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REVIEW

Interventions for Prevention of Non-Communicable Diseases among Adolescents Living with HIV: A Systematic Review

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Abstract

While the uptake of antiretroviral drugs has rapidly expanded among adolescents and adults living with HIV, research evidence suggests that people living with HIV have a higher risk of non-communicable diseases (NCDs). With more than 35% of the global burden of NCDs stemming from adolescence, there is a need to comprehend the existing evidence on early prevention, detection, and disease management, especially among the at-risk population. In line with the WHO Global Action Plan, 2013–2020 and “Best Buys”, recommendations on practical interventions for NCDs prevention, this systematic review seeks to synthesise evidence on the current interventions for preventing NCDs among adolescents living with HIV (ALHIV) and assessing the effectiveness of interventions targeted at preventing cardiovascular diseases, diabetes, and cancer among ALHIV. A systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The bibliographic database search yielded 2588 articles, though only four (4) studies met the inclusion criteria after screening for eligibility. While sub-Saharan Africa (SSA) suffers the brunt of HIV and NCDs, only one study was conducted in SSA, and three in high-income countries (Brazil and the USA). Physical activity and aerobic exercises (lifestyle interventions) indicated potential beneficial health effects in reducing cardiovascular conditions and improving quality of life among ALHIV. Hospital-based training and a home-based exercise program effectively improved fitness strengths and changes in body composition. Despite the disproportionate global burden of the HIV and NCDs comorbidities, limited adolescent-specific evidence exists on the interventions for the prevention of NCDs among ALHIV. Thus, there is a need for health policy experts and researchers to steer research on interventions focused on the various NCDs among the ALHIV.

Keywords Adolescents · Non-communicable Diseases · HIV · Interventions · Systematic Review

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Background

Non-Communicable Diseases among Adolescents Living with HIV

Globally, the burgeoning burden of HIV-NCD comorbidities threatens to reverse the gains realised in the management of HIV across the life course. In 2017 and 2020, the World Health Organization (WHO) and the Center for Diseases Prevention and Control (CDC) [1] reported that NCDs account for more than 41 million (71%) deaths globally, and 80.6% of years survived with a disability; thus, making them the leading cause of premature deaths [2–4]. In 2016, the WHO global factsheet indicated that Cardiovascular Diseases (CVDs) annually claim 17.9 million peoples' lives, cancer 9 million, diabetes 1.6 million, and chronic respiratory diseases 3.9 million, with three quarters occurring in low-and-middle-income countries (LMICs) [5, 6]. Consequently, there is an urgent need to address escalating risk factors for NCDs among the at-risk adolescents for economic, social, and generational health benefits [7].

A cross-sectional study conducted in six primary care units to examine the prevalence of NCDs and risk factors among Adolescents Living with HIV (ALHIV) in South Africa indicated a high prevalence of: central obesity (37%), hypertension (5%), consumption of sugary beverages, limited physical activity, and low intake of vegetables and fruits [8]. A cross-sectional study conducted among HIV-positive patients (15–49 years) receiving HIV care in two rural and urban clinics based in Zomba district in Malawi to assess the prevalence of the CVD risk factors, diabetes, and hypertension revealed that a high incidence of hypertension (23.7%), diabetes (4.1%), elevated cholesterol (15.5%), and proteinuria (2.1%) associated with antiretroviral regimen [9]. Poor diet, insulin deficiency, obesity, and lack of physical activity are significantly associated with NCDs among the HIV-infected [2, 3, 10]. Other authors have suggested the implementation of nutrition and physical exercise intervention to reduce risk factors for NCDs [10].

NCDs are a direct cause of multimorbidity, living with two or more chronic illnesses, prevalent in sub-Saharan Africa (SSA) among ALHIV, and at higher risk of cardiovascular diseases and other lifestyle conditions resulting from HIV infections [8, 11]. ALHIVs, especially those with increased HIV viral load, have been documented to have increased triglyceride, cholesterol levels, and vascular dysfunction biomarkers compared to the HIV-uninfected cohort [12, 13]. A study conducted by Kansime in Uganda established a 4.7% multimorbidity in People Living with HIV (PLHIV), with at least one in every five individuals living with HIV having an NCD [14]. Similarly, an assessment of NCDs among highly active antiretroviral therapy (HAART) recipients aged 18 years

and above in Kagera Tanzania revealed a 57.8% self-reported prevalence of heart diseases, diabetes mellitus, hypertension, arthritis, and cancer, among other infectious diseases [15]. The prevention and management of HIV is a significant concern among adolescents [16, 17]. However, while various studies present data on the burden of NCDs among People Living with HIV (PLHIV) [18–23], there is a paucity of age-specific research focused on the interventions for NCDs and NCDs risk factors among the vulnerable ALHIV. Indeed, little is known on existing evidence-based studies assessing NCDs prevention mechanisms among the ALHIV.

Prevalence of HIV and Uptake of Antiretroviral Therapy among PLHIV

In 2019, the United Nations Children's Fund (UNICEF) reported that 1.7 million adolescents (10–19 years) were living with HIV globally, with an estimated rate of 29 infections per hour and 80% prevalence in SSA [24–26]. With sub-Saharan Africa accounting for 88% of ALHIV and an annual projection of 183,000 new adolescents' HIV infections in 2030 [26], there is a looming need to develop life-saving investments targeting prevention and treatment for ALHIV and the risk factors for NCDs. PLHIV are heavily impacted by NCDs [27]. Part of the at-risk population includes ALHIV, who have limited knowledge of their vulnerability to NCDs and their health and economic impact.

In recent years, the uptake of antiretroviral therapy (ART) has rapidly expanded among adolescents and adults living with HIV. By the end of 2020, approximately 37.7 million people were HIV-positive worldwide, and by December 2020, 27.5 million were receiving antiretroviral (ARV) drugs, an increase from 7.8 million registered by 2010. Compared to 1.3 million lives claimed by HIV in 2010, the death toll decreased by 47% (680,000) in 2020 due to increasing uptake of ARVs. However, existing literature suggests that HIV and ART are directly or indirectly associated with hypertension, cardiovascular disease, and diabetes mellitus [28]. Further, the increased use of ART increases the risk of obesity, cardiovascular diseases, diabetes, and myocardial infarction [29, 30]. Within SSA, researchers project an increase in the rates of obesity resulting from ART; thus, alluding to the need for immediate integration of care for NCDs and HIV among ALHIV [27, 31–33]. A home-based HIV counseling and testing study conducted in South Africa among adolescents and adults living with HIV revealed a high prevalence of NCDs risk factors [34]. The magnitude of NCDs risk factors is significantly higher among those receiving ART than those not receiving ART among adolescents and adults living with HIV [21, 35]. Significant efforts are required to strengthen health systems to control, prevent, early detect, and treat SSA chronic diseases [21]. With the efficacy of ART in prolonging HIV patients'

lifespan, and the vulnerability of PLHIV to NCDs [36, 37], there is a continued upsurge in healthcare burden due to the HIV and NCDs syndemic.

While the NCD target of the Sustainable Development Goals (SDGs) emphasises improved access to care across the life continuum and development of evidence-based responses, there is a dearth of literature on NCDs interventions targeting the ALHIV. Given that more than 35% of the global burden of NCDs stems from adolescence [3, 8, 38], there is a significant need to comprehend the existing evidence on prevention, early detection, and management of disease, especially among the at-risk population, such as ALHIV. Despite the significant body of knowledge on adult interventions for preventing NCDs [10, 39–46], minimal studies have explored adolescent-specific interventional measures. Further, most of the interventions conducted have focused on the control of NCDs among the general population living with HIV [39, 42, 45–50]. Therefore, a study on interventions focusing on adolescent-specific measures will present valuable knowledge on efficient and sustainable strategies for preventing NCDs among ALHIV.

In line with the WHO Global Action Plan, 2013–2020 and “Best Buys”, recommendations on practical interventions for NCDs prevention [21, 51], this review focuses on assessing population-specific interventions in preventing the NCDs among the ALHIV. Specifically, this systematic review addresses the existing gap by synthesising evidence on the current interventions for preventing NCDs among ALHIV and assessing the effectiveness of interventions targeted at preventing cardiovascular diseases, diabetes, and cancer among ALHIV.

Methods

The review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [52].

Eligibility Criteria

The main population of interest in this study was adolescents living with HIV. Thus, the review defined adolescents as any person aged between 10 and 19 years as stipulated by the WHO [53]. Studies focusing on mixed populations, people living with HIV or adolescent youths living with HIV, without a definite age range within our definition of adolescents or with less than 30% adolescents were excluded. Interventions targeted at preventing NCDs such as diabetes, cardiovascular disease, cancer, and risk factors for NCDs such as obesity, overweight, physical inactivity, hypertension, tobacco use, alcohol use, and unhealthy diets among ALHIV were of interest. In ensuring a comprehensive and

representative evidence search, this review integrated results from different research designs. These included meta-analysis, systematic reviews, randomised controlled trials (RCTs), case–control studies, cohorts, cross-sectional, observational studies, pre and post studies, quasi-experimental studies, and qualitative studies.

The primary studies of interest pertained to any interventions for preventing NCDs among ALHIV. These outcomes included changes in knowledge and practices towards NCDs and risk factors, increased awareness of NCD services and programmes or interventions, increased utilisation of NCD health services and programmes or interventions, reduced prevalence of the NCD risk factors (unhealthy diets, tobacco use, alcohol use, physical inactivity, obesity or overweight), enhanced self-care, and healthy lifestyles. On the other hand, the secondary outcome encompassed aspects, such as adherence or compliance to NCD medications or interventions.

Search Strategy

We structured and conducted an electronic literature search on the interventions for the prevention of NCDs among ALHIV. The relevant databases searched included; PubMed, Cochrane Central Library, CINAHL, PsychINFO, and Scopus. First, we conducted a search using keywords defining our target NCDs diseases on the relevant databases to enhance comprehension of the existing literature on the subject matter. Some of the keywords for the preliminary searches were HIV, AIDS, non-communicable diseases, NCDs, diabetes, cardiovascular disease, and cancer. Besides, the NCD risk factors, such as unhealthy diets, tobacco use, alcohol use, physical inactivity, and obesity or overweight, were used to conduct the preliminary search. The preliminary search provided broader knowledge and understanding of whether there was an ongoing review on this topic.

Regarding the grey literature publications search, we examined the WHO, UNAIDS, and UNICEF websites and other government publications and conference proceedings informing the current review. Seemingly, the search databases and grey literature publications were purposively selected based on their relevance to availing materials on interventions for the prevention of NCDs and NCD risk factors among adolescents living with HIV. However, we limited the search to studies published in English over the last twenty (20) years (2001 to 2021).

Search Terms

The keywords for this search were both Medical Subject Heading (MESH) terms and free texts. The key MESH terms were HIV, AIDS, non-communicable diseases, NCDs, diabetes, cancer, obesity, overweight, cardiovascular diseases, and physical inactivity. The free texts used in our search

were NCD risk factors, tobacco use, alcohol use, smoking, and unhealthy diets. Besides, we used the word adolescents in some databases that had no age filters. The detailed results from our search are presented in Supplementary Table 1.

Selection of the Eligible Studies

After conducting the database search, we downloaded the abstracts and titles of the selected studies and saved them into the Endnote library. We removed the duplicates, and before engaging in full-text reading, two independent reviewers (BM, CS) screened the titles and abstracts of the relevant articles of interest from the list of references to examine the eligibility of the studies based on the inclusion and exclusion criteria. Any emerging difference on eligible studies for inclusion in full-text screening was harmonised through consensus. However, any disagreement on the study's eligibility was resolved through consultation and mutual agreement with a third independent reviewer (PG) opinion. The articles screening process involved: review the publications' abstracts and titles to exclude the non-relevant studies and reading through the primarily selected studies to discard the non-relevant articles with a specific rationale. Only the studies that met the stipulated inclusion and exclusion criteria were included in the systematic review.

Data Extraction and Management

We employed the PICO Framework to validate the design and approach of data extraction based on the PRISMA guidelines. A standardised tool for data extraction was adopted based on the Cochrane approach for the interventions reviews data collection. The two independent reviewers (BM, CS) conducted data extraction using the eligible studies included in the final systematic review. They jointly reviewed and harmonised the extracted data through consensus and mutual engagement of the third reviewer (PG). Some of the parameters of interest in the data extraction were; Author(s) and year of publication, country, participants' age, study design and sample size, description of the intervention, results, and the underlying recommendations. The two independent reviewers (BM, CS) conducted the data extraction and resolved variances in their final extracts before presenting data for synthesis.

Risk of Bias Assessment

The quality assessment of the included studies was conducted using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology [54]. The double-checking of the quality of the included studies through an independent reviewer and Critical Appraisal Skills Programme (CASP) appraisal tools [55] helped the

reviewers identify both weak and robust evidence and enhance the internal validity of the final results. The Risk Of Bias In Non-randomized Studies—of Interventions (ROBINS-I) tool [56] was employed to assess the quality of the nonrandomised controlled studies. At the same time, the Newcastle–Ottawa Quality Assessment Scale (NOS) was used to evaluate both cross-sectional and cohort studies [57]. The NOS quality assessment tool included items, such as evaluation of the study designs' bias, representativeness of the sample, and the sufficiency of follow-up in outcome assessment.

Strategy for Data Synthesis

The review provided a narrative summary of the extracted data relative to the prevalence of the underlying NCD interventions among ALHIV as evidenced in the included studies. Besides, a tabular presentation of the included studies was made detailing interventions, study type, quality assessment, location, and interventions characteristics. Additionally, we developed a narrative synthesis of the evident interventions and their impacts on the prevention of NCDs among ALHIV.

Results

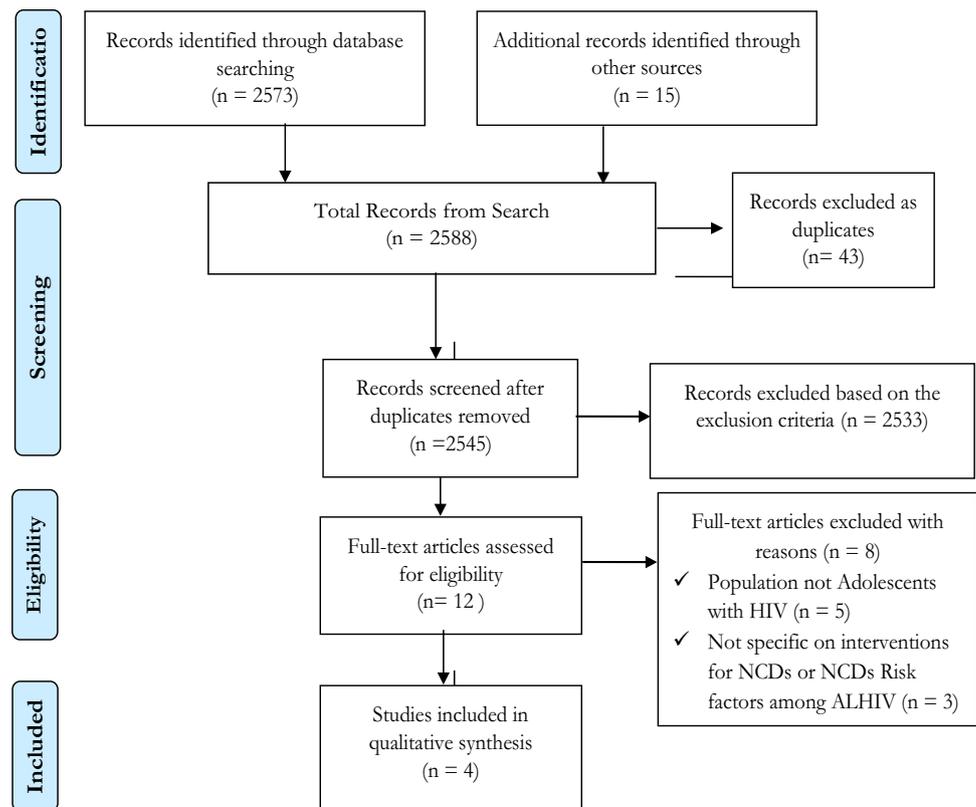
Study Selection

The comprehensive bibliographic database search yielded 2588 articles, and the deduplication process realised 2545, which were screened for eligibility and inclusion into the final synthesis. Interestingly, only four (4) out of 2545 identified studies met the reviews' inclusion criteria [58–61] (See Fig. 1). The reasons for the exclusion of 2540 studies were: some studies did report any intervention nor focus on ALHIV; studies focused on mixed population (PLHIV) and did not specify the proportion of adolescents in the results section; the population was not ALHIV, and others did not specifically focus on interventions for NCDs among ALHIV. The reviewers outlined the specific reasons at each stage of the screening process.

Characteristics of the Included Studies

Table 1 summarises the key characteristics of the four (4) studies included in this review. One of the included studies' interesting attributes was that three were published between 2017 and 2020 [58–60], while the remaining one was published in 2010 [61]. The four studies were conducted in three different countries: Brazil [58, 60], the USA [61], and South Africa [59]. Only one study was conducted in sub-Saharan Africa [59] despite the growing burden of the HIV

Fig. 1 PRISMA flow diagram of the studies screening and selection process



and NCDs comorbidities in the region. The study designs were cross-sectional study ($n = 1$) [58], non-randomized controlled trials ($n = 2$) [60, 61], and descriptive retrospective study ($n = 1$) [59]. The studies' sample sizes ranged from 10 to 491 ALHIV.

The studies assessed intervention for various NCDs and NCD risk factors among ALHIV, including cardiovascular diseases [58–61], cancer, diabetes, smoking, obesity, and unhealthy diets [59]. The common intervention models examined in most of the studies were physical activity and nutritional interventions [58], aerobics and resistive exercise programs [60] as well as, hospital-based and home-based fitness exercise [61]. Other intervention programs evident in the included studies included alcohol counseling, mental health counseling, healthy diet or weight counseling, smoking counseling, substance abuse counseling, and diabetes screening [59].

Quality Assessment of the Included Studies

Risk of Bias in Non-Randomised Studies

The quality assessment was implemented using the different components of the Risk Of Bias In Non-randomized Studies—of Interventions (ROBINS-I) tool [56]. The two non-randomised studies [60, 61] had an overall moderate risk of

bias (See Supplementary Table 3). However, one of the studies had no documented evidence of bias due to confounding and classification of the intervention [60]. Additionally, the study exhibited a moderate risk of bias due to participants' recruitment and reporting, though the outcome assessment employed validated tools. The second study reported no information regarding the classification of the intervention and a moderate bias in the selection of the participants, outcome assessment, and handling of the missing data [61]. The study employed validated measures to assess the outcomes and detailed the intervention follow-ups without one instance of dropout and missed training sessions.

Risk of Bias in Cross-sectional Studies

The two included cross-sectional studies conducted by de Lima et al., Kamkuemah et al. [58, 59] registered an overall good quality, that is, low risk of bias (See Supplementary Table 4). Specifically, the two studies documented a justified selection of a representative sample and sample size with no non-response rate and evidence of statistical appropriateness of the applied test. However, Kamkuemah et al. study [59] had a limitation in exposure ascertainment due to under-reporting and screen bias drawing from the retrospective nature of the study, while de Lima et al. [58] had a bias in outcomes assessment despite adjusting for confounders,

Table 1 Characteristics of the included studies

Author (year)	Country	Objectives	Study design and sample size	NCD type	Interventions	Study findings
de Lima, L. R. A., et al. (2019) [58]	Brazil	This study aimed to investigate if moderate to vigorous physical activity (MVPA) and aerobic fitness are associated with cardiovascular risk factors in HIV + children and adolescents	cross-sectional study n = 65	Cardiovascular	Physical activity and aerobic fitness	Results indicated that higher MVPA was associated with lower values of total and trunk body fat, total cholesterol and LDL-c. High levels of MVPA and aerobic fitness may prevent developing cardiovascular risk factors in children and adolescents' HIV +
Lima, L. R. A. d., et al. (2017) [60]	Brazil	The pilot study aimed to verify the effect of a playful exercise program on cardiovascular, morphological, metabolic, fitness, and quality of life outcomes	Nonrandomised clinical trial n = 10	Cardiovascular	24 sessions of aerobic and resistive exercises	A decrease was observed in systolic blood pressure (6.6%) and CCA-IMT (12.2%), as well as an increase in muscular endurance (63.5%), flexibility (26.0%) and quality of life (27.5%)
Miller, T. L., et al. (2010) [61]	USA	To examine the effect of a structured exercise program on nutrition and fitness outcomes in Human Immunodeficiency Virus-Infected Children	A nonrandomised intervention study n = 34	Cardiovascular	Hospital-based exercise-training program and home-based program for improving fitness, strength, and changes in body composition	A short-term exercise program was associated with improvement in cardiovascular risk, fitness, and quality of life
Kamkuemah, M., et al. (2020) [59]	South Africa	This study aimed to investigate how NCD comorbidity (prevention, diagnosis, and management) is incorporated within existing adolescent HIV primary healthcare services in Cape Town, South Africa	Descriptive retrospective study n = 491	NCD comorbidity	<ul style="list-style-type: none"> ✓ Alcohol counselling ✓ Mental health counselling ✓ Healthy diet or weight counseling ✓ Smoking and Substance abuse counseling ✓ Diabetes screening 	Twenty-six percent had a documented health-promoting intervention, 42% of which were NCD-related; ranging from alcohol or substance abuse (13%); smoking (9%); healthy weight or diet (9%), and mental health counseling (10%)

though the study used validated instruments to measure the outcomes of the intervention.

Overview of Study Results

Kamkuemah et al. [59] conducted a study to assess the integration of NCD comorbidity management, diagnosis, and prevention in the primary healthcare settings for ALHIV in South Africa, Cape Town. With the underpinning knowledge that NCD risk behaviours start during adolescence, Kamkuemah et al. [59] designed a descriptive retrospective study. They systematically reviewed 491 medical records of adolescents and youth living with HIV (AYLHIV) and aged between 10 and 24 years. The sample had a median age of 20, with the median age for ART initiation at 18 years. The participants had been on ART for at least 3 years, with 55% of them having documented comorbidities. Eleven percent of those with comorbidities had NCD diagnosis, with the most common being chronic respiratory disorder at 60% and mental disorders at 37%. A majority (59%) of the individuals had high blood pressure, 27% abnormal. Some participants (26%) were involved in the health-promoting intervention, with 42% of these interventions for NCD-related conditions. The research results showed limited interventions and health promotion among AYLHIV that access healthcare services and a missed opportunity to prevent multimorbidity through NCD screening and health promotion. The results indicate few health-promoting interventions, with strategies such as mental health counseling, healthy diets and weights, and quitting smoking all being undertaken in less than 10% of the population under study. Majorly, the study articulated a salient need to broaden health promotion initiatives to target adolescents and reduce comorbidities.

Another study on the interventions for NCDs among AYLHIV was conducted by de Lima et al. [58] to assess if aerobic fitness, peak oxygen uptake, and moderate-vigorous physical activities (MVPA) were associated with cardiovascular disease risk factors among adolescents and children living with HIV. The study utilised a cross-sectional research design. A priori approach ($\beta=0.80$ and $\alpha=0.05$) was used to estimate a sample of 65 participants aged 8–15, who were subjected to various forms of physical activity and aerobic exercise exercises. The participants provided minutes of MVPA measured by accelerometers, and peak oxygen uptake (VO_2), measured by the breath-by-breath respiratory exchange. Blood pressure, body fat, total cholesterol, high-density cholesterol (HDL-c), low-density cholesterol (LDL-c), glucose, triglycerides, insulin, interleukin (IL)-6, C-reactive protein (CRP), carotid intima-media thickness, and tumor necrosis factor-alpha (TNF- α) were all used to assess cardiovascular risk factors. de Lima et al. [58] observed that higher MVPA was associated with lower levels of total ($\beta= -3.566$) and trunk body fat ($\beta= -3.495$), as well as

lower cholesterol ($\beta= -0.112$) and LDL-c ($\beta= -0.830$). Equally, higher peak VO_2 led to low total ($\beta= -0.629$) and trunk body fat values ($\beta= -0.592$) and lower CRP levels ($\beta= -0.059$). The study findings established that physical activity and aerobic exercises have potential health benefits to reduce cardiovascular conditions among children and adolescents living with HIV. The research emphasises the need to explore effective health interventions to reduce NCDs among ALHIV, including physical activity and aerobic exercises.

Lima et al. [60] conducted a nonrandomised study to assess the impacts of playful exercise on morphological, cardiovascular, metabolic, fitness, and the quality of life outcomes among children and ALHIV in Florianopolis Brazil. Using a sample of 10 children and adolescents (age interquartile range 11.5–15.5 years) who had contracted HIV through mother-to-child transmission, the researchers administered an intervention program comprising 24 sessions of physical exercises, each lasting 90 min, and observed them over 8 weeks. While assessing the intensity of the physical activities, standardised measures were used to evaluate the intervention outcomes, including blood pressure, CRP, common carotid artery intima-media thickness (CCA-IMT), LDL-c, and aerobic fitness. The intervention study results indicated a decrease in systolic blood pressure (6.6%) and CCA-IMT (12.2%), and the participants also had a remarkable increase in muscular endurance (63.5%), flexibility (26.0%), and quality of life (27.5%). Despite the small sample size that could limit the generalizability of the results, the findings emphasise the importance of physical activity and aerobic exercises in reducing blood pressure, cardiovascular risks and improving quality of life among ALHIV [60]. Indeed, findings by Lima et al. [60] and de Lima et al. [58] indicate that moderate to vigorous physical activity and aerobic exercises should be included as part of the health interventions to reduce NCDs among ALHIV.

Miller et al. [61] conducted a nonrandomised study in the USA to evaluate the effectiveness and feasibility of a hospital-based training program that precedes a home-based program in improving fitness strengths and changes in body composition among children and adolescents living with HIV. The hospital-based training (3 months nonrandomised exercise intervention) program featured 34 HIV-infected children and adolescents 6 years and above (median age 15.0–17.6), while 12 children completed the home-based training program. The physical activities under the hospital-based training included strength testing, flexibility, and muscular endurance training, aerobic fitness, and home-based training. The supervised hospital session comprised warm-up, stretching, aerobics, resistance training, and cool-down and stretching sessions. The home-based training program was similar, except that they had less structured aerobic exercises. The randomised intervention exercise outcomes, such

as strength, aerobic fitness, anthropometric and body composition, cholesterol, LDL-C, and HDL-C, were assessed at three-time points. The baseline, completion of the two weeks training, and post three months' post-completion. The hospital-based training observed an increase in strength ($p < 0.001$), endurance ($p < 0.006$), flexibility ($p < 0.001$), and cardiorespiratory fitness relative to oxygen uptake assessment ($p < 0.001$). Relative to anthropometric measurements, there was an increase in body mass ($p < 0.001$) from baseline. However, the median deviation of the lipid profiles and trunk adiposity were almost zero ($p < 0.001$). Seemingly, the results were similar for home-based training except for flexibility, which declined. The study findings demonstrate the importance of both home-based and hospital-based training regimens for children and adolescents living with HIV; thus, informing generation of knowledge for drawing up intervention plans to reduce NCDs risks among ALHIV, and improve quality of life.

While this review targeted a broader set of outcomes relative to interventions for the prevention of NCDs among the ALHIV, the findings were indeed interesting. Three [58, 60, 61] of the four included studies assessed the effects of the physical exercise (lifestyle) interventions on cardiovascular risk factors among ALHIV in Brazil [58, 60] and nutritional outcomes in the USA [61]. Physical activity and aerobic exercises (lifestyle interventions) indicated potential beneficial health effects in reducing cardiovascular conditions [58], as well as blood pressure, cardiovascular risks, and improving quality of life among ALHIV [60]. Additionally, the hospital-based training and a home-based exercise program effectively improved fitness strengths and changes in body composition [61] among ALHIV. Other interventions were alluded to in a high-quality descriptive retrospective study conducted in South Africa [59], which assessed the incorporation of NCD comorbidity management, diagnosis, and prevention. The study revealed that alcohol abuse counseling, diabetes screening, mental health counseling, and emphasis on healthy diets and weights management were recommended in less than 10% of the cases. Consequently, although our review aimed to assess the effectiveness of interventions targeted at preventing CVDs, diabetes, and cancer among ALHIV, only two studies reported the efficacy of interventions: physical activity, hospital-based training, and aerobic exercises that targeted the CVDs risk factors.

Discussion

The main objective of this study was to synthesise evidence on the existing interventions for preventing NCDs among ALHIV and assess the effectiveness of interventions targeted at the prevention of cardiovascular diseases, diabetes, and cancer among ALHIV. The review found that only four

studies met the inclusion criteria: three published between 2017 and 2020 [58–60], and the earliest one was published in 2010 [61]. Three studies were conducted in high-income countries [58, 60, 61], while only one was conducted in SSA [59]. Further, the study found that physical activity and aerobic exercises (lifestyle interventions) indicated practical potential health effects in reducing cardiovascular conditions [58], blood pressure, and improving quality of life among ALHIV [60]. The hospital-based training and home-based exercise program also improved fitness strengths and changes in body composition [61] among ALHIV. Additionally, counseling on alcohol abuse, diabetes screening, mental health counseling, and emphasis on healthy diets and weights management were also noted as services provided in one of the reviewed studies, but without associated health outcomes.

To the best of our knowledge, this is the first systematic review of the interventions for the prevention of NCDs among the ALHIV. Thus, our findings have identified notable research gaps and demonstrate a significant gap in research evidence focusing on the interventions for NCDs to promote safety and quality of life among ALHIV. Although only four (4) studies met our inclusion criteria, none of the studies included in this review explored any intervention focusing on increasing knowledge and practices towards NCDs, increasing awareness of NCD services and programmes or interventions, promoting utilisation of NCD health services and programmes or interventions, enhancing self-care or reducing the prevalence of the NCD risk factors, such as unhealthy diets, tobacco use, and obesity or overweight. Additionally, all the studies synthesised in this review focused on cardiovascular risk factors indicating less exploration of other NCDs, such as cancer and diabetes, common among PLHIV [46, 62–64]. Besides, the included studies had mixed population aspects since they involved either adolescents' youths living with HIV (ALYHIV) or children and adolescents; thus, indicating a significant gap in adolescent-specific interventions. Indeed, the lack of intervention studies in both SSA and high-income countries presents a potential gap necessitating the development of targeted multidisciplinary interventions to contain the growing incidences of HIV and NCDs comorbidity in both developing and developed countries among the ALHIV.

Seemingly, the research findings indicated a gap in utilisation of various study designs and modalities of intervention delivery in the prevention and management of NCDs among ALHIV. Globally, the study revealed that only two nonrandomised and two cross-sectional studies had been conducted to assess the interventions for NCDs among ALHIV. This finding indicated a lack of randomised controlled trials, which are much needed to advance the science in preventing and managing NCDs among the ALHIV. Further, the quality of the included studies suggested a need

for future research studies to report more details to enhance a robust quality assessment. While most of the evidenced interventions, aerobic and restrictive physical exercises, and training, were delivered either at home or at the hospital settings, none of the studies reported on the sustainability of the programs beyond the projects life. Besides, although various intervention delivery modalities exist, the synthesised interventions were delivered under supervision by trainers, caregivers, or healthcare providers, especially in hospital settings. This signifies the need to explore further other intervention models, such as peer-led, community-based, educational, and digital-based interventions, among different approaches in managing and preventing NCDs among ALHIV.

The review findings indicate the importance of developing interventions to promote physical exercises and aerobics in reducing some common NCD risk factors and promoting the quality of life. Seemingly, as evidenced in the review, physical and aerobic exercises are some of the effective interventions for managing and reducing NCD exposure ALHIV [58, 60, 61]. The moderate to vigorous physical activities and aerobic exercises studied by researchers aim to address cardiorespiratory issues and improve strength and resilience. Similar results have been reported among adult PLHIV [42, 50, 65]. Physical activity has been established to enhance fitness and immunity, hence reducing diseases and disorders that could impact PLHIV [42, 66]. Moderate to vigorous activities also strengthen the cardiorespiratory process, reducing risks related to cardiovascular issues, such as obesity and sedentary lifestyle, among others [67].

Interventions to enhance physical activity among AYLHIV could be modeled along the hospital-based and home-based trainings studied by Miller et al. [61] and de Lima et al. [58]. These training programs, conducted in consultation with physicians, could effectively enhance endurance, strength, flexibility and reduce risks factors for cardiovascular or mental health conditions. However, further research is required to establish how the home-based training programmes can be effectively administered among AYLHIV and monitor and track results to enhance effectiveness.

Despite the growing prevalence of NCDs and NCDs risk factors among ALHIV, limited studies have explored adolescent-specific interventions focusing on HIV and NCDs comorbidity. Adolescence marks the onset of the various NCDs, as adolescents and young adults are the most exposed to NCD risk factors, responsible for the comorbidities alongside HIV [59]. The most common NCDs identified are related to cardiovascular diseases, such as: hypertension, hypercholesterolemia, elevated low-density lipoprotein, hypertriglyceridemia and high-density lipoprotein, hyperglycemia, and hyperlipidemia [68]. The high prevalence of NCDs could be associated with increased use of ART, which is responsible for the high incidence of overweight or obese

conditions [22]. Other drivers of NCDs among AYLHIV could be categorised as behavioural, social, and economical.

While the current review indicates that physical exercise, aerobics, and home-based interventions are effective in the management of NCDs among ALHIV [58, 60, 61], further research evidence indicates that there have been ineffective and insufficient health intervention strategies to address NCD prevalence among PLHIV [43, 69–71]. As Kamkue-mah et al. [59] established, health intervention plans that create awareness and emphasise behaviour change to reduce exposure to NCDs are not effective among adolescents. Interventions such as quitting smoking, reducing alcohol intake, mental health counseling, maintaining healthy diets, and body weight were the least used in preventing or managing NCDs risk factors among AYLHIV. These interventions are not likely to be effective if AYLHIV are not knowledgeable about NCDs and their shared risk factors. A research study by Kavishe et al. [21] and Biraguma et al. [18] indicated that 64% of AYLHIV did not have appropriate knowledge of the NCD risk factors hindering health interventions from managing NCDs. Limited NCD-HIV integrated programs that involve screening and management approaches exist [68]. Thus, an opportunity is missed during HIV care to establish, create awareness and manage NCDs and their risk factors.

Limitations

While our review presents novel insights on the need to focus on interventions for NCDs among ALHIV, a few limitations were evident. For instance, while this review recognises mental health and chronic respiratory diseases as some of the major types of NCDs, our search strategy was limited to specific NCDs, such as cancer, cardiovascular diseases, and diabetes that share common risk factors; and studies published in English language only. Thus, the restriction in our search strategy might have prejudiced the ability to reach a broader and suitable scope of relevant studies to improve our small sample of the included studies (4). Additionally, based on our definition of adolescents and studies inclusion criteria, the literature search might have missed studies that did not focus on this population since we intended to conduct an adolescent-specific review. Besides, the arbitrary inclusion of the mixed population studies exhibiting at least 30% of the sample size as ALHIV could have disadvantaged studies which had a larger sample size. However, we believe our review findings present a footing for further research targeting a broader scope of review to expand the NCDs interventions reach among the vulnerable population. Quality ratings were limited to the information provided by the authors. In some instances, some studies did not report specific quality indicators; thus, limiting our ability to capture

the extent quality of the particular articles. Despite the comprehensiveness of our database searches, the limitation to institutional subscriptions access may have hindered us from expanding our search scope; however, the richness of the study anchored on the exact population, ALHIV, and interventions targeting at preventing cardiovascular diseases, diabetes, and cancer.

Conclusion and Recommendations

Overall, despite the disproportionate global brunt of the HIV and NCDs comorbidities, our systematic review findings indicate limited adolescent-specific evidence on the interventions for the prevention of NCDs among ALHIV. In fact, interventions to manage NCDs among ALHIV are insufficient and not targeted at adolescents only. Therefore, health researchers and policy experts need to steer evidence-based research to address NCD risk factors and the increasing exposure to NCDs due to the adoption of risky behaviours. Aside from health interventions targeted at behavioural changes, such as quitting smoking, alcohol use, sedentary behaviours, and avoiding unhealthy diets, it is essential to note that health interventions for managing NCDs among ALHIV are incomplete without physical exercises. Thus, there is a need to enhance physical activity and exercises programs, healthy weights, and regular health counseling sessions to reduce NCDs risk factors. Moderate to vigorous physical activities and aerobic exercises have proven effective in reducing NCDs risk factors, such as cardiorespiratory issues and depressive symptoms, and enhancing strength, flexibility, and resilience among AYLHIV. Therefore, health policy experts and researchers should steer research on interventions focused on the various NCDs, including CVDs, diabetes, cancer, and respiratory diseases. The interventions should also be developmentally appropriate by integrating playful exercises and behavioural components appealing to the priorities of the adolescents to foster acceptability and steer adoption.

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Data Availability All the preliminary materials are provided as supplementary materials.

Code Availability The PubMed database search codes are documented in the provided supplementary materials.

Declarations

Ethics Approval and Consent to Participate The study adhered to the Aga Khan University Ethics Review Board guidelines. The researchers conducted review and synthesis of the published data only without access to any individual human data. Thus, no ethical approval was required.

Consent for Publication All authors reviewed the article and approved the final manuscript for publication.

Conflict of Interest The authors declare no competing interests.

Prospero Registration The Protocol for this Review was not registered in Prospero. However, the review team conducted a thorough search, which confirmed that no Systematic Review or a Review Protocol exists in this area of study.

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