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High prevalence of multimorbidity and non-communicable disease risk factors in South African adolescents and youth living with HIV: Implications for integrated prevention

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Background. Adolescents and youth living with HIV (AYLHIV) face an elevated non-communicable disease (NCD) risk resulting from HIV, psychosocial challenges, and the complications of antiretroviral therapy.
Objectives. To investigate the prevalence of common NCDs and their risk factors among AYLHIV in urban Cape Town, South Africa, in order to inform an integrated approach to NCD screening and prevention in AYLHIV.
Methods. We conducted a cross-sectional study in six primary care facilities in Cape Town between March 2019 and January 2020. We collected sociodemographic information, and assessed dietary intake, physical activity and nutritional knowledge. We also screened for pre-existing and previously unidentified NCDs and modifiable risk factors in 92 adolescents and youth receiving treatment for HIV in primary care settings using self-report and objective measures. Differences between sexes and age groups were compared using parametric and non-parametric statistical tests.
Results. Three out of four participants were female, and the median (interquartile range) age was 20.5 (18.9 - 22.9) years. More than a quarter were not in education, employment or training, and 44% were multidimensionally poor. Five percent of participants had measured hypertension, and 37% had central obesity. AYLHIV self-reported high levels of household food insecurity (70%), low daily fruit and vegetable consumption (28% and 52%, respectively), high refined sugar and sugar-sweetened beverage intake (31% and 29% daily intake, respectively), regularly skipping breakfast (42%), low nutritional knowledge (37% average score) and insufficient weekly physical activity levels (31%). A third (30%) were current smokers, and 24% engaged in binge drinking.
Conclusions. Our findings of a high prevalence of NCDs and risk factors in AYLHIV highlight the importance of NCD risk screening as part of HIV care for AYLHIV. Such integrated approaches are needed to achieve the dual purpose of improving outcomes through early diagnosis of pre-existing NCDs as well as the prevention of NCD multimorbidity in AYLHIV. This study further demonstrates the need for early intervention on the social, environmental and economic determinants of NCDs targeting adolescents and youth.

Globally, non-communicable diseases (NCDs) are the leading cause of disability and premature mortality, accounting for 71% of deaths worldwide and 80.6% of years lived with disability in 2016.[1] NCDs affect low- and middle-income countries (LMICs) disproportionately, with more than three-quarters of NCD deaths occurring in LMICs.[2] In 2017, the burden of NCDs in sub-Saharan Africa (SSA) was higher than the global average, almost equivalent to the total burden associated with communicable, maternal, neonatal and nutritional diseases.[3] Of note, unhealthy diets and physical inactivity, which are significantly associated with cardiometabolic conditions and cancers, are rising globally,[1,4] especially among the poor residing in urban LMIC settings.[5] South Africa (SA) also has the largest HIV epidemic and the largest antiretroviral treatment (ART) programme globally, with 7.5 million people living with HIV in 2019 and 5.2 million on ART.[6] Of note, SA also has the highest burden of adolescent HIV globally.[7]

Against this background, the prevalence of NCDs and NCD risk factors has increased over the past two decades. The prevalence of overweight and obesity among adult women increased from 56% to 68% between 1998 and 2016.[8] One in three SA adults has hypertension, 12.8% have diabetes,[8] 16.2% smoke daily,[9] and 18.3% engage in binge drinking.[10] SA also has the highest prevalence of childhood and adolescent overweight and obesity in SSA (19% of

boys and 26% of girls aged <20 years).[11] Furthermore, >40% of young South Africans have insufficient levels of physical activity,[12] and 20% consume sugar-sweetened beverages (SSBs) daily.[9] Moreover, HIV and ART are associated with several NCDs. Evidence of rising prevalences of both NCD comorbidities[13] and NCD risk factors such as physical inactivity[14] and smoking[15] has been documented in adults living with HIV, with an excess burden of NCD risk factors compared with the general population. Similarly, adolescents and youth living with HIV (AYLHIV) face elevated health risks with similar comorbidity patterns to adults due to HIV and long-term ART.[16,17]

Even though many risk behaviours for NCDs are initiated or reinforced in adolescence,[18] little is known about NCD risk and comorbidity patterns in AYLHIV. Given that AYLHIV routinely access care and are potentially additionally vulnerable to NCDs compared with their age peers, there is an opportunity for early intervention to identify risk factors and prevent other comorbidities. However, there has been little focus on NCD prevention in AYLHIV. A previous folder review of AYLHIV conducted by the authors in the same urban setting identified limited integration of NCD screening and health promotion in adolescent HIV healthcare services,[19] raising questions about the true prevalence of NCD multimorbidity and NCD risk factors in AYLHIV.

Objectives

Given the emerging NCD epidemic in SSA and increased comorbidity risk in people living with HIV (PLHIV), this study aimed to measure the prevalence of commonly occurring cardiometabolic NCDs and risk factors in AYLHIV accessing primary healthcare in Cape Town, SA, in order to inform a comprehensive, integrated approach to NCD screening and prevention in AYLHIV.

Methods

Study setting and population

We conducted a cross-sectional study of AYLHIV aged 15 - 24 years attending primary care health facilities in Cape Town. Cape Town is the second-biggest city in SA, with an estimated population of 4 million people, of whom 16.3% are aged 15 - 24 years.[20] NCDs, including diabetes mellitus, ischaemic heart disease, cerebrovascular disease and HIV, are ranked among the top five causes of premature death in Cape Town.[21] Recruitment and data collection took place at six public sector HIV clinics located in four legislated health substructures in the city. These facilities serve patients living in periurban, high-density, low-income townships.

Study design and sampling

The sample size was determined using prevalence estimates for youth aged 15 - 24 years, for whom data are readily available.[9] The confidence level was set at 95%, with a 5% degree of precision and an obesity prevalence of 5.6%, yielding a minimum required sample size of 82. We previously described the method used to estimate the number of AYLHIV accessing care at each facility.[19] Study procedures were conducted at each clinic using a convenience sampling approach from March 2019 until January 2020.

Ethical considerations

This study was performed in line with the principles of the Declaration of Helsinki. Ethical clearance was obtained from the Human Research Ethics Committee in the Faculty of Health Sciences at the University of Cape Town (ref. no. HREC 520/2017) and the health research ethics committees of the City of Cape Town and the Western Cape provincial government. Parents or legal guardians provided written consent for their children to participate in the study, and participants provided written informed assent (or consent if aged ≥18 years).

The data that support the findings of this study are not publicly available owing to the sensitive nature of the information that could compromise minor research participants' privacy/consent, but are available from the corresponding author MK on reasonable request.

Study procedures

Sociodemographic characteristics

Adolescence can be categorised into three primary developmental stages: early adolescence (10 - 14 years), middle adolescence (15 - 17 years), and late adolescence/young adulthood (18 - 24 years).[22] We categorised participants into four age groups in line with these stages, further subdividing the oldest age group as follows: 15 - 17, 18 - 19, 20 - 21 and 22 - 24 years.

Deprivation was assessed using the Youth Multidimensional Poverty Index (YMPI), comprising 11 weighted indicators in five dimensions: educational attainment, general health and functioning, living environment, household assets and employment.[23] An individual was defined as being YMPI poor if deprived in a third or more of the weighted indicators, with a composite score >33.3%.[23]

Food insecurity was measured using the Household Food Insecurity Access Scale (HFIAS).[24] Participants were categorised as living in food-secure or mildly, moderately or severely food-insecure households.[24]

Behaviour and knowledge

Physical activity was assessed using the International Physical Activity Questionnaire (IPAQ), validated in youth and adults in SA.[25] We used the Ainsworth *et al.*[26] scoring algorithms to derive an average metabolic equivalent of task (MET) score. Insufficient physical activity was defined as a score <600 MET minutes/week.[27] Sedentary behaviour was defined as spending ≥3 hours per day watching television or other sitting activities.[28]

Dietary intake was assessed using a food frequency questionnaire (FFQ) adapted from the Health Behaviour in School-aged Children Survey, validated for adolescents.[29] Skipping breakfast was defined as eating breakfast on 0 - 2 days/week, semi-skipping as 3 - 4 days/week, and not skipping as 5 - 7 days/week.

Smoking and alcohol use. Tobacco and alcohol use were assessed using questions from the 2011 South African Youth Risk Behaviour Survey.[12] Current smoking and drinking were defined as smoking cigarettes or other tobacco products and consuming alcohol at least once during the preceding month, respectively.[12] Binge drinking was defined as drinking five or more drinks in succession at least once during the preceding month.[12]

Nutritional knowledge was assessed using a revised General Nutrition Knowledge Questionnaire (GNKQ-R), validated for young people.[30] A nutritional knowledge score was generated across four domains with a maximum possible score of 88: 18 for questions on dietary recommendations, 36 for questions on food groups, 13 for healthy food choices, and 21 for associations between diet and disease.

Comorbidities

Blood pressure (BP). Sitting BP was measured in mmHg using an automatic BP monitor (Rossmax (Shanghai) Incorporation Ltd, China) according to the SA hypertension practice guideline.[31]

Overweight and obesity. Height, weight and waist circumference (WC) were measured according to the World Health Organization (WHO) STEPS protocol.[32] The abdominal obesity criteria for WC were ≥102 cm in males and ≥88 cm in females and a waist-hip ratio >0.85 for females and >0.90 for males.[32] A waist-to-height ratio (WHtR) >0.5 was used as a measure of central obesity.[33]

Statistical analysis

Data were analysed using Stata version 14.0 (StataCorp, USA). All variables were checked for normality using graphical data exploration and the Shapiro-Wilk test and analysed stratified by sex and age. If the normal distribution assumption was violated, non-parametric statistical methods were used. Data were described using summary statistics (frequencies, percentages, medians and interquartile ranges (IQRs)) or means and 95% confidence intervals. Comparisons were made between sexes and age groups using Pearson's χ^2 and Fisher's exact tests. The Mann-Whitney *U*-test was used to compare medians between sexes, and the Kruskal-Wallis test to compare medians across age groups. All tests of significance were two-tailed and performed at the 5% significance level.

Results

Sociodemographic characteristics

A total of 176 adolescents and youth were recruited, of whom 92 were successfully interviewed. The majority (76%) were female, and the median (IQR) age was 20.5 (18.9 - 22.9) years. Overall, 44% of participants were YMPI poor, 70% were living in food-insecure households, and 38% were severely food insecure. Further details of the socioeconomic characteristics of participants are shown in Table 1.

Behaviour and knowledge

Physical activity

Overall, a third of respondents had insufficient levels of weekly physical activity. The median MET minutes per week was higher for males than for females, but this was not statistically significant (Table 2). Over two-thirds of participants reported using active transport in a typical week, while almost half were sedentary for >3 hours per day.

Dietary intake

Fifty-two percent of participants ate vegetables daily, while a lower proportion ate fruits (28%) and whole grains (33%) daily (Table 2).

Significantly more males than females ate fruit frequently, and younger adolescents had the lowest prevalence of daily consumption of fruits, vegetables and whole grains compared with older age groups. A third of respondents reported daily intake of added sugar, either drinking SSBs or eating sweets and cakes daily. SSB consumption was similar across sexes and age groups. Adolescents aged 18 - 19 years reported the highest daily consumption of deep-fried and fast foods compared with other age groups (Table 3). More than two-fifths of participants skipped breakfast regularly (on ≥3 days), although skipping breakfast did not differ significantly by sex or age.

Table 1. Participant sociodemographic characteristics by sex

Variable	Description	Male (*n*=22; 24%)	Female (*n*=70; 76%)	Total (*N*=92)
Age (years), median (IQR)		20.7 (18.9 - 21.6)	20.4 (19.0 - 23.0)	20.5 (18.9 - 22.9)
Adolescent stage by age group (years), *n* (%)	Middle adolescence: 15 - 17	3 (14)	10 (15)	13 (14)
	Late adolescence: 18 - 19	5 (23)	18 (26)	23 (26)
	Young adulthood: 20 - 21	9 (41)	16 (24)	25 (28)
	Young adulthood: 22 - 24	5 (23)	24 (35)	29 (32)
Family structure (who they live with), *n* (%)	Biological parents	10 (45)	35 (50)	45 (49)
	Grandparents	4 (18)	8 (11)	12 (13)
	Relative (aunt or uncle)	6 (27)	23 (33)	29 (32)
	Siblings	15 (68)	33 (47)	48 (52)
	Non-family (foster care/children's home)	0	2 (3)	2 (2)
Ever pregnant/impregnated someone, *n* (%)		1 (5)	19 (28)	20 (22)
Current occupation/ employment status, *n* (%)	In school/college/university/other tertiary education	7 (32)	37 (54)	44 (48)
	In training	3 (14)	6 (9)	9 (10)
	Employed	5 (23)	8 (11)	13 (14)
	Not in education, employment or training	7 (32)	18 (26)	25 (27)
Youth multidimensionally poor* (*n*=88), *n* (%)		9 (41)	30 (45)	39 (44)
Educational attainment		4 (18)	16 (24)	20 (22)
	Aged 17 - 20 and completed <9 years of schooling	1 (5)	2 (3)	3 (3)
	Aged 21 - 24 and completed less than matric or equivalent	3 (14)	14 (21)	17 (19)
Any difficulty with general health and functioning†		16 (73)	46 (67)	62 (68)
Living environment deprivation	Fuel for lighting other than electricity/gas/solar power	0	1 (1)	1 (1)
	Fuel for heating other than electricity/gas/solar power	5 (23)	21 (30)	26 (28)
	Fuel for cooking other than electricity/gas	0	1 (1)	1 (1)
	Sanitation: household without a flush toilet	3 (14)	5 (7)	8 (9)
	Water: household without piped water on site	1 (5)	15 (21)	16 (17)
	Dwelling that is an informal shack/caravan/tent/other	4 (18)	28 (41)	32 (35)
Household asset ownership deprivation‡		3 (14)	20 (29)	23 (25)
Household adult unemployment: no employed adults (18 - 64 years)		1 (5)	13 (19)	14 (15)
HFIAS, median (IQR)		2.5 (1 - 5)	3 (0 - 7)	3 (0 - 7)
Food insecurity, *n* (%)	Food secure	4 (19)	24 (34)	28 (30)
	Mildly food insecure	7 (32)	11 (16)	18 (20)
	Moderately food insecure	4 (19)	7 (10)	11 (12)
	Severely food insecure	7 (32)	28 (40)	35 (38)

IQR = interquartile range; HFIAS = Household Food Insecurity Access Scale; YMPI = Youth Multidimensional Poverty Index.
*YMPI poor: those with a composite score >33.3%.
†Difficulty hearing, seeing, moving around, concentrating or with self-care.
‡Individual living in a household that does not own more than two of: radio, television, landline, mobile phone, bike, motorbike or refrigerator AND does not own a motor car or truck.

Table 2. Cardiometabolic risk factors of AYLHIV by sex

Variable	Description	Male (n=19; 22%)	Female (n=67; 78%)	Total (N=86)
Behavioural characteristics				
Physical activity				
Intensity, n (%)	Vigorous-intensity PA for ≥10 minutes/week	11 (58)	26 (39)	37 (43)
	Moderate-intensity PA for ≥10 minutes/week	15 (79)	53 (79)	68 (79)
	Active travel: walking/cycling for ≥10 minutes/week	16 (84)	45 (67)	61 (71)
Total physical activity (MET minutes/week), median (IQR)		2 504.25 (690 - 7 146)	1 173 (495 - 2 826)	1 215 (495 - 3 348)
Insufficient PA (<600 MET minutes/week), n (%)		4 (21)	23 (34)	27 (31)
High PA (≥3 000 MET minutes/week), n (%)		8 (42)	15 (22)	23 (27)
Sedentary behaviour (≥3 hours of sedentary time per day), n (%)		10 (53)	32 (48)	42 (49)
Dietary behaviour (n=82), n (%)				
Dietary intake	Daily fruits consumption	6 (32)	17 (27)	23 (28)
	Daily vegetables consumption	8 (44)	34 (54)	42 (52)
	Daily whole-grain consumption (N=68)	5 (26)	22 (35)	27 (33)
	Daily consumption of SSBs	5 (26)	20 (30)	25 (29)
	Daily consumption of deep-fried foods	3 (16)	15 (22)	18 (21)
	Daily consumption of fast foods	1 (5)	12 (18)	13 (15)
	Daily consumption of sweets and cakes	2 (11)	25 (37)	27 (31)
Breakfast consumption	Skippers: ate breakfast 0 - 2 days/week	5 (23)	13 (20)	18 (21)
	Semi-skippers: ate breakfast 3 - 4 days/week	5 (23)	13 (20)	18 (21)
	Non-skippers: ate breakfast 5 - 7 days/week	12 (54)	39 (60)	51 (58)
Tobacco use	Cigarette smoking in past month	9 (47)	17 (25)	26 (30)
	Use of other tobacco products in past month	6 (32)	12 (18)	18 (21)
Alcohol use	Drank alcohol in past month	11 (58)	24 (36)	35 (41)
	Binge drinking in past month	7 (37)	14 (21)	21 (24)
Knowledge				
GNKQ-R score, % (average score/88) (95% CI)		40.3 (34.5 - 46.1)	36.5 (34.0 - 38.9)	37.5 (35.1 - 39.6)
	Dietary recommendations (score/18)	44.2 (35.3 - 53.0)	42.5 (38.7 - 46.3)	42.9 (39.4 - 46.4)
	Food groups (score/36)	40.4 (35.5 - 45.4)	37.1 (34.1 - 40.1)	37.9 (35.3 - 40.4)
	Healthy food choices (score/13)	36.8 (27.3 - 46.2)	30.5 (26.0 - 35.1)	31.9 (27.9 - 36.0)
	Diet, disease, and weight management (score/21)	36.8 (28.2 - 45.3)	33.9 (30.6 - 37.1)	34.5 (31.4 - 37.6)

AYLHIV = adolescents and youth living with HIV; PA = physical activity; MET = metabolic equivalent of task; SSBs = sugar-sweetened beverages; GNKQ-R = revised General Nutrition Knowledge Questionnaire.

Table 3. Cardiometabolic risk factors of AYLHIV by age group

Variable	Description	15 - 17 years (n=11; 13%)	18 - 19 years (n=23; 27%)	20 - 21 years (n=23; 27%)	22 - 24 years (n=29; 34%)	Total (N=86)
Behavioural characteristics						
Physical activity						
Intensity	Vigorous-intensity PA for ≥10 minutes/week	8 (80)	9 (39)	11 (50)	9 (31)	37 (43)
	Moderate-intensity PA for ≥10 minutes/week	5 (50)	17 (74)	19 (86)	25 (86)	68 (79)
	Active travel: walking/cycling for ≥10 minutes/week	7 (70)	19 (83)	14 (64)	20 (69)	60 (71)
Total physical activity (MET minutes/week)		984 (280 - 5 295)	2 160 (800 - 3 756)	1 639 (420 - 6 624)	8 76 (508.5 - 1 878)	1 215 (495 - 3 348)
Insufficient PA (<600 MET minutes/week)		5 (45)	5 (22)	7 (30)	10 (34)	27 (31)
High PA (≥3 000 MET minutes/week)		3 (27)	8 (35)	9 (39)	3 (10)	23 (27)
Sedentary behaviour (≥3 hours of sedentary time per day)		7 (70)	9 (39)	12 (54)	14 (49)	42 (49)
Dietary behaviour (n=82)						
Dietary intake	Daily fruits consumption	1 (10)	9 (39)	5 (23)	8 (30)	23 (28)
	Daily vegetables consumption	4 (40)	12 (52)	11 (52)	15 (56)	42 (52)
	Daily whole-grain consumption (n=68)	1 (10)	9 (39)	7 (32)	10 (37)	27 (33)
	Daily consumption of SSBs	3 (27)	6 (26)	9 (39)	7 (24)	25 (29)
	Daily consumption of deep-fried foods*	1 (9)	8 (35)	5 (22)	4 (14)	18 (21)
	Daily consumption of fast foods	2 (18)	6 (26)	2 (9)	3 (10)	13 (15)
	Daily consumption of sweets and cakes	4 (36)	9 (39)	6 (26)	8 (28)	27 (31)
Breakfast consumption	Skippers: ate breakfast 0 - 2 days/week	2 (20)	7 (30)	3 (14)	7 (26)	19 (23)
	Semi-skippers: ate breakfast 3 - 4 days/week	1 (10)	4 (17)	6 (27)	3 (11)	14 (17)
	Non-skippers: ate breakfast 5 - 7 days/week	7 (70)	12 (52)	13 (59)	17 (63)	49 (60)
Tobacco use	Cigarette smoking in past month	5 (45)	7 (30)	6 (26)	8 (28)	26 (30)
	Use of other tobacco products in past month	5 (45)	4 (17)	6 (26)	3 (10)	18 (21)
Alcohol use	Drank alcohol in the past month	5 (45)	10 (43)	7 (30)	13 (45)	35 (41)
	Binge drinking in past month	6 (55)	6 (26)	4 (17)	5 (17)	21 (24)
Knowledge						
GNKQ-R score, % (average score/88) (95% CI)		35.6 (28.4 - 42.9)	38.1 (34.1 - 42.1)	34.3 (28.9 - 39.6)	39.6 (35.7 - 43.4)	37.5 (35.1 - 39.6)
	Dietary recommendations (score/18)	39.9 (27.8 - 52.0)	46.1 (39.8 - 52.4)	40.2 (32.3 - 48.1)	43.4 (37.5 - 49.3)	42.9 (39.4 - 46.4)
	Food groups (score/36)	37.6 (31.6 - 43.7)	37.4 (32.3 - 42.5)	35.0 (29.7 - 40.3)	40.4 (35.5 - 45.4)	37.9 (35.3 - 40.4)
	Healthy food choices (score/13)	33.6 (21.5 - 45.6)	35.1 (28.4 - 41.8)	27.7 (17.8 - 37.6)	31.6 (24.2 - 39.0)	31.9 (27.9 - 36.0)
	Diet, disease relationship (score/21)	29.9 (20.6 - 39.2)	34.4 (29.4 - 39.3)	30.2 (23.3 - 37.1)	39.7 (34.0 - 45.3)	34.5 (31.4 - 37.6)

AYLHIV = adolescents and youth living with HIV; PA = physical activity; MET = metabolic equivalent of task; SSBs = sugar-sweetened beverages; GNKQ-R = revised General Nutrition Knowledge Questionnaire.
*Significant ($p<0.05$).

Tobacco and alcohol use

Overall, a third of participants reported current smoking, 21% reported using other tobacco products, and 41% reported current drinking. Current drinking and binge drinking did not differ by sex. The prevalences of current smoking and binge drinking were highest for the youngest age group (Table 3). More than half (15/26) of current smokers also drank alcohol during the preceding month.

Nutrition knowledge

Overall, the mean GNKQ-R score was 33/88 points (37.5%). Knowledge of dietary recommendations was the highest-scoring domain with an average of 42.9%, while knowledge of healthy food choices was the lowest-scoring domain at 31.9%. There were no significant differences in nutrition knowledge by sex or age.

Comorbidities

Overweight and obesity

A quarter of participants were overweight and 11% were obese, with significant differences by sex (Fig. 1). A greater proportion of participants aged 18 - 19 years were overweight or obese compared with the other age groups (Fig. 1). More females had central obesity compared with males (44% and 14%, respectively). A quarter of participants with a normal BMI had an abnormal WHtR consistent with central obesity.

Blood pressure

Overall, 20% had elevated BP, and 5% had hypertension. The prevalences of elevated BP and hypertension were higher in males

compared with females (Fig. 2). The median (IQR) age of participants with elevated BP or hypertension was 21.2 (18.8 - 22.7) years, similar to those with normal BP (20.2 (19.0 - 22.8) years) (data not shown). Of those with elevated BP or hypertension, 11 (35%) were overweight or obese, and 2 (6%) reported a previous diagnosis of hypertension (data not shown).

Discussion

This study describes the prevalence of cardiometabolic NCDs and risk factors among SA AYLHIV in an urban setting. We found that a quarter had elevated BP or hypertension, more than a third were overweight or obese, a third had insufficient levels of weekly physical activity, the majority did not meet dietary guidelines for fruit and vegetable intake, a third were current smokers, and almost a quarter were binge drinkers. There was low nutritional knowledge, particularly on healthy food choices and diet-disease relationships. A detailed interpretation and comparisons with other studies and settings are discussed further below, beginning with risk factors.

Almost three-quarters of AYLHIV did not meet recommended dietary guidelines for daily fruit and vegetable intake necessary to reduce the risk of NCDs. More respondents, particularly females, consumed deep-fried foods and fast foods daily compared with previous estimates for youth in the same province.[12] Skipping breakfast in adolescence tends to persist until adulthood and has been associated with cardiometabolic risk factors, including higher prevalences of excess body weight and central obesity[34] and increased risk for NCDs.[35] Notably, a greater proportion
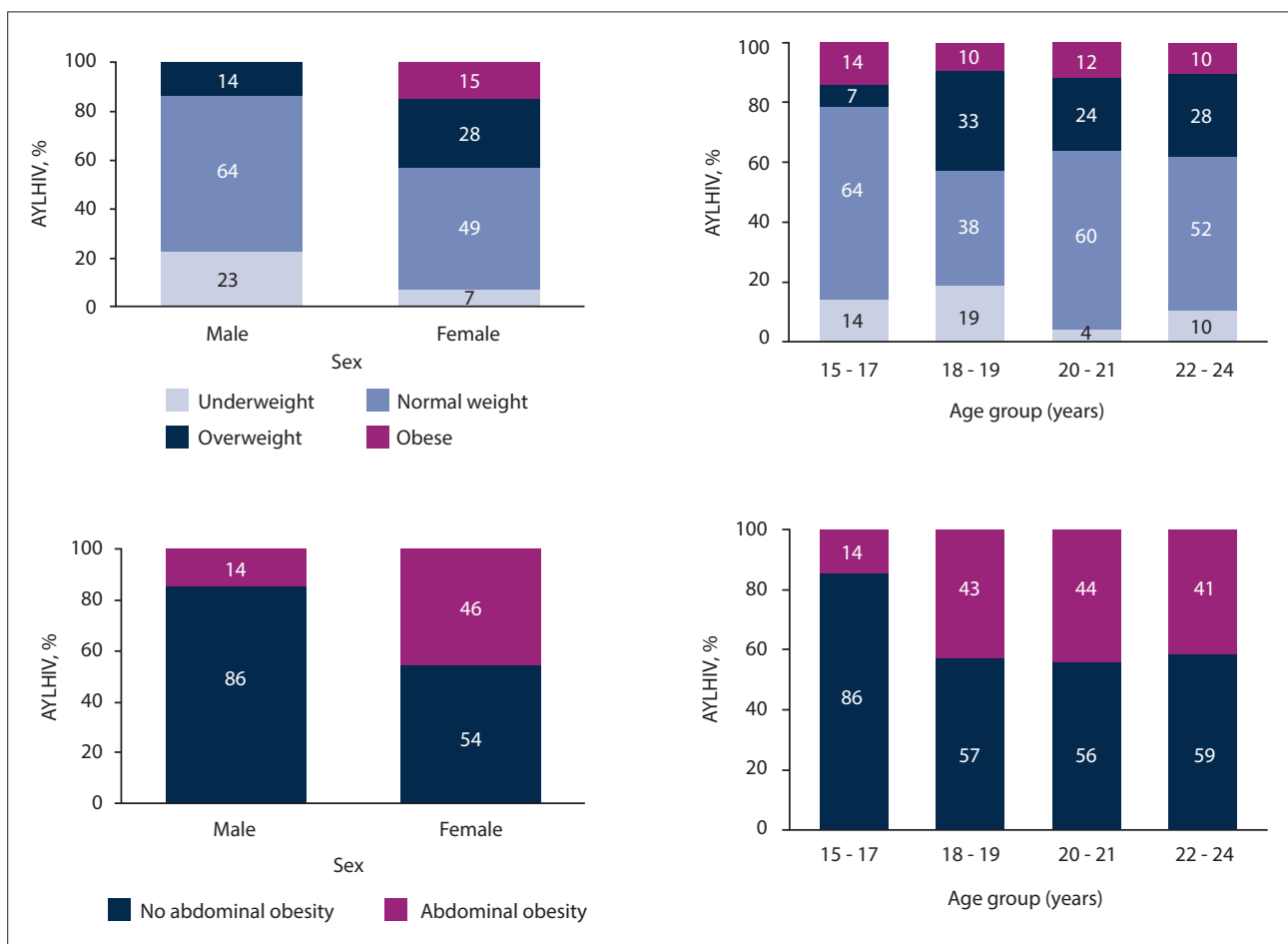

Fig. 1. Weight status and abdominal obesity by sex and age group. Not all percentages total 100 due to rounding. (AYLHIV = adolescents and youth living with HIV).
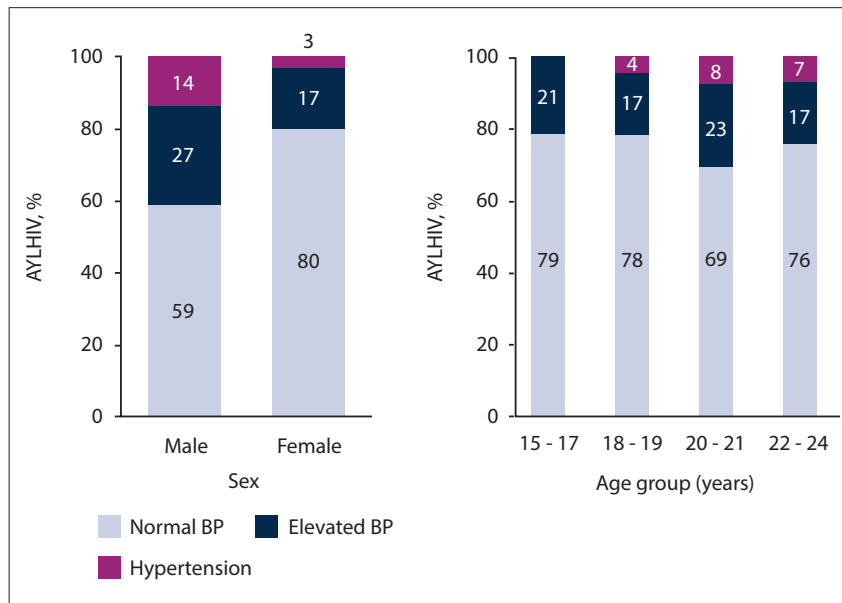
Fig. 2. Measured BP by sex and age group. Not all percentages total 100 due to rounding. (AYLHIV = adolescents and youth living with HIV; BP = blood pressure.)

of AYLHIV reported skipping breakfast regularly compared with national estimates of 13 - 36%[36] and other LMICs (40%).[37] The high prevalence of food insecurity (50% moderate or severe food insecurity) experienced undoubtedly poses a challenge in terms of addressing these unhealthy dietary practices, with implications for NCD risk and viral suppression.[38] The finding that 44% of participants in this study were multidimensionally poor (higher than provincial estimates for youth of 22.8%[39]) is particularly striking. Addressing this challenge requires a multisectoral approach.

The SA government has implemented mandatory legislation for salt reduction in processed foods[40] and a tax on SSBs[41] to promote healthier food environments. Our findings suggest that greater efforts are needed, including appropriate social protection systems, to translate these legislations into action at a community and household level, especially among young girls, who have a higher prevalence of obesity than boys.

Furthermore, participants also scored low on general nutrition knowledge questions and specifically had poor knowledge of healthy food choices and associations between diet and diseases. Inadequate knowledge of nutrition-related NCDs among AYLHIV in our study is concerning in a country undergoing nutritional transition.[42] Although adolescents may lack autonomy in navigating their food environment, this life stage is characterised by increasing independence, highlighting

the importance of good dietary knowledge to support healthier food choices, including daily breakfast consumption.

On the other hand, more than two-thirds of our respondents used active transport, walking to and from either school or work. This behaviour is encouraging, and it would be important for future interventions aimed at promoting physical activity to consider strategies to retain this healthy behaviour. The levels of physical inactivity in our study are similar to levels reported in urban SA students,[43] although we found a higher prevalence of sedentary behaviour.[12] Our results are consistent with those of studies from Botswana and Brazil, which found that AYLHIV had significantly lower daily physical activity levels than HIV-negative controls.[44,45] Additional research is needed to explore the relationship between physical activity and HIV in adolescents and promote physical activity in the context of a dynamic urban built environment.

We also found a higher prevalence of current smoking and drinking compared with national estimates for young people,[8,12] though aligned with smoking trends in Western Cape, the province with the highest prevalence of tobacco smoking in SA.[12] Concerningly, the prevalence of these risky behaviours was highest in the youngest age group, suggesting that targeted interventions to reduce uptake of smoking and drinking should start before adolescence. Smoking and alcohol use amplify the risk of developing cardiovascular diseases in PLHIV compared with HIV-negative people.[46] Studies from

high-income settings and SSA report higher rates of smoking and alcohol use among AYLHIV compared with the general population.[47,48] Our findings corroborate this and add to the limited literature from LMIC settings. However, further research is needed in settings where heavy drinking is endemic to identify patterns of comorbidity and cardiovascular risk associated with increased alcohol consumption in AYLHIV.

With regard to other cardiometabolic risk factors, we found evidence of pre-existing hypertension and obesity in AYLHIV in our study. Our BP findings are consistent with those for youth in urban SA, with measured elevated BP and hypertension prevalences of 31% and 5%, respectively.[49] Hypertension is associated with ART in adults,[50] but there are conflicting data on the link between HIV infection and elevated BP in paediatric and adolescent populations.[51] Our findings support routine monitoring of BP in HIV care, even in younger populations, in settings such as SA with a high background prevalence of hypertension, to avert future disease.

Additionally, more than a third of our respondents were overweight or obese, with significant differences by sex. Obesity in PLHIV is well documented in high-income countries and is emerging as a significant challenge in Africa, with several studies showing increased rates of obesity in PLHIV.[52,53] Notably, we found that 26% of our respondents with a normal BMI met the criteria for central obesity. This finding underscores the importance of anthropometric measurements beyond BMI, especially in females.

Moreover, in our study, obesity co-occurred with hypertension – 35% of those with elevated BP or hypertension were also overweight or obese (data not shown). This finding hints at the potential for obesity screening to help detect other related conditions that tend to cluster with obesity. Given that anthropometric measurements and calculations are non-invasive, low-cost and easy-to-use interventions, our findings support the value of integrating this screening into routine care to identify AYLHIV who are at increased cardiometabolic risk earlier and intervene as they transition into adulthood.

In the context of pre-existing multi-morbidity, our findings suggest that NCD care should be integrated with HIV care and should include screening for weight status and BP to identify comorbid NCDs and intervene early to improve NCD outcomes. Anthropometric assessment is especially pertinent given prolonged exposure to

ART regimens linked to obesity, altered glucose metabolism and dyslipidaemia. Of note, the updated 2021 WHO HIV treatment guidelines call for integrated delivery of NCD health services within HIV care.[54]

In AYLHIV without a current NCD comorbidity, HIV care should include early identification of the most common NCD risk factors to facilitate early intervention and prevent NCD multimorbidity. To this end, our findings of low levels of nutritional knowledge, poor dietary practices and binge drinking (particularly in the youngest age group) suggest that these risk factors should be incorporated into HIV care to prevent multimorbidity.

Study limitations

While our study provides novel findings for the SSA context, adding to the limited evidence base on NCD prevalence and risk factors in AYLHIV, we note some limitations. Lack of random sampling may limit the generalisability of our findings. The necessity for parental consent may also have led to participant bias in the age distribution. However, sampling from six different facilities across all substructures in the City of Cape Town improved representativeness. We utilised subjective recall methods to assess behavioural risk factors, which may be prone to information bias. However, self-report methods such as the IPAQ and FFQ have acceptable validity and have been widely used in similar contexts. We did not measure ART-associated and laboratory measures of other NCD risk factors such as blood lipids and renal function, as we were particularly interested in methods that can be implemented easily at the point of care in primary care settings. The use of point-of-care screening methods narrows the range of NCDs covered by the study. Despite these limitations, this study represents an essential contribution to the limited literature on HIV/NCD multimorbidity in adolescents and youth in SSA.

Conclusions

This study contributes to a critical gap in the literature on NCD comorbidity in AYLHIV in SSA. We identified existing cardiometabolic risk factors and conditions (obesity, abdominal obesity, hypertension, physical inactivity, unhealthy diet, inadequate nutritional knowledge, binge drinking) in this vulnerable population. Our findings suggest that these risk factors should be integrated into routine HIV care for the primary and secondary prevention of NCD multimorbidity in AYLHIV. Beyond healthcare, the findings of high levels of food insecurity and multidimensional poverty reinforce the need to address the social, economic and environmental exposures that coexist with and perpetuate NCD risk. Multisectoral interventions are required beyond the healthcare sector to reduce the impact of NCDs on health systems and broader societal development. Further studies are needed to assess risk factors at a broader socioecological level and explore multilevel determinants of HIV/NCD comorbidity in adolescents and youth.

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