The burden of non-communicable diseases among people living with HIV in Sub-Saharan Africa: a systematic review and meta-analysis

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eClinicalMedicine 2023;65: 102255
Published Online xxx
https://doi.org/10.1016/j.eclinm.2023.102255

Summary

Background Non-communicable diseases (NCDs) are increasing among people living with HIV (PLHIV), especially in Sub-Saharan Africa (SSA). We determined the prevalence of NCDs and NCD risk factors among PLHIV in SSA to inform health policy makers.

Methods We conducted a systematic review and meta-analysis on the prevalence of NCDs and risk factors among PLHIV in SSA. We comprehensively searched PubMed/MEDLINE, Scopus, and EBSCOhost (CINAHL) electronic databases for sources published from 2010 to July 2023. We applied the random effects meta-analysis model to pool the results using STATA. The systematic review protocol was registered on PROSPERO (registration number: CRD42021258769).

Findings We included 188 studies from 21 countries in this meta-analysis. Our findings indicate pooled prevalence estimates for hypertension (20.1% [95% CI:17.5–22.7]), depression (30.4% [25.3–35.4]), diabetes (5.4% [4.4–6.4]), cervical cancer (1.5% [0.1–2.9]), chronic respiratory diseases (7.1% [4.0–10.3]), overweight/obesity (32.2% [29.7–34.7]), hypercholesterolemia (21.3% [16.6–26.0]), metabolic syndrome (23.9% [19.5–28.7]), alcohol consumption (21.3% [17.9–24.6]), and smoking (6.4% [5.2–7.7]).

Interpretation People living with HIV have a high prevalence of NCDs and their risk factors including hypertension, depression, overweight/obesity, hypercholesterolemia, metabolic syndrome and alcohol consumption. We recommend strengthening of health systems to allow for improved integration of NCDs and HIV services in public health facilities in SSA. NCD risk factors such as obesity, hypercholesterolemia, and alcohol consumption can be addressed through health promotion campaigns. There is a need for further research on the burden of NCDs among PLHIV in most of SSA.

Funding This study did not receive any funding.

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Keywords: Non-communicable diseases; People living with HIV; Sub-Saharan Africa; HIV/AIDS; Systematic review; Meta-analysis

Introduction

Non-communicable diseases (NCDs) have become a global public health emergency, particularly in low- and middle-income countries (LMICs) where most (85%) premature deaths occur due to NCDs.[1] NCDs affect the developing economies of LMICs[2] since most deaths occur in the productive age group (30–69 years), leading to a diminished workforce. Employees are often absent from work due to the chronic nature of NCDs and in the event of death, families are left with financial difficulties. The World Health Organization (WHO) has iterated that NCDs threaten progress towards achieving the 2030 Sustainable Development Goals (SDG's), particularly SDG target 3.4, which aims to reduce premature deaths due to NCDs by one-third through prevention, treatment, and promotion of mental health and well-being.[3]

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Research in context

Evidence before this study

The previous systematic review by Patel and colleagues published in 2018, which included 52 low-and-middle-income country (LMIC) studies from 2010 to 2016, found pooled prevalence estimates of 21.2% for hypertension, 27.2% hypercholesterolemia, 7.8% obesity, 24.4% depression, 1.3%–1.7% invasive cervical cancer and 1.3%–18% diabetes, among people living with HIV. However, several studies on the prevalence of NCDs and their risk factors have now been published, and there is an urgent need to update the evidence.

Added value of this study

In this study, we included updated evidence from 188 studies from 21 countries, representing 2,838,350 people living with HIV (PLHIV) from Sub-Saharan Africa (SSA), which has the largest number of PLHIV, from 2010 to July 2023. Our findings show that the burden of NCDs/NCD risk factors among PLHIV in SSA is 20.1% for hypertension, 30.4% for depression, 21.3% for hypercholesterolemia, 32.2% for overweight/obesity, and 5.4% for diabetes. We also report on the burden of more NCDs/risk factors, including chronic respiratory diseases that were not included in the previous systematic review.

Implications of all the available evidence

Our findings confirm that the burden of NCDs among PLHIV is a public health emergency that SSA needs to address. The provision of integrated HIV and NCD services at primary health care facilities needs to be strengthened. The NCD risk factors such as obesity, harmful use of alcohol and tobacco use, can be addressed by health promotion campaigns.

The introduction of antiretroviral therapy (ART) for people living with HIV (PLHIV) has increased their life expectancy; however, this has also increased their risk of acquiring NCDs as they age. NCDs are increasing in Sub-Saharan Africa (SSA), the region with the highest burden of HIV.[1] In SSA, urbanisation has exacerbated the burden of modifiable risk factors for NCDs[4,5] such as sedentary lifestyles, unhealthy diets, harmful use of alcohol and tobacco, and exposure to pollution.[6,7] On top of these factors, the effects of HIV along with the adverse effects of ART,[8,9] may increase the risk of NCDs among PLHIV.[10] According to the WHO, deaths due to the four major NCDs (cardiovascular disease (CVD), diabetes, cancers, chronic respiratory diseases (CRDs), and mental illnesses have increased.[11] In particular, among PLHIV, the four most common conditions are CVDs, cervical cancer, diabetes, and depression.[1]

Knowledge of the burden of NCDs among PLHIV can inform health-policy makers on how to strengthen health systems in SSA. This knowledge will likely foster the integration of NCD/HIV care at primary health care facilities in the region, and hence improve comprehensive healthcare delivery.

A 2018 published systematic review on the burden of NCDs among PLHIV in LMICs[12] included articles published between 2010 and 2016. Several articles have been published since 2016, and the evidence needs to be updated. In this systematic review, we updated evidence on the burden of NCDs and NCD risk factors among PLHIV in SSA. We included studies published from 2010 to July 2023, and we report on changes in trends of the burden of NCDs among PLHIV.[13] Our systematic review also included chronic respiratory diseases (CRDs), which were excluded from the previous systematic review.[12]

Methods

The systematic review protocol was registered on PROSPERO (registration number: CRD42021258769) and methods are described in full in the published protocol.[13]

Eligibility criteria

Studies published between 2010 and July 2023 that focused on the burden of any of the five major NCDs and their respective risk factors among PLHIV in SSA were eligible for inclusion. Studies published before January 1, 2010 were excluded. We did not include articles that we could not access. Clinical trials and systematic reviews were noted for bibliographic searches but were excluded from the systematic review.

Two authors independently screened the titles and abstracts of the articles identified from the search. Study participants were any adult (≥13 years old) living with HIV in SSA. The main exposure of interest was HIV. Outcomes of interest were prevalence of any NCD or NCD risk factors in HIV populations. Study designs that were reviewed included observational studies (cross sectional and cohort), interventional studies, case control studies, longitudinal studies, HIV and NCD reports, Demographic and Health Survey (DHS) articles, and other similar studies.

Data sources

We searched for eligible peer reviewed articles on the PubMed/MEDLINE, Scopus, and EBSCOhost online databases. A PubMed/MEDLINE search strategy was developed and adapted for all other databases as suggested by Patel and coworkers.[12] Boolean operators, Medical Subject Heading (MESH) terms, and key words were used as part of the search strategy. Bibliographies of the included studies were used to identify further

eligible studies. Grey literature was also searched for relevant studies. Included studies were corroborated with those included in previously published systematic reviews. The date of the last search was July 19, 2023.

Search strategy

Details of the search strategy are provided in Supplementary materials–Appendix I. EndNote X20 (Clarivate Analytics, Philadelphia, PA) and Rayyan software[14] were used to collect, review, de-duplicate, and manage citations.

Data extraction

A predesigned data extraction form was used by two review authors (MMC and KM), who independently extracted data on the prevalence of any of the following NCDs among PLHIV: cervical cancer, depression, CRD, and diabetes. We also extracted data on the prevalence of NCD risk factors, including hypertension, hypercholesterolemia, obesity, smoking, and alcohol consumption in PLHIV. For each article, we recorded the study design, sample size, participants' age, recruitment methods, study country, and date of publication. Discrepancies were resolved by discussion with a third review author (AM). The data were exported to Stata V.17 (Stata IC/V.17.0, StataCorp) for meta-analysis.

Data synthesis

Meta-analysis was performed using the 'metan' and 'metaprop' commands in Stata V.17. A random-effects meta-analysis was used to estimate pooled prevalence of hypertension, diabetes, cervical cancer, CRDs, depression, hypercholesterolemia, overweight/obesity, metabolic syndrome, current smoking, and alcohol consumption. The main outcome of interest was the prevalence of NCD or NCD risk factors among PLHIV with respective 95% confidence intervals (CI). We zeroed negative 95% CIs to avoid negative prevalence measures. Forest plots were constructed to display meta-analysis results. The Chi-square test and I^2 statistic were used to measure statistical heterogeneity between studies. We used the Doi plots and LFK index (lfk command)[15] to check the potential effect of publication bias on the meta-analysis. Approximately, LFK index between −1 and 1 may indicate symmetry (absence of publication bias) while values outside of this range may signify potential for publication bias.[15]

Role of funding

This study did not receive any funding.

Results

Results of the search

We retrieved 7857 studies from three electronic databases (PubMed/Medline, Scopus, and EBSCOHost). After removing 1350 duplicate records and 2487 records that had titles mismatching our study topic, we were left with 4020 records for abstract screening. Abstract screening resulted in the exclusion of 3448 non relevant records. We tried to retrieve the full texts of 572 records, but were unable to retrieve 17 records, which left 555 full-text reports that were assessed for eligibility by two review authors. Finally, 367 records were excluded after full-text screening, and 188 studies were included in this systematic review and meta-analysis (Fig. 1).

Characteristics of included studies

The 188 included studies were from 21 countries representing 2,838,350 PLHIV (Table 1), in SSA (Fig. 2), namely; Benin,[16] Burkina Faso,[17–19] Burundi,[20,21] Cameroon,[22–34] Cote d'Ivoire,[35] Democratic Republic of Congo (DRC),[36,37] Eriteria,[38] Eswatini,[39] Ethiopia,[40–64] Ghana,[65–73] Guinea Bissau,[74] Kenya,[4,75–95] Lesotho,[96] Malawi,[97–104] Mozambique,[105] Nigeria,[94,95,106–123] South Africa,[8,124–150] United Republic of Tanzania,[10,94,95,151–163] Uganda,[94,95,164–189] Zambia,[190–196] and Zimbabwe.[194,197–200] We reviewed two multi-country studies, as indicated in Fig. 2.[94,95]

Many of the included studies were cross sectional (n = 153, 81%), and we only reviewed two intervention studies that included baseline data on the burden of NCDs/risk factors (Fig. 3).

In total, 96 (53%) studies reported prevalence of hypertension among PLHIV in SSA, followed by overweight/obesity (n = 85, 45%), smoking (n = 84, 45%), diabetes (n = 73, 39%), depression (n = 38, 20%), current consumption of alcohol (n = 61, 32%), hypercholesterolemia (n = 41, 22%), and metabolic syndrome (n = 22, 12%) Cervical cancer (n = 12, 6%) and CRD (n = 11, 6%) were reported in the fewest studies (Fig. 4).

The burden of NCDs among PLHIV

Detailed results are given separately for each NCD/risk factor.

Hypertension

Most studies (n = 97)[20,150,151,154,156,158–162] reviewed, reported on hypertension among PLHIV in SSA with a pooled prevalence of 20.1% (95% CI:17.5–22.7). Most of the studies (n = 18) were from Uganda.[16,165,167,170–174,176,179–183,186–189] South Africa followed with 15 studies.[8,125,126,131–133,135–137,140,141,145,148–150] In 2021, Chiwandire[126] reported trends for hypertension over three time points (2005, 2008, and 2017) in South Africa, and this study is indicated three times on the forest plot. Tanzania,[10,16,151,152,155,157,159–163] and Kenya,[4,16,75–79,86,90,92,93] each had eleven studies. Ethiopia[40,42,47,50,53,55,61,64] and Nigeria[16,108,109,113,114,119,121,123] each had eight studies. Cameroon[22,23,27,29–31] had six studies,[25,107,108,112,113,118,120,122] while Ghana[65,66,68,71,72] had five studies. Malawi[97,98,100,104] and Zimbabwe[194,197,199,200] each had four studies while Zambia,[190,194] and Burkina Faso[17,19] each had two studies. Burundi,[21] DRC,[36] Lesotho,[96] and Mozambique[105] each had one study. Despite the definition of hypertension being

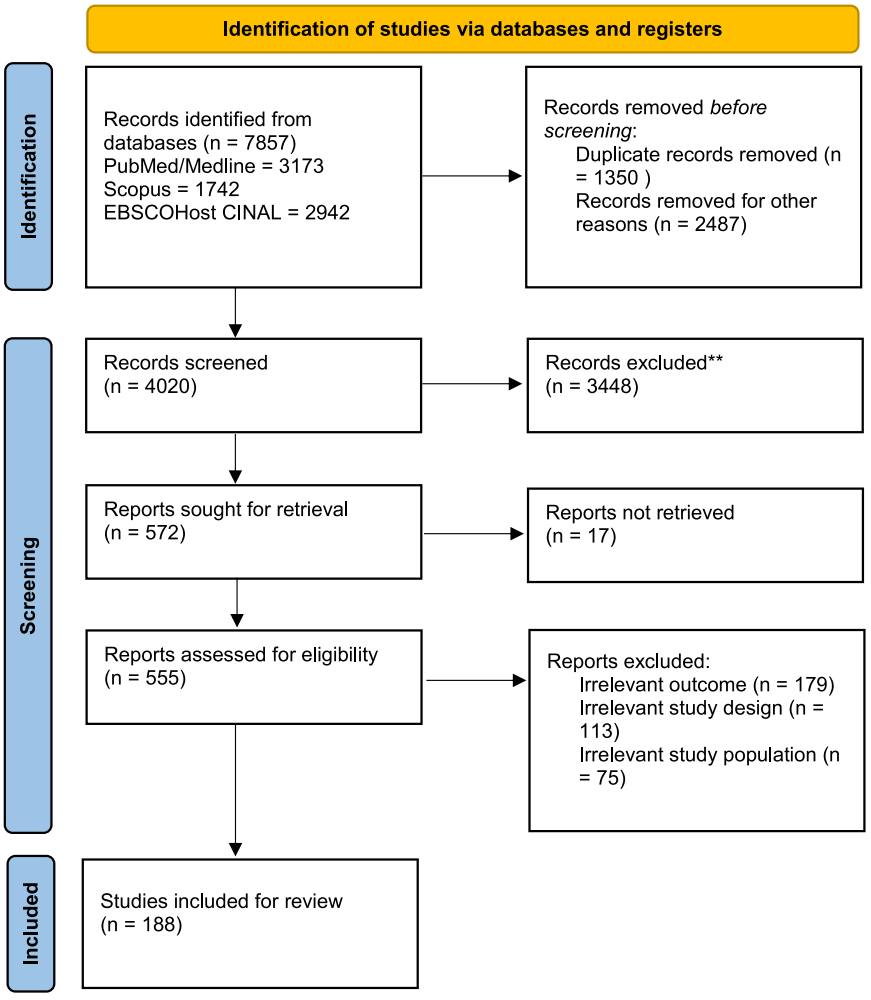

Fig. 1: Selection of studies on non-communicable diseases among people living with HIV (PLHIV) in Sub-Saharan Africa (SSA).

similar across studies, the prevalence of hypertension ranged very widely from 1% in Kenya[76] and South Africa[145] to 52.9% in South Africa,[150] hence there was very high heterogeneity across studies (I^2 = 98.1%) (Fig. 5). However, the LFK index (=1.59), and the Doi plot (Supplementary material; Appendix III: Fig. A) indicated evidence of minor upward potential for publication bias.

Depression

We reviewed 38 studies reporting depression among PLHIV in SSA with a pooled prevalence of 30.4% (95% CI: 25.3–35.4). Most studies (n = 10) reporting depression were conducted in Ethiopia.[41,43–45,48,51,52,56–58] Nigeria followed with seven studies[106,112,115–119] while Cameroon[24–26,28,32] had five studies. Uganda[164,169,173,175] and South Africa[124,129,138,147] had four studies each. Ghana,[70,73] Malawi[101,102] and Zambia[193,195] each had two studies. Tanzania,[156] and Zimbabwe[198] each had one study. Different tools were used to measure depression across studies, but the most common tool was the patient health questionnaire module for depression (PHQ-9). The prevalence of depression across studies was very wide, from 5.3% in Nigeria[116] to 81.6% in Ethiopia[52] with very high heterogeneity (I^2 = 97.4%) (Fig. 6). The LFK index (3.57) and the corresponding doi plot (Supplementary material; Appendix III: Fig. B) suggested potential of major upward publication bias.

Diabetes

In this review, 73 studies reported the burden of diabetes among PLHIV in SSA with a pooled prevalence of 5.4% (95% CI: 4.4–6.4). Most of the studies reporting the prevalence of diabetes were from South Africa (n = 13),[126,127,130–133,135–137,140,141,145,146] followed by Ethiopia (n = 9)[40,46,47,49,50,54,55,59,64] and Tanzania (n = 9).[10,95,152–154,159,161–163] Kenya[4,76,78,87,90,91,95] and Uganda[95,165,167,173,180,182,183] each had seven studies. Cameroon,[27,29–31] Ghana,[65–67,69] Malawi,[97,98,100,104] Nigeria,[95,108,110,114] and Zimbabwe[194,197,199,200]

Study ID	Country	Study setting	Study design	Number of PLHIV	Age in years/age range	Female Sex	Hypertension	Depression	Diabetes	Cervical Cancer	CRD	Smoking	Alcohol	Overweight/ obese	Hypercholesterolemia	Metabolic syndrome
Codjo 2022	Benin	HIV clinic	Cross sectional	114	18+	72%	√	X	√	X	X	√	X	X	X	√
Diallo 2017	Burkina Faso	HIV clinic	Cohort	3367	15+	70%	√	X	X	X	X	X	X	X	√	X
Guira 2016	Burkina Faso	HIV clinic	Cross sectional	300	18+	69%	X	X	X	X	X	X	√	√	√	√
Tougouma 2021	Burkina Faso	HIV clinic	Cohort	123	36–50	79%	√	X	√	X	X	√	X	√	√	X
Ndizeye 2019	Burundi	HIV clinic	Cross sectional	680	25–65	100%	X	X	X	√	X	√	√	X	X	X
Harimenshi 2023	Burundi	HIV clinic	Cross sectional	1250	35–50	82%	√	X	√	X	X	√	√	√	X	X
Dimala 2016	Cameroon	HIV clinic	Cross sectional	200	21+	70%	√	X	X	X	X	√	√	√	X	X
Dzudie 2021	Cameroon	Database	Cross sectional	9839	18+	66%	√	X	X	X	X	√	√	√	X	X
Gaynes 2012	Cameroon	HIV clinic	Cross sectional	400	18+	74%	X	√	X	X	X	X	X	X	X	X
Kanmogne 2016	Cameroon	HIV clinic	Cross sectional	169	18+	80%	X	√	X	X	X	X	X	X	X	X
L'akoa 2013	Cameroon	HIV clinic	Cross sectional	100	18–62	52%	X	√	X	X	X	X	X	X	X	X
Ngu 2018	Cameroon	HIV clinic	Cross sectional	311	22–73	84%	√	X	√	X	X	√	X	√	X	X
Ngum 2017	Cameroon	HIV clinic	Cross sectional	300	22–74	73%	X	√	X	X	X	X	X	X	X	X
Noumegni 2017	Cameroon	HIV clinic	Cross sectional	452	30–74	80%	√	X	√	X	X	X	X	√	√	√
Nsagha 2015	Cameroon	HIV clinic	Cross sectional	215	21–73	75%	√	X	√	X	X	√	X	√	√	X
Rhee 2016	Cameroon	HIV clinic	Cross sectional	500	16–65	73%	√	X	√	X	X	X	X	√	X	X
Filiatreau 2022	Cameroon	HIV clinic	Cohort	426	21–40	59%	X	√	X	X	X	X	X	X	X	X
Pambou 2023	Cameroon	HIV clinic	Cross sectional	112	50–77	63%	X	X	X	X	X	√	√	√	√	X
Parcesepe 2022	Cameroon	Database	Cross sectional	12,507	18+	66%	X	X	X	X	X	√	X	X	X	X
Jaquet 2014	Cote d'Ivoire	Database	Cross sectional	2998	25+	100%	X	X	X	√	X	X	X	X	X	X
Mukeba-Tshialala 2017	DRC	HIV Clinic	Cross sectional	445	18+	58%	√	X	√	X	X	X	X	X	√	X
Ndona 2012	DRC	HIV clinic	Cross sectional	102	18+	51%	X	X	√	X	X	√	√	X	X	X
Achila 2022	Eritrea	HIV clinic	Cross sectional	382	18–82	67%	X	X	X	X	X	X	X	√	√	X
Harris 2021	Eswatini	HIV clinic	Cross sectional	50	50–75	52%	X	X	X	X	X	√	X	X	X	X
Ataro 2018	Ethiopia	HIV clinic	Cross sectional	425	18–68	70%	√	X	√	X	X	√	√	√	√	X

(Table 1 continues on next page)

Study ID	Country	Study setting	Study design	Number of PLHIV	Age in years/age range	Female Sex	Hypertension	Depression	Diabetes	Cervical Cancer	CRD	Smoking	Alcohol	Overweight/ obese	Hypercholesterolemia	Metabolic syndrome
(Continued from previous page)																
Beyene 2019	Ethiopia	HIV clinic	Cross sectional	411	18–62	42%	X	√	X	X	X	X	X	X	X	X
Bitew 2016	Ethiopia	HIV clinic	Cross sectional	393	18+	59%	X	√	X	X	X	√	√	X	X	X
Bosho 2018	Ethiopia	HIV clinic	Cross sectional	286	18+	79%	√	X	X	X	√	√	√	√	√	√
Dorsisa 2020	Ethiopia	HIV clinic	Cross sectional	303	18+	53%	X	√	X	X	X	√	√	X	X	X
Duko 2018	Ethiopia	HIV clinic	Cross sectional	401	18+	71%	X	√	X	X	X	X	X	X	X	X
Duko 2019	Ethiopia	HIV clinic	Cross sectional	363	18+	66%	X	√	X	X	X	X	X	X	X	X
Faurholt-Jepsen–2019	Ethiopia	HIV clinic	Cross sectional	332	18+	67%	X	X	√	X	X	X	X	X	X	X
Fiseha 2019	Ethiopia	HIV clinic	Cross sectional	408	18+	67%	√	X	√	X	X	√	√	√	X	X
Gebremariam 2017	Ethiopia	HIV clinic	Cross sectional	417	18+	58%	X	√	X	X	X	X	X	X	X	X
Gebrie 2020	Ethiopia	HIV clinic	Cross sectional	407	18+	60%	X	X	√	X	X	√	√	X	X	X
Getahun 2020	Ethiopia	HIV clinic	Cross sectional	560	18+	62%	√	X	√	X	X	X	√	√	X	X
Kemal 2021	Ethiopia	HIV clinic	Cross sectional	353	18+	45%	X	√	X	X	X	√	√	X	√	X
Lukas 2021	Ethiopia	HIV clinic	Cross sectional	382	19–63	54%	√	X	X	X	X	X	X	√	X	√
Mohammed 2015	Ethiopia	HIV clinic	Cross sectional	393	21–75	70%	X	X	√	X	X	X	X	X	X	X
Mulugeta 2021	Ethiopia	HIV Clinic	Cohort	302	18+	51%	√	X	√	X	X	√	√	√	X	X
Seid 2020	Ethiopia	HIV clinic	Cross sectional	395	25–34	61%	X	√	X	X	X	X	X	X	X	X
Tareke 2018	Ethiopia	HIV clinic	Cross sectional	407	18+	58%	X	√	X	X	X	X	X	X	X	X
Tesfaw 2016	Ethiopia	HIV clinic	Cross sectional	417	18+	60%	X	√	X	X	X	X	X	X	X	X
Tadesse 2022	Ethiopia	HIV clinic	Cross sectional	351	18+	70%	X	X	√	X	X	√	√	√	X	X
Tilahun 2022	Ethiopia	HIV clinic	Cross sectional	228	18+	55%	X	X	X	X	X	√	X	X	√	X
Woldeyes 2022	Ethiopia	HIV clinic	Cross sectional	333	18+	68%	√	X	X	X	X	√	√	√	√	√
Woldeyes 2022b	Ethiopia	HIV clinic	Cross sectional	285	19–83	68%	X	X	X	X	X	√	√	X	X	X
Zelalem 2022	Ethiopia	HIV clinic	Cross sectional	267	18–65	100%	X	X	X	X	X	√	√	X	X	X
Zewudie 2022	Ethiopia	HIV clinic	Cross sectional	388	18+	61%	√	X	√	X	X	√	√	X	X	X

(Table 1 continues on next page)

Study ID	Country	Study setting	Study design	Number of PLHIV	Age in years/age range	Female Sex	Hypertension	Depression	Diabetes	Cervical Cancer	CRD	Smoking	Alcohol	Overweight/ obese	Hypercholesterolemia	Metabolic syndrome
(Continued from previous page)																
Appiah 2019	Ghana	HIV clinic	Cross sectional	345	18+	85%	√	X	√	X	X	√	X	√	√	X
Sanuade 2021	Ghana	HIV clinic	Cross sectional	525	19–40	16%	√	X	√	X	X	√	√	√	√	X
Sarfo 2019	Ghana	HIV clinic	Cross sectional	451	30+	81%	√	X	√	X	X	√	√	√	X	√
Sarfo 2019b	Ghana	HIV clinic	Cross sectional	451	30+	81%	√	X	X	X	X	√	X	X	√	X
Sarfo 2020	Ghana	HIV clinic	Cross sectional	502	30+	75%	X	X	√	X	X	X	X	X	X	X
Ayisi-Boateng 2022	Ghana	HIV clinic	Cohort	491	30+	81%	X	√	X	X	X	X	√	X	X	X
Dzudzor 2023	Ghana	HIV clinic	Case control	308	25–52	67%	√	X	X	X	X	√	√	√	√	√
Kotey 2022	Ghana	HIV clinic	Cohort	222	16+	65%	√	X	X	X	X	√	X	X	X	X
Nutor 2023	Ghana	HIV clinic	Cross sectional	159	18+	20%	X	√	X	X	X	X	X	X	X	X
Steiniche 2016	Guinea Bissau	HIV clinic	Cross sectional	893	15+	63%	X	X	√	X	X	X	X	X	X	X
Achwoka 2019	Kenya	Database	Cohort	3170	15+	67%	√	X	√	X	√	X	X	X	X	X
Achwoka 2020	Kenya	Database	Cohort	1478	15+	94%	√	X	√	√	√	X	X	√	X	X
Juma 2019	Kenya	Database	Cross sectional	1502	18+	69%	√	X	√	X	X	√	X	√	√	X
Manuthu 2008	Kenya	HIV clinic	Cross sectional	295	20+	58%	√	X	X	X	X	√	X	X	√	X
Masyuko 2020	Kenya	HIV clinic	Cross sectional	300	30+	50%	√	X	√	X	X	√	√	√	X	√
Mbuthia 2021	Kenya	HIV clinic	Cross sectional	939	18–84	69%	√	X	X	X	X	X	X	√	X	X
Memiah 2012	Kenya	HIV clinic	Cross sectional	191	18–69	100%	X	X	X	√	X	X	X	X	X	X
Memiah 2015	Kenya	HIV clinic	Cross sectional	614	18–69	100%	X	X	X	√	X	X	X	X	X	X
Menon 2018	Kenya	HIV clinic	cross sectiona	74	18+	100%	X	X	X	√	X	X	X	X	X	X
Mungo 2013	Kenya	HIV clinic	cross sectional	4308	22–50	100%	X	X	X	√	X	X	X	X	X	X
Njue 2021	Kenya	HIV clinic	Cross sectional	73	18–46	100%	X	X	X	√	X	X	X	X	X	X
Nyongesa 2019	Kenya	HIV clinic	Cross sectional	450	18–60	79%	√	√	X	X	X	√	√	X	X	X
Nyongesa 2021	Kenya	HIV clinic	Cross sectional	406	18–24	57%	X	X	X	X	X	√	√	X	X	X
Osoti 2018	Kenya	HIV clinic	Cross sectional	300	18+	64%	X	X	√	X	X	√	√	√	X	√
Temu 2015	Kenya	HIV clinic	Cross sectional	300	18–80	64%	X	X	X	X	X	√	X	√	√	X
Tilahun 2021	Kenya	HIV clinic	Cross sectional	287	30+	50%	X	X	X	X	X	√	√	√	√	X

(Table 1 continues on next page)

Study ID	Country	Study setting	Study design	Number of PLHIV	Age in years/age range	Female Sex	Hypertension	Depression	Diabetes	Cervical Cancer	CRD	Smoking	Alcohol	Overweight/ obese	Hypercholesterolemia	Metabolic syndrome
(Continued from previous page)																
Ahmed 2022	Kenya	HIV clinic	Cross sectional	200	30+	60%	√	X	√	X	X	√	X	√	√	X
Farrant 2022	Kenya	HIV clinic	Cross sectional	145	30+	56%	X	X	√	X	X	√	X	√	√	X
Mogaka 2022	Kenya	HIV clinic	Cross sectional	300	30+	50%	√	X	X	X	X	√	√	√	√	X
Oyawa 2022	Kenya	HIV clinic	Cross sectional	280	21–80	69%	√	X	X	X	X	X	√	√	X	X
Monroe 2022	Kenya,Nigeria, Tanzania & Uganda	HIV clinic	Cohort	2774	18+	59%	X	X	X	X	X	√	√	√	√	X
Chang 2022	Kenya,Nigeria, Tanzania & Uganda	HIV clinic	Cohort	3099	15+	59%	X	X	√	X	X	X	X	X	X	X
Sebilo 2021	Lesotho	Database	Cohort	785	18+	60%	√	X	√	X	X	X	X	X	X	X
Amberbir 2019	Malawi	HIV clinic	Cohort	820	18+	72%	√	X	√	X	X	√	X	√	√	X
Divala 2016	Malawi	HIV clinic	Cross sectional	952	18+	72%	√	X	√	X	X	√	√	√	√	X
Kohler 2016	Malawi	Database	Cross sectional	226	18+	100%	X	X	X	√	X	X	X	X	X	X
Malava 2018	Malawi	HIV clinic	Cross sectional	206	18+	59%	X	√	X	X	X	X	X	X	X	X
Rucker 2018	Malawi	HIV clinic	Cross sectional	379	30+	73%	√	X	√	X	X	√	X	X	√	X
Stockton 2021	Malawi	HIV clinic	Cross sectional	1091	18+	53%	X	√	X	X	X	X	X	X	X	X
Moucheraud 2022	Malawi	HIV clinic	Cross sectional	134	30–88	49%	X	X	X	X	X	X	√	√	X	X
Steffen 2023	Malawi	HIV clinic	Cohort	1288	18+	58%	√	X	√	X	X	X	X	√	X	X
Mocumbi 2019	Mozambique	HIV clinic	Cohort	70	18+	59%	√	X	√	X	X	√	X	√	√	X
Dakum 2021	Nigeria	HIV clinic	Cross sectional	19,566	50+	47%	X	X	X	X	X	X	X	√	X	X
Egbe 2017	Nigeria	HIV clinic	Cross sectional	1187	18+	67%	X	√	X	X	X	√	X	X	X	X
Ekrikpo 2018	Nigeria	HIV clinic	Cross Sectional	12,167	18+	60%	√	X	√	X	X	X	X	√	√	X
Ekun 2021	Nigeria	HIV clinic	Cross sectional	196	25–84	64%	√	X	X	X	X	X	X	√	X	X
Isa 2016	Nigeria	HIV clinic	Cross sectional	2632	18+	65%	X	X	√	X	X	X	X	X	X	X
Muhammad 2017	Nigeria	HIV clinic	Cross sectional	300	18+	64%	X	X	X	X	X	√	√	X	X	√
Obadeji 2014	Nigeria	HIV clinic	Cross sectional	130	18+	69%	X	√	X	X	X	X	X	X	X	X
Ogunmola 2014	Nigeria	HIV clinic	Cross sectional	250	13–52	62%	√	X	X	X	X	X	X	X	X	X
Ojong 2022	Nigeria	HIV clinic	Cross sectional	150	30+	51%	√	X	√	X	X	X	X	X	X	√
Olagunju 2012	Nigeria	HIV clinic	Cross sectional	300	28+	62%	X	√	X	X	X	X	X	X	X	X

(Table 1 continues on next page)

Study ID	Country	Study setting	Study design	Number of PLHIV	Age in years/age range	Female Sex	Hypertension	Depression	Diabetes	Cervical Cancer	CRD	Smoking	Alcohol	Overweight/ obese	Hypercholesterolemia	Metabolic syndrome
(Continued from previous page)																
Olagunju 2013	Nigeria	HIV clinic	Cross sectional	295	31–40	61%	X	√	X	X	X	X	X	X	X	X
Olisah 2015	Nigeria	HIV clinic	Cross sectional	310	18+	68%	X	√	X	X	X	X	X	X	X	X
Abiodun 2022	Nigeria	HIV clinic	Cross sectional	458	18+	100%	X	√	X	X	X	X	X	X	X	X
Adebajo 2023	Nigeria	HIV clinic	Cross sectional	761	16+	0%	√	√	X	X	X	X	X	√	√	X
Adedokun 2023	Nigeria	HIV clinic	Cross sectional	277	20+	64%	X	X	X	X	X	√	√	√	√	X
Badru 2022	Nigeria	HIV clinic	Cross sectional	301	18+	69%	√	X	X	X	X	X	√	√	X	X
Fink 2022	Nigeria	HIV clinic	Cross sectional	170	18+	77%	X	X	X	X	√	√	X	X	X	X
Jackson 2022	Nigeria	HIV clinic	Cross sectional	417	18+	69%	√	X	X	X	X	X	X	√	X	X
Brennan 2018	South Africa	HIV clinic	cohort	77,696	18+	61%	√	X	X	X	X	X	X	√	X	X
Chiwandire 2021	South Africa	Database	Cross sectional	4484	25+	66%	√	X	√	X	X	X	X	X	X	X
Dave 2011	South Africa	HIV clinic	Cross sectional	849	28–44	77%	X	X	√	X	X	X	X	X	X	X
Dhokotera 2021	South Africa	Database	Cross sectional	8479	20–24	54%	X	X	X	√	X	X	X	X	X	X
Freeman 2007	South Africa	HIV clinic	Cross sectional	900	18+	74%	X	√	X	X	X	X	X	X	X	X
Hopkins 2021	South Africa	HIV clinic	Cross sectional	149	18+	73%	X	X	√	X	X	X	X	√	√	X
Hyle 2019	South Africa	HIV clinic	Cross sectional	458	21+	78%	√	X	√	X	X	√	X	√	X	X
Julius 2011	South Africa	HIV clinic	Cross sectional	304	18–45	78%	√	X	√	X	X	X	X	√	√	√
Kubiak 2021	South Africa	HIV clinic	Cross sectional	1207	18+	56%	√	X	√	X	X	√	√	√	X	X
Kummerow 2019	South Africa	Community	Cross sectional	394	18+	68%	X	X	X	X	√	√	X	√	X	X
Magodoro 2022	South Africa	Database	Cross sectional	1213	15+	68%	√	X	√	X	X	√	X	√	X	X
Manne–Goehler 2018	South Africa	Community	longitudinal study	1035	40+	54%	√	X	√	X	X	X	X	√	X	X
Mashinya 2015	South Africa	HIV clinic	Cross sectional	214	15+	80%	√	X	√	X	X	√	√	X	√	√
Myer 2008	South Africa	HIV clinic	Cross sectional	443	18–65	75%	X	√	X	X	X	X	X	X	X	X
Nguyen 2017	South Africa	HIV clinic	Cross sectional	748	18+	79%	X	X	X	X	X	X	X	X	X	√
Olley 2006	South Africa	HIV clinic	Cohort	105	18–55	100%	X	√	X	X	X	X	X	X	X	X
Rabkin 2015	South Africa	HIV clinic	Cross sectional	175	30+	74%	√	X	√	X	X	√	X	√	√	X

(Table 1 continues on next page)

Study ID	Country	Study setting	Study design	Number of PLHIV	Age in years/age range	Female Sex	Hypertension	Depression	Diabetes	Cervical Cancer	CRD	Smoking	Alcohol	Overweight/ obese	Hypercholesterolemia	Metabolic syndrome
(Continued from previous page)																
Rajagopaul 2021	South Africa	HIV clinic	Cross sectional	301	18+	63%	√	X	√	X	X	X	X	X	X	X
Rohner 2017	South Africa	HIV clinic	Cohort	10,640	18+	100%	X	X	X	√	X	X	X	X	X	X
Ruffieux 2021	South Africa	Database	Cohort	2,507,909	18+	100%	X	X	X	√	X	X	X	X	X	X
Sobieszczyk 2016	South Africa	HIV clinic	Cohort	160	18+	100%	X	X	X	X	X	X	X	X	X	√
Umar 2021	South Africa	HIV clinic	Cohort	1203	18+	66%	√	X	√	X	X	X	X	X	X	X
Brennan 2023	South Africa	HIV clinic	Cohort	6948	18+	60%	√	X	X	X	X	X	X	√	X	X
de Vries 2023	South Africa	HIV clinic	Cross sectional	356	18+	72%	X	X	√	X	X	X	X	X	X	X
Haas 2023	South Africa	Database	Cross sectional	54,378	15+	55%	X	√	X	X	X	X	X	X	X	X
Kamkuemah 2023	South Africa	HIV clinic	Cross sectional	87	15–24	76%	√	X	X	X	X	X	X	√	X	X
Okyere 2022	South Africa	Database	Cross sectional	517	50+	77%	√	X	X	X	X	√	√	√	X	X
Tsuro 2022	South Africa	HIV clinic	Cohort	361	15+	89%	√	X	X	X	X	√	√	√	X	X
Albrecht 2019	Tanzania	HIV clinic	Cohort	1622	15+	65%	√	X	X	X	X	√	√	X	X	X
Hertz 2022	Tanzania	HIV clinic	Cross sectional	500	18+	72%	√	X	√	X	X	X	X	X	X	X
Jeremiah 2020	Tanzania	Database	Cross sectional	1292	18+	61%	X	X	√	X	X	√	X	√	X	X
Kafuruki 2013	Tanzania	HIV clinic	Cross sectional	355	18–63	100%	X	X	X	√	X	X	X	X	X	X
Kagaruki 2014	Tanzania	HIV clinic	Cross sectional	671	18+	71%	√	X	√	X	X	√	√	√	√	X
Maganga 2015	Tanzania	HIV clinic	Cross sectional	301	18+	68%	X	X	√	X	X	√	√	√	X	X
Manavalan 2020	Tanzania	HIV clinic	Cohort	555	18+	79%	√	X	X	X	X	X	X	X	X	X
Marwick 2010	Tanzania	HIV clinic	Cross sectional	220	16–75	74%	X	√	X	X	X	X	X	X	X	X
Memiah 2021	Tanzania	HIV clinic	Cross sectional	261	18+	76%	√	X	X	X	X	X	√	√	X	X
Msoka 2018	Tanzania	HIV clinic	Cross sectional	102	30+	74%	X	X	X	X	X	X	X	X	X	√
Peck 2014	Tanzania	HIV clinic	Cross sectional	301	18+	68%	√	X	√	X	X	√	√	√	X	X
Kavishe 2022	Tanzania	HIV clinic	Cohort	640	18+	67%	√	X	X	X	X	√	√	√	X	X
Malindisa 2023	Tanzania	HIV clinic	Cross sectional	223	18+	80%	√	X	√	X	X	√	√	√	√	√
Mwakyandile 2023	Tanzania	HIV clinic	Cross sectional	430	18+	65%	√	X	√	X	X	X	X	√	√	X
Prattipati 2022	Tanzania	HIV clinic	Cross sectional	497	18+	73%	√	X	√	X	X	√	√	X	X	X
Akena 2013	Uganda	HIV clinic	Cross sectional	735	18+	71%	X	√	X	X	X	X	X	X	X	X

(Table 1 continues on next page)

Study ID	Country	Study setting	Study design	Number of PLHIV	Age in years/age range	Female Sex	Hypertension	Depression	Diabetes	Cervical Cancer	CRD	Smoking	Alcohol	Overweight/ obese	Hypercholesterolemia	Metabolic syndrome
(Continued from previous page)																
Enriquez 2022	Uganda	Database	Cross sectional	960	35–49	64%	√	X	√	X	X	√	√	√	√	X
Kansiime 2019	Uganda	Database	Cross sectional	387	18+	66%	√	X	√	X	√	√	√	X	X	X
Kayongo 2020	Uganda	HIV clinic	Cross sectional	722	35+	62%	X	X	X	X	√	√	X	√	X	X
Kinyanda 2017	Uganda	HIV clinic	Cross sectional	899	18+	78%	X	√	X	X	X	X	X	X	X	X
Kwarisiima 2019	Uganda	Community	Intervention	2071	18+	58%	√	X	X	X	X	X	X	X	X	X
Lubega 2021	Uganda	HIV clinic	Intervention	2026	18–59	74%	√	X	X	X	X	X	X	√	X	X
Mateen 2013	Uganda	HIV clinic	Cohort	5563	13+	67%	√	X	X	X	X	X	X	X	X	X
Muyanja 2016	Uganda	HIV clinic	Cross sectional	250	20+	68%	√	X	√	X	X	√	X	√	√	√
Nakimuli-Mpungu 2011	Uganda	HIV clinic	Cross sectional	500	18–80	70%	X	√	X	X	X	X	√	X	X	X
Niwaha 2021	Uganda	HIV clinic	Cross sectional	721	35+	60%	√	X	X	X	X	√	X	√	X	X
North 2018	Uganda	HIV clinic	Cross sectional	143	40+	46%	X	X	X	X	√	√	X	√	X	X
Okello 2015	Uganda	HIV clinic	Cohort	3389	18+	67%	√	X	X	X	X	X	X	√	X	X
Sander 2015	Uganda	HIV clinic	Cross sectional	426	18+	71%	√	X	X	X	X	X	X	√	X	X
Amutuhaire 2023	Uganda	HIV clinic	Cross sectional	309	18+	59%	√	X	√	X	X	√	X	√	√	√
Buzaalirwa 2022	Uganda	HIV clinic	Cross sectional	1426	18+	65%	√	X	X	X	X	X	X	√	X	X
Byonanebye 2023	Uganda	HIV clinic	Cohort	970	40–51	62%	√	X	√	X	X	√	√	X	X	X
Gilbert 2022	Uganda	HIV clinic	Cross sectional	140	40+	46%	√	X	√	X	√	X	X	√	√	X
Kayongo 2023	Uganda	HIV clinic	Cross sectional	100	35–80	44%	X	X	X	X	√	√	X	√	X	X
Kiyimba 2022	Uganda	Community	Cross sectional	254	18+	71%	X	X	X	X	X	√	√	X	X	√
Mugisha 2016	Uganda	HIV Clinic	Cross sectional	244	50+	60%	√	√	√	X	√	√	√	X	X	X
Migisha 2023	Uganda	HIV clinic	Cross sectional	1045	13–25	68%	√	X	X	X	X	√	√	√	X	X
Mulindwa 2023	Uganda	HIV clinic	Cross sectional	243	18+	58%	√	X	X	X	X	√	√	√	X	X
Mutebi 2023	Uganda	HIV clinic	Cross sectional	430	18+	71%	√	X	X	X	X	X	X	√	√	X
Niwaha 2022	Uganda	HIV clinic	Cross sectional	140	18+	70%	√	X	X	X	X	√	X	√	X	X
Bauer 2017	Zambia	HIV clinic	Cohort	896	18+	52%	√	X	X	X	X	√	X	√	X	X
Hamooya 2021	Zambia	HIV clinic	Cross sectional	1108	18+	60%	X	X	X	X	X	√	√	X	X	√

(Table 1 continues on next page)

Study ID	Country	Study setting	Study design	Number of PLHIV	Age in years/age range	Female Sex	Hypertension	Depression	Diabetes	Cervical Cancer	CRD	Smoking	Alcohol	Overweight/ obese	Hypercholesterolemia	Metabolic syndrome
(Continued from previous page)																
Shankalala 2017	Zambia	HIV clinic	Cross sectional	270	20–70	69%	X	X	√	X	X	√	X	√	X	X
van den Heuvel 2013	Zambia	HIV clinic	Cross sectional	418	16–92	53%	X	√	X	X	X	X	X	X	X	√
Chipanta 2021	Zambia	Community	Cross sectional	153	16+	87%	X	√	X	X	X	X	X	X	X	X
Kaluba 2023	Zambia	HIV clinic	Cross sectional	91	30+	58%	X	X	X	X	X	√	√	X	X	X
Chihota 2022	Zambia, Zimbabwe	HIV clinic	Cross sectional	420	30+	52%	√	X	√	X	X	√	X	√	X	√
Chibanda 2016	Zimbabwe	HIV clinic	Cross sectional	165	18+	75%	X	√	X	X	X	X	X	X	X	X
Chimbetete 2017	Zimbabwe	HIV clinic	Cohort	4110	16+	67%	√	X	√	X	X	X	X	√	X	X
Shamu 2021	Zimbabwe	HIV clinic	Cohort	420	50+	57%	√	X	√	X	X	X	X	X	X	X
Cheza 2022	Zimbabwe	HIV clinic	Cross sectional	324	18+	60%	√	X	√	X	X	X	X	X	X	X

CRD = Chronic respiratory diseases; DRC = Democratic Republic of Congo; PLHIV = People living with HIV. √ = prevalence data extracted for condition; X = prevalence data not available for this condition.

Table 1: **Characteristics of 188 included studies grouped by country.**

had four studies each. The DRC[36,37] and Zambia[192,194] each had two studies. Benin,[16] Burkina Faso,[19] Burundi,[21] Guinea Bissau,[74] Lesotho,[96] and Mozambique,[105] each had one study reporting diabetes prevalence. In 2021, Chiwandire[126] reported the prevalence of diabetes over three time points (2005, 2008 and 2017) in South Africa and hence appears three times on the forest plot. Heterogeneity was relatively high (I^2 = 81.1) as the prevalence of diabetes ranged widely from 0.3% in Kenya[76] to 41% in Zimbabwe[197] (Fig. 7). The LFK index (5.05) and the corresponding Doi plot (Supplementary material; Appendix III: Fig. C) suggested potential for major upward publication bias.

Cervical cancer

We reviewed 12 studies reporting the burden of cervical cancer among PLHIV in SSA with a pooled prevalence of 1.5% (95% CI: 0.1–2.9). Five studies described the burden of cervical cancer in Kenya,[80–84] three studies from South Africa,[128,142,143] a study each from Burundi,[20] Cote d'Ivoire,[35] Malawi,[99] and Uganda.[166] The prevalence of cervical cancer ranged from 0.1% in Cote d'Ivoire[35] to 28.8% in Malawi.[99] Heterogeneity was moderate (I^2 = 66.6%) (Fig. 8). The LFK index (10.07) and the corresponding Doi plot (Supplementary material; Appendix III: Fig. D) suggested potential for major upward publication bias.

Chronic respiratory diseases (CRDs)

We reviewed 11 studies reporting the prevalence of CRDs among PLHIV, with a pooled prevalence of 7.1% (95% CI: 4.0%–10.3%). The burden of asthma,[42,75,76,134,167] and that of chronic obstructive pulmonary diseases (COPD)[122,168,173,177,184] were each reported by five studies. We reviewed one study that described both asthma and COPD.[183] Most of the studies (n = 6) describing CRD were conducted in Uganda,[167,168,173,177,183,184] two studies in Kenya,[75,76] and a study each from Ethiopia,[42] Nigeria,[122] and South Africa.[134] The prevalence of CRD ranged from 0.3% in Kenya[75] to 50% in Uganda[184] and there was very high heterogeneity (I^2 = 90.7%) (Fig. 9). The LFK index (7.5) and the corresponding Doi plot (Supplementary material; Appendix III: Fig. E) suggested potential for major upward publication bias.

Overweight/obesity

We found 85 studies reporting the prevalence of being overweight or obese among PLHIV in SSA with a pooled prevalence of 32.2% (95% CI: 29.7–34.7). This was the highest burden among PLHIV in SSA. Most of the studies (n = 15) were conducted in Uganda[94,165,168,171,174,177,179–181,183,184,186–189] followed by South Africa (n = 13),[8,125,130–136,140,148–150] Kenya[4,75,78,79,87–94] with 12 studies, and Tanzania[10,94,153,154,157,159–162] had nine studies. Ethiopia[40,42,47,50,53,55,59,61] and Nigeria[94,107–109,119–121,123] each had eight studies. Cameroon[22,23,27,29–31,33] had seven

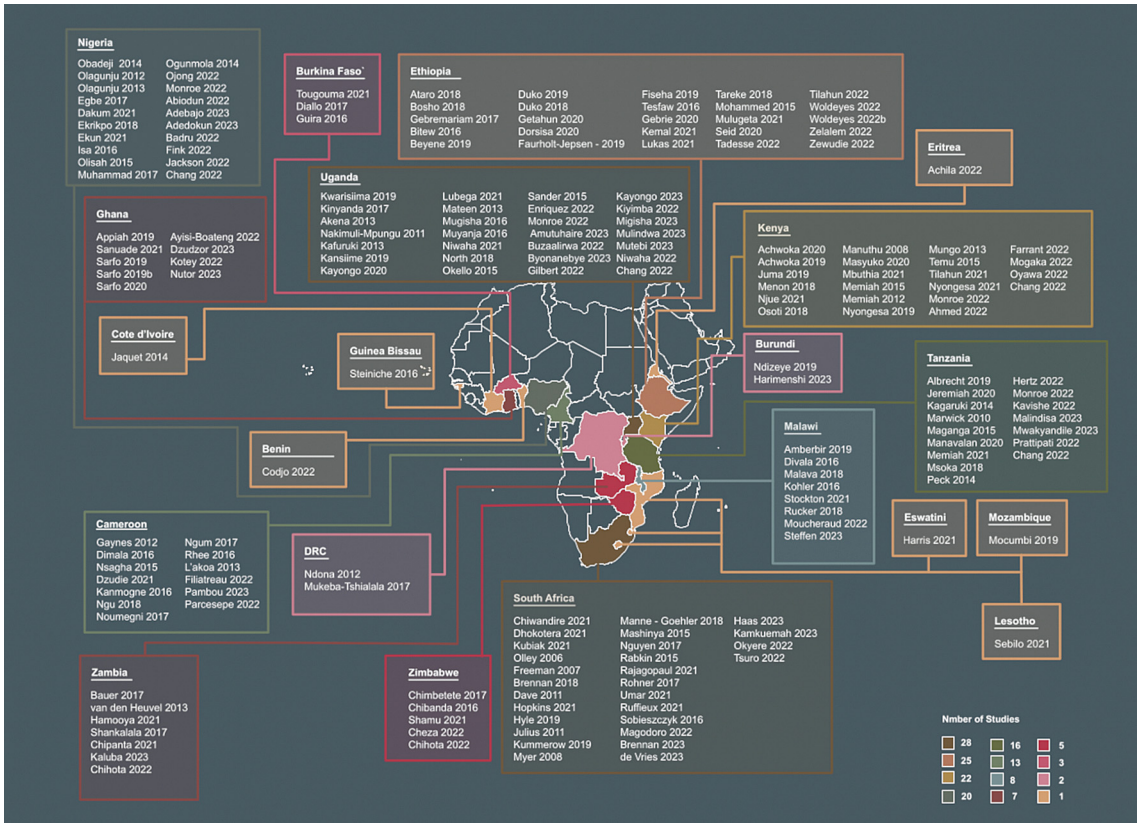

Fig. 2: Map showing countries where included studies on the burden of NCD/risk factors among PLHIV in SSA were conducted.

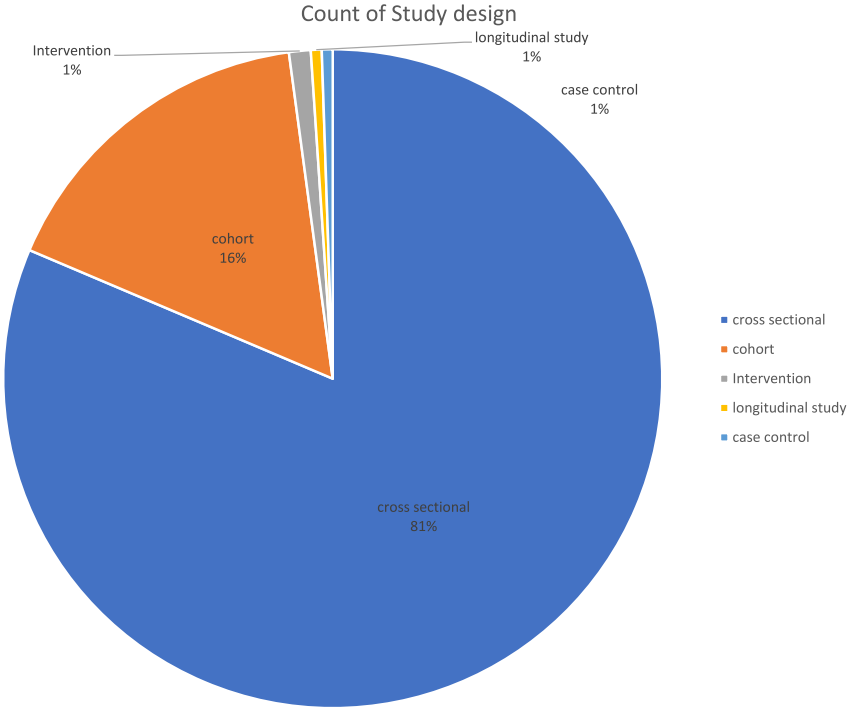

Fig. 3: Pie chart showing study designs for the burden of NCD/risk factors among PLHIV in SSA.

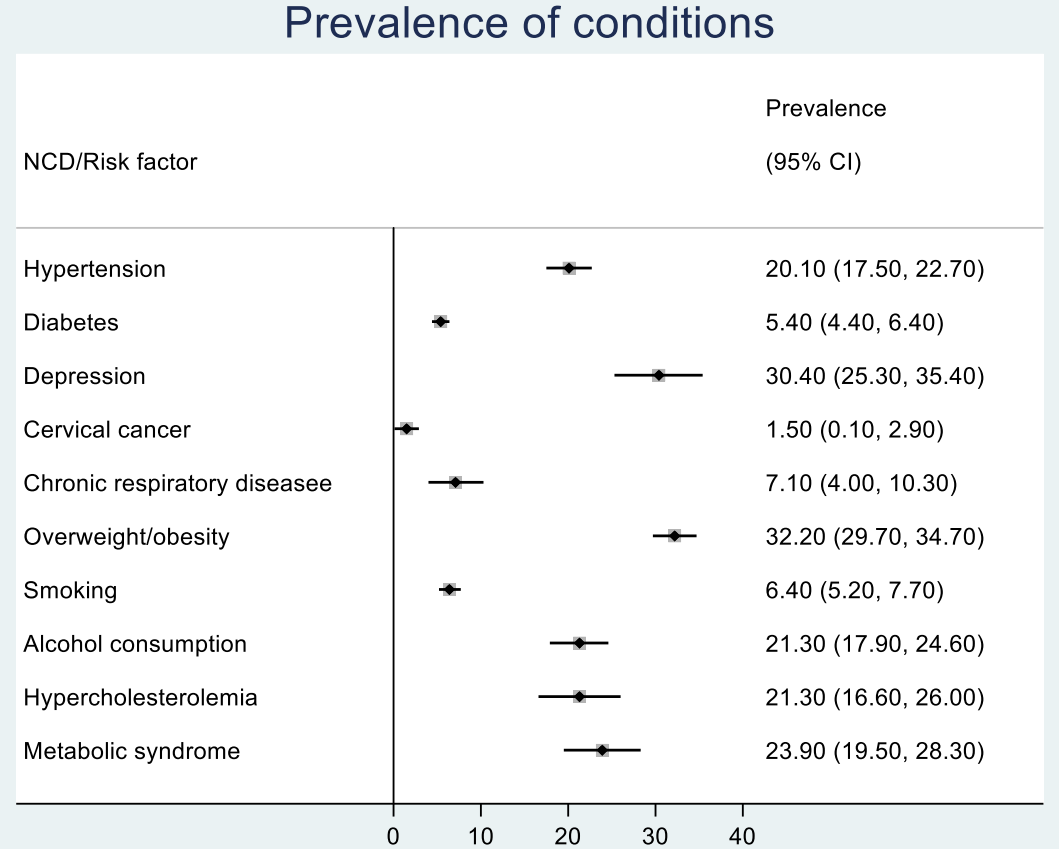

Fig. 4: Forest plot of pooled estimates generated by meta-analyses for prevalence of selected conditions among PLHIV in SSA.

studies, while Malawi,[97,98,103,104] had four studies. Ghana[66,67,71] and Zambia[190,192,194] each had three studies. Burkina Faso[18,19] and Zimbabwe[194,199] each had two studies, while Burundi,[21] Eritrea,[38] and Mozambique,[105] each had one study. The prevalence of overweight/obese ranged from 1.4% in Ethiopia[53] to 64.5% in Kenya[90] and heterogeneity was very high (I^2 = 96.1%) (Supplementary material; Appendix II: Fig. I). The LFK index (3.36) and the corresponding Doi plot (Supplementary material; Appendix III: Fig. F) suggested evidence of major upward potential for publication bias.

Hypercholesterolemia

We found 40 studies reporting hypercholesterolemia among PLHIV in SSA with a pooled prevalence of 21.3% (95% CI: 16.6–26.0). Kenya[4,77,88,90–92,94] had seven studies, while Ethiopia,[42,52,60,61,89] Tanzania[10,94,161,162,183] and Uganda[94,165,174,180,188] each had five studies. Ghana,[65,66,68,71] Nigeria,[94,108,119,120] and South Africa[130,132,137,140] had four studies each followed by Cameroon,[29,30,33] and Malawi[97,98,100] each with three studies. Eritrea,[38] Burkina Faso,[17] DRC,[36] and Mozambique[105] each had one study. The prevalence of hypercholesterolemia ranged from 4.1% in Nigeria[108] to 60.4% in Ethiopia[61] and heterogeneity was quite high (I^2 = 95.4%) (Supplementary material; Appendix II: Fig. II). The LFK index (3.36) and the corresponding Doi plot (Supplementary material; Appendix III: Fig. G) suggested evidence of major upward potential for publication bias.

Metabolic syndrome

We found 22 studies reporting the prevalence of metabolic syndrome among PLHIV in SSA with a pooled prevalence of 23.3% (95% CI: 18.8–27.8). Most of the studies (n = 4) were conducted in South Africa[132,137,139,144] followed by Uganda[174,180,185] with three studies. Ethiopia,[42,61] Ghana,[67,71] Kenya,[78,87] Nigeria,[111,114] Tanzania,[158,161] and Zambia[191,194] each had two studies. Benin,[16] Burkina Faso,[18] Cameroon,[29] and Zimbabwe[194] each had one study. The prevalence ranged from 6.3% in Kenya[78] to 58% in Uganda,[174] and heterogeneity was quite high (I^2 = 86.1%) (Supplementary material; Appendix II: Fig. III). The LFK index (1.38) and the corresponding Doi plot (Supplementary material; Appendix III: Fig. H) indicated evidence of minor upward potential for publication bias.

Alcohol consumption

We found 61 studies reporting current alcohol consumption among PLHIV in SSA with a pooled prevalence of 19.4% (95% CI: 14.4–24.4). Most of the studies (n = 15) were conducted in Ethiopia[40–43,47,49,50,52,55,59,61–64,89] followed by Tanzania[10,94,151,157,159–161,163] with nine studies. Kenya[78,85–88,92–94] and Uganda[94,167,173,175,182,185–187] each had eight studies while Ghana,[66,67,70,71] Nigeria[94,111,120,121] and South Africa[133,137,149,150] had four studies each. Burundi,[20,21] Malawi[98,103] and Zambia[191,196] had two studies each, while Burkina Faso,[18] and DRC,[37] had one study each. The prevalence of alcohol consumption ranged from 1.3% in Nigeria[121] to 66.1% in Cameroon,[33] and heterogeneity was quite high (I^2 = 93%), (Supplementary material; Appendix II: Fig. IV). The LFK index (2.44) and the corresponding Doi plot (Supplementary material; Appendix III: Fig. I) indicated evidence of major upward potential for publication bias.

Smoking

We included 84 studies describing the prevalence of current smoking among PLHIV in SSA with a pooled prevalence of 6.2% (95% CI: 5.0–7.4). Most of the studies (n = 14) were conducted in Ethiopia,[40–43,47,49,52,55,59–64] and Uganda.[165,167,173,174,176,177,180,182,184–187,189] followed by Kenya[4,77,78,85–92,94] with 12 studies and Tanzania[10,94,151,153,154,159–161,163] with nine studies. South Africa[131,133–135,137,140,149,150] had eight studies while Cameroon[22,23,27,30,33,34] had six studies. Ghana,[65–67,71,72] Nigeria[94,106,111,120,122] and Zambia[190–192,194,196] followed, each with five studies. Burundi[20,21] and Malawi[97,98] had two studies each, while Benin,[16] Burkina Faso,[19] DRC,[37] Eswatini,[39] Mozambique[105] and Zimbabwe[194] followed, each with one study. There were two multi-country studies[94,194] that included current alcohol use among PLHIV. The pooled prevalence of current smoking ranged from 0.8% in Burkina Faso[19] to 40% in Uganda[168] and the heterogeneity was moderate (I^2 = 64.7%) (Supplementary material; Appendix II: Fig. V). The LFK index (3.08) and its corresponding Doi plot (Supplementary material; Appendix III: Fig. J) showed evidence of major upward potential for publication bias.

Discussion

We estimated the prevalence of the major NCDs and their risk factors among PLHIV in SSA from 188 studies compared to 57 articles (in LMICs) from the previous review. Among the NCDs considered, depression had the highest prevalence at 31.4% (95% CI: 24.4–38.3) confirming the common occurrence of depression among PLHIV. However, it is important to note that other systematic reviews have reported varied estimates for the prevalence of depression at 36.3% (95% CI: 28.4%–44.2%) in Ethiopia[201] and 24.4% (95%

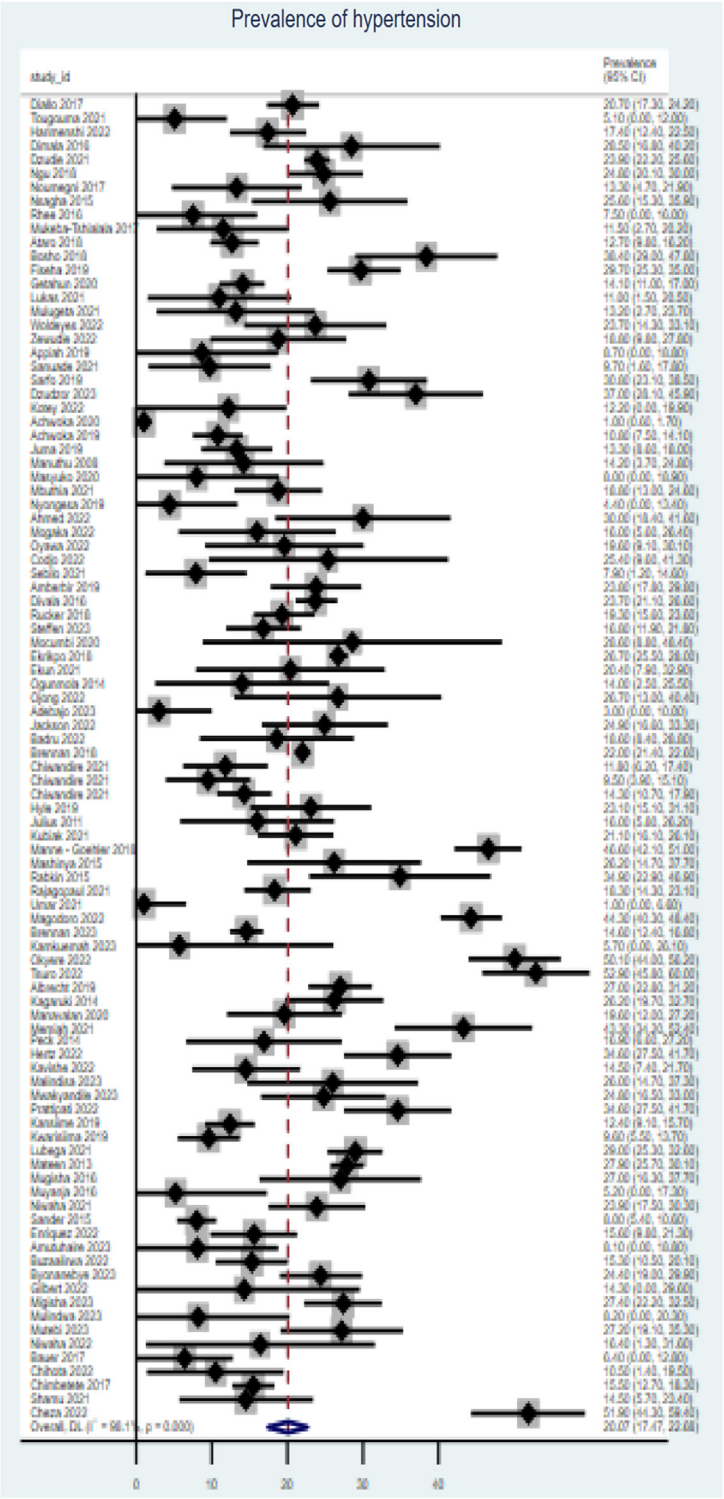

Fig. 5: Forest plot of pooled estimates generated by meta-analyses for prevalence of hypertension among PLHIV in SSA.

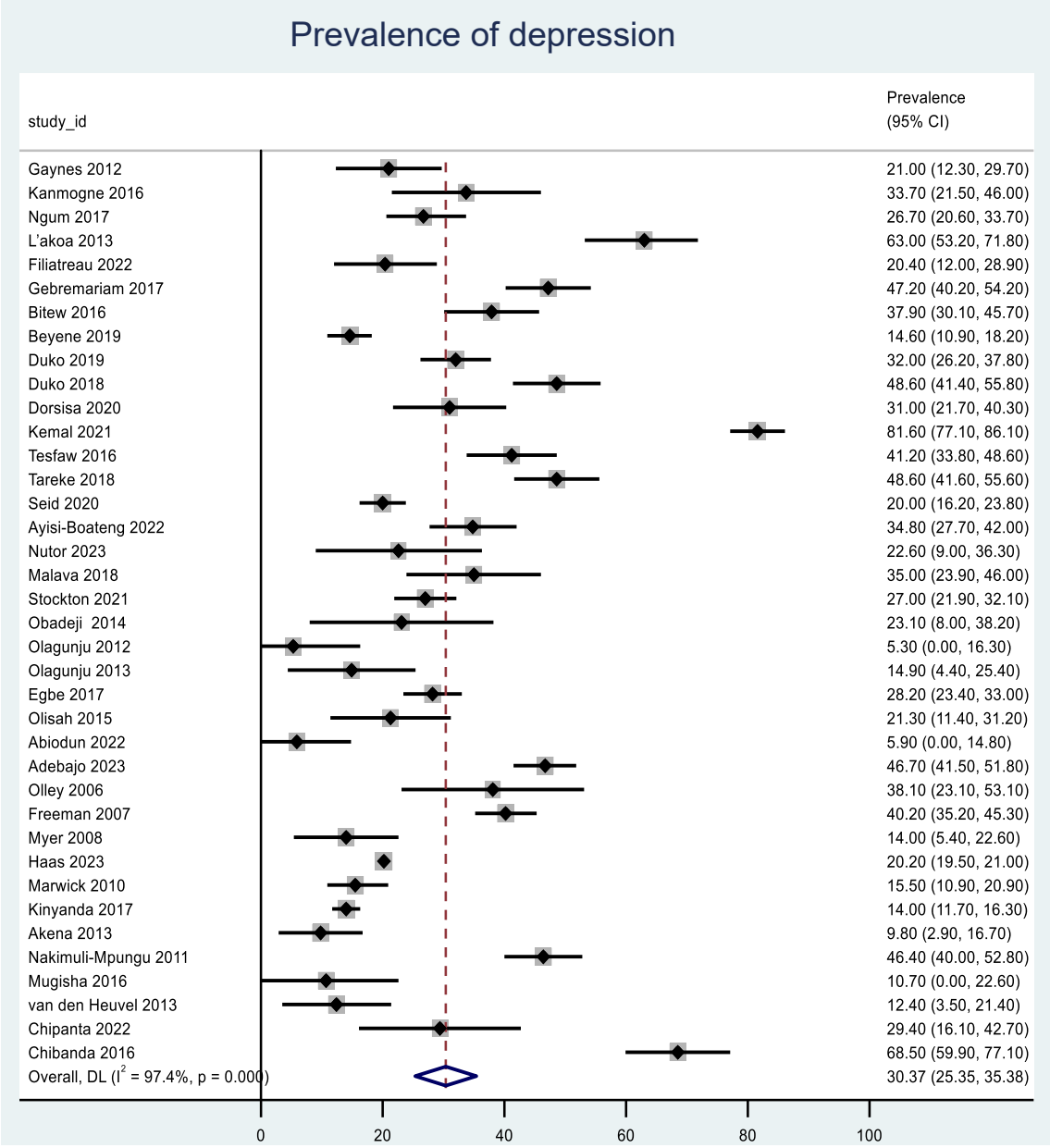

Fig. 6: Forest plot of pooled estimates generated by meta-analyses for prevalence of depression among PLHIV in SSA.

CI: 12.5–42.1) in LMICs.[12] The variation in prevalence may be due to different tools used to diagnose depression and study settings, in addition to potential publication bias.

The most common CVD risk factor, hypertension, reported a relatively high prevalence of 20.1% (95% CI: 17.5–22.7), among PLHIV in SSA. This prevalence estimate was slightly lower than the previously reported prevalence of 21.2% (95% CI: 16.3–17.1)in LMICs,[12] 19.9% (95% CI: 17.2–22.8) in Eastern and Southern Africa,[202] and 23.5% (95% CI: 16.6–31.0) in West and Central Africa.[202] The slight variation in estimates may be attributed to variations in the measurement process of blood pressure.[203] Although most studies used the same definition of hypertension, the measurement process may have varied. Factors such as whether resting blood pressure was measured, and the frequency of blood pressure measurements before confirming hypertension and perhaps differences in the type of sphygmomanometer used might have

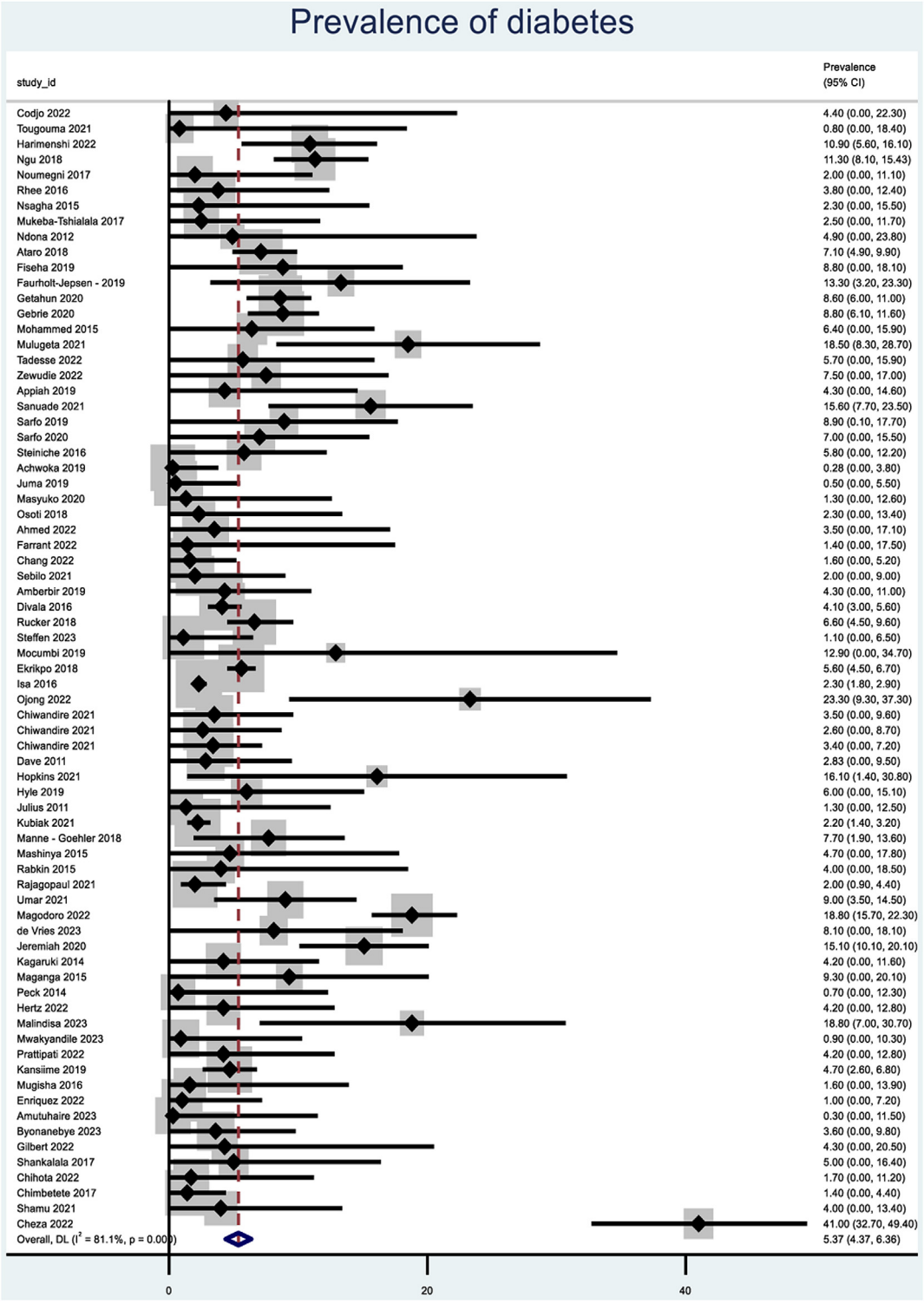

Fig. 7: Forest plot of pooled estimates generated by meta-analyses for prevalence of diabetes among PLHIV in SSA.

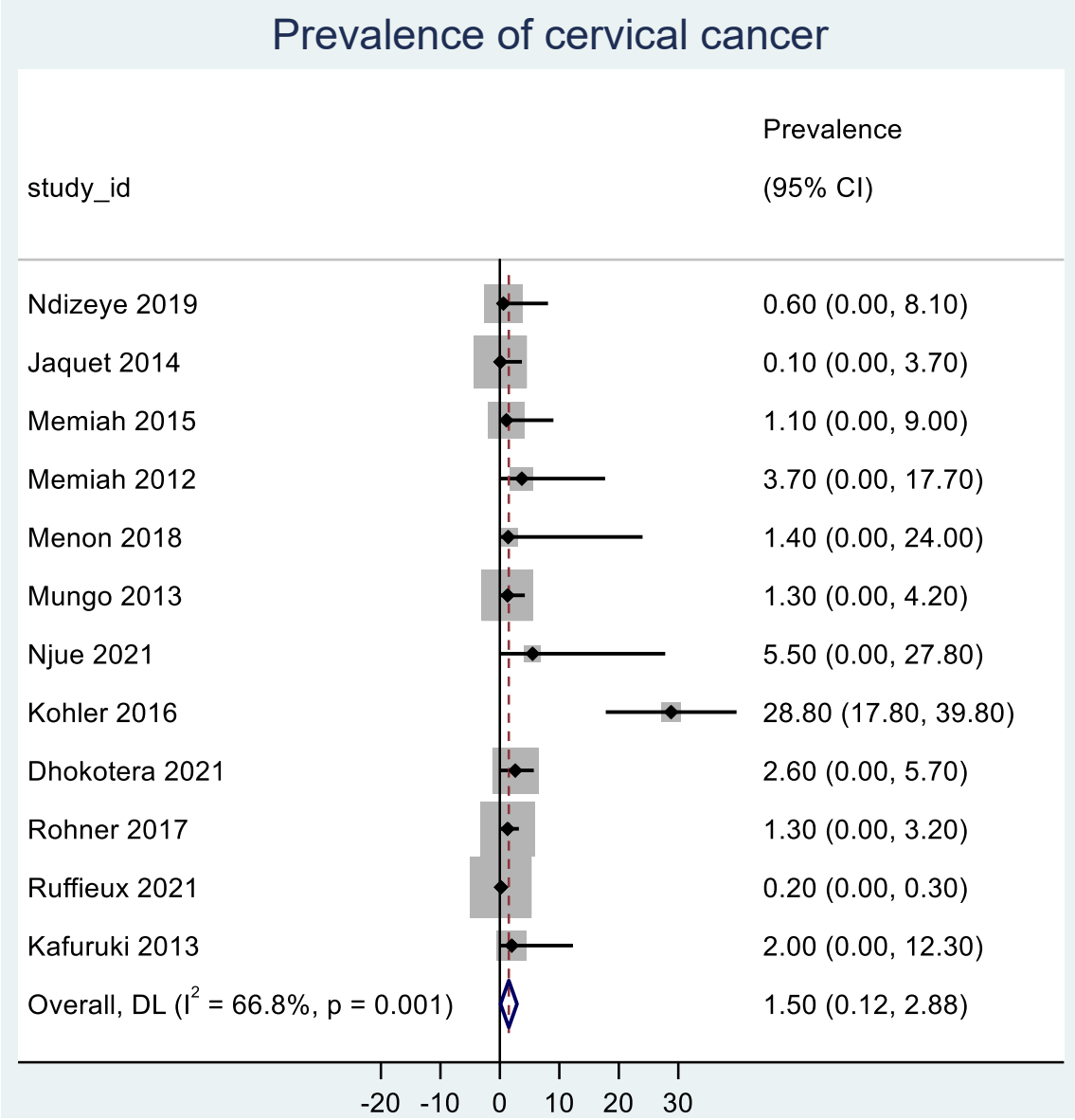

Fig. 8: Forest plot of pooled estimates generated by meta-analyses for prevalence of cervical cancer among PLHIV in SSA.

contributed to these differences,[203] including potential publication bias.

We estimated the prevalence of diabetes to be 5.4% (95% CI: 4.4–6.4, min = 0.3%; max = 41%) which was a wider range than previous findings in SSA, that reported diabetes prevalence rates ranging from 1% to 26%.[204] The high heterogeneity in diabetes prevalence could be attributed to variations in testing methods used across studies (Fig. 4). Most of the studies used the point of care glucometers and chemistry analyzer platforms or both. Additionally, some studies did not explicitly mention the method of diabetes testing employed. Potential publication bias and other factors such as diet and physical activity of various study populations should be explored as a means of explaining the variation in diabetes prevalence across populations. Implementing regular screening for diabetes among PLHIV during their routine health facility visits can help identify cases early and facilitate timely and appropriate care to mitigate the impact of diabetes in this population.

In our study, we obtained relatively lower prevalence estimates for cervical cancer and CRDs among PLHIV in SSA. The prevalence of cervical cancer was estimated to be 1.5%, which is consistent with previous reports of (1.3%–1.7%) by Patel et al.[12] However, our prevalence of

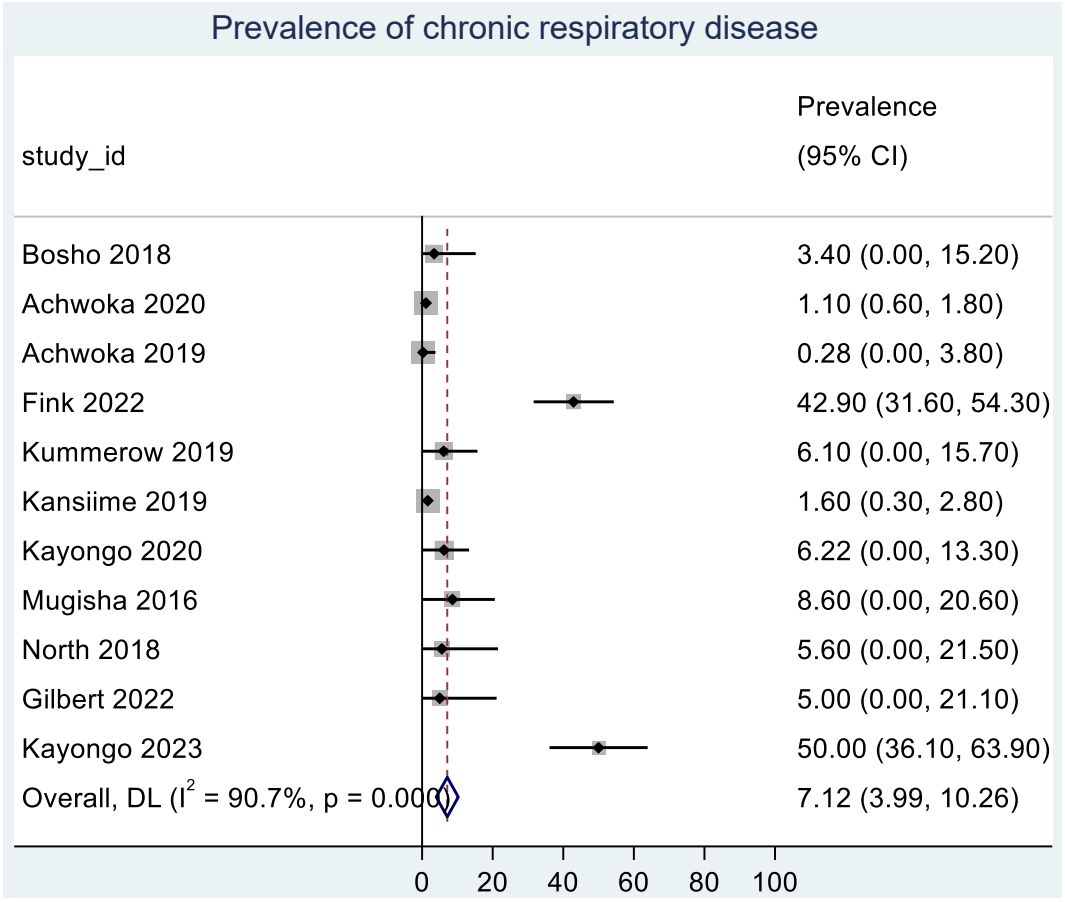

Fig. 9: Forest plot of pooled estimates generated by meta-analyses for prevalence of chronic respiratory diseases among PLHIV in SSA.

CRD (7.1%) was lower than the global estimate of 10.4%, that was previously reported in a systematic review that mainly included studies from Europe, with only four studies from Africa.[205] Potential publication bias may have contributed to the variation in our findings. The limited number of studies for meta-analysis of CRDs in SSA might explain the high heterogeneity observed.

Given the scarcity of studies on cervical cancer and CRDs among PLHIV in SSA, further research is warranted to investigate the burden of these conditions in this population. Screening for cervical cancer among adult women living with HIV remains essential as they face a six-fold higher risk[206] compared to HIV negative women.

We found a high prevalence of being overweight/obese among PLHIV in SSA at 32.2% (95% CI: 29.7–34.7), which is consistent with previous reports in LMICs.[13] Despite using similar definitions across studies, there was wide variation in the prevalence of overweight/obesity among PLHIV. This variation may be attributed to differences in diet and levels of activity among the study populations, in addition to potential publication bias.

The prevalence of hypercholesterolemia among PLHIV in SSA was found to be high at 24.3% (95% CI: 19.1–29.6), comparable to previous findings in LMICs at 22.2% (95% CI:14.7–32.1).[13] Among PLHIV in SSA, alcohol consumption (19.7%) was more prevalent than smoking (7.7%), indicating that interventions should target reducing alcohol consumption in this population. Both hypercholesterolemia and alcohol consumption showed high heterogeneity (I^2 > 90%) which could be attributed to differences in study populations. The prevalence of smoking varied moderately (I^2 = 53.8%).

We also reported a high prevalence of metabolic syndrome (23.9% [95% CI: 19.5–28.3]) among PLHIV that was slightly higher than previously reported rates at 21.5% (95% CI: 15.09–26.86).[207] This was not reported in the previous systematic review.[12] The heterogeneity observed may be due to variations in definitions of metabolic syndrome across studies.

Our systematic review has several limitations that should be acknowledged: Firstly, the generalizability of

our findings may be limited as our review focused on studies conducted in SSA, which may not fully reflect the global burden of NCDs among PLHIV. Additionally, the majority of the studies included in our review were conducted in only three countries within SSA, potentially introducing bias and limiting the representativeness of the findings.

We did not perform an analysis stratified by age, which could have provided valuable insights into variations in NCD prevalence among different adult age groups of PLHIV. Furthermore, comparisons between NCD prevalence among PLHIV and the general population were not explored, potentially missing out on important insights.

We also did not investigate gender differences, distinctions between urban and rural settings or differentiate between PLHIV on ART and those not on ART. These factors could have contributed to heterogeneity in our findings. Urban and rural environments may have distinct healthcare access, lifestyle patterns and sociodemographic characteristics that can influence NCD prevalence. Additionally, the use of ART might impact the development and management of NCDs among PLHIV.

Furthermore, there may be potential publication bias affecting the prevalence estimates of all selected NCDs/risk factors in our study, although it was minor for hypertension and metabolic syndrome. Previous studies used the Egger test and funnel plots to test for publication bias while we have used the Doi plots and LFK index[15] which is a more appropriate method of assessing the potential of publication bias in proportion studies. Therefore, although we compare with previous findings, we are uncertain on the impact of publication bias on previous findings. Considering these limitations, future studies should aim to address these factors to enhance the precision of prevalence estimates and enable more targeted interventions.

We had a few deviations from our protocol. To begin with, our systematic review only included SSA while Patel et al.[12] included LMICs. Therefore our study only updated data for the SSA region. We provided estimates for CRD, alcohol intake, and smoking that the previous systematic review did not report on. We only reported hypercholesterolemia for lipids.

We did not utilise the Grading of Recommendations, Assessment, Development and Evaluations Framework (GRADE) because we were reporting prevalence from observational studies. The GRADE is mainly used for intervention studies.

In this review, the determination of associations between being on ART and NCDs and/or NCD risk factors among PLHIV in SSA was not done due to large numbers of articles which warrants a separate article on it.

We used the Doi plots and LFK index (a newer method) to test for publication bias instead of the Egger test and funnel plots.

The burden of NCDs among PLHIV is a public health emergency. The heterogeneity of the estimated burden of NCDs among PLHIV may be due to differences in definitions of disease, measurement methods, variations in modifiable risk factors across populations and potential publication bias. Our review still provides sufficient evidence that NCDs are a public health problem that should be addressed among PLHIV and the general population.

Our findings should encourage researchers in SSA to conduct studies on the burden of NCDs and NCD risk factors in the many under represented countries and NCDs, such as cervical cancer and CRDs in SSA. Furthermore, health policy makers should strengthen the promotion of integrated health care for PLHIV in poorly resourced settings, as a step towards promoting universal access to health care. As PLHIV visit primary health care facilities for regular care, screening for NCDs/risk factors should be considered with the aim of preventing disease as much as possible. The health systems in SSA are faced with an emergent need to provide NCD care among the general population but particularly for PLHIV, as the gains achieved by the well-established HIV care programs may be lost due to NCD-related mortality.

Contributors

MMC-Co-ordination of the review, search and selection of studies for inclusion in the review, accessed and verified the data (collection, analysis, and interpretation of data), writing of the review.

KM-Selection of studies for inclusion in the review, accessed and verified the data (collection and interpretation of data), and writing of the review.

MM-Selection of studies for inclusion in the review, interpretation of data, writing of the review.

KK-Adapting of search strategy for the three databases and search of studies for inclusion in the review, writing of the review.

CH-Interpretation of data, writing of the review.

AM-Conception of review, design of the review, selection of studies for inclusion in the review, accessed and verified the data (analysis and interpretation of data), writing of the review, supervision.

All the authors agreed to submit the manuscript for publication.

Data sharing statement

Data will be made available upon reasonable request.

Declaration of interests

The authors declare that they have no competing interests both financial and non-financial.

Acknowledgements

Dr Cheryl Tosh (University of Pretoria) for editing.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.eclinm.2023.102255.

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