



**Cardiovascular disease in sub-Saharan African prisons: A scoping review.**

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## Abstract

**Purpose:** The dual epidemic of noncommunicable diseases (NCDs) and human immunodeficiency virus (HIV) in sub-Saharan Africa has increased substantially in recent years, with cardiovascular disease representing a significant contributor to the regional burden of disease. Very little is known about the cardiovascular health of people deprived of their liberty in the region.

**Design/Methodology/Approach:** A scoping review mapped and described what is known about cardiovascular disease in prison populations in sub-Saharan Africa. A systematic search of empirical literature with no date limitation was conducted in English. Sixteen studies representing six sub-Saharan African countries (Cameroon, Nigeria, Guinea, Burkina Faso, Ghana, Ethiopia) were charted, categorised and thematically analysed.

**Findings:** Seven key themes were identified; *Custodial deaths and autopsy*; *Cardiorespiratory fitness and exercise*; *Cardiovascular disease and elderly people in prison*; *Cardiovascular disease and women in prison*; *Dietary deficiencies*; *Influence of sleep patterns on cardiovascular disease*; and *Other associated risk factors*. Most natural deaths at autopsy of custodial deaths were due to cardiovascular disease. Cardiorespiratory fitness was low in prisons, and poor sleep patterns and dietary deficiencies are likely contributors to the burden of cardio-vascular disease in prisons. The needs of elderly and female prison populations are ill considered.

**Originality:** This is the first known attempt to scope extant literature on cardiovascular disease in sub-Saharan African prisons. A strategic focus on cardiovascular health of people in prison is warranted. Routine monitoring and expansion of existing prison healthcare services, and integration of NCD services with infectious disease (HIV, tuberculosis) programmes in prisons are required.

**Key words:** Prison, detention, people in prison, non-communicable disease, cardiovascular disease, sub-Saharan Africa.

## Background

The global burden of non-communicable diseases (NCDs) continues to increase, accounting for an estimated 41 million deaths annually, equivalent to 71% of all deaths globally (World Health Organisation, 2021). Cardiovascular disease accounts for the majority of NCD related deaths (estimated 17.9 million per year globally), followed by cancers (9.3 million), respiratory diseases (4.1 million), and diabetes (1.5 million) (World Health Organisation, 2021). Chronic long term NCD conditions are a growing challenge to healthcare systems worldwide (Adler et al., 2015; NCD Countdown 2030 Collaborators, 2020) but particularly in low- and middle-income countries (LMICs) where the majority of premature deaths (82%) occur (Allen et al., 2017). Cardiovascular disease, in the form of coronary heart disease and cerebrovascular accidents, is common in those under 70 years of age in LMICs (Yeats et al., 2015).

Sub Saharan Africa is experiencing a dual burden of chronic human immune-deficiency virus (HIV) and NCDs. Integration of HIV chronic care management pathways, resources and infrastructure, and newly developing NCD services is now being advocated for in the region (Jaffar et al., 2021). Efforts to generate evidence to inform health policy and coordinate NCD care programmes alongside HIV services (traditionally provided vertically) are developing in the region (Katende et al., 2015; Manne-Goehler et al., 2016; Jaffar, 2016; Lupafya et al., 2016; Jaffar & Gill, 2017; Price et al., 2018; Adeyemi et al., 2021). Increased urbanisation in the region, poor lifestyle (inadequate nutrition and sedentary behaviours) and poverty affect both HIV and NCD rates, and related chronic ill-health and multi-morbidity (Addo et al., 2007; Chang et al., 2019; George et al., 2019; Achwoka et al., 2019; Achwoka et al., 2020; Shiri et al., 2021). Women are also disproportionately affected and NCDs are the leading cause of death and disability-adjusted life years for women older than 50 years in the region (Ibrahim & Damasceno, 2012; McCombe et al., 2021; UNAIDS, 2021; Cheza et al., 2021; UNAIDS, 2021; NCD Alliance, 2022).

Over one million people are deprived of their liberty in the 53 African states (outside of the unknown figures from Somalia and Eritrea), and with on average 42% held in pre-trial detention (World Prison Brief-Africa, 2022). Prison systems are ill resourced, and due to dated infrastructure, poor environmental determinants of health, and severe congestion constitute high-risk environments for

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3 communicable disease outbreaks (Todrys et al., 2011; Telisinghe et al., 2016; Amon, 2020; Muntingh,  
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5 2020; Nweze et al., 2020; Van Hout, 2020a; 2020b). Continuity of care spanning prison and community  
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7 remains underdeveloped and ill-resourced (Van Hout, 2022). Despite the recognition that people living  
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9 in prisons in Africa suffer chronic ill-health and hindered access to adequate healthcare (Van Hout &  
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11 Mhlanga-Gunda, 2018; Van Hout & Mhlanga-Gunda, 2019a; Van Hout & Mhlanga-Gunda, 2019b;  
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13 Van Hout, 2022), the bulk of surveillance has focused on communicable diseases such as HIV,  
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15 tuberculosis and COVID-19. Prison health research remains under-developed due to political  
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17 sensitivities, securitisation and structural barriers to access (Ako et al., 2020; Mhlanga-Gunda et al.,  
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19 2020).

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22 Disadvantaged sectors of society are overrepresented in the most prison systems (Plugge et al.,  
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24 2014), and therefore it is likely that NCDs are more common among people who live in prison than in  
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26 the general population (Herbert et al, 2012). The prison environment, regime and ethos can affect  
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28 exposure to risk factors for NCDs (Herbert et al., 2021, Farhoudi et al., 2020). People living in prisons  
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30 have a higher prevalence of chronic medical conditions when compared to the general population,  
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32 including diabetes mellitus, hyper-tension, and asthma (Binswanger et al., 2009, Wang et al, 2013,  
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34 World Health Organisation, 2022a; World Health Organisation, 2022b). Greater exposure to known  
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36 risk factors such as smoking and physical inactivity, compounded by other factors such as dietary  
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38 deficiencies and stress are contributing factors (Agyapong et al., 2013). The bulk of information on  
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40 NCDs in prison populations comes from high-income countries despite the domestic burden of disease  
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42 in LMICs (Plugge et al., 2014). A recent overview of the literature on inequities related to cancer and  
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44 cardiovascular disease in prison settings conducted by the World Health Organization-Europe  
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46 highlighted the importance of this area and areas for action but also identified considerable evidence  
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48 gaps (World Health Organisation, 2022a).

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51 Very little is known about levels or characteristics of NCDs in people are deprived of their  
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53 liberty or the prison health response to NCD detection, treatment and care in sub Saharan African  
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55 prisons. Hence we conducted a scoping review to map and describe extant literature on one NCD,  
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57 namely cardiovascular disease in prison populations in the region, ultimately to sensitise regional  
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3 authorities and governments to guide and inform targeted prison based NCD health policy and practice  
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5 (Levac et al., 2010; Daudt et al.,2013).  
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## 9 **Methods**

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11 The scoping review methodology of Arksey and O'Malley (2005) was closely adhered to and has been  
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13 used to map and describe prison health situation of vulnerable prison populations in the sub Saharan  
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15 African region (Van Hout & Mhlanga-Gunda, 2018, Van Hout & Mhlanga-Gunda, 2019a; Van Hout &  
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17 Mhlanga-Gunda, 2019b). The scoping exercise was guided by the research question; "*what is the known*  
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19 *about cardiovascular disease in sub Saharan African prison populations?* and utilised the Arksey and  
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21 O'Malley (2005) five-step process which involved specifying the research question, identifying relevant  
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23 literature, selecting studies, mapping the data, and summarising, synthesising and reporting the results.  
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27 A comprehensive systematic search of peer reviewed empirical literature was conducted with  
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29 no date limitation. Databases were CINHALL Plus with full text, Medline (EBSCO) and Cochrane  
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31 Library (Wiley), Scopus and PubMed. The search was restricted to English. All types of sources of  
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33 research design, studies from sub Saharan African countries, and cardiovascular NCDs as defined by  
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35 the Global Burden of Disease Study (2015) were included. We excluded studies referring to  
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37 Communicable/infectious diseases, and trauma/ accidents; and excluded editorials, letters, and book  
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39 reviews. Searches of the electronic databases above were supplemented with journal searches, author  
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41 searches and forwards and backwards citation tracking. See Table 1.  
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Insert **Table 1 Search terms** about here

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52 The PRISMA extension for scoping reviews (Tricco et al., 2018) was used to guide the essential  
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54 reporting items to include when completing the scoping review. Title and abstract screening followed  
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56 by full-text screening were employed using pre-defined eligibility criteria. Extensive lateral search  
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58 techniques proved extremely useful in searching the literature, and this included checking reference  
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60 lists, using the 'cited by' option in PubMed and key word searches on several search engines. Scanning  
of reference lists of key articles and included studies, and website searches of key organisations as well

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3 was done to account for the fact that database searching is not always efficient (Aveyard, 2019).  
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5 Endnote was used as the reference manager. Duplicates were removed manually. All selected studies  
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7 were initially screened based on title and abstract to exclude duplicate publications and articles without  
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9 clear relevance. This was followed by full-text analysis to determine eligibility. The database searches  
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11 identified 1335 articles, with an additional 79 studies identified through other sources and reference list  
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13 search. After screening by abstract and title, 165 studies were selected for full-text analysis, and of these  
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15 studies, 16 fulfilled the inclusion criteria necessary for them to be included in the review. See Figure 1.  
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20 Insert **Figure 1 PRISMA Flowchart** about here  
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24 Charting of essential themes or ideas from the information gleaned from the selected studies is  
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26 recognized as a key step to data synthesis and interpretation (Arksey & O'Malley, 2005). A standardised  
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28 data extraction form was developed to assist in the process. After a thorough assessment by author one,  
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30 data was extracted based on the country of study, design of study, the source of the study (that is, author,  
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32 year of publication), and various details regarding method and aim, data, collection and analysis  
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34 approaches, participant pool size, gender, and the age groups. This was charted using a spreadsheet, and  
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36 identification of commonalities and themes in the findings. A trial charting exercise was conducted  
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38 which aimed at attempting to improve the study's consistency, establish prior categories and subsequent  
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40 extraction of data (Daudt et al., 2013).  
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43 Following charting, information was synthesized descriptively and thematically. Particular  
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45 attention was paid to finding the possible explanations for similarities and differences found in the  
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47 study, considered in a logical way. The focus was on generating theories and investigating relationships  
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49 within and between studies. Seven key themes were identified; *Custodial deaths and autopsy*;  
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51 *Cardiorespiratory fitness and exercise*; *Cardiovascular disease and elderly people in prison*;  
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53 *Cardiovascular disease and women in prison*; *Dietary deficiencies*; *Influence of sleep patterns on*  
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55 *cardiovascular disease*; and *Other associated risk factors*.  
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## Results

The review demonstrated the limited body of peer-reviewed evidence on cardiovascular disease in prison populations in sub-Saharan Africa. Included records were published between the years 2010-2021, with the exception of one article published in the 1990s (Olubudun, 1996). The majority (82%) were published in the years from 2015 to 2021. The final included records consisted of sixteen studies representing six sub-Saharan African countries (Cameroon, Nigeria, Guinea, Burkina Faso, Ghana, Ethiopia). The majority of the studies were from Nigeria (n=10). See Supplemental Table.

Most of included records were quantitative and most analysed health statistics or involved measuring of cardiovascular-related health parameters. Of the 16 records included 15 were observational studies, including cross-sectional studies, case control studies, and retrospective and prospective cohort studies. One was a qualitative exploratory study. Various combinations of data collection methodologies were used which included examination of records (n=1), clinical examination (n=2), clinical examination with questionnaire (n=7), questionnaire (n=7) and interviews (n=1). Reflective of the majority male prison population at the global and African levels, men constituted at least 80% of the study population in almost all of the studies. Almost all studies reported on a small proportion of women in their research.

### *Custodial deaths and autopsy*

Two studies conducted in Nigeria focused on autopsy findings following deaths in custody (Soyemi et al., 2021; Nwafor et al., 2021). Both were retrospective studies based on autopsy findings and showed cardiovascular disease to be a common cause of deaths. Nwafor et al., (2021) found in their four-year study in Uyo (South Nigeria), that natural deaths were the most common manner of death (44.4% of cases), with hypertensive cardiovascular disease and myocardial infarction constituting almost all the cases of natural deaths in custody. Natural deaths accounted for 57.8% of cases, with heart failure due to hypertension and head injury being the two commonest causes of death in the 11 year Lagos study by Soyemi et al., (2021). In both studies, possible under-reporting of cases and inadequacies in post-mortem examinations were noted as challenges to the collection of accurate data from the prisons.

### ***Cardiorespiratory fitness and exercise***

Two cross-sectional studies conducted in Nigeria strengthen previous well-established findings on the benefits of regular exercise and physical activity on reducing cardiovascular complications. Oyeyemi et al., (2016) and Olaitan et al., (2010), both explored the area of cardiovascular fitness among inmates in Nigeria. Olaitan et al., (2010) showed a greater prevalence (93.1%) of lower cardiorespiratory fitness among those incarcerated at the facility and significant correlation between the chosen indices of physical fitness (cardiorespiratory fitness, body mass index and waist circumference) and duration of imprisonment. The study was conducted at Kano prison in Nigeria. In contrast, Oyeyemi et al., (2015) found high levels of cardiorespiratory fitness among those incarcerated at Maiduguri maximum prison (Nigeria), and they posited that this difference from that of Olaitan et al., (2010) might be attributed to the availability of provisions and facilities for vocational training and sporting activities at Maiduguri prison. These findings strengthen the argument for improvement of prison facilities to tackle the problem of physical inactivity among prison populations.

### ***Cardiovascular disease and elderly people in prison***

Qualitative exploratory research by Aborisade et al., (2016) in Nigeria found that elderly people in prisons' self-reporting of health status was low due to entrenched negative perceptions and prison conditions that promote poor health. 70.4% of participants in this study were incarcerated after the age of 50 years, hence the majority entered prison already needing care and follow-up. All respondents had some medical condition upon incarceration, but only 60% had reported them on admission into prison, with lack of confidence in the capacity of the prison health system being able to help them cited as the main reason for this lack of disclosure. The cost of treatment and management is borne by the person in prison and their family, and available prison healthcare facilities were grossly inadequate. Agyapong et al., (2018) in a study of the Ashanti Region of Ghana also note the higher prevalence of cardiovascular disease risk factors (dyslipidaemia and elevated blood pressure) among those aged above 40 years who had been incarcerated for more than three months. They found an overall prevalence of hypertension was 57.5% and dyslipidaemia constituted 57.5% of the study population among all participants. Over



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3 half (55%) of people living in prison were sedentary and of those who exercised only 13.8 % did so  
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### 10 ***Cardiovascular disease and women in prison***

11 Agyapong et al., (2018) in their cross-sectional study in Ghana noted a higher prevalence of  
12 cardiovascular risk factors (pre-diabetes, hypertension, overweight, obesity and metabolic syndrome)  
13 among women living in prison. There are several independent risk cardiovascular disease factors  
14 exclusive to women, including pregnancy-induced hypertension and diabetes, and common female  
15 endocrine disorders such as early menopause. Oyeyemi et al., (2015) in their Nigerian study illustrated  
16 gender differences in cardiorespiratory fitness, with lower levels in women living in prison.  
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### 26 ***Dietary deficiencies***

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28 Poor diets and resultant dietary deficiencies are commonplace in sub Saharan African prison settings  
29 due to persistent underfunding of prison services and poor financial management practices. A  
30 significant proportion of people in prison had vitamin B1 (thiamine) deficiency in the study by Diendere  
31 et al., (2021) in Burkina Faso, a cross-sectional descriptive and analytical study. They found  
32 approximately 30% of participants had clinical beriberi and 8% were underweight. A prospective study  
33 conducted by Cisse et al.,(2016) also investigated vitamin B1 deficiency in Guinea, which is associated  
34 with cardiomyopathy, and followed up people in prison who were incarcerated for at least 1 year, who  
35 received one single meal per day without meat intake and fruit. Clinical beriberi was found in 16.6% of  
36 the prison population. They reported on severe malnutrition and noted high rates of overall heart failure  
37 (31,5%) with thiamine deficiency, arising from poor diets and clandestine consumption of traditional  
38 alcohols. Thiamine deficiency's association with neurological and cardiovascular disorders is not  
39 always common knowledge to prison health workers.  
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### 56 ***Influence of sleep patterns on cardiovascular disease***

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58 Fakorede et al., (2015) conducted a cross sectional study examining the sleep efficiency and quality of  
59 sleep in a Nigerian prison. The majority of the participants (94%) had sub-normal sleep efficiency, with  
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3 approximately one third (37.7%) having poor sleep quality. Getachew et al.,(2020) found that the  
4 prevalence of poor sleep quality among those incarcerated in Ethiopia was 53.9% and associated with  
5 other co-morbidities that are also risk factors for cardiovascular disease such as depression and  
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10 smoking.

### 11 12 13 ***Other associated risk factors***

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15 Two studies done at Yaoundé Central prison in Cameroon clearly illustrated the higher prevalence of  
16 cardiovascular risk factors among the prison population. Tinmou et al., (2019) measured blood pressure  
17 levels of people in the prison, revealing a higher prevalence of hypertension in Yaoundé Central Prison  
18 of 39.6%. The researchers went on to identify the main cardiovascular risk factors as sedentary lifestyle  
19 (91.1%), smoking (31.6%), alcohol consumption (28.1%), known hypertension (14%) and obesity  
20 (11.7%). Njonnou et al., (2020), also from Yaoundé, found a higher prevalence of diabetes of 9.4% in  
21 the studied population (compared to 5.8% in the general population), and also noted that obesity and  
22 sedentary lifestyle were associated with diabetes. Otuu & Shu (2017) showed that hypertension and  
23 chest pain were the commonest cardiovascular presentations in a cross-sectional study done in Nigeria.  
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25 Another Nigerian study conducted by Sabir and Jimoh (2015) produced data indicating a high  
26 prevalence of systemic hypertension in the prison population, with 60 (16.1%) people in the prison  
27 found to have systemic hypertension, and 2 (0.5%) with diabetes mellitus. Similarly, Olubudun (1996)  
28 found both systolic and diastolic blood pressure to be higher among a Nigerian prison population when  
29 compared to a group of controls, and both increased with duration of confinement. The study reflected  
30 an increased risk of cardiovascular disease risk factors among people deprived of their liberty. Another  
31 Nigerian study by Audu et al.,(2014) also reported on the high burden of both communicable and NCDs,  
32 with 2.4% of the total number of all diseases identified being attributed to cardiovascular disease.  
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### 54 **Discussion**

55 This is the first review to scope extant literature on NCDs in sub-Saharan African prison populations.  
56 The review underscores continued harsh conditions of detention in the six sub-Saharan African  
57 countries, with related health inequalities directly related to inadequate care by prison authorities, and  
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3 reflective of malnutrition, confinement, inability to sleep and the aging population of people living in  
4 prison. It also illustrates the continued dearth of prison health research and clinical surveillance of the  
5 health of people living in prisons in the region (Van Hout & Mhlanga-Gunda, 2018; Van Hout &  
6 Mhlanga-Gunda 2019a; Van Hout & Mhlanga-Gunda 2019b; Mhlanga-Gunda et al., 2020), and the  
7 lack of attention paid to NCDs (as opposed to communicable diseases such as HIV, tuberculosis and  
8 COVID-19), the environmental determinants of health and the needs of an aging population living  
9 within African prison settings. However, the fact that the majority of the papers were published in recent  
10 years offers hope: that the health community is no longer ignoring this issue but choosing instead to  
11 explore and expose it.

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22 The findings of the review, although coming from LMICs, align with studies conducted in high  
23 income countries in Europe (Hannan et al., 2011; Unal et al., 2016) which report that cardiovascular  
24 disease is the commonest natural cause of custodial deaths. This review suggests a number of possible  
25 underpinning mechanisms. People in prison are less likely to be able to take sufficient physical activity  
26 to benefit their health and this has been documented previously in high income countries (Herbert et  
27 al., 2012). However, nutritional deficiencies as a cause were evident in sub-Saharan African prisons;  
28 heart failure resulting from beriberi has been shown to improve significantly with return of thiamine  
29 levels to normal. Sleep disturbances are more common in the prison population (Elger 2004; Dewa et  
30 al., 2015; Elger, 2003) and insomnia has been linked to high blood pressure, coronary heart disease,  
31 heart failure, and cardio-vascular disease mortality (Javaheri & Redline, 2017; Zheng et al., 2019).  
32 Overcrowding and poor living conditions are factors promoting poor sleep patterns and insomnia among  
33 people deprived of their liberty that have been documented (Dewa et al., 2015), but the effect of this on  
34 cardio-vascular disease prevalence has not yet been clearly studied.

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The adverse impact of these poor conditions on imprisoned populations' health will have been  
compounded by the COVID-19 pandemic, which presented substantial challenges for prison authorities  
in sub-Saharan Africa (Muntingh, 2020; Van Hout, 2020a; 2020b; Van Hout & Wessels, 2021; Van  
Hout et al., 2022a; Van Hout et al., 2022; Van Hout, 2022; Jumbe et al., 2022; Mhlanga-Gunda et al.,  
2022). Although the mortality and infection rates were ultimately lower than expected (Lawal, 2021),  
high numbers of asymptomatic cases and seroprevalence levels (Usuf, 2021) could lead to future

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3 increases in cardiovascular related morbidity and mortality. Studies have shown the effects of 'Long  
4 *Covid syndrome*' (Davis et al., 2021; Proal & van Elzakker, 2021). It is therefore reasonable to expect  
5 changes in prisoner morbidity and mortality over the coming years as the effects of this multiorgan  
6 damage caused by COVID-19 infections begins to translate into long-term manifestations such as  
7 development of NCDs.  
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14 This scoping review was conducted systematically following published guidelines and is the  
15 first to focus on sub-Saharan Africa and examine an emerging major public health issue in this region.  
16 Limitations of the review centre on the restriction on the English language, thereby potentially missing  
17 French and Portuguese records, and yet are indicative of the small scale nature of the included studies,  
18 and the lack of representation of many sub-Saharan African countries. Scoping reviews also do not  
19 include a quality assessment of methodology of included records (Arkesy & O'Malley, 2005).  
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27 Prioritisation and an increased focus on ensuring adequate standards of detention particular to  
28 the general and cardiovascular health of people in prison in sub-Saharan Africa is warranted. Preventive  
29 and health promotion activities in sub-Saharan Africa prisons are at present clearly insufficient, with  
30 priority being given to curative activities. Even these curative activities are frequently underfunded and  
31 understaffed (Diendere, 2021). The 2022 World Health Organisation report "*Addressing the NCD  
32 burden in prisons in the WHO European Region: interventions and policy options*" outlines a revised  
33 approach to reducing the NCD risks and bringing benefits to all Member States (World Health  
34 Organisation, 2022b). Key aspects to reducing NCD risks in detention spaces centre on tobacco and  
35 alcohol use, sedentarism, stress and poor nutrition. Most applicable to the African prison context are  
36 the severe congestion, exposure to violence and lack of opportunity to exercise, inadequate nutrition,  
37 limited access to NCD screening and care, and under resourced prison health systems (Van Hout, 2022).  
38 Improvement of prison populations' lifestyles and habits, and reducing stress, trauma, physical and  
39 sexual violence should be a priority. Whole prison approaches could incorporate brief interventions  
40 targeting NCDs (information, physical activity) and have the potential to improve health literacy and  
41 influence the modifiable risk factors of cardiovascular disease.  
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58 Significant investment in access to NCD treatments and collaboration with public health  
59 systems is required to support the routine monitoring and expansion of existing prison healthcare  
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3 services. Greater effort therefore needs to be directed towards the building of a comprehensive baseline  
4 data on cardiovascular disease in prison in order to provide a starting point for effective intervention  
5 programmes and strategies. Prison health authorities should upscale their health surveillance systems  
6 moving beyond that of HIV and tuberculosis monitoring. Simple and affordable clinical interventions  
7 in prisons have been shown to of immense prognostic and financial benefit when implemented  
8 correctly. For example, lessons learnt from prison telemedicine (opportunistic triage) may also offer  
9 additional low cost supports when faced with hurdles such as understaffing and a lack of qualified  
10 specialists in prisons (Brunetti et al., 2015). Integration of NCD services with infectious disease (HIV,  
11 tuberculosis) programmes in prisons will enable effective treatment whilst in prison and, very  
12 importantly, support the NCD continuity of care bridging prison and community.  
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## 26 **Conclusion**

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28 It is imperative that people deprived of liberty in sub-Saharan Africa are not left behind in efforts to  
29 tackle the dual NCD and HIV burden of disease. Governments are reminded of their obligation to  
30 uphold the fundamental rights of those living in prisons, particularly their rights to reasonable  
31 accommodation, right to adequate food and clean water, right to access healthcare equivalent to that in  
32 the community, and right to access medicine (Van Hout, 2022). The lack of proper financial and human  
33 resource investment into tackling NCDs that is seen in many health sectors in the region has, by default,  
34 extended to prison health systems as well. Governments, prison health authorities and relevant  
35 stakeholders need to develop a holistic approach to health in prisons in order to implement meaningful  
36 strategies and interventions. Prison health authorities should consider establishing strategies that  
37 incorporate the aging and vulnerable prison population in national NCD programmes. The lack of health  
38 research data from prisons in sub-Saharan Africa remains challenging, along with prison resourcing and  
39 clinical capacity (Mhlanga-Gunda et al., 2020). Many sub-Saharan Africa countries i do not publish  
40 prison health research, and remain reliant on external research teams, and United Nations/human rights  
41 agencies to enter prisons and document prison health standards and detention conditions.  
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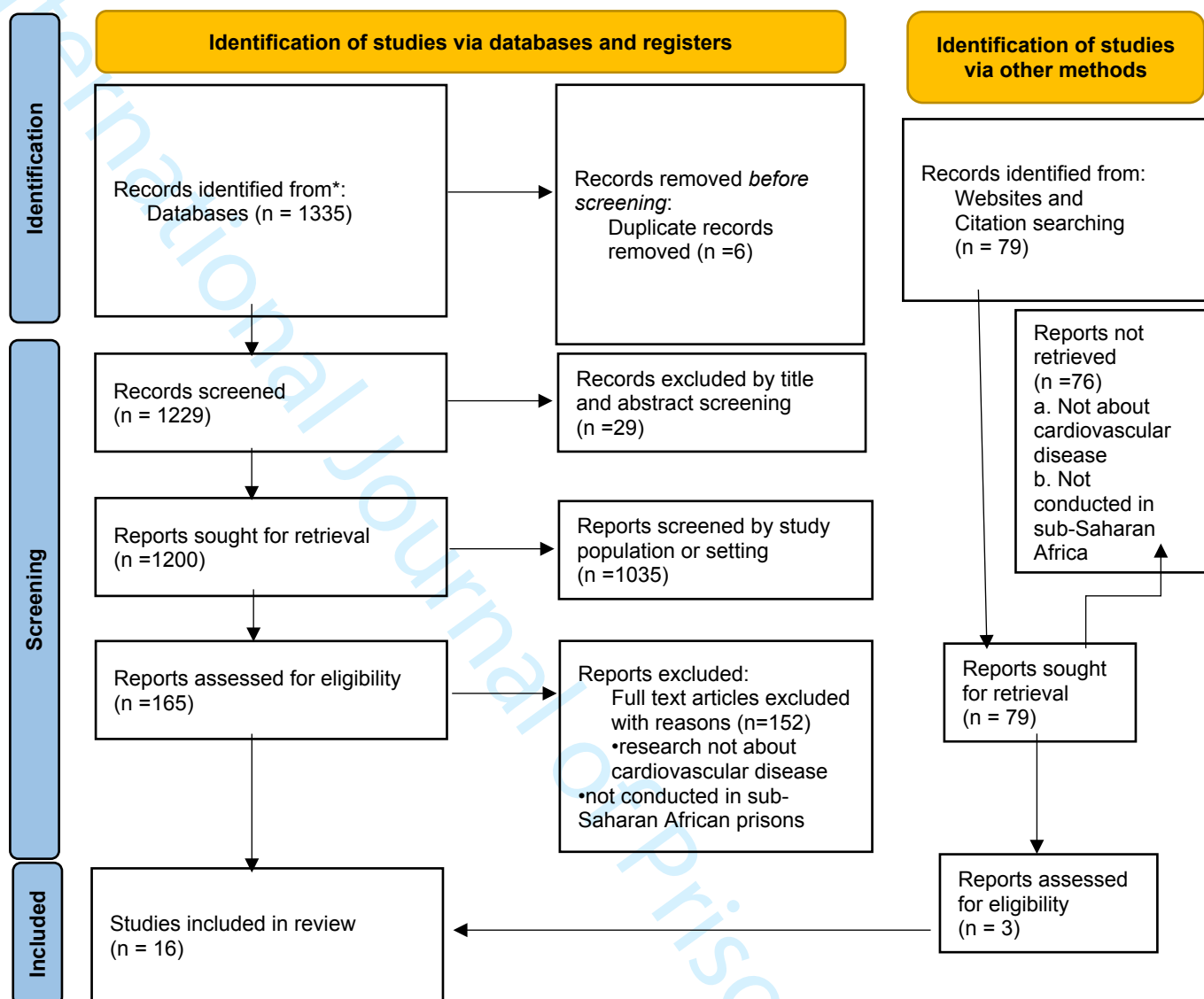
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Figure 1 PRISMA Flowchart

Table 1 Search terms

PEO elements	Concepts	Search terms
Population	<p>People in prisons of both genders</p> <p>Sub Saharan Africa: countries located within region according to the World Bank groupings</p> <p>All age groups</p>	<p>Angola OR Benin OR Botswana OR "Burkina Faso" OR Burundi OR Cameroon OR "Central African Republic" OR Chad OR Congo OR "Cote d'Ivoire" OR Eritrea OR Ethiopia OR Gabon OR Gambia OR Ghana OR Guinea OR "Guinea-Bissau" OR Kenya OR Lesotho OR Liberia OR Madagascar OR Malawi OR Mali OR Mauritania OR Mauritius OR Mozambique OR Namibia OR Niger OR Nigeria OR Rwanda OR Senegal OR "Sierra Leone" OR Somalia OR "South Africa" OR "United Republic of Tanzania" OR Togo OR Uganda OR Zaire OR Zambia OR Zimbabwe</p>
Concept	<p>NCD: Cardiovascular Disease in Sub Saharan Africa</p> <p>Cardiovascular risk factors</p>	<p>OR "chronic disease*" OR "NCD" OR "non-communicable disease*" OR "non-infectious disease*" OR "noncommunicable disease*" OR "non-infectious disease**"</p>
Context	<p>People deprived of liberty in sub-Saharan Africa</p>	<p>prison* OR detainee OR detention OR incarceration OR custod* OR jail OR "correctional facilit*" OR "correctional setting*" OR "detained setting*" OR "place* of detention" OR offender* OR criminal*</p>

## Supplemental file of Date: Charted Studies

Author and year	Aborisade et al., 2016	Agyapong et al., 2018	Audu et al., 2014	Cisse et al., 2016
<b>Study design</b>	Qualitative exploratory research	Cross-sectional study	Retrospective study	Prospective study
<b>Focus of the study</b>	Capacity of prisons in Ogun State to cater for the health and other physiological needs of the elderly under incarceration	Assess prevalence of cardiovascular risk factors among older prison populations	Assessed five-year disease profiles of people living in three prisons - January 2007 to December 2011	Cardiovascular and neurological manifestations associated with thiamine deficiency in Guinean prisons
<b>Study setting</b>	Ogun State, Nigeria	Ashanti Region, Ghana	Kaduna state, north western Nigeria.	Conakry, Guinea
<b>Age group</b>	Prison population above 55yrs of age	Individuals aged above 40years; In prison for > 3months	All age groups	Peak age frequency after thirty years (92.6%)
<b>Sample size (N)</b>	n = 27 Males 85.19% Females 14.81%	n=160 Males 93. 8% Females 6.2%	n=24,327 Males 92.5% Females 7.5%	n=38 Males 36 Females 2
<b>Methodology</b>	In-depth and key informant interviews	Questionnaire & BMI, waist circumference and blood pressure. Fasting blood samples for lipid profile and FBG. Mean systolic BP 141.1±23.2 mmHg, diastolic 88.9±15 mmHg, BMI 22.8±4.1 kg/m <sup>2</sup> , waist circumference 81±10.3 cm, FBG 4.3±0.9 mmol/L, HDL 1.4±0.4 mmol/L. mmol/L.	Questionnaire	Blood tests, ECG, BMI & nutritional status follow-up. Follow-up period of 4 years.
<b>Key findings</b>	Elderly people in prison clinical outcomes and self-reporting of health status is low, including relating to cardiovascular disease.	Prevalence: hypertension and dyslipidaemia (57.5% each), metabolic syndrome (8.1%), and 21.9% had two	Psychiatric cases (24.1%), gastrointestinal diseases (22.6%), diseases of the respiratory tract (10.9%), dermatology/allergy (5.4%) and cardiovascular diseases (2.4%).	Sensorimotor polyneuropathy and pure sensory (52.2%), overall heart failure (31.5%) and to a lesser degree by Gayet Wernicke's encephalopathy (7.8%) and shoshin beriberi with severe evolution (5.2%).

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<b>Author explanations (of key findings)</b>	Perception that the prison authorities will not assist them medically, fear of stigmatisation, fear of confinement in solitary cells, and negative attitude of prison officials.	cardiovascular disease. risk factors. Prevalence of dyslipidaemia and elevated blood pressure were high among people in prison and cardiovascular risk factors were higher among female prison populations compared to males.	There is a huge communicable and non-communicable disease burden among prison populations in Kaduna State, Nigeria.	People living in prison are severely malnourished.
<b>Additional relevant findings</b>	Other factors: poor diet, overcrowding, poor room ventilation, inadequate physical exercise, passive smoking, water rationing/shortage, inter-personal violence, mosquito and other insect bites, poor sleep patterns	Most people in prison were sedentary and occasionally consumed fruits. Interventions of appropriate dietary provision and exercise schedule should begin within Ghanaian prisons.	Malaria (21.6%) was found to be the most prevalent condition, followed by accidents/deliberate harms (3.6%), and tumours (0.6%)	High rates of overall heart failure with thiamine deficiency
<b>Authors' Conclusions</b>	Educational campaigns on health improvement and health awareness among the older prison populations. Authorities must assume greater role in management of health of the aged in prisons.	Health screening, exercise programmes and proper diets in all prisons to reduce nutritional/metabolic disorders.	Improve health education, sanitation, and give balanced nutrition. Mental health care for people living in prisons is needed.	Need for improved diets for prison populations by prison authorities; Governments should employ prison dieticians.

<b>Author and year</b>	<b>Diendere et al, 2021</b>	<b>Fakorede et al., 2015</b>	<b>Getachew et al., 2020</b>	<b>Njonnou et al., 2020</b>
<b>Study design</b>	Cross-sectional study	Cross-sectional study	Cross-sectional study	Cross-sectional study
<b>Focus of the study</b>	Study of the factors associated with the occurrence of diseases and	Determine the sleep efficiency and quality of a Nigerian prison population.	Assess the quality of sleep and related factors among people in prison.	Prevalence of diabetes and associated risk factors

	beriberi among people in prison.			
<b>Study setting</b>	Burkina Faso	Ogun State, Nigeria	Diredawa correctional facility, Diredawa, eastern Ethiopia	Yaoundé Central Prison, Cameroon
<b>Age group</b>	Median age 31.6 years.	All age groups	All age groups	All age groups.
<b>Sample size (N)</b>	n=1004 Males 96% Females 4%	n=300 Male 100%	n=421 Males 393 Females 28	n=437 Males 344 Females 93
<b>Methodology</b>	Observation, interviews and clinical examination. Anonymous and confidential standardized questionnaire.	Questionnaire. A sleep efficiency score of >85% normal while a Pittsburgh Sleep Quality Index score of ≤5 was defined as good sleep quality	A semi-structured questionnaire used to assess participants' socio-demographic data, sleep quality, depression, and sleep hygiene.	Standardised questionnaire and physical examination. January to July 2017.
<b>Key findings</b>	A total of 302 people in prison (30.1%) had clinical beriberi and 80 (8%) were underweight.	Majority (94%) had sub-normal sleep efficiency while about a third (37.7%) had poor sleep quality	Prevalence of poor sleep quality was 227 (53.9%)	Prevalence of diabetes was 9.4%. only obesity and sedentary lifestyle were associated with diabetes.
<b>Author explanations (of key findings)</b>	Incarceration > 9months independently associated with a high risk of digestive and cardio-respiratory diseases, plus beriberi (thiamine deficiency).	Efforts should be made in improving the Nigerian prison conditions and identifying possible factors responsible for poor sleep efficiency and sleep quality among this vulnerable group	Associated factors for poor sleep quality - depression, smoking/substance use, caffeine intake, poor sleep hygiene	Diabetes prevalence high, at 9.4%, compared to general population. Associated with other classical cardiovascular risk factors and factors linked to the sentence (minor and major crimes).
<b>Additional relevant findings</b>	Implications for cardiomyopathy	Insomnia is linked to high blood pressure and heart disease	Sleep disturbance and co-morbid factors are inextricably interlinked	Improvement of diet and physical activity could improve cardio-vascular health, particularly diabetes control or metabolic syndrome among prison populations.

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**Authors' Conclusions**

Specialists care in prisons must be addressed. Improvements in the hygiene conditions and environment of the prison, quality and quantity of the food rations is urgent. Strategies to reduce prison overcrowding will assist.

Improvement of living conditions of prison populations

More studies required to understand and improve sleep patterns among prison populations.

Cardiovascular health and diabetes specialists needed in prison health systems.

Author and year	Nwafor, et al, 2021	Olubodun, 1996	Otuu & Shu, 2017	Oyeyemi et al., 2015
<b>Study design</b>	Retrospective study	Cross-sectional study	Cross-sectional study	Cross-sectional study
<b>Focus of the study</b>	The peculiarities of custodial deaths and to suggest preventive measures.	Measure blood pressure of the people living in a developing community prison	Establish demography, prevalent diseases and environmental problems	Determine the level of cardiorespiratory fitness of prison populations and also to determine the effects of age, gender, and period of incarceration on cardiorespiratory fitness.
<b>Study setting</b>	Uyo, South-Soth Nigeria	Developing community prison in Nigeria	South-East geo-political zone of Nigeria	Maiduguri Maximum Security Prison, Nigeria
<b>Age group</b>	Aged between 22-44 years with an average age of 31.1 years	All age groups	Between 18 and above 50 years	The mean age, body mass index were 26.34 ± 6.21 years, 19.49±2.68kg/m
<b>Sample size (N)</b>	n=9 Male 100%	n=81	n=854	n=247



<b>Methodology</b>	Post-mortem examinations performed on people in detention that died in police or prison custody over 4 years	Interviews (medical and diet history, alcohol and smoking habit, use of hard drugs, salt intake and duration of prison) and blood pressure measurements	Well-structured questionnaires: demography, prevalent diseases and environmental problems	Subjects performed a one mile walk test from which their VO2 max was derived using a nomogram.
<b>Key findings</b>	4 natural causes of death were 2 cases of hypertensive cardiovascular disease, a case of myocardial infarction and a case of alcoholic hepatitis.	Systolic blood pressure ranged from 80-150 mm Hg (mean 115.1 +/- 1.7) for people living in prison and 80 to 140 mm Hg (mean 107.5 +/- 1.6) for controls (P < 0.05); Diastolic blood pressure ranged from 50-110 mm Hg (mean 74.1 +/- 1.3) and 45-90 mm Hg (mean 68.8 +/- 1.6) respectively (P < 0.05).	Hypertension, 148 (41.23%), 47 (15.67%), 39 (20.00%). chest pain, 179 (49.86%), 134 (44.67%), 95 (48.72%),	Prison populations appear to have a high level of cardiorespiratory fitness. Males found to have higher level than their female counterparts
<b>Author explanations (of key findings)</b>	Natural death is the most common manner of death among detainees in Uyo.	The study suggests that both systolic and diastolic blood pressures are higher in people in prison compared to controls and appear to increase with duration of prison confinement	Post incarceration depression associated with ischemic heart diseases, high blood pressure, obesity, diarrhoea and chest pain	Cardiorespiratory fitness of people living in Maiduguri Maximum Security Prison is good.
<b>Additional relevant findings</b>	Higher natural deaths (poor prison conditions, people in prison with chronic illness without regular supply of their medication, denial of treatment, lack of timely intervention or outright negligence)	Both systolic and diastolic blood pressures increased with duration of confinement (r = 0.26 P = 0.02 and 0.22 P = 0.057 respectively).	Hypertension and chest pain all peaked in the period <2yrs and 2-5yrs after incarceration, Lower afterwards. Greater number of people had spent less than 2yrs in all the prisons, followed by 2-5yrs.	Correlations with underlying conditions would be useful.

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**Authors' Conclusions**

Clinics in detention centres should be made to function effectively with a good referral system.

Continued follow-up of prison populations is required

Studies on depression in African prison populations needed.

Promote physical exercise and fitness. Investigate influence of physical activity variables such as vocational facilities and sporting opportunities on the CRF.

Author and year	Sabir & Jimoh, 2015	Soyemi et al., 2021	Olaitan et al., 2010	Timnou et al., 2019
Study design	Cross-sectional study	Retrospective study	Cross-sectional study	Cross-sectional study
Focus of the study	Prevalence and pattern of NCDs in prison populations	Study of all autopsy cases of custodial deaths in the Office of the Chief Medical Examiner.	Evaluate the incidence and relationship between the measures of physical fitness and the duration of incarceration of people living in Kano-Nigeria prisons.	Determine characteristics of hypertension among people in prison. January to July 2017
Study setting	Sokoto Central Prison, North-West Nigeria.	Lagos State, Nigeria	Kano Prison, Nigeria	Yaoundé Central Prison, Cameroon
Age group	Mean age was 31.2 (9.7) years with age range 18-82years	Male 84.4% Female 15.6%. Age 20 to 64 years, with a mean age of 37 ± 11.0 years.	All age groups	Average age of 37.01±13.2 years.

Sample size (N)	n=373	n= 45	n=116 Males 108 (93.1%) Female 8 (6.9%)	n= 437 Males 344 Females 93
Methodology	Interviewer-administered questionnaire	Variables including age, sex, offence, place of death, duration in custody prior to death and cause and manner of death were extracted from the records	Subjects' physical fitness level (cardio-respiratory fitness, body mass index and waist circumference) was assessed using standardized protocols	Standardised questionnaire and physical examination
Key findings	60 (16.1%)-systemic hypertension, 2 (0.5%) diabetes mellitus, 16 (4.3%) obesity and 24 (6.4%) underweight	These deaths were most common in the third decade	High (93.1%) prevalence of low cardio-respiratory fitness among people in prison and significant correlation between the selected indices of physical fitness (cardio-respiratory fitness, body mass index and waist circumference) and duration of incarceration.	prevalence of hypertension was 39.6%

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Author explanations (of key findings)

Prevalence of NCDs, especially hypertension in Nigerian prison is high

The two leading causes of death were acute cardiac failure from hypertensive heart disease and cranio-cerebral injury from blunt-force trauma.

Prevalence of low cardio-respiratory fitness was high among people in prison and long period of inadequate physical activity may be implicated as causative factor of low physical fitness among people living in Kano prison

Main cardiovascular risk factors were a sedentary lifestyle (91.1%), smoking (31.6%), alcohol consumption (28.1%), known hypertension (14%) and obesity (11.7%)

Additional relevant findings

Prison health care system capacity utilisation needs revamping

Custodial deaths are not investigated fully in most instances

Prison administration and staff should encourage healthy behaviours for people living in prison. Provision of adequate facilities to encourage physical activity and sports participation is highly needed.

Detention variables significantly associated with hypertension: age (>40 years), middle and high social class, sentence for a major crime or major offense, severe sentence, incarceration length.

Authors' Conclusions

Policy makers and stakeholders should formulate strategies to reduce cardio-respiratory disease burden.

More forensic studies of custodial deaths in sub-Saharan African prisons to identify patterns.

Adequate facilities for sports participation needed.

There is a need to implement preventive strategies for hypertension in prison. Maintain continuum of care for all.