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Ngoye, Abel

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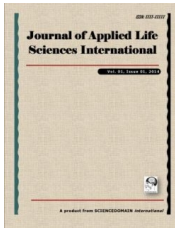
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Differences in Hypertension Risk Factors between Rural Maasai in Ngorongoro and Urban Maasai in Arusha Municipal: A Descriptive Study

Abel Ngoye¹, Pammla Petrucka^{2*} and Joram Buza¹

¹Nelson Mandela African Institution of Science and Technology, School of Life Sciences and Bioengineering, Tanzania.

²University of Saskatchewan, College of Nursing, Canada; Adjunct Nelson Mandela African Institution of Science and Technology, School of Life Sciences and Bioengineering, Tanzania.

Authors' contributions

This work was carried out in collaboration between all authors. Author AN as a graduate student, carried out the data collection, and data entry, as well as contributed to the manuscript. PP conceived of the overarching study including design and methods, plus co-supervised all stages of the study and its dissemination. JB participated in the study design, co-supervised all stages of the study and drafts of the manuscript. All authors have read and approved the final manuscript.

Original Research Article

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ABSTRACT

Background: Many ethnic groups within Tanzania are migrating from rural to urban areas in search of jobs and better livelihoods. One such group is the Maasai, whose distinct ethnicity and lifestyle potentially offers significant learnings in hypertension-related population health. This project investigated potential risk factors for hypertension in two Maasai settings with contrasting lifestyles: rural Ngorongoro Conservation Area and urban Arusha Municipal.

Methods: A cross-sectional descriptive study in three rural villages (i.e., Olbalba, Misigiyo, Alelilayi) and urban Arusha Municipal, sampling 724 individuals aged 18 to 75 years, (i.e., 335 males; 389 females). Quantitative measurements included blood pressure, body mass index (BMI), waist to hip ratio (WHR), total cholesterol, alcohol

*Corresponding author: E-mail: pammla.petrucka@usask.ca;

consumption, cigarette/tobacco use, and level of physical activity. Qualitative measurements included self-reports of lifestyle related risk factors such as distance walked, daily meal frequencies, alcohol and cigarette/tobacco use.

Results: Prevalence of hypertension in urban Maasai 27.7% (n=97) was significantly higher ($p<0.0001$) than for rural Maasai 10.9% (n=41). Systolic blood pressure in urban Maasai was significantly positively correlated with obesity parameters including BMI, weight, waist-circumference, hip circumference and WHR while distance walked was significantly ($p=0.004$) negatively associated. In urban Maasai, hypertension prevalence increased with age being highest at 60 years and above. Gender differences were apparent between 40-59 years where prevalence in urban males was significantly higher than females. Compared to rural counterparts, urban Maasai were significantly higher ($p<0.05$) for overweight, number of daily meals consumed, alcohol use, and less physical activity. No difference occurred across sites with respect to WHR and total cholesterol. For rural Maasai, systolic blood pressure was only significantly ($p<0.0033$) positively associated with BMI. In contrast to urban Maasai, prevalence of hypertension amongst rural Maasai decreased with increasing age and, furthermore, there were no gender differences across age.

Conclusions: The unique lower hypertension pattern for rural Maasai may reflect a number of emerging environmental and life style factors. Amongst rural Maasai, a distinctive pattern emerged of underweight, low WHR, lower meal consumption frequency, and more physical activities. Urban Maasai showed higher prevalence of hypertension and its risk factors compared to their rural counterparts. Findings emphasized the need for hypertension prevention lifestyle programmes including ongoing monitoring of blood pressure trends within the Maasai, especially within the context of urbanization.

Keywords: Hypertension; Maasai; Tanzania; Rural Health; Urbanization Health; Ngorongoro Conservation Area.

1. INTRODUCTION

Across the African continent, there is evidence of mass movements and relocation of people from rural to urban areas in search of better livelihoods[1]. In Tanzania, the urban population is rising at a rate of 4.2%, compared to 1.9% in the rural areas of Tanzania [2]. Numerous studies have reported higher rates of hypertension in urban than rural settings[3, 4]. Hypertension is an acute or chronic medical state in which the blood pressure is elevated to or above systolic BP 140 mmHg or diastolic BP 90 mmHg [5]. In a recent 4 African nation cross-sectional study, the age-adjusted prevalence in Tanzania was 23.7% compared with 19.3% in Nigeria, 21.4% in Kenya and 38% in Namibia[6]. It is projected that by 2020, three-quarters of all deaths in Africa may be attributable to this disease [7]. Generally, hypertension is associated with increasing age, low education, obesity, sedentary lifestyle, family history, smoking, alcohol use, and diet [6]. However, the change in lifestyle from the active rural to sedentary urban life is also contributory to an increased proportion of overweight and obese individuals, which further predisposes them to chronic and non-communicable diseases including hypertension [8].

Two linked cross-sectional population-based surveys in Dar as Salaam (Ilala) and a village in the rural area of Kilimanjaro (Shari) found no differences in prevalence of hypertension between rural and urban areas of Tanzania [9]. However, this study

involved individuals from different ethnic tribes, which may limit its interpretation and generalizability, as susceptibility to hypertension has been shown to depend on race and ethnic line [10]. Therefore it is important to study hypertension susceptibility with in different tribes in Tanzania. The susceptibility of Tanzania's Maasai to hypertension is not well established but presents a very intriguing investigation because of their distinct origin, as well as unique culture and lifestyle. Maasai are the only Nilo–Hamitic tribe in Tanzania, living a very active life involving cattle herding and surviving on a protein rich diet comprised of milk, meat, blood and low starch content [11]. This lifestyle may make them less prone to obesity and other environmental factors for hypertension. In fact, studies done in Kenya showed that the Maasai had the lowest prevalence of hypertension when compared to other ethnic groups, such as the Kamba and Luos [12]. In recent years, many Maasai have shifted to urban living due to socio-economic factors. The objective of this study was to compare the prevalence of hypertension between select Maasai living in Ngorongoro Conservation Area (NCA) (i.e., traditional settings) and those living in an urban settings (Arusha Municipal).

2. METHODS

2.1 Study Area

This study focused on three Maasai community villages in the NCA and Arusha Municipal. The NCA is administered by the Tanzanian Government with its boundaries matching those of the Administrative Ngorongoro Division of Ngorongoro District. As shown in Fig. 1 (below), it covers an area of 8,288 km² (3,200 square miles).



Fig. 1. The ngorongoro conservation area. source: http://tanzania.travel-culture.com/Ngorongoro_Crater_Tanzania.shtml [13]

2.2 Research Design and Target Population

This descriptive cross sectional quantitative study involved three (3) villages in NCA-Olbalba, Misigiyo, Alelilayi- plus Arusha Municipal as sampling locations. A total of 724 individuals aged 18 to 75 years, including 335 male and 389 female subjects were enrolled (See Table 1) in the study.

Table 1. Demographic characteristics of study participants by residence and sex

Site	Numberof participants	Sexof participants	Numberof participants
Urban	350	Female	157
		Male	193
Rural	374	Female	232
		Male	142

2.3 Sampling Criteria and Selection

In determining sample size, we estimated population of 30000 individuals in the three villages and 15000 individuals in Arusha Municipal which was informed by the local administrators and Pastoral Councils. We adopted a 95% confidence interval with 5% margin of error (E) and response distribution (r) of 50. Based on the following formula calculation we established a sample size of rural participants at 380 and urban participant at 375:

$$x = Z(c/100)2r(10101-2r)$$

$$n = N x / ((N-1) 2 + x)$$

$$113$$

$$E = \text{Sqrt}[(N - n)x/n(N-1)]$$

Convenience sampling was utilized which was appropriate at the level of a descriptive study. Rural participants were recruited at meetings held with the community leaders from the three communities to explain the purpose of the study. A similar approach was used to recruit participants in Arusha municipality as there are local groups and leaders who congregate. Enrolment of participants was done for those who volunteered to participate based on the following inclusion and exclusion criteria.

All participants were selected based on the following criteria:

1. Member of Maasai tribe (heredity not by marriage or other means)
2. Over age of 16 years
3. No previous diagnosis of hypertension
4. Able to respond (either verbally or in writing) to the study instrument
5. Willing to participate voluntarily
6. Able to give consent (either verbally or in writing)
7. Reside in one of the three Villages or Arusha Municipality continuously for at least 3 years (i.e., rural for 3 years OR urban for 3 years)

2.4 Data Collection

The demographic and questionnaire components were developed by the research team based on the literature on hypertension, risk factors, and trends. The questionnaire was not pilot tested but it was reviewed by a medical practitioner for face validity before implementation. All data was collected by trained individuals and all laboratory tests were processed at the Endulen Hospital in NCA and Nelson Mandela African Institute of Science and Technology (Arusha). The following description outlines each of the measurement strategies including instrumentation.

2.4.1 Blood pressure

Blood pressure was measured using an automated machine (Omron™ M4 from Omron Americas Division). Each participant was seated and blood pressure was measured on each participant's right arm using an appropriately sized automatic blood pressure cuff. Before measurements, each participant was allowed to be seated for five (5) minutes to rest. Two measurements were taken for each participant within an interval of two hours, to be methodologically congruent with previously described approaches². The average of the two measurements were used in analysis.

2.4.2 Height and weight

Height and Weight were measured using a stadiometer (Seca™ 217, USA) was used for height measurements in centimeters. Weight was measured in kilograms with the participants wearing light clothes but without shoes.

2.4.3 Waist circumference

Waist circumference was determined using a tape measure with measurements taken around the mid-axillary line at the midpoint between the lower costal margin and the iliac crest. The participants were requested to undertake a gentle expiration during measurement.

2.4.4 Cholesterol levels

Cholesterol levels were determined on fasting blood samples. Total cholesterol levels were measured using a BA-88A Semi-auto Chemistry Analyzer (Mindray Diagnostics™, Mindray Medical International Limited, China) with the reagent kit supplied by the manufacturer.

2.4.5 Self-reported risk factors

Self-reported risk factors were obtained through a verbal probing with each participant in the local language. Each participant was asked a series of open and close ended questions regarding known or potential risk factors for hypertension. Included in this open ended questioning were factors such as type and frequency of alcohol and tobacco, recall of dietary intake (i.e., staple foods, meal frequencies, plant/animal ratio, and salt), and physical activities capturing distance walked and intensity. The results were recorded and coded on an Excel™ spreadsheet for easier capture and interpretation.

2.5 Data Analysis

Data was, first entered, coded, cleaned and analyzed using GraphPad Prism™ Software Version 6 (Graphpad Software Inc, Ca, USA). Chi square test was used to compare prevalence, with Pearson's correlation and linear regression analysis used to determine the degree of linear dependence between select variables with $p < 0.05$ deemed as significant.

2.6 Ethical Approval and Consent

Ethical clearance to conduct research was obtained from the Tanzanian National Institute for Medical Research and the Tanzania Wildlife Research Institute. In the field, clearance was obtained from the Ngorongoro Conservation Area Authority. Written informed consent signed or dole gumba (oral consent) was obtained from all respondents before administering the questionnaire or taking measurements.

3. RESULTS

3.1 Prevalence of Hypertension

Differences in the prevalence of hypertension were observed between rural and urban Maasai communities. The prevalence of hypertension in urban residents (27.7%) was significantly higher ($p < 0.001$) than for rural (10.9%) residents (Fig. 2).

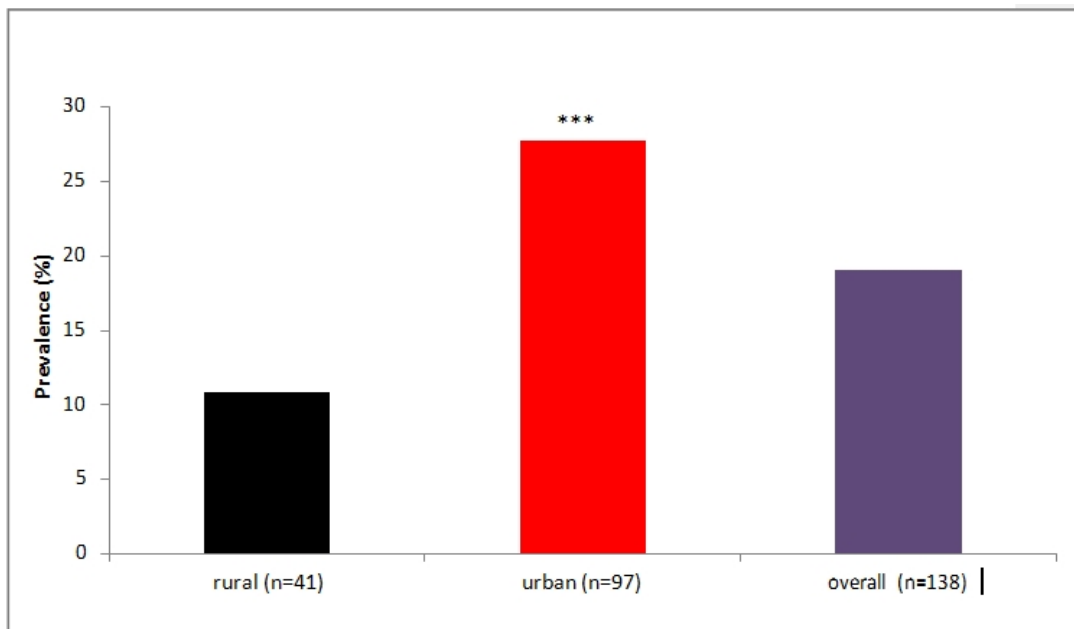


Fig. 2. Prevalence of hypertension in rural and urban Maasai (** $p < 0.001$, $N = 724$)

3.2 Correlates and Linear Regression Analysis of Systolic Blood Pressure

Systolic blood pressure in urban Maasai was positively ($p < 0.0001$) associated with diastolic blood pressure, age, waist circumference, weight, body mass index, waist to hip ratio, hip circumference and number of meals (Table 2A). Positive association with systolic blood pressure was also noted with fasting blood sugar ($p = 0.0002$) and annual income ($p = 0.0457$) while daily distance covered was negatively associated ($p = 0.004$). For rural Maasai, however, systolic blood pressure was only positively associated with diastolic blood pressure ($p < 0.001$) and BMI ($p = 0.033$) (Table 2B).

3.3 Prevalence of Hypertension Risk Factors in Urban and Rural Maasai Communities

Demographic factors

The prevalence of hypertension in rural and urban Maasai took contrasting directions with advancing age (Fig. 3). In the rural Maasai, the prevalence was seen decreasing with age; in urban Maasai prevalence was increasing with age. The prevalence of urban hypertension was significantly higher ($p < 0.0001$) from age 40 and above. There were also gender differences in urban hypertension prevalence between males and females. While the prevalence was equal at 0-39 and 60+ years, male prevalence was significantly ($p < 0.0001$) higher at 40-59 years.

Table 2A. Pearson correlation and linear regression analysis for urban systolic blood pressure

Risk factor	Pearson's correlation		Linear regression	
	Correlation coefficient (R)	P	R ²	Line equation
Diastolic blood pressure	0.8196	<0.0001	0.6717	$Y = 0.4123 * X + 30.57$
Age	0.5818	<0.0001	0.3385	$Y = 0.3664 * X - 8.129$
Waist circumference	0.3506	<0.0001	0.1229	$Y = 0.1520 * X + 61.92$
Weight	0.2867	<0.0001	0.0822	$Y = 0.1486 * X + 45.30$
Body mass index	0.2837	<0.0001	0.0805	$Y = 0.04573 * X + 15.35$
Waist to hip ratio	0.2628	<0.0001	0.0691	$Y = 0.0006743 * X + 0.7824$
Hip circumference	0.2122	<0.0001	0.0450	$Y = 0.09502 * X + 81.6$
Number of meals	0.2063	<0.0001	0.0426	$Y = 0.005289 * X + 1.929$
Distance walked	-0.1533	0.004	0.00016	$Y = -0.03141 * X + 8.338$

Table 2B. Pearson correlation and linear regression analysis for rural systolic blood pressure

Risk factor	Pearson's correlation		Linear regression	
	Correlation coefficient (R)	P	R ²	Line equation
Diastolic blood pressure	0.681	<0.0001	0.4637	$Y = 0.2672 * X + 44.70$
Body Mass Index	0.1103	P=0.033	0.0122	$Y = 0.0223 * X + 16.98$

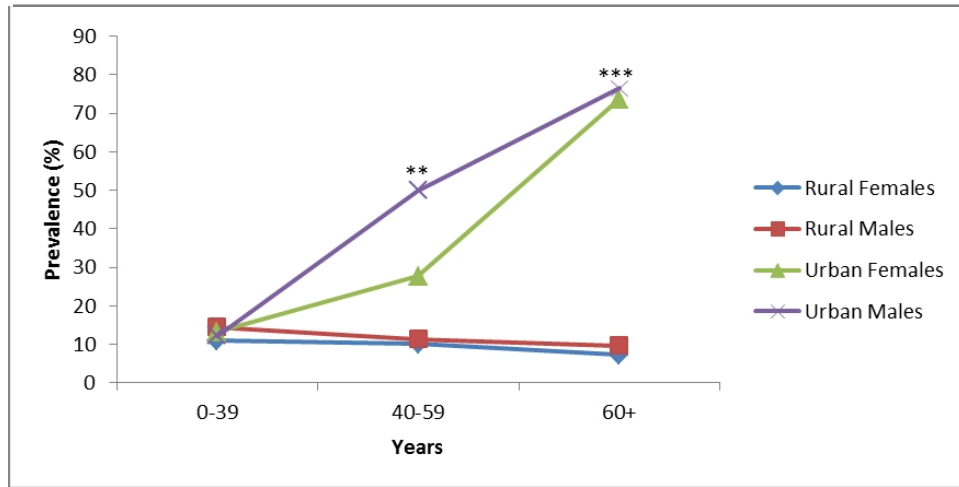


Fig. 3. Age and sex in relation to prevalence of hypertension in rural and urban Maasai. (p < 0.0001; ***p < 0.0001, n=724)**

3.4 Body Mass Index

The rural and urban Maasai displayed contrasting profiles for BMI. While the rural Maasai were predominantly underweight, their urban counterparts were ranged primarily in the categories of normal or overweight (Fig. 4). A significantly higher proportion of rural Maasai fell in the underweight category ($p < 0.0001$) while urban Maasai dominated the normal ($p < 0.001$) and overweight ($p < 0.0001$) categories.

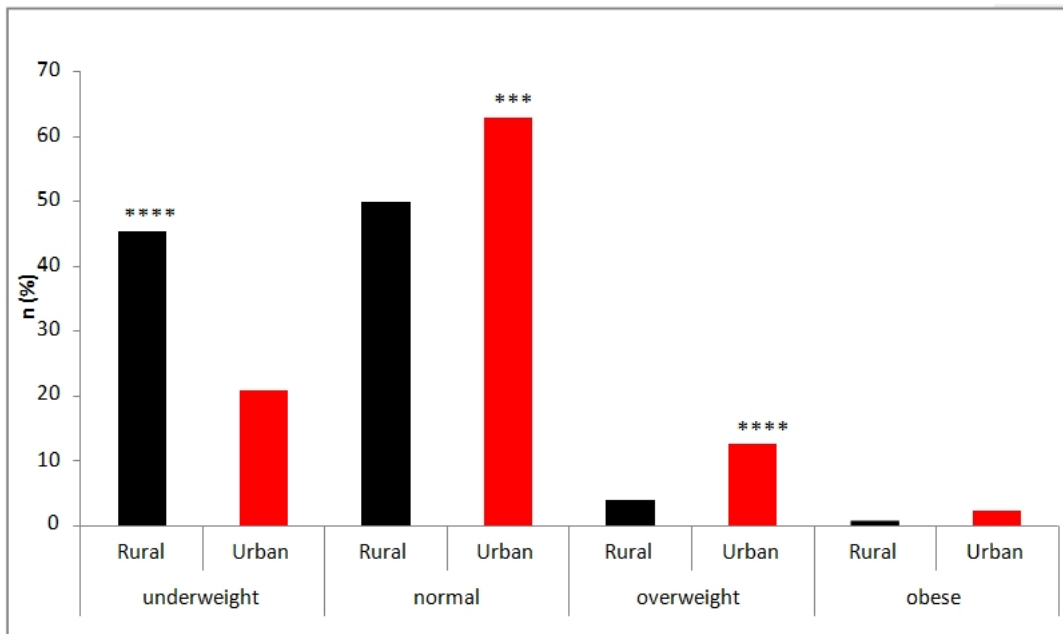


Fig. 4. Body mass index in rural and urban Maasai (**p < 0.0001; ***p < 0.002; n=724)**

3.5 Waist to Hip Ratio

The study findings showed no difference in WHR between the rural and urban Maasai. About 60-70% of the participants (both urban+ rural) fell within the normal WHR category and the rest fell within the high WHR category (Fig. 5).

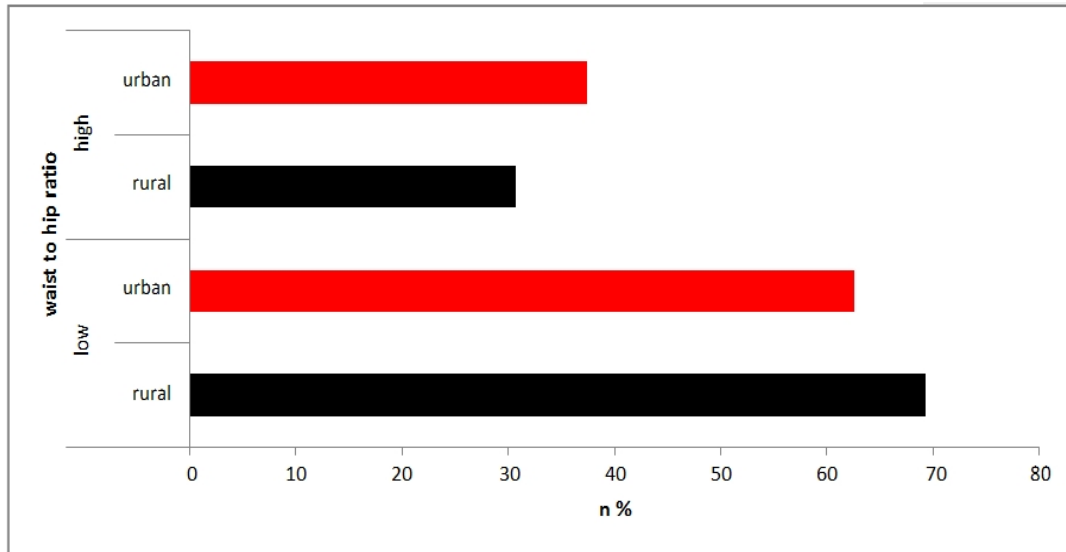


Fig. 5. Waist-to-hip ratio in rural and urban Maasai (n=724)

3.6 Physical Activity

The rural Maasai lifestyle demands more physical activity compared to the urban setting. While the urban Maasai predominantly covered less walking distance (1-5 kilometers [km]) ($p < 0.0001$), their rural counterparts predominantly covered 5 km and above ($p < 0.0001$) (Fig. 6). In qualitative reporting, the majority of rural participants stated high levels of activity for every day. This contrasted with the urban participants' reports of moderate to low activities two to three times per week.

3.7 Total Cholesterol

Only 10% of Maasai (rural and urban) had total cholesterol within the normal or high categories (Fig. 7). The majority (90%) of Maasai had total cholesterol falling within the low category. Total cholesterol levels were not found to be different between rural and urban Maasai.

3.8 Number of Meals Consumed Per Day

Differences in lifestyle were also noted in terms of the number of meals consumed per day. Significantly more ($p < 0.0001$) rural Maasai consumed less meals daily (1-2) in comparison with their urban counterparts who consumed more meals ($p < 0.0001$) (Fig. 8). In the qualitative recording of their diets, more urban dwellers reported consuming both plant and animal products when compared to the rural participants. Additionally, less than 10% of rural

respondents indicating consuming fruits and vegetables in comparison to over 70% of the urban respondents. Further, 'eating out' was virtually invisible in the report of rural Maasai, but was seen in about one-third of the urban Maasai interviewed.

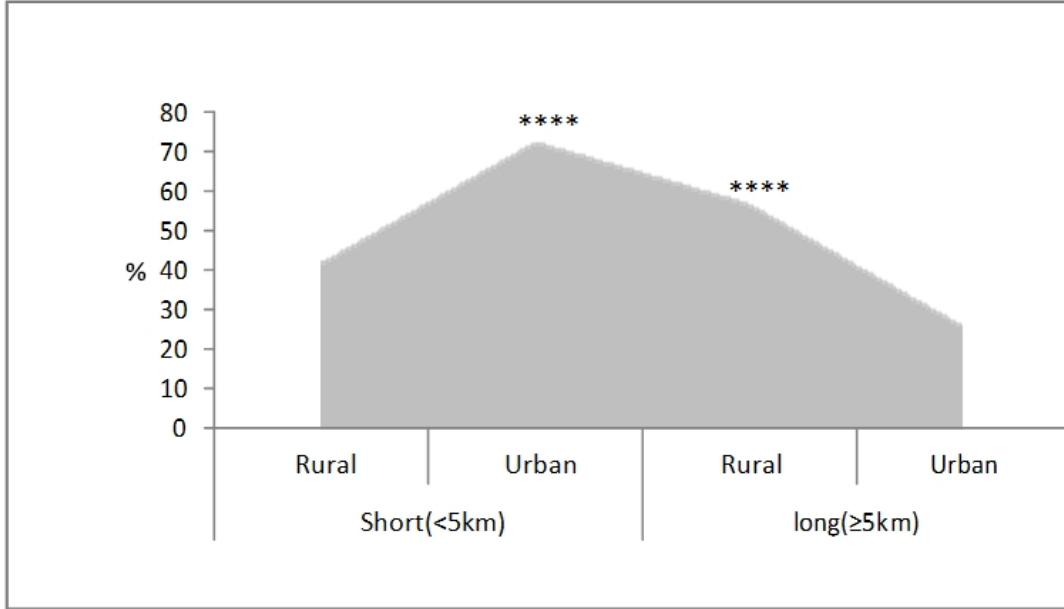


Fig. 6. Physical activity (as measured by daily walking distance) of rural and urban Maasai (**p < 0. 0001, n=724)**

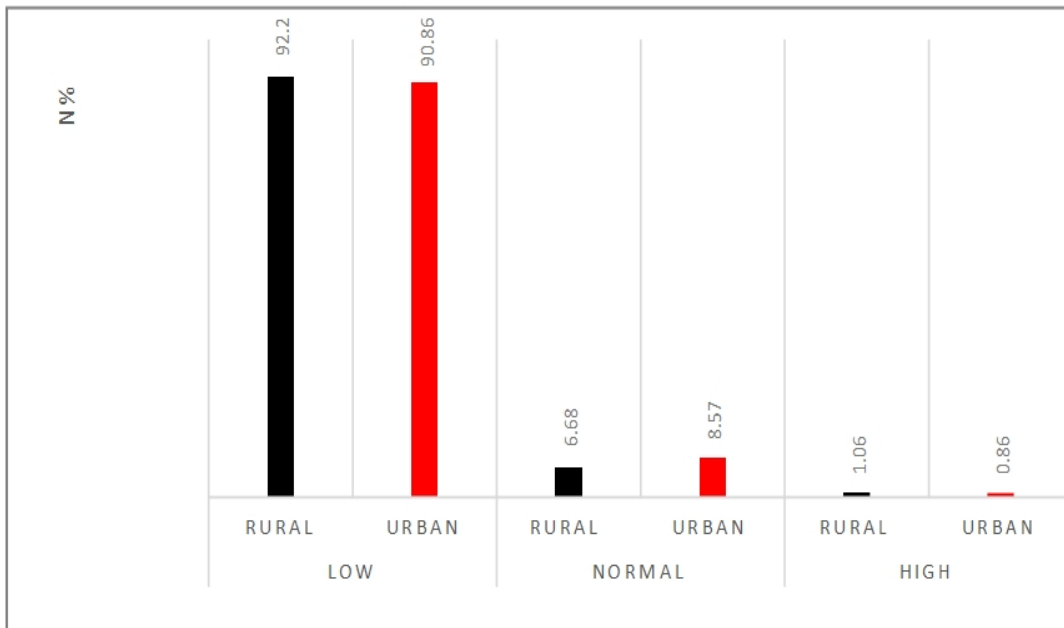


Fig. 7. Total cholesterol levels by geographic location

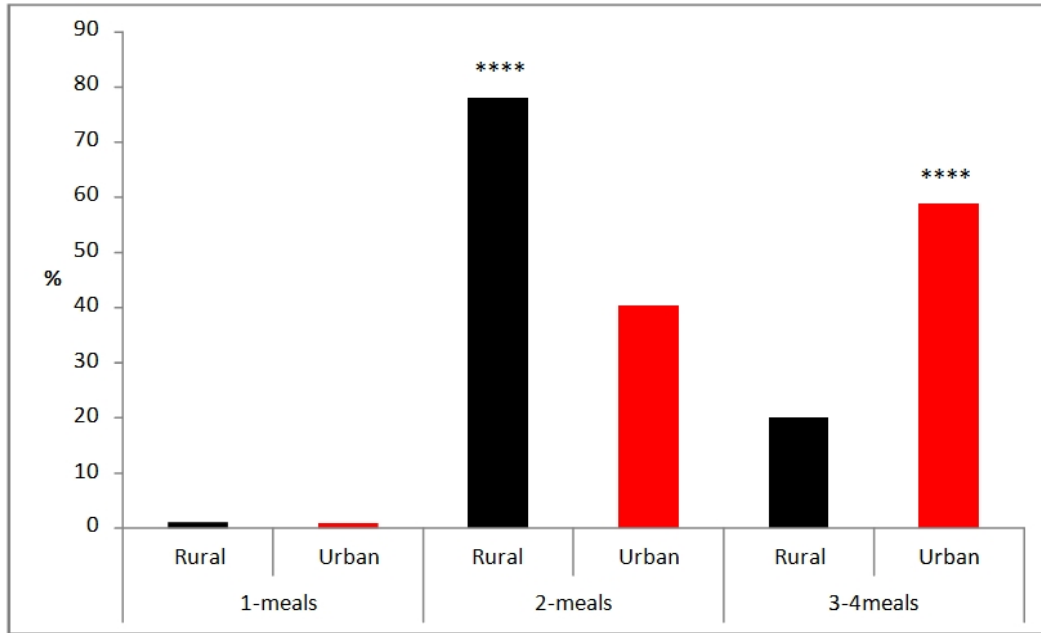


Fig. 8. Meals consumed daily by urban and rural Maasai (** $p < 0.0001$, $n = 724$)**

3.9 Alcohol Consumption, Tobacco and Salt Use

While alcohol consumption was significantly higher ($p < 0.001$) in urban Maasai, by contrast, tobacco use was more predominant ($p < 0.01$) in rural Maasai. Approximately 20% of urban participants reported consuming alcohol on regular basis in comparison to 11% of rural counterparts. Twenty-two percent of urban respondents reported using tobacco versus nearly 35% of the rural respondents. It is noted that in neither group was salt consumption found to be significant.

4. DISCUSSION

The aim of this study was to investigate differences in blood pressure and risk factors associated with hypertension among urban and rural Maasai ethnic group. Migration of Maasai into urban centers in Tanzania and other parts of East Africa began in early 1990s, being driven by the search for alternative livelihoods due to devastation of their livestock by diseases and shrinkage of pasture land for grazing their animals[14]. The migration from rural to urban areas is known to be associated with changes in type of food and physical activity which increases risks for non- communicable diseases such as hypertension[15].

In traditional rural settings, the Maasai diet is comprised mainly of high protein food (milk, meat, blood) [16]. Further this traditional diet is inclusive of fermented milk which contain saponins and phenolic additive from plants, known to have a protective effect for hypertension by lowering cholesterol levels in blood [17]. Upon moving to urban centers, Maasai migrants change their eating habits and start eating foods stuff typical of urban areas including ugali, rice, kande, chapati, beans and soft drinks (Papaye, H. personal communication, 2013). These changes not only included food selection, but changes in meal frequency and sources of food (i.e., eating out) amongst the urban Maasai.

There is also an increase in the urban participants in terms of their consumption of alcohol which is a known risk factor for hypertension. Further, tobacco use, another known contributor to hypertension, was found to be slightly higher amongst the rural participants than their urban counterparts. This study considered whether this change in life style has resulted in an altered pattern between rural and urban setting respecting susceptibility to hypertension.

Our study indicated higher prevalence of hypertension in urban than rural Maasai. This finding is consistent with similar studies on rural-urban differences in blood pressure and factors associated with blood pressure in Tanzania [15,18] and other developing countries[19]. Other authors[10] did not find differences in prevalence of hypertension between Dar-es-salaam residents (urban) and rural residents in Shari, Moshi; however, this may be due to the non-ethnic segregation of participants and/or the higher standard of living enjoyed by the rural (Shari) residents) than the current study participants.

Through the statistical analysis it was possible to reflect on the significance of specific variables related to lifestyle changes and other risk factors as influencing hypertension in rural and urban Maasai. For urban hypertension, significant positive correlates were age, obesity indicators (waist, weight, BMI, WHR, hip size), number of meals while physical activity (distance covered) was significantly negatively associated. Further, in this study, prevalence of hypertension within the urban Maasai participants increased with advancing age especially in middle age and older agegroups. This was more evident in urban males; where the findings showed increased age yielded increased risk of high blood pressure. This finding aligns with the natural physiological process in which blood vessels lose elasticity with advancing age potentially contributing to systolic hypertension after age 60 years [20]. These findings reinforce the work in a number of other studies [21,22]. However, in rural Maasai, prevalence of hypertension decreased with increasing age and was lowest at age 60 years and above. These results are consistent with a study done in rural community in South East Nigeria which found blood pressure tends to decrease after 50 years of age[23].

Overweight and obesity have been described as the major risk factors in non-communicable diseases including hypertension [24]. The relationship between hypertension and obesity is well established [25]. Obesity impacts on a number of hormones and hormonal patterns, particularly the renin-angiotensin-aldosterone system which is responsible for controlling blood volume along with the sympathetic nervous system [26]. The obesity-mediated interference in this process leads to hypertension [27]. From this study, overweight and obesity were more prevalent in urban compared to rural Maasai communities. Similarly, a study carried out among Luo, Kamba, and Maasai in rural and urban Kenya found high prevalence of overweight and obesity among urban Maasai and the urban population as compared to rural counterparts [12].

Based on understanding of African culture, increased income means there is disposable income which can increase the risk of hypertension in many ways. Individuals with higher income will tend to eat more meals, eat high calorie diets, drink more alcohol and undertake less physical activity because they can afford hired labor and also afford transport which reduces energy expenditure. In this study, the findings reflected in the number of meals consumed daily were positively correlated with hypertension while distance covered was negatively correlated with hypertension. All activities lower blood pressure and daily activity such as job related, sports, training, household, or other activities [28] produce larger blood pressure fall than when performed three times per week [29]. Activity contributes to the management of blood pressure in overweight as well as in lean individuals [30]. As we observed in Ngorongoro the job allocation was based in gender and age group

whereby women play important role in the community. Women's and youth roles include collecting firewood, drawing water short and long distance, taking care of children, building huts and milk cows. Through these activities they experience an extremely high energy expenditure. However, Maasai in urban settings were found to be less active and exposed to higher risk for hypertension [31].

For rural hypertension, only BMI was positively associated with diastolic hypertension. BMI was found to be a very significant risk indicator of obesity and risk factor for both rural and urban Maasai. In contrast to urban hypertension, age or sex did not correlate to rural hypertension. It was evident from the age/sex related changes in hypertension prevalence that hypertension tended to remain the same or decreased with advancing age. Marginal increases in hypertension with age were observed for the Hadzabe hunter gatherers tribes in their natural lifestyle [32]. These findings indicate that the impact of age or sex depends on the presence of other risk factors for hypertension and in the absence of which their expression is negated.

5. CONCLUSION

This study considered the hypertension pattern of a select group of Maasai peoples, the only Nilo-Hamitic tribe in Tanzania. Our interest was rooted in assessing the impacts of the rural to urban shift facing the Maasai in order to address pressing and persistent socio-economic factors. This took the study team to compare the prevalence of hypertension between select Maasai living in Ngorongoro Conservation Area (i.e., traditional settings) with those living in more urban settings (i.e., Arusha Municipal) – truly at the interface of rural and urban.

Results from this study demonstrate that hypertension is more prevalent in urban than rural Maasai participants. The magnitude and pattern of urban hypertension fits well with the well-established risk factors including obesity, and age. This means interventions to control urban hypertension in migrant Maasai should focus on reducing obesity by encouraging healthier lifestyle choices in terms of quality of food and physical activity. However, the rural hypertension in Maasai does not fit exactly with the well-known pattern with obesity as an important risk factor, the impact of age and sex is negated. The rural Maasai hypertension is therefore closer to the pattern reported for the other hunter gatherer ethnic groups which aligns with the pre-urbanization era.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

ACKNOWLEDGEMENTS

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