HABITUAL HEALTH ENHANCING PHYSICAL ACTIVITY IS RELATED TO LOWER LEVELS OF BODY ADIPOSITY AND BLOOD PRESSURE AMONG COMMUNITY DWELLING ADULTS IN MAIDUGURI, NIGERIA

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ABSTRACT

Background: Community-based promotion of physical activity for health and primary prevention of chronic non-communicable diseases are integral components of physiotherapy practice. This study examined the relationship between habitual health enhancing physical activity and cardiometabolic risk factors among community dwelling adults in Maiduguri, Nigeria. **Methodology:** A cross-sectional survey of 280 male and female adults (age=20–76 years) randomly selected from the State Low Cost Housing Estate in Maiduguri. Participants' physical activity was measured using the international physical activity questionnaire-short form. Health enhancing physical activity was defined as $\geq$ 150 minutes/week of moderate to vigorous physical activity (MVPA). Blood pressure, body weight, height, and waist and hip circumferences were measured following standardized procedures. **Results:** Most of the participants (85%) engaged in sufficient health enhancing MVPA. The prevalence of generalized **obesity (26.1%) and overweight (36.2%),** central obesity (68.6%), **and hypertension (**26.4%) was relatively high. Overall, there were significant negative associations between MVPA and BMI (β = -0.163, *P*= 0.005), and waist-to-hip ratio (β= -0.138, *P*= 0.023). Both BMI and waist-to-hip ratio accounted for about 5% (R^2=0.049) of the variance in MVPA. In gender specific analysis, only among women was MVPA significantly associated with lower BMI (β= -0.189, *P*= 0.046), and decreased systolic blood pressure (β= -0.241, *P*= 0.010) and diastolic blood pressure (β= -0.212, *P*= 0.026). **Conclusions:** Higher health enhancing MVPA was associated with lower levels of obesity and blood pressure among community dwelling adults (especially women). This evidence can be used to inform effective community physiotherapy practice and health promotion in Maiduguri.

Keywords: Physical inactivity, Exercise, Overweight, Obesity, Hypertension, Non-communicable diseases

INTRODUCTION

Habitual physical activity is any recreational or leisure-time physical activity, active transportation (e.g walking or cycling), occupational activities (i.e work or job), household chores, play or games that is performed in the context of daily, family and community activities.[1] This kind of physical activity and its structured form, exercise, are considered as effective as pharmacological interventions in preventing cardiovascular disease and reducing mortality in the general population.[2] Yet, between 23.3% and 31.1% of adults in the general population do not engage in sufficient levels of physical activity for health benefits worldwide.[3,4] Although there is no national data on the prevalence of physical activity in Nigeria[5], there is evidence that the prevalence of physical inactivity-related non-communicable diseases such as stroke, heart diseases, type-2 diabetes, cancers and chronic pulmonary diseases is on the increase in the country.[6,7] Recent estimate indicates that chronic non-communicable diseases account for about 24% of all deaths in Nigeria.[8,9] Thus, promoting physical

activity and controlling the risk factors of chronic diseases in the population should be considered as important public health priority in Nigeria.

The promotion and maintenance of physical activity for health and primary prevention of chronic diseases are integral components of physiotherapy practice.[10–12] Due to their strong training focus and experience on physical activity as well as exercise prescription and administration in health and disease, physiotherapists are best prepared and ideally placed to use physical activity as an effective non-invasive modality to improve individual and population health and wellbeing at the community level.[13–15] However, for effective community physiotherapy practice and health promotion in Nigeria, local specific evidence is needed to understand the influence of physical activity on cardiometabolic risk factors of non-communicable diseases. The majority of studies investigating the relationship of habitual health enhancing physical activity with cardiometabolic risk factors were conducted in western developed countries.[16–22]

In Nigeria, a previous study found that lack of physical activity was associated with higher levels of cardiometabolic risk factors such as body weight, body mass index (BMI), waist-to-hip ratio (WHR), blood pressure, insulin, total cholesterol and triglycerides among male civil servants in Benin City.[23] Also, prevalence of low physical activity was found to be related to adverse cardiometabolic markers including higher BMI, waist circumference, heart rate and systolic blood pressure among office workers in Maiduguri.[24] Similarly, Oladimeji et al found physical inactivity as the most prevalent behavioural factor associated with hypertension and overweight/obesity among civil servants in Kaduna.[25] However, these available studies in Nigeria were conducted mainly among government employees and produced a sample of relatively high socioeconomic status (higher educational and income levels).[23–25] Thus, findings from these few studies may not be generalized to other Nigerian samples, especially those who are unemployed or engaged in other jobs outside of government.

Beyond the previously conducted office-based studies in Nigeria, community-based studies have the potential to reach the most vulnerable population subgroups and identify the needs to address the complex nexus between social disparity and health inequalities among population at the community level. Moreover, in order to inform evidence-based community physiotherapy practice and effective context specific health promotion interventions in Maiduguri, it is important to understand the relationship between physical activity and cardiometabolic risk factors of chronic non-communicable diseases among the population at the community level. This kind of evidence can contribute to effective and broader public health actions against the ongoing epidemic of lifestyle related non-communicable diseases in Nigeria.[6-9] Therefore, the purpose of this study was to evaluate the relationship between health enhancing physical activity (moderate to vigorous physical activity) and cardiometabolic risk factors (e.g., BMI, WHR, waist circumference and blood pressure) among community dwelling adults at the state low cost housing estate in Maiduguri.

MATERIALS AND METHOD

Study design and participants: This study utilized a cross-sectional research design approach to answer the research questions. Participants were invited into the study if they met the inclusion criteria of: (1) Being apparently healthy adults, aged 20 years and above; (2) Residing at the State Low Cost Housing Estate in Maiduguri; and (3) Willing to participate in the study. Using the method described by Lwanga and Lemeshow,[26] the minimum necessary representative sample size was calculated to be 246 participants, with a statistical precision of at least 0.05 to estimate the risk factor prevalence of 20% at a 95% confidence level. The participants were recruited from various households utilizing multi-stage (3 stages) random sampling technique. In the first stage, fifty streets were randomly selected from available 80 streets at the State Low Cost Housing Estate in Maiduguri. In stage 2, three blocks were randomly selected in each of the 50 listed streets. In stage 3, all odd numbered houses from the randomly selected 150 blocks were chosen for participants' recruitment. From each of the selected houses, one male and female adults

who met the inclusion criteria were enrolled in the study. Data collection and all measurements were completed at the participants' home. All participants provided signed informed consent and the study was approved by the Ethics Committee of the University of Maiduguri Teaching Hospital.

Physical activity assessment: The seven-item international physical activity questionnaire- short form (IPAQ-SF) was used to assess the physical activity levels of the participants. The questionnaire estimated vigorous- and moderate- intensity activities across the domains of leisure, occupation (work), household (domestic), and active transportation (i.e., walking and bicycling) in terms of frequency (days/week) and duration (minutes/day) in the last 7 days. These activity categories (moderate and vigorous) were treated separately by computing the total minutes of each category in a week.[27] Total minute of moderate-to vigorous physical activity (MVPA) was the primary physical activity outcome in this study, and was computed by summing the minutes of time per week of moderate- and vigorous-intensity activities. Meeting recommendation on health enhancing physical activity was defined, according to the World Health Organization (WHO) guidelines, as accumulating at least 150 minutes of MVPA per week.[1] The IPAQ-SF has been widely used in Nigeria and its test-retest reliability (ICC = 0.33- 0.73) and concurrent validity (ρ =0.78- 0.92) among adults are good and acceptable.[28]

Anthropometric measurement: All measurements were taken with participants bare footed and wearing light clothing. Height was measured to the nearest 0.1 centimeter (cm) using a stadiometer in an upright position with the head in Frankfort plane. Body weight was measured to the nearest 0.1 kilogram (kg) on a bathroom weighing scale (HANA, China). Body mass index (BMI) was calculated as body weight divided by the square of height (kg/m^2), and participants were categorized as underweight (<18.5 kg/m^2), normal weight (18.5-24.9 kg/m^2), overweight (25.0- 29.9 kg/m^2) and obese ($\geq$ 30.0 kg/m^2) according to the WHO guidelines.[29] Waist circumference to the nearest 0.5 centimeter (cm) was measured with inelastic tape (Butterfly, China) midway between the lowest rib and iliac crest, in a standing position.[30] The criterion for defining central/abdominal obesity was based on the international consensus cut-points of waist circumference of $\geq$ 94cm and $\geq$ 80cm for African men and women, respectively.[30,31] Hip circumference measurement was standardized by placing the inelastic tape (Butterfly, China) at the widest portion of the buttocks, in standing position.[30] Waist-hip ratio was calculated as waist circumference divided by hip circumference. Central/abdominal obesity was defined as waist–to-hip ratio above 0.90 for men and above 0.85 for women.[30]

Blood pressure measurement: Resting blood pressure was measured with Dinamap (model 8100/8101) digital blood pressure measuring device, after the participants have been seated quietly for at least 5 minutes. Three measurements were taken at intervals of 3–5 minutes on the left arm, and the mean systolic blood pressure (SBP) and diastolic blood pressure (DBP) were used in the analysis. The updated national and international hypertension guidelines were used to define hypertension as SBP $\geq$140 mmHg and DBP $\geq$90 mmHg.[32]

Socio-demographic characteristics: *Self-reported information on a*ge, gender, ethnicity, marital status, education and employment was collected from the participants. Marital status was categorized as 'married', 'single/never married', and 'divorced/separated'. Education level was categorized into 'greater than secondary school', 'at least secondary school' and 'less than secondary school'. Employment status was classified as 'formal employment' (e.g., government, company or office work), 'self-employed' (e.g., traders, business men/women, farmers), 'student' or 'unemployed'.

Data Analyses: All the measured variables were examined for normality by visual inspection and test statistics of their histograms and normal distribution curves. Both health enhancing physical activity (minutes/week of MVPA) and waist–to-hip ratio variables had skewed distribution (skewness = 1.26 and -4.63 for MVPA and waist–to-hip ratio, respectively). Therefore, natural-log

transformation of the original variables was used to improve their normality when computing the inferential statistics. Raw data were used to calculate the descriptive statistics for all variables; and presented as means and standard deviation (SD) for continuous variables and proportions for categorical variables. The independent t- test was computed to compare the differences in MVPA levels and cardiometabolic disease risk factors between men and women. Chi-square statistic was used to compare the proportion of men and women who were overweight, obese and hypertensive. Linear regression analysis adjusted for participants' sociodemographic characteristics was used to determine the associations between MVPA (dependent variable) and cardiometabolic risk factors of CVD (BMI, waist circumference, waist-to-hip ration and blood pressure; independent variables). *P*-values were set at 0.05 as significant level for all statistical tests. All analyses were conducted in SPSS 15.0 for windows.

RESULTS

The final sample for the present study comprised 280 (124 women and 156 men) adults with a mean age of 37.8 ± 10.7 years. Most of the participants were married (81.8%), not formally employed (58.2%), and had more than secondary school education (54.6%). Compared to women, the men were more likely to be older ($P < 0.001$), employed ($P < 0.001$) and had more than secondary school education ($P < 0.001$) (Table 1).

Table 2 shows the prevalence of physical activity and cardiometabolic risk factors among the participants. Overall, majority of the participants (85.5%) engaged in sufficient levels of health enhancing MVPA. The participants spent about 10 hrs/week (595.2 minutes/week) in health enhancing MVPA. For cardiometabolic risk factors, 68% of the participants had central/abdominal obesity based on waist-to-hip ratio, and about 62% of the participants were either overweight (36.2%) or obese (26.1%) based on BMI cut-points. About one quarter of the participants had systolic (26.4%) and diastolic (25.4%) hypertension. Compared to men, more women did not engage in health enhancing MVPA ($P < 0.001$) and were more obese ($P < 0.001$). However, more men than women had central/abdominal obesity ($P < 0.001$), systolic hypertension ($P < 0.001$) and diastolic hypertension ($P = 0.004$).

Table 3 shows the linear associations between health enhancing MVPA and cardiometabolic risk factors. Overall, a unit increase (minute/week) in health enhancing MVPA was significantly ($P < 0.05$) associated with about 16% reduction in BMI (β = -0.163, 95% CI: -0.023 to -0.004) and 14% reduction in waist-to hip ratio (β = -0.138, 95% CI: -0.845 to -0.064). Both BMI and waist-to-hip ratio accounted for about 5% (R^2=0.049) of the variance in MVPA. In the sex specific analysis, a unit increase in health enhancing MVPA was significantly ($P < 0.05$) associated with about 19%, 24% and 21% reduction in BMI (β = -0.189, 95% CI: -0.027 to 0.000), systolic blood pressure (β = -0.241, 95% CI: -0.009 to -0.001) and diastolic blood pressure (β = -0.212, 95% CI: -0.014 to -0.001), respectively among women. There was no significant association in men.

Table 1. Sociodemographic characteristics of the participants

Variables	**Total Sample** (N=280)	**Women** (n=124, 44.3%)	**Men** (n=156, 55.7%)	***P*-values†**
Age (years)	37.8 ± 10.7	38.2 ± 8.6	41.9 ± 10.7	<0.001
Age group (n, %)				<0.001
20 – 29	73 (26.1)	52 (71.2)	21 (28.8)	
30 – 39	97 (34.6)	47 (48.5)	50 (51.5)	
40 – 49	68 (24.3)	18 (26.5)	50 (73.5)	
50 – 59	29 (10.4)	6 (20.7)	23 (79.3)	
>60	13 (4.6)	1 (7.7)	12 (92.3)	
Marital status (n, %)				0.176
Single/never married	34 (12.1)	10 (29.4)	24 (70.6)	
Divorced/ separated	17 (6.1)	8 (47.1)	9 (52.9)	
Married	229 (81.8)	106 (46.3)	123 (53.7)	
Ethnicity (n, %)				<0.001
Igbo	15 (5.4)	6 (40.0)	9 (60.0)	
Hausa/Fulani	57 (20.4)	18 (31.6)	39 (68.4)	
Yoruba	54 (19.3)	24 (44.4)	30 (55.6)	
Kanuri	60 (21.4)	34 (56.7)	26 (43.3)	
Others	94 (33.6)	42 (44.7)	52 (55.3)	
Employment (n, %)				<0.001
Formal employment	117 (41.8)	31 (26.5)	86 (73.5)	
Self employed	81 (28.9)	21 (25.9)	60 (74.1)	
Student	35 (12.5)	25 (71.4)	10 (28.6)	
Unemployed	47 (16.8)	47 (100.0)	0 (0)	
Education (n, %)				<0.001
>Secondary school	153 (54.6)	38 (24.8)	115 (75.2)	
Secondary school	106 (37.9)	67 (63.2)	39 (36.8)	
< Secondary school	21 (7.5)	19 (90.5)	2 (9.5)	

† = values based on independent t-tests statistics for continuous variables and chi-Square Statistics for categorical variables

Table 2: Physical activity level and cardiometabolic risk factors overall and by gender

Variables	**Total Sample** (N=280)	**Women** (n=124, 44.3%)	**Men** (n=156, 55.7%)	*P*-values†
MVPA (min/wk)	595.3 ± 470.1	371.1 ± 315.9	773.3 ± 496.4	<0.001**
Sufficient MVPA (n, %)				
No	42 (15.0)	33 (78.6)	9 (21.4)	<0.001**
Yes	238 (85.0)	91 (38.2)	147 (61.8)	
BMI (Kg/m^2)	27.1 ± 4.99	28.1 ± 6.22	26.3 ± 3.55	0.002*
Weight status (n, %)				
Underweight	6 (2.1)	6 (100.0)	0 (0)	<0.001**
Normal weight	100 (35.7)	38 (38.0)	62 (62.0)	
Overweight	101 (36.1)	29 (28.7)	72 (71.3)	
Obese	73 (26.1)	51 (69.9)	22 (30.1)	
Waist circumference (cm)	33.6 ± 7.78	32.4 ± 7.61	34.5 ± 7.83	0.029*
Abdominal obesity (WC)				
No	278 (99.3)	123 (44.2)	155 (55.8)	0.870
Yes	2 (0.7)	1 (50.0)	1 (50.0)	
High Waist-to-hip ratio (cm)	0.89 ± 0.13	0.83 ± 0.11	0.92 ± 0.13	0.030*
Abdominal obesity (WHR)				
No	88 (31.4)	64 (72.7)	24 (27.3)	<0.001**
Yes	192 (68.7)	60 (31.3)	132 (68.8)	
SBP (mmHg)	124.2 ± 20.9	118.6 ± 23.2	128.7 ± 9.1	<0.001**
Systolic Hypertension				
No	206 (73.6)	107 (51.7)	99 (48.1)	<0.001**
Yes	74 (26.4)	17 (23.0)	55 (77.0)	
DBP (mmHg)	80.0 ± 11.4	76.9 ± 13.3	82.5 ± 9.1	<0.001**
Diastolic Hypertension				
No	209 (74.6)	103 (49.3)	106 (50.7)	0.004*
Yes	71 (25.4)	21 (29.6)	50 (70.4)	

† = values based on independent t-tests statistics for continuous variables and chi-Square Statistics for categorical variables;
* = significant at $P < 0.05$; ** = significant at $P < 0.001$

Table 3: Relationship between health enhancing moderate-to-vigorous physical activity (MVPA) and cardiometabolic risk factors, overall and by gender

Cardiometabolic risk factors	**Main effect†**			**Women specific‡**			**Men specific‡**		
	β	**95% CI**	**P-value**	**β**	**95% CI**	**P-value**	**β**	**95% CI**	**P-value**
Body mass index	**-0.163**	**-0.023, -0.004**	**0.005***	**-0.189**	**-0.027, -0.000**	**0.046***	**0.093**	**-0.006, 0.023**	**0.254**
Waist circumference	**-0.064**	**-0.010, 0.003**	**0.290**	**0.057**	**-0.008, 0.015**	**0.572**	**-0.126**	**-0.012, 0.001**	**0.125**
Waist-to-hip ratio	**-0.138**	**-0.845, -0.064**	**0.023***	**-0.049**	**-0.957, 0.566**	**0.612**	**-0.014**	**-0.370, 0.443**	**0.860**
Systolic blood pressure	**-0.052**	**-0.004, 0.001**	**0.383**	**-0.241**	**-0.009, -0.001**	**0.010***	**0.039**	**-0.002, 0.004**	**0.633**
Diastolic blood pressure	**-0.081**	**-0.007, 0.001**	**0.172**	**-0.212**	**-0.014, -0.001**	**0.026***	**-0.076**	**-0.008, 0.003**	**0.867**

β = regression coefficient; 95% CI = 95% confidence intervals; †= All regression coefficients adjusted for participants' age, sex, marital status, education and employment; ‡= Regression coefficients not adjusted for sex because analysis was gender specific; * = significant at P<0.05

DISCUSSION

To our knowledge, few studies have been published on how cardiometabolic risk factors relate to physical activity behaviours of adults in Nigeria. The present study found some associations of health enhancing physical activity with lower levels of cardiometabolic risk factors in a sample of adults in Maiduguri. The main finding was that higher health enhancing moderate-to-vigorous physical activity (MVPA) was related to lower body adiposity in the full sample. This finding is consistent with previous Nigerian studies,[23–25] and those from western developed countries[16–22] that found sufficient levels of physical activity to be related to lower rates of overweight and obesity in adults.

Interestingly, higher MVPA was negatively associated with both BMI and waist-to-hip ratio. It is appealing that habitual physical activity (not structured exercise) could be associated with markers of obesity among community dwelling adults in the present study. While the BMI is a measure of generalized obesity (total body fat/adipose tissue), the waist-to-hip ratio provides an index of both subcutaneous and intraabdominal adipose tissue (abdominal fat mass; referred to as central/abdominal or visceral obesity).[30] Thus, our finding of consistent association of MVPA with both measures of body adiposity affirms the potential importance and centrality of habitual physical activity as a simple non-invasive strategy relevant to weight control or management among community dwelling adults in Maiduguri. Since overweight/obesity is a cardinal risk factor to the development of many chronic diseases,[33] the evidence from our study is important and could inform effective community physiotherapy practice and health promotion strategies against non-communicable diseases in Nigeria.

Compared to men, women in the present study did not engage in sufficient health enhancing MVPA and were more obese based on their BMI status. This finding is consistent with the global evidence that men are more physically active than women,[3,4] and that women have substantially more generalized obesity than men.[30,34–36] Thus, replicating this finding in the present study is not surprising or unexpected. Perhaps, it is a reflection of the prevailing socio-cultural norm in Maiduguri that allow women to stay more at home to take care of children and to engage in other domestic duties. This practice tends to predispose women to more sedentary related domestic activities, limits their opportunities for physical activity in other domains (e.g., active transportation, recreational and occupational physical activities) and subsequently predisposing them to higher body adiposity. Such patterns of physical activity and body weight status have previously been reported among women in Maiduguri.[24,37] Also, our findings of higher central/abdominal obesity and systolic and diastolic hypertension in men than in women is consistent with previous studies.[30,38,39] The greater central distribution of adipose tissue commonly found in men has been attributed to the reduction in sex hormones (both total and free testosterone levels) that decline during adulthood in men.[40]

In the present study, the negative relationship of MVPA with body adiposity and blood pressure was more pronounced in women than men. The effect size for risk reduction of MVPA on high BMI and blood pressure in women is about 19% to 24%. This finding suggests, albeit preliminarily, that increasing physical activity represents an important intervention strategy that could be used to control or prevent overweight/obesity and hypertension among women. Paradoxically, hypertension was more prevalent among men in the present study but it was not significantly associated with MVPA. Perhaps, because the prevalence of MVPA among men was also very high, there is little variation within MVPA and blood pressure to detect significant association between both variables in men. Nevertheless, these findings reveal the needs for sex-specific intervention focus when designing physical activity strategies to prevent and control the risk factors of cardiometabolic diseases among adults in Maiduguri. It could be that women in Maiduguri being mostly physically inactive and sedentary are also at greater risk of cardiometabolic disorders and the benefits of physical activity interventions in this group would manifest quickly than in men.

The results of the present study have some practical

application to community physiotherapy practice and health promotion in Maiduguri. Majority of participants met the international physical activity recommendations for sufficient physical activity levels, yet the prevalence of cardiometabolic risk factors for non-communicable diseases among these participants was relatively high. This raises practical concern on the continued utilization of the current international guideline of 150 minutes/week of MVPA as the minimum threshold for health benefits among community residents in Maiduguri and perhaps among adults in Nigeria. It would be misguided for community physiotherapy practice and health promotion to benchmark this guideline as the standard for determining sufficient physical activity level among adults in Nigeria. Thus, it would be timely to consider the formulation of evidence on sufficient health enhancing physical activity guidelines that are specific to adults in Nigeria. Nevertheless, evidence from the present study suggests that a unit increment in physical activity could substantially lower cardiometabolic risks in individuals meeting the current international physical activity recommendation and those not meeting the recommendation. This suggests physical activity promotion interventions should target both community resident people that are already active and those not active according to the minimum threshold recommended by the current international guidelines. This evidence is appealing to health promotion practice considering that any increment to an individual current physical activity level, regardless of whether the individual is already active or not, can confer protection against cardiometabolic risks.

STRENGHT AND LIMITATION

Strengths of the study included objective assessment of cardiometabolic risk factors, a tested and valid measure of physical activity in Nigeria, and utilization of probability sampling technique that enhanced the external validity of the findings. However, this study has some limitations that should be acknowledged when interpreting its findings. The use of self-report measure of physical activity could have introduced respondent's bias and some measurement errors into the physical activity estimates. Also, the utilization of cross-sectional design limits our ability to preclude reverse causality from our findings. It is not absolute if higher MVPA truly causes the reduction in BMI, waist-to-hip ratio and blood pressure or just that participants with higher BMI, waist-to-hip ratio and blood pressure were inactive due to their cardiometabolic condition. A future study with longitudinal design is needed to help disentangle this important nexus.

CONCLUSIONS

We found that higher health enhancing MVPA was associated with lower levels of obesity and blood pressure in a sample of community dwelling adults in Maiduguri. This finding was more consistent in women than men, suggesting the need for gender specific attention when administering and implementing physical activity interventions to control obesity and hypertension among adults in Maiduguri. Evidence from the study can be used in community physiotherapy practice and health promotion to improve physical activity and reduce cardiometabolic risk factors among adults in Nigeria.

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