identifying as other.

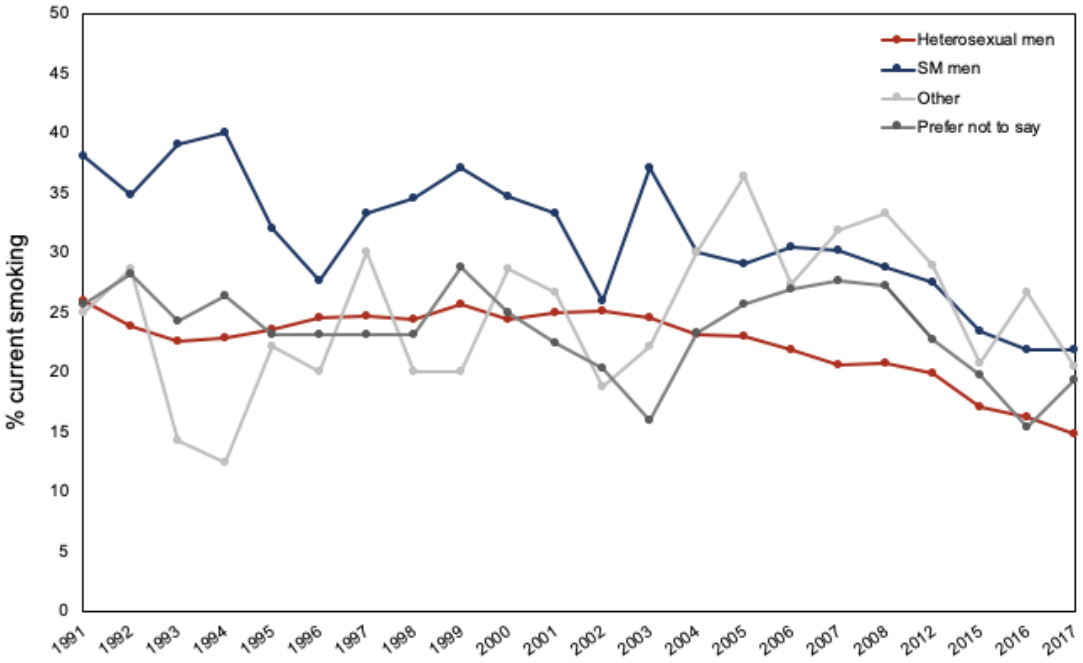

Figure 6.2. Percentage of current smokers per year for men by sexual orientation

Figure 6.3 shows that smoking prevalence has been consistently higher for SM women compared to heterosexual women, starting at 47% prevalence in 1991 and decreasing to 26% in 2017. Heterosexual women started with a prevalence of 26% which has decreased to 14% in 2017. Again, those identifying as other had a more erratic pattern over time; changes in smoking were seen peaking and dropping over all time points, whereas prefer not to say followed a similar pattern to heterosexual women.

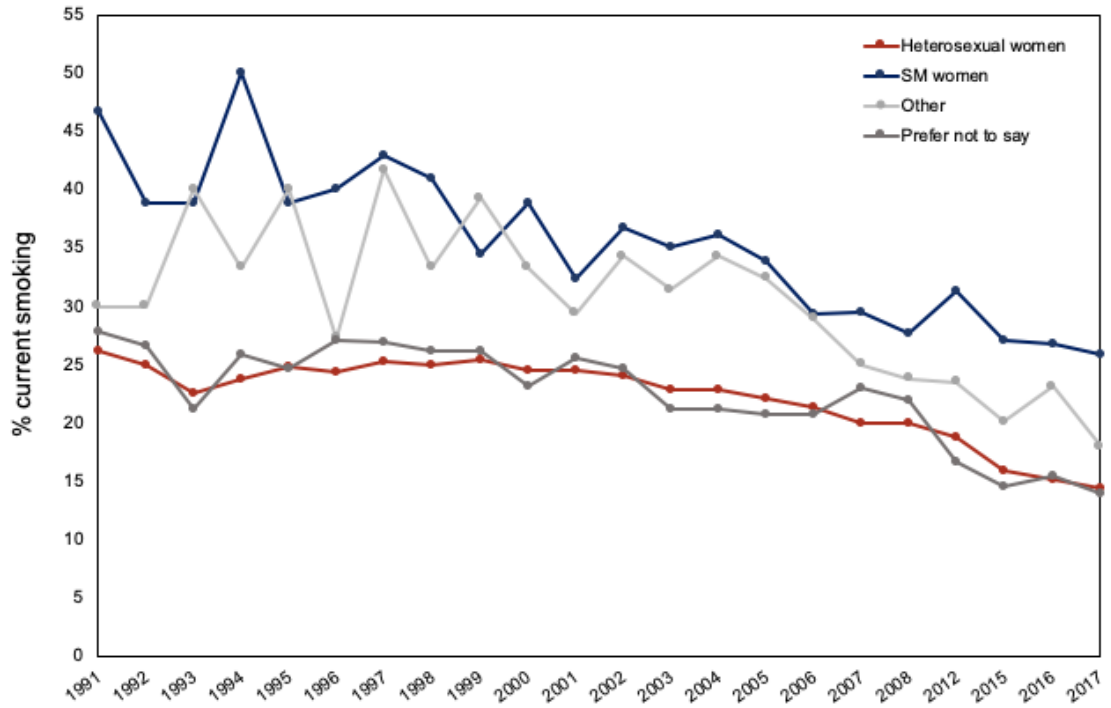

Figure 6.3. Percentage of current smokers per year for women by sexual orientation

We initially ran a null model to gain the DIC to compare to subsequent nested models. Table 6.2 shows the null model results for men and women, showing that most of the variance lies at level two (individual) compared to level three (LA). Level one variance is not estimated in the repeated measures model as variance in binary outcomes is fixed.

Table 6.2. Null model variance and fit criterion

	Men	**Women**
DIC	25725.92	28916.91
Residual variance level 2	44.74	49.06
Residual variance level 3	0.77	1.13

6.5.2 Fixed effects

Table 6.3 shows the odds ratios (ORs) and their 95% credible intervals of smoking across different groups. The fixed effects represent the fixed OR of smoking across all 22 waves of US and BHPS.

6.5.2.1 Sexual orientation

Men identifying as SM compared to heterosexual men had a 2.78 increased odds of being a current smoker. For women, identifying as SM compared to heterosexual women was associated with a 13.50 increased odds of being a current smoker. Answering 'prefer not to say' was not associated significantly with being a current smoker for men or women, nor was identifying as 'other' for men. For women, identifying as 'other' was associated with a 5.59 increased odds of being a smoker compared to heterosexual women.

6.5.2.2 Age and ethnicity

Increasing older age categories were associated incrementally with decreased odds of being a current smoker in all models. In the initial model only being 25-34 years old (compared to being 15-24 years old) was associated significantly with smoking status for both men and women. Being Black, Indian, Bangladeshi or Chinese compared to being White were not significant predictors of smoking for men, but for women across all ethnic groups compared to being White there was a significantly decreased odds of being a current smoker.

6.5.2.3 Education and employment level

For both men and women, having no post-16 qualifications was associated with an increased odds of being a smoker compared to those with post-16 qualifications. Being unemployed was not a significant predictor of smoking for women but being economically inactive was associated with decreased odds of smoking compared to being employed. For men, being unemployed was significantly associated with increased odds of being a current smoker, but being economically inactive was not. Being in full-time education/apprenticeship was associated with decreased odds of being a smoker for both men and women.

6.5.2.4 Region

We found that region had less of an impact on smoking status for men than for women. Men living in East Midlands, North West and London had an increased odds of being a smoker compared to those living in the South West. Women, living in Scotland, Wales, North West England, North East England and Yorkshire and the Humber had an increased odds of being a current smoker compared to those living in the South West.

6.5.2.5 Wave

Wave was added to the model as a continuous measure and included as a polynomial term. Wave showed a modest but significant decrease in smoking likelihood with increasing year for both men

and women, and the polynomial term was not significant for men or women. The lack of a significant effect may suggest that the decrease in smoking over time for men and women has been relatively linear.

6.5.2.6 Interaction effects

The interaction terms for wave and sexual orientation were not significant for men or women identifying as LGB or other, but there were increased odds for those who answered prefer not to say.

6.5.2.7 Random slopes and intercepts

In each model for men and women, the variance was significant at levels two and three; however, the majority of the variance lies at level two, suggesting that smoking status varies more between individuals than between LAs. The random level three slopes for SM men and SM women in each model were not significant, suggesting that the likelihood of being a current smoker among those identifying as SM men or women does not differ between LAs. The covariance values were not significant, suggesting that there is no relationship between the intercept and the slope for SM men and SM women (Duncan et al., 1998).

Table 6.3. Adjusted odds ratios and credible intervals of fixed and random effects on smoking status

Model results		
	Men	**Women**
Fixed Intercept logit (SE)	**-4.53 (0.30)**	**-5.54 (0.35)**
Sexual orientation (ref heterosexual)		
Lesbian/ gay or bisexual	**2.78* (1.25-6.17)**	**13.50 (5.87-31.07)**
Other	2.34 (0.52-10.51)	**5.59 (1.37-22.73)**
Prefer not to say	2.06 (0.88-4.86)	0.98 (0.42-2.26)
Age (ref 15-24)		
25 - 34	1.01 (0.84-1.20)	0.94 (0.80-1.11)
35 - 44	**0.57 (0.46-0.71)**	**0.62 (0.50-0.76)**
45 - 54	**0.23 (0.18-0.30)**	**0.32 (0.25-0.42)**

55 - 64	**0.07 (0.05-0.10)**	**0.11 (0.08-0.15)**
65+	**0.02 (0.01-0.03)**	**0.01 (0.01-0.02)**
Ethnicity (ref white)		
Black	0.77 (0.34-1.79)	**0.23 (0.10-0.51)**
Indian, Pakistani or Bangladeshi	0.95 (0.49-1.82)	**0.01 (0.00-0.01)**
Chinese/other/mixed	0.76 (0.39-1.47)	**0.08 (0.04-0.17)**
Employment status (ref employed)		
Unemployed	1.90 (1.57-2.31)	1.13 (0.91-1.39)
Economically inactive	1.12 (0.93-1.35)	**0.81 (0.71-0.91)**
Full time study/apprenticeship	0.14 (0.11-0.18)	**0.24 (0.20-0.30)**
Other	1.84 (1.03-3.29)	0.74 (0.44-1.25)
Education (ref post 16 qualifications)		
No post 16 qualifications	3.46 (2.81-4.27)	**3.59 (2.96-4.36)**
Other qualifications	4.16 (3.02-5.74)	**3.92 (2.86-5.38)**
Region (ref South West England)		
North East	2.11 (0.85-5.24)	**3.24 (1.19-8.76)**
North West	**2.00 (1.00-3.99)**	**2.76 (1.26-6.05)**
Yorkshire and the Humber	2.11 (0.98-4.54)	**3.13 (1.32-7.40)**
East Midlands	**2.32 (1.10-4.95)**	1.40 (0.62-3.18)
West Midlands	1.43 (0.67-3.07)	1.55 (0.67-3.59)
South East	1.35 (0.68-2.68)	1.17 (0.56-2.47)
East	1.55 (0.74-3.25)	1.90 (0.86-4.21)
London	**2.04 (1.00-4.16)**	1.84 (0.82-4.16)
Scotland	1.88 (0.92-3.82)	**2.93 (1.29-6.65)**
Wales	1.62 (0.77-3.40)	**2.93 (1.26-6.85)**
Continuous measures		
Year	**0.91 (0.90-0.92)**	**0.91 (0.90-0.92)**

Year^	1.00 (0.99-1.00)	1.00 (1.00-1.00)
Interactions		
LGB and year	1,03 (0.98-1.08)	1.03 (0.98-1.08)
Other and year	1.07 (0.97-1.17)	0.98 (0.92-1.05)
Prefer not to say and year	1.01 (0.96-1.07)	**1.06 (1.02-1.11)**
Random effects logit scores (standard errors)		
Level 2 variance	**41.49 (1.54)****	**48.94 (1.76)****
Level 3 variance	**0.56 (0.17)**	**0.76 (0.19)**
LGB slope level 3	0.55 (0.75)	0.00 (0.04)
Covariance level 3	-0.17 (0.40)	0.02 (0.03)
Model fit		
DIC	24048.67	26531.60

* Odds ratios in bold indicates confidence intervals that do not span 1

** Household level is excluded from this model, as such the variance goes to the next lowest level which is the individual at level 2, resulting in a large variance

6.6 Smoking over time

We modelled the average individual trajectories comparing SM men to heterosexual men, estimating the mean probability of being a current smoker from 1991 to 2017 (figure 6.4). For all groups, probability of smoking very slightly increases in the mid- to late 1990s and then steadily decreases.

The mean probability trajectory for SM men remains higher than for heterosexual men over time; however, the confidence intervals for SM men are wider than for heterosexual men. The gap between SM men and heterosexual men appears to have widened slightly, as SM men had a mean probability of 0.26 compared to 0.24 for heterosexual men compared to 0.24 vs. 0.19 in 2017.

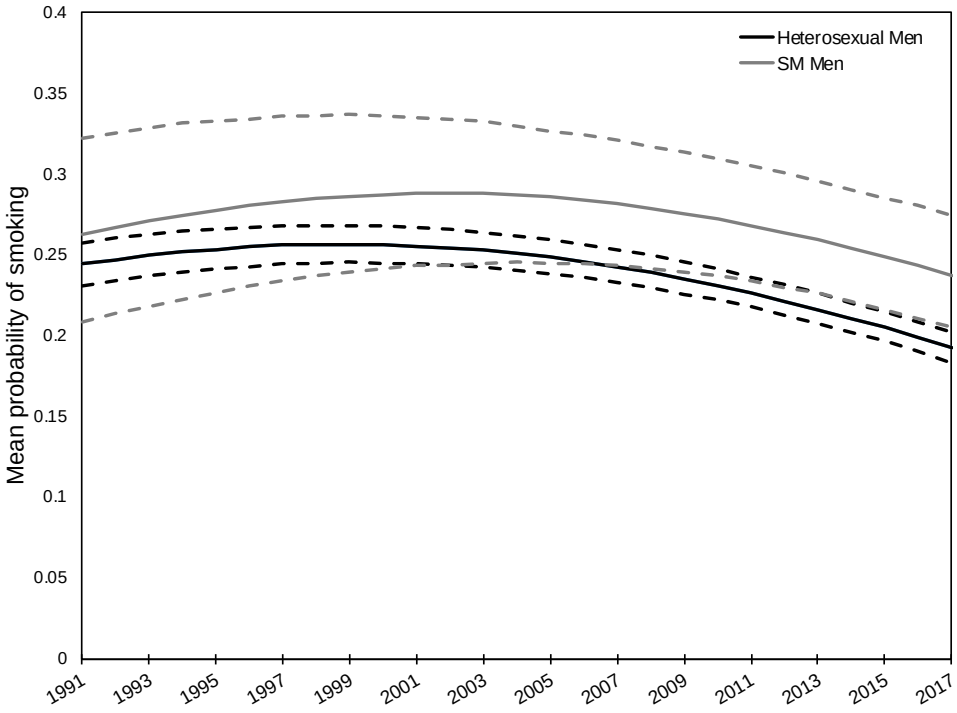

Figure 6.4. Mean probability of smoking over time with confidence intervals for SM men compared to heterosexual men

Figure 6.5 shows the mean probability trajectories for SM women compared to heterosexual women. The mean probability trajectories for SM women remain higher than for heterosexual women over time; however, again the confidence intervals are wider for SM women. The gap between SM women compared to heterosexual women may has increased very slightly over time. The mean probability for SM women was 0.32 compared to 0.23 for heterosexual women in 1991, but 0.27 compared to 0.17 in 2017.

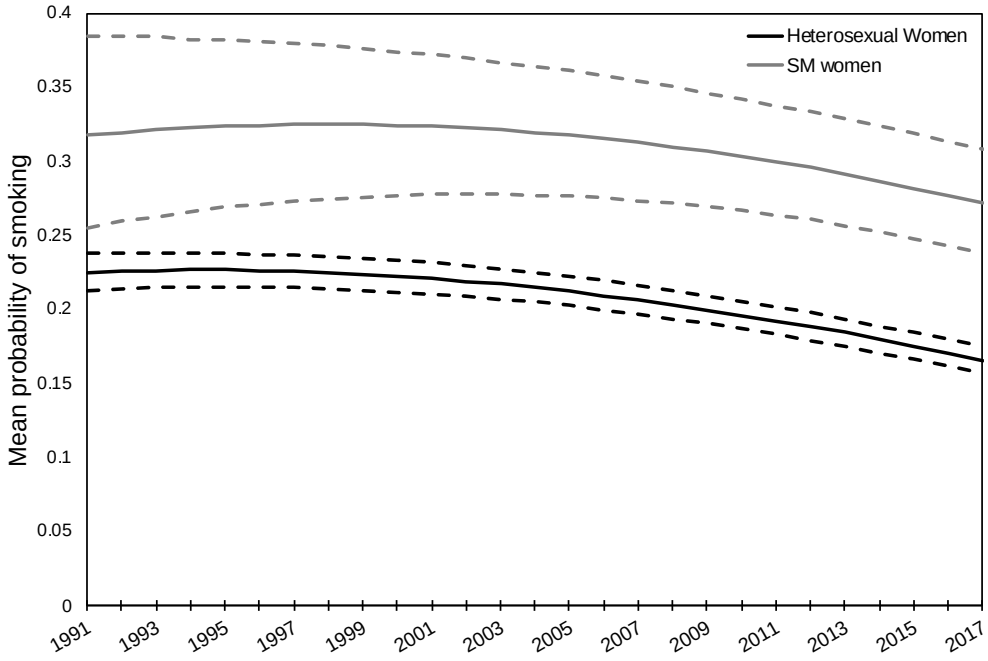

Figure 6.5. Mean probability of smoking over time with confidence intervals for SM women compared to heterosexual women

6.7 Analysis of spatial variation

Figure 6.6 shows the LAs with the top 20% of decrease in predicted probability of smoking from 1991–2017 for SM and heterosexual men across GB. Blue represents those within the top 20% decrease in predicted probability, with outside less than the top 20%. In line with the smoking prevalence and predicted probability, SM men had a greater decrease in predicted probability of smoking over time than heterosexual men as smoking probability was higher in 1991 for SM men. LAs with larger residuals showed the greatest decrease for SM and heterosexual men, though some areas were different for both groups.

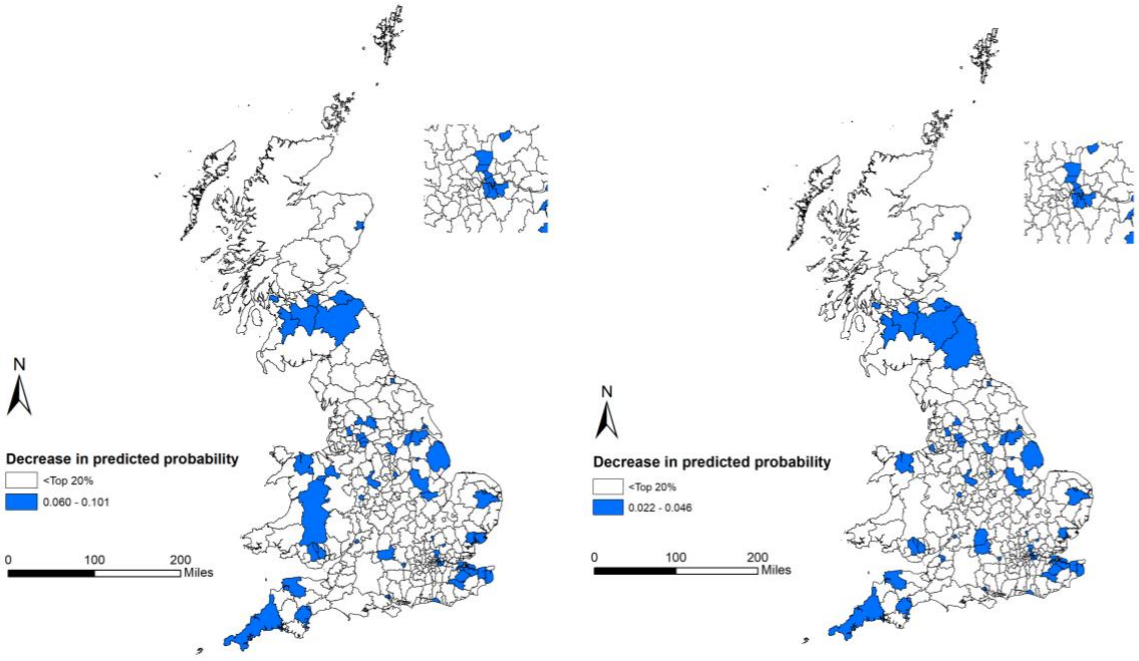

Figure 6.6. Top 20% decrease in predicted probability of smoking for SM men (left) and heterosexual men (right) 1991 to 2017 across Great Britain

Figure 6.7 shows the LAs with the top 20% of decrease in predicted probability of smoking from 1991-2017 for SM and heterosexual women across GB. SM women again had a greater decrease than heterosexual women, despite the predicted probability and prevalence rate remaining higher overall in this group. The areas with the largest decreases were the same across both groups, unlike in the previous maps for men where some areas had experienced a greater decrease for SM men and not heterosexual men, and vice versa. SM women had a greater decrease than all other sexual orientation groups, which is in line with the initial prevalence rates where SM women had the highest rates and greatest decrease over time.

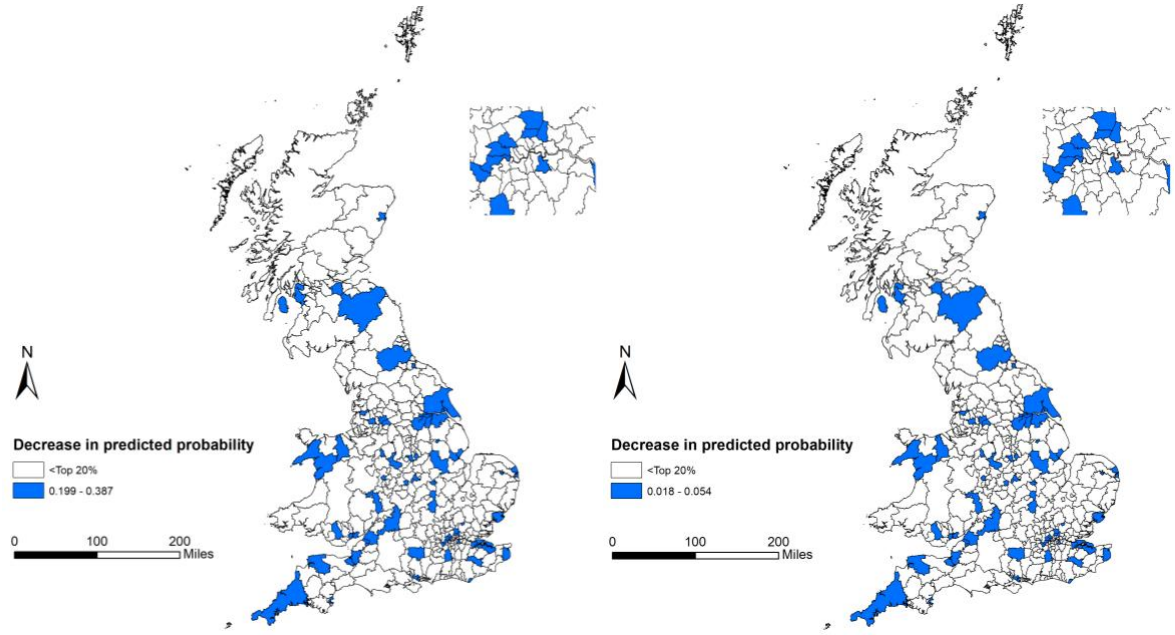

Figure 6.7. Top 20% decrease in predicted probability of smoking for SM women (left) and heterosexual women (right) 1991 to 2017 across Great Britain

Figures 6.8 and 6.9, and 6.10 and 6.11 show the decrease in predicted probability of LA supergroup type from 1991-2017 for SM men, SM women and heterosexual men and women. For SM men and heterosexual men, the greatest decrease in predicted probability of LA type was in London Cosmopolitan areas, with a greater decrease for SM men than heterosexual men. The next area with the greatest decrease for SM men was Business, Education and Heritage Centres, which refers to larger urban cities and university towns and cities, whereas for heterosexual men it was Service and Industry Legacy Areas. Ethnically Diverse Metropolitan Living areas had the smallest decrease for both SM and heterosexual men. For SM women, the greatest decrease in predicted probability was in Business, Education and Heritage Centres. Affluent England followed by Town and Country living had the smallest decrease, which may be due to lower smoking rates initially in these types of areas.

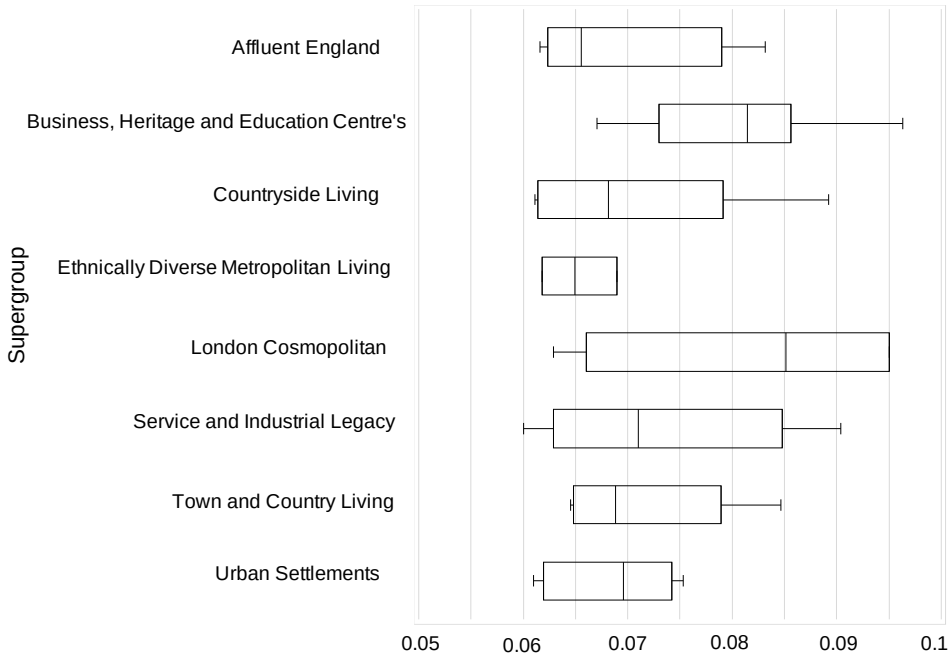

Figure 6.8. Box and whisker plots of LA supergroup type and decrease in predicted probability from 1991-2017 for SM men

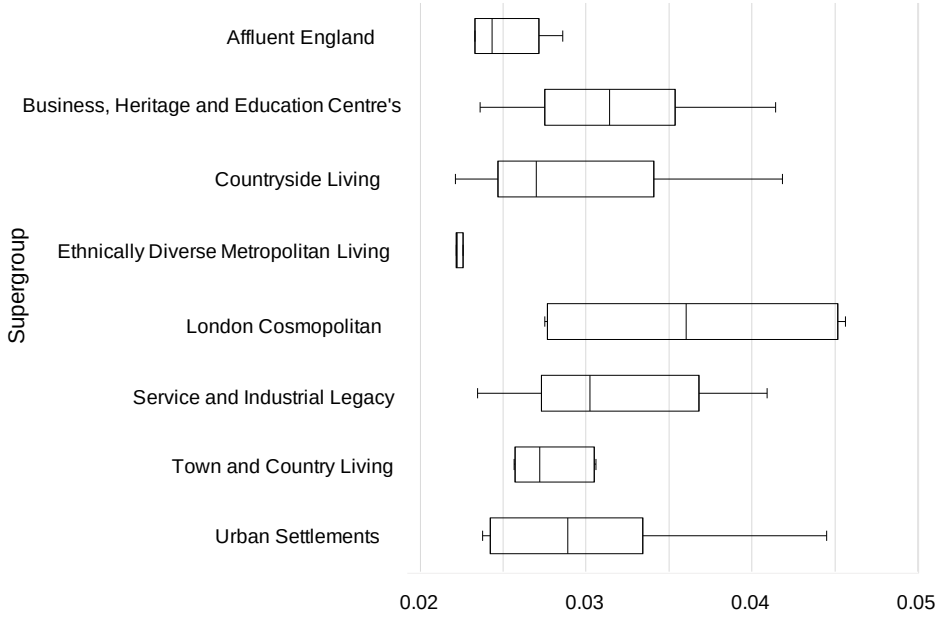

Figure 6.9. Box and whisker plots of LA supergroup type and decrease in predicted probability from 1991-2017 for heterosexual men

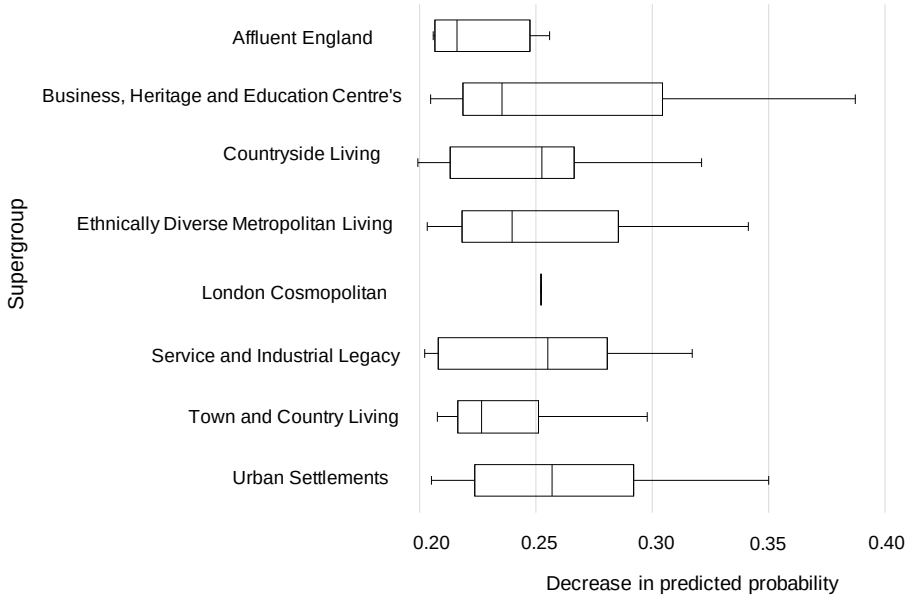

Figure 6.10. Box and whisker plots of LA supergroup type and decrease in predicted probability from 1991-2017 for SM women

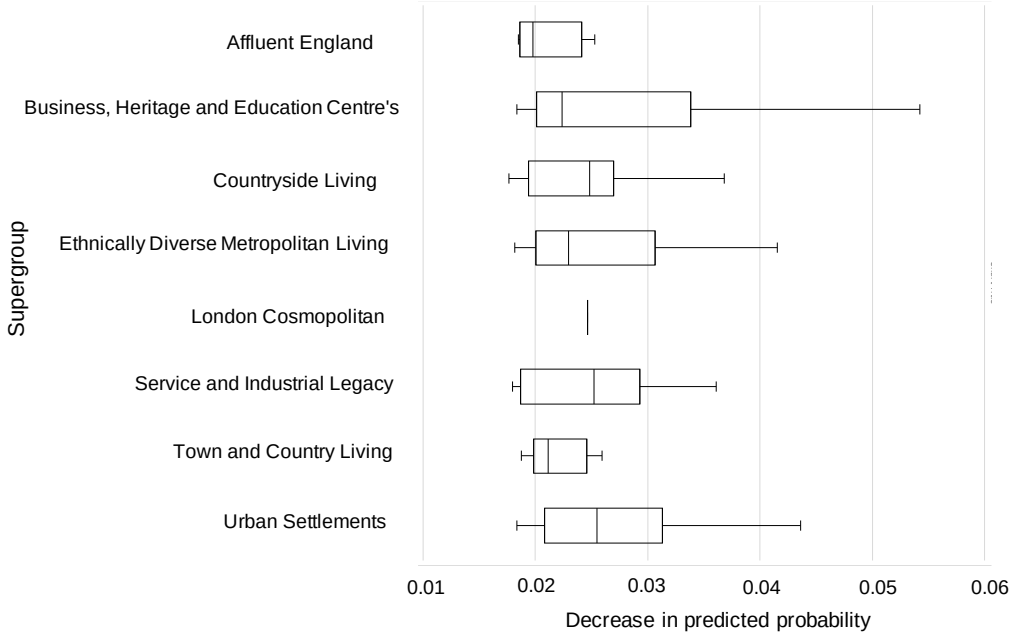

Figure 6.11. Box and whisker plots of LA supergroup type and decrease in predicted probability from 1991-2017 for heterosexual women

6.8 Discussion

The higher likelihood of current smoking for both SM women and SM men compared to heterosexual individuals in GB corroborates previous research carried out in the United States, consistently establishing the link between sexual orientation and smoking inequalities (Fallin et al., 2015a; Pizacani et al., 2009; Watson et al., 2018b). Smoking over time among LGB populations

has not been explored in GB, and our research suggests that smoking may have followed a different pattern for SM women than SM men compared to their heterosexual counterparts since 1991. We found that smoking has decreased in SM women and SM men over time, but that the gap may still be larger for SM women compared to heterosexual women than SM men compared to heterosexual men. The decrease in current smoking trends might be attributable to anti-smoking policies that produced greater decreases in urban areas compared to rural areas.

Our findings suggest that research in the United States finding decreased smoking rates but persistent gaps between sexual minority and heterosexual groups (Max et al., 2016) also applies to a British context. We found that identifying as SM for men or women predicted a higher probability of being a current smoker compared to identifying as heterosexual for both men and women (see Fallin et al., 2015a; Watson et al., 2018b), even when controlling for other known determinants of smoking. Over all time points, the odds of being a current smoker were higher for SM women compared to heterosexual women. The gap between SM and heterosexual men was smaller than that for SM and heterosexual women, but the odds of smoking were still significantly higher in SM men compared to heterosexual men. Other covariates predicted smoking in the direction expected; younger age, a lack of post 16 qualifications, unemployment and white ethnicity were all positive predictors of current smoking.

When we examined the probability of smoking over time, the gap between SM and heterosexual men has stayed about the same whereas it may have grown wider for SM compared to heterosexual women. This corroborates previous research suggesting that smoking rates are declining faster for heterosexuals and gay men than for SM women (Fish et al., 2019b; Homma et al., 2016). In GB, these findings suggest specific sex *and* sexual orientation interventions are necessary to reduce inequality gaps in smoking behaviours.

Smoking inequalities affecting SM women may also be attributable to the effect of national tobacco policies. When we examined the geographical changes in predicted smoking probability for SM women and SM men compared to their heterosexual counterparts, we found that the top 20% of predicted probability decreases strongly favoured urban areas for men with no such trend for SM women. Urban areas such as London Cosmopolitan areas and Business and Education and Heritage Centres showed large decreases for men and particularly SM men. Since 1991, anti-smoking policies generally have targeted smoking in more public spaces. The prevention of smoking in bars and clubs, as well as the ban on tobacco vending machines, may have reduced social smoking in nightlife spaces more than smoking in private spaces such as at home. In Anglo-American countries, LGB-specific venues are primarily geared towards gay men, with few lesbian bars existing (Mattson, 2015). These findings suggest, in line with the temporal changes in

smoking probability, smoking inequalities remain higher for sexual minority women than for men and the decrease in smoking in this population may align with general decreasing rates over time. In SM men, anti-smoking policies may have driven declines due to policies targeting smoking in public spaces and particularly reducing social smoking.

6.9 Conclusion and policy implications

We found that identifying as an LGB individual was associated with being a current smoker, even when considered alongside other known determinants of smoking. This study is the first to examine temporal and spatial changes in smoking probability across sexual orientation groups in GB. Smoking prevalence remained higher in LGB individuals over all time points compared to heterosexual individuals, yet rates of smoking and the probability of being a smoker over time has declined in this population. The gap for SM men compared to heterosexual men may have decreased, whilst for SM women compared to heterosexual women, the gap appears to have widened, and SM women have higher odds of being smokers. Across GB, smoking probability has decreased to a greater extent for SM men than for SM women, especially in urban areas.

Our research has some limitations. First, whilst the inclusion of sexual orientation within surveys lends to the need of more population-based studies within this population, the proportion of LGB individuals is often small in respect to heterosexual individuals. Whilst we aimed to control for this using robust MCMC analysis methods that account for unequal sample sizes, the LGB sample in this survey is below the national average of LGB individuals in the UK. Therefore, whilst we were able to examine sex specific differences, we had to aggregate SM women and SM men rather than disentangle gay or lesbian and bisexual differences. Second, sexual orientation was self-reported in this survey, which may mean some individuals did not wish to disclose their identity. The use of other sexual orientation indicators in other surveys, such as sexual attraction and behaviours, may include more individuals that are not strictly heterosexual but might not categorise themselves as LGB. Third, we also held sexual orientation as constant, though some individuals may have changed their sexual orientation and how they identify over time. Some research has found that amongst sexual minority individuals changes in self-reported sexual orientation is higher than in heterosexual individuals. The acknowledgement of sexual fluidity, whereby sexual attraction or identity may change, has also increased, with some research suggesting that sexual fluidity exists to an extent in both heterosexuals and sexual minorities (Katz-Wise, 2015). In this study an assumption of constant sexuality was necessary as data did not exist on sexual orientation over time. Longitudinal surveys that include sexual orientation over multiple time points are needed to more fully determine any changing associations of sexual orientation and smoking.

Despite national efforts to increase smoking cessation and address smoking inequalities across socially disadvantaged groups, smoking remains disproportionately higher in sexual minority groups and particularly lesbian and bisexual women. Although the UK is a global leader in anti-smoking policies (Arie, 2017), targeted strategies are needed to increase cessation and reduce initiation in LGB individuals. For sexual minority women, the inequalities are potentially more pronounced and more effort should be made to prevent initiation in this group and implementing interventions that are further reaching than those that affect mostly public spaces and thereby may have a greater impact in urban areas. Considering recent policy objectives to reduce smoking inequalities at LA level, our results shows the importance of tackling smoking prevalence both collectively across GB and acknowledging differences in populations with higher prevalence and likelihood of smoking across LAs for men and women.

Chapter 7 Smoking and co-behaviours in sexual minority individuals: comparing measures for sexuality health risk behaviour outcomes using a multilevel multivariate model

This chapter has been prepared for submission to *Social Science and Medicine*

7.1 Abstract

Previous research has found that sexual minority individuals are more likely than heterosexual individuals to engage in health risk behaviours such as the consumption of illicit drugs, heavy drinking and tobacco smoking, with sexual minority (SM) women at greater risk. This study compares multivariate models for men and women, comparing measures of sexuality using sexual attraction and sexual identity, to look simultaneously at cannabis use, current smoking and alcohol use and variance across LAs. Sexual attraction was a greater predictor of engaging in health risk behaviours compared to sexual identity for men and women, and SM women experienced greater odds of engaging in all health risk behaviours than SM men. Across LAs, there was some variation in cannabis use by LA type for women, though it was not significant, and engaging in one health risk behaviour did not predict engaging in another at LA level for men and women. These findings highlight the importance of using different measures of sexuality, and that SM women are more vulnerable to risky health behaviour, and may require sexuality-specific interventions and support.

7.2 Introduction

Research has consistently demonstrated that SM individuals face a broad range of health inequalities compared to heterosexual individuals (Zeeman et al., 2018). Studies have found that SM individuals are more likely to engage in health-damaging risk behaviours, with such behaviours contributing to a significant proportion of the global burden of disease (Peacock et al., 2018). Inequalities in health risk behaviours have received significant attention in recent studies, as SM individuals have been found to have a higher reported lifetime substance misuse for alcohol and illicit drugs (Reisner et al., 2013), and higher rates of smoking tobacco than heterosexual individuals (Fallin et al., 2015a). Due to the negative health outcomes associated with tobacco and other risky substance use, such as increased cancer risk, chronic disease

morbidity and poorer mental health outcomes (Rehm et al., 2006), research in SM health has endeavoured to understand the prevalence rates of engaging in such health risk behaviours across different countries, and to explain what drives these behaviours compared to their heterosexual counterparts.

Smoking behaviours in SM populations have been well documented, with increased prevalence rates, heavier smoking, earlier initiation and greater difficulty quitting smoking in SM individuals compared to heterosexual individuals (Davies et al., 2019; Fallin et al., 2015a; Watson et al., 2018b). The majority of research on smoking in SM populations has been carried out in the United States, whereby determinants of smoking may differ elsewhere. Whilst discrimination and microaggressions have been cited as driving smoking behaviours, elevated rates have also been associated with advertising from tobacco companies due to less strict advertising regulations compared to GB (Trocki et al., 2009). Smoking behaviours have been mainly attributed to stress and poorer mental wellbeing stemming from stigma and discrimination, which appears to be a common determinant in multiple countries (Baams et al., 2015; Davies et al., 2019). Recent research comparing smoking outcomes between LGB and heterosexual individuals found higher rates, particularly in SM women, suggesting unique factors associated with certain SM groups might be driving higher smoking rates (Shahab et al., 2017).

The co-occurrence of smoking and other health risk behaviours has also been documented (Bränström & Pachankis, 2018; Conway et al., 2018), with research suggesting that rather than tobacco being a gateway to other substances such as cannabis or hazardous alcohol use, these health risk behaviours might mutually reinforce one another (Falk et al., 2006; Pacek et al., 2013). LGB nightlife spaces which promote a culture of risky alcohol behaviours are often seen as an integral part of a SM individuals identity (McNair et al., 2016), and social smoking has been strongly associated with alcohol use (Jiang et al., 2014). The co-occurrence of smoking and cannabis use has been suggested to be related to the possibility that smoking is a gateway to trying cannabis, or instead that using cannabis might encourage initiation of tobacco smoking (Hublet et al., 2015). A recent study by Hequembourg et al. (2020) found that co-occurrent use of tobacco and alcohol was higher in lesbian and bisexual women compared to heterosexual women.

Previous research on hazardous alcohol use in SM populations has found increased odds in SM women compared to heterosexual women and SM men. Research has attributed this to higher incidences of anxiety and depression in SM women, whereby alcohol and other substances are used as a coping mechanism (Roxburgh et al., 2016). Bloomfield et al. (2011) found international differences in alcohol use in LGB individuals, with North America reporting greater differences

between LGB and heterosexual populations, particularly in women, compared to other countries in Europe and the UK that reported smaller odds between sexual minority women and heterosexual women, and even smaller for sexual minority men and heterosexual men. Recent research in the UK however has found LGB individuals compared to heterosexual individuals report higher hazardous alcohol use, but in men this affect was muted when socio-economic status was included in the model (Shahab et al., 2017).

Research on illicit drug use in SM populations has been particularly associated with MSM who use drugs to enhance sexual activity, a phenomenon known as 'chemsex' (Weatherburn et al., 2017). However, research has also established a link between SM women and using drugs to enhance sex, with cannabis the mostly frequently reported drug (Hibbert et al., 2019). Previous research in the United States has found that SM youths have higher prevalence rates of cannabis use than their heterosexual counterparts, and particularly in neighbourhoods with LGBT hate crimes reported (Duncan et al., 2014). A study looking at cannabis use in young people living with HIV found that area level variables were not associated with ever having tried cannabis or daily use of cannabis, and only identifying as bisexual for males predicted daily cannabis use compared to other sexual orientation groups (Bruce et al., 2015). Robinson et al. (2016) found that cannabis use in bisexual women was associated with involvement of the LGBT community, degree of social support available and depression. Colledge et al. (2015) found that bisexual women were more likely to have poorer mental health and use cannabis than lesbian women in the UK.

The majority of studies looking at health risk behaviours amongst differing sexuality groups have used sexual identity as the predictor variable or sample, largely due to limited access of sexuality data in secondary health surveys. However, some studies have suggested that other indicators of sexuality might be important and could be excluding some individuals at higher risk of substance misuse or poor mental health that might not self-identify as LGB. Research has found that individuals questioning their sexual identity faced greater barriers accessing healthcare and increased stigma compared to LGB and heterosexual individuals, and youths questioning their sexual orientation reported higher rates of alcohol, cannabis and tobacco use again than heterosexual or LGB individuals (Birkett et al., 2009; MacApagal et al., 2016). Some surveys, mainly sexuality surveys, have started including sexual attraction as a way to capture a population that may not wish to attach an identify to themselves, and there is evidence to suggest relying solely on sexual identity can miss a large number of people that report same-sex attraction (Geary et al., 2018). Including these measures when available is important in determining potential hidden populations at risk of health risk behaviours and other poorer health outcomes.

Factors associated with engaging in health risk behaviours apart from sexual identity include measures of social class, such as education level and socioeconomic status. In GB, research has found the effects of sexual identity on health risk behaviours can often be confounded by socio-economic status (Shahab et al., 2017). Other research however has not been consistent, as more recent studies have found sexual orientation to significantly predict substance use and smoking when such factors are controlled for (Davies et al., 2019). Health risk behaviours are strongly associated with social class in GB, and it can be difficult to untangle the effects of sexual orientation alone. Controlling for social class indicators is important in untangling the effect of sexuality on health risk behaviours. In addition, controlling for geographical clustering is also necessary, as the role of place has been established in engaging in health risk behaviours (Pearce et al., 2009). The influence of contextual factors in GB has particularly been under-explored in LGB populations. In the United States, studies have shown that states with more restrictive same-sex legislations such as marriage bans had higher prevalence rates of substance use disorders than states with more progressive legislations (Hatzenbuehler, 2010).

Other individual determinants of health risk behaviours in SM populations include poor mental health and wellbeing, particularly minority stress related to increased stigma (Fallin et al., 2015a; Kerr et al., 2014; Meyer, 2003). Individuals with poorer mental wellbeing might be at risk for depression and anxiety, whereby substance use and maladaptive behaviours might be used as a coping mechanism to decrease stress. Cannabis use itself in bisexual women has been associated with depressive symptoms yet not associated with anxiety, suggesting that cannabis might have alleviated anxiety symptoms but exacerbated depressive ones (Robinson et al., 2016). Thus, mental health and substance use might be a mutually reinforcing cycle in SM populations. The inequalities in rates of alcohol use and smoking between SM male and female youths has been attributed to a decrease in bullying for SM males and increased support, but less so for SM females (Watson et al., 2018a). Controlling for mental health determinants is therefore necessary to understand the role of sexuality in health risk behaviours.

Whilst research has established the link between smoking, alcohol use and cannabis use, showing engaging in one health risk behaviour predicts increased use of another (Gubner et al., 2016; Patton et al., 2005; Subbaraman & Kerr, 2015), the majority of these studies that have examined the association between sexuality and health risk behaviours have looked at outcomes separately. However, examining the outcomes at the same time allows us to infer the relationship between them, and gives better information about how sexuality is implicated in health behaviour outcomes by controlling for each other. This multivariate approach also allows us to understand the influence of an exposure variable on the outcomes simultaneously, and standard errors are

more accurate for independent variables than if the outcomes were modelled in isolation (Mohan et al., 2011; Snijders & Bosker, 1999).

Based on the gaps in current research in health risk behaviours and sexuality, this paper aims to (1) examine the associations between sexuality and health risk behaviour use whilst controlling for known determinants, (2) compare if substituting sexual attraction for sexual identity differs in its effectiveness at predicting health risk behaviour use for men and women, and (3) understand the relationship between smoking, alcohol use and cannabis use at the individual and community level.

7.3 Methods

7.3.1 Data

We used data from the 2012 wave of NATSAL, the most recent available. NATSAL was administered to households, and a random individual aged between 16-74 was selected from each household and asked a range of questions about sexual behaviours and lifestyle, as well as demographic variables (Erens et al., 2014). We were granted access to NATSAL data with attached LA geocodes (see appendix C). Missing data was handled using listwise deletion.

7.3.2 Measures

7.3.2.1 Dependent variables

Three binary variables were used as outcomes in this analysis. The first was smoking status, whereby individuals indicated they were light smokers, heavy smokers, ex-smokers or non-smokers. We recoded light smokers and heavy smokers to a single smoker category, and ex-smokers were combined with non-smokers, to estimate only those who were current smokers. Smoking was collapsed to a binary variable due to software limitations that do not allow for multilevel, multivariate multinomial models. The second outcome was alcohol use, which was a derived variable about weekly units of alcohol, collapsed into a binary variable which measured if respondents regularly drink over the weekly recommended limit, with the answers being ‘yes’ or ‘no’. The third outcome variable was about cannabis use, with the question asking ‘have you ever used cannabis’, with the answers being ‘yes’ or ‘no’.

7.3.2.2 Exposures: Sexual orientation and attraction

Sexuality was measured using two variables; ‘which of the following best describes how you think of yourself’ measuring individual’s self-reported sexual identity. The options included ‘gay or

lesbian', 'bisexual', or 'heterosexual' or 'other', which was excluded from this analysis due to a small number of respondents in this category. Sexual attraction was measured by asking 'who are you attracted to', with options being 'only same sex' 'mostly same sex and sometimes opposite sex', 'equal sexes', 'mostly opposite sex and sometimes same sex', and 'only opposite sex'. We collapsed the categories 'mostly same sex and sometimes opposite sex' and 'same sex only' to create a 'mostly same sex' category, as the numbers within these for respondents were too small to model and would lead to biased estimates.

7.3.2.3 Demographic covariates

Age was categorised into 5 categories with 10 year intervals. Based on previous research that highlights differences within sexual orientation groups, we stratified our data based on the individual's sex to have separate models for men and women (Davies et al., 2018; Shahab et al., 2017).

7.3.2.4 Socioeconomic covariates

Education was measured by asking for the individual's highest education level, which we collapsed into two categories, 'post 16 qualifications' for those with qualifications higher than GCSE, such as A level, degree level, higher or equivalents. 'No post 16 qualifications' was categorised as those whose highest qualification was GCSE level, or equivalent, lower or no qualifications. Individual social class status was derived using the National Statistics Socio-Economic Classification, whereby occupation is used as an indicator (Office for National Statistics, 2016). Five categories were initially used 'professional occupation', 'intermediate occupation' 'routine workers' 'other' and 'non-classifiable'. Due to small numbers in some categories and to avoid over-parameterisation of the model, we combined 'professional' and 'intermediate' into one category which was used as the referent category, and excluded 'non-classifiable'.

7.3.2.5 Mental health covariate

We included a binary variable that was created based on mental wellbeing scores from the Patient Health Questionnaire-2 (PHQ2), whereby scores above 3 were indicated as screening positive for depression (Arroll et al., 2010).

7.3.3 Statistical analysis

Data were prepared using SPSS version 24. We undertook multivariate multilevel modelling using MLwiN software to analyse the association of sexual orientation on three different health risk behaviours. Models were estimated using 1st order MQL estimation, followed by 2nd order PQL

estimation. This method is recommended as MQL estimation can lead to biased results, and so PQL provides better estimates (Rasbash et al., 2009). Logit scores were transformed into odds ratios (OR). The multivariate model is structured so that the outcomes are level 1, nested within individuals at level 2, nested within LAs at level 3. The model for this can be expressed as;

$$logit\left(p_{1jk}\right) = \beta_{0k}x_{0ijk} + \beta_3 sexuality + \beta_6 age + \beta_9 ethnicity + \beta_{12} depression + \beta_{15} education + \beta_{18} social\ class$$

$$\beta_{0k} = \beta_0 + v_{0k}$$

$$logit\left(p_{2jk}\right) = \beta_{1k}x_{1ijk} + \beta_4 sexuality + \beta_7 age + \beta_{10} ethnicity + \beta_{13} depression + \beta_{16} education + \beta_{19} social\ class$$

$$\beta_{1k} = \beta_1 + v_{1k}$$

$$logit\left(p_{3jk}\right) = \beta_{2k}x_{2ijk} + \beta_5 sexuality + \beta_8 age + \beta_{11} ethnicity + \beta_{14} depression + \beta_{17} education + \beta_{20} social\ class$$

$$\beta_{2k} = \beta_2 + v_k$$

$$\begin{bmatrix} v_{0k} \\ v_{1k} \\ v_{2k} \end{bmatrix} \sim \mathrm{N}\left(0, \Omega_v\right) : \ \Omega_v = \begin{bmatrix} \sigma_{v0}^2 & & \\ \sigma_{v01} & \sigma_{v1}^2 & \\ \sigma_{v02} & \sigma_{v12} & \sigma_{v2}^2 \end{bmatrix}$$

Where $logit$ is the log odds for ever having used cannabis, being a current smoker and regularly going over the weekly limit of alcohol, respectively. $\beta_{0k}x_{0ijk}$, with subscript 1 and 2, are the random intercept term for each outcome varying at LA level. The coefficients from β_3 onwards are the predictor variables that are added as common coefficients to each outcome. Sexuality refers to either sexual identity or sexual attraction. v_{0k} with subscript 1 and 2 are the random effect for LA level. The matrix at the end of the equation are the covariances for the three outcomes.

Using a multilevel multivariate model has many advantages when testing for the effect of predictor variables on different outcomes. Firstly, multivariate models are used when theory suggests that the outcomes are likely to be correlated to a certain extent. By using multilevel modelling, this allows us to test the outcomes together and infer the relationship between the outcomes, at both the individual and LA level. Secondly, only by looking at the outcomes together can we look at the association between the effects of common independent variables. This study looks at sexual orientation measures and other potential confounding variables simultaneously, whilst other studies have looked at the effects separately. Using multivariate multilevel modelling also allows us to estimate correct standard errors and the residual variance at the LA level, to determine the effect of environmental factors that may be muted using single level models (Mohan et al., 2011; Subramanian et al., 2005). We examined the patterning in the residuals for

each outcome using the supergroup for the 2011 Area classifications for LAs, which has 8 supergroups (Office for National Statistics, 2015).

7.4 Results

7.4.1 Differences in health risk behaviours by sexuality for men and women

Table 7.1 shows the number and percentage of individuals who report being current smokers, regularly go over the weekly limit for alcohol, and have ever tried cannabis. The prevalence of engaging in health risk behaviours was lower for men and women attracted to the opposite sex only, compared to the other sexual attraction groups. Lower prevalence was also seen in heterosexual men and women compared to gay or lesbian and bisexual individuals. A chi-square test confirmed that the association between sexuality and each health risk behaviour was significant ($p<.001$).

Table 7.1. Sample size and percentages of health risk behaviours by sexuality measure for men and women

	Ever used cannabis				**Current smoker**				**Alcohol use**			
	Men		**Women**		**Men**		**Women**		**Men**		**Women**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Sexual attraction												
Opposite sex only	2121	39	1731	24	1649	29	1957	26	483	8	753	10
More often opposite sex at least once same sex	145	54	557	62	87	32	343	38	38	14	165	18
About equally often to same sex and opposite sex	17	38	46	41	15	30	46	39	8	16	18	15
Mostly same sex	74	54	50	47	59	41	39	35	18	13	23	21
Sexual identity												

Heterosexual	2258	39	2257	27	1729	29	2287	27	525	9	902	11
Gay/lesbian	60	51	43	47	47	39	34	37	16	13	21	23
Bisexual	35	53	80	52	33	49	68	43	9	13	33	21

Some research has shown differences between men and women in those that report same sex attraction and LGB identity (Geary et al., 2018). We looked at the cross tabulation between the exposure groups to explore the differences and associations between attraction and identity (see appendix D). Heterosexual women reported 10% of some attraction to the same sex, compared to 5% of heterosexual men. Lesbian women reported 87% attraction to mostly same sex, with some reporting attraction to both sexes, whilst gay men reported 98% attraction to mostly the same sex. Bisexual men and women were mostly attracted to both sexes, though some reported attraction to the opposite sex only at 3% and 10% for women and men, respectively.

7.4.2 Multivariate model results

Table 7.2 and 7.3 show the unadjusted ORs for cannabis use, smoking and alcohol use stratified by sex, with different models for sexual attraction and sexual identity. The constant logit scores suggest that, for both men and women, the likelihood of ever having used cannabis, being a current smoker, and frequently going over the alcohol limit is lower for those attracted to the opposite sex only and for identifying heterosexuals. Men attracted to mostly the opposite sex but at least once same sex were more likely to use cannabis and go over the weekly recommended alcohol limit than those attracted to the opposite sex only. Being attracted to mostly same sex was associated with being a current smoker for men. All three sexual attraction groups predicted cannabis use, being a current smoker and going over the weekly alcohol limit for women. Identifying as bisexual or gay predicted being a current smoker and cannabis use for men. Sexual identity did not predict alcohol use for men. Identifying as lesbian or bisexual predicted cannabis use and alcohol use for women, and identifying as bisexual predicted being a current smoker.

Table 7.2 Unadjusted odds ratios for sexual attraction for men and women

	Ever used cannabis		**Current smoker**		**Alcohol use**	
	Men	Women	Men	Women	Men	Women
Constant logit (SE)	**-0.46 (0.03)**	**-1.17 (0.03)**	**-0.92 (0.03)**	**-1.06 (0.03)**	**-2.40 (0.05)**	**-2.22 (0.04)**
Sexual attraction (ref opposite sex only)						
More often opposite sex, at least once same sex	**1.92* (1.50, 2.47)**	**5.27 (4.55, 6.10)**	1.14 (0.87, 1.49)	**1.74 (1.50, 2.01)**	**1.73 (1.20, 2.49)**	**1.98 (1.64, 2.39)**
About equally often to same sex and opposite sex	0.99 (0.53, 1.85)	**2.33 (1.59, 3.42)**	0.99 (0.50, 1.94)	**1.99 (1.36, 2.93)**	2.13 (0.93, 4.87)	**1.71 (1.02, 2.87)**
Mostly same sex	**1.77 (1.26, 2.49)**	**2.97 (2.02, 4.38)**	**1.68 (1.19, 2.37)**	**1.58 (1.05, 2.36)**	1.49 (0.88, 2.52)	**2.47 (1.53, 3.96)**

*Bold text indicates confident intervals that do not span 1, significant at p<.05

Table 7.3. Unadjusted odds ratios for sexual identity for men and women

	Ever used cannabis		**Current smoker**		**Alcohol use**	
	Men	Women	Men	Women	Men	Women
Constant logit (SE)	**-0.45 (0.03)**	**-0.97 (0.03)**	**-0.92 (0.03)**	**-1.00 (0.03)**	**-2.36 (0.05)**	**-2.13 (0.04)**
Sexual identity (ref heterosexual)						
Gay/lesbian	**1.59* (1.10, 2.30)**	**2.45 (1.61, 3.73)**	**1.51 (1.04, 2.21)**	1.51 (0.98, 2.33)	1.51 (0.86, 2.64)	**2.46 (1.50, 4.04)**
Bisexual	**1.76 (1.07, 2.90)**	**2.95 (2.13, 4.09)**	**2.49 (1.52, 4.09)**	**2.01 (1.44, 2.79)**	1.71 (0.83, 3.51)	**2.18 (1.46, 3.26)**

*Bold text indicates confident intervals that do not span 1, significant at p<.05

7.4.3 Adjusted models

We adjusted the models for our two exposure measures, to test the impact of sexuality on health risk behaviours after controlling for theoretically justified covariates, shown in table 7.4 and 7.5. Covariate adjustment challenged suggestions that being attracted to mostly the same sex was associated with cannabis use among men, and that being attracted to mostly the same sex was associated with smoking among women. Identifying as gay also challenged suggestions of associations with cannabis use. Conversely, covariate adjustment strengthened suggestions of an association between being attracted to mostly the same sex and identifying as gay for smoking among men.

7.4.3.1 Sexual attraction

Ever having tried cannabis use for men was associated with increased odds for those more often attracted to the opposite sex and at least once same sex [OR 1.90] than those attracted to the opposite sex only. Being equally attracted to the opposite and same sex, and being attracted to mostly same sex was not significantly associated with cannabis use for men. Women more often attracted to the opposite sex were more likely to have ever tried cannabis [OR 4.17], those equally attracted to the same and opposite sex were more likely [OR 1.80], and those attracted to mostly same sex were more likely [OR 2.32] than those attracted to the opposite sex only.

Smoking was not associated for men with being attracted to mostly the opposite sex and at least once same sex or being equally attracted to both the opposite and same sex. Being attracted to mostly same sex was associated with being a current smoker compared to the opposite sex only [OR 1.73]. For women, being attracted to mostly the opposite sex and at least once same sex was associated with current smoking [OR 1.70], as was being equally attracted to both the opposite and same sex [OR 1.75] compared to being attracted to the opposite sex only. Being attracted to mostly same sex was not significantly associated with being a current smoker.

Frequently going over the weekly limit for alcohol for men was associated with being most often attracted to the opposite sex but at least once same sex [OR 1.60]. Being equally attracted to both the opposite and same sex, and mostly same sex were not significant. For women, being most often attracted to the opposite sex but at least once same sex was associated with increased likelihood of frequently going over the weekly limit of alcohol [OR 1.79], as did being attracted to mostly same sex [OR 2.16]. Being equally attracted to both the opposite and same sex was not significant for women.

7.4.3.2 Sexual identity

Men who identified as bisexual were more likely than heterosexuals to have ever tried cannabis [OR 1.87], but gay men were not significantly more likely. For women, identifying as a lesbian was associated with increased odds [OR 1.92] odds, as was identifying as bisexual [OR 2.14] compared to heterosexuals.

Increased odds of being a current smoker was associated with identifying as gay [OR 1.57] and identifying as bisexual for men [OR 2.42] compared to heterosexuals. For women, identifying as bisexual was associated with increased odds of being a smoker [OR 1.55], whereas identifying as a lesbian was not significant.

For men, identifying as gay or bisexual was not significantly associated with frequently going over the weekly limit of alcohol compared to heterosexual men. For women, identifying as lesbian [OR 2.16] or bisexual [OR 2.00] was associated with increased odds of frequently going over the weekly alcohol limit.

7.4.3.3 Covariates

Associations with covariates were as expected. Older individuals had decreased odds of ever having tried cannabis, except for 25-34 year old men, and the same pattern was seen for current smoking. Increasing age was associated with an increase in likelihood of frequently going over the weekly limit for alcohol for men, but a decrease in likelihood for women. Compared to white individuals, other ethnicities were associated with decreased odds of cannabis use, smoking and alcohol use for men and women, though not all were significant. Routine occupation was only significantly associated with increased likelihood of smoking for men and women, and those in other professions were less likely to have ever tried cannabis only. Having no post-16 qualifications was associated with a decreased likelihood of cannabis use for men and women, and alcohol use but only for women, and an increased likelihood of smoking for men and women. Screening positive for depression was associated with increased odds of ever having tried cannabis and being a current smoker for both men and women. No significant results were associated with alcohol use for either men or women.

7.4.3.4 Unexplained Local Authority level variance

The variance at LA level was significant only for women in the sexual attraction model, and then only for cannabis use. It suggests that an estimated 7% of the residual variance lies at LA level. This suggests that there is some LA level clustering in cannabis consumption by women that is unexplained by either exposure measures and the covariates. All other residual variances for both

men and women were not significant. In the sexual identity model, cannabis use was significant for women, with an estimated 9% of the residual variance at LA level.

Table 7.4. Odds ratios fully adjusted model for men and women for cannabis use, current smoking and alcohol use by sexual attraction

	Ever used cannabis		**Current smoker**		**Alcohol use**	
	Men	Women	Men	Women	Men	Women
Constant logit (SE)	**0.16 (0.07)**	**-0.38 (0.07)**	**-1.37 (0.08)**	**-1.44 (0.08)**	**-2.71 (0.14)**	**-1.75 (0.09)**
Sexual attraction (ref opposite sex only)						
More often opposite sex, at least once same sex	**1.90* (1.45, 2.50)**	**4.17 (3.58, 4.87)**	1.23 (0.93, 1.62)	**1.70 (1.46, 1.99)**	**1.60 (1.11, 2.32)**	**1.79 (1.47, 2.17)**
About equally often to same sex and opposite sex	0.91 (0.47, 1.79)	**1.80 (1.21, 2.68)**	0.91 (0.45, 1.84)	**1.75 (1.16, 2.63)**	2.16 (0.92, 5.05)	1.64 (0.98, 2.77)
Mostly same sex	1.35 (0.94, 1.93)	**2.32 (1.55, 3.48)**	**1.73 (1.21, 2.48)**	1.48 (0.97, 2.25)	1.35 (0.80, 2.29)	**2.16 (1.34, 3.48)**
Age (ref 16-25)						
25-34	**1.22 (1.04, 1.43)**	0.94 (0.81, 1.06)	**1.19 (1.01, 1.41)**	0.96 (0.83, 1.10)	**1.50 (1.11, 2.02)**	**0.76 (0.63, 0.92)**
35-44	0.89 (0.74, 1.07)	**0.74 (0.62, 0.87)**	**0.80 (0.65, 0.98)**	**0.68 (0.57, 0.81)**	**1.45 (1.03, 2.06)**	**0.73 (0.58, 0.93)**
45-54	**0.48 (0.39, 0.58)**	**0.39 (0.33, 0.48)**	0.82 (0.67, 1.00)	**0.68 (0.57, 0.81)**	**2.16 (1.57, 2.97)**	1.00 (0.79, 1.25)
55-64	**0.22 (0.18, 0.27)**	**0.22 (0.17, 0.27)**	**0.46 (0.37, 0.58)**	**0.44 (0.36, 0.53)**	**2.15 (1.56, 2.96)**	**0.67 (0.51, 0.87)**
65+	**0.07 (0.05, 0.12)**	**0.07 (0.05, 0.10)**	**0.41 (0.32, 0.52)**	**0.34 (0.27, 0.42)**	**1.79 (1.26, 2.53)**	**0.55 (0.40, 0.75)**
Ethnicity (ref white)						
Black/ Black British	**0.40 (0.28, 0.57)**	**0.34 (0.23, 0.48)**	**0.56 (0.38, 0.83)**	**0.37 (0.26, 0.53)**	**0.18 (0.06, 0.57)**	**0.11 (0.04, 0.30)**
Asian/Asian British	**0.25 (0.19, 0.34)**	**0.17 (0.11, 0.25)**	0.88 (0.66, 1.17)	**0.19 (0.12, 0.28)**	**0.17 (0.07, 0.43)**	**0.13 (0.06, 0.30)**
Mixed/Chinese/other	1.00 (0.73, 1.37)	**0.69 (0.52, 0.91)**	1.30 (0.94, 1.81)	1.02 (0.78, 1.34)	**0.31 (0.12, 0.76)**	**0.59 (0.38, 0.92)**

Social class group (ref professional/ intermediate)						
Routine	0.97 (0.84, 1.12)	0.85 (0.72, 1.01)	**1.67 (1.45, 1.93)**	**1.59 (1.37, 1.84)**	0.97 (0.76, 1.23)	1.16 (0.94, 1.43)
Other	**0.66 (0.54, 0.79)**	**0.64 (0.55, 0.75)**	1.04 (0.86, 1.25)	1.00 (0.87, 1.15)	0.80 (0.58, 1.10)	**0.71 (0.57, 0.88)**
Education (ref post 16 qualifications)						
No post 16 qualifications	**0.78 (0.69, 0.88)**	**0.76 (0.69, 0.85)**	**2.10 (1.84, 2.39)**	**2.68 (2.39, 3.00)**	0.98 (0.81, 1.19)	**0.84 (0.73, 0.98)**
Depression (ref no)						
Yes	**1.68 (1.40, 2.02)**	**1.33 (1.13, 1.55)**	**1.77 (1.49, 2.13)**	**1.74 (1.51, 2.01)**	1.27 (0.96, 1.68)	0.96 (0.78, 1.20)
Unexplained LA level variance (standard error)	0.033 (0.021)	**0.066 (0.022)**	0.030 (0.022)	0.034 (0.018)	0.075 (0.055)	0.054 (0.033)

*Bold text indicates confident intervals that do not span 1, significant at p<.05

Table 7.5. Odds ratios fully adjusted model for men and women for cannabis use, current smoking and alcohol use by sexual identity

	Ever used cannabis		**Current smoker**		**Alcohol use**	
	Men	Women	Men	Women	Men	Women
Constant logit (SE)	**0.20 (0.07)**	**-0.17 (0.07)**	**-1.37 (0.08)**	**-1.34 (0.07)**	**-2.66 (0.13)**	**-1.66 (0.09)**
Sexual identity (ref heterosexual)						
Gay/lesbian	1.16 (0.79, 1.71)	**1.92* (1.24, 2.98)**	**1.57 (1.05, 2.32)**	1.53 (0.97, 2.41)	1.33 (0.76, 2.34)	**2.16 (1.31, 3.56)**
Bisexual	**1.87 (1.10, 3.18)**	**2.14 (1.52, 2.99)**	**2.42 (1.45, 4.06)**	**1.55 (1.10, 2.19)**	1.69 (0.82, 3.52)	**2.00 (1.34, 3.01)**
Age (ref 16-25)						
25-34	**1.23 (1.05, 1.44)**	0.95 (0.83, 1.09)	**1.21 (1.02, 1.43)**	**0.96 (0.83, 1.10)**	**1.51 (1.12, 2.04)**	**0.76 (0.63, 0.92)**

35-44	0.89 (0.74, 1.07)	**0.73 (0.62, 0.86)**	0.80 (0.65, 0.98)	**0.67 (0.56, 0.80)**	**1.45 (1.02, 2.05)**	**0.73 (0.57, 0.93)**
45-54	**0.48 (0.40, 0.58)**	**0.38 (0.32, 0.46)**	**0.81 (0.66, 1.00)**	**0.66 (0.56, 0.79)**	**2.15 (1.56, 2.96)**	0.97 (0.77, 1.21)
55-64	**0.22 (0.18, 0.28)**	**0.20 (0.16, 0.25)**	**0.46 (0.37, 0.58)**	**0.42 (0.35, 0.51)**	**2.15 (1.56, 2.96)**	**0.64 (0.49, 0.83)**
65+	**0.07 (0.05, 0.10)**	**0.06 (0.04, 0.09)**	**0.41 (0.32, 0.52)**	**0.32 (0.26, 0.40)**	**1.77 (1.25, 2.50)**	**0.52 (0.38, 0.71)**
Ethnicity (ref white)						
Black/ Black British	**0.39 (0.27, 0.55)**	**0.32 (0.22, 0.46)**	**0.55 (0.37, 0.82)**	**0.37 (0.26, 0.52)**	**0.18 (0.05, 0.56)**	**0.11 (0.04, 0.30)**
Asian/Asian British	**0.25 (0.18, 0.34)**	**0.16 (0.11, 0.24)**	0.86 (0.65, 1.15)	**0.18 (0.12, 0.27)**	**0.13 (0.05, 0.37)**	**0.12 (0.05, 0.28)**
Mixed/Chinese/other	0.99 (0.72, 1.35)	**0.69 (0.52, 0.91)**	**0.69 (0.52, 0.91)**	1.02 (0.78, 1.34)	**0.31 (0.12, 0.76)**	**0.60 (0.39, 0.94)**
Social class group (ref professional/ intermediate)						
Routine	0.97 (0.84, 1.12)	0.86 (0.73, 1.01)	**1.67 (1.44, 1.92)**	**1.58 (1.36, 1.83)**	0.96 (0.76, 1.22)	1.17 (0.95, 1.44)
Other	**0.67 (0.55, 0.80)**	**0.64 (0.54, 0.74)**	1.04 (0.87, 1.26)	0.99 (0.86, 1.14)	0.81 (0.59, 1.11)	0.71 (0.57, 0.88)
Education (ref post 16 qualifications)						
No post 16 qualifications	**0.77 (0.68, 0.87)**	**0.72 (0.65, 0.80)**	**2.08 (1.83, 2.37)**	**2.59 (2.32, 2.90)**	0.96 (0.79, 1.17)	**0.82 (0.71, 0.95)**
Depression (ref no)						
Yes	**1.67 (1.39, 2.00)**	**1.39 (1.19, 1.62)**	**1.77 (1.48, 2.11)**	**1.78 (1.54, 2.06)**	1.29 (0.97, 1.71)	0.99 (0.80, 1.23)
Unexplained level 3 Variance (standard error)	0.034 (0.022)	**0.086 (0.024)**	0.031 (0.022)	0.036 (0.018)	0.073 (0.055)	0.050 (0.032)

*Bold text indicates confident intervals that do not span 1, significant at p<.05

7.4.4 Analysis of residuals

Based on the residual variance and 95% confidence intervals from the adjusted models, we examined the LA level residuals for cannabis use for women, in the sexual identity and attraction exposure groups. Figure 7.1 and 7.2 shows the LA residuals for cannabis use for women, in the

sexual attraction exposure group and the sexual identity exposure group. The residual plots show error bars for all the residuals that cross zero, suggesting that the LA variances do not vary significantly.

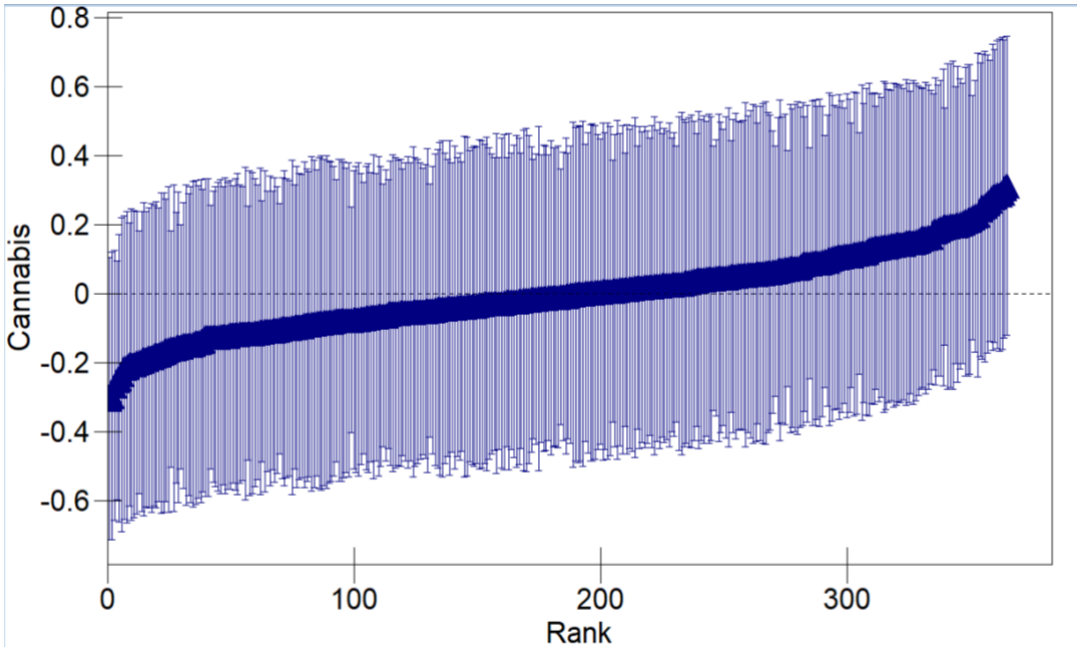

Figure 7.1. Residuals for cannabis use for women in sexual attraction exposure group

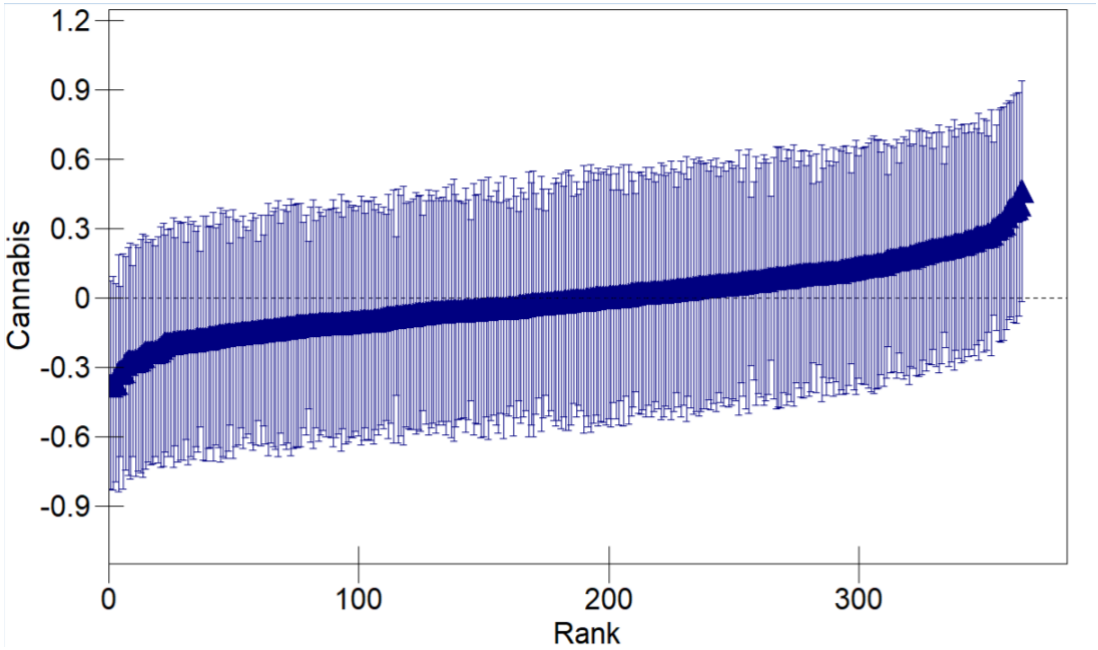

Figure 7.2. Residuals for cannabis use for women in sexual identity exposure group

Despite this indication, we wanted to see if the residuals were grouped by type of LA. Figure 7.3 shows the residuals for sexual attraction and sexual identity for women who have ever used cannabis, by LA type. The LA type most positively associated with cannabis use is London Cosmopolitan, which also had the greatest variation between the residual for sexual attraction

exposure group and that for sexual identity. This difference suggests that sexual identity may be more effective at predicting cannabis use than sexual attraction in London Cosmopolitan areas, as there is a closer fit to the zero line. All other area types were similar for both exposure measures. The LA type with clearly negative residuals is the Service and Industrial Legacy, suggesting that women are less likely to consume cannabis in such areas.

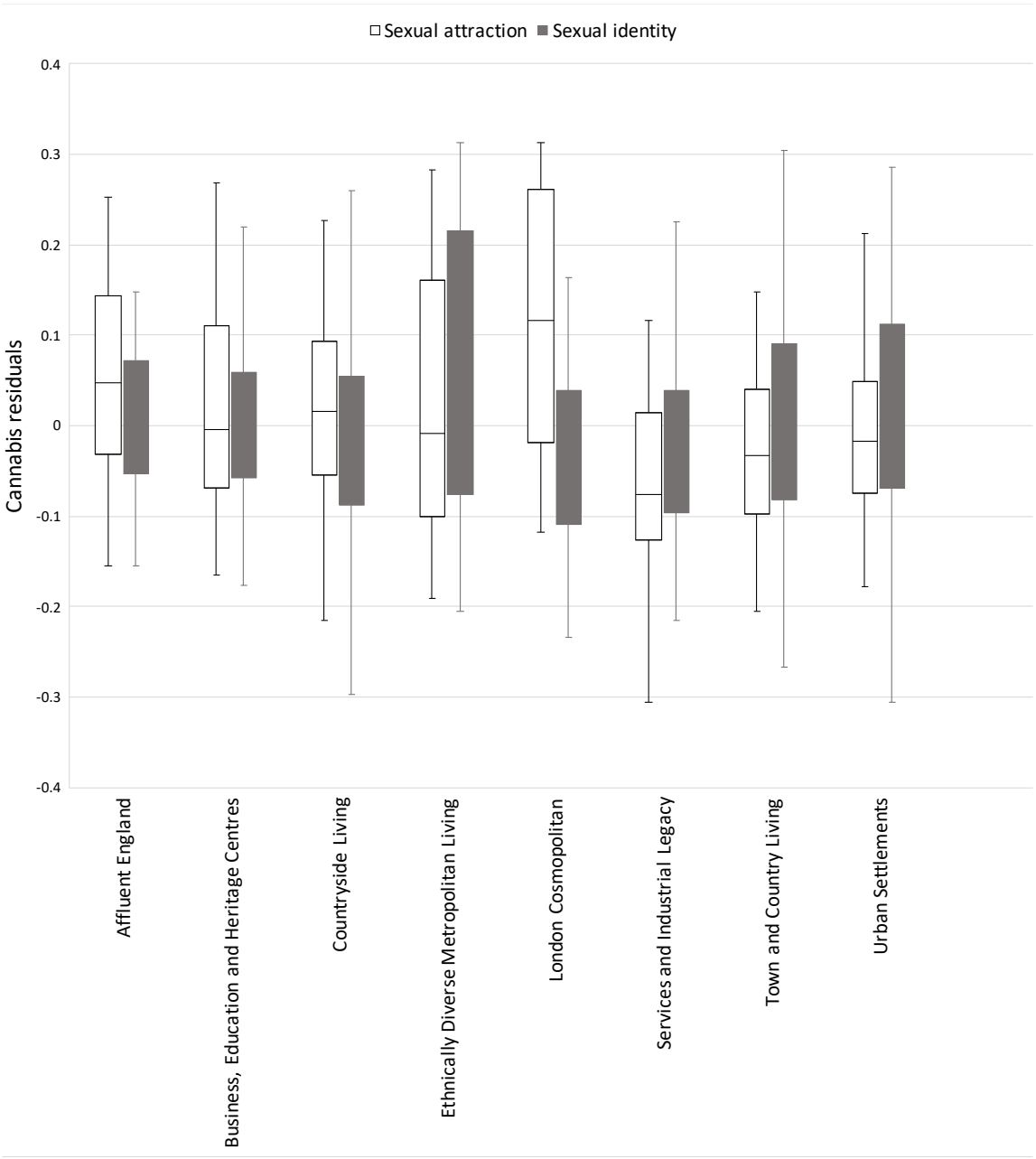

Figure 7.3. Residuals by LA type for women in sexual attraction and sexual identity groups

7.4.5 LA level covariance between health risk behaviours

Table 7.6 indicates the covariance estimates at the LA level. These show how the outcomes are related geographically across LAs. For men, although not significant, the covariances for smoking and cannabis are positive, indicating that areas with people who are likely to have ever tried

cannabis are also likely to be areas with current smokers. All three outcomes and covariates show similar LA level patterning in both exposure groups for men, though the covariances are very low. For women, smoking and cannabis use shows a slightly different pattern from in each exposure group, though again the covariances are not statistically significant. Overall, there is little residual covariance, which suggests that the individual covariates have effectively accounted for LA level associations between the health risk behaviours.

Table 7.6. LA level covariance for sexual attraction and sexual identity exposure groups for men and women

	Sexual attraction		**Sexual identity**	
Covariance (SE)	**Smoking**	**Cannabis**	**Smoking**	**Cannabis**
Men				
Cannabis	0.030		0.032	
	(0.017)		(0.017)	
Alcohol	-0.002	0.008	-0.002	0.006
	(0.025)	(0.025)	(0.025)	(0.025)
Women				
Cannabis	-0.003		0.005	
	(0.015)		(0.015)	
Alcohol	0.003	-0.015	0.002	-0.013
	(0.018)	(0.019)	(0.018)	(0.020)

7.5 Discussion

This study is the first to look at health risk behaviours simultaneously whilst comparing sexual attraction and identity as exposure groups stratified by sex. Using different measures for sexual orientation may capture otherwise hidden populations that have a high risk of substance use. Examining the outcomes together also gives better and more accurate estimates of how the same covariates predict each outcome (Mohan et al., 2011). Whilst some studies have started to look at sexual attraction as a sexuality measure and acknowledge the need to include it when examining

inequalities (Geary et al., 2018; Kuyper & Bos, 2016), our study extends current findings by also comparing sexuality measures. We found that sexual attraction appears to show slightly higher odds for each health risk behaviour than sexual identity. Our findings suggest that studies using only sexual identity may be missing some individuals who might not identify as LGB but may be vulnerable to engaging in health risk behaviours. These individuals could be questioning their identity, as previous studies have shown questioning individuals have greater barriers to healthcare and increased anxiety than LGB and heterosexual individuals (Birkett et al., 2009; MacApagal et al., 2016).

We found that being attracted to mostly the opposite sex but at least once same sex was a stronger predictor for cannabis use and smoking for women and cannabis use for men, whereas being attracted to mostly the same sex was a stronger predictor for alcohol intake for women and smoking for men than other sexual attractions. Identifying as gay for men only predicted being a current smoker, but identifying as bisexual predicted smoking and cannabis use. For women, identifying as lesbian predicted cannabis use and alcohol use, and identifying as bisexual significantly predicted all three outcomes. These findings are in line with previous research that suggests that being an SM woman predicts engaging in health risk behaviours more than SM men, and compared to their heterosexual counterparts (Fish et al., 2019b; Shahab et al., 2017; Watson et al., 2018b). It also suggests that bisexual individuals are more at risk for maladaptive behaviours, in both men and women (Shahab et al., 2017), which may be due to double vulnerability from both heterosexual and gay and lesbian communities (Homma et al., 2016). Few studies in GB have examined the link between sexuality and cannabis use, as the majority of drug risk behaviour studies have looked at substances used for 'chemsex', such as amphetamines and cocaine (Hibbert et al., 2019; Weatherburn et al., 2017). Our findings support United States based research that suggests SM men and women are more likely to have ever tried cannabis, and also extends this by finding sexual attraction is a greater predictor for cannabis use than sexual identity, particularly for women.

Whilst other studies have demonstrated the link between sexuality and health risk behaviours (Davies et al., 2019; Robinson et al., 2016; Shahab et al., 2017), our findings highlight the importance of looking within SM groups, and also across sexuality measures. The majority of research on health risk behaviours in SM groups has been carried out in the United States, and research in GB has been limited and focussed on sexual identity as a measure of sexuality (Shahab et al., 2017), largely due to access, or lack of, to health and social surveys with appropriate sexuality data (Uhrig, 2015). When we looked at a cross-tabulation (see appendix D) between sexual identity and sexual attraction, some individuals who reported identifying as heterosexual reported at least once being attracted to the same sex, particularly women. As this group

particularly had greater odds of engaging in health risk behaviours, these individuals may not have 'come out' due to feeling stigmatised or uncertain of their sexual identity, and could be engaging in health risk behaviours as a coping mechanism. For cannabis use, women attracted to at least once same sex had the highest odds for other groups, and more than smoking and alcohol intake. Previous studies have suggested that increased engagement in health risk behaviours in SM women may be due to again bisexuality stigma, and also being particularly vulnerable due to more stigma and less support in schools compared to men (Watson et al., 2019).

We found that compared to the model adjusting for sexuality only, sexual attraction and sexual identity still predicted engaging in health risk behaviours when determinants such as social class and education were controlled for. The effect of cannabis for men disappeared for those attracted to mostly the same sex, and those who identified as gay. We also found the effect of being attracted to both sexes equally disappeared for women for alcohol use when other factors for controlled for. Other research in GB has found that when controlling for socio-economic status, the effect of identifying as gay for men disappeared for risky alcohol use, but not for women (Shahab et al., 2017). This might suggest a more complex link between alcohol use for SM women, and cannabis use for SM men. As depressive symptoms were positively associated with ever having tried cannabis, this might also imply that for men inequalities persist in bisexual individuals or those attracted to both sexes, due to stigma and greater levels of minority stress (Baams et al., 2015). In the United States, whilst support for bisexual and gay men is better than for SM women (Watson et al., 2019, 2018a), it is unclear if support in GB is equal between sexual minority groups for men.

Looking at outcomes simultaneously using multilevel multivariate modelling has several advantages, and allowed us to infer the relationship between each outcome at LA level when controlling for individual level covariates (Subramanian et al., 2005). The LA level covariances for both men and women were not significant, suggesting that between LAs there are no significant relationships between health-risk behaviours that cannot be accounted for in terms of individual-level covariates. We found there was some unobserved residual variance for cannabis use for women, but not for other outcomes and not for men across all outcomes. When we examined at the residuals for cannabis use in women, we found that LAs did not differ from the overall average significantly. We also looked at LA type, and found that there was some variation between exposure groups, particularly in the case of London Cosmopolitan type areas, with sexual attraction having higher positive residuals than sexual identity. This corroborates previous research, albeit in gay men, finding that gay enclaves with a concentration of LGBT nightlife spaces have been found to facilitate cannabis use (Carpiano et al., 2011). Whilst the effect was not significant, the closer fit to the zero line suggests metropolitan areas may be associated with

greater cannabis use in women than other types of areas, though individual level factors may be more effective in predicting the relationship. Though other studies have not looked at LA level factors in cannabis use in women, research that has found community level risk factors in the UK to be smaller than individual level risk factors in smoking behaviours (Adachi-Mejia et al., 2012).

7.6 Limitations and policy implications

Despite our novel findings, our study is not without limitations. Firstly, using predictors for sexuality is difficult with secondary health surveys, as the groups are often unbalanced and thus it is difficult to examine particular trends without over-parameterising the model. Numbers of sexual minority individuals are often small in survey data and rely on self-reporting. The NATSAL sample size of sexual minority individuals estimates are slightly higher than current UK estimates of LGB individuals which were roughly 2% in 2017 (Office for National Statistics, 2019a), though individual categories are still small. Whilst using more robust analysis techniques, such as MCMC, to account for small numbers would have been preferential, limitations in current MLwiN software restricts which estimation methods can be used. Secondly, the data in this survey were captured before changes in guidelines for alcohol use for men, which are now in line with guidelines for women at 14 units per week. Therefore, male drinking habits in this study are based on outdated guidelines, and the odds could actually be greater now. Finally, health risk behaviours were self-reported and not objective measures, so again could under-represent true figures of smoking, cannabis use and alcohol intake, particularly where individuals might be less inclined to report taking illicit drugs and other stigmatised health behaviours.

Future research could extend our findings by looking at other health risk behaviours, such as diet and exercise, and other drugs explored in the context of sexual activity. Previous studies have also found that SM individuals engage in earlier initiation of health risk behaviours than their heterosexual counterparts (Talley et al., 2019), and the role of mental health in LGB individuals and health risk behaviours has been well established (Davies et al., 2019; Watson et al., 2019). Looking at the interaction of these known determinants and sexuality was beyond the remit of this paper and would have risked over-parameterisation of the models. Future studies could however look at these interactions, comparing sexuality measures. With recent policy calls for reducing smoking in England and Wales (Department of Health, 2017), and current research highlighting the negative health consequences of binge drinking (Kuntsche et al., 2017), policies should take into account different groups that are more vulnerable and consider sexuality specific interventions. In addition, though we found possible differences between LAs for cannabis use for women, other health risk behaviours did not differ by LA or have unexplained residual variance. This sustains calls for nationally standard policies to reduce health risk behaviours for men and

women, with a greater focus on individual determinants, including sexuality but also social class, education and mental health. There is however still a need for LAs to assist specific populations that are unequally affected, such as LAs with a greater sexual minority population.

Chapter 8 Overall Conclusions

This thesis aimed to address the gaps in the literature looking at the associations between sexuality, smoking and co-behaviours across GB. The literature review found that the majority of research in this area has been conducted in the United States, and those studies carried out in GB have highlighted the scale of the problem, without addressing why higher prevalence rates exist, or how smoking has changed over time and place. The data landscape and methodology chapter discussed how surveys were selected to be used for empirical analysis, with three surveys finally chosen for each empirical chapter. A methodology and contribution chapter highlighted the methods used in each empirical chapter to extend previous sexuality and smoking research, and how these fit in with the three research questions. The three empirical chapters each address one research question, using different variations of multilevel modelling. These chapters have contributed to understanding the associations between sexuality and smoking behaviour across GB, from a health geography perspective that takes into account both compositional and contextual factors.

This chapter begins by summarising the key findings and research aims that were addressed in each chapter in this thesis. Limitations applicable across all of the empirical chapters are then discussed before turning to how this thesis has contributed to the wider literature on sexuality and smoking. The chapter next addresses policy implications and what could be done to tackle smoking and other health risk behaviour inequalities in LGB populations, and what future research could contribute to this field. Finally, concluding remarks draw together the findings and novelty of this thesis.

8.1 Summary of results and research aims

Each of the empirical chapters extended previous studies into the inequalities between LGB and heterosexual populations. We found that LGB individuals were more likely to smoke, be heavier smokers, and more likely to engage in co-consumption of cannabis and risky alcohol use. The research questions that we developed aimed to broaden what we already knew about the relationship between sexuality and smoking behaviours.

The first research question ‘what are the determinants of smoking in LGB individuals in Great Britain?’ was addressed in the first empirical paper in chapter five. Whilst this question has been posed in previous papers, this study used structural equation modelling which has not been done in sexuality research before, to look at the pathways to smoking comparing known at risk groups.

Using justification from previous literature, this chapter tested the claims that mental health was a mediator for heavier smoking in LGB individuals compared to heterosexuals, and that other factors such as earlier age of initiation and increased exposure to smoke also mediated heavier smoking. An important novel aspect of this paper was the was comparison to social class groups. Other papers have used social class as a covariate in regression models, as low social class or low level of education is known to be a strong predictor of smoking in England (Honjo et al., 2006; Shahab et al., 2017). We wanted to compare if sexual identity had the same pathways to smoking as social class groups, that being earlier initiation of smoking, greater exposure per week to second-hand smoke, and poorer mental wellbeing. We found that earlier age of initiation and exposure to smoke mediated social class only but not LGB individuals, though mental health was a mediator for both groups. These findings suggest that mental health may be a key driver of smoking inequalities for socially disadvantaged groups, and particularly might be the key path for greater smoking prevalence and smoking heaviness for LGB individuals. This corroborates previous research suggesting minority stress theory is implicated in smoking inequalities (Frost & Meyer, 2015; Meyer, 2003). Despite research suggesting social class confounds the effect of sexuality, our findings suggest otherwise (Shahab et al., 2017).

The second research question 'Has there been change over time and space in smoking prevalence in LGB populations across Great Britain?' was addressed by the second empirical paper in chapter six. Smoking over time in LGB populations has received little attention in much of the literature and has not been examined in GB. Longitudinal data from the BHPS and US were merged to look at smoking changes between heterosexual and LGB populations, comparing differences between men and women. Smoking decreased across all groups over time, but there appeared to be less of a decrease for sexual minority women compared to heterosexual women. Across GB, smoking prevalence decreases were seen in more urban type LA areas for sexual minority men than for sexual minority women. This research contributes to the literature on smoking behaviours amongst LGB populations in the context of GB (Hagger-Johnson et al., 2013b; Shahab et al., 2017), and highlights that changing policies may have had more significant implications for sexual minority men than women across GB, which may partially explain why smoking prevalence rates remain persistently higher amongst sexual minority women. This chapter also highlights that whilst individual determinants of smoking are important to consider, the context and relationship to place is necessary to understand the complexities of the association between sexuality and smoking in GB.

The third research question 'how does smoking behaviour co-vary with other behaviours and how is it affected by measurement of sexuality?' was addressed in chapter seven in the third empirical paper. The concept of using different measures for sexuality has only gained recent interest in

research (Geary et al., 2018), and due to limited availability of data has not been looked at in relation to outcomes in GB. This paper compared sexual attraction and sexual identity in smoking and co-behaviour engagement, drawing comparisons between sexual minority men and women, compared to their heterosexual counterparts. Sexual attraction as a predictor of sexuality had greater odds of engaging in health risk behaviours than sexual identity, and sexual minority women had greater odds than men. Individuals who reported attraction to both sexes and those who identified as bisexual had greater likelihood of engaging in health risk behaviours. We also found that health risk behaviours were not associated with each other at LA level, which suggests individual level factors accounted for the variation between outcomes, which may be a better indicator of the likelihood of smoking predicting other co-behaviours. This paper adds to the literature on sexuality and health risk behaviours by extending how we should consider other measurements of sexuality in addition to self-identification, sexual attraction might be a more accurate predictor and include more vulnerable or at-risk individuals who could otherwise be hidden.

8.2 Strengths and Limitations

The strengths of this thesis lie within the contributions made to the literature on sexuality and smoking behaviours, and using available data to push further knowledge on what we currently understand about smoking in sexual minority populations in GB. The use of more sophisticated and advanced modelling techniques has allowed us to address more detailed and complex research questions in this area. Access to LA data has enabled us to investigate how smoking and co-behaviours vary spatially, how smoking has changed over time in different groups, and what are the types of areas where these behaviours and change are most evident. Using different data sources for each empirical chapter has also been a strength of this thesis, as each data source had its own benefits and limitations. Using only one data source would have challenged our ability to address the breadth of questions we have, for example potential mediators of smoking were only available in HSE, change over time longitudinally could only have been investigated using BHPS/US, and different measures of sexuality were only available in NATSAL.

However, it is important to acknowledge limitations from our research. Throughout this thesis, efforts are made to minimise issues that might occur during analysis, due to the implications of using secondary data sources and working with small unbalanced population sizes. Each paper discusses the limitations within each chapter, however some of the limitations are applicable on a wider level for the overall methodologies and themes of this thesis. Measuring sexuality relies on self-reporting, which can often lead to bias and under-reporting, due to individuals not wanting to disclose their orientation, or people may not have ‘come out’ yet. The availability of appropriate

sexuality data in GB, as seen in the data landscape chapter, is limited. Health and social surveys that look at sexuality often use self-reported sexual orientation, which whilst it could capture those who have a 'label' could also miss others who are uncertain of their sexuality. Whilst this thesis endeavoured to address these gaps by using other measurements of sexuality, these still rely on self-reporting of sexual attraction, and individuals might not wish to disclose ever having attraction to members of the same sex due to perceived stigma.

Sample sizes have remained an issue in each analytical chapter in this thesis. Whilst we have tried wherever possible to minimise the effects of this by using more robust modelling techniques like MCMC, small numbers have prevented some analysis taking place, such as exploring interaction effects between sexuality and other determinants, due to due to the risk of over parameterisation of the model. In addition, software limitations have also prevented some estimation methods, such as in chapter seven, whereby MCMC is not available for logit multivariate models. This can have implications for estimation, though we attempted to mitigate this by aggregating sub-groups where possible to prevent very small sample sizes, and by using estimation methods recommended for MLwiN multivariate analysis, such as using starting values for PQL estimation (Rasbash et al., 2009).

8.3 Contributions to the literature

The findings presented in this thesis address a number of gaps in sexuality research from a health geography perspective in GB. This thesis contributes to the literature in four ways in particular, (1) by extending current LGB research to GB, (2) by applying more sophisticated modelling techniques to address new research questions, (3) adding in consideration of geographical variation and finally, (4) by exploring different measurements of sexuality to examine smoking and co-behaviour risk.

In chapter two, the literature review discussed how the majority of research looking at smoking and other health risk behaviours in LGB populations has been dominated by a North American perspective. Some of the factors implicated in greater smoking prevalence amongst this population are common to both GB and United States, but some are likely to be specific to the United States only, such as tobacco advertising where the legislative context is different to the UK (Stevens et al., 2004). Therefore, there was a need to address the gaps in research looking at why and what the contributing factors are in smoking behaviours in LGB populations using data from GB. Chapter six in particular examines this in the context of change over time. Smoking prevalence may be associated with changing smoking policies that target public spaces. In the UK, LGBT nightlife spaces are primarily geared towards gay men, which demonstrates the importance

of examining smoking patterns that are culturally specific to GB, rather than using North American research to make generalisations.

This thesis goes beyond current studies that have primarily used univariate analyses to examine associations between sexuality and smoking characteristics. We have advanced these studies by using different methods of multilevel modelling to address gaps in the literature. The use of SEM allowed us to examine factors that may mediate the relationship between sexuality and smoking heaviness, whilst also controlling and drawing comparisons between social class groups. Longitudinal multilevel analysis allowed us to examine the effects of time and space simultaneously. Finally, multivariate multilevel modelling enabled us to compare smoking with other co-behaviours rather than examining their effects independently. These methodologies have advanced sexuality research and given more insight into the associations between sexuality and smoking behaviours, rather than simply reporting prevalence and associations.

The methodology used throughout this thesis enables us to explore the effect of both compositional and contextual factors. Survey data gives varying degrees of information regarding spatial indicators, for example HSE has limited geospatial indicators due to the sample size, yet the nested structure of the data still allows for multilevel modelling to give information on variance at each level, and is still beneficial for obtaining correct standard errors. In addition, whilst we looked at only individual level variables in chapter five, the mediators of exposure to smoke and initiation of smoking link back to the literature review on composition versus context effects that shows social norms are intertwined with individual and environmental factors. BHPS and US allowed us to examine probability estimates of smoking and how these vary across LAs over time, and look at changes across LA types. The geographical variation of smoking behaviours in LGB populations has not been examined in GB previously, and this thesis provides greater insight into how place might impact smoking prevalence and affect smoking cessation rates. The use of multilevel models allow us to explore this whilst also controlling for other determinants of smoking, to gain a clearer picture of the geographical variations of smoking in sexual minority groups whilst considering the impact social class may have, which emerged from chapter five. The predicted probability that we calculated from the model was then grouped by type of LA, to determine if there are variations between urban metropolitan areas with rural type areas. Similarly, the residual variance explored in chapter seven also enabled us to examine differences by LA type for cannabis use amongst women. These techniques have advanced sexuality and smoking literature, by explaining the links better and enabling us to examine individual and environmental level associations.

A final contribution made by this thesis refers to the use of comparing different measures of sexuality, comparing sexual identity with sexual attraction. Due to the way sexuality is often addressed in health and social surveys, there have been limited opportunities for studies to compare sexuality measures and how these might vary for smoking and other health risk behaviours. Sexual identity is most commonly used in surveys such as HSE, US and other surveys that were discussed in chapter three. Surveys with a focus on sexuality might include different measures, including NATSAL and EMIS, which enables us to capture individuals who might not identify within LGB categories but might still experience non-heterosexual attraction or behaviours. Chapter seven used data from NATSAL to compare odds ratios for smoking and co-behaviours from sexual identity to sexual attraction as a measure for sexuality. Sexuality research using alternate measures of sexuality are limited, and no studies have compared whether one measure of sexuality might be greater associated with the likelihood of engaging in health risk behaviours.

8.4 Policy implications and future research

Current policies, whilst acknowledging that inequalities exist for sexual minority populations, do not currently include ways to reduce smoking prevalence or prevent initiation in these groups. The TCP aims by 2022 to reduce smoking in the population in England from 15% to 12%, and states that LAs should implement actions based on the inequalities within their populations (Department of Health, 2017). Chapter five of this thesis highlights the pathways to greater smoking in LGB individuals, with mental health being a clear driver of smoking inequalities compared to heterosexual individuals. Preventing initiation of smoking is key, and thus understanding why inequalities persist in sexual minority groups is imperative. The link between mental health and heavier smoking suggests that improving mental health services for LGB individuals is a key component in decreasing and preventing smoking rates for those who might use it as a coping mechanism. Though not directly supported in this thesis, other studies have found that LGB individuals are more likely to smoke earlier than heterosexual individuals (Fish et al., 2019b; Watson et al., 2018b), so therefore ensuring mental health is addressed in schools and universities for sexual minority populations is key.

The results from this thesis in chapter six highlights the inequalities between sexual minority men and sexual minority women, whereby women remain more vulnerable to greater smoking prevalence and might have been less affected by changing smoking policies targeting public spaces. LGB individuals in general had a higher likelihood of smoking than heterosexual individuals across GB, which has remained higher from 1991-2017. The TCP should consider the results of studies that highlight the inequalities across these groups, and implement specific policies that

have been shown to be effective in smoking cessation for LGB groups, such as LGB specific cessation and intervention programmes (Eliason et al., 2012; Matthews et al., 2013) and make use of LGB specific venues or events to promote anti-smoking public health messages.

The higher rates of engaging in other health risk behaviours such as cannabis use and risky alcohol behaviours have been suggested to be linked to mental health much like smoking behaviours in this population. The co-occurrence of smoking and alcohol and illicit substance use also demonstrate the importance of improving smoking cessation to deter hazardous alcohol use and co-consumption of cannabis (Conway et al., 2018). Again, age of initiation of cannabis use or alcohol intake has also been shown to be lower for sexual minority individuals compared to heterosexual individuals, and thus support for sexual minority groups should be better implemented in educational settings. The findings in this thesis and supported in other studies that inequalities in health risk behaviours is greater amongst sexual minority women suggests more is needed to provide support for this group in particular (Colledge et al., 2015; Robinson et al., 2016).

Further research could extend this thesis in a number of ways. Multilevel latent class analysis could be used to uncover subgroups of LGB individuals likely to engage in smoking behaviours or other health risk behaviours, and if the data allowed it, draw comparisons between sexual minority groups. Due to the risk of over-parameterisation of the models used in this thesis, interaction effects were not included except for in chapter five looking at the interaction between social class and sexuality. However, we did not find an effect between these groups, which may be related to the data used or small sample sizes, therefore future research could also look at the intersection between sexuality and class using other data sources, as these two populations have been found to be the most at risk for smoking and other health risk behaviours.

Due to data restrictions on the geographical areas included as part of the surveys used in this thesis, GB was used as the case study area rather than the UK. After we assessed the suitability of the surveys available for the research aims to be addressed in this thesis, only one of the surveys included the UK as a whole region, with HSE looking only at England due to the limitations on merging the SHS, and NATSAL using data only in GB. Whilst the BHPS/US included Northern Ireland, we decided to focus only on GB for two reasons, first to keep continuity within this thesis and use GB as a case study, with the exception of the first empirical chapter looking only at England. Secondly, Northern Ireland was not included as part of the US survey data from the beginning and was only included in later waves. The sample size was oversampled, and legislation with respect to sexuality have until recently differed from GB. Future research however could explore smoking or other health risk behaviour differences in Northern Ireland compared to the

rest of GB. As recent legislations have improved equality for LGB populations by legalising same sex marriage (Fairbairn, 2020), it would be interesting to determine whether in previous years the less inclusive policies relative to the rest of GB have led to greater smoking or other health risk behaviour inequalities, and whether these might decrease in the future. As Hatzenbuehler et al. (2009) found that supportive and pro-equality legislative states in the United States were associated with improved health outcomes, this could be an interesting way to compare other aspects of the environment that were beyond the scope of this thesis.

The scale of geography chosen for analysis in this thesis mainly reflects how the data were collected in each of the surveys, and also to visualise the change in smoking across GB. Whilst this was useful to capture smoking prevalence across GB which is necessary for understanding how smoking policies could vary in each LA, these may not be indicative of other aspects of social geographies which could impact smoking behaviour. Deprivation measures were not included due to data and variable availability, which may have impacted the interpretation of the results. In addition, using residential geographies may not reflect where individuals spend large amounts of time socialising, such as at work or in educational settings, which could be associated with engaging in health risk behaviours but is not captured by looking at geographies of where individuals live. Future research could look at other social geographies and how these may impact smoking behaviours and whether these vary by sexuality.

8.5 Concluding remarks

This thesis has addressed the gaps in sexuality and smoking research, by extending previous research that has shown an association between identifying as LGB and having higher prevalence rates of smoking and other health risk behaviours. Multilevel modelling was used throughout to endeavour to examine both the individual and environmental level factors implicated in the complex relationship between sexuality and smoking behaviour. The findings in this thesis could inform policy decisions on how to reduce inequalities in sexual minority populations.

Appendix A Extra information for surveys analysed in chapter 3

A.1 NATSAL

NATSAL			
Variable name	Question	Possible answers	Filter
SmokeNow	Do you ever smoke cigarettes at all nowadays?	Include roll-ups but exclude cigars 1. yes 2. no	
NoSmoke	About how many cigarettes a day do you usually smoke?	Enter number per day. If respondent can only give range, take the mid-point If respondent smokes roll-ups ask them to estimate the number of roll-ups If respondent says more at weekends than weekdays, take weekend number. If less than one a day, enter 0 Numeric: 0…97	If SmokeNow = yes
ExSmoke	Did you ever smoke cigarettes regularly, that is, at least one cigarette a day?	1. yes 2. no	If SmokeNow = no
DrugUse	Have you ever taken any of the drugs listed below? (please do not count any drugs you have injected)	Please type the numbers of all the drugs you have taken, but did not inject. If you have never taken drugs, type 11. 1. cannabis (marijuana, grass, hash, ganja, draw, skunk, weed, spliff) 2. amphetamines (speed, whizz, uppers, billy) 3. cocaine or coke (Charlie) 4. crack (rock, stones, white) 5. ecstasy (e)	

		6. heroin that was not injected (smack, skag, H, brown, gear, horse) 7. acid or LSD (tabs, trips) or magic mushrooms 8. crystal meth 9. amyl nitrates (poppers, liquid gold, rush) 10. other non prescribed drugs 11. none of these	
DrCan12m	Have you taken cannabis in the last 12 months?	1. yes 2. no	If DrugUse = cannabis
DrCan4w	Have you taken cannabis in the last 4 weeks?	1. yes 2. no	If DrCan12m = yes
Drg12m	You mentioned that you had taken (name of drug/s). have you taken (this drug/any of these drugs) in the last 12 months?	1. yes 2. no	If drugUse = amphetamines or druguse = cocaine of coke or druguse = crack or drug use = ecstasy or druguse = heroin or druguse = acid or LSD or druguse = crystal meth or druguse = amyl nitrates or druguse = other
Drg4k	Have you taken (this drug/any of these drugs) in the last 4 weeks?	1. yes 2. no	If Drg12m = yes
Inject2	Have you ever injected yourself with any non-prescribed drugs or other substances?	1. yes 2. no	
WhenInj	When was the last time you injected yourself with non-prescribed drugs or other substances?	1. in the last 7 days 2. between 7 days and 4 weeks ago 3. between 4 weeks and 1 year ago 4. over 1 year ago	If Inject2 = yes
InjAgLst	How old were you the last time you injected yourself with non-prescribed drugs or other substances?	1…74	If WhenInj= over 1 year ago
InjAgFst	How old were you the first time you injected non-	1…74	

	prescribed drugs or other substances?		
Needle	Have you ever shared a needle, or other equipment used for injecting, with someone else?	1. yes 2. no	
SexID	Which of the options on this card best describes how you think of yourself?	1. (R) heterosexual/straight 2. (H) gay/lesbian 3. (I) bisexual 4. (J) other	
AttScale	Now please read this card carefully as it is important that you understand it and are as honest as you can be in your answer. When you've finished reading, tell me which letter represents your answer.	I have felt sexually attracted.. 1. (k) only to (females/males), never to (males/females) 2. (c) more often to (females/males), and at least once to a (male/female) 3. (f) About equally often (females/males) and to (males/females) 4. (l) More often to (males/females), and at least once to a (female/male) 5. (d) only ever (males/females), never to (females/males) 6. (n) I have never felt sexually attracted to anyone at all 7. refused	
ExpScale	As before, please read this card carefully and be as honest as you can be in your answer. When you've finished reading, tell me which letter represents your answer.	Sexual experience is any kind of contact with another person that you felt was sexual (it could be just kissing or touching, or intercourse or any other form of sex). I have had some sexual experience.. 1. (R) only with (females/males), never with (males/females) 2. (Q) more often with (females/males), and at least once with a (male/female)	

		3. (T) About equally often with (females/males) and with (males/females) 4. (B) More often with (males/females), and at least once with a (female/male) 5. (Z) only with (males/females), never with a (females/males) 6. (W) I have never felt sexually attracted to anyone at all 7. refused	
EverSam	Have you ever had any kind of sexual experience or sexual contact with a (male/female)?	Please say 'yes' here even if it was a long time ago or did not involve contact with the (genital area/penis/vagina). 1. yes 2. no	
Drink	Do you ever drink alcohol nowadays?	If the respondent does not drink alcohol at the moment because she is pregnant then answer no 1. yes 2. no	
DrinkOft	How often have you had an alcoholic drink of any kind during the last 12 months?	1. five or more days a week 2. three or four days a week 3. once or twice a week 4. once or twice a month 5. once or twice in the last 12 months 6. not at all in the last 12 months	If Drink = yes
ManyAlc2	About how many units do you usually have on the days when you have any. Please don't count special occasions?	1. one or two 2. three or four 3. five or six 4. more than six 5. I only drink on special occasions 6. other answer	If DrinkOft = 1-4
DrinkNum	How often do you have (six/eight) or more units on one occasion?	1. never 2. less than monthly 3. monthly 4. weekly or 5 daily or almost daily	If drinkOft = 1-4

A.2 HSE

Health Survey for England 2013/14			
Variable name	Question	Possible answers	Filter
QualA	At what age did you finish your continuous full-time education at school or college?	1. not yet finished 2. never went to school 3. 14 or under 4. 15 5. 16 6. 17 7. 18 8. 19 or over	If age of respondent in 16+
Origin	What is your ethnic group?	1. white – English/Welsh/Scottish/Northern irish/British 2. White – Irish 3. White – Gypsy or Irish Traveller 4. any other white background (please describe) Mixed/multiple ethnic groups: 5. White and Black Caribbean 6. White and Black African 7. White and Asian 8. Any other mixed/multiple ethnic background (please describe) Asian/Asian British 9. Indian 10. Pakistani 11. Bangladeshi 12. Chinese 13. any other Asian background (please describe) Black/African/Caribbean/Black British 14. African 15. Caribbean 16. any other Black/African/Caribbean background any other ethnic group 17. Arab 18. any other ethnic group (please describe)	
Q39 (self-completion booklet)	Which of the following options best describes how you think of yourself?	1. heterosexual or straight 2. gay or lesbian 3. bisexual 4. other 5. prefer not to say	If adult or young adult self-completion booklet
SmokEver	May I just check, have you ever smoked a	Yes No	If age of respondent is 18 years or over OR bookchk = asked

	cigarette, a cigar or a pipe?		
smokeNow	Do you smoke cigarettes at all nowadays?	Yes no	If SmokEver = yes
DlySmoke	About how many cigarettes a day do you usually smoke on weekdays?	If less than one a day, enter 0. If range given and cant estimate, enter mid point. If respondent smokes rolls ups and cannot give number of cigaretes, code 97. Range 0…97	If SmokeNow = yes
WKndSmok	About how many cigarettes a day do you usually smoke at weekends?	If less than one a day, enter 0. If range given and cant estimate, enter mid point. If respondent smokes rolls ups and cannot give number of cigaretes, code 97. Range 0…97	
SmNoDay	How easy or difficult would you find it to go without smoking for a whole day? Would you find it	1. very easy 2. fairly easy 3. fairly difficult 4. or very difficult	If SmokeNow = yes
FirstCig	How soon after waking do you usually smoke your first cigarette of the day?	1. less than 5 minutes 2. 5-14 minutes 3. 15-29 minutes 4. 30 minutes but less than 1 hour 5. 1 hour but less than 2 hours 6. 2 hours or more	
SmYrAgo	Would you say that you are smoking about the same number of cigarettes as a year ago, or more than a year ago or fewer than a year ago?	1. same as a year ago 2. more than a year ago 3. fewer than a year ago	
SmokeCig	Have you ever smoked cigarettes?	1. yes 2. no	If SmokeNow<> Yes (smoked but doesn't smoke cigarettes nowadays?)
StartSmk	How old were you when you started to smoke cigarettes regularly?	If never smoked regularly code 97 Range 1..97	If SmokeNow = yes OR SmokeReg = smoked cigarettes regularly
ExpSm	Now, in most weeks, how many hours a week are (you/name of child) exposed to other peoples tobacco smoke?	If exposed for some time but less than one hour enter 1, otherwise record to the nearest hour. Range 0…168	If age 0-12 or age >=18 and bookchk =1
Passive	Are you regularly exposed to other peoples tobacco	1. at own home 2. at work 3. in other peoples homes 4. travelling by car/van	If age >=18

	smoke in any of these places?	5. outdoor smoking areas of pubs/restaurants/cafes 6. in other places 7. no, none of these	
Drink	I am now going to ask you a few questions about what you drink – that is if you drink. Do you ever drink alcohol nowadays?	1. yes 2. no	If Age of respondent is 25 year or over OR bookChk = asked
DrinkOft	Thinking now about all kinds of drinks, how often have you had an alcoholic drink of any kind during the last 12 months?	1. almost every day 2. five or six days a week 3. three or four days a week 4. once or twice a week 5. once or twice a month 6. once every couple of months 7. once or twice a year 8. not at all in the last 12 months	If Drink = Yes OR DrinkAny = very occasionally
DrinkL7	Did you have an alcoholic drink in the seven days ending yesterday?	1. yes 2. no	If DrinkOft <> Not at all in the last 12 months
DrnkDay	On how many days out of the last seven did you have an alcoholic drink	Range: 1….7	If DrinkL7 = yes
DrnkSame	Did you drink more on *one of the days/some days than others*, or did you drink about the same on *both/each of those* days?	1. drank more on one/some day(s) than other(s) 2. same each day	If DrnkDay = 2 to 7 days
DrAmount	Compared to five years ago, would you say that on the whole you drink more, about the same of less nowadays?	1. more nowadays 2. about the same 3. less nowadays	
NBeer	Id like to ask you first about normal strength beer, lager, stout, cider or shandy which has less than 6% alcohol. How often have you had a drink of normal strength beer, lager, stout cider or shandy (excluding cans and bottles of	1. almost every day 2. five or six days a week 3. three or four days a week 4. once or twice a week 5. once or twice a month 6. once every couple of months 7. once or twice a year 8. not at all in last 12 months	

	shandy) during the last 12 months? (normal = less than 6% alcohol by volume)		
SBeer	Now id like to ask you about strong beer or cider which has 6% or more alcohol (e.g. Tennants extra, Special Brew, Diamond White). How often have you had a drink of strong beer, lager, stout or cider during the last 12 months? Strong = 6% and over alcohol by volume.	1. almost every day 2. five or six days a week 3. three or four days a week 4. once or twice a week 5. once or twice a month 6. once every couple of months 7. once or twice a year 8. not at all in last 12 months	If Drinknow = 1 or DrinkAny =1
Spirits	How often have you had a drink of spirits or liquers such as gin, whiskey, brandy, rum, vodka, advocaat or cocktails during the last 12 months?	1. almost every day 2. five or six days a week 3. three or four days a week 4. once or twice a week 5. once or twice a month 6. once every couple of months 7. once or twice a year 8. not at all in last 12 months	If Drinknow = 1 or DrinkAny = 1
Sherry	How often have you had a drink of sherry or martini including port, vermouth, Cinzano and Dubonnet, during the last 12 months?	1. almost every day 2. five or six days a week 3. three or four days a week 4. once or twice a week 5. once or twice a month 6. once every couple of months 7. once or twice a year 8. not at all in last 12 months	If Drinknow = 1 or DrinkAny = 1
Wine	How often have you had a drink of wine including Babycham and champagne, during the last 12 months?	1. almost every day 2. five or six days a week 3. three or four days a week 4. once or twice a week 5. once or twice a month 6. once every couple of months 7. once or twice a year 8. not at all in last 12 months	If Drinknow = 1 or DrinkAny = 1
Pops	How often have you had a drink of alchopops (i.e. alcoholic lemonade, alcoholic colas or other alcoholic fruit-or-herb flavoured drinks for e.g. Smirnoff ice, Bacardi	1. almost every day 2. five or six days a week 3. three or four days a week 4. once or twice a week 5. once or twice a month 6. once every couple of months 7. once or twice a year 8. not at all in last 12 months	If Drinknow = 1 or DrinkAny = 1

	Breezer, WKD, Metz etc) during the last 12 months?		

A.3 SHS

Scottish Health Survey 2013/14			
Variable name	Question	Possible answers	Filters
Sexual orientation (SXORIEN)	Which of the following options best describes how you think of yourself?	(1) Heterosexual or straight (2) Gay or lesbian (3) Bisexual (4) Other	Everyone asked
Smoking (SmokeEv)	May I just check, have you ever smoked a cigarette, a cigar or a pipe?	Code all that apply: (1) Yes: cigarette (2) Yes: cigars (3) Yes: pipe (4) No	All 20+ asked and some 18-19
Smoke ever (SmokEver)	Have you ever smoked a cigarette, a cigar or a pipe?	Yes No	If any smokeEv are yes then ask, if no to cigarettes for SmokeEv the do not ask
SmokeNow	Do you smoke cigarettes nowdays?	Yes No	If SmokEver =yes
DlySmoke	About how many cigarettes a day do you usually smoke on weekdays?	If respondent can only give range, take mid point. If less than one enter 0. If smokes roll ups and cannot give cigarette number code 97. Range 0..97	If SmokeNow =yes
DlyEst	How much tobacco do you usually smoke on weekdays?	Code here whether the amount is to be coded in grams or ounces. Enter the amount at the next question: Grams Ounces	If DlySmoke = 97

WkndSmok	And about how many cigarettes a day do you usually smoke at weekends?	If respondent can only give range, take mid point. If less than one enter 0. If smokes roll ups and cannot give cigarette number code 97.	If SmokeNow = Yes
WkndEst	How much tobacco do you usually smoke on weekends?	Code here whether the amount is to be coded in grams or ounces. Enter the amount at the next questions Grams Ounces	If WkendSmok = 97
StartSmk	How old were you when you started to smoke cigarettes regularly?	If never smoked regularly code 97. range 0….97	If SmokeNow = Yes OR SmokeReg = smoked cigarettes regularly
Passive	Are you regularly exposed to other people's tobacco smoke in any of these places? Probe: where else? Interview: if asked: only include current exposure to other peoples tobacco	1. at own home 2. at work 3. in other peoples homes 4. in cars, vans etc 5. outside of buildings (e.g. pubs, shops, hospitals) 6. in other public places 7. no none of these	Ask all – age range extended to all (0+) in 2012
Drink	I am now going to ask you a few questions about what you drink – that is if you drink. Do you ever drink alcohol nowadays, including drinks you brew or make at home?	1. yes 2. no	
Nbeer	Id like to ask you first about normal strength beer or cider which has less than 6% alcohol. How often have you had a drink	1. almost every day 2. five or six days a week 3. three or four days a week 4. once or twice a week	Ask all 18/20+ who drink alcohol if drink = yes or drinkAny = very occasionally

	of normal strength beer, lager, stout, cider or shandy (excluding cans and bottles of shandy) during the last 12 months? (normal = less than 6% alcohol by volume)	5. once or twice a month 6. once every couple of months 7. once or twice a year 8. not at all in the last 12 months	
Sbeer	Now id like to ask you about strong beer or cider which has 6% or more alcohol (e.g. Tennants extra, Special Brew). How often have you had a drink of strong beer, lager, stout or cider during the last 12 months? Strong = 6% and over alcohol by volume.	1. almost every day 2. five or six days a week 3. three or four days a week 4. once or twice a week 5. once or twice a month 6. once every couple of months 7. once or twice a year 8. not at all in the last 12 months	Ask all 18/20+ who drink alcohol if drink = yes or DrinkAny = very occasionally
Spirits	How often have you had a drink of spirits or liqueurs, such as gin, whiskey, brandy, rum, vodka, advocaat or cocktails during the last 12 months?	1. almost every day 2. five or six days a week 3. three or four days a week 4. once or twice a week 5. once or twice a month 6. once every couple of months 7. once or twice a year 8. not at all in the last 12 months	
Sherry	How often have you had a drink of sherry or martini including port, vermouth, Cinzano and Dubonnet, during the last 12 months?	1. almost every day 2. five or six days a week 3. three or four days a week 4. once or twice a week 5. once or twice a month 6. once every couple of months	

		7. once or twice a year 8. not at all in last 12 months	
	How often have you had a drink of wine including Babycham and champagne, during the last 12 months?		
	How often have you had a drink of alcoholic soft drink (alcopop) or a pre-mixed alcoholic drink such as WKD, Smirnoff ice, Bacardi breezer etc in the last 12 months?	1. almost every day 2. five or six days a week 3. three or four days a week 4. once or twice a week 5. once or twice a month 6. once every couple of months 7. once or twice a year 8. not at all in last 12 months	
	Thinking now about all kinds of drinks, how often have you had an alcoholic drink of any kind during the last 12 months?	1. almost every day 2. five or six days a week 3. three or four days a week 4. once or twice a week 5. once or twice a month 6. once every couple of months 7. once or twice a year 8. not at all in last 12 months	
	You have told me what you have drunk over the last 12 months, but we know that what people drink can vary a lot from week to week. Did you have an alcoholic drink in the seven days ending yesterday?	1. yes 2. no	

DrnkDay	On how many days out of the last seven did you have an alcoholic drink?	Range: 1…7	
DrWher1	In which of these places would you say you drink the most alcohol?	1. in a pub or bar 2. in a restaurant 3. in a club or disco 4. at a party with friends 5. at my home 6. at someone elses home 7. out on the street, in a park or other outdoor area 8. somewhere else (write in)	
	Who are you usually with when you drink the most alcohol?	1. my husband or wife/boyfriend or girlfriend/partner 2. male friends 3. female friends 4. male and female friends together 5. work colleagues 6. members of my family/relatives 7. someone else (write in) 8. on my own	
EducEnd	At what age did you finish your continuous full-time education at school or college?	1. not yet finished 2. never went to school 3. 14 or under 4. 15 5. 16 6. 17 7. 18 8.19 or over	
Ethnic12	What is your ethnic group?	1 A-White: Scottish 2. A-White: Other british 3. A-White: Irish	

		4. A-White: Gypsy/Traveller 5. A-White: Polish 9. A-White: Other 10. B-Mixed: any mixed or multiple ethnic groups 11. C-Asian: Pakistani, Pakistani Scottish or Pakistani British 12. C-Asian: Indian, Indian Scottish or Indian British 13. C-Asian: Bangladeshi, Bangladeshi Scottish or Bangladeshi British 14. C-Asian: Chinese, Chinese Scottish or Chinese British 15. C-Asian: other 16. D-African: African, African Scottish or African British 17. D-African other 17. E- Caribbean or Black: Caribbean Scottish, or Caribbean British 18. E- Caribbean or Black: Black, Black Scottish or Black British 19. E-Caribbean or Black: other 20. F-Other ethnic group: Arab, Arab Scottish, Arab British 21. F-Other ethnic group: other	
Self completion booklet for adults			

DXOFT	How often do you have a drink containing alcohol?	1. never 2. monthly or less 3. 2-4 times a month 4. 2-3 times a week 5. 4 or more times a week	
DXNUM	How many drinks containing alcohol do you have on a typical day when you are drinking?	1. 1 or 2 2. 3 or 4 3. 5 or 6 4. 7 to 9 5. 10 or more	If DXOFT – 2…5
DXBINGE	How often do you have six or more drinks on one occasion?	1. never 2. less than monthly 3. monthly 4. weekly 5. daily or almost daily	If DXOFT – 2…5
DXNSTOP	How often during the last year have you found that you were not able to stop drinking once you had started?	1. never 2. less than monthly 3. monthly 4. weekly 5. daily or almost daily	If DXOFT – 2…5
DRUNK1	I have been drunk at least once a week, on average, in the last three weeks	1. yes 2. no	If DXOFT – 2…5

A.4 BHPS/US

BHPS/US			
Variables			

Highest qualification	Can you tell me the highest educational or school qualification you have obtained?	(1) University Higher Degree (e.g. MSc, PhD) (2) First degree level qualification including foundation degrees, graduate membership of a professional institute, PGCE (3) Diploma in higher education (4) Teaching qualification (excluding PGCE) (5) Nursing or other medical qualification not yet mentioned (6) A level (7) Welsh Baccalaureate (8) International Baccalaureate (9) AS level (10) Higher grade/advanced higher (Scotland (11) Certificate of sixth year studies (12) GCSE/O level (13) CSE (14) Standard/Ordinary (O) Grade/ Lower (Scotland) (15) Other school (inc. school leaving exam certificate or matriculation) None of the above	If new entrant never interviewed
Ethnic group	What is your ethnic group?	(1) British/English/Scottish/Welsh/Northern Irish (2) Irish (3) Gypsy or Irish Traveller (4) Any other White background (5) White and Black Caribbean (6) White and Black African (7) White and Asian (8) Any other mixed background (9) Indian (10) Pakistani (11) Bangladeshi (12) Chinese (13) Any other Asian background (14) Caribbean (15) African (16) Any other Black background (17) Arab (97) Any other ethnic group	If new entrant never interviewed AND mode is face-to-face
Sexual orientation US only	Which of the following options best describes how you think of yourself?	(1) Heterosexual (2) Gay or lesbian (3) Bisexual (4) Other Prefer not to say	**WAVE 3** if mode is face-to-face and has agreed to self-completion **WAVE 5** If mode is face-to-face or telephone or web and has agreed to self-

			completion and if aged 16-21
Ever smoke cigarettes at all US only	Do you ever smoke cigarettes at all?	(1) Yes no	**WAVE 3** If mode is face-to-face and respondent has agreed to self-completion and if aged 16-21 **WAVE 5** If mode is face-to-face and respondent has agreed to self-completion
Smoke cigarettes now	Do you smoke cigarettes at all nowadays?	(1) yes (2) no	If smever =(1)
Usual no. of cigarettes smoked per day US only	Approximately how many cigarettes a day do you usually smoke including those you roll yourself?	ENTER NUMBER PER DAY	If smever =(1) AND smnow =(1)
Age when first stated smoking US only	How old were you when you first started to smoke cigarettes regularly?	IF NEVER SMOKED CIGARETTES REGULARLY, ENTER 0 TYPE IN AGE	If smever =(1)
Frequency of smoking US only	Please read the statements below and select the statement that describes you best	(1) I have smoked only once or twice (2) I used to smoke but I don't now (3) I sometimes smoke but not every week (4) I usually smoke between one and six cigarettes a week I usually smoke more than six cigarettes a week	If mode is face-to-face and respondent has agreed to self-completion and if aged 16-21

A.5 EMIS

EMIS		
About where you live	How would you describe the place you live in?	(1) A very big city or town (a million or more people) (2) A big city or town (500,000-999,999 people) (3) A medium sized city or town (100,000-499,999 people) (4) A small city or town (10,00-99,999 people)

		(5) A village/the countryside (less than 10,000 people)
Sexually attracted to	Who are you sexually attracted to?	(1) Only men (2) Mostly to men and sometimes to women (3) Both to men and women equally (4) Mostly to women and sometimes to men (5) Only to women
Sexual identity	Which of the following options best describes how you think of yourself?	(1) Gay or homosexual (2) Bisexual (3) Straight or heterosexual (4) Any other term (5) I don't usually use a term
Last time consumed alcohol	When was the last time you consumed alcohol?	(1) Never (2) Within the last 24 hours (3) Within the last 7 days (4) Within the last 4 weeks (5) Within the last 6 months (6) Within the last 12 months (7) Within the last 5 years (8) More than 5 years ago
Last time consumed tobacco products	When was the last time you consumed tobacco products?	(1) Never (2) Within the last 24 hours (3) Within the last 7 days (4) Within the last 4 weeks (5) Within the last 6 months (6) Within the last 12 months (7) Within the last 5 years (8) More than 5 years ago
Other drugs	Have you EVER taken any other recreational or illicit drugs?	(1) No (2) Yes

Appendix B Special Licence Access form

UK Data Service

Special Licence

Institute for Social and Economic Research

~~Public~~

21 February 2017
Version: 06.00

T +44 (0)1206 872143

E help@ukdataservice.ac.uk

ukdataservice.ac.uk

Definitions

- Licence holder – the licence holder specified in section 1
- Data depositor – Institute for Social and Economic Research
- Data – the collections detailed in section 7
- Dispute arbitrator – ESRC

Researcher application form - Your details

Surname	Davies
First name(s)	Megan
Institution/Organisation	University of Southampton
Institution/Organisation Address	University of Southampton, Highfield Campus, Southampton, SO17 1BJ
Telephone No.	07415782431
Email:	m.davies@soton.ac.uk
UK Data Service Project Number:	108934

Research team

Please list the names of all member(s) of your research team who **need access** to the data and their contact email address. Note: each person listed below will need to complete their own form.

Name	**Email address**
Megan Davies	m.davies@soton.ac.uk
Nathaniel Lewis	N.M.lewis@soton.ac.uk
Graham Moon	G.Moon@soton.ac.uk

Location

Please state the site of access. Include the address of where the data will be **accessed and stored**, including your organisation/institution name:

University of Southampton, Highfield Campus, Building 44

If the location is different to the organisation/institution specified in your registration details, please state the reasons in the box below:

Title of the research proposal

Determinants of smoking and substance use behaviours in LGB populations across the UK

Abstract of the research proposal

Please include a short description of the project and its benefits.

My PhD looks at smoking behaviours and substance use in lesbian, gay and bisexual (LGB) populations in the UK compared to heterosexual. Disparities in health inequalities and behaviours LGB and heterosexual populations have been widely reported. Previous research has identified that LGB populations have higher rates of smoking and drug use in comparison to their heterosexual counterparts, yet little is known why these inequalities exist. The aim of this

project is to explore factors that may contribute to smoking behaviours and substance use in LGB populations across the UK. Previous research has looked at individual factors, such as stress and mental health issues, and geographical and environmental factors distinctly. Using multilevel modelling techniques to explore spatial variances in the UK, this project will explore both individual and environmental factors that may be implicated in different rates of smoking and drug use consumption.

Details of the research proposal

Please provide a full and detailed description of the purpose for which the data are requested, describing the aims of the study/research. Where research is part of a larger programme, please include details below.

This research aims to explore the link between sexual orientation and higher rates of smoking and substance use. Using multilevel modelling techniques, this research aims to explore changes in smoking behaviours through time using different waves of Understanding Society, and through geographic location. This research is part of a larger thesis that is looking at smoking and substance use in LGB populations through different methods using both cross-sectional and panel surveys. This particular project is the next phase after exploring differences in smoking rates in LGB populations compared to heterosexual, and other individual level factors that may contribute to higher rates.

Data required

Title(s) and study number(s) of datasets

Understanding Society waves 1-7, 2009-2016: Special Licence Access, Local Authority District

Justification

Please provide a justification as to why you are requesting access to these data. You should include:

- An explanation as to why you require these data, including information about specific variables or questions of interest and how you'll use these in your research

- An explanation demonstrating that you have considered alternative sources of data, and reasons why these data are not sufficient for your research

IMPORTANT: when applying for social survey data, we strongly recommend that you consider using less restrictive versions of the data that are available. Please visit ukdataservice.ac.uk and use the Discover search function to locate less restrictive sources.

Special licence access is required for these data for finer geographic details, to allow for the exploration of place-specific effects and differences across the UK. The end user version of this data does not provide finer geographic information, which limits the opportunity to explore variances in smoking rates across the UK at different waves of the survey.

Does your project proposal include any linking of data sources?

If yes, please provide the following details below:

- A description of the data source(s) to be linked to the data;
- A summary of the key variables;
- A summary of the linking methodology;
- Justification for the linking.

The project proposes to link together the British Household Panel Survey and Understanding society, to trace back participants and look at smoking rates.

Duration of access

Please indicate how long access to data is likely to be required:

The data is likely to be required for six months

Outputs

Details of the products/outputs that will be produced from your use of the data (e.g. analysis, reports, tables, books):

The outputs of the data will be used for analysis as part of a PhD research project, and will be written up as a paper by the three researchers.

Protection of confidentiality in outputs

Describe the methods you will use to determine whether the outputs listed in Section 10 above are disclosive and the measures you will use to protect confidentiality in those outputs.

Methods and standards specified in the Microdata Handling and Security Guide to Good Practice and GSS Statistical Disclosure Control for tables produced from surveys must be applied to statistical outputs.

The data will be accessed via a password protected computer in an access controlled organisational environment only. Data will be discussed only with supervisors. Data will be analysed using Mplus or MLwiN and prepared using SPSS, on a secure network and private computer used for research purposes only. Any outputs produced will be stored on the same password protected computer, and printed copies will be stored in secure physical conditions, in a locked drawer with private use in a research office. Statistical outputs will follow GSS Statistical Disclosure Control guidelines. Data will be deleted after completion of the project, in line with the Microdata Handling and Security Guide to Good Practice document.

Funding

Is your research being funded? YES

If Yes, has funding been obtained: YES

If yes, which organisation/institution is funding the research?

Name of organisation
ESRC Southampton DTP

Declaration

The data to which this Licence permits access are made available under 'Special Conditions', as specified in section 5 of the End User Licence (EUL). Access to the data is conditional upon signing this Declaration.

The licence holder:

- has read and will abide by the Microdata Handling and Security: Guide to Good Practice;
- will take all necessary administrative, technical and organisational measures to ensure that the data are used only in the manner stated and for the proposal specified;
- confirms that access to the data is required in order to meet the aims of the proposal and that the access is proportionate and not excessive to the stated purpose;
- will not process, disseminate or otherwise allow any of the data to be made available or used for any other purpose whatsoever and will remain bound by this obligation once the period of access has expired;
- guarantees that none of these data will be distributed to third parties;
- guarantees that any duplication of the data will only be for the purpose of making personal copies to aid their own research and analysis for the proposal specified;
- will not attempt to use these data after the period of access has expired;
- will not attempt to identify by any means whatsoever, any individual, household or organisation in the data , nor will the licence holder claim to have done so;
- will comply with the data security requirements in the Microdata Handling and Security: Guide to Good Practice;
- guarantees that the prime focus for accessing the data is for research purposes and not for the purpose of personal or commercial gain;
- guarantees that any outputs made available to anyone other than those named on the Licence (who must also have signed this Declaration), will meet required standards, including the guarantee, methods and standards contained in the Code of Practice for Official Statistics and the ONS Statistical Disclosure Control for tables produced from surveys;
- will apply methods and standards specified in the Microdata Handling and Security Guide to Good Practice for disclosure control for statistical outputs;
- will supply to the UK Data Archive the bibliographic details of any published work based wholly or in part on the data collection/s accessed. Details are to be provided on publication;
- Any plans to match or attempt to match individual or household records to any other data source at the level of the individual or household must be declared and can only be undertaken with the permission of the data depositor and the owners of the data sources;
- where the data depositor so requires, must supply a copy of any proposed publication, based wholly or in part on the data collections accessed, to enable the data depositor to consider it and comment as regards compliance with the conditions for disclosure protection and will make any [reasonable] changes that are required by the data depositor in order to make the proposed publication comply with these conditions;
- will, at the end of the access period, destroy all copies of the data, including temporary copies, CDs, printed copies, personal copies, back-ups, derived datasets and all electronic copies;
- will ensure that the data are destroyed to the standards specified in the Microdata Handling and Security: Guide to Good Practice;
- will, at the end of the access period, sign and send to the UK Data Archive a declaration to confirm that all copies of the data have been destroyed and to the required standards;
- will report promptly non-compliance with any of the terms of this Licence;
- confirms the accuracy of any information provided to support this application;
- will abide by any other requirements made by the UK Data Archive relating to this use of data;
- understands that the principles of the Freedom of Information Act apply and nothing provided in this Licence is confidential to the licence holder or to the data depositor. To disclose the details of the Licence would not be a breach of any duty of confidence and therefore the details would be made available to the public on request.

Data requested under the Special Licence will only be accessed at a site that has security standards that meet the requirements outlined in the document *Microdata Handling and Security: Guide to Good Practice*.

Data can be accessed at a location outside the UK.

Additional conditions of access specified by the depositor

NON-COMPLIANCE PROCEDURES

Any non-compliance with any of the provisions of this Licence will result in the immediate termination of the licence holder's access to the data, the termination of the licence and the prohibition of any further access to the data depositor's data via the Special Licence. It will also lead to immediate termination of the services provided by the UK Data Archive data team, either permanently or temporarily (as stated in section 16 of the EUL). The Licence Holder's institution will be informed of non-compliance.

Non-compliance with any of the provisions of this Licence may result in sanctions being sought against the licence holder. These may include legal proceedings being taken by the data depositor for breach of obligations under statute or common law.

DISPUTE PROCEDURES

Any disputes arising from the use of the data and/or the terms of this licence will be resolved initially between the UK Data Archive, on behalf of the University of Essex and the Licence Holder. Otherwise, outstanding issues will be referred to the dispute arbitrator.

Licence holder signature

I have read, understood and will abide by (you must tick all three boxes):

☒ any and all terms and conditions of this Declaration

☒ any additional conditions of access specified by the depositor and shown above

☒ the Microdata Handling and Security: Guide to Good Practice

Name	Signature	Date
Megan Davies		3/1/18

Appendix C Email correspondence regarding Local Authority data for NATSAL

Thanks Megan.

Attached are 2 Stata data files, one saved in the latest version (15) and the other, an older version of Stata. If you use SPSS then I think both can be opened in SPSS even though they're .dta files. Each contain: 'sin2', 'laname' and 'lacode' (as I'm not sure which will be most useful to you) and you can use 'sin2' to merge into the version of the dataset you have from the UK Data Service.

Given the number of participants in some LAs is very small then you must be mindful of the potential for deductive disclosure. Also, please follow standard protocol and not report estimates for sub-groups where there are fewer than 30 participants, and add a note of caution where there are less than 50 participants.

Do let me know how you get on as I'd be interested to hear about findings. What are the timelines for this work?

Best wishes
Cath

From: Davies M. <M.Davies@soton.ac.uk>
Sent: 28 August 2018 14:59
To: Mercer, Cath
Cc: Lewis N.M. <N.M.Lewis@soton.ac.uk>
Subject: Re: Your UKDS application for secure access to Natsal

Hi Cath,

I have downloaded the Natsal-3 dataset to my computer and have just cancelled my request for secure access.

Many thanks,

Megan

From: "Mercer, Cath"
Date: Tuesday, 28 August 2018 14:42
To: Megan Davies <m.davies@soton.ac.uk>
Cc: "Lewis N.M." <N.M.Lewis@soton.ac.uk>
Subject: RE: Your UKDS application for secure access to Natsal

No problem Megan.

I guess the next step is for you to request 'regular' access to the Natsal-3 dataset on the UK Data Service. Please will you also cancel your secure request?

BW
Cath

Appendix C

From: Davies M. <M.Davies@soton.ac.uk>
Sent: 28 August 2018 14:34
To: Mercer, Cath
Cc: Lewis N.M. <N.M.Lewis@soton.ac.uk>
Subject: Re: Your UKDS application for secure access to Natsal

Hi Cath,

Thank you for your reply.

I should have clearer about the two level analysis sorry, I only need one geographical level, as level one is the participant in the data set and level two is the local authority. Hope that makes sense.

Brilliant, that sounds great, thank you for being so helpful.

Many thanks,

Megan

From: "Mercer, Cath"
Date: Tuesday, 28 August 2018 14:07
To: Megan Davies <m.davies@soton.ac.uk>
Cc: "Lewis N.M." <N.M.Lewis@soton.ac.uk>
Subject: RE: Your UKDS application for secure access to Natsal

Hi Megan

Sorry for not responding sooner but I've been away.

Thanks for your email and for explaining more about your project. So, you're needing 2 geographical levels for your multilevel analysis – local authority and…?

There's data on the local authority of each participant in the original version of the dataset. So, to speed things up, if you download the version of the Natsal-3 dataset routinely-available from the UK Data Service (vs. requesting secure access) then I'll just send you a separate Stata data file containing the participant's local authority code and the other geographical identifier, together with their serial number, so you can just merge in the first two to your dataset using the serial number as the link. How does that sound?

Best wishes
Cath

Appendix D Sexuality cross tab for chapter 7

	Sexual attraction			
Sexual identity	Opposite sex only	More often opposite sex, and at least once same sex	About equally often to opposite sex and same sex	Mostly same sex
Women				
Heterosexual	7611	823	38	17
Gay/lesbian	0	3	9	80
Bisexual	5	76	65	12
Men				
Heterosexual	5732	247	19	12
Gay	0	1	1	118
Bisexual	7	22	26	12

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