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Elevated blood pressure and correlates in a cohort of HIV-infected adults who started antiretroviral therapy when undernourished

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Prehypertension; hypertension; undernutrition; HIV; Tuberculosis

To the editor

Undernutrition is common among HIV patients starting antiretroviral therapy (ART) in Africa (1), but data on determinants of long-term health including hypertension among these patients are lacking. As part of a cross-sectional follow-up study to investigate predictors of dysglycaemia in HIV patients who were recruited in the Nutritional Support for African Patients Starting Antiretroviral Therapy (NUSTART) trial 2–3 earlier(2, 3), we determined prevalence and correlates of elevated blood pressure among patients who started ART when undernourished in Tanzania.

Data on demography, non-communicable diseases risk factors (smoking, alcohol drinking, physical activity, and vegetable and fruit intake), anthropometry, body composition, ART use history and adherence, tuberculosis (TB) treatment history since NUSTART enrolment, C-Reactive Protein, CD4 count, and pre-diabetes and diabetes were collected as described previously(3). TB and HIV treatment were confirmed with treatment cards or clinics. Blood pressure was assessed using a digital machine (Omron Healthcare, Binh Duong, Vietnam).

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Authors' contributions: GP, JT, SF conceived the study, GP, RP, SK, JC substantially contributed to data acquisition, GP analysed data with help from JT, SF, RP and wrote the first draft, all authors interpreted results, critically revised the manuscript, approved the final version and agree to take responsibility for the content of the manuscript.

Prehypertension was defined as systolic blood pressure of 120 to 139 mm Hg and/or diastolic blood pressure of 80 to 89 mm Hg whereas hypertension was defined as systolic blood pressure of ≥140 mmHg and/or diastolic blood pressure of ≥90 mmHg(4). Both prehypertension and hypertension were considered elevated blood pressure. The predictors of elevated blood pressure) were determined using logistic regression; age, sex and covariates with $P \leq 0.10$ in the univariate analysis were included in the multivariable models.

The background characteristics of 273 patients followed-up have been reported(3). Briefly, the mean age was 41.5(9.8) years and 178 (65.2%) were females; 11 (4%) were current smokers, 31 (11.4%) were current alcohol drinkers, 12 (4.2%) were either overweight or obese, and 77 (28.2%) had received TB treatment since NUSTART enrolment 2–3 years previously. Five (1.8 %) had hypertension and 51 (18.7%) had either prehypertension or hypertensionwhich is elevated blood pressure in excess of 120/80mmHg. In multivariable logistic regression, age (OR 1.05 (1.0, 1.1) increased the risk of elevated blood pressure, but receiving TB treatment reduced the risk (OR: 0.25 (0.1, 0.7) of elevated blood pressure (Table 1). Other covariates were not significant predictors.

In this analysis, we report a very high prevalence of elevated blood pressure. Although the prevalence of frank hypertension was low, the high prevalence of prehypertension (about 16.9%) is of concern, since similar to hypertension, prehypertension is associated with an increased risk of cardiovascular disease among the general population(5) and possibly among HIV-infected patients.

The lack of association with traditional modifiable risk factors for non-communicable diseases suggests that non-traditional risk factors, in addition to age, may be major contributors to the evolution of elevated blood pressure in this population. Although not receiving TB treatment could be one of those determinants, the mechanism underlying this association is difficult to explain. We suggest two possible explanations. First, those not on TB treatment could have latent or undiagnosed subclinical TB which could have compromised the integrity of blood vessels due cell-mediated immune response and chronic inflammation (6). The damaged vessels would probably increase their risk of elevated blood pressure. The existence of widespread latent or subclinical TB in the NUSTART population is likely, based on our previous observation that TB treatment was associated with decreased mortality in these patients (2). Second, mortality in this cohort, during NUSTART trial and 2–3 years follow-up, was high (approximately 40%; unpublished data). Given the many competing factors leading to death in this initially seriously ill population, it is possible that the association between being on TB treatment at the start of ART and elevated blood pressure after 2–3 years on ART is spurious.

Further research is needed to investigate TB and other potential determinants of elevated blood pressure to help control this condition among patients starting ART when malnourished.

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Table 1

Analysis of socio-demography, alcohol drinking, smoking, fruit and vegetable intake, physical activity, and body composition as predictors for pre-hypertension and hypertension at 2 to 3 years post-antiretroviral therapy initiation

	Patients with elevated blood pressure (n=51)	Patients without elevated blood pressure (n=222)	Crude Odds Ratio (95% CI)	*P-value*	Adjusted Odds Ratio (95% CI)[9]	*P-value*
	n (%) or mean (sd)	n (%) or mean (sd)				
Age at follow-up, *years*	45.0 (10.1)	40.6 (9.6)	1.05 (1.01–1.1)	0.005	1.05 (1.0, 1.1)	0.008
Sex						
Male	22 (23.2)	73 (76.8)	Reference	0.17	Reference	0.44
Female	29 (16.3)	149 (83.7)	0.65 (0.3, 1.2)		0.76 (0.4, 1.5)	
Socioeconomic status[1]						
Lowest	14 (24.1)	44 (75.9)	Reference	0.73		
Low	13 (20.3)	51 (79.7)	1.80 (0.3, 1.9)			
Middle	8 (15.1)	45 (84.9)	0.56 (0.2, 1.5)			
High	8 (16.7)	40 (83.3)	0.62 (0.2, 1.7)			
Highest	8 (16.0)	42 (84.0)	0.60 (0.2, 1.6)			
Alcohol drinking[2]						
Never	22 (20.4)	86 (79.6)	Reference	0.64		
Past	22 (16.5)	111 (83.5)	0.77 (0.4, 1.5)			
Current	7 (22.6)	24 (77.4)	0.27 (0.4, 2.9)			
Smoking status						
Never	36 (18.3)	161 (81.7)	Reference	0.95		
Past	13 (20.0)	52 (80.0)	0.12 (0.6, 2.3)			
Current	2 (18.2)	9 (81.8)	0.99 (0.2, 4.8)			
Fruits and vegetables intake per day						
1–2 servings	19 (23.5)	62 (76.5)	Reference	0.42		
3–4 servings	13 (16.5)	66 (83.5)	0.64 (0.3, 1.4)			
≥ 5 servings	19 (16.8)	94 (83.2)	0.66 (0.3, 1.3)			
Months on ART[3]	30.5 (5.5)	30.4 (4.9)	1.00 (09, 1.1)	0.86		
Current ART regimen[4]						
AZT+3TC+EFV	7 (17.1)	34 (82.9)	Reference	0.39		

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	Patients with elevated blood pressure (n=51)	Patients without elevated blood pressure (n=222)	Crude Odds Ratio (95% CI)	*P-value*	Adjusted Odds Ratio (95% CI)[9]	*P-value*
	n (%) or mean (sd)	n (%) or mean (sd)				
AZT+3TC+NVP	21 (25.0)	63 (75.0)	1.61 (0.6, 4.2)			
TDF+FTC+EFV	10 (14.3)	60 (85.7)	0.81 (0.3, 2.3)			
TDF+3TC+EFV	12 (18.5)	53 (81.5)	1.10 (0.4, 3.1)			
TB treatment since baseline						
Did not receive TB treatment	46 (23.5)	150 (76.5)	Reference	0.003	Reference	0.007
Received TB treatment	5 (6.5)	72 (93.5)	0.23 (0.1, 0.6)		0.25 (0.1, 0.7)	
CD4 count						
≥100 (cells/μL)	21 (15.2)	117 (84.8)	Reference			
<100 (cells/μL)	30 (22.2)	105 (77.8)	1.59 (0.9, 2.9)	0.14		
Baseline CRP tertiles[5]						
Lower	13 (14.9)	74 (85.1)	Reference	0.10	Reference	0.27
Middle	22 (25.3)	65 (74.7)	1.92 (0.9, 4.1)		1.95 (0.9, 4.4)	
Upper	12 (13.9)	74 (86.1)	0.92 (0.4, 2.1)		1.36 (0.5, 3.4)	
Follow-up CRP tertiles[6]						
Lower	19 (20.9)	72 (79.1)	Reference	0.73		
Middle	15 (16.5)	76 (83.5)	0.75 (0.4, 1.6)			
Upper	16 (17.8)	74 (82.2)	0.81 (0.4, 1.7)			
Pre-diabetes and diabetes						
No	36 (17.0)	176 (83.0)	Reference	0.18		
Yes	15 (24.6)	46 (75.4)	1.59 (0.8, 3.2)			
Baseline anthropometrics and body composition						
Waist circumference tertiles						
Lower	17 (17.4)	81 (82.6)	Reference	0.90		
Middle	16 (18.8)	69 (81.2)	1.10 (0.5, 2.3)			
Upper	18 (20.0)	72 (80.0)	1.19 (0.6, 2.5)			
Hip circumference tertiles						
Lower	19 (20.7)	73 (79.3)	References	0.84		
Middle	16 (17.8)	74 (82.2)	0.83 (0.4, 1.7)			

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	Patients with elevated blood pressure (n=51)	Patients without elevated blood pressure (n=222)	Crude Odds Ratio (95% CI)	*P-value*	Adjusted Odds Ratio (95% CI)[9]	*P-value*
	n (%) or mean (sd)	n (%) or mean (sd)				
Upper	16 (17.6)	75 (82.4)	0.82 (0.4, 1.7)			
Body mass index tertiles						
Lower	13 (14.3)	78 (85.7)	Reference	0.42		
Middle	19 (20.9)	72 (79.1)	1.58 (0.7, 3.4)			
Upper	19 (20.9)	72 (79.1)	1.58 (0.7, 3.4)			
fat mass index tertiles[7]						
Lower	14 (16.9)	69(83.1)	Reference	0.37		
Middle	19 (22.9)	64 (77.1)	1.46 (0.7, 3.2)			
Upper	12 (14.6)	70 (85.4)	0.84 (0.4, 2.0)			
Fat-free mass index tertiles[7]						
Lower	11 (13.3)	72 (86.7)	Reference	0.28		
Middle	19 (22.9)	64 (77.1)	1.94 (0.9, 4.4)			
Upper	15 (18.3)	67 (81.7)	1.47 (0.6, 3.4)			
Follow-up anthropometrics and body composition						
Waist circumference tertiles						
Lower	15 (16.1)	78 (83.9)	Reference	0.26		
Middle	22 (24.2)	69 (75.8)	1.65 (0.8, 3.4)			
Upper	14 (15.7)	75 (84.3)	0.97 (0.4, 2.1)			
Hip circumference tertiles						
Lower	18 (19.6)	74 (80.4)	Reference	0.89		
Middle	18 (19.4)	75 (80.6)	0.98 (0.5, 2.0)			
Upper	15 (17.0)	73 (83.0)	0.84 (0.4, 1.8)			
Body mass index tertiles						
Lower	17 (18.7)	74 (81.3)	Reference	0.93		
Middle	18 (19.8)	73 (80.2)	1.07 (0.5, 2.2)			
Upper	16 (17.6)	75 (82.4)	0.92 (0.4, 1.9)			
Fat mass index tertiles[8]						
Lower	17 (18.9)	73 (81.1)	Reference	0.32		

	Patients with elevated blood pressure (n=51)	Patients without elevated blood pressure (n=222)	Crude Odds Ratio (95% CI)	*P-value*	Adjusted Odds Ratio (95% CI)[9]	*P-value*
	n (%) or mean (sd)	n (%) or mean (sd)				
Middle	20 (22.2)	70 (77.8)	1.23 (0.6, 2.5)			
Upper	12 (13.5)	77 (86.5)	0.67 (0.3, 1.5)			
Fat-free mass index tertiles[8]						
Lower	16 (17.8)	74 (82.2)	Reference			
Middle	14 (15.6)	76 (84.4)	0.85 (0.4, 1.9)	0.60		
Upper	19 (21.4)	70 (78.6)	1.26 (0.6, 2.6)			

[1] Computed using principal component analysis as described earlier(2);

[2] Data for 1 patient in group without elevated blood pressure-group missing;

[3] Data for 2 patients in group with elevated blood pressure and 19 patients in group without elevated blood pressure group missing;

[4] Data for 1 patient in group with elevated blood pressure and 12 patients in group without elevated blood pressure missing;

[5] Data for 4 patients in group with elevated blood pressure and 9 patients in group without blood pressure missing;

[6] Data for 1 patient in group with elevated blood pressure missing;

[7] Data for 6 patients in group with elevated blood pressure and 19 patients in group without elevated blood pressure missing;

[8] Data for 2 patients in group with elevated blood pressure and 2 patients in group without elevated blood pressure missing;

[9] Adjusted for age, sex, TB treatment and baseline CRP. ART, antiretroviral therapy; AZT, Zidovudine; 3TC, Lamivudine; EFV, Efavirenz; NVP, Nevirapine; TDF, Tenofovir; FTC, Emtricitabine