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Body Composition and Anthropometric Indices Association with Blood Pressure Levels among Hypertensive Patients at a County Hospital in Kenya

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Abstract Hypertension is one of the leading cardiovascular diseases globally. The documentation on body composition, anthropometric indices and blood pressure level is limited, among Sub-Sahara Africa countries, despite the growing burden of non-communicable diseases. This study determined associations between body composition and anthropometric indices with blood pressure among hypertensive patients attending a referral hospital in Tharaka Nithi County, Kenya. A hospital based cross-sectional study was conducted among 234 adult hypertensive patients attending the hypertension clinic. A researcher administered questionnaire was used to collect data for six months. The body composition, waist circumference, weight and height were measured. A p value of less than 0.05 was considered significant. Most (88.0%) of the participants had increased risk of cardiovascular disease based on waist hip ratio of men: ≥0.90cm; women: ≥0.85cm. Nearly half (42.7%) of the participants had uncontrolled blood pressure (≥140/90 mm Hg). Further, 62.4% of the participants were overweight (BMI: 25.0-29.9), while 25.2% were obese. Blood pressure levels were significantly associated with BMI (X^2=26.6; p<0.001), body fat(X^2=10.8; p=0.028), waist hip ratio(X^2=8.2; p=0.004) and skeletal muscle (X^2=16.5; p<0.001). Skeletal muscle, BMI, waist circumference and visceral fat were significantly associated with higher odds of uncontrolled blood pressure. Body composition and anthropometric indices were associated with blood pressure levels among hypertensive patients.

Keywords: *hypertension, Tharaka-nithi county, body composition, anthropometric indices*

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1. Introduction

Hypertension or high blood pressure is a leading cause of cardiovascular disease worldwide [1]. It is also the global leading cause of morbidity and mortality [1,2]. High blood pressure has also been identified as the key driver of cardiovascular disease in Africa where it affects 20% - 40% of the population impeding economic development [3]. Improving the body composition and anthropometric indices such as the waist circumference and body weight are recommended to control hypertension and prevent progression to a more serious condition [10,27]. This highlights the urgent need to address the situation. Hypertension contributes to morbidity and mortality thus has socio-economic impacts at individual and societal level, as it affects health costs as well as the labour force. In resource-constrained settings such as Kenya, focused intervention is thus important.

A study conducted in Kenya on hypertension reported existence of poor nutrition indicators among hypertensives such as high BMI (28.3%), waist circumference (18.8%) and 54.4% with high waist to hip ratio [6]. A similar study conducted in Kenya reported 59% overweight and 23.9% obesity among hypertensive patients [7]. A study on non-communicable diseases reported increased risk of obesity related morbidity among 28% of men and 36% of women [8]. [6], reported association of high BMI, OR=2.13 (CI: 1.77, 2.58) with hypertension in Nairobi. High waist circumference, OR= 2.39 (CI: 1.57 - 3.64) has also been associated with high blood pressure in Kenya [9].

A study on cardiovascular disease reported high body fat among 31.1% of the participants [10]. Another study found the levels of high density lipoproteins among 50% of men were low (less than 1.03 Mmol/L) while 60% of women had low (less than 1.29Mmol/L) high density lipoproteins [8]. Body fat %, OR=1.48 (CI 0.63 to 3.51)) has been associated with higher likelihood of high blood pressure [10]. Strategies like weight reduction could alleviate hypertension and cardiovascular diseases in Kenya [11]. A recent study at Tharaka nithi county reported hypertension prevalence of 50% among participants [12]. There is need for context specific contributing factors to inform the Ministry of health on the

need to prioritize interventions aimed at preventing and improving blood pressure levels, Tharaka nithi county in eastern Kenya. It is against this background that the study on body composition, anthropometric indices and blood pressure levels in Tharaka nithi county was conducted among adult individuals aged ≥ 18 years.

2. Materials and Methods

2.1. Research Design, Period and Location

This was a hospital based cross-sectional study conducted from March to August at the hospital in eastern Kenya. The hospital serves as a main referral facility for Tharaka nithi county residents where the hypertension clinic offers services such as blood pressure monitoring and weight management to hypertensive patients [13].

2.2. Study Population

Patients with hypertension and have other medical conditions as determined in the medical records (secondary hypertension) attending the hypertension clinic at the county hospital were targeted. The inclusion criteria was; adult hypertensive patients; attending the clinic and voluntary willing to participate in the study. The study excluded hypertensive patients who were pregnant, diagnosed with protein energy malnutrition, had amputations and unilateral hemiparesis to ensure accuracy of bioelectric impedance analysis results [14].

2.3. Sampling Techniques and Sample Size

The county hospital was purposively selected since it is the county referral hospital hence representative of the study location. Simple random sampling was conducted to select participants using the hypertensive patients' clinic register as sampling frame [15,16]. The table of random numbers was used to select participants until a sample size of 234 was achieved from a population size of 600 as recommended by [17]. This is calculated based on a given population size at a standard error of 0.05.

2.4. Data Collection Instruments and Procedures

A pretested researcher-administered questionnaire was used to collect information on demographic characteristics. The body mass index (BMI) was calculated from measures of height obtained using a stadiometer (Seca-217) to the nearest 0.1cms, and weight measured to the nearest 0.1kgs, using a digital bathroom scale (Seca-Clara 803). A standard measuring tape was used to measure waist and hip circumference to the nearest 0.1cms. A digital blood pressure monitor equipment (OMRON-M6) was used to determine the blood pressure of the participants. Omron Bioelectric Impedance Analysis equipment (HBF-516B) was used for body composition of the participants. All data was collected at the hospital's hypertension consultation room.

Validity of the instruments was ensured by use of already validated tools such as the socio-demographic questionnaire developed by Kenya National Bureau of Statistics [18]. To ensure reliability, the test re-test method was used during a pretest that was conducted prior to the main study at the county hospital among patients with similar characteristics as the study participants. Data was collected twice during the pre-test on 24 participants at an interval of one week. A Pearson correlation coefficient of 0.72(CI: 0.65-0.78) was achieved between the two sets of data and was considered adequate [19,20]. The participants in the pretest did not participate in the main study.

2.5. Statistical Analyses

Quantitative data collected from this study was analysed using statistical package for social sciences version 23.0. Logistic regression and chi-square tests were performed to establish the association of body composition, anthropometric indices and blood pressure levels. A p value of less than 0.05 was considered significant. The waist to hip circumference ratio was used to define risk of metabolic complications (men: ≥0.90cm; women: ≥0.85cm). Blood pressure level defined hypertension (systolic blood pressure level: ≥140 mm Hg and or diastolic blood pressure level: ≥90 mm Hg). Obesity (BMI: ≥30) and overweight (BMI: 25.0-29.9) was defined by Body Mass Index. The normal body composition according to [21] classification on age and sex: body fat percent (female: 20-39 years: (21.0%-32.9%), 40-59 years: (23.0%-33.9%), 60-79 years: (24.0%-35.9%), male: 20-39 years: (8.0%-19.9%), 40-59 years: (11.0%-21.9%), 60-79 years: (13.0%-24.9%), skeletal muscle percent (female: 18-39 years: (24.3%-30.3%), 40-59 years: (24.1%-30.1%), 60-80 years: (23.9%-29.9%), male: 18-39 years: (33.3%-39.3%), 40-59 years: (33.1%-39.1%), 60-80 years: (32.9%-38.9%) and visceral fat: normal ≤9;high ≥10 was used.

2.6. Ethical Considerations

Ethical clearance was sought from Kenyatta university ethics and review committee. A research permit was sought from National Commission of Science, Technology and Innovation. The researcher sought permission from the County government of Tharaka Nithi and the study hospital administration. Written voluntary informed consent was also obtained from the participants. Confidentiality was ensured by use of codes instead of names and password protected files.

3. Results

3.1. Demographic Characteristics

The mean age of the participants was 52.51±11.08 years, with slightly more than a third, (38.5%) of the study participants being ages 41-50 years, while 26.1% were 51-60 years of age. There were more females (68.4%) than males. Majority (74.8%) were married while 100% were Christians. Higher proportion (56.0%) of participants were residing in Maara Sub-county (Table 1).

Table 1. Demographic characteristics

Characteristic	N=234	CI (95%)
	n	%
Age (completed years)		
20-30	7	3
31-40	20	8.5
41-50	90	38.5
51-60	61	26.1
61-70	49	20.9
>70	7	3.0
Sex		
Male	74	31.6
Female	160	68.4
Marital status		
Married	175	74.8
Unmarried/ Single	59	25.2
Religion		
Christian	234	100
Muslim	0	0
Place of residence		
Maara Sub-county	131	56.0
Chuka Igamba Ng'ombe	94	40.2
Tharaka South	6	2.6
Tharaka North	3	1.3

3.2. Economic Characteristics

Factor analysis was used to classify the group into three economic levels namely; Low (L), middle (M) and Upper (U). Most of the participants (60.7%) were from middle economic level, while 40.6% were on salaried employment. More than a third (38.9%) had completed college (Table 2)

Table 2. Economic characteristics

Characteristic	N=234	CI (95%)
	N	%
Education level		
Completed Primary	40	17.1
Completed Secondary	53	22.6
Completed College	91	38.9
Completed University	50	21.4
Occupation		
Employed (Salaried)	95	40.6
Farmer	69	29.5
Self-employed (business)	30	12.8
Unemployed	28	12.0
Casual labourer	12	5.1
Economic level		
Upper	19	8.1
Middle	142	60.7
Low	73	31.2

3.3. Anthropometric Indices

Based on BMI, the majority (62.4%) of the respondents were overweight while 25.2% were obese. Majority (88%) had increased risk for cardiovascular diseases based on waist to hip ratio. Overall, 84.6% of the participants had cardiovascular risk based on waist circumference (Table 3).

Table 3. Anthropometric indices among the study participants

Characteristic			N=234
	n	%	CI (95%)
Waist circumference			
Substantially high risk (Women >88cm)	121	51.7	42.8-60.6
Substantially high risk (Men>102cm)	4	1.7	-11.0-14.4
High risk (Women >80cm)	30	12.8	0.8-24.8
High risk(Men >94cm)	43	18.4	6.8-30.0
Cardiovascular risk	198	84.6	79.6-89.6
Normal(Women:≤80cm)	9	3.8	-8.7-16.3
Normal(Men:≤94cm)	27	11.6	-0.5-23.7
Total	234		
Waist hip ratio			
Reduced risk(men: <0.90cm,women:<0.85cm)	28	12.0	-0.0-24.0
Increased risk (men: ≥0.90cm; women: ≥0.85cm)	206	88.0	83.6-92.4
BMI			
Low(<18.5)	0	0.0	0.0-0.0
Normal (18.5-24.9)	29	12.4	0.4-24.4
Overweight (25.0-29.9)	146	62.4	54.5-70.3
Obese (≥30)	59	25.2	14.1-36.3

3.4. Body Composition

Most (40.2%) participants presented with low skeletal muscles, 85% with high visceral fat, while 77.8% presented with high body fat (Table 4).

Table 4. Body composition among the study participants

Characteristic			N=234
	n	%	CI (95%)
Skeletal Muscle			
High	61	26.0	15.0-37.0
Normal	79	33.8	23.4-44.2
Low	94	40.2	30.3-50.1
Body fat			
High	182	77.8	71.8-83.8
Normal	52	22.2	11.0-33.5
Low	0	0.0	0.0-0.0
Visceral fat			
High	199	85	80.0-90.0
Normal	35	15	10.9-59.1

3.5. Blood Pressure

Almost half (42.7%) of the respondents had uncontrolled blood pressure (≥140/90 mm Hg) with a mean systolic level of 137.1±19.4 mm Hg. Further, more females (36.8%) than males (20.5%) participants had controlled blood pressure. More than a third (39.3%) of the participants were in the high normal (130-139 mm Hg and or 85-89 mm Hg) category of hypertension.

However, 4.7% presented with grade three hypertension (Table 5).

Table 5. Blood pressure levels

Characteristic	N=234		
	n (%)	CI (95%)	Mean ±SD
Blood pressure Levels (mm Hg)			
Systolic level			137.1±19.4
Diastolic level			83.7±11.4
Blood pressure			
Controlled (Less than 140/90 mm Hg)	134 (57.3)	48.9-65.7	
High normal(130-139 mm Hg)	92 (39.3)	29.3-49.3	
Uncontrolled blood pressure			
(≥140/90 mm Hg)	100(42.7)	33.0-52.4	
Grade 3(≥180 and ≥110 mmHg)	11(4.7)	-7.8-17.2	
Controlled blood pressure by sex (≤140/90 mm Hg)			
Male	48(20.5)	9.08-31.9	
Female	86(36.8)	26.6-47.0	

3.6. Associations between Anthropometric, Body Composition Indices and Blood Pressure

Table 6. Anthropometric, body composition indices and blood pressure

Variable	X^2		
	Value	Df	P-value
BMI	21.7	1	<0.001*
Body fat	1.8	1	0.180
Waist hip ratio	8.2	1	0.004*
Skeletal muscle	16.5	2	<0.001*
Visceral fat	16.7	1	<0.001*
Waist circumference	21.3	1	<0.001*

A chi-square test was performed to identify anthropometric and body composition indices associated with blood pressure. The body mass index (X^2=21.7; p<0.001), Waist circumference(X^2=21.3; p<0.001), waist hip ratio (X^2=8.2; p<0.004), skeletal muscle (X^2=16.5; p<0.001) and visceral fat (X^2=16.5; p<0.001) were significantly associated with blood pressure levels among hypertensive study participants (Table 6).

The body indices that predicted blood pressure levels were BMI, skeletal muscle, visceral fat and waist circumference. High BMI (overweight and obese) participants were 13 times more likely to have uncontrolled blood pressure levels compared to those with normal BMI (OR=13.0; CI: 3.3-51.1; p<0.001). The participants with low skeletal muscle were 6 times (OR=5.7; CI: 1.8-18.0; p=0.003) more likely than those with high skeletal muscles to have uncontrolled blood pressure levels, and those with normal skeletal muscle were 13 times (OR=13.1; CI: 4.1 – 41.6; p<0.001) more likely to have uncontrolled blood pressure levels than those with high skeletal muscles. Those with high visceral fat were 12 times (OR=11.9; CI: 4.4 – 31.8; p<0.001) more likely to have uncontrolled blood pressure levels than those with normal visceral fat. The participants with high waist circumference had higher odds (OR=11.6; CI: 3.6 – 37.0; p<0.001) of uncontrolled blood pressure than those with normal waist circumference. (Table 7).

Table 7. Anthropometric, body composition indices and blood pressure

Variable							
	%	β	Wald	OR	CI (95%)		P
BMI (normal)				Ref (1)			
High	87.6	2.6	13.4	13.0	3.3	51.1	0.001*
Skeletal muscle (high)				Ref (1)			
Low	40.2	1.7	9.0	5.7	1.8	18.0	0.003*
Normal	33.8	2.6	19.1	13.1	4.1	41.6	0.001*
Body fat (Normal)				Ref (1)			
High	77.8	0.6	1.3	1.9	0.6	5.9	0.260
Waist to hip ratio (Normal)				Ref (1)			
High	88.0	0.5	0.7	1.6	0.5	4.6	0.396
Visceral fat (Normal)				Ref (1)			
High	85.0	2.5	24.2	11.9	4.4	31.8	0.001*
Waist circumferece (Normal)				Ref (1)			
High	84.6	2.5	17.2	11.6	3.6	37.0	0.001*
Constant		-3.6	24.6	0.0			0.001

4. Discussion

Global report emphasizes on reduction of overweight and obesity to control non communicable diseases. [1] recommends that ideal body should be (BMI ≥18.5 to <25) as a strategy to reduce 25% premature mortality by 2025. [13] Achievement of normal BMI is also recommended to manage uncontrolled blood pressure. According to a recent finding in Ethiopia by [22], 60.5% of the participants with hypertension were overweight. A study done in Nigeria reported overweight and obesity on majority (65.5%) of participant with hypertension [23].

A study on hypertension conducted by [7] at a district hospital in Kenya, reported similar results where most (82.1%.) participants were overweight and obese. Similar findings were determined in the current study finding where 87.6% of the respondents were overweight and obese. The findings is an indication that most hypertensive patients have not achieved the ideal body weight despite the condition.

According to [24], obesity in Sri Lanka is associated with higher likelihood of uncontrolled blood pressure. A recent study in Bangladeshi conducted by [25] also established higher likelihood of uncontrolled blood pressure level among overweight and obese individuals. Similarly, increasing weight in Malaysia has been shown as a predictor of uncontrolled blood pressure level [26]. Obesity has been associated with higher likelihood of uncontrolled blood pressure level among hypertensive patients in Ethiopia [22]. Obesity and overweight (BMI) among participants in the current study has been

associated with higher likelihood of uncontrolled blood pressure levels. Strategies to reduce the body weight should be prioritized as one component of care and management of patients.

Visceral fat has been more significantly associated with uncontrolled blood pressure compared to other types of body fat [27]. The metabolic activities in the visceral fat compartment may explain changes in the metabolic profile hence a strong contributor to uncontrolled blood pressure [28]. Hypertensives have been reported to have hypoadiponectinemia [29]. A study in Japan has significantly associated visceral fat with increased blood pressure [30]. Visceral fat has also been identified as an underlying cause of excess adiposity and development of uncontrolled blood pressure [31]. Decrease in visceral fat compared to other measures of obesity has been significantly associated with reduction of uncontrolled blood pressure among overweight and obese individuals [32]. A recent clinical trial established visceral adiposity index among other obesity indices significantly associated with left ventricular hypertrophy [33]. In the current study, visceral fat had significant association with blood pressure and a predictor of uncontrolled blood pressure. Visceral fat control may therefore play a role in reduction of uncontrolled blood pressure among overweight and obese hypertensive individuals.

A study significantly associated participants with low skeletal muscle percentage with higher likelihood of uncontrolled blood pressure [34]. Low muscle mass has been associated with arterial stiffness and increased risk of uncontrolled blood pressure [35]. Increase in skeletal muscle has been suggested to reduce blood pressure levels in obesity [36]. Further, hypertensive individuals with low muscle mass have a higher likelihood of uncontrolled blood pressure levels and metabolic complications [37]. The current study finding agree with the previous studies where skeletal muscle was associated with blood pressure and higher likelihood of uncontrolled blood pressure among hypertensives. Interventions targeting increased muscle mass would be beneficial in management of blood pressure.

Waist circumference has been highlighted as an identifier of hypertension risk and significantly associated with uncontrolled blood pressure [38,39], supported use of waist circumference to identify risk of uncontrolled blood pressure and obesity. The participants with high waist circumference are twice more likely to have uncontrolled blood pressure than those with normal waist circumference [40]. In the current study, waist circumference was significantly associated with blood pressure and a predictor of uncontrolled blood pressure levels. The use of waist circumference should be emphasized in management of uncontrolled blood pressure.

5. Conclusion

Overweight, obesity, skeletal muscles, waist circumference visceral fats are associated with blood pressure levels among hypertensive patients attending hypertension clinic at Tharaka nithi county referral hospital. The ministry of health both at national and county level should emphasize interventions focussing on weight management and increased muscle mass among hypertensives to control blood pressure.

Statement of Competing Interest

The authors declare that they have no competing interests.

List of Abbreviations

BMI-Body mass index
CI-Confidence interval
KNBS-Kenya national bureau of statistics
WHO-World health organization.

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