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HIV care coverage among HIV-positive adolescent girls and young women in South Africa: Results from the HERStory Study

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Background. Health service coverage cascades measure the proportion of a population in need of a service that experienced a positive health outcome from the service, and enable tracking of progress in achieving universal health coverage and inequities in care coverage.
Objectives. To investigate HIV care coverage among HIV-positive adolescent girls and young women (AGYW) living in six South African districts, compare coverage by age and socioeconomic status (SES), and investigate other associated factors including participation in a combination HIV prevention intervention.
Methods. The HERStory Study was an evaluation of the combination intervention, comprising a representative household survey of AGYW aged 15 - 24 years living in six intervention districts. From September 2017 to November 2018, biological, sociodemographic and behavioural data were collected. HIV-positive status, initiation of antiretroviral therapy (ART) and viral suppression were determined through laboratory tests (enzyme-linked immunosorbent assay for HIV antibodies, antiretroviral (ARV) metabolites and viral load (VL) testing). Viral suppression was defined as a VL <1 000 copies/mL. Knowledge of HIV-positive status was self-reported, and participants testing positive for ARV metabolites were assumed to have known their HIV-positive status. Unconditional HIV care cascades were created, stratified by age and SES. We used Pearson's χ^2 tests corrected for survey-based analysis to describe factors associated with knowledge of HIV status, and being on ART.
Results. Of the 4 399 participants, 568 were HIV-positive (12.4%), of whom 60.8% (95% confidence interval (CI) 57.1 - 64.5) knew their status, 50.6% (95% CI 46.6 - 54.0) were on ART, and 62.1% (95% CI 58.4 - 65.9) were virally suppressed. Most participants (84.9%) were in the lower SES group, and they had better coverage than the higher SES group: 61.9% (95% CI 58.3 - 65.4) knew their status, 52.1% (95% CI 48.4 - 55.9) were on ART, and 64.9% (95% CI 61.3 - 68.4) were virally suppressed, compared with 55.0% (95% CI 42.1 - 68.0), 40.0% (95% CI 29.2 - 50.8), and 46.6% (95% CI 34.5 - 58.7), respectively. Participants aged 15 - 19 years had slightly inferior coverage to the 20 - 24-year-old group: 57.5% knew their status, 46.1% were on ART and 59.5% were virally suppressed, compared with 62.3%, 52.2% and 63.3%.
Conclusions. These findings emphasise the need to close the gaps in HIV care coverage among AGYW, of whom only 61% knew their HIV-positive status and only 62% were virally suppressed. There is pro-poor inequality in HIV care coverage, with those in lower socioeconomic groups more likely to be virally suppressed.

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Health interventions during adolescence and young adulthood have the potential to generate a triple dividend: improved health during adolescence and young adulthood, during later adulthood, and for the next generation.[1,2] For adolescents (aged 10 - 19 years) and young people (aged 20 - 24 years) living with HIV, who are among the most vulnerable populations,[3] HIV diagnosis and treatment interventions have the potential to reduce mortality, improve health and wellbeing, and halt transmission to other individuals. However, adolescents and young people have had inadequate access to HIV diagnosis and treatment, which contributes to avoidable AIDS-related morbidity and deaths.[4] For example, compared with adults on antiretroviral therapy (ART), adolescents diagnosed with HIV have poorer adherence to ART[5] and are the only age group with increasing HIV mortality.[6]

South Africa (SA) has the world's largest ART programme, which has increased life expectancy and saved lives,[7] as well as cut maternal-to-child transmission (MTCT) of HIV from 25 - 30% before 2001 to 1.4% in 2016.[8] However, SA adolescents and young people are less likely than adults to benefit from HIV interventions, and are less likely to be diagnosed and to know their HIV positive status compared with older people,[9] many with HIV do not start ART,[10] and more than half of HIV-positive young men and women aged 15 - 24 years are not virally suppressed.[9] Compared with adult mothers, adolescent mothers living with HIV are more likely to have unplanned pregnancies and less likely to access interventions to prevent MTCT.[11]

Combination HIV prevention and care interventions, which merge effective biomedical, behavioural and structural interventions for combined delivery, are one of the key strategies for reaching the 90-90-90 targets and achieving the Sustainable Development Goal (SDG) of ending the HIV epidemic by 2030.[12] Between 2016 and 2019, the Global Fund made an investment of USD67 million in a 3-year comprehensive combination HIV prevention and care programme for SA adolescent girls and young women (AGYW) aged 10 - 24 years. The intervention was implemented by government and non-government organisations in 10 districts in which young women were at high risk of HIV acquisition and in which there was no other large-scale HIV prevention intervention. In each district, the intervention was targeted to selected subdistricts, areas or wards where it was determined that risk of HIV was highest. Key intervention components were Soul Buddyz Clubs[13] for adolescent girls and boys aged 10 - 14 years in primary schools, the Keeping Girls in School (KGS) programme for AGYW aged 14 - 18 years in high schools (https://www.mietafrica.com/projects-programmes/youth-development/keeping-girls-in-school-kgs/), RISE Clubs for AGYW in school aged 15 - 19 years, and RISE Clubs and Women of Worth Clubs for AGYW out of school aged 19 - 24 years. HIV testing and linkage to HIV prevention and care services were offered through the Club and KGS programmes. HIV testing was also promoted indirectly, by referring AGYW to clinics. In some districts, young people were employed as clinic 'navigators' and placed in clinics to meet and welcome AGYW and to promote youth-responsive clinic services.

Global initiatives such as the United Nations SDGs, the Lancet Commission on Adolescent Health and Wellbeing[1,2] and Countdown to 2030 have called attention to tracking progress in the health of adolescents and young people up to age 24 years. The concept of 'effective coverage' (EC), defined as the proportion of a population in need of a service that experienced a positive health outcome from the service, is critical to measuring such progress.[14] Health service coverage cascades have been proposed as the most appropriate way to measure EC, and enable us to monitor progress in achieving universal health coverage and a high-quality health system.[14,15] They enable the measurement of inequities in care coverage: as HIV care coverage increases, there may be uneven progress in reaching subpopulations, and inequities may remain or even increase.[16] It is important to monitor disparities in access to care by socioeconomic status (SES). Socioeconomic inequalities are associated with inequities in sexual and reproductive health (SRH) among adolescents. For example, in sub-Saharan Africa, poorer adolescent girls (compared with wealthier) face more barriers in meeting their SRH needs and are more likely to have their first sexual encounter and to start childbearing at a younger age.[17]

Objectives

We used HIV care coverage cascades stratified by age and SES to describe the coverage of HIV care services among AGYW aged 15 - 24 years living in geographical areas in which the combination intervention was implemented. We also investigated whether age, SES (poverty level), being in high school, having a deceased parent, recency of HIV infection, and participation in key components of the combination intervention were associated with care coverage.

Methods

Study design and sampling

The data were generated from the HERStory Study, an evaluation of the combination intervention. For these analyses, the design was a cross-sectional, representative household survey of AGYW aged 15 - 24 years living in six of the 10 districts in which the combination HIV prevention intervention was implemented: City of Cape Town (Western Cape Province), Ehlanzeni (Mpumalanga Province), OR Tambo (Eastern Cape Province), Tshwane (Gauteng Province), King Cetshwayo and Zululand (KwaZulu-Natal Province). The survey began in 2017, ~18 months after the start of the intervention, and it was completed in 2018, 32 months after implementation started.

We used a stratified cluster sampling design, with three stages of sampling. First, we took a simple random sample of census, small area layers (SALs) within the sub-areas in which the intervention was implemented in each district. Then we conducted a systematic random sample of 35% of households within each SAL. Finally, all AGYW aged 15 - 24 years in each household were invited to participate in the study. If the members of a selected household declined to participate, we did not replace the household. Our original sample size calculation of 14 000 AGYW, in 10 districts (Table 1), was based on being able to measure a difference in HIV incidence over 2 years using cross-sectional data.[18] However, the survey could only be completed in six districts within the time allocated to the study, and the four districts scheduled last for data collection were not completed.

Measures

We used electronic questionnaires developed using the Mobenzi Researcher data collection software suite (https://www.mobenzi.com/researcher/home), administered using a tablet. Demographic, socioeconomic and behavioural data were collected from all enrolled participants using these structured electronic questionnaires administered by trained fieldworkers.

The questionnaire included a number of categorical variables related to SES:[19] (*i*) AGYW was away from home for more than 1 month in the past 12 months (internal migration has been shown to cause and be caused by poverty;[20] (*ii*) has piped water in household; (*iii*) has a flushing toilet in household; (*iv*) household has working electricity; (*v*) household has a car; (*vi*) household has a computer; (*vii*) household has internet; (*viii*) household has

Table 1. Sampling realisation and response rate, HERStory survey, in six districts in South Africa, 2017 - 2018

District	SAL count, *n*	SALs sampled, *n*	Households sampled (35%), *n*	AGYW sample size, *n**	SALs visited, *n*	Households visited, *n*	Households ineligible, *n*	Eligible households completed, *n*	AGYW completed, *n*	Sample realisation, %
Cape Town	135	60	2 913	1 100	60	2 970	2 382	309	367	33.4
Tshwane	153	70	4 788	1 300	70	4 870	3 486	673	778	59.8
Ehlanzeni	146	70	3 901	1 300	70	3 886	2 534	679	806	62.0
OR Tambo	148	70	3 673	1 300	70	3 670	2 762	516	697	53.6
King Cetshwayo	103	50	2 392	1 000	50	3 438	1 285	600	760	76.0
Zululand	138	70	3 526	1 300	70	3 554	2 012	743	1 018	78.3
Total completed	823	390	21 193	7 300	390	22 388	14 461	3 520	4 426	60.6
Total planned	2 470	755	40 919	14 000						

SAL = small area layer; AGYW = adolescent girls and young women.
*These numbers were used to construct the sample weights.

a refrigerator; (*ix*) household has a stove; (*x*) AGYW or household member went a day/night without eating in the past month; (*xi*) AGYW has own money; (*xii*) AGYW saves money; and (*xiii*) AGYW owes money.

We asked about participation in the key components of the combination HIV prevention intervention, which were branded and therefore easy to identify. A participant was defined as having participated if she reported ever attending or being a member of Soul Buddyz or RISE or Women of Worth, or had ever attended a KGS health education or homework support session.

The HIV status of participants was determined using blood samples that were analysed in a laboratory. The samples were tested with the Bio-Rad HIV1/2 Combo Assay (Genscreen, France) and any reactive result was confirmed by a second 4th-generation test (HIV1/2 COMBI COBAS E411 (Roche Diagnostics, Germany). All positive specimens were confirmed for HIV-1 infection by Western blot (GS HIV-1 Western Blot, Bio-Rad Laboratories, USA).

To distinguish recent HIV infection, we used a limiting antigen avidity immunoassay (LAg EIA; Maxim Biomedical, USA). Specimens confirmed by Western blot to be HIV-positive were tested to determine recent or early v. long-term HIV infection using the single-well LAg-Avidity EIA test (Maxim Biomedical). Recent HIV infections had a mean duration of 161 days. The HIV-1 RNA viral load (VL) assay and ART drug measurements were included in a recent infection testing algorithm to minimise the false recent rate, to determine the proportion of HIV-infected persons on ART and those who were ART naive with detectable and undetectable VLs.

Participants were asked whether they had ever had an HIV test, and if yes, what their test result was at the most recent test. Later in the questionnaire, they were asked whether they knew their HIV status (negative, positive, unknown). Participants were classified as having knowledge of their HIV-positive status if they answered that they were positive in either of those two questions. In addition, they were assumed to have knowledge of their status if a laboratory test confirmed that they were positive and antiretroviral (ARV) metabolites were present in their blood.

ART testing was performed on HIV serology-positive specimens for measurement of ARVs that were in use in either first- or second-line regimens in the public sector. Antiretroviral testing was performed using dry blood spots (DBSs) determined by high-performance liquid chromatography (HPLC) coupled with tandem mass spectrometry (HPLC-Module 1260 Infinity 11 (Agilent Technologies Inc., Germany), mass spectrometer ABSciex 6.5+ (USA). The assay was a validated qualitative detection of nevirapine, emtricitabine, lamuvidine, abacavir and tenofovir (the lower limit of detection was 25 ng/mL/0.025 µg/mL), efavirenz, and lopinavir (lower limit of detection 100 ng/mL/0.1 µg/mL). Known standards were analysed with every batch of samples to ensure reproducibility and adequate quality assurance. If any metabolite was detected in their blood, the participant was considered to have ART exposure.

To determine VL, HIV-1 VL testing was performed on all confirmed HIV-positive specimens using the Abbott m2000 HIV Real-Time System (Abbott Molecular Inc., USA). Viral suppression was defined as a cut-off ≤1 000 copies/mL.

Procedures

The field team identified the sampled households using aerial maps, and determined the geographical co-ordinates using the Global Positioning System (GPS). If the selected household was vacant, there was no AGYW in the household, or the household head declined to complete a household listing form to determine whether there were eligible AGYW, the household on the right was visited and assessed for eligibility. Only one eligible household was enrolled at the random point selected through this approach. We obtained consent from AGYW, and parental consent for AGYW <18 years of age. Trained fieldworkers first administered the survey to consenting AGYW. The sections of the questionnaire with questions about sexuality, HIV testing and HIV status were completed by the participants themselves to diminish social desirability bias. The fieldworker read each question to the participant and allowed the participant to enter her responses in the tablet privately. Then the fieldworker collected two microtainers of whole blood using a finger prick. After the questionnaire had been completed and specimens collected, participants were offered rapid HIV testing in the household. Microtainers of blood were shipped daily to the laboratory for preparation of DBSs and centrifugation to obtain plasma. Specimens not shipped on the same day were stored at 4 - 8°C until shipped the next day. Participants were reimbursed with a gift and voucher to the value of ZAR75 (USD5) to compensate them for their time. They were invited to

visit their nearest clinic 2 weeks after their participation to obtain the results of the study laboratory tests, using a bar-coded referral card. The study was approved by the South African Medical Research Council Research Ethics Committee (ref. no. EC036-11/2016) and by the Center for Global Health Associate Director for Science, US Centers for Disease Control and Prevention (CDC) (ref. no. CGH 2017-194a).

Analysis

The analyses were restricted to participants who tested HIV-positive in the study laboratory tests (n=568), except for a description of the HIV prevalence in the study population. Since the aim was to generalise study results to the broader population of AGYW across all six districts and interpret the estimates as true population-level estimates, we incorporated sample weights into the analysis, and all estimates are weighted. The sample weights take into account the probability of sampling SALs in each district and the systematic probability of sampling households within each SAL. Survey-based analysis was performed with the six districts specified as survey strata, and SALs as the primary sampling unit. Finite population sampling estimation was used in the survey analysis to improve the precision of the estimates, and the number of SALs in each district was used for this approach.

We produced overall and stratified unconditional HIV care cascades for the HIV-positive AGYW in the study. The cascades presented here summarise: (*i*) the proportion of HIV-positive AGYW who know their status ('status known'); (*ii*) the proportion of HIV-positive AGYW who had ARV metabolites detected in their blood ('on ART'); and (*iii*) the fraction of HIV-positive AGYW who were virally suppressed ('virally suppressed'). The HIV care cascades are 'unconditional' because each proportion across the cascade uses the number of HIV-positive AGYW in the denominator.

Stratification variables included age group (15 - 19/20 - 24 years) and SES (relatively low/relatively high). A participant's SES group was determined using cluster analysis with the K-modes algorithm,[21] with the 13 SES questions described above. Cluster analysis is an exploratory and unsupervised machine learning technique that allows analysts to divide data into meaningful groups based upon shared features. For further details about the SES variable, see Appendix A (available as a supplementary file at http://samj.org.za/public/sup/15351.pdf).

HIV-positive participants were characterised by calculating descriptive statistics for the overall population and by knowledge of their HIV status. We also described the participants who were HIV-positive and knew their status, by ART status. For these bivariate analyses, Pearson's χ^2 test was used, corrected for the survey-based analysis to describe whether age group, SES group, orphanhood (one or both parents deceased), being in school, recency of HIV infection, and self-reported participation in the AGYW combination intervention were associated with knowledge of HIV status, and being on ART. Risk differences and their 95% confidence intervals (CIs) were also calculated for each of these bivariate analyses.

Stata 15.1 (StataCorp, USA) and R version 3.5.0 (R Core Team, Austria) were used to perform the analyses.[22] In R the 'survey' and 'srvyr' packages were used for the survey-based analyses.[23,24] The package 'klaR' was used for the cluster analysis.[25]

Results

Sampling realisation and response rates of participants

The data were collected during 2017 - 2018. In the six districts, we sampled 7 300 AGYW and visited 22 388 households. All the primary sampling units were visited in each of the districts (Table 1). The number of households visited met the target, but the number of ineligible households was higher in the urban-based districts, which led to a lower sample realisation. The overall sample realisation of participants was 60.6% in the six completed districts. Ultimately, 4 436 AGYW completed the survey, and 4 399 were in the age range, were enrolled in the study and were weighted to the total sample size of 7 300.

Table 2. Characteristics of the sample (N=568) of HIV-positive adolescent girls and young women aged 15 - 24 years in six districts in South Africa, 2017 - 2018*

Characteristics	*n* (%)	95% CI
Age group (years)		
15 - 19	185 (30.9)	27.9 - 34.1
20 - 24	383 (69.1)	65.9 - 72.1
Currently in school		
No	354 (64.6)	61.3 - 67.9
Yes	214 (35.4)	32.1 - 38.7
Has a deceased parent†		
No	219 (39.2)	35.9 - 42.6
Yes	345 (60.8)	57.4 - 64.1
Socioeconomic status		
Relatively low socioeconomic group	490 (84.9)	81.1 - 88.2
Relatively high socioeconomic group	78 (15.1)	11.8 - 18.9
Self-reported exposure to a Global Fund intervention		
No	334 (56.8)	53.1 - 60.4
Yes	234 (43.2)	39.6 - 46.9
Recent HIV infection		
No	542 (95.5)	94.0 - 96.7
Yes	26 (4.5)	3.3 - 6.0

CI = confidence interval.
*All estimates are weighted.
†There were four missing observations for this variable.

Characteristics of participants

Of the 4 399 participants in the broader study, 568 were HIV-positive (12.4%) and comprised the study population for the analyses reported here. Most of the HIV-positive participants were in the 20 - 24-year age range (69.1%), 35.4% were enrolled in high school, 84.9% fell into the relatively low SES group, and 43.2% reported they had participated in a key component of the combination HIV prevention intervention (Table 2). We classified 4.5% of participants as having recently been infected with HIV.

Overall HIV care coverage

Of all 568 participants with laboratory-confirmed HIV-positive status, 60.8% (95% CI 57.1 - 64.5) knew their status, 50.3% of 568 (95% CI 46.6 - 54.0) were on ART, and 62.1% of 568 (95% CI 58.4 - 65.9) were virally suppressed (Fig. 1). Interestingly, there was a higher fraction of AGYW who were virally suppressed, than of AGYW who knew their status.

Age-stratified HIV care coverage

A slightly smaller fraction of participants in the younger age group knew their HIV status (57.5%; 95% CI 52.1 - 62.8) compared with the older age group (62.3%; 95% CI 57.6 - 67.0) (Fig. 2). Only 46.1% (95% CI 40.5 - 51.7) of younger HIV-positive AGYW were on ART compared with 52.2 (95% CI 47.7 - 56.7) of older HIV-positive AGYW. Following a similar pattern, 59.5% (95% CI 54.1 - 64.8) of AGYW aged 15 - 19 years were virally suppressed, while 63.3% (95% CI 58.4 - 68.2) of AGYW aged 20 - 24 years were virally suppressed.

SES-stratified HIV care coverage

In Fig. 3, the HIV care cascades, disaggregated by level of SES, show that participants in the lower SES group had better HIV care cascades: 61.9% (95% CI 58.3 - 65.4) knew their status, 52.1% (95% CI 48.4 - 55.9) were on ART, and 64.9% (95% CI 61.3 - 68.4) were virally suppressed, compared with 55.0% (95% CI 42.1 - 68.0), 40.0% (95% CI 29.2 - 50.8) and 46.6% (95% CI 34.5 - 58.7), respectively, in the relatively high SES group. The differences were most pronounced for viral suppression, indicating higher levels of care coverage for the relatively low SES group.

HIV care coverage stratified by age and SES

Participants in the older age and relatively high SES group had the worst cascades (Fig. 4). Approximately half in this group did not know their status, and nearly two-

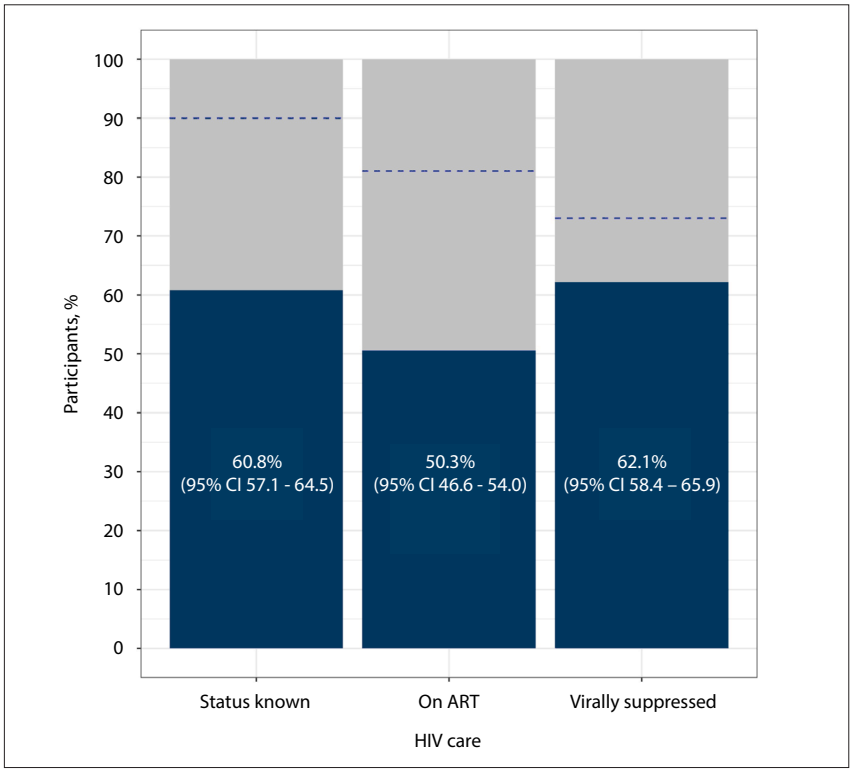

Fig. 1. HIV care coverage among 568 adolescent girls and young women aged 15 - 24 years in six districts in South Africa, 2017 - 2018. (CI = confidence interval; ART = antiretroviral therapy.)

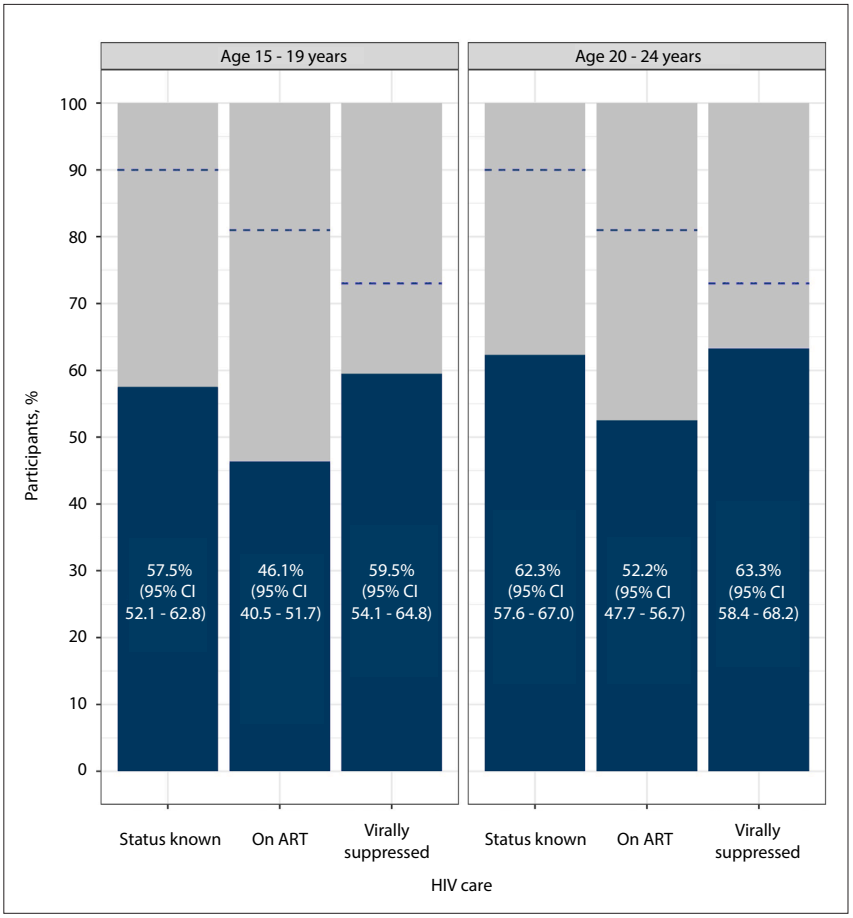

Fig. 2. HIV care coverage among 568 adolescent girls and young women aged 15 - 24 years in six districts in South Africa, 2017 - 2018, stratified by age group. (CI = confidence interval; ART = antiretroviral therapy.)

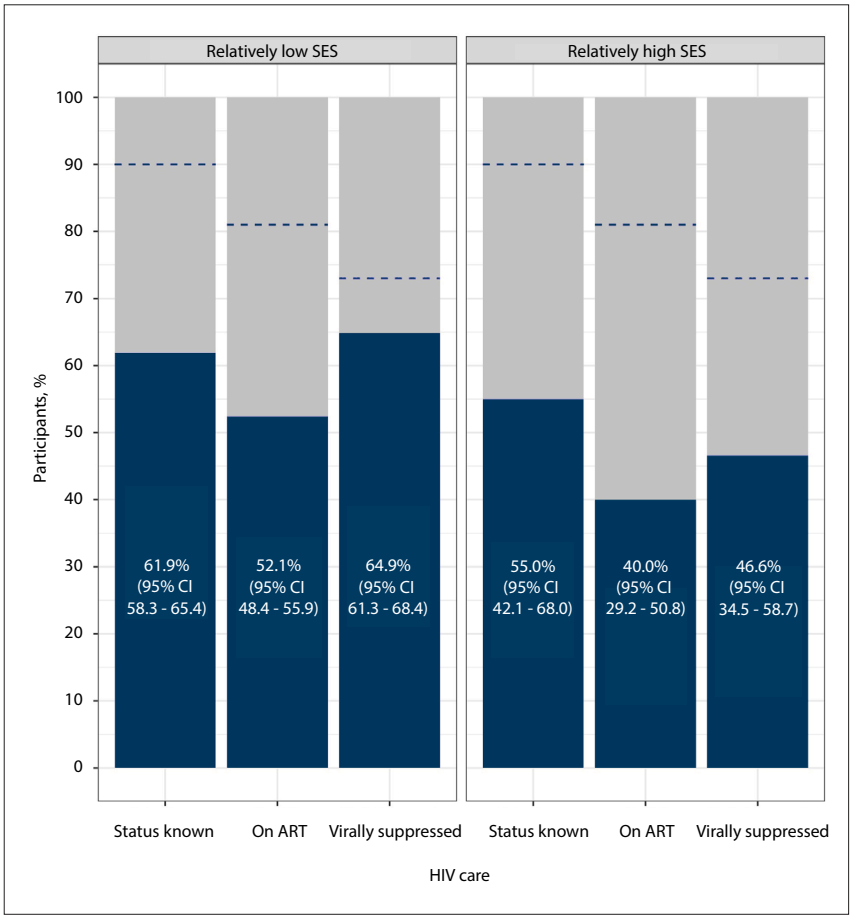

Fig. 3. HIV care coverage among 568 adolescent girls and young women aged 15 - 24 years in six districts in South Africa, 2017 - 2018, stratified by SES. (SES = socioeconomic status; CI = confidence interval; ART = antiretroviral therapy.)

thirds were not on treatment. Those in the older age group who were in the relatively low SES group had the best outcomes, with 64.4% knowing their status, 55.4% being on treatment and 66.5% being virally suppressed.

Factors associated with HIV care coverage

Table 3 examines differences between participants who knew about their HIV-positive status v. those who did not. Among HIV-positive AGYW, 54.5% (95% CI 49.0 - 59.9) who did not have a deceased parent knew their status v. 64.5% (95% CI 59.2 - 69.5) of those with a deceased parent, with a risk difference of 10.0% (95% CI 2.8 - 17.2). Those who had recently been infected with HIV had 55.2 fewer instances of knowing their status per 100 AGYW (95% CI –64.1 - –46.2), compared with those with long-term infections (63.3% v. 8.2%; $p<0.000$).

To develop hypotheses about why people who knew their HIV-positive status were not on ART, a description of these participants is presented in Table 4. Overall, 358 participants were HIV-positive and knew their HIV status, and 57 of these were not on ART. In this subpopulation, 84.8% (95% CI 81.2 - 87.9) of those in the low-SES group were on ART v. 72.6% (95% CI 61.2 - 82.2) of those in the high-SES group, a difference of 12.15% (95% CI –22.52 - –1.79). There were ~6 more AGYW on ART per 100 (95% CI 0.19 - 12.04) among those who participated in the combination intervention compared with those who did not participate (86.7% v. 80.6%).

Discussion

The study findings emphasise the weaknesses in the continuum of care for HIV-positive AGYW, of whom 39% did not know their HIV-positive status and therefore would not have had access to HIV treatment. Participants who were recently infected were less likely to know their HIV status, which highlights the importance of regular HIV testing to reduce rates of undiagnosed infection. AGYW who had a deceased parent were more likely to know their HIV status. HIV is a common underlying cause of orphanhood, and orphans are more likely to be HIV-positive than children who are not orphaned.[26] It is likely that young people who have lost a parent to HIV have had their own HIV diagnosed through the process of their parent's diagnosis or death.

To achieve the Joint United Nations Programme on HIV and AIDS (UNAIDS) target for the third '90', we need to achieve viral suppression in 73% of the population of HIV-positive AGYW. We have demonstrated a gap in HIV care coverage, with only 62.1% of the AGYW in our study virally suppressed. Nevertheless, the level of care coverage among AGYW in our study population, which was receiving an HIV combination prevention intervention, is substantially higher than the estimates from a nationally representative survey conducted in 2017, which found that only 47.7% of all HIV-positive AGYW aged 15 - 24 years were virally suppressed.[9] The substantially higher estimates in our study raise the question about whether the combination HIV prevention intervention, which was being implemented at the time of the survey, may have been contributing to closing gaps in HIV care coverage. Supporting this, we found that a higher fraction of participants on ART had participated in the combination HIV intervention compared with those not on ART. However, our study design does not enable us to draw conclusive evidence about the intervention effect.

Adolescents (aged 15 - 19 years) had slightly poorer levels of care coverage than young women aged ≥20 years of age. This is consistent with other studies that show the difficulty of achieving EC of HIV care among adolescents in SA and sub-Saharan Africa.[4-6,27] We found that AGYW in the lower SES group had substantially better levels of care coverage than those in the higher SES group. A similar pro-poor inequality in care coverage has been observed in the uptake of HIV testing among pregnant women in SA.[28] A possible explanation is that AGYW who were employed were more likely to be in the higher SES group and had little time away from work to access HIV services. Another possible explanation is that the free HIV care services provided by the public sector were more acceptable to AGYW in the lower SES group compared with those in the higher SES group, while at the same time private sector HIV care services were not accessible to either group. The disparities in levels of care coverage by SES group suggest that efforts to make services more youth-friendly need to consider the accessibility, acceptability and appropriateness of the service for different AGYW subgroups.

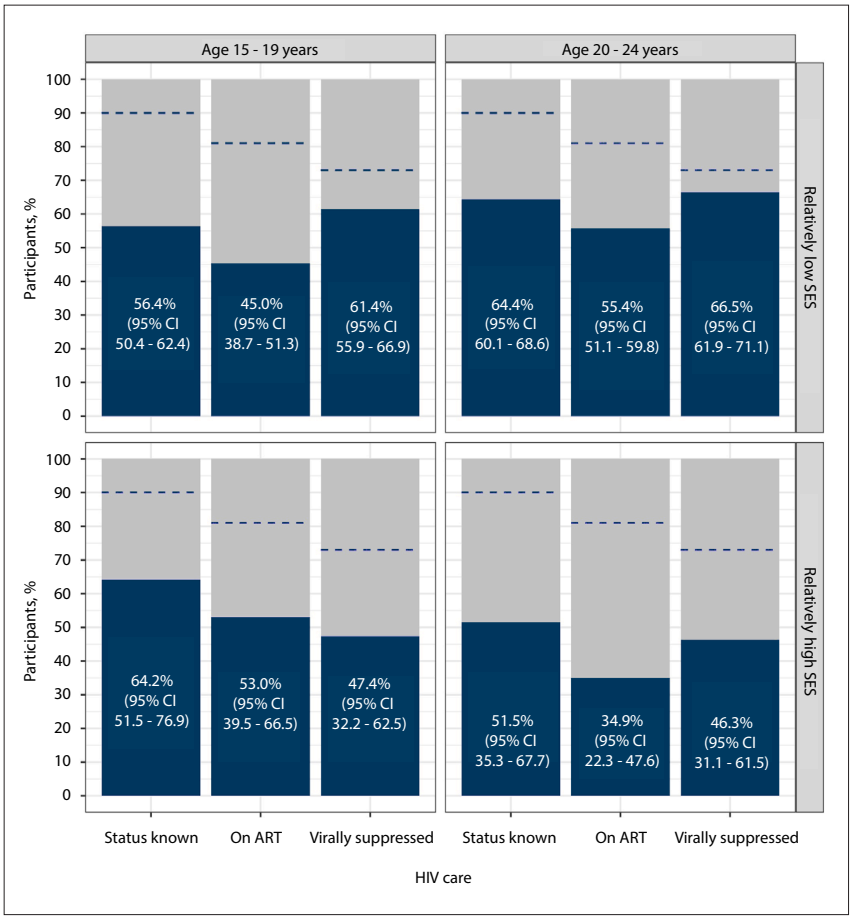

Fig. 4. HIV care coverage among 568 adolescent girls and young women aged 15 - 24 years in six districts in South Africa, 2017 - 2018, stratified by age group and SES. (SES = socioeconomic status; CI = confidence interval; ART = antiretroviral therapy.)

Study limitations

Some participants were virally suppressed but did not know their HIV status, based on our measures of knowledge of HIV status. Furthermore, some participants were determined to be virally suppressed, but ARVs were not detected in their blood, a phenomenon observed elsewhere.[9] There are several possible explanations for these observations, including imperfect sensitivity of laboratory tests to detect ART. Another possible reason is that the progression of HIV in the absence of ART includes periods of time when the VL is lower than the threshold used for determining viral suppression.[29] Furthermore, AGYW may be treated with ART by parents/guardians and not know their HIV status.

The cross-sectional study design limits our ability to attribute the higher levels of care coverage observed in the study population (compared with the national average) to the HIV prevention intervention that was being implemented. Furthermore, the survey was conducted during the 2nd and 3rd years of the intervention, and the intervention may not have had time to demonstrate impact on care coverage. The validity of participants' reports of participation in the intervention in unknown. The sample realisation of 61% is a limitation, but it compares well with the 2016 South African Demographic and Health Survey response rate (56% among 15 - 19-year-olds and 57% among 20 - 24-year-old women selected to provide samples for HIV testing).[30]

Conclusions

These findings emphasise weaknesses in HIV care for AGYW in these study districts, of whom 39% did not know their HIV-positive status and would not have access to treatment. To achieve the UNAIDS target for the third '90' (viral suppression among 90% of those who know their status and are on ART), viral suppression needs to be achieved in 73% of the population of HIV-positive AGYW. This study has demonstrated a gap in care coverage, with only 62.1% of the AGYW study population virally suppressed. Special efforts are needed to improve care coverage for adolescent girls and AGYW in the higher SES group, who have relatively low levels of HIV care coverage.

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Author contributions. CM and MC conceptualised the study and wrote the manuscript. All authors were co-investigators on the study. RB and CL performed the statistical analysis. AP directed the laboratory methods. All authors reviewed and contributed to drafts of the manuscript.

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Conflicts of interest. None.

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Table 3. Description of knowledge of HIV status among adolescent girls and young women aged 15 - 24 years (*N*=568) in six districts in South Africa, 2017 - 2018

	HIV knowledge*						
	Did not know HIV+ status		Knew HIV+ status				
Variable	*n* (%)	95% CI	*n* (%)	95% CI	*p*-value	Risk difference, %	95% CI
Age group (years)					0.1742	4.88	−2.14 - 11.90
15 - 19	77 (42.5)	37.1 - 48.1	108 (57.5)	51.9 - 62.9			
20 - 24	133 (37.7)	33.0 - 42.6	250 (62.3)	57.4 - 67.0			
Currently in school					0.9623	−0.17	−7.29 - 6.95
No	127 (39.1)	34.1 - 44.3	227 (60.9)	55.7 - 65.9			
Yes	83 (39.3)	34.2 - 44.6	131 (60.7)	55.4 - 65.8			
Has a deceased parent					0.0070	9.98	2.80 - 17.15
No	97 (45.5)	40.1 - 51.0	122 (54.5)	49.0 - 59.9			
Yes	113 (35.5)	30.5 - 40.8	232 (64.5)	59.2 - 69.5			
Socioeconomic status					0.3471	−6.81	−20.07 - 6.45
Relatively low socioeconomic group	180 (38.1)	34.6 - 41.8	310 (61.9)	58.2 - 65.4			
Relatively high socioeconomic group	30 (45.0)	31.7 - 58.8	48 (55.0)	41.2 - 68.3			
Self-reported exposure to a Global Fund intervention					0.1848	−5.27	−12.94 - 2.41
No	117 (36.9)	32.6 - 41.4	217 (63.1)	58.6 - 67.4			
Yes	93 (42.2)	35.8 - 48.8	141 (57.8)	51.2 - 64.2			
Recent HIV infection					0.0000†	−55.15	−64.11 - 46.19
No	186 (36.7)	32.8 - 40.7	356 (63.3)	59.3 - 67.2			
Yes	24 (91.8)	79.5 - 97.9	2 (8.2)	2.1 - 20.5			

CI = confidence interval.
*All estimates are weighted.
†Owing to a low sample size among those recently infected, we conducted a Fisher's exact test for the association with recent infection and HIV knowledge.

Table 4. Description of HIV-positive participants aged 15 - 24 years who knew their HIV-positive status (*N*=358) by ART status in six districts in South Africa, 2017 - 2018

	ART status						
	No exposure to ART		Exposed to ART				
Variable	*n* (%)	95% CI	*n* (%)	95% CI	*p*-value	Risk difference, %	95% CI
Age group (years)							
15 - 19	19 (19.0)	13.3 - 26.0	88 (81.0)	74.0 - 86.7	0.3873	3.05	−3.88 - 9.97
20 - 24	38 (16.0)	12.5 - 20.0	211 (84.0)	80.0 - 87.5			
Currently in school							
No	34 (16.4)	12.4 - 21.0	192 (83.6)	79.0 - 87.6	0.6653	-1.46	−8.10 - 5.18
Yes	23 (17.8)	13.0 - 23.5	107 (82.2)	76.5 - 87.0			
Has a deceased parent							
No	22 (18.3)	12.9 - 24.8	100 (81.7)	75.2 - 87.1	0.4951	2.28	−4.25 - 8.81
Yes	34 (16.0)	12.5 - 20.0	196 (84.0)	80.0 - 87.5			
Socioeconomic status							
Relatively low socioeconomic group	45 (15.2)	12.1 - 18.8	263 (84.8)	81.2 - 87.9	0.0278	-12.15	−22.52 - −1.79
Relatively high socioeconomic group	12 (27.4)	17.8 - 38.8	36 (72.6)	61.2 - 82.2			
Self-reported exposure to a Global Fund intervention							
No	37 (19.4)	15.2 - 24.2	178 (80.6)	75.8 - 84.8	0.0484	6.11	0.19 - 12.04
Yes	20 (13.3)	9.4 - 18.1	121 (86.7)	81.9 - 90.6			

CI = confidence interval.

1. Azzopardi PS, Hearps SJC, Francis KL, et al. Progress in adolescent health and wellbeing: Tracking 12 headline indicators for 195 countries and territories, 1990 - 2016. Lancet 2019;393(10176):1101-1118. https://doi.org/10.1016/S0140-6736(18)32427-9
2. Patton GC, Sawyer SM, Santelli JS, et al. Our future: A Lancet commission on adolescent health and wellbeing. Lancet 2016;387(10036):2423-2478. https://doi.org/10.1016/S0140-6736(16)00579-1
3. Nagata JM, Hathi S, Ferguson BJ, Hindin MJ, Yoshida S, Ross DA. Research priorities for adolescent health in low- and middle-income countries: A mixed-methods synthesis of two separate exercises. J Glob Health 2018;8(1):010501. https://doi.org/10.7189/jogh.08.010501
4. Sam-Agudu NA, Folayan MO, Ezeanolue EE. Seeking wider access to HIV testing for adolescents in sub-Saharan Africa. Pediatr Res 2016;79(6):838-845. https://doi.org/10.1038/pr.2016.28
5. Adejumo OA, Malee KM, Ryscavage P, Hunter SJ, Taiwo BO. Contemporary issues on the epidemiology and antiretroviral adherence of HIV-infected adolescents in sub-Saharan Africa: A narrative review. J Int AIDS Soc 2015;18:20049. https://doi.org/10.7448/IAS.18.1.20049
6. Enane LA, Vreeman RC, Foster C. Retention and adherence: Global challenges for the long-term care of adolescents and young adults living with HIV. Curr Opin HIV AIDS 2018;13(3):212-219. https://doi.org/10.1097/COH.0000000000000459
7. Dorrington R, Bradshaw D, Laubscher R, Nannan N. Rapid Mortality Surveillance Report 2017. Cape Town: South African Medical Research Council, 2019. https://www.samrc.ac.za/sites/default/files/files/2019-02-06/RapidMortalitySurveillanceReport2017.pdf (accessed 1 April 2021).
8. Goga A, Sherman G, Chirinda W, et al. Eliminating mother to child transmission of HIV in South Africa: 2002 - 2016, progress, challenges and the Last Mile Plan. In: South African Health Review. Durban: Health Systems Trust, 2017:137-146. http://www.hst.org.za/publications/south-african-health-review-2017 (accessed 1 April 2021).
9. Simbayi L. South African National HIV Prevalence, Incidence, Behaviour and Communication Survey, 2017. Boulder, Colo.: Lynne Rienner, 2019. https://www.hsrcpress.ac.za/books/south-african-national-hiv-prevalence-incidence-behaviour-and-communication-survey-2017 (accessed 1 April 2021).
10. Maskew M, Bor J, MacLeod W, Carmona S, Sherman GG, Fox MP. Adolescent HIV treatment in South Africa's national HIV programme: A retrospective cohort study. Lancet HIV 2019;6(11):e760-e768. https://doi.org/10.1016/S2352-3018(19)30234-6
11. Ramraj T, Jackson D, Dinh TH, et al. Adolescent access to care and risk of early mother-to-child HIV transmission. J Adolesc Health 2018;62(4):434-443. https://doi.org/10.1016/j.jadohealth.2017.10.007
12. Joint United Nations Programme on HIV/AIDS (UNAIDS). 90-90-90: An ambitious treatment target to help end the AIDS epidemic. October 2014. https://www.unaids.org/sites/default/files/media_asset/90-90-90_en.pdf (accessed 1 April 2021).
13. Johnson S, Magni S, Dube Z, Goldstein S. Extracurricular school-based social change communication program associated with reduced HIV infection among young women in South Africa. J Health Comm 2018;23(12):1044-1050. https://doi.org/10.1080/10810730.2018.1544675
14. Marsh AD, Muzigaba M, Diaz T, et al. Effective coverage measurement in maternal, newborn, child, and adolescent health and nutrition: Progress, future prospects, and implications for quality health systems. Lancet Glob Health 2020;8(5):e730-e736. https://doi.org/10.1016/S2214-109X(20)30104-2
15. Kruk ME, Gage AD, Arsenault C, et al. High-quality health systems in the Sustainable Development Goals era: Time for a revolution. Lancet Glob Health 2018;6(11):e1196-e1252. https://doi.org/10.1016/S2214-109X(18)30386-3
16. Assefa Y, Hill PS, Van Damme W, Dean J, Gilks CF. Leaving no one behind: Lessons from implementation of policies for universal HIV treatment to universal health coverage. Glob Health 2020;16(1):17. https://doi.org/10.1186/s12992-020-00549-4
17. Melesse DY, Mutua MK, Choudhury A, et al. Adolescent sexual and reproductive health in sub-Saharan Africa: Who is left behind? BMJ Glob Health 2020;5(1):e002231. https://doi.org/10.1136/bmjgh-2019-002231
18. Konikoff J, Brookmeyer R. Sample size methods for estimating HIV incidence from cross-sectional surveys. Biometrics 2015;71(4):1121-1129. https:doi.org/10.1111/biom.12336
19. Rutstein SO, Johnson K. The DHS wealth index. DHS Comparative Reports No. 6. Calverton, Md.: ORC Macro, 2004. https://doi.org/10.13140/2.1.2806.4809
20. Crush J, Frayne B, eds. Surviving on the Move: Migration, Poverty and Development in Southern Africa. Pretoria: IDASA and Development Bank of Southern Africa, 2010.
21. Huang Z. A fast clustering algorithm to cluster very large categorical data sets in data mining. In: Lu H, Matoda H, Luu H, eds. KDD: Techniques and Applications. Singapore: World Scientific, 1997:21-34.
22. R Core Team: A language and environment for statistical computing. Vienna, Austria, 2018. https://www.R-project.org/ (accessed 1 April 2021).
23. Lumley T. Analysis of complex survey samples. J Stat Softw 2019. https://doi.org/10.18637/jss.v009.i08
24. Freedman Ellis G. srvyr: 'dplyr'-like syntax for summary statistics of survey data. 2019. http://gdfe.co/srvyr; https://github.com/gergness/srvyr (accessed 1 April 2021).
25. Weihs C, Ligges U, Luebke K, Raabe N. klaR analyzing German business cycles. In: Baier D, Decker R, Schmidt-Thieme L, eds. Data Analysis and Decision Support. Berlin: Springer-Verlag, 2005:334-343. https://doi.org/10.1007/3-540-28397-8_36
26. Kidman R, Anglewicz P. Are adolescent orphans more likely to be HIV-positive? A pooled data analyses across 19 countries in sub-Saharan Africa. J Epidemiol Comm Health 2016;70(8):791-797. https://doi.org/10.1136/jech-2015-206744
27. Green D, Tordoff DM, Kharono B, et al. Evidence of sociodemographic heterogeneity across the HIV treatment cascade and progress towards 90-90-90 in sub-Saharan Africa – a systematic review and meta-analysis. J Int AIDS Soc 2020;23(3):e25470. https://doi.org/10.1002/jia2.2547
28. Ngandu NK, Van Malderen C, Goga A, Speybroeck N. Wealth-related inequality in early uptake of HIV testing among pregnant women: An analysis of data from a national cross-sectional survey, South Africa. BMJ Open 2017;7(7):e013362. https://doi.org/10.1136/bmjopen-2016-013362
29. Fraser C, Hollingsworth TD, Chapman R, de Wolf F, Hanage WP. Variation in HIV-1 set-point viral load: Epidemiological analysis and an evolutionary hypothesis. Proc Nat Acad Sci 2007;104(44):17441-17446. https://doi.org/10.1073/pnas.0708559104
30. National Department of Health, South Africa, Statistics South Africa, South African Medical Research Council, and ICF. South Africa Demographic and Health Survey 2016. Pretoria: NDoH, Stats SA, SAMRC and ICF, 2019. http://www.samrc.ac.za/sites/default/files/attachments/2019-01-29/SADHS2016.pdf (accessed 1 April 2021).

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