

# BMJ Open Demographics and health profile on precursors of non-communicable diseases in adults testing for HIV in Soweto, South Africa: a cross-sectional study

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## ABSTRACT

**Objectives** This cross-sectional study investigated the burden of HIV-non-communicable disease (NCD) precursor comorbidity by age and sex. Policies stress integrated HIV-NCD screenings; however, NCD screening is poorly implemented in South African HIV testing services (HTS).

**Setting** Walk-in HTS Centre in Soweto, South Africa.

**Participants** 325 voluntary adults, aged 18+ years, who provided written or verbal informed consent (with impartial witness) for screening procedures were enrolled.

**Primary and secondary outcomes** Data on sociodemographics, tuberculosis and sexually transmitted infection symptoms, blood pressure (BP) ( $\geq 140/90$ =elevated) and body mass index ( $< 18.5$  underweight;  $18.5$ – $25.0$  normal;  $> 25$  overweight/obese) were stratified by age-group, sex and HIV status.

**Results** Of the 325 participants, the largest proportions were female (51.1%;  $n=166/325$ ), single (71.5%;  $n=231/323$ ) and 25–34 years (33.8%;  $n=110/325$ ). Overall, 20.9% ( $n=68/325$ ) were HIV infected, 27.5% ( $n=89/324$ ) had high BP and 33.5% ( $n=109/325$ ) were overweight/obese. Among HIV-infected participants, 20.6% (14/68) had high BP and 30.9% (21/68) were overweight/obese, as compared with 29.3% (75/256) and 12.1% (31/256) of the HIV-uninfected participants, respectively. Females were more likely HIV-infected compared with males (26.5% (44/166) vs 15.1% (24/159);  $p=0.012$ ). In both HIV-infected and uninfected groups, high BP was most prevalent in those aged 35–44 years (25% (6/24) vs 36% (25/70);  $p=0.3353$ ) and >44 years (29% (4/14) vs 48% (26/54);  $p=0.1886$ ). Males had higher BP than females (32.9% (52/158) vs 22.3% (37/166);  $p=0.0323$ ); more females were overweight/obese relative to males (45.8% (76/166) vs 20.8% (33/159);  $p<0.0001$ ). Females were more likely to be HIV infected and overweight/obese.

**Conclusion** Among HTS clients, NCD precursors rates and co-morbidities were high. Elevated BP occurred more in older participants. Targeted integrated interventions for HIV-infected females and HIV-infected people aged 18–24 and 35–44 years could improve HIV public health outcomes. Additional studies on whether integrated HTS

## Strengths and limitations of this study

- This study established the previously unknown level of comorbidity of non-communicable disease (NCD) precursors among adults presenting to a standard of care HIV testing services (HTS) centre in Soweto, South Africa.
- This study investigates NCD precursor and HIV comorbidity by sex and age group (18–24 years, 25–34 years, 35–44 years and  $\geq 45$  years) to determine demographics of higher risk.
- This study has a convenience sample of participants self-selecting to attend a single HTS clinic in Soweto. There is potential for bias as these participants were not randomly sampled from multiple facilities.
- As standard of care HTS includes syndromic screening for sexually transmitted infections (STIs) and tuberculosis (TB), this study was not able to confirm suspected STIs and TB with diagnostic testing in clinic.

will improve the uptake of NCD treatment and improve health outcomes are required.

## INTRODUCTION

The epicentre of the HIV epidemic is South Africa which is estimated to have 7.9 million people living with HIV (PLHIV) and has a high HIV prevalence among the general population aged 15–49 years (20.6%).<sup>1</sup> South Africa's colliding epidemics of HIV/AIDS, and other communicable and chronic non-communicable diseases (NCDs), specifically HIV-NCD comorbidities, may complicate HIV treatment and impact survival.<sup>2 3</sup> To combat this, the South African National HIV Testing Services (HTS) Policy and Guidelines 2015<sup>4</sup> stresses the importance of integrating screening efforts for HIV, tuberculosis (TB),

sexually transmitted infections (STIs) and NCDs.<sup>4</sup> Globally, South Africa has the highest estimated TB incidence among PLHIV with nearly 200 000 TB/HIV cases in 2017.<sup>5,6</sup> In South Africa, 3.4% of new TB cases and 7.1% of previously treated TB cases are multidrug resistant/rifampicin resistant.<sup>6</sup> The STI prevalence in South Africa is high,<sup>7</sup> though there is no baseline epidemiological data that exists.<sup>8</sup> Additionally, the prevalence of chronic NCDs is predicted to cause almost three-quarters as many deaths as communicable, maternal, perinatal and nutritional disease combined by 2020, exceeding them as the most common causes of death by 2030 in Africa.<sup>9</sup>

While the KwaZulu-Natal Province has the highest HIV prevalence (27.0%) out of South Africa's nine provinces,<sup>1</sup> the Gauteng Province has the highest number of new HIV infections.<sup>10</sup> Another cause for concern is the rise of precursors of NCDs, such as obesity and high blood pressure (BP) within this province. The South African Demographics and Health Survey (SADHS) in 2016 reported about one-in-five Gauteng residents are severely obese (body mass index (BMI)  $\geq 35$ ), and the province's prevalence of hypertension in women and men aged 15 years or older to be 42.3% and 39.5%, respectively. The prevalence of hypertension is slightly higher for the black/African ethnic group, and increased even more for women and men in urban areas of residence (46.5% and 45.4%).<sup>11</sup>

Soweto, the largest group of urban African townships in South Africa, falls within the City of Johannesburg Metropolitan Municipality (JHB) district, Gauteng Province.<sup>12</sup> By 2003, the Greater Soweto area consisted of 87 townships grouped together into zones.<sup>7</sup> Measuring 200 km<sup>2</sup>, it holds a population of about 1.3 million people which has increased by 48.1% in the last 10 years.<sup>6,8</sup> With South African townships known to have a higher HIV prevalence and the SADHS reporting urban populations have a higher prevalence of NCD precursors than the overall national prevalence,<sup>11,13</sup> the community of Soweto could be one of the most vulnerable populations to HIV-NCD comorbidities.<sup>12</sup> Collecting data on the health status of the general population of Soweto could prove useful in understanding the true burden of comorbid disease and provide insight to prevention and treatment programmes.

Black Africans comprise 98.1% of the population in Soweto.<sup>14</sup> While there has been a large collection of data depicting the health profile of Gauteng province and the JHB district, there is a paucity of literature on the burden of disease affecting the general population of Soweto. Existing data are largely from studies targeting key populations, and/or age or sex groups. For example, there is no systematically collected and reported baseline STI prevalence data for Soweto, however studies have clearly explained the STI health profile of men who have sex with men and for adolescents residing in Soweto.<sup>15,16</sup> The Heart of Soweto Study established a prospective registry of men and women from Soweto presenting with heart disease to the Chris Hani Baragwanath Academic (Bara) Hospital.<sup>17</sup> Preliminary results published in 2006 from

information collected on 12 000+ men and women identified cardiovascular disease in 35% of the individuals, with almost a quarter affected aged below 40 years. Two of the five most common diagnoses overall were hypertension (54%) and diabetes (10%).<sup>17</sup>

The South African National HTS: Policy and Guidelines<sup>4</sup> call for integrated screenings was adopted from the WHO Consolidated Guidelines on HIV Counselling and Testing (HCT),<sup>18</sup> a collation of evidence-based best practices for effective delivery of HTS and subsequent linkage to HIV prevention, care and treatment services. The global guidance, as well as the national policy, also focus on supporting the Joint United Nations Programme on HIV/AIDS 90-90-90 global HIV targets.<sup>19</sup> The aim of 90-90-90 is to diagnose 90% of all HIV-infected persons, provide antiretroviral therapy (ART) for 90% of those diagnosed and achieve viral suppression for 90% of those treated by 2020.<sup>19</sup>

The aim of this paper was to establish the level of comorbidity of NCD precursors among adults presenting to a standard of care HTS in Soweto, South Africa. Here we present baseline demographic and health profile data. National and global policies stress integrated screening to address NCD precursors (eg, BP and BMI). However, screening is poorly implemented in many South African HTS, and programmes need data for health planning.

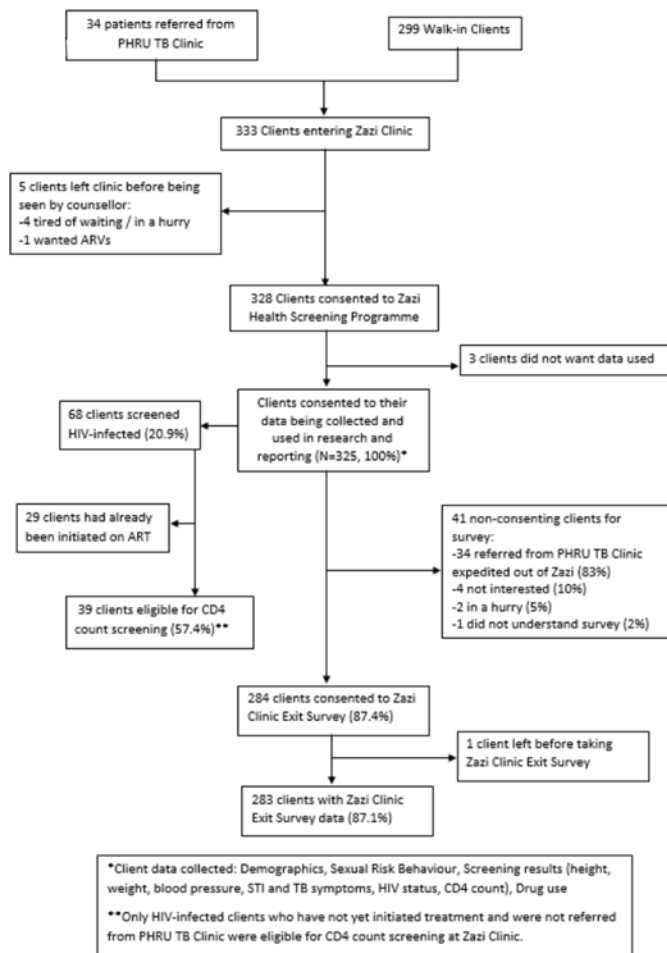
## METHODS

### Study design and setting

This was a cross-sectional study which evaluated a health screening programme within the Zazi' HTS clinic at the Perinatal HIV Research Unit (PHRU), a leading research centre situated at the Bara Hospital in Soweto.

The PHRU Zazi HCT Clinic, which loosely translates from Zulu to English as 'Know Yourself', has provided on-site HIV testing and counselling for adults in Soweto since 2001. It also facilitates CD4 count testing for clients not yet initiated on treatment. Zazi initially conducted CD4 count screening as  $>350$  cells/mm<sup>3</sup> was formerly required to start treatment. Now that a CD4 count threshold is no longer required to initiate treatment, Zazi still offers the test as an indicator of health for HIV-infected clients not yet on treatment. Zazi is currently the only service provider of walk-in, free, accessible HTS service supplied to Bara Hospital, the largest hospital in the southern hemisphere. HIV treatment is not provided on-site, but clients are given referral letters to local clinics.

To align itself with the global and national policies, the Zazi clinic expanded its health service provision in 2018, and began offering height and weight measurements, BP readings and symptom screenings for STIs and TB within its HTS. If required, clients were given referral letters for additional testing and treatment at their local government clinics; treatment was not provided on-site for any illness. In this manner, the Zazi clinic reflected the South African National Department of Health's (NDoH) newly proposed HTS standard of care.



**Figure 1** Participant flow chart for the Zazi clinic. PHRU, Perinatal HIV Research Unit; STI, sexually transmitted disease; TB, tuberculosis.

### Sampling and sample size

The study sample was comprised of all eligible walk-in PHRU Zazi HTS clients, who consented for both the health screening programme and for their data to be captured and used in research, between 19 February 2018 and 14 June 2018. Any client who allowed the use of his/her health screening results and data via study consent were included in the aggregate data capture. If consent was not given, the client was still able to undergo health screening without data capture. All clients who consented to the programme and to data capture were then asked if they would like to partake in a clinic exit survey prior to leaving the clinic and consent was obtained. [Figure 1](#) depicts the participant flow chart in Zazi.

### Inclusion and exclusion criteria

Eligibility criteria for participation in the integrated screenings were the following: at least 18 years of age; able to communicate in either English, IsiZulu and/or Sotho; and able and willing to provide written or verbal informed consent (with impartial witness) for health screening procedures. If a client presented to the clinic and there was immediate cause for concern, they were

excluded from the programme and redirected to the Bara casualty ward.

### Data collection and management

Client demographic and clinic exit survey data were either self-collected by literate clients in the reception area, or collected with help of the clinic receptionist or lay counsellors for clients unable to read or write. Clinical data were collected by the study lay counsellors and enrolled nurse while in private rooms through consultation with the client. Demographic, behavioural and clinical data were collected through screenings and questionnaires and recorded onto paper forms comprising PHRU Zazi HTS client file. Clinical data collected included health profile and screening results (see *Study measures: Health profile and screening results* section below) and client interest in pre-exposure prophylaxis (PrEP). Source documents were the client file and CD4 count pathology reports as accessed and printed by the enrolled nurse from the electronic National Health Laboratory Services InterSystems' TrakCare Laboratory Information System.

The Programme Manager and statistician led data cleaning checks prior to clinical staff entering data into the electronic database (REDCap), performing a 100% cross-check of all captured data against the client files for verification purposes.

### Study measures

#### Demographic and substance use information

Data were collected on sex, age, race, nationality, ethnic group, marital status, highest level of education, employment, details regarding home residence—type of housing, source of water and fuel for cooking and lighting, type of toilet facility, as well as possession of household and ownership items.

A wealth quintile was developed using the socioeconomic measures and determined using Principal Component Analysis (PCA).<sup>20–22</sup> The socioeconomic measures included the following variables: *type of house, source of water, type of toilet facility; type of fuel used for cooking; type of fuel used for lighting; possession of household items and other ownership items.* Prior to calculating the wealth quintile, variables with more than two levels were recoded into binary (0 or 1) for each level of response. Frequencies were run on all the binary variables and only those with responses between 5% and 95% were retained. The retained variables were evaluated by the PCA method using the varimax rotation to identify those contributing largely to the wealth construct. Variables meeting a prespecified cut-off and loading in at least two factors were excluded. The remaining variables were retained and scored to create the socioeconomic index. Five wealth quintiles were estimated on the scored measure using 20 percentile intervals.

Additional information was collected on substance use including how often clients drank alcohol in the last year and number of drinks per occasion, usage of illicit drugs and type of illicit drugs, current cigarette smoking status and number of cigarettes smoked per day. Questions



surrounding alcohol, tobacco and drug use were taken from the validated 2003 SADHS.<sup>23</sup>

### Health profile and screening results

Client health profile and screening results include BMI, BP readings, STI and TB symptoms, HIV results and CD4 count.

*BMI* was calculated by dividing client weight (in kg) by the square of height (in m<sup>2</sup>) and classified as underweight, normal, overweight and obese using the WHO classification.<sup>24</sup> Overweight and obese categories were merged resulting in three categories.

*BP* was classified as high, normal or low using systolic and diastolic BP. High BP was defined as >140/90 mm Hg, normal BP was considered ≤140/90 and ≥90/60 mm Hg, and low BP was classified as <90/60 mm Hg. If the first measurement was high or low then a second BP reading was conducted, and an average BP was used for the classification. BP cut-offs used were from the South African Hypertension Practice Guidelines, as per standard of care.<sup>25</sup>

*STI symptoms* were defined as having at least one of the following symptoms: (1) abnormal, bad-smelling or itchy discharge from the vagina/penis/anus; (2) any blood coming from the vagina/penis/anus; (3) current sores on/in vagina/penis/anus; (4) burning sensation while passing urine and/or (5) any lower abdominal pain (if female).

*TB symptoms* were defined as having one or more of the following symptoms: (1) cough for more than 2 weeks, (2) blood in the sputum, (3) persistent fever and/or night sweats for more than 2 weeks, (4) weight loss of ≥1.5 kg in the last month and/or (5) lived with someone who has/had TB in the last month.<sup>26</sup> TB symptoms were assessed for clients who were not already diagnosed with TB on entering the clinic.

The STI and TB symptom screening utilised standardised questions provided by the NDoH.

### Data analysis

Descriptive statistics (eg, medians and IQRs) were determined for continuous variables (eg, age, BMI and CD4 count). Frequencies and their percentages were determined for categorical variables and stratified by age group (18–24, 25–34, 35–44 and ≥45 years), sex and HIV status where appropriate.

To test statistical significance for categorical measures stratified by sex, Fisher's exact test or  $\chi^2$  analysis as appropriate was used. Continuous variables were compared by sex using the Kruskal-Wallis test. The distribution of precursors of NCDs (BMI and BP) were presented graphically by age-group and sex.

All statistical analysis was conducted in SAS Enterprise Guide V.7.1 (SAS Institute) using SAS/STAT procedures PROC FREQ, PROC NPARIWAY and PROC FACTOR.

### Patient and public involvement

This research was done without patient involvement. Patients were not invited to comment on the study design

and were not consulted to develop patient relevant outcomes or interpret the results. We have invited our research community advisory board to help us disseminate our findings.

### Ethical considerations

This study was reviewed in accordance with the Centers for Disease Control and Prevention human research protection procedures and was determined to be a research, but investigators did not interact with human subjects or had access to identifiable data or specimens for research purposes.

## RESULTS

Demographic, substance use and health profile data were collected on 325 eligible walk-in Zazi clients.

### Demographics and substance use

Males were significantly older than females (median (IQR) age 37.5 (31.0–45.0) years vs 33.0 (26.0–41.0) years, respectively;  $p=0.001$ ) (table 1). The largest proportion of clients were female (51.1%, (n=166/325)), predominantly black Africans (98.5% (n=320/325)), South African (95.0% (n=305/321)), Zulu-speaking (41.7% (n=135/324)) and single (71.5% (n=231/323)). About one-third had completed high school (31.5% (n=102/324)), and the majority had initially come to Zazi for HIV testing (96.3% (n=313/325)). Most clients belonged to the lower wealth quintiles: first quintile (24.0% (78/325)), second quintile (26.8% (n=87/325)) and third quintile (24.9% (n=81/325)). Clients aged 25–34 and 35–44 years mostly fell within the first quintile (28.2% (n=31/110) and 28% (n=26/94), respectively), whereas the younger age group (18–24 years) mostly reflected the second quintile (40% (n=21/52)). The oldest clients (≥45 years) did not contribute towards the highest wealth quintile. Of clients with substance use data available, 11.0% (n=32/290), 7.4% (n=24/325) and 26.9% (n=78/290) reported drinking alcohol, using drugs weekly and ever smoked cigarettes, respectively. People aged 18–24 years reported drinking alcohol on a monthly basis (49% (n=22/45)) and drank >4 standard-size drinks per sitting (75% (n=24/32)). Clients aged 25–34 years reported drinking weekly (14% (n=14/98)) and monthly (38% (n=37/98)), and among those who do drink, the majority drank >4 standard-size drinks per sitting (72% (n=49/68)). The majority of clients who reported having ever smoked cigarettes, still smoke (99% (n=77/78)) about 10 cigarettes per day (43% (33/77)). Of these, the highest proportion were aged 25–34 (53% (n=16/30)) and 35–44 years (52% (n=11/21)) (table 1).

### Communicable disease screening results

Overall, 3.5% (n=11/318) had STI symptoms, 1.4% (n=4/289) had TB symptoms and 20.9% (n=68/325) were HIV infected. There were 34 laboratory-confirmed TB clients who entered Zazi, and of those, 19 (56%) were

**Table 1** Demographic characteristics and substance use by age group

Variable	Overall	Age in years			
		18–24	25–34	35–44	≥ 45
<b>Sex</b>					
Female (%)	166/325 (51.1)	39/52 (75.0)	56/110 (50.9)	44/94 (46.8)	27/69 (39.1)
Male (%)	159/325 (48.9)	13/52 (25.0)	54/110 (49.1)	50/94 (53.2)	42/69 (60.9)
<b>Race</b>					
Black (%)	320/325 (98.5)	51/52 (98.1)	108/110 (98.2)	92/94 (97.9)	69/69 (100.0)
Coloured/mixed race (%)	5/325 (1.5)	1/52 (1.9)	2/110 (1.8)	2/94 (2.1)	0/69 (0.0)
<b>Nationality</b>					
South African (%)	305/321 (95.0)	51/52 (98.1)	103/109 (94.5)	86/91 (94.5)	65/69 (94.2)
Other (%)	16/321 (5.0)	1/52 (1.9)	6/109 (5.5)	5/91 (5.5)	4/69 (5.8)
<b>Ethnic group</b>					
Zulu (%)	135/324 (41.7)	26/52 (50.0)	49/109 (45.0)	29/94 (30.9)	31/69 (44.9)
Sotho (%)	60/324 (18.5)	10/52 (19.2)	17/109 (15.6)	21/94 (22.3)	12/69 (17.4)
Tsonga (%)	31/324 (9.6)	5/52 (9.6)	12/109 (11.0)	10/94 (10.6)	4/69 (5.8)
Tswana (%)	24/324 (7.4)	1/52 (1.9)	10/109 (9.2)	7/94 (7.4)	6/69 (8.7)
Xhosa (%)	27/324 (8.3)	5/52 (9.6)	7/109 (6.4)	10/94 (10.6)	5/69 (7.2)
Other (%)	47/324 (14.5)	5/52 (9.6)	14/109 (12.8)	17/94 (18.1)	11/69 (15.9)
<b>Marital status</b>					
Divorced/widowed (%)	19/323 (5.9)	0/52 (0.0)	2/110 (1.8)	7/92 (7.6)	10/69 (14.5)
Living together/married (%)	73/323 (22.6)	3/52 (5.8)	21/110 (19.1)	17/92 (18.5)	32/69 (46.4)
Single (%)	231/323 (71.5)	49/52 (94.2)	87/110 (79.1)	68/92 (73.9)	27/69 (39.1)
<b>Highest education</b>					
Up to high school (%)	138/324 (42.6)	19/52 (36.5)	41/110 (37.3)	37/93 (39.8)	41/69 (59.4)
Matriculated (%)	102/324 (31.5)	21/52 (40.4)	35/110 (31.8)	30/93 (32.3)	16/69 (23.2)
Tertiary education (%)	84/324 (25.9)	12/52 (23.1)	34/110 (30.9)	26/93 (28.0)	12/69 (17.4)
<b>Why did you decide to come to the clinic today?</b>					
HIV testing (%)	313/325 (96.3)	52/52 (100.0)	106/110 (96.4)	92/94 (97.9)	63/69 (91.3)
CD4 count retest (%)	18/325 (5.5)	1/52 (1.9)	6/110 (5.5)	4/94 (4.3)	7/69 (10.1)
TB screening (%)	14/325 (4.3)	4/52 (7.7)	4/110 (3.6)	6/94 (6.4)	0/69 (0.0)
General STI screening (%)	15/325 (4.6)	5/52 (9.6)	3/110 (2.7)	7/94 (7.4)	0/69 (0.0)
Check blood pressure (%)	15/325 (4.6)	4/52 (7.7)	4/110 (3.6)	5/94 (5.3)	2/69 (2.9)
<b>Wealth quintile</b>					
Quintile 1 (%)	78/325 (24.0)	13/52 (25.0)	31/110 (28.2)	26/94 (27.7)	8/69 (11.6)
Quintile 2 (%)	87/325 (26.8)	21/52 (40.4)	21/110 (19.1)	20/94 (21.3)	25/69 (36.2)
Quintile 3 (%)	81/325 (24.9)	9/52 (17.3)	25/110 (22.7)	24/94 (25.5)	23/69 (33.3)
Quintile 4 (%)	60/325 (18.5)	7/52 (13.5)	25/110 (22.7)	15/94 (16.0)	13/69 (18.8)
Quintile 5 (%)	19/325 (5.8)	2/52 (3.8)	8/110 (7.3)	9/94 (9.6)	0/69 (0.0)
<b>In the last year, how often would you usually drink alcohol?</b>					
Weekly (%)	32/290 (11.0)	5/45 (11.1)	14/98 (14.3)	9/84 (10.7)	4/63 (6.3)
Monthly (%)	93/290 (32.1)	22/45 (48.9)	37/98 (37.8)	23/84 (27.4)	11/63 (17.5)
Sometimes (%)	51/290 (17.6)	5/45 (11.1)	17/98 (17.3)	20/84 (23.8)	9/63 (14.3)
Never drank alcohol in the last year (%)	114/290 (39.3)	13/45 (28.9)	30/98 (30.6)	32/84 (38.1)	39/63 (61.9)

Continued

Table 1 Continued

Variable	Overall	18–24	Age in years		
			25–34	35–44	≥ 45
About how many standard-size drinks do you usually have in 1 day?					
1–2 (%)	25/175 (14.3)	5/32 (15.6)	7/68 (10.3)	8/52 (15.4)	5/23 (21.7)
3–4 (%)	34/175 (19.4)	3/32 (9.4)	12/68 (17.6)	12/52 (23.1)	7/23 (30.4)
>4 (%)	116/175 (66.3)	24/32 (75.0)	49/68 (72.1)	32/52 (61.5)	11/23 (47.8)
Do you use drugs?					
Yes often (weekly) (%)	24/325 (7.4)	3/52 (5.8)	15/110 (13.6)	2/94 (2.1)	4/69 (5.8)
Sometimes (%)	8/325 (2.5)	2/52 (3.8)	3/110 (2.7)	3/94 (3.2)	0/69
No (%)	293/325 (90.2)	47/52 (90.4)	92/110 (83.6)	89/94 (94.7)	65/69 (94.2)
Have you ever smoked cigarettes?					
No (%)	212/290 (73.1)	29/45 (64.4)	68/98 (69.4)	63/84 (75.0)	52/63 (82.5)
Yes (%)	78/290 (26.9)	16/45 (35.6)	30/98 (30.6)	21/84 (25.0)	11/63 (17.5)
Do you still smoke cigarettes now?					
No (%)	1/78 (1.3)	1/16 (6.3)	0/30 (0.0)	0/21 (0.0)	0/11 (0.0)
Yes (%)	77/78 (98.7)	15/16 (93.8)	30/30 (100.0)	21/21 (100.0)	11/11 (100.0)
About how many cigarettes do you or did you usually smoke in 1 day?					
1–2 (%)	12/77 (15.6)	2/15 (13.3)	2/30 (6.7)	4/21 (19.0)	4/11 (36.4)
<5 (%)	27/77 (35.1)	6/15 (40.0)	12/30 (40.0)	4/21 (19.0)	5/11 (45.5)
10 (%)	33/77 (42.9)	5/15 (33.3)	16/30 (53.3)	11/21 (52.4)	1/11 (9.1)
20 (%)	5/77 (6.5)	2/15 (13.3)	0/30 (0.0)	2/21 (9.5)	1/11 (9.1)

The total frequencies for each variable do not necessarily equal the total sample size due to missing responses. STI, sexually transmitted disease; TB, tuberculosis.

among the HIV infected. STI symptoms were highest in the group of people aged 18–24 years (10% (n=5/51)). HIV infections were most prevalent in the group of aged 35–44 years (26% (n=24/94)) followed by those ≥45 years (20% (n=14/69)) and 25–34 years (20.0% (n=22/110)). Of the 68 HIV-infected clients, 39 had their CD4 count measured (median CD4: 327 cells/mm<sup>3</sup>, IQR: 157–569). The remaining 29 HIV-infected clients were already in care, monitored regularly. A higher proportion of clients aged ≥45 years were overweight/obese (46% (n=32/69)) (table 2).

In comparing screening results by age groups, clients in age groups 35–44 and ≥45 years were more likely to be overweight/obese compared with the group aged 25–34 years (37.2% (n=35/94) vs 22.7% (n=25/110); p=0.0234) and (46.4% (n=32/69) vs 22.7% (n=25/110); p=0.0009). The older age groups (25–34, 35–44 and ≥44 years) had significantly high proportions of high BP (22.7% (n=25/110) vs 5.8% (n=3/52; p=0.0077)), (33.0 (n=31/94) vs 5.8% (n=3/52; p=0.0002) and (44.1% (n=30/68) vs 5.8% (n=3/52; p<0.0001) relative to the younger age group (18–24 years). In addition, clients who were ≥45 years were more likely to be obese compared with the group aged 25–34 years (44.1% (n=30/68) vs 22.7% (n=25/110); p=0.0027).

Females obtained a significantly higher rate of HIV diagnosis than males (26.5% (n=44/166) vs 15.1% (n=24/159); p=0.012) (table 2). The proportion of males and females reporting no interest in learning about PrEP (95.6% (n=129/135) vs 91.8% (n=112/122); p=0.21) was similar between sex. Females were significantly more likely to be overweight/obese than males (45.8% (n=76/166) vs 20.8% (n=33/159); p<0.001). A significantly higher number of males were diagnosed with high BP compared with females (32.9% (n=52/158) vs 22.3% (n=37/166); p=0.032). Overall, 33.5% (n=109/325) were overweight/obese, 27.5% (n=89/324) and 1.5% (n=5/324) had high and low BP, respectively (table 2).

### NCD screening results, stratified by HIV status

Both figure 2 and table 3 present the distribution of BP and BMI, stratified by age-group and sex for HIV-infected and HIV-uninfected clients. All HIV-infected clients aged 18–24 years (n=8) had normal BP readings, regardless of BMI (figure 2A, table 3). High BP readings increased with age with the highest readings being among the oldest age group (≥45 years, 28.6%). Though not significant, HIV-infected females had higher BP readings relative to HIV-infected males (25.0% vs 12.5%; p=0.22) (figure 2B, table 3). For HIV-uninfected clients, a similar BP trend

**Table 2** Screening results by age group and sex

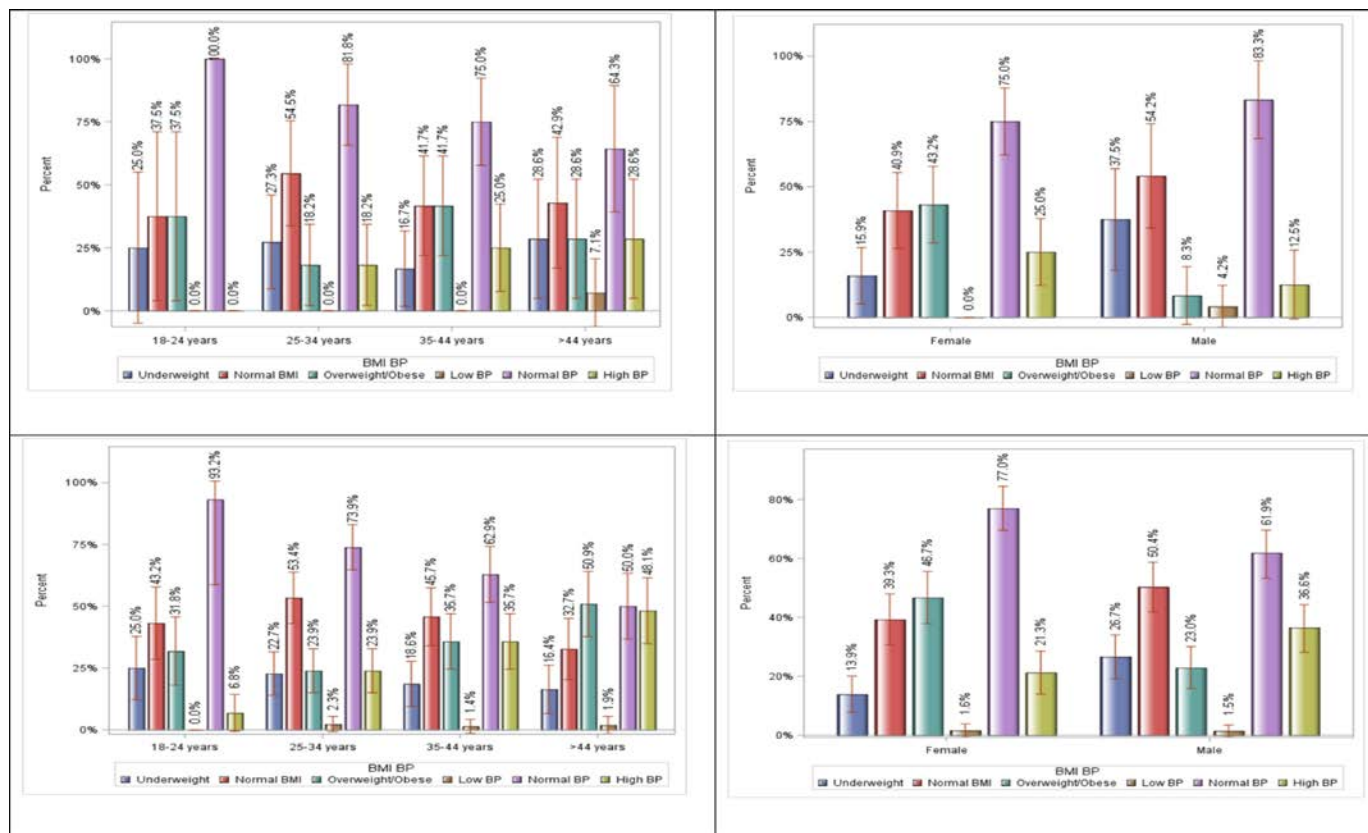
Variable	Age in years				Sex		P value
	Overall	18–24	25–34	35–44	≥45	Female	
Body mass index (BMI)							
Underweight (%)	69/325 (21.2)	13/52 (25.0)	26/110 (23.6)	17/94 (18.1)	13/69 (18.8)	24/166 (14.5)	45/159 (28.3)
Normal (%)	147/325 (45.2)	22/52 (42.3)	59/110 (53.6)	42/94 (44.7)	24/69 (34.8)	66/166 (39.8)	81/159 (50.9)
Overweight/obese (%)	109/325 (33.5)	17/52 (32.7)	25/110 (22.7)	35/94 (37.2)	32/69 (46.4)	76/166 (45.8)	33/159 (20.8)
Median number of BMI (IQR)	n=325, 220.1 (19.1–27)	n=52, 210.4 (18.4–26.5)	n=110, 210.0 (18.5–24.7)	n=94, 220.8 (19.4–27.7)	n=69, 230.9 (19.4–28.9)	n=166, 240.0 (20.1–29.6)	n=159, 200.4 (18.0–23.8)
Min-max number of BMI	n=325 (13–43)	n=52 (14–35)	n=110 (14–40)	n=94 (14–43)	n=69 (13–35)	n=166 (14–43)	n=159 (13–33)
Blood pressure							
High (%)	89/324 (27.5)	3/52 (5.8)	25/110 (22.7)	31/94 (33.0)	30/68 (44.1)	37/166 (22.3)	52/158 (32.9)
Low (%)	5/324 (1.5)	0/52 (0.0)	2/110 (1.8)	1/94 (1.1)	2/68 (2.9)	2/166 (1.2)	3/158 (1.9)
Normal (%)	230/324 (71.0)	49/52 (94.2)	83/110 (75.5)	62/94 (66.0)	36/68 (52.9)	127/166 (76.5)	103/158 (65.2)
Syndromic STI							
1 + symptoms (%)	11/318 (3.5)	5/51 (9.8)	2/109 (1.8)	4/94 (4.3)	0/64 (0.0)	10/163 (6.1)	1/155 (0.6)
No symptoms (%)	307/318 (96.5)	46/51 (90.2)	107/109 (98.2)	90/94 (95.7)	64/64 (100.0)	153/163 (93.9)	154/155 (99.4)
Syndromic TB							
1 + symptoms (%)	4/289 (1.4)	0/46 (0.0)	1/97 (1.0)	2/84 (2.4)	1/62 (1.6)	2/155 (1.3)	2/134 (1.5)
No symptoms (%)	285/289 (98.6)	46/46 (100.0)	96/97 (99.0)	82/84 (97.6)	61/62 (98.4)	153/155 (98.7)	132/134 (98.5)
HIV result							
Positive (%)	68/325 (20.9)	8/52 (15.4)	22/110 (20.0)	24/94 (25.5)	14/69 (20.3)	44/166 (26.5)	24/159 (15.1)
Negative (%)	257/325 (79.1)	44/52 (84.6)	88/110 (80.0)	70/94 (74.5)	55/69 (79.7)	122/166 (73.5)	135/159 (84.9)
Was CD4 count (cells/mm <sup>3</sup> ) measured for all HIV-infected clients?							
No (%)	29/68 (42.6)	4/8 (50.0)	7/22 (31.8)	9/24 (37.5)	9/14 (64.3)	17/44 (38.6)	12/24 (50.0)
Yes (%)	39/68 (57.4)	4/8 (50.0)	15/22 (68.2)	15/24 (62.5)	5/14 (35.7)	27/44 (61.4)	12/24 (50.0)
CD4 count (cells/mm <sup>3</sup> )							
Median (IQR)	n=39, 327 (157–569)	n=4, 310 (209–452)	n=15, 259 (144–468)	n=15, 335 (94.0–653)	n=5, 591 (463–615)	n=44, 365 (190–511)	n=24, 244 (124–622)
Min-max	n=39 (27–1000)	n=4 (190–511)	n=15 (91–845)	n=15 (27–1000)	n=5 (313–953)	n=44 (27–1000)	n=24 (72–845)

The total frequencies for each variable do not necessarily equal the total sample size due to missing responses. Participants were able to opt out of any screening, and specifically syndromic TB screening was only conducted for clients not already presenting with diagnosed TB.

P values (overweight/obese): 25–34 vs 35–44 years=0.0234, 25–34 vs ≥45 years=0.0009; p values (high blood pressure): 18–24 vs 25–34=0.0077, 18–24 vs 35–44 years=0.0002, 18–24 vs ≥45 years<0.0001, 25–34 vs ≥45 years=0.0027.

STI, sexually transmitted disease; TB, tuberculosis.





**Figure 2** Distribution of BMI and BP by HIV status: (A) BMI and BP for HIV-infected people by age group (B) BMI and BP for HIV-infected people by sex. (C) BMI and BP for HIV-uninfected people by age group. (D) BMI and BP for HIV-uninfected people by age group. BMI, body mass index; BP, blood pressure.

was seen by age (figure 2C, table 3), while the opposite was seen by sex (figure 2D, table 3).

In the HIV-infected group, high BP was most common among those who were overweight/obese as opposed to normal weight (57.1% (n=8/14) vs 24.5% (n=13/53);  $p=0.0193$ ). Whereas, in the HIV-uninfected group, clients who were underweight had normal BP relative to high BP (24.3% (n=43/177) vs 10.7% (n=8/75);  $p=0.0138$ ). In addition, a high proportion of males who were overweight/obese had high BP compared with normal BP (34.7% (n=17/49) vs 15.7% (13/83);  $p=0.0117$ ) (table 3).

## DISCUSSION

This study has shown that there is a high prevalence of HIV, NCD precursors and HIV-NCD precursor comorbidity among an urban, adult population in Johannesburg, South Africa; and could depict similar health burden outcomes within analogous geographical locations in South Africa. Men have significantly higher BP than women, even though females are significantly more overweight/obese than males. Women have significantly more HIV-infection than men, and there is an association between high BMI and hypertension among HIV-infected women. Overall, HIV-uninfected persons have higher BP compared with their HIV-infected counterparts among all age groups, and HIV-uninfected males have higher BP compared with HIV-infected males. Our study reports

a higher HIV prevalence than the national prevalence.<sup>1</sup> Over one-third of clients were overweight/obese, representing a higher prevalence of this BMI among black Africans as compared with the SADHS.<sup>11</sup> The prevalence of high BP among our study participants is nearly three times that of a recent national general household survey conducted by Statistics South Africa, which reported an overall 10.4% prevalence of hypertension, as diagnosed by a medical professional.<sup>27</sup>

Our study results are compatible with national data regarding females having significantly more HIV-infections as compared with men<sup>28 29</sup>; a high prevalence of overweight/obesity among all age-groups which increased with age<sup>11</sup>; significantly more overweight/obesity among women<sup>11 30</sup>; and prevalence of hypertension increasing with age.<sup>31</sup> However, our study's overall HIV prevalence was slightly higher than the national prevalence,<sup>5</sup> with the majority of infections being clients 35+ years of age. One-third of all Zazi clients being overweight/obese represented a lower prevalence than reported by the SADHS for the black African population (67.4% of women and 27.4% of men).<sup>11</sup> We found all age-groups to exhibit a high prevalence of elevated BP, even the youth; and men had significantly higher BP than women. This contradicts the Statistics South Africa national household survey in which prevalence of high BP increased with age in both sexes and was higher in women for all age groups.<sup>27</sup>



**Table 3** BMI and blood pressure by age group and sex for HIV-infected and uninfected clients

Variable	HIV infected			HIV uninfected				
	Overall	Low BP	Normal BP	High BP	Overall	Low BP	Normal BP	High BP
<b>Body mass index (BMI)</b>								
<i>Age group</i>								
18–24 years								
Underweight (%)	2/8 (25.0)	0/0	2/8 (25.0)	0/0	11/44 (25.0)	0/0	11/41 (26.8)	0/3 (0.0)
Normal (%)	3/8 (37.5)	0/0	3/8 (37.5)	0/0	19/44 (43.2)	0/0	17/41 (41.5)	2/3 (66.7)
Overweight/obese (%)	3/8 (37.5)	0/0	3/8 (37.5)	0/0	14/44 (31.8)	0/0	13/41 (31.7)	1/3 (33.3)
25–34 years								
Underweight (%)	6/22 (27.3)	0/0	5/18 (27.8)	1/4 (25.0)	20/88 (22.7)	1/2 (50.0)	17/65 (26.2)	2/21 (9.5)
Normal (%)	12/22 (54.5)	0/0	11/18 (61.1)	1/4 (25.0)	47/88 (53.4)	1/2 (50.0)	32/65 (49.2)	14/21 (66.7)
Overweight/obese (%)	4/22 (18.2)	0/0	2/18 (11.1)	2/4 (50.0)	21/88 (23.9)	0/2 (0.0)	16/65 (24.6)	5/21 (23.8)
35–44 years								
Underweight (%)	4/24 (16.7)	0/0	4/18 (22.2)	0/6 (0.0)	13/70 (18.6)	0/1 (0.0)	8/44 (18.2)	5/25 (20.0)
Normal (%)	10/24 (41.7)	0/0	8/18 (44.4)	2/6 (33.3)	32/70 (45.7)	1/1 (100.0)	20/44 (45.5)	11/25 (44.0)
Overweight/obese (%)	10/24 (41.7)	0/0	6/18 (33.3)	4/6 (66.7)	25/70 (35.7)	0/1 (0.0)	16/44 (36.4)	9/25 (36.0)
>44 years								
Underweight (%)	4/14 (28.6)	1/1 (100.0)	3/9 (33.3)	0/4 (0.0)	9/54 (16.7)	1/1 (100.0)	7/27 (25.9)	1/26 (3.8)
Normal (%)	6/14 (42.9)	0/1 (0.0)	4/9 (44.4)	2/4 (50.0)	18/54 (33.3)	0/1 (0.0)	9/27 (33.3)	9/26 (34.6)
Overweight/obese (%)	4/14 (28.6)	0/1 (0.0)	2/9 (22.2)	2/4 (50.0)	27/54 (50.0)	0/1 (0.0)	11/27 (40.7)	16/26 (61.5)
<b>Sex</b>								
<i>Female</i>								
Underweight (%)	7/44 (15.9)	0/0	7/33 (21.2)	0/11 (0.0)	17/122 (13.9)	1/2 (50.0)	13/94 (13.8)	3/26 (11.5)
Normal (%)	18/44 (40.9)	0/0	14/33 (42.4)	4/11 (36.4)	48/122 (39.3)	1/2 (50.0)	38/94 (40.4)	9/26 (34.6)
Overweight/obese (%)	19/44 (43.2)	0/0	12/33 (36.4)	7/11 (63.6)	57/122 (46.7)	0/2 (0.0)	43/94 (45.7)	14/26 (53.8)
<i>Male</i>								
Underweight (%)	9/24 (37.5)	1/1 (100.0)	7/20 (35.0)	1/3 (33.3)	36/134 (26.9)	1/2 (50.0)	30/83 (36.1)	5/49 (10.2)
Normal (%)	13/24 (54.2)	0/1 (0.0)	12/20 (60.0)	1/3 (33.3)	68/134 (50.7)	1/2 (50.0)	40/83 (48.2)	27/49 (55.1)
Overweight/obese (%)	2/24 (8.3)	0/1 (0.0)	1/20 (5.0)	1/3 (33.3)	30/134 (22.4)	0/2 (0.0)	13/83 (15.7)	17/49 (34.7)

P values (HIV infected): normal BP vs high BP (underweight)=0.1239, normal BP vs high BP (normal)=0.3732, normal BP vs high BP (overweight/obese)=0.0193.

P values (HIV uninfected): normal BP vs high BP (underweight)=0.0138, normal BP vs high BP (normal)=0.5664, normal BP vs high BP (overweight/obese)=0.1389.

P values (HIV-uninfected males): normal BP vs high BP (overweight/obese)=0.0117.

BP, blood pressure.

Additionally, it is possible that clinical practice guidelines used in South Africa are underdiagnosing elevated BP and hypertension, as they are more liberal than other scales utilised globally. While South Africa defines hypertension as >140/90 mm Hg, the USA defines stage 1 hypertension being either systolic 130–139 mm Hg or diastolic 80–89 mm Hg.<sup>32</sup>

When stratifying data by HIV-status, HIV-infected women have higher BP than HIV-infected men. The opposite is true for the HIV-uninfected group which is more reflective of the overall population. Previous studies suggest that hypertension in HIV-positive individuals is associated primarily with traditional risk factors such as being of older age, overweight and having other NCDs, such as diabetes and dyslipidaemia.<sup>33</sup> Investigations have suggested a lower CD4 count as a strong independent predictor of hypertension in HIV-infected individuals through processes of persistent immune activation, chronic inflammation, endothelial dysfunction and microbial translocation associated with inadequate immune recovery.<sup>34–37</sup> Of the 39 clients who had their CD4 count taken at Zazi, males had a lower median CD4 count than women (244 vs 365 cells/mm<sup>3</sup>, respectively). While this does not support the hypothesis that lower CD4 count is linked with increased BP in HIV-infected individuals, it does follow the trend that men present to healthcare facilities later—and therefore often more sickly—than women. A systematic literature review yielded conflicting and inconclusive evidence to determine prevalence of hypertension in PLHIV and its association with ART and HIV-related and traditional risk factors—including sex.<sup>33 38</sup> Evidence has shown binge drinking and tobacco use increase the risk of NCDs.<sup>39 40</sup> A study using data from the WHO Study on global AGEing and adult Health Wave 1 showed smoking and hypertension were both risk factors of stroke among older South African adults.<sup>41</sup> South Africa is ranked as having one of the highest consumption rates of absolute alcohol per drinker per year.<sup>42</sup> In 2009, it was reported that 23.7% of South African adults smoked cigarettes, and while this is a 7% decrease since 1995, the reduction has plateaued.<sup>43</sup> Zazi men were more likely than women to consume alcohol and to smoke cigarettes which may account for their increased likelihood of elevated BP.<sup>44 45</sup>

Both longitudinal and cross-sectional study data have shown obesity to be a known independent risk factor for hypertension.<sup>46–48</sup> This is shown within our study, as we found that elevated BP was associated with overweight/obesity in women and not men. The majority of men with higher BP had a normal BMI. Studies have shown for every 1 kg/m<sup>2</sup> increase in BMI, there were between 1.3–1.7 and 1.2–1.4 mm Hg increases in BP for men and women, respectively.<sup>49</sup> Furthermore, antihypertensive treatment mitigates the association of BMI with systolic BP by two-thirds.<sup>50</sup> There is less data known on the relationship of body composition and BP in black African men.<sup>31</sup>

Our study demographics largely reflect that of the general population of Soweto—a nearly all black African,

gender-balanced population of lower socioeconomic status, with the great majority speaking Zulu, followed by Sesotho.<sup>14 51</sup> The Zazi clinic, however, seems to draw more clients who have received higher education than that of the general population.<sup>52</sup> Therefore, aside from having clients with an overall higher education, the Zazi study population does reflect the same demographics as the general population of Soweto and could be generalisable to similar geographical populations.

While the gender-balanced Zazi population is representative of the general population, there is conflicting literature to determine if it mimics typical attendance by sex within HTS centres. Literature historically shows men tend to be under-represented in HIV testing and treatment services in sub-Saharan Africa and globally.<sup>53 54</sup> However, the latest SADHS reports that 69% of men had ever tested and 45% did so within the previous 12 months; not radically different from what our study has found. When stratifying our data by age-group and sex, only one age category (18–24 years) contained low male attendance (one-quarter) in comparison to their female counterparts. A study using data from three national HIV population-based household surveys (2005, 2008, 2012) reported sociodemographic factors linked to poor HIV testing uptake in men: being aged 15–24 years, of black African race group, being single and unemployed, and residing in urban informal and rural informal areas.<sup>54</sup>

Within the Zazi clinic, the two age-groups with the lowest attendance were 18–24 years and 45+ years, despite these age-groups comprising the two largest of the adult age demographics among the general population of Soweto (23.1% and 20.3%, respectively).<sup>55</sup> Unfortunately, these are also the age groups largely related to the HIV transmission cycles in South Africa. HIV transmission dynamics in South Africa include cyclical intergenerational sex.<sup>56</sup> Younger women (aged 15–24 years) tend to have age-disparate partners (5+ years senior), with the odds of HIV infection increasing for each year increase in the male partner's age.<sup>57</sup> Once older, these infected women have same-age relationships, infecting their male partners, who in turn infect younger women.<sup>58 59</sup> Furthermore, global data depict older women sharing many of the same risk factors for HIV as younger women, including lack of HIV prevention knowledge, having multiple sex partners (if divorced or widowed) and less likely to practice safer sex due to being postmenopausal and not of reproductive age.<sup>60</sup> Unfortunately within South Africa, ageing women are not the target of HIV risk reduction programmes which focus on men and young women,<sup>61</sup> and they are less likely to go for testing.<sup>60</sup>

Currently, South Africa and other low-income and middle-income countries (LMICs) largely provide government healthcare through vertical programmes of dedicated staff operating within separate physical spaces among facilities offering these services (ie, HIV, TB, NCDs). Large funders focus on specific diseases and are reluctant to fund costs for other conditions, which may increase the cost of service provision.<sup>62</sup> Furthermore,

combining HIV with other platforms, such as NCDs, has also been perceived as a threat to gains made in HIV control programmes.<sup>16</sup> Disadvantages of vertical models are service duplication, inefficiency and service fragmentation.<sup>62</sup>

The WHO promotes integration as a solution. Intended outcomes are improved efficiency and quality of health services, and increased access and utilisation of health services between geographical and socioeconomic groups, leading to greater equity.<sup>62</sup> Integrated care cascades require clinical space and skilled personnel, and it is necessary to leverage the existing infrastructure and build integrated care capacity of staff who have supported unilateral HIV programmes.<sup>16</sup> While integration of HIV with other programmes, such as reproductive health and TB, has occurred through the establishment of inclusive national policies, evidence of HIV-NCD integration in clinical practice is scarce.<sup>63–65</sup> Five studies within LMICs which integrated an additional health service component into an existing service (eg, adding family planning or HTS to routine services) indicated that adding on services probably increases service utilisation and outputs of healthcare delivery. However, there is no evidence to date that a fuller form of integration improves healthcare delivery or health status.<sup>62</sup>

The top cause of death and disability worldwide are chronic NCDs, which attribute to more than three in five deaths,<sup>66</sup> with LMICs, such as South Africa, being disproportionately impacted.<sup>67</sup> Successful ART programmes enable PLHIV to reach a near-normal life expectancy,<sup>20</sup> and HIV infection is now considered a chronic condition requiring long-term management, just like NCDs.<sup>16</sup> PLHIV are also at increased risk of NCDs,<sup>21</sup> and comorbidities of disease can be particularly devastating as they are compounded by the metabolic consequences of the roll out of ART medications.<sup>68</sup> Our study population exhibited high rates of HIV, overweight/obese BMI and elevated BP across all age groups. HIV-infected females had higher BP than HIV-uninfected females, and HIV-infected people aged 18–24 and 35–44 years were more overweight/obese than their HIV-uninfected counterparts. These precursors to NCDs increased the risk for HIV-NCDs comorbidities in these populations. Now, more than ever, healthcare must be integrated, and targeted interventions among these groups at HIV clinics could help reduce the risk of disease.

### Limitations

Zazi only conducted STI symptoms screening and was unable to refer for asymptomatic STIs. One could assume the STI prevalence is higher in actuality. The clinic only screened for TB symptoms which is only the very beginning of the TB diagnostic algorithm and may not accurately describe the TB prevalence as other pathogens can cause TB symptoms. Without any other means of confirming TB, it could be confirmed if the clients identified with TB symptoms actually had TB, needing to start treatment. The clinic did, however, have 34 clients who presented

to Zazi with laboratory-confirmed TB (10.5%). Unfortunately, the clinic was not able to collect CD4 count for all identified HIV-infected individuals; only for those who had not already initiated treatment and were not referred by the PHRU TB Clinic. Additionally, viral loads were not available, and therefore there were no ART referrals based on this biomarker. Responses to specific clinical questions were left to the interpretation and disclosure of the client. For example, questions surrounding drug use did not specify a timeframe (ie, within the last 6 months).

This study has a convenience sample of participants self-selecting to attend a single HTS clinic in Soweto. There is potential for bias as these participants have not been randomly sampled from multiple facilities. Some of our sub-group sample sizes for comparison are small which therefore affects statistical precision.

### CONCLUSION

This study has shown a high prevalence of HIV-NCD comorbidity among an urban, adult population in Johannesburg, South Africa, which can be generalisable to similar settings. There is a need for an HIV-NCD integrated approach when considering health screening and interventions. A more holistic, patient-centred approach would benefit HIV-infected patients specifically, as NCD comorbidity can cause worsened conditions. Integrating screening for NCDs into HTS may increase service uptake. Targeted integrated interventions for HIV-infected females and HIV-infected people aged 18–24 and 35–44 years could improve HIV public health outcomes. More studies on whether integrated healthcare screenings will improve the uptake of NCD treatment and improve health outcomes are required. There is also a critical need to revise the current national hypertension result category cut-offs in order to improve the prevention and treatment of this NCD precursor for both the general population and PLHIV.

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