

# Socio-demographic correlates of non-adherence to anti-retroviral therapy (ART) at a health clinic in Mpumalanga province, South Africa

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## ABSTRACT:

- **Objective:** Long-term retention in care for people living with HIV and AIDS (PLH) remains a public health challenge in South Africa.
- **Patients and Methods:** The study used the clinical records of people living with HIV and AIDS attending a health clinic in the Mpumalanga province of South Africa to examine the effect of selected sociodemographic factors on patients' non-adherence to anti-retroviral therapy (ART). Pearson Chi-square test was used to examine treatment default proportion. Generalized estimating equation (GEE) was used for the bivariate and multivariate analysis. Statistical analyses were performed using Statistical Analysis System (SAS Institute, Cary, NC, USA) version 9.4.
- **Results:** Of 777 participants selected, more than half were female (56%, n=435) and over 60% were aged between 24 and 44 years old (69.6%, n=541), 62.7% (n=487) had never been married, 67% (n=521) were unemployed, almost half had an incomplete high school education (44%, n=342), and 56.5% (n=439) lived in an urban area. The mean age and standard deviation of all enrolled patients were 37 and 10. Mean and standard deviation of patients who defaulted on treatment was 35 and 9. Overall, 293 (37.7%) defaulted on ART between 2010 and 2014. Sociodemographic predictors significantly associated to non-adherence to ART were age, education, employment status and place of residence. The multivariate analysis shows that patients between 20 and 24 years old were five times more likely with default on treatment and those between 25 and 34 years old [AOR=2.23 (95% CI, 1.32-3.76)] and those from 35 to 44 years old [AOR=2.30 (95% CI, 1.37-3.85)] were twice as likely to default compared to the older age groups (from 45 and above). Patients with no formal education were four times more likely to default on treatment [AOR=4.32, (95% CI, 2.57-7.24)] than those who had completed high school. Those unemployed at the time of the study were twice as likely to default on treatment [AOR=2.83, (95% CI, 1.85-4.32)] as to those employed. Patients residing in a rural area were nine times more likely to default on ART [AOR=9.47, (95% CI, 6.53-13.7)] compared to those residing in an urban area.
- **Conclusions:** Strategies and intervention should be patient-focused, with comprehensive individualized programs and interventions. Socio-demographic factors should be targeted to improve ART adherence.
- **Keywords:** HIV, ART adherence, Viral suppression, South Africa.



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## INTRODUCTION

Globally, 38.4 million people are currently living with HIV, of whom 67% live in sub-Saharan Africa<sup>1</sup>. South Africa is the epicenter, with a total number of 7.7 million people living with HIV (PLH) and 230,000 new HIV infections in 2021<sup>2,3</sup>. Reducing the number of new infections and the associated mortality remains a major goal for HIV services globally<sup>4</sup>. In response to the epidemic, South Africa adopted the Universal Test and Treat (UTT) strategy<sup>5,6</sup> as recommended by the World Health Organization (WHO)<sup>4</sup>. A key to this strategy's success is improving the links to care for PLH, retention in care, support, and adherence to treatment to achieve viral suppression<sup>7</sup>. However, long-term patients' retention on antiretroviral therapy (ART) is one of the major challenges ART programs face globally<sup>8</sup>. ART interruption is the single most important factor known to be associated with treatment failure for PLH in both developed and developing countries<sup>9-11</sup>.

If South Africa is to achieve the Joint United Nations Program for HIV/AIDS's (UNAIDS) 95-95-95 targets by 2030, PLH must be linked to care and followed-up so that they can reach the point of an undetectable viral load<sup>8</sup>. Globally, in 2020, only 84% of PLH knew their status. Of those who knew their status, 73% were on ART, and of those on ART, 90% had undetectable viral loads<sup>1</sup>. There has been an improvement in the quality of life for PLH around the world, thanks to the introduction of ART, especially in developing countries such as South Africa<sup>12</sup>. Full adherence to ART improves quality of life, reduces the transmission of HIV, and slows the progression of HIV to AIDS (Acquired Immune Deficiency Syndrome)<sup>13</sup> and contributes to a reduction in HIV incidence<sup>14</sup>. However, for patients to fully benefit from ART, they have to show a 95% adherence to the treatment protocol<sup>15</sup>. ART interruption is a common problem among HIV patients, with rates ranging from 19% in North America and Western Europe to 40% in Latin America, 28-42% in Africa, and 40% in Asia-Pacific<sup>16</sup>.

South Africa has made a commitment to reach the UNAIDS 95-95-95 targets with a view to controlling the HIV epidemic<sup>8</sup>. In pursuing this goal, an ART policy has been implemented in the country. This policy makes available comprehensive healthcare services and the use of highly effective ART<sup>7</sup>. However, for patients who receive ART to fully benefit, the sociodemographic factors affecting ART adherence should be identified and addressed.

Studies<sup>9,17-22</sup> conducted around the world have indicated that both socio-demographic and structural factors affect ART adherence. Studies<sup>23-25</sup> from South Africa show that personal factors such as forgetfulness, side effects, work-related demands, marital status and education levels are associated with ART discontinuation. Perceived stigma and interpersonal factors such as family support, knowledge of the disease and general health literacy have also been linked<sup>18</sup> to ART interruption. There are also treatment-related factors such as the effects of the medication or access to the treatment that influence adherence. In addition to these person-

al and treatment-related factors, studies<sup>11,15,17</sup> conducted in Ethiopia, Nigeria and other parts of the world identified socio-demographic factors such as age, marital status, social support, education levels and employment status as factors associated with ART discontinuation. These factors should be investigated further in South Africa<sup>26-28</sup>. The aim of this study was to examine the impact of selected socio-demographic factors on ART interruption among patients attending a health clinic in a province of South Africa<sup>3</sup>.

## PATIENTS AND METHODS

### Study Area and Population

The Piet Retief Health Clinic is situated in the Gert Sibande District Municipality in the Mpumalanga province of South Africa. This district is one of three district municipalities in the Mpumalanga province. The total population of the Gert Sibanda District Municipality is 943,137. Approximately 86% of the population does not have medical insurance and therefore depend on the Department of Health for healthcare service delivery. The HIV prevalence rate is 40.5%<sup>3</sup>, which is the highest prevalence rate among all the districts in the Mpumalanga province and more than double the country's HIV prevalence rate<sup>3</sup>. It is estimated that at least 33% of the inhabitants of the Gert Sibanda District Municipality are unemployed<sup>3</sup>.

### Study Data

The population included 777 PLH aged 15 to 49 years old who were enrolled at the health clinic for ART from 2010 to 2014. Information on the status of their ART adherence, which is categorized as either default or non-default, was collected from patient records. Missing a hospital appointment for refill purposes within 30 days from the assigned appointment date was considered a default. Biographical data such as age, education level, employment status, gender, marital status, and place of residence were also collected from medical records. For the purpose of this study, being employed meant that the participant was working at the time of data collection (as indicated on the patient's records). It included students who worked part-time and full-time employees.

### Study Design

A multi-stage stratified random sampling was used to select both defaulters and non-defaulters for the effective sample, using a sample fraction of 10%. A sample size should comprise of at least 10% of the study population<sup>29</sup>. The total number of patients who started antiretroviral treatment at the wellness center from 2010 to 2014 was 7,773. Since the sample fraction for the present study was set at 10% of the total study population from each stratum, a total of 486 ( $4,862 \times 0.10 = 486$ ) patients

from the non-defaulting group and 291 ( $2,991 \times 0.10 = 291$ ) from the defaulting group were selected for the collection of quantitative data.

The first step in the sampling process involved organizing the patients' files according to the two "natural" strata, namely defaulting and non-defaulting patients. The second step involved the use of a simple random sampling technique to select a total of 291 patients from the defaulting stratum and 486 patients from the non-defaulting stratum, yielding a total sample size of 777 patients.

### Statistical Analysis

All statistical analyses were performed using Statistical Analysis System (SAS Institute, Cary, NC, USA) version 9.4. Descriptive statistics were used to explore the overall participants' characteristics according to their ART adherence and non-adherence status. The outcome variable was the ART status, which was stated binary as adherence (never-defaulted), coded as 0, and non-adherence (ever-defaulted), coded as 1. Pearson Chi-square test was performed to assess the correlation between non-adherence and adherence to treatment and study characteristics. Pearson Chi-square test was used due to its advantage of providing robust estimation, rather than an approximation of the subject categories, as well as due to its widely use on larger sample size without underestimation<sup>30</sup>.

An initial bivariate analysis was conducted to examine the individual variables independently associated with ART non-adherence, while controlling for confounding variables. The Spearman's rank correlation was used to examine correlated variables. After adjusting for the effect of all variables in the model, the following uncorrelated variables were included in the multivariate model: age, education, employment, and place of residence. In the multivariate analysis, age was modelled as a categorical variable using the mean age (overall) as the threshold. A generalized estimating equation (GEE) model was used to examine factors associated with non-adherence to ART. Statistical significance was assessed at 5% level for all analysis.

## RESULTS

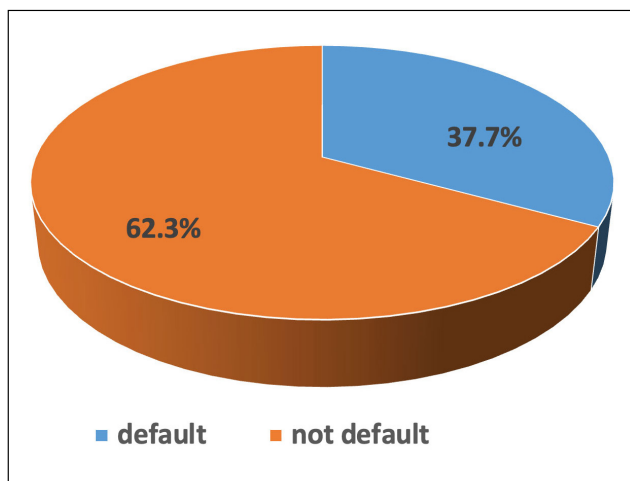
### Descriptive Statistics

Slightly more than two-thirds, 66%, ( $n=435$ ), of the respondents were female. The mean age and standard deviation of all enrolled patients was  $37 \pm 10$  years. A total of 62.7%, ( $n=487$ ) of the participants were married, 33.1% ( $n=257$ ) had completed high school, 67.0% ( $n=521$ ) were unemployed, and 56.5% ( $n=439$ ) resided in an urban area (Table 1).

**Table 1.** Proportion of adherence and non-adherence to ART treatment by socio demographic characteristics.

Variables	Non-Adherence N (%)	Adherence N (%)	<i>p</i> -value	Overall N (%)
<b>Gender</b>				
Female	156 (35.9)	279 (64.1)	0.23	435 (56.0%)
Male	137 (40.1)	205 (59.9)		
<b>Marital status</b>				
Ever married	175 (35.9)	312 (64.1)	0.19	487 (62.7%)
Never married	118 (40.7)	172 (59.3)		
<b>Education level</b>				
Complete high school	77 (30.0)	180 (70.0)	0.0001	342 (44.0%)
Incomplete high school	97 (28.4)	245 (71.6)		
No education	119 (66.9)	59 (33.2)		
<b>Education status</b>				
Employed	55 (21.5)	201 (78.5)	0.0001	256 (33.0%)
Unemployed	238 (45.7)	283 (54.3)		
<b>Place of residence</b>				
Rural	220 (65.1)	118 (34.9)	0.0001	338 (43.5%)
Urban	73 (16.6)	366 (83.4)		
	<b>Mean (<math>\pm</math>SD)</b>	<b>Mean (<math>\pm</math>SD)</b>		
<b>Age (overall)</b>	24 ( $\pm$ 6)	39 ( $\pm$ 8.2)	0.001	37 ( $\pm$ 10)
Age (female)	26 ( $\pm$ 4.1)	35 ( $\pm$ 6.0)	0.02	35 ( $\pm$ 8.2)
Age (male)	23 ( $\pm$ 3)	40 ( $\pm$ 10.3)	0.01	39 ( $\pm$ 11.1)

SD: Standard Deviation.



**Figure 1.** Percentage distribution of ART defaulters and non-defaulters at the Piet Retief Wellness Clinic between 2010 and 2014.

**Prevalence of Non-Adherence to ART**

Table 1 shows the distribution of patients who defaulted at least once and patients who adhered to their ART after first enrolment between 2010 and 2014. A total of 37.7% (n=293) of the patients defaulted during the four-year period, while 62.3% (n=484) took their medication without fail (Figure 1 and Table 1). Overall, the mean and ±SD of patients who defaulted was 24±6 years while

those who did not default was 39±8 years. Mean age and ±SD of those that defaulted was 26±4.1 years for female and 23±3 years for male. 40.1% (n=137/342) of males defaulted compared to 35.9% (n=156/435) females. Higher treatment default was found in patients who had never been married (40.7%, n=118/280), and among those with no formal education (66.9%, n=119/178). More patients without employment (45.7%, n=238/521) defaulted compared to those employed (21.5%, n=55/256). Over 60% of patients who resided in a rural area (65.1%, n=220/338) had defaulted on ART.

**Sociodemographic Factors Associated with ART Default among HIV Patients Attending a Wellness Clinic**

Table 2 shows the results of the bivariate and multivariate analyses of factors associated with ART default among the PLH attending the clinic. The bivariate analysis shows that education level, employment status and place of residence were independently associated with treatment default. The multivariate analysis shows that patients with no formal education were four times more likely to default on their treatment [adjusted odds ratio (AOR)=4.32, 95% CI: 2.57-7.24] compared with those who had completed high school. Those unemployed at the time of the study were twice as likely to default on treatment (AOR=2.83, 95% CI: 1.85-4.32) compared to

**Table 2.** Bivariate and multivariate analysis to examine socio demographic factors associated with non-adherence to ART treatment among.

Variables	Unadjusted Odds Ratio		Adjusted Odds Ratio	
	OR (95% CI)	p-value	AOR (95% CI)	p-value
<b>Age</b>				
Above 24 years old (ref)	1		1	
24 years old and below	3.14 (3.01-4.18)	<0.0001**	5.15 (2.41-7.17)	<0.0001**
<b>Gender</b>				
Female (ref)	1		NA	
Male	1.12 (0.93-1.37)	0.23		
<b>Marital status</b>				
Ever married (ref)	1		NA	
Never married	1.08 (0.95-1.21)	0.19		
<b>Education level</b>				
Complete high school (ref)	1		1	
Incomplete high school	0.95 (0.74-1.22)	0.07	0.81 (0.52-1.25)	0.34
No education	2.23 (1.80-2.76)	<0.0001**	4.32 (2.57-7.24)	<0.0001**
<b>Education status</b>				
Employed (ref)	1			
Unemployed	2.13 (1.65-2.74)	<0.0001**	2.83 (1.85-4.32)	<0.0001**
<b>Place of residence</b>				
Urban (ref)	1		1	
Rural	3.91 (3.13-4.89)	<0.0001**	9.47 (6.53-13.7)	<0.0001**

ref: reference category; CI: Confidence Interval; SD: Standard Deviation; NA: Not Applicable; OR: Odds Ratio; AOR: Adjusted Odds Ratio. \*\*significant at 5% level.

those employed. Patients residing in a rural area were nine times more likely to default (AOR=9.47, 95% CI: 6.53-13.7) compared to those residing in an urban area, patients 24 years and below were five times likely to default (AOR=5.15, 95% CI: 2.41-7.17) compared to those above the mean age.

## DISCUSSION

This study aimed to examine the effects of socio-demographic factors on ART non-adherence at a health clinic in the Mpumalanga province of South Africa between 2010 and 2014.

We found no statistically significant association between gender and ART default after adjusting for the effects of all the factors in the model. This corresponds with findings from Kenya<sup>29</sup>, Indonesia<sup>30</sup>, Cuba<sup>31</sup> and Nepal<sup>32</sup>, where studies reported no significant association between gender and adherence to ART.

This study found a significant association between age and poor adherence to ART. Our data showed that younger age (24 years and below) patients are more likely to default on ART compared to older ages. This was similar to findings<sup>17,33-35</sup> from Ethiopia and other parts of the world where an age below 25 was found to be a predictor of poor ART adherence. Also, studies<sup>11,31,36,37</sup> from Italy, Ghana, Tanzania, and Cuba showed that older participants were more likely to adhere to ART. Only one study<sup>15</sup> from Nigeria found a higher chance of ART default among older age groups. It should be added that individuals who maintain greater compliance with treatment recommendations may outlive those who are non-adherent<sup>9,17,31</sup>.

Some studies<sup>36</sup> conducted in other parts of the world reveal that young people (aged 25 and below) may not visit health clinics to start treatment due to fear of discrimination and stigma. Furthermore, since most PLH in this age group are unemployed, at school or enrolled at universities may have less access to ART due to unavailability of transport money for travelling to the health clinics for ART refill as they are unemployed<sup>30</sup>. Those who live in rural areas and have no financial means to travel to urban areas to access ART may have significant difficulties to access health services<sup>30</sup>. It is recommended that the government consider interventions targeting this at-risk groups of PLH.

Our study reveals a strong association between the level of education and adherence to ART. Patients with no formal education were four times more likely to default on treatment compared with those with a complete high school education. This corresponds with findings<sup>15,31,33,38,39</sup> from Ethiopia, Vietnam, Nigeria and Cuba, where education level was found to increase patients' adherence to ART. Likewise, we found a strong association between employment status and patients' ART adherence. Patients who were unemployed were twice likely to default on treatment compared to those who were employed. This was similar to findings from other studies<sup>9,15,18,30,35,40-41</sup> where unemployed patients

were more likely to interrupt treatment compared to those employed. This shows the crucial role that employment status plays in ART adherence.

Apart from ART adherence as such, studies<sup>34</sup> from all over the world reveal that unemployment status represent a challenge for patients on ART through several mechanisms, such as food shortages, inability to travel to health clinics to collect medication if patients live in a rural area, as well as emotional distress due to lack of financial support. In a study that was conducted in Nigeria and Zambia, poverty and food shortages resulting from unemployment were strongly associated with ART non-adherence. These studies show the need for urgent interventions aimed at supporting unemployed PLH so that they can access treatment in a timely manner and with sufficient food to ensure retention to care<sup>19,40</sup>. Providing community-based support aimed at PLH has been shown<sup>26</sup> to be effective in the management of HIV and AIDS.

There was no significant association between ART interruption and patients' marital status in our study. Similar findings<sup>42</sup> have been reported in Ethiopia. We did find a strong association between ART and living in either a rural or urban setting. Patients who resided in rural areas were nine times more likely to default compared to their urban counterparts. Our finding is consistent with studies from Ethiopia<sup>17,43,44</sup> and Nigeria<sup>45</sup> which found that the risk of treatment default was higher among participants living in rural areas compared to participants living in urban areas. Locally, findings<sup>9,46</sup> from the KwaZulu-Natal province in South Africa revealed that ART adherence was three times greater for urban residents than for rural residents. In Kenya, South Africa and Nepal, long travel times to ART centers for rural patients was identified as one of the major causes of ART non-adherence<sup>29,47,35</sup>. We recommend that government provide community-based ART clinics to support PLH who struggle to access treatment.

## Limitations of the Study

Firstly, this study was not a clinical trial and not justified to conduct one, therefore the number of years from diagnosis were not collected and included in our data. Secondly, the study relied on medical records to find the challenges PLH face with adherence to ART. Further studies are recommended with the aim of investigating the patient's point of view on reasons for ART discontinuation. Finally, further research should be done to investigate the effect of drug abuse, sexual orientation, and field of occupation on ART adherence. This will inform policy on the interventions needed to support PLH currently affected by these issues.

## CONCLUSIONS

The findings of this study offer empirical evidence to support the strength of health belief model's (HBM) socio-demographic component as a framework for understanding individuals' health-related decision making.

Strategies and interventions should be patient-focused, with comprehensive individualized programs and interventions, including socio-demographic strategies to improve ART adherence. Further research on behavioral characteristic is recommended to explain adherence default among PLH. Additionally, interventions in the form of ART village delivery should be provided to support ART patients who stay far from a health clinic. Finally, local healthcare facilities should be supported in being licensed to provide ART at the community level.

#### INFORMED CONSENT:

Written informed consent was obtained from all participants in the study. The participants signed an informed consent form to indicate their willingness to participate in the study. The relevant Ethics Committees approved the informed consent form.

#### CONFLICT OF INTEREST:

None declared.

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#### ETHICS APPROVAL:

The process to obtain Ethics approval before conducting the study was as follows:

We submitted the research protocol to the National Health Research database and obtained provincial approval from the Mpumalanga Provincial Government to conduct research at the Piet Retief Health Clinic, ethics number (MP\_2017 RP48\_681).

We submitted the research protocol and obtained approval from the Research Ethics Committee of the North-West University, ethics number (NWU-00335-17-A9).

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#### REFERENCES

- UNAIDS. Global HIV and AIDS statistics: 2020 fact sheet. 2021. [Access date: 20 March 2022]. Available at: [https://www.unaids.org/sites/default/files/media\\_asset/UNAIDS\\_FactSheet\\_en.pdf](https://www.unaids.org/sites/default/files/media_asset/UNAIDS_FactSheet_en.pdf).
- UNAIDS. The state of HIV prevention in South Africa. HIV and AIDS estimates, South Africa. 2021. [Access date: 20 March 2021]. Available at: <https://hivpreventioncoalition.unaids.org/wp-content/uploads/2022/02/South-Africa-1.pdf>.
- Statistics South Africa (STATSA SA). Statistical release: Mid-year population estimates. 2020. [Access date: 22 March 2022]. Available at: <http://www.statssa.gov.za/publications/P0302/P03033030.pdf>.
- World Health Organization. Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection. 2016. [Access date: 20 March 2022]. Available at: <https://www.who.int/publications/item/9789241549684>.
- South Africa National Department of Health (SANDoH). Implementation of the Universal Test and Treat Strategy for HIV-positive patients and differentiated care for stable patients. 2016. [Access date: 20 March 2022]. Available at: [http://www.sahivsoc/Files/22%208%2016%20Circular%20UTT%20%20%20Decongestion%20CCMT%20Directorate%20\(2\).pdf](http://www.sahivsoc/Files/22%208%2016%20Circular%20UTT%20%20%20Decongestion%20CCMT%20Directorate%20(2).pdf).
- Iwuji CC, Orne-Gliemann J, Larmarange J, Balestre E, Thiebaut R, Tanser F, Okesola N, Makowa T, Dreyer J, Herbst K, McGrath N, Bärnighausen T, Boyer S, De Oliveira T, Rekecwicz C, Bazin B, Newell ML, Pillay D, Dabis F; ANRS 12249 TasP Study Group. Universal test and treat and the HIV epidemic in rural South Africa: a phase 4, open label, community cluster randomised trial. *Lancet HIV* 2018; 5: e116-e125.
- South Africa National Department of Health (SANDoH). National Retention Adherence Policy: Policy and service delivery guidelines for linkage to care, adherence to treatment and retention in care. 2016. [Access date: 20 March 2022]. Available at: <https://www.nacosa.org.za/wp-content/uploads/2016/11/integrated-Adherence-Guidelines-NDOH.pdf>.
- UNAIDS. Global AIDS Strategy 2021-2026, End inequalities. *End AIDS*. 2021. [Access date: 20 March 2022]. Available at: <https://www.unaids.org/en/Global-AIDS-Strategy-2021-2026>.
- Laher A, Richards G, Paruk F, Venter W. Antiretroviral therapy non-adherence among HIV-positive patients presenting to an emergency department in Johannesburg, South Africa: Associations and reasons. *S Afric M J* 2021; 111: 753-758.
- Babo YD, Alemie GA, Fentaye F. Predictors of first-line antiretroviral therapy failure amongst HIV-infected adult clients at Woldia Hospital, Northeast Ethiopia. *PLoS One* 2017; 12: e0187694.
- Saracino A, Zaccarelli M, Lorenzini P, Bandera A, Marchetti G, Castelli F, Gori A, Girardi E, Mus-sini C, Bonfanti P, Ammassari A, d'Arminio MA, Icona Foundation Study Group. Impact of social determinants on antiretroviral therapy access and outcomes entering the era of universal treatment for people living with HIV in Italy. *BMC Public Health* 2018; 18: 1-12.
- Euvrard J, Schulz T, Hilderbrand K, Bosland M, Osler M, Boule A, Davies MA. How accurately do routinely reported HIV viral load suppression proportions reflect progress towards the 90-90-90 target in the population on antiretroviral treatment in Khayelitsha, South Africa? *S Afric M J* 2019; 109: 174-177.
- Zeluf-Andersson G, Eriksson LE, Schönnesson LN, Höijer J, Måneshall P, Ekström AM. Beyond viral suppression: the quality of life of people living with HIV in Sweden. *AIDS Care* 2019; 31: 403-412.
- Tanser F, Bärnighausen T, Grapsa E, Zaidi J, Newell M. High coverage of ART associated with decline in risk of HIV acquisition in rural KwaZulu-Natal, South Africa. *J Sci* 2013; 339: 966-971.
- Wanvoegbe F, Attinsonon C, Agbodande K, Houndekon M, Allassani. Determinants of Adherence to Antiretroviral Treatment Among HIV-Infected Patients at the Departmental Teaching Hospital of Oueme-Plateau, Nigeria. *Curr Trends Intern Med* 2022; 6: 154.

16. Johnson LF, Anderegg N, Zaniewski E, Eaton JW, Rebeiro PF, Carrquiry G, Nash D, Yotebieng M, Ekouevi DK, Holmes CB, Choi JY, Jiamsakul A, Bakoyannis G, Althoff KN, Sohn AH, Yiannoutsos C, Egger M, International epidemiology Databases to Evaluate AIDS (IeDEA) Collaboration (2019). Global variations in mortality in adults after initiating antiretroviral treatment: an updated analysis of the International Epidemiology Databases to evaluate AIDS cohort collaboration. *AIDS* 2019; 33: S283-S294.
17. Tolossa T, Wakuma B, Mulisa D, Besho M, Tsegaye R, Tigistu M, Kebebe H, Markos J, Hiko N, Hasen T, Wirtu D. ART adherence among people living with HIV seeking services from public health facilities in Western Ethiopia. *HIV AIDS (Auckl)* 2021; 13: 1149.
18. Fuge TG, Tsourtos G, Miller E. Factors affecting optimal adherence to antiretroviral therapy and viral suppression amongst HIV-infected prisoners in South Ethiopia: a comparative cross-sectional study. *AIDS Res Ther* 2022; 19: 1-14.
19. Ogundahunsi OA, Daniel OJ, Oladapo OT. Adherence to antiretroviral drugs among AIDS patients in Sagamu, Nigeria. *Int J Med Sci* 2021; 10: 4.
20. Hernández-Huerta D, Parro-Torres C, Madoz-Gúrpide A, Pérez-Eliás MJ, Moreno-Guillén S, Ochoa-Mangado E. Personality and adherence to antiretroviral therapy in HIV-infected adult patients. *J Psychosom Res* 2021; 144: 110413.
21. Dorcéus L, Bernard J, Georgery C, Vanessa C. Factors associated with antiretroviral therapy adherence among people living with HIV in Haiti: a cross-sectional study. *AIDS Res Ther* 2021; 18: 1-9.
22. Heestermans T, Browne JL, Aitken SC, Vervoort SC, Klipstein-Grobusch K. Determinants of adherence to antiretroviral therapy among HIV-positive adults in Sub-Saharan Africa: a systematic review. *BMJ Glob Health* 2016; 1: e000125.
23. Adeniyi OV, Ajayi AI, Ter Goon D, Owolabi EO, Eboh A, Lambert J. Factors affecting adherence to antiretroviral therapy among pregnant women in the Eastern Cape, South Africa. *BMC Infect Dis* 2018; 18: 1.
24. Kheswa J. Non-adherence to antiretroviral treatment by people living with HIV/AIDS in Black communities in South Africa: Socio-cultural challenges. *Mediterr J Soc Sci* 2014; 5: 450.
25. Moosa A, Gengiah TN, Lewis L, Naidoo K. Long-term adherence to antiretroviral therapy in a South African adult patient cohort: a retrospective study. *BMC Infect Dis* 2019; 19: 1-12.
26. Okawa S, Mwanza Kabaghe S, Mwiya M, Kikuchi K, Jimba M, Kankasa C, Ishikawa N. Psychological well-being and adherence to antiretroviral therapy among adolescents living with HIV in Zambia. *AIDS Care* 2018; 30: 634-642.
27. Yu Y, Luo D, Chen X, Huang Z, Wang M, Xiao S. Medication adherence to antiretroviral therapy among newly treated people living with HIV. *BMC Public Health* 2018; 18: 1-8.
28. Habibi M, Rahardjo SS, Murti B. Associations between HIV Status Disclosure, Social Support, and Adherence to and Antiretroviral Therapy in Adults Patients with HIV/AIDS. *J Epidemiology Public Health* 2021; 6: 112-124.
29. Wakibi SN, Ng'ang'a, ZW, Mbugua GG. Factors associated with non-adherence to highly active antiretroviral therapy in Nairobi, Kenya. *AIDS Res Ther* 2011; 8: 43.
30. Suryana K, Suharsono H, Antara I. Factors associated with adherence to anti-retroviral therapy among people living with HIV/AIDS at Wangaya Hospital in Denpasar, Bali, Indonesia: a cross-sectional study. *HIV AIDS (Auckl)* 2019; 11: 307.
31. Aragonés CSL, Campos JR, Pérez J. Antiretroviral therapy adherence in persons with HIV/AIDS in Cuba. *MEDICC Rev* 2011; 13: 17-23.
32. Sharma SKP, Dhungana G, Chitrakar U. Medication Adherence to Antiretroviral Therapy Among Patients Visiting Antiretroviral Therapy Center at Tribhuvan University Teaching Hospital, Kathmandu, Nepal. *Kathmandu Univ Med J* 2022; 11: 50-53.
33. Nigusso FT, Mavhandu-Mudzusi AH. Magnitude of non-adherence to antiretroviral therapy and associated factors among adult people living with HIV/AIDS in Benishangul-Gumuz Regional State, Ethiopia. *PeerJ* 2020; 8: e8558.
34. Peña S, Bravo PM, Tomás C, Ángel M, Almansa-Martínez, P, Guillen PC, Jiménez-Ruiz I. Factors related to adherence to antiretroviral treatment in women with HIV: A mixed study with sequential design. *Enfermería Glob* 2021; 20: 1-34.
35. Shigdel RKE, Bhandari A, Ahmed LA. Factors associated with adherence to antiretroviral therapy in HIV-infected patients in Kathmandu District, Nepal. *HIV AIDS (Auckland)* 2014; 24: 109-166.
36. Adu C, Mensah KA, Ahinkorah BO, Seidu AA, Minta AY, Tetteh AW. Socio-demographic factors associated with medication adherence among people living with HIV in Kumasi Metropolis, Ghana. *Research Square* 2021; 1: 212 (Pre-print).
37. Sangeda RZ, Mosha F, Aboud S, Kamuhabwa A, Chalamilla G, Vercauteren J, Van Wijngaerden E, Lyamuya EF, Vandamme AM. Predictors of non-adherence to antiretroviral therapy at an urban HIV care and treatment Center in Tanzania. *Drug Healthc Patient Saf* 2018; 10: 79.
38. Jima F, Tatiparthi R. Prevalence of nonadherence and its associated factors affecting on HIV adult's follow-up at antiretroviral therapy clinic in Batu Hospital, Eastern Ethiopia. *Indian J Sex Transm Dis AIDS* 2018; 39: 91-97.
39. Le PM, Nguyen PT, Nguyen HV, Bui DH, Vo SH, Nguyen NV, Nguyen TV, Tran AT, Le AD, Ha NM, Dao AT, Gilmour S. Adherence to highly active antiretroviral therapy among people living with HIV and associated high-risk behaviours and clinical characteristics: A cross-sectional survey in Viet Nam. *Int J STD AIDS* 2021; 32: 911-918.
40. Van Wyk BMK. Social and economic barriers to adherence among patients at Livingstone General Hospital in Zambia. *Afr J Prim Health Care Fam Med* 2019; 11: 1-6.
41. Makhado L. Factors influencing non-adherence to antiretroviral therapy in South Africa: a systematic review. *HIV AIDS Rev* 2019; 18: 239-246.
42. Aychiluhm SB, Tadesse AW, Urmale MK, Melaku MS, Ibrahim IM, Ahmed O, Ebrahim OA, Wa-gris M, Member Y, Kassa AM. Level of non-adherence and its associated factors among adults on first-line antiretroviral therapy in Amhara Regional State, Ethiopia. *PLoS One* 2021; 16: e0255912.
43. Hailasilassie K, Etana B, Alemayehu M, Fisseha, G. Factors associated with adherence of highly active antiretroviral therapy among adult HIV/AIDS patients in Mekelle Hospital Northern Ethiopia. *Sci J Pub Health* 2014; 2: 257-262.
44. Angelo AT, Alemayehu, DS. Adherence and Its Associated Factors Among Adult HIV-Infected Patients on Antiretroviral Therapy in South-Western Ethiopia. *Patient Preference Adherence* 2020; 15: 299-308.
45. Augustina O, Omotayo OE, Geoffrey E. Factors associated with non-adherence of HIV/AIDS patients to HAART regimen in a healthcare facility in Ikot Ekpene, Akwa Ibom State, Nigeria. *J AIDS HIV Res* 2019; 11: 16-24.
46. Peltzer KTC, Matseke G, Simbayi L. Lay counsellor-based risk reduction intervention with HIV positive diagnosed patients at public HIV counselling and testing sites in Mpumalanga, South Africa. *Eval Program Plann* 2010; 33: 379-385.
47. Simelane PT, Simelane MS, Amoateng AY. Barriers and facilitators to adherence for antiretroviral therapy: the perspectives of patients from a wellness center in the Mpumalanga Province, South Africa. *Afri Health Sci* 2022; 22: 455-462.