Article

Factors Associated with Treatment Outcomes among Patients Living with HIV and Hypertension Comorbidity in the Eastern Cape Province, South Africa

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Abstract: Globally, non-communicable diseases like hypertension are on the rise, existing concurrently with the human immunodeficiency virus (HIV) in populations, especially those in low- to middle-income countries. The introduction of antiretroviral treatment (ART) for people living with HIV was welcomed with great enthusiasm across populations. A cross-sectional study of 100 purposively selected adult participants on antiretroviral treatment living in the OR Tambo district was conducted to determine factors associated with treatment outcomes among patients living with HIV and hypertension comorbidity. The data was analyzed using the Statistical Package for Social Sciences, with a p-value of 0.05 considered significant. A total of 86% of the female population, with a mean age of 39.76, was studied. Participants with improved viral load and CD4 cell count after initiation of ART increased from 63% to 68% and 74% to 90%, respectively whilst viral load suppression increased from 45.1% to 90.2%. Hypertension post-ART initiation increased from 9% to 34%, exacerbated by smoking (12%), alcohol (14%), vegetable consumption (39%), skipping breakfast (50%), sugar use (62%), and vigorous physical activity (12%). The onset of hypertension was linked to the start of ART, and risky behaviors influenced treatment outcomes. Primordial prevention, like strong health promotion interventions for risk factors, is needed to improve life expectancy.

Keywords: keyword 1; keyword 2; keyword 3 (List three to ten pertinent keywords specific to the article yet reasonably common within the subject discipline.)

1. Introduction

Annually, non-communicable diseases (NCDs) account for more than 41 million deaths worldwide [1], with over 75% of these fatalities occurring in low- and middle-income countries, which includes the Sub-Saharan Africa [2]. This situation was exacerbated by the prevalence of hypertension in persons aged 30-79 years which was reported to be 32% globally in 2019 [3] and human immune deficiency virus (HIV) prevalence estimated at 38.4 million people worldwide [4]. The global prevalence of hypertension in HIV-infected adults was reported at 35% across all populations, though youth living with HIV were more vulnerable to hypertension, and across all populations, people living with HIV (PLWHIV) were at risk of developing chronic complications and comorbidities, such as NCDs and mental health disorders [5-7]. Godongwane and De Wet-Billings further indicate that PLWHIV are at an increased risk of developing hypertension because of antiretroviral therapy (ART) initiation. In sub-Saharan Africa alone, it is estimated that

levels of HIV-hypertension comorbidity range between 17% and 30%, whereas South Africa recorded 22% of the comorbidity [8,9]. Initiation and expanded access to antiretroviral therapy have significantly reduced the devastating impact of the global HIV epidemic in recent decades [10].

The primary goals of antiretroviral therapy are to maintain maximal suppression of the viral load, restore immunologic function, improve quality of life and reduce HIV-related morbidity and mortality [11]. The development of antiretroviral drugs has significantly changed the perception of HIV/AIDS from a very fatal to a chronic and potentially manageable disease, and the availability and administration of antiretroviral therapy (ART) has significantly reduced mortality and morbidity associated with HIV and AIDS [12]. Whilst the combination antiretroviral therapy (cART) significantly increases patients' chances of surviving for a long period with HIV, it is also reported to increase risk of developing comorbidities [13]. This increased survival, however, also made PLWHIV more susceptible to developing NCDs like hypertension and other cardiovascular conditions [14].

The escalation levels of adults living with HIV and hypertension is concerning because it is associated with increased morbidity and mortality and has shown upward trends in the recent years [6,15,16]. However, it is reported that the use of ART medications improves the quality of life and life expectancy of PLWHA in Northern Uganda, though exposure to the effects of aging, including the influence of environmental risk factors, was known to act in the general population and contribute to the occurrence of NCDs such as hypertension, heart attacks, and stroke, chronic renal diseases, and osteoporotic fractures [17,18].

With South Africa having the world's largest burden of HIV, with an HIV prevalence of 12%, and largest free ART programme globally, risks for hypertension and diabetes are even increased [6,19-21]. Since the advent of effective ART, HIV has become a chronic, manageable illness, with lifespan approaching that of HIV-negative persons [22]. Such improvement in life expectancy, along with the aging effect of HIV and drug interactions, accounted for increased risk of developing NCDs and consequentially an increased burden of multimorbidity among PLWHIV. This study explored factors associated with treatment outcomes among patients living with HIV and hypertension comorbidity in the Eastern Cape Province, South Africa

2. Materials and Methods

2.1. Study design

A cross-sectional exploratory study was conducted to determine factors associated with treatment outcomes for patients living with HIV and hypertension morbidity.

2.2. Setting

This study was conducted in selected facilities in the OR Tambo District of the Eastern Cape Province. The OR Tambo District Municipality is a coastal Category C municipality with Area of 12 096 km² located on the East of the Eastern Cape Province. It constituted 2.6% of South Africa's total population in 2016 and is the most populous of the six district municipalities in the Eastern Cape Province, with a population of 1 382 399 and a population density of 114.3 persons per km² [23].

2.3. Population

The study population consisted of patients aged 18 and older living with HIV and hypertension comorbidities who were receiving care at the selected health facilities. Any patient who was visiting or using other facilities outside the selected facilities was excluded.

2.4. Sampling

Purposive sampling was used to select study population among patients living with HIV and hypertension comorbidity in OR Tambo district municipality where expected proportion: P = 50%, Confidence level: 95% ($Z_\propto$ = 1.96) and the maximum error admitted by the researcher: e=10% using the following formular:

$$n = \frac{Z_\propto^2 * P\,(100 - P)}{e^2}$$

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2.5. Data collection

A researcher-filled and customized, validated World Health Organization (WHO) Stepwise questionnaire was used for collecting data. Data was gathered through face-to-face interactions and, when necessary, phone calls between April and June 2021. Data was collected per appointment and during the day when participants had time without disrupting their daily routine. Local language was used through the use of a professionally translated version of the WHO Stepwise questionnaire.

2.6. Data Analysis

Data analysis was performed using version 23 of the Statistical Package for Social Sciences (SPSS) program (SPSS Inc., Chicago, IL, USA). Inferential statistics were used to make inferences concerning research propositions using univariate and multivariate analyses, means, and proportions. The researcher used the Chi-square test and/or the Fisher's exact test to compare two categorical variables. Parametric statistics (mean, standard deviation, range, and t-tests) were used to report on normally distributed data, while non-parametric statistics (median, interquartile range, Wilcoxon sum rank test, Wilcoxon signed rank test, and the Kruskal-Wallis test) were used to report on data that is not normally distributed. A p-value of 0.05 was considered statistically significant and a 95% confidence interval were used for reporting. Frequencies are used for categorical variables and numerical variables are reported as means ±standard deviations.

2.7. Ethical and Legal Considerations

Ethical approval from the Walter Sisulu University Faculty of Health Sciences Ethics and Biosafety committee (022/2021) as well as permission from Eastern Cape Department of Health (ECDOH) were obtained. Participant protection was ensured through all the provisions listed in the Helsinki declaration.

2.8. Validity and Reliability

A validated WHO-Stepwise tool was used for the study.

3. Results

3.1. Socio-demographics of the sampled population

A total of one hundred (n=100) participants living with HIV (PLWHIV) were recruited for this study. Table 1 summarizes the demographic data of the participants. The output shows that 86% of the population were females, with a male to female ratio of 1:6. The mean age of the population was 39.76 years (SD = 10.03 years). A total of 25% of the participants were aged 32-37 years and least were aged between 26-31 years age group (18.0%). Females mean age was 40.07 years (SD = 10.14) and were older than males with mean age of 37.86 years (SD = 9.46).

In line with the South African national marriage rate of 2019, most (72%) of the participants had never been married. Only 14% of the participants were married and 2% were divorced. Almost half (46%) of the participants lived in peri-urban areas, and 41% lived in rural areas. The majority at 57% attained secondary education, followed by 30% who

had attained tertiary education, and 11% who attained primary education. The unemployment rate among the participants was 63%.

Table 1. Demographic characteristics of participants with HIV-hypertension comorbidity.

Variables	Categories	Frequency (N=100)	Percent (%)
Gender	Male	14	14.0
	Female	86	86.0
	Total	100	100
Age groups	25 years and younger	4	4.0
	26-31 years	18	18.0
	32-37 years	25	25.0
	38-43 years	19	19.0
	Above 44 years	18	18.0
	50-55 years	7	7.0
	≥56 years	9	9.0
Marital status	Never married	72	72.0
	Married	14	14.0
	Cohabiting	6	6.0
	Divorced	2	2.0
	Widowed	6	6.0
Location	Rural	41	41.0
	Per-urban	46	46.0
	Urban	13	13.0
Educational level	Primary	11	11.0
	Secondary	57	57.0
	Trade vocational school	2	2.0
	Tertiary	30	30.0
Employment	Unemployed	63	63.0
	Employed	37	37.0
		Mean ± SD	Min – Max
Age (years)		39.76±10.03	19-68
Age by Gender (years), *p=0.432*			
Male		37.86±9.46	28-57
Female		40.07±10.14	19-68

*3.2. HIV and hypertension treatment outcomes using viral load (VL), CD4 count and blood pressure history*

When comparing viral load before ART initiation and after initiation, an improved viral load suppresion was observed with participants with lower than detected VL increasing from 63% to 68% whilst those with 50-999 copies/ml reducing from 34% to 21%, and it was statistically significant (p = 0.031). However, there was a noted increse among those with 20-49 copies owing to shift from the 50-999 copies group. increase in number of   viral load pre- and post- ART initiation. There were no participant who had a viral load of ≥1000 copies/ml compared after initiation of ART compared to 2% before initiation (Figure 1). There was an improvement in CD4 cell count after ART initiation. A total of 90% of the participants had a CD4 cell count of 350 cells/mm^3 and more compared to 74% before initiation. However, there was no change in number of patients with less than 200 cells/mm^3 pre- and post-ART initiation at 6%.
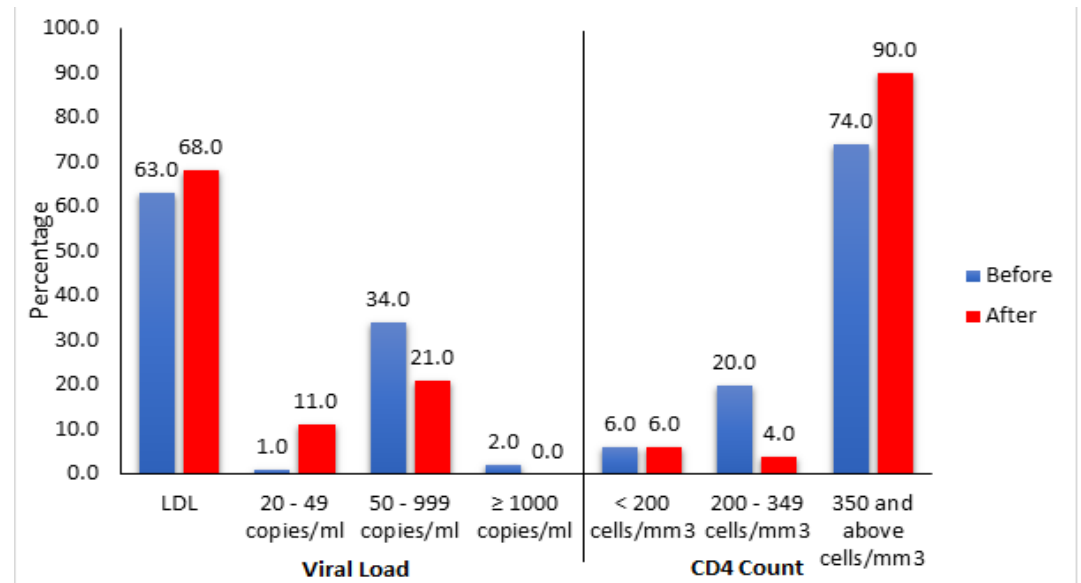
p-value = 0.031 (Marginal Homogeneity test / Stuart-Maxwell test)

Figure 1. Distribution of participants according to viral load and CD4 cell count before and after the ARV treatment initiation.

Improved CD4 cell count is translated as effectiveness of the treatment taken towards a particular diseases. There was a significant improvement in the number of CD4 cells among participants after they were initiated on ART (mean count = 624.8 cells/mm^3) was statistically significant (p= 0.001) than before ART initiation (mean = 534.4 cell/mm^3) (Figure 2).
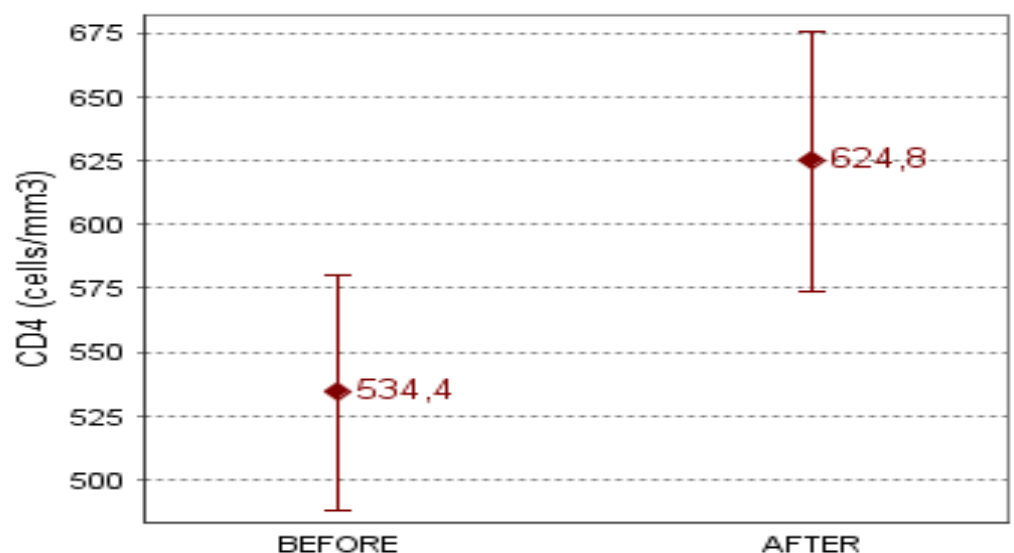
p-value = 0.001 (Paired samples T-test) (Min-Max: Before = 51-1232; After = 105-1619).

Figure 2. Distribution of participants according to CD4 cell count before and after the ART initiation.

In order to ensure desirable treatment outcomes, patients diagnosed with HIV and with hyertension are out to treament immediately so as to prevent severance of the disease whilst improving the quality of life. Figure 3 shows that 34% of the participants were

hypertensive post-ART initiation compared to only nine percent pre-ART initiation, and were subsequently on hypertension treatment and management.
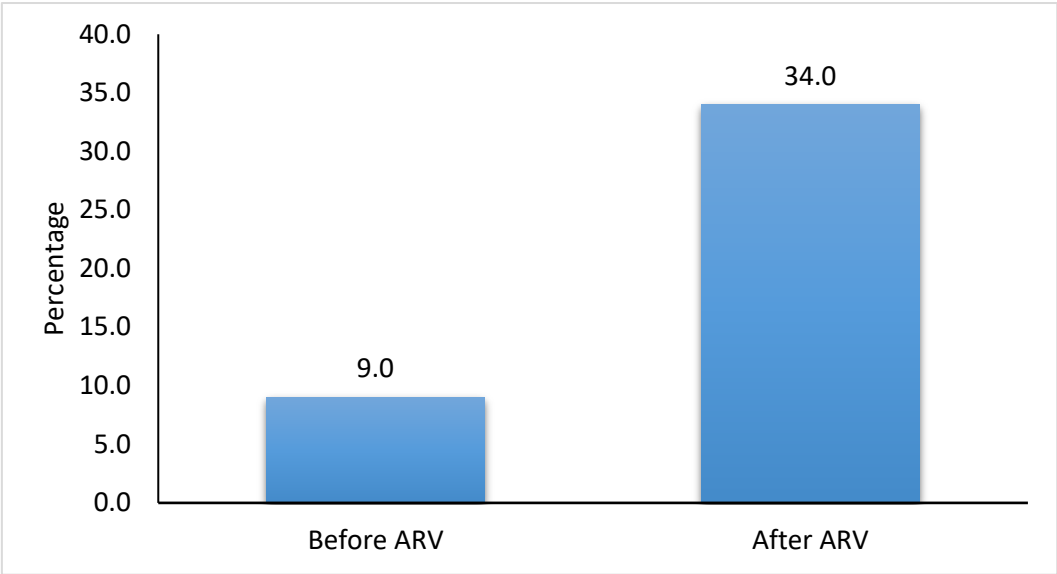

Figure 3. Distribution of participants with high blood pressure before and after the ARV treatment.

3.3. Risk factors associated with HIV and hypertension treatment outcome

3.3.1. Toxic behaviours

Smoking is chategorised as one of major risk factors for NCDs especially cardiovascular diseases whilst alcohol is also associated with diabesity. Table 2 presents the gender specific lifestyle data of the participants. Among the males, almost half (42.9%) were smoking tobbacco compared to 7% of females and it was statistically significant (p = 0.001) whilst 35.7% of males were consuming alcohol compared to 10.5% of females (p = 0.025). This data indicated that males were likely to engage in risky behaviours than females.

Table 2. Distribution of gender by tobacco usage and alcohol consumption.

Toxic habits		Male		Female		p-value
		№	%	№	%	
Tobacco	Smoker	6	42.9	6	7.0	0.001
	Never smoke	8	57.1	80	93.0	
Alcohol	Yes	5	35.7	9	10.5	0.025
	No	9	64.3	77	89.5	

3.3.2. Lifestyle behaviours

Overall, only a minority of the participants were smokers (12%) and used alcohol products (14%). The mean age of onset of smoking was 21.18 years (SD= 5.83) though a juvenile and adult onset were observed (min-max age at onset = 15-35 years) which is contrary to South African legislation on regulation of minimum age for smoking. The maximum frequency of smoking was twice a day (Table 3). However, in line with the South African legislation on use of alcohol, the data indicates that the youngest age at onset of using alcohol products was 18 years, and the oldest was 25 years.

Considered as mitigating factor, physical activity plays an important role in improving quality of life and delaying onset of several NCDs. The average number of days in a week doing heavy physical activity by participants was 2.04 days (SD 1.52) and 6.43 days (SD 0.82) for moderate physical activity. Half (50%) of the participants ate breakfast every day, 14% participants drank coffee and tea though 4% drank neither coffee nor tea. Half

of participants drank less than a litre of water per day which was considered significantly lower that what the food based dietary guidelines recommend. Only 3% of the participants were on a special diet whilst slightly more than half (53%) felt that losing weight was important.

Table 3. Habits of HIV patients with other chronic conditions.

Variables	Categories	Frequency (N=100)	Percent (%)
Tobacco smoking	Never smoke	88	88.0
	Smoker	12	12.0
Use alcohol products	No	86	86.0
	Yes	14	14.0
Sport activity	No	88	88.0
	Yes	12	12.0
Type of sports activity n=12	Jogging	5	41.7
	Soccer	5	41.7
	Netball	1	8.3
	Rugby	1	8.3
Eat breakfast every day	No	50	50.0
	Yes	50	50.0
Take coffee or tea	Never	4	4.0
	Once	82	82.0
	Both	14	14.0
Special diet	No	97	97.0
	Yes	3	3.0
Drink water	Less than 1l	50	50.0
	1l	25	25.0
	2l	22	22.0
	>2l	3	3.0
Losing weight is important	No	47	47.0
	Yes	53	53.0
		Mean ± SD	Min – Max
Age when started smoking (years), n=11		21.18±5.83	15-37
Frequency of smoking (per day)		1.82±0.41	1-2
Age when started using alcohol products		20.43±2.24	18-25
Heavy physical activity (days/week)		2.04±1.52	0-7
Moderate physical activity (days/week)		6.43±0.82	3-7

3.3.3. Food consumption

Food consumption habits were assessed from the participants in order to associate these with treatment outcomes. Table 4 indicates that all (100%) of the participants reported that they ate bread and non-bread starches as the basis of their meals more than three times in a week. Almost all (96%) the participants ate meat as a source of protein and coffee was a beverage of choice for 92% who consumed it more than three times a week. A high proportion (62%) also ate crisps, sweets and desserts more than three times a week. Contrary to the standard food based dietary guidelines, only 33%, 39% and 40% ate dairy products, vegetables and fruits more than three times in a week, respectively.

Table 4. Frequency of consumption of different foods types.

Type of food that the person eats/drinks	Once		Twice		Three times		More than 3 times		Never	
	№	%	№	%	№	%	№	%	№	%
Dairy foods	4	4.0	32	32.0	31	31.0	33	33.0	0	0.0
Vegetables	1	1.0	25	25.0	35	35.0	39	39.0	0	0.0
Fruits	2	2.0	23	23.0	35	35.0	40	40.0	0	0.0
Meat	0	0.0	1	1.0	3	3.0	96	96.0	0	0.0
Starch excluding bread	0	0.0	0	0.0	0	0.0	100	100.0	0	0.0
Bread	0	0.0	0	0.0	0	0.0	100	100.0	0	0.0
Eat outside home	24	24.0	27	27.0	6	6.0	40	40.0	3	3.0
Crisps, sweets, desserts	5	5.0	17	17.0	16	16.0	62	62.0	0	0.0
Drink coffee	2	2.0	1	1.00	1	1.00	92	92.00	4	4.00

4. Discussion

Literature records that patients initiated on ART are at risk of developing a range of NCDs, including hypertension. The current study was conducted to explore factors associated with treatment outcomes among patients living with HIV and hypertension comorbidities. The findings from the study reflect that out of the total number of participants, 86% were females, and the mean age of the study population was 39.76 years, which was consistent with the national demographic characteristics in South Africa, which indicate that there are generally more females than males and the majority of the population is youth [23]. A total of 41% and 47% of the respondents reported living in rural and peri-urban settings, respectively, while 57% and 30% had secondary education and tertiary academic achievement, respectively. Tertiary academic achievement is slightly lower than the national rate of 36%[23].

Treatment outcomes

This study discovered that ART improved outcomes, with patients having a lower-than-detected viral load increasing from 63% to 68% after starting ART. This records a positive treatment outcome owing to ART and a positive role played by ART in enhancing the quality of life of PLWHIV. In a multinational study conducted among patients initiated on ART between 2010 and 2014, viral load suppression increased from 45.1% to 90.2%[24]. Another multinational study of 46 countries also recorded improvements on viral load suppression from 58.2% to 61.1% [25]. Similarly, for the CD4 cell count, this study noted that there was a significant improvement in the number of patients with an improved CD4 cell count from 74% to 90%. Different studies have associated treatment outcome with the duration of treatment.

It is reported that patients on ART are susceptible to developing NCDs like hypertension. In the current study, a total of only nine percent of participants had hypertension before ART initiation. However, this number exponentiated to 34% post-ART initiation leading to the need to be placed on hypertension treatment and management programs. In a study conducted in Malawi, hypertension was diagnosed among 23.8% while 20.4% in Ethiopia among the population after treatment initiation [26,27] and 33% diagnosed in Zambia [28]. A higher rate of 44% was reported in a different population in Italy [29].

Risky behavioral factors

Whilst risks of developing hypertension and other NCDs post-ART initiation were higher, participants reported other behaviours that facilitated or exposed them to hypertension. Such toxic behaviours affected efficacy of treatment and interfered with adherence levels. Overall, smoking was reported by 12% and alcohol use by 14% of the participants. Of note, 42.9% of male population were smoking whilst alcohol use was reported by 35.7% of the male population. This finding was higher than smoking rate of 3.4% and 36.5% alcohol use reported in Malawi, and 25% alcohol use in Ethiopia [26,30]. A rate of 60.7% smoking was reported by participants with poor treatment adherence in the similar population [31]. In a population with different characteristics in United States, 30%

smoking and 50% non-hazardous alcohol consumption was reported while 44% smoking in Spain, 24.7% in Italy were reported [29,32,33], which was significantly higher than the current study.

Lifestyle factors

Physical activity is a recommended lifestyle factor generally important for improving blood circulation, weight regulation or loss, stress relief, delay of the onset of NCDs and a wide array of health benefits. Participants in this study (53%) felt weight loss was important and further reported participating on vigorous (12%) and moderate (50%) physical activity. This rate was lower than 68% physical activity reported in a Vietnamese study [34]. Findings in this study show significantly lower physical activity levels compared to Malawian study which reported 9.4% moderate and 90.6% vigorous physical activity among participants [26]. A rate of 29.2% vigorous physical activity was reported in Ethiopia [27], 24% moderate physical activity reported by Safeek and colleagues [35] and 35.6% vigorous physical activity in other South African study [36].

Dietary habits

Whilst breakfast is an important meal of the day and skipping it has a strong association with the development of NCDs [37], only half of participants reported taking breakfast and 3% were on special diets. Such a behaviour was reported by 33% in Ethiopia [38] but was comparable (50.8%) to Iranian study [39] and lower than 61.9% reported in Uganda [40]. Water health in numerous functions in a human's body including flushing toxins and normalizing blood pressure, and this value of drinking adequate quantities of water is widely known however the majority of the study population reported using less water than required. Making starchy food basis of your meal and eating meat almost daily are the important recommendations in the food based dietary guidelines and participants in the current study reported having complied to these. However, daily use of dairy products was poor. Similarly to this study population, 22.6% was reported in a Polish study [41] and 22.9% in Nepal [42]. Dairy products provide the body with essential protein and nutrient important for muscle development and they lower blood pressure [43]. These benefits are even more important for people on ART as they have increased risks of developing hypertension.

Consumption of fruit and vegetables helps with the general health of the body through their high constitution of antioxidants important for fighting free radicals in your body. Lower frequency in the consumption of fruits and vegetables was reported in the current study. This eating habit compromises the general health of this population but comparative to 38.7% reported in other study with similar characteristics [41], significantly lower than 78.9% in Nepal [42] and 65.8% in Ethiopia [44].

Coffee is a worldwide popular beverage enjoyed by many. Frequently consuming coffee is associated with elevation of blood pressure [45,46]. Frequent consumption of more than three time in a week was reported by the majority (92%) of the participants in this study. Coupling elevation of blood pressure with ART initiation increases chances of poor health outcomes among PLWHIV especially when other risk factors like alcohol consumption and smoking are also present [47]. A lower rate of 27.4% coffee use was reported in a population with different characteristics [48] and 42.1% reported in Nigeria [49].

Use of added sugar or sugary food exposes user to increase calorie intake which is a risk factor for obesity, dental carries and hypertension. Participants in this study reported use of sugar as part of their meals. A lower rate of 12.4% sugar intake was reported in Nigeria [50], 87.2% reported on patients who developed dental carries in Uganda [51].

Findings of this study showed pertinent factor that affect treatment outcomes, either negatively or positively, among patients living with HIV and on ART.

5. Conclusions

This study found a significant association between ART initiation and improvements in CD4 cell count and viral load suppression. Indeed, ART plays a significant role in improving the quality of life of patients living with HIV through strengthening CD4 cell counts and suppressing viral loads. However, this study confirms an association between ART initiation and the development of hypertension among HIV-positive patients. Risky behaviors and an unhealthy lifestyle undermined the value and contribution of ART in improving health and prolonging lives and exposed patients to the development of adversities like hypertension. To improve life expectancy, strong health promotion interventions for primary controls of hypertension risk factors in this population were required.

6. Patents

No patents.

References

1. Laxmi, V. Clarification of non communicable diseases their types and risk factor and some preventive action to reduce the chronic diseases. **2022**.

2. Kamtchum-Tatuene, J.; Tchuisseu-Kwangoua, L.A.; Moko-Tatuene, N.A.; Bigna, J.J.; Noubiap, J.J. Write With the Reviewers in Mind: Why You Got a Rejection and How to Avoid the Next. *Stroke* **2022**, STROKEAHA. 122.036142.

3. Zhou, B.; Carrillo-Larco, R.M.; Danaei, G.; Riley, L.M.; Paciorek, C.J.; Stevens, G.A.; Gregg, E.W.; Bennett, J.E.; Solomon, B.; Singleton, R.K.; et al. Worldwide trends in hypertension prevalence and progress in treatment and control from 1990 to 2019: a pooled analysis of 1201 population-representative studies with 104 million participants. *The Lancet* **2021**, *398*, 957-980, doi:https://doi.org/10.1016/S0140-6736(21)01330-1.

4. Doychinov, N. The Global Health Observatory Available online: https://www.who.int/data/gho/data/themes/hiv-aids (accessed on 5 September 2022).

5. Shamu, T.; Chimbetete, C.; Egger, M.; Mudzviti, T. Treatment outcomes in HIV infected patients older than 50 years attending an HIV clinic in Harare, Zimbabwe: A cohort study. *PloS one* **2021**, *16*, e0253000.

6.   Godongwana, M.; De Wet-Billings, N. Time to hypertension development among people living with HIV in South Africa: A longitudinal analysis of the National Income Dynamics Survey (NIDS). *Heliyon* **2021**, *7*, e07750, doi:https://doi.org/10.1016/j.heliyon.2021.e07750.

7.   Yendewa, G.A.; Lakoh, S.; Jiba, D.F.; Yendewa, S.A.; Barrie, U.; Deen, G.F.; Samai, M.; Jacobson, J.M.; Sahr, F.; Salata, R.A. Hepatitis B Virus and Tuberculosis Are Associated with Increased Noncommunicable Disease Risk among Treatment-Naïve People with HIV: Opportunities for Prevention, Early Detection and Management of Comorbidities in Sierra Leone. *Journal of Clinical Medicine* **2022**, *11*, 3466.

8.   Rodríguez-Arbolí, E.; Mwamelo, K.; Kalinjuma, A.V.; Furrer, H.; Hatz, C.; Tanner, M.; Battegay, M.; Letang, E.; Group, K.S. Incidence and risk factors for hypertension among HIV patients in rural Tanzania–A prospective cohort study. *PloS one* **2017**, *12*, e0172089.

9.   Chiwandire, N.; Zungu, N.; Mabaso, M.; Chasela, C. Trends, prevalence and factors associated with hypertension and diabetes among South African adults living with HIV, 2005–2017. *BMC public health* **2021**, *21*, 1-14.

10.   Ruzicka, D.J.; Kamakura, M.; Kuroishi, N.; Oshima, N.; Yamatani, M.; Yi, J.; Crawford, B.; Tsukada, K.; Oka, S. Characteristics of 2-drug regimen users living with HIV-1 in a real-world setting: A large-scale medical claim database analysis in Japan. *PloS one* **2022**, *17*, e0269779.

11.   McCann, N.C.; Horn, T.H.; Hyle, E.P.; Walensky, R.P. HIV antiretroviral therapy costs in the United States, 2012-2018. *JAMA internal medicine* **2020**, *180*, 601-603.

12.   Korencak, M.; Byrne, M.; Richter, E.; Schultz, B.T.; Juszczak, P.; Ake, J.A.; Ganesan, A.; Okulicz, J.F.; Robb, M.L.; de Los Reyes, B. Effect of HIV infection and antiretroviral therapy on immune cellular functions. *JCI insight* **2019**, *4*.

13.   Tshikuka, J.G.; Rankgoane-Pono, G.; Magafu, M.; Masupe, T.; Molefi, M.; Nsikungu-Kalukul, M.; Tlhakanelo, J.T.; Hamda, S.G.; Setlhare, V. Relationship between combination antiretroviral therapy regimens and diabetes mellitus-related comorbidities among HIV patients in Gaborone Botswana. *BMC Public Health* **2018**, *18*, 464, doi:10.1186/s12889-018-5232-0.

14.   Dlamini, S.B.; Dahms, H.-U.; Wu, M.-T. Factors associated with prognostic or treatment outcomes in HIV/AIDS patients with and without hypertension in Eswatini. *Scientific Reports* **2021**, *11*, 1-13.

15.   Brennan, A.T.; Jamieson, L.; Crowther, N.J.; Fox, M.P.; George, J.A.; Berry, K.M.; Stokes, A.; Maskew, M.; Sanne, I.; Long, L. Prevalence, incidence, predictors, treatment, and control of hypertension among HIV-positive adults on antiretroviral treatment in public sector treatment programs in South Africa. *PloS one* **2018**, *13*, e0204020.

16.   Rivera, J.G.M.; Hashmi, M.F. HIV Nephropathy. In *StatPearls [Internet]*; StatPearls Publishing: 2022.

17.   Bernard, O.; Bosco, O.; Bony, A.; Kiweewa, F.; Donggo, P.; Amone-P'Olak, K. The Burden of Non-Communicable Diseases among Hospitalized HIV Positive Patients at Lira Regional Referral Hospital, Northern Uganda: Retrospective Chart Review 2016-2020. **2022**.

18.   Mutagonda, R.F.; Siril, H.; Kaaya, S.; Amborose, T.; Haruna, T.; Mhalu, A.; Urassa, D.; Mtisi, E.; Moshiro, C.; Tarimo, E. Prevalence and determinants of non‐communicable diseases including depression among HIV patients on antiretroviral therapy in Dar es Salaam, Tanzania. *Tropical Medicine & International Health* **2022**.

19.   Moosa, A.; Gengiah, T.N.; Lewis, L.; Naidoo, K. Long-term adherence to antiretroviral therapy in a South African adult patient cohort: a retrospective study. *BMC Infectious Diseases* **2019**, *19*, 775, doi:10.1186/s12879-019-4410-8.

20.   Gausi, B.; Berkowitz, N.; Jacob, N.; Oni, T. Treatment outcomes among adults with HIV/non-communicable disease multimorbidity attending integrated care clubs in Cape Town, South Africa. *AIDS research and therapy* **2021**, *18*, 1-13.

21.   Manne-Goehler, J.; Montana, L.; Gómez-Olivé, F.X.; Rohr, J.; Harling, G.; Wagner, R.G.; Wade, A.; Kabudula, C.W.; Geldsetzer, P.; Kahn, K.; et al. The ART Advantage: Health Care Utilization for Diabetes and Hypertension in Rural South Africa. *J Acquir Immune Defic Syndr* **2017**, *75*, 561-567, doi:10.1097/qai.0000000000001445.

22.   Hirasen, K.; Fox, M.P.; Hendrickson, C.J.; Sineke, T.; Onoya, D. HIV treatment outcomes among patients initiated on antiretroviral therapy pre and post-universal test and treat guidelines in South Africa. *Therapeutics and clinical risk management* **2020**, *16*, 169.

23.   StatsSA. Community Survey 2016. **2018**.

24.   Jiamsakul, A.; Kariminia, A.; Althoff, K.N.; Cesar, C.; Cortes, C.P.; Davies, M.A.; Do, V.C.; Eley, B.; Gill, J.; Kumarasamy, N.; et al. HIV Viral Load Suppression in Adults and Children Receiving Antiretroviral Therapy-Results From the IeDEA Collaboration. *J Acquir Immune Defic Syndr* **2017**, *76*, 319-329, doi:10.1097/qai.0000000000001499.

25.   Brazier, E.; Tymejczyk, O.; Zaniewski, E.; Egger, M.; Wools-Kaloustian, K.; Yiannoutsos, C.T.; Jaquet, A.; Althoff, K.N.; Lee, J.S.; Caro-Vega, Y. Effects of national adoption of Treat-All guidelines on pre-ART CD4 testing and viral load monitoring after ART initiation: A regression discontinuity analysis. *Clinical infectious diseases* **2021**.

26.   Amberbir, A.; Banda, V.; Singano, V.; Matengeni, A.; Pfaff, C.; Ismail, Z.; Allain, T.J.; Chan, A.K.; Sodhi, S.K.; van Oosterhout, J.J. Effect of cardio-metabolic risk factors on all-cause mortality among HIV patients on antiretroviral therapy in Malawi: A prospective cohort study. *PLoS One* **2019**, *14*, e0210629.

27.   Ataro, Z.; Ashenafi, W.; Fayera, J.; Abdosh, T. Magnitude and associated factors of diabetes mellitus and hypertension among adult HIV-positive individuals receiving highly active antiretroviral therapy at Jugal Hospital, Harar, Ethiopia. *HIV AIDS (Auckl)* **2018**, *10*, 181-192, doi:10.2147/hiv.S176877.

28.   Kalaluka, K.P. Dietary patterns and the risk of metabolic syndrome among HIV positive individuals from selected health facilities in Lusaka district, Zambia. The University of Zambia, 2021.

29.   Adinolfi, L.E.; Petta, S.; Fracanzani, A.L.; Coppola, C.; Narciso, V.; Nevola, R.; Rinaldi, L.; Calvaruso, V.; Staiano, L.; Di Marco, V.; et al. Impact of hepatitis C virus clearance by direct-acting antiviral treatment on the incidence of major cardiovascular events: A prospective multicentre study. *Atherosclerosis* **2020**, *296*, 40-47, doi:https://doi.org/10.1016/j.atherosclerosis.2020.01.010.

30.   Asfaw, A.B.; Nigusie, A.; Shewanow, T.; Gudina, E.K.; Getnet, M.; Amdisa, D.; Lemma, T.B.; Dadi, L.S. Determinants of first-line antiretroviral treatment failure among patients on antiretroviral therapy in public hospitals Jimma, southwest Ethiopia a case-control study. *Rehabilitation* **2019**, *4*, 13-24.

31.   Adeniyi, O.V.; Ajayi, A.I.; Ter Goon, D.; Owolabi, E.O.; Eboh, A.; Lambert, J. Factors affecting adherence to antiretroviral therapy among pregnant women in the Eastern Cape, South Africa. *BMC infectious diseases* **2018**, *18*, 1-11.

32.   Crane, H.M.; Ruderman, S.A.; Whitney, B.M.; Nance, R.M.; Drumright, L.N.; Webel, A.R.; Willig, A.L.; Saag, M.S.; Christopoulos, K.; Greene, M.; et al. Associations between drug and alcohol use, smoking, and frailty among people with HIV across the United States in the current era of antiretroviral treatment. *Drug and Alcohol Dependence* **2022**, *240*, 109649, doi:https://doi.org/10.1016/j.drugalcdep.2022.109649.

33.   Fontela, C.; Castilla, J.; Juanbeltz, R.; Martínez-Baz, I.; Rivero, M.; O'Leary, A.; Larrea, N.; San Miguel, R. Comorbidities and cardiovascular risk factors in an aged cohort of HIV-infected patients on antiretroviral treatment in a Spanish hospital in 2016. *Postgraduate Medicine* **2018**, *130*, 317-324, doi:10.1080/00325481.2018.1446653.

34.   Dang, A.K.; Nguyen, L.H.; Nguyen, A.Q.; Tran, B.X.; Tran, T.T.; Latkin, C.A.; Zhang, M.W.; Ho, R.C. Physical activity among HIV-positive patients receiving antiretroviral therapy in Hanoi and Nam Dinh, Vietnam: a cross-sectional study. *BMJ open* **2018**, *8*, e020688.

35.   Safeek, R.H.; Hall, K.S.; Lobelo, F.; Del Rio, C.; Khoury, A.L.; Wong, T.; Morey, M.C.; McKellar, M.S. Low levels of physical activity among older persons living with HIV/AIDS are associated with poor physical function. *AIDS Research and Human Retroviruses* **2018**, *34*, 929-935.

36.   Bam, N.E.; Chitha, W.; Ntsaba, J.; Nomatshila, S.C.; Apalata, T.; Mabunda, S.A. Lifestyle determinants of diabetes mellitus amongst people living with HIV in the Eastern Cape province, South Africa. *African Journal of Primary Health Care & Family Medicine* **2022**, *14*, 7.

37.   Nomatshila, S.C.; Mabunda, S.A.; Puoane, T.; Apalata, T.R. Prevalence of Obesity and Associated Risk Factors among Children and Adolescents in the Eastern Cape Province. *International journal of environmental research and public health* **2022**, *19*, 2946.

38.   Weldegebreal, F.; Digaffe, T.; Mesfin, F.; Mitiku, H. Dietary diversity and associated factors among HIV positive adults attending antiretroviral therapy clinics at Hiwot Fana and Dilchora Hospitals, eastern Ethiopia. *HIV AIDS (Auckl)* **2018**, *10*, 63-72, doi:10.2147/hiv.S138638.

39.   Zareipour, M.; Movahed, E.; Sadeghi, R.; Sotoudeh, A.; Sadeghi, S.; Ameri, M. Evaluation of anthropometric indices, eating habits, and their relationship with CD4 level in individuals with HIV/AIDS. *HIV & AIDS Review. International Journal of HIV-Related Problems* **2020**, *19*, 237-243.

40.   Jennings Mayo-Wilson, L.; Devoto, B.; Coleman, J.; Mukasa, B.; Shelton, A.; MacCarthy, S.; Saya, U.; Chemusto, H.; Linnemayr, S. Habit formation in support of antiretroviral medication adherence in clinic-enrolled HIV-infected adults: a qualitative assessment using free-listing and unstructured interviewing in Kampala, Uganda. *AIDS Research and Therapy* **2020**, *17*, 30, doi:10.1186/s12981-020-00283-2.

41.   Duda, P.; Knysz, B.; Gąsiorowski, J.; Szetela, B.; Piotrowska, E.; Bronkowska, M. Assessment of dietary habits and lifestyle among people with HIV. *Advances in Clinical and Experimental Medicine* **2020**, *29*, 1459-1467.

42.   Khatri, S.; Amatya, A.; Shrestha, B. Nutritional status and the associated factors among people living with HIV: an evidence from cross-sectional survey in hospital based antiretroviral therapy site in Kathmandu, Nepal. *BMC Nutrition* **2020**, *6*, 22, doi:10.1186/s40795-020-00346-7.

43.   Thorning, T.K.; Raben, A.; Tholstrup, T.; Soedamah-Muthu, S.S.; Givens, I.; Astrup, A. Milk and dairy products: good or bad for human health? An assessment of the totality of scientific evidence. *Food & Nutrition Research* **2016**, *60*, 32527, doi:10.3402/fnr.v60.32527.

44.   Shiferaw, H.; Gebremedhin, S. Undernutrition Among HIV-Positive Adolescents on Antiretroviral Therapy in Southern Ethiopia. *Adolesc Health Med Ther* **2020**, *11*, 101-111, doi:10.2147/ahmt.S264311.

45.   Klag, M.J.; Wang, N.-Y.; Meoni, L.A.; Brancati, F.L.; Cooper, L.A.; Liang, K.-Y.; Young, J.H.; Ford, D.E. Coffee intake and risk of hypertension: the Johns Hopkins precursors study. *Archives of Internal Medicine* **2002**, *162*, 657-662.

46.   Rull, G.; Lobo, M.D. DRUG-INDUCED HYPERTENSION 56. *Manual of Hypertension of the European Society of Hypertension* **2019**, 455.

47.   Miranda, A.M.; Goulart, A.C.; Benseñor, I.M.; Lotufo, P.A.; Marchioni, D.M. Coffee consumption and risk of hypertension: A prospective analysis in the cohort study. *Clinical Nutrition* **2021**, *40*, 542-549, doi:https://doi.org/10.1016/j.clnu.2020.05.052.

48.   Yaya, I.; Marcellin, F.; Costa, M.; Morlat, P.; Protopopescu, C.; Pialoux, G.; Santos, M.E.; Wittkop, L.; Esterle, L.; Gervais, A. Impact of alcohol and coffee intake on the risk of advanced liver fibrosis: a longitudinal analysis in HIV-HCV coinfected patients (ANRS CO-13 HEPAVIH cohort). *Nutrients* **2018**, *10*, 705.

49.   Akwiwu, U.N. NUTRITIONAL INTAKE OF PEOPLE LIVING WITH HIV/AIDS (PLWHA) IN RURAL COMMUNITIES OF IMO STATE, NIGERIA.

50.   Gambo, A.; Gqaleni, N.; Babalola, T.K. Dietary diversity and impact of Moringa oleifera Lam. leaves supplemented – Diet on the nutritional status and CD4 cell counts of patients receiving antiretroviral therapy in Nigeria: A double - Blind randomized trial. *Heliyon* **2022**, *8*, e09524, doi:https://doi.org/10.1016/j.heliyon.2022.e09524.

51.   Kalanzi, D.; Mayanja-Kizza, H.; Nakanjako, D.; Mwesigwa, C.L.; Ssenyonga, R.; Amaechi, B.T. Prevalence and factors associated with dental caries in patients attending an HIV care clinic in Uganda: a cross sectional study. *BMC Oral Health* **2019**, *19*, 159, doi:10.1186/s12903-019-0847-9.