

Factors associated with hypertension among persons living with HIV in Mombasa County, Kenya

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ABSTRACT

Introduction: Hypertension has been reported to be on the rise among persons living with HIV (PLHIV) with a global and highest recorded Kenya prevalence of 35% and 18% respectively in 2021. Identification of context-specific hypertension-associated factors among PLHIV is needed to design targeted interventions. We sought to determine the factors associated with hypertension among PLHIV in Mombasa, Kenya. **Methods:** A cross-sectional study using a standardized questionnaire was conducted among adult PLHIV in the Comprehensive Care Clinics in Mombasa County, Kenya from December 2021 to February 2022. Hypertension was defined as having two or more blood pressure readings of $\geq 140/90$ mmHg. Prevalence ratio (P.R), and Adjusted Prevalence Ratio (A.P.R) were calculated to determine the associated factors of hypertension. **Results:** A total of 235 participants were enrolled with a mean age of 42.8 ± 10.7 years. About 71% (167/235) of the patients were female, and the age group 35–44 years was at 35%. The prevalence of hypertension among PLHIV was 25%. Factors identified to be independently associated with hypertension were having a body mass index (BMI) 25–29.9 (A.P.R: 2.41, 95%CI: 1.30–4.42), BMI ≥ 30 (A.P.R: 3.37 95% CI: 1.69–6.73) and use of tenofovir-based antiretroviral regimen (A.P.R: 0.32, 95%CI: 0.17–0.60). **Conclusion:** The prevalence of hypertension among PLHIV in Mombasa was higher than previous recorded findings. One of the key risk factors for hypertension was having an elevated BMI. Weight monitoring and management as well as tenofovir-based therapy are recommended among PLHIV to reduce their risk of developing hypertension.

KEYWORDS: COVID-19, factory, outbreak, monitoring of adherence, case study, Ghana

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Introduction

The survival rate of Persons Living with HIV (PLHIV) globally has improved due to the decreasing opportunistic infections following the availability of Antiretroviral Therapy (ART) [1,2]. This improvement in survival translates to increasing age among PLHIV which predisposes them to diseases related to aging especially non-communicable diseases (NCD) [3]. The commonest reported NCD among PLHIV is hypertension which also becomes a risk factor for other NCDs as well [1,4,5].

Hypertension is defined as persistently elevated blood pressure with a systolic reading greater than or equal to 140mm/Hg and/or diastolic blood pressure greater than or equal to 90mm/Hg [6,7]. Hypertension is one of the cardiovascular diseases with an estimated 1.28 billion people living with the disease globally [8]. The prevalence of hypertension in Sub-Saharan Africa is estimated to be at 25.9% [9]. This has been attributed to the rise in smoking, change in diet, and lifestyles that are risk factors for the disease [10].

Globally, an estimated 26% of the world's population suffers from hypertension [11,12]. Among PLHIV 23.6% to 35% on ART have been reported to have hypertension compared to HIV-negative individuals, and over 50% of PLHIV aged 50 years and older were also reported to have hypertension [13,14]. In Sub-Saharan Africa, the prevalence of hypertension among PLHIV has been estimated to be at 18% [15]. In central Kenya, a hypertension prevalence of 18.9% was reported among PLHIV [16].

Persons living with HIV have an increased risk of developing NCDs compared to their age-matched uninfected population [14]. This can be attributed to increased age-related degenerative changes and ongoing inflammation from the virus, progressive immune dysfunction from the attack of the CD4 cells, and cumulative exposure to drug-related toxicities from ARTs [4,17,18]. Endothelial dysfunction from the virus causes arterial damage and physiological changes such as glucocorticoid and insulin resistance which have all been linked to high blood pressure in these patients [19,20]. Longer duration of ART has also been associated with a higher probability of developing hypertension [20,21].

Age and sex have been reported to be associated with hypertension among PLHIV. Some studies report ages >45 years and females having a higher prevalence of hypertension [4,17,21]. Whilst other studies have reported males to have a higher prevalence of hypertension, some few others report no difference between the two sexes [13,16,22]. In addition, an increase in Body Mass Index (BMI), and hereditary hypertension have been associated with hypertension among PLHIV [3,23,24].

Different studies have also revealed the different effects that ART has on hypertension. A study in Zambia reports that the use of a dolutegravir-based regimen had a two times higher risk of hypertension as compared to previous regimens based on the non-nucleoside reverse transcriptase inhibitors such as nevirapine and efavirenz [15]. In Ethiopia, a previous study reports an almost three-fold higher risk of hypertension in patients who are on Zidovudine-based regimens compared to other regimens [22]. In contrast, in Uganda, a study revealed a lower rate of hypertension among PLHIV who are on second-line regimens with ritonavir and lopinavir compared to the patients on first-line-based regimens using Nevirapine [25].

In Mombasa County in Southeastern Kenya, the prevalence of HIV is reported to be 5.6% which is higher than the national average of 4.9% [26]. The county is also well known for indulging in high-risk behaviors such as tobacco use (24.1%), alcohol abuse (33.8%), and drug abuse which are risk factors for hypertension [22,23]. Thus, PLHIV in Mombasa County may have a higher risk of hypertension which may be sub-clinical and therefore undiagnosed. However, the few studies conducted on hypertension among PLHIV in Kenya have been in Central and Western Kenya.

There has been advocacy for integrating prevention and control of NCDs in PLHIV to provide holistic and comprehensive care at the Comprehensive Care Centres (CCCs) where PLHIV are currently treated [1,14,24,25]. This necessitates the identification of the disease burden and patterns to inform the development of context-specific and robust integrated implementation plans for the care of PLHIV.

Therefore, this study sought to determine the burden of hypertension and its associated factors among PLHIV in Mombasa County in Kenya.

Methods

Study design and setting: A cross-sectional study with a quantitative approach was conducted in three of Mombasa County's highest HIV volume Comprehensive Care Centers (CCC). The CCCs provided a holistic approach to HIV patients that included clinical care, psychological, socio-economical support, nutritional counseling, palliative care, and stress management.

Study participants: All stable HIV-positive patients registered with the clinics and aged 18 years and above, residents of Mombasa County, and accessing outpatient services from the clinics in these CCCs were engaged for the study.

Using a prevalence of hypertension of 18.9% among HIV patients in Kiambu County [10], a 5% desired level of precision and a z score of 1.96, a minimum sample size of 235 was calculated, using this formula is as follows [27]

$$n = \frac{Z^2 \cdot p \cdot q}{d^2}$$

Systematic random sampling was applied to identify the study participants. Data were collected over one month. The daily sampling interval in each facility was determined in three steps. First, the average number of patients per month in the facility was divided by 20 working days (equivalent to one month) to get the average daily number of patients. Second, the target number of participants to enroll daily was obtained by dividing the total participant allocation for the site by the number of days (20) of the study. Finally, the sampling interval was determined by dividing the average daily number of patients with the daily enrolment target in the facility.

A pre-designed paper-based questionnaire was utilized to collect data from the participants and used to obtain information on sociodemographic characteristics and clinical characteristics such as blood pressure, and risk factors associated with hypertension such as weight, and height. Data that the participants were not aware of such as viral load, CD4 count, treatment regimen, and WHO clinical stage of disease was further obtained from patient's medical files and entered into the questionnaire [27].

Measurements:

Clinical measurements of weight, height, and blood pressure were conducted for enrolled patients. Weight was measured by asking patients to offload any goods they were carrying, remove their shoes and stand on a *Seca* weighing scale. Height was measured after asking patients to remove their shoes, then stand up and the distance from their feet to the tip of their heads was measured in meters using a *Seca* stadiometer. Blood pressure was measured using the Omron sphygmomanometer. Each patient was asked to sit down for at least 15 minutes prior to blood pressure measurement. An appropriately sized cuff was put on the patient's arm at the level of the heart and then their blood pressure measurement taken.

Study Definitions

Hypertension was defined as a documented history of two or more blood pressure readings of ≥ 140 mmHg for a systolic reading and/or ≥ 90 mmHg for a diastolic reading within one year, OR any history of being on an antihypertensive, OR a repeat high blood pressure reading greater than or equal to 140/90mmHg that is taken during the time of the clinic visit, for a patient with only one high blood pressure reading previously [7].

Data Analysis

Data analysis was performed using Stata (Stata Corp). Frequencies and proportions were calculated for the categorical variables and measures of central tendency such as mean and measures of dispersion such as standard deviation and range were calculated for continuous variables.

The prevalence of hypertension was determined using proportions.

The participants without hypertension were compared to the participants with hypertension for univariable analysis to calculate the prevalence ratio of the assessed factors. The exposure variables that had a p-value of < 0.2 on univariable analysis were then subjected to multivariable poisson regression using the backward elimination method to calculate the adjusted prevalence ratio.

To assess multicollinearity, we determined the Variable Inflation Factor (VIF). A value of 5 or more suggested significant multicollinearity.

Participants BMI was categorized using the WHO classification of less than 18 kg/m^2 as underweight; 18 to 24.9 kg/m^2 as normal, 25 to 29.9 kg/m^2 as overweight, $\geq 30 \text{ kg/m}^2$ was classified as obese [28].

The level of significance for all analyses was set at p -value < 0.05 .

Ethical Considerations

The study was approved by the Institutional Research and Ethics Committee of Moi University (Approval number 0004013). Approval was also obtained from the National Commission for Science Technology and Innovation (NACOSTI) (Approval number NACOSTI/P/21/14403). Additional approval was obtained from the County Department of Health in Mombasa County and all Medical superintendents. Informed consent was obtained from eligible participants before enrolment into the study.

Results

A total of 235 participants were recruited. The majority, 167 (71.1%) of participants were females. The range of patient's age was from 20 to 76 years with a mean age of 42.8 ± 10.7 . The age group 35 – 44 contributed the largest proportion (35.3%, 83/235) of patients. Thirteen percent of the patients (30/235) had a history of being non-adherent to their ART regimens. The largest proportion of patients at 46.0% (108/235) had been on ART for more than 10 years and 86.4% (203/235) were still on the first-line regimens. About three-quarters, (77.0%, 181/235) of the participants had their most recent viral load reported as undetectable. The prevalence of hypertension among all the participants was 25.1% (59/235). The prevalence among males and females was 26.5% and 24.6% respectively. There was a higher prevalence of hypertension in older age groups and the highest prevalence was 36.4% among those aged greater than 55 years. Participants who were not on a Tenofovir-based regimen had the highest prevalence of hypertension at 50% (**Table 1**).

At bivariable analysis, the factors found to have a p -value less than 0.2 for consideration for multivariable analysis were between hypertension and age groups, hypertension and BMI, and between hypertension and tenofovir-based regimens, from the calculation of prevalence ratio between hypertension and the different variables (**Table 2**).

At multivariable analysis, two factors: BMI and ART regimen were found to be associated with hypertension among PLHIV (**Table 2**). A BMI

between 25 and 29 had a 2.40 (95% C.I: 1.30 – 4.42) higher prevalence ratio compared to those with a BMI less than 25 and a BMI of 30 plus had a 3.37 (95% C.I: 1.69 – 6.73) higher prevalence ratio compared to a BMI < 25 . Lastly, using a tenofovir-based regimen had a 0.32 (95% C.I: 0.17 – 0.60) lower prevalence ratio compared to those on other regimens.

Discussion

Majority of the participants were female, which is in keeping with other studies that show that females have a higher prevalence of HIV as compared to their male counterparts. In Kenya, the Kenya Population-based HIV Impact Assessment (KeNPHIA) report showed that the prevalence of HIV in women was 6.6% as compared to that in males at 3.1% [26]. The higher prevalence in women has been attributed to the biological differences between males and females.

About one-third of the participants were aged 35 – 44 years and contributed the largest proportion. Our findings are also in keeping with the KeNPHIA report. According to KeNPHIA the highest prevalence of HIV was among their study participants who were aged 40 – 44 years. In this age group, the HIV prevalence among females was 11.9%, and among males was 6.3% [26].

Our study reported the prevalence of hypertension among PLHIV in Mombasa County is high with 1 out of every 4 participants having hypertension. This study revealed a higher prevalence of hypertension in PLHIV than that reported in previous studies where the prevalence was between 14.5 to 18.9% [16,20]. The overall prevalence of hypertension in Kenya has been estimated to be at 24% in previous studies [29]. These findings suggest that the prevalence of hypertension among PLHIV in Mombasa is similar to the general population hypertension prevalence in Kenya. However, the findings suggest a higher prevalence of hypertension in the PLHIV in Mombasa as compared to other PLHIV in other localities such as Kiambu County [16]. This may be attributed to the higher obesity rates in urban settings such as Mombasa County compared to other rural settings [30].

In comparison to the global trends, our findings revealed that the prevalence of hypertension in

PLHIV was lower in Mombasa County [14]. This is also in keeping with other global meta-analysis studies that revealed a prevalence of hypertension among PLHIV at 25.2% in Malaysia and the USA [12].

Our study also revealed no statistically significant difference in the prevalence of hypertension between males and females for PLHIV in Mombasa County. This may be because the study incorporated a wide age spectrum of participants, thus the effects of a higher prevalence of hypertension among males in younger age groups is nullified by the higher increase in prevalence of hypertension among older women. This finding is similar to a global meta-analysis study that looked at studies from all over the world that revealed no difference in the prevalence of hypertension when comparing males and females [13]. This reveals that there are no differences in the prevalence of hypertension when comparing males and females even though the risk factors of these genders are different.

In contrast, among PLHIV other previous studies have shown a higher prevalence of hypertension among females as compared to males [4,17,21]. These studies have shown that women are more likely to be overweight and obese due to their increased sedentary lifestyles which then contribute to a higher prevalence of hypertension in females than males. Other studies revealed a higher prevalence of hypertension among males as compared to females [16,22]. The possible reason for men having a higher prevalence of hypertension compared to their female counterparts may be the increased stress encountered by men as they are more likely to be breadwinners in their homes and thus the survival of their families is dependent on them.

The prevalence of hypertension was also shown to increase with an increase in age with the age group over 55 years being the most affected. A similar study done in Uganda revealed that the prevalence of NCDs including hypertension was shown to be higher in older patients with patients aged 70 years and older having a prevalence of up to 50% [17]. Another study in Ethiopia also found that the risk of hypertension was almost three times higher in older patients as compared to younger patients [22]. This finding can also be attributed to the structural changes that occur as age increases. As patients

become older, their blood vessels become more rigid. The increased rigidity within the arteries increases the overall blood pressure [31].

A BMI equal to or greater than 25 was demonstrated to be associated with a two to three times higher prevalence of hypertension compared to participants with a BMI < 25. The prevalence ratio of hypertension was also noted to increase with an increase in BMI. These findings are similar to a study in Kenya that found that persons with a BMI over 25 have a 3 times greater risk of hypertension as compared to persons with a BMI less than 25 [29]. Similar studies in Ethiopia and Uganda also revealed a higher risk of hypertension among patients with a higher BMI [22,25]. These findings reveal the direct association of BMI with hypertension. They also show the compounding effect of BMI on hypertension and possibly other NCDs in that patients with a higher BMI in the obese category have a greater risk of hypertension compared to those whose BMI is still over 25 but in the overweight category.

In addition, PLHIV put on tenofovir-based regimen were found to have a lower risk of hypertension. A previous study in Nigeria found that the use of tenofovir-based regimens was associated with a lower risk of obesity [32]. Obesity and weight loss are factors that are known to be associated with hypertension [27]. The increase in weight is associated with a commensurate increase in blood pressure and weight loss through exercise or diet results in a decrease in blood pressure. The negative association between the tenofovir-based regimen and hypertension is likely because of the lower risk of obesity associated with the TDF regimen. A previous study also reported a lower rate of hypertension among persons who were on dolutegravir as opposed to nevirapine or efavirenz [15]. Most of the patients on Tenofovir-based regimens also had dolutegravir and thus this may have contributed to the lower prevalence of hypertension among these participants.

The public health implications of our findings that show a rising trend in hypertension among PLHIV is the need to have more NCD-focused treatment strategies in our HIV treatment centres. More research needs to be employed into the ART that is associated with a decreased risk in the development of hypertension and other NCDs. In addition, more stringent strategies need to be employed to screen for

NCDs among PLHIV and new innovative co-treatment strategies for HIV and NCDs need to be researched and employed.

Study Limitations

This cross-sectional study on hypertension among PLHIV poses some limitations. Firstly, the study was likely to recruit participants with good adherence to ART and those who are enrolled in HIV care thus there may be an underrepresentation of patients that are not enrolled in care and have poor adherence to ART. In addition, the review of medical records to verify and extract additional information on the participants may introduce information bias depending on how well the information was documented.

Conclusion

In conclusion, we found that one-quarter of PLHIV had hypertension. The prevalence of hypertension was higher in older age groups with about two-fifths of those aged 55 years and above having hypertension.

A BMI of 25 or greater was associated with a two to three-times higher prevalence, whereas the use of tenofovir-based regimens was associated with a 68% lower risk of developing hypertension.

Recommendations

We recommend that healthcare providers conduct routine screening for hypertension and other NCDs among PLHIV especially, in older age groups during clinic visits for early detection and management. There should be regular monitoring of the weight of PLHIV during clinic visits and those identified with a high BMI should be on a tenofovir-based regimen unless contra-indicated.

What is already known about the topic

- The increase in hypertension and other NCDs among PLHIV was already known.

What this study adds

- This study adds to the existing literature on hypertension and its associated factors among PLHIV.

- It also provides context-specific findings relevant to designing targeted interventions for PLHIV in East Africa.

Competing Interest

The authors declare that they have no competing interests.

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Authors' contributions

FNM conceptualized the study, FNM was involved in data acquisition, FNM, AA, EO, VG were involved in formal analysis, FNM, EO wrote the initial draft, FNM, SN, AA, MO, VG and EO made substantial contributions to the revision of the manuscript. All authors approved the final draft.

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Table 1: Prevalence of hypertension by Sociodemographic and Clinical Characteristics of PLHIV in Mombasa County, 2021–2022

Characteristic	Hypertension N = 235		Total
	Yes n (%)	No n (%)	
Overall	59 (25.1)	176 (74.9)	235
Sex			
Female	41 (24.6)	126 (75.4)	167
Male	18 (26.5)	50 (73.5)	68
Age group (years):			
18 – 34	8 (14.3)	48 (85.7)	56
35 – 44	19 (22.9)	64 (77.1)	83
45 – 54	20 (31.7)	43 (68.3)	63
>55	12 (36.4)	21 (63.6)	33
Income level (Ksh):			
< 15,000	41 (24.6)	126 (75.4)	167
15,000 – < 50,000	18 (29.5)	43 (70.5)	61
50,000 – < 100,000	0 (0.0)	4 (100.0)	4
>100,000	0 (0.0)	3 (100.0)	3
History of ART non-adherence:			
Yes	8 (26.7)	22 (73.3)	30
No	51 (24.9)	154 (75.1)	205
Duration of ART treatment:			
<5 years	14 (21.2)	52 (78.8)	66
5 – 10 years	11 (18.0)	50 (82.0)	61
>10 years	34 (31.5)	74 (68.5)	108
Type of regimen:			
First-line regimen	49 (24.1)	154 (75.9)	203

Table 1: Prevalence of hypertension by Sociodemographic and Clinical Characteristics of PLHIV in Mombasa County, 2021–2022

Characteristic	Hypertension N = 235		Total
	Yes n (%)	No n (%)	
2nd–line regimen	10 (31.3)	22 (68.7)	32
Most recent viral load:			
Detectable	10 (23.0)	44 (77.0)	54
Undetectable	49 (27.1)	132 (72.9)	181
ART Regimen:			
Tenofovir Based	45 (21.7)	162 (78.3)	207
Non-Tenofovir Based	14 (50.0)	14 (50.0)	28
BMI			
30 and above	16 (45.7)	19 (54.3)	35
25 – 29.9	23 (34.8)	43 (65.2)	66
<25	20 (17.5)	114 (82.5)	134
Family history of comorbidities:			
Yes	22 (22.5)	76 (77.5)	98
No	37 (27.0)	100 (73.0)	137
<p><i>*Tenofovir based regimens include: TDF/3TC/DTG, TDF/3TC/EFV, TDF/3TC/ATVr, and TDF/3TC/LPVr. Non–Tenofovir based regimens include: AZT/3TC/ATVr, ABC/3TC/ATVr, ABC/3TC/DTG, ABC/3TC/LPVr, ABC/3TC/EFV, AZT/3TC/NVP, TDF/3TC/LPVr.</i></p>			

Table 2: Factors associated with hypertension among PLHIV in Mombasa, 2021–2022				
Characteristic	Crude Prevalence Ratio (95% CI)	P-value	Adjusted Prevalence Ratio (95% CI)	P-value
Sex				
Female	ref		ref	
Male	0.93 (0.58 – 1.49)	0.758	1.49 (0.66 – 3.33)	0.334
Age				
18 – <45 years	ref		ref	
≥45 years	1.71 (1.10 – 2.67)	0.016*	1.77 (0.90 – 3.47)	0.097
Income				
≥15,000 Ksh	1.10 (0.67 – 1.74)	0.758	0.92 (0.62 – 1.36)	0.689
<15,000 Ksh	ref		ref	
BMI				
<25	ref		ref	
25 – 29	2.33 (1.39 – 3.93)	0.001*	2.40 (1.30 – 4.42)	0.005*
≥30 and above	3.06 (1.78 – 5.27)	<0.001*	3.37 (1.69 – 6.73)	0.001*
Treatment adherence				
Adherent	ref		ref	
Non-adherent	1.07 (0.57 – 2.03)	0.833	0.90 (0.33 – 2.47)	0.833
ART Regimen				
Non-Tenofovir Based	ref		ref	
Tenofovir based	0.28 (0.20 – 0.40)	<0.001*	0.32 (0.17 – 0.60)	<0.001*
Most recent viral load				
Undetectable	ref		ref	
Detectable	0.68 (0.37 – 1.26)	0.203	1.39 (0.58 – 3.32)	0.458