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## Examining the reliability and validity of a modified version of the International Physical Activity Questionnaire, long form (IPAQ-L) in Nigeria

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Complete List of Authors:	Oyeyemi, Adewale; University of Maiduguri, Physiotherapy Bello, Umar; University of Maiduguri, Physiotherapy Philemon, Saratu; Jos University Teaching Hospital, Physiotherapy Aliyu, Habibu; University of Maiduguri, Physiotherapy Majidadi, Rebecca; University of Maiduguri, Physiotherapy Oyeyemi, Adetoyeje; University of Maiduguri, Physiotherapy
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8 9 10	4	Adewale L. Oyeyemi* <sup>1</sup> , Umar M. Bello <sup>1</sup> , Saratu T. Philemon <sup>2</sup> , Habeeb N. Aliyu <sup>1</sup> , Rebecca W.
11	5	Majidadi <sup>1</sup> , Adetoyeje Y. Oyeyemi <sup>1</sup>
12 13	6	
14 15	7	<sup>1</sup> Department of Physiotherapy, College of Medical Sciences, University of Maiduguri,
16	8	Nigeria
17	9	<sup>2</sup> Department of Physiotherapy, Jos University Teaching Hospital, Nigeria
18	10	
19	11	
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21 22 23	13	*Correspondence to Dr. Adewale L. Oyeyemi, Department of Physiotherapy, College of
24	14	Medical Sciences, University of Maiduguri, Nigeria. Email: <u>alaoyeyemi@yahoo.com;</u>
25 26 27	15	Telephone: +234-802-945-8230
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#### 33 ABSTRACT

 Objectives: To investigate the reliability and validity of a modified version of the long
International Physical Activity Questionnaire (Hausa IPAQ-LF) in Nigeria.

**Design:** Cross-sectional study, examining the test-retest reliability and construct validity of the

37 Hausa IPAQ-LF compared with anthropometric and biological variables.

Setting: Metropolitan Maiduguri, the capital city of Borno State in Nigeria.

39 Participants: 180 Nigerian adults (50% women) with a mean age of 35.6 (SD=10.3) years,

40 purposively selected from neighbourhood with diverse socioeconomic status and walkability.

41 Outcome measures: Domains (domestic PA, occupational PA, leisure-time PA, active
42 transportation and sitting time) and intensities of PA (vigorous, moderate and walking) were
43 measured with the Hausa IPAQ-LF on two different occasions, eight days apart. Outcomes for
44 construct validity were measured BMI, SBP and DBP.

**Results:** The Hausa IPAQ-LF demonstrated good test-retest reliability (ICC>75) for total PA (ICC=0.79, 95% CI=0.65-0.82), occupational PA (ICC=0.77, 95% CI=0.68-0.82), active transportation (ICC=0.82, 95% CI=0.75-0.87) and vigorous intensity activities (ICC=0.82, 95% CI=0.76-0.87). Reliability was substantially higher for total PA (ICC=0.80), occupational PA (ICC=0.78), leisure-time PA (ICC=0.75) and active transportation (ICC=0.80) in men than women, but domestic PA (ICC=0.38) and sitting time (ICC=0.71) demonstrated substantial reliability coefficients in women than men. For the construct validity, domestic PA was significantly related mainly with SBP ( $\rho = -0.27$ ) and DBP ( $\rho = -0.17$ ), and leisure-time PA and total PA were significantly related only with SBP ( $\rho = -0.16$ ) and BMI (( $\rho = -0.29$ ), respectively. Similarly, moderate-intensity PA was mainly related with SBP ( $\rho = -0.16$ , p< 0.05) and DBP ( $\rho$ = -0.21, p< 0.01), but vigorous-intensity PA was only related with BMI ( $\rho$  = -0.11, p< 0.05). 

56 Conclusions: The modified Hausa IPAQ-LF demonstrated sufficient evidence of test-retest
57 reliability and may be valid for assessing context specific PA behaviours of adults in Nigeria.

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4 5	67	A	ATICLE SUMMART						
6	68	St	Strengths and limitations of this study.						
7 8 9	69 70	•	Systematic adaptation and tailoring of items on the original IPAQ-LF to reflect the common						
10	71		PA behaviours of adults in Nigeria.						
11 12	72	•	The first study to describe the cultural adaptation and translations of the IPAQ-LF and						
13 14	73		explore its psychometric relevance in an African country.						
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16 17	75		reliably collect context specific PA behaviours of adults in the African region.						
18 19	76	-	The non-availability of objective criterion measures of PA to validate the modified IPAQ-LF						
20 21	77		limit comparability of our validity findings to that of many studies from the developed						
22 23	78		countries.						
24	79	•	The use of non-probability sampling technique may limit generalizability of findings to other						
25 26	80		samples of Nigerian adults with different characteristics from the study's sample.						
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#### 106 INTRODUCTION

The importance of physical activity (PA) for promoting health and preventing disease is well established.[1-3] However, for effective health promotion and PA surveillance and monitoring, it is important to have standardized, reliable and valid instruments that can be used to accurately describe population levels and patterns of PA within and across countries.[4, 5] In this context, the international physical activity questionnaire (IPAQ) was developed to obtain internationally comparable data on health-related physical activity of adults (18-65 years). [5, 6] Two versions of the IPAQ that could be administered by interview or self-completed were developed. The short form (SF) was designed for population surveillance of PA; while the long form (LF) was designed to be appropriate for use in research that requires detailed information on different PA domains, including PA at work, household, during leisure and transportation, and time spent in sedentary activities.[6] 

The initial evaluation of the IPAQ across 12 countries produced acceptable evidence of reliability and validity that are as good as other self-report measures of PA.[5] Consequently, in order to enhance the utility of IPAQ and to further evaluate its psychometrics worldwide, efforts have been made to translate and adapt the IPAQ in many other countries, but most of the research in this context were from the Western developed countries.[7-14] In Africa, the psychometric properties of IPAO have only been tested in South-Africa as part of the initial development process of the questionnaire, [5] and in older adults. [15] Because the largest increases and burden of non-communicable diseases (NCDs) are in the low-income countries where the understanding of evidence-based strategies for increasing PA remains poor,[16-19] improving PA research is a top priority for low-income countries.[20] However, to advance PA research in Africa, it is important to first develop or tailor standardized measures to be culturally sensitive to PA behaviours of people in the region countries. Because Nigeria is the most populous country in Africa with culture and languages similar to most of the other West African countries, it is a good choice to evaluate the IPAQ for cultural and psychometric relevance in this country.

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Recently, a cultural adaptation study of the IPAQ-SF was conducted among adults in Nigeria,[21] with good evidence of test-retest reliability similar to findings in some other studies.[10, 22-24] However, because the IPAQ-SF is not domain specific and does not provide context specific information on PA behaviour, it is important to evaluate the IPAQ-LF for relevance in Nigeria. Psychometric evaluation of a culturally modified version of the IPAQ-LF in sub-Saharan African countries can impact PA research and surveillance in the African region where the prevalence of inactivity related NCDs is on the increase. [20, 25] The aim of the present study was to investigate the test-retest reliability and construct validity of a modified version of the IPAQ-LF among adults in Nigeria. 

146 METHODS

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#### 25 148 **Participants**

A purposive sample of 180 adults from eight neighbourhoods that varied in socioeconomic status and walkability in Maiduguri city were recruited for the study. The neighbourhood selection strategy has been described in details elsewhere.[26] Maiduguri with an estimated population of 749,123 people is the largest and capital city of Borno State in North-Eastern Nigeria.[27] The city attracts immigrants from neighbouring countries of Cameroon, Niger and Chad Republic, and Hausa language is the common means of communication for commercial activities among the diverse inhabitants of Maiduguri. [27, 28] Participants were eligible for this study if they were willing to complete a written survey twice in English Language, the official language in Nigeria. Additional eligibility criteria included living within the identified neighbourhood categories in the last 12 months, being adults (18-65 years) and not having any disability that prevented independent walking. All participants were fully informed of the study protocol and provided written informed consent. The study protocol was approved by the Research and Ethic Committee of the University of Maiduguri Teaching Hospital, Maiduguri, Nigeria. Data were collected between March and May, 2012. 

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 164 Measures

#### 165 The adapted international physical activity questionnaire- long Hausa version

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The cultural adaptation, translation and back translation of the Hausa version of IPAO-LF is similar to that of the Hausa IPAQ-SF that has been described in details elsewhere.[21] Briefly, interviews were conducted with public health experts, exercise scientists and not highly educated local people to identify the items and examples of PA on the original questionnaires that needed to be culturally adapted. Several cultural adaptations were made to the original items to reflect the reality in Nigeria. First, adjustments to English words like vigorous and moderate activity that can be misunderstood and not associated with PA behaviours in Nigeria were replaced with words that are more representative of the language used in Nigeria, like 'very hard' and 'hard' respectively. Second, examples of various intensities of activity that were common in the Nigerian culture were added, and those already on the questionnaire but not common in the Nigerian context were replaced with culturally applicable examples that are equivalent in energy intensity (METs) with the original items and examples. Third, concepts like physical activity and walking for transportation that were misconstrued outside the health context were refined to indicate they were referring to health behaviours. 

After adaptation, the questionnaire was independently translated from English into Hausa language by two native speakers of Hausa who also speaks English, and able to read and write in both languages. One of the translators was familiar with the questionnaire and the second was an expert in Hausa language. The translated questionnaires were mutually revised by the translators and the research team for consistency and then back translated into English language by a third bilingual person who was familiar with the construct measured by IPAQ. The back translated version was checked by the research team for any discrepancies and to ensure that the construct measures by IPAQ had not been lost during the adaptation and translation process. 

The modified questionnaire, hereafter referred to as the Hausa version of the long international physical activity questionnaire (Hausa IPAQ-LF), contains thirty-one questions that asked about physical activity done in the last 7-days in terms of frequency (days/week) and duration (min/day) spent in four activity domains (transportation, occupation, domestic and leisure time), and included sections on walking, moderate- and vigorous- intensity activities, and time spent in sedentary behaviours (sitting during leisure and motorized transportation). The Hausa IPAQ-LF

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data were presented as the MET-min/week for total walking, moderate, and vigorous intensity activity and overall physical activity across the four domains, and in each of the domains. The MET intensity values used to score the Hausa IPAQ-LF questions in this study were 8 METs for vigorous activity, 4 METs for moderate activity and 3.3 METs for walking,[2, 6] One MET represents the energy expended while sitting quietly at rest and is equivalent to 3.5 ml/kg/min of VO<sub>2</sub> Max.[3] To assess the test-retest reliability of the Hausa IPAQ-LF, participants completed all items on the measure twice, with an interval of one week between administrations.

#### 204 Anthropometrical and biological measurements

Body weight (to nearest 0.5 kg) and Height (to nearest 0.1 cm) were measured in light clothing using a digital scale and stadiometer. Body mass index (BMI) was calculated as body weight divided by the square of height  $(kg/m^2)$ . The principal cutoff points as recommended by WHO were used to create the categories: underweight (< 18.5 kg/m<sup>2</sup>), normal weight (18.5 - < 25 kg/m<sup>2</sup>), overweight  $(25 - \langle 30 \text{kg/m}^2)$  and obese  $(\langle 30 \text{ kg/m}^2)$ . [28] Resting blood pressure and heart rate were measured with Digital Sphygmomanometer (Diagnostic Advanced Wrist Blood Pressure Monitor, Model 6016, USA). Body mass index and resting diastolic blood pressure (DBP) have previously been used for validating the IPAQ.[7,24] Similarly, for this study, construct validity was evaluated by investigating the relationship of outcomes from the Hausa IPAO-LF with anthropometric (BMI) and biological (SBP and DBP) measurements, and also by comparing the differences in time spent in PA and sitting across sociodemograpic subgroups. These types of validation for PA measures have been referred as indirect or construct validity in previous studies.[7,24,30]

#### 219 Sociodemographic Characteristics

Information on age, gender, marital status, religion, income, educational level and employment status were elicited from the participants. Marital status was classified as married or not married. Educational level was classified as more than secondary school education, secondary school education and less than secondary school education. Employment status was classified into white collar (government or private employed), blue collar (self- employed, trader, artisan etc) and unemployed (homemaker, student, retired, or unable to find job). 

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#### 227 Data Analysis

Descriptive data were reported as mean, standard deviation and percentages. Mean group differences for continuous variables by gender were examined by independent t-test, and for dichotomous variables by chi-square statistics. The two- way mixed model (single measure) intraclass correlation coefficient (ICC) with 95% confidence interval (CI) was utilized to evaluate test-retest reliability of the instrument. The reliability analyses were conducted overall, and by gender and socioeconomic status. ICC estimates >0.75 were considered as good reliability scores, between 0.50 and 0.75 as moderate reliability and <0.50 as poor reliability.[31] To assess construct validity, the non-parametric Spearman correlation coefficients ( $\rho$ ) were utilized to explore the relationship between MET-min/week of PA from the Hausa IPAQ- LF, and resting blood pressure and body mass index. Independent t-test and one-Way ANOVA were used as appropriate to compare the time spent (minutes/week) in PA across sociodemographic subgroups. Data were analyzed using Statistical Package for the Social Science (SPSS), version 15.0 for windows (SPSS Inc., Chicago, Illinois, USA) and the level of significance was set at p<0.05.

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#### 243 RESULTS

The socio-demographic characteristic of the participants are shown in Table 1. The participants comprised 50% women and men, with a mean age of  $35.6 \pm 10.3$  years and body mass index of  $23.8 \pm 3.9$ kg/m<sup>2</sup>. Majority of the participants were married (58.9%, n=106), had more than secondary school education (62.7%, n=111) and were employed (75%, n=117). Compared to men, the women were more likely to be married (71.1% vs 46.7%, p=0.001) and unemployed (52.2% vs 17.8%, p<0.001), but men were more likely to have more than secondary school education (76.7% vs 48.2%, p<0.001).

#### **Test-retest Reliability**

Table 2 shows the test-retest reliability of the modified IPAQ-LF. Overall, reliability coefficients
were good (ICC >75) for total PA, occupational PA, active transportation and vigorous intensity
(very hard) PA. Domestic PA, sitting activity and leisure PA demonstrated moderate reliability

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(ICC ranges from 0.51- 0.71). While, the reliability coefficients of total PA (ICC=0.80, 95%) CI=0.69-0.87), active transportation (ICC=0.83, 95% CI=0.73-0.89), occupational PA (ICC=0.78, 95% CI=0.66-0.85) and leisure time PA (ICC=0.75, 95% CI=0.63-0.84) were substantially higher among men than women, reliability coefficients for domestic PA (ICC=0.38, 95%, CI=0.01-0.57) and sitting time (ICC=0.71, 95% CI=0.46-0.85) were higher among women than men. According to the intensity of PA, ICCs range between 0.61 and 0.82, with the lowest value recorded for moderate intensity (hard) PA and the highest value for vigorous intensity (very hard) PA. The reliability coefficients for walking, moderate-intensity (hard) and vigorous intensity (very hard) activities were substantially greater in men than women. 

Similarly, socioeconomic status differences were observed in the reliability coefficients of the modified IPAQ-LF (Table 3). Across all domains of PA, reliability coefficients were substantially higher among participants with less than secondary school education (ICC from 0.77 [sitting activity] to 0.92 [leisure activity]) compared to those with secondary school education (ICC from 0.28 [active transport] to 0.58 [occupational activity]) and higher than secondary school education (ICC from 0.23 [sitting activity] to 0.67[active transport]). While reliability coefficients were higher for overall PA (ICC=0.80, 95% CI=0.71- 0.86), active transport (ICC=0.83, 95% CI=0.74- 0.88), occupational PA (ICC=0.79, 95% CI=0.70- 0.86) and leisure-time PA (ICC= 0.79, 95% CI= 0.69- 0.85) among participants that were employed compared to their unemployed counterparts, it was higher for domestic PA (ICC=0.65, 95% CI=0.43- 0.79) and sitting time (ICC= 0.68, 95% CI= 0.36- 0.83) among participants that were unemployed than in the employed subgroup. 

#### **Construct Validity**

Overall, correlations between energy expenditure (MET-Min/wk) according to the modified IPAQ-LF and anthropometric and biological measures were statistically significant in the expected direction for all domains and intensities of PA, except for occupation and active transport domains and walking (table 4). In the full sample, domestic PA was mainly related with SBP ( $\rho = -0.27$ , p< 0.01) and DBP ( $\rho = -0.17$ , p< 0.05), while leisure PA and total PA were only related with SBP ( $\rho = -0.16$ , p< 0.05) and BMI (( $\rho = -0.29$ , p< 0.01), respectively. Similarly,

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moderate-intensity PA was mainly related with SBP ( $\rho = -0.16$ , p < 0.05) and DBP ( $\rho = -0.21$ , p < 0.01), but vigorous-intensity PA was only related with BMI ( $\rho = -0.11$ , p < 0.05). In the gender based analyses, total PA, domestic PA and sedentary time were more consistently related with anthropometric and biological variables. The strongest rho value (-0.41) was found for the relationship between total PA and BMI for the male subgroup. The rho values of -0.23 was reached between total PA and DBP for the women subgroup. Only in women was domestic PA significantly related with BMI ( $\rho = -0.23$ ), DBP ( $\rho = -0.20$ ) and SBP ( $\rho = -0.31$ ). Leisure-time PA ( $\rho = -0.39$ ) and occupational PA ( $\rho = -0.22$ ) were significantly related with BMI only in men. The rho value for the relationship between sitting time and BMI was slightly higher in women ( $\rho = 0.19$ ) than men ( $\rho = 0.15$ ).

Table 5 shows the patterns of PA across sociodemographic subgroups during the first (IPAQ1) and second (IPAQ2) administrations of the modified IPAQ-LF. Overall and across all stratified variables, time spent in PA reported during the first administration tends to be higher than those reported during the second administration. At both time points, men reported significantly (p<0.05) higher mean time (Min week<sup>-1</sup>) in active transportation, occupational PA, and leisuretime PA than women. However, women spent significantly (p < 0.001) more time (Min week<sup>-1</sup>) in domestic PA than men (IPAQ1=236.9 vs 82.3, IPAQ2=195.5 vs 52.4). For educational status, participants that had lower than secondary school education compared to those with at least secondary school education reported statistically significant higher mean time (Min week<sup>-1</sup>) at both time points for total PA, active transport, occupational PA, walking and vigorous intensity activity compared to those with at least secondary school education. While participants that were employed reported statistically significant (p < 0.05) more time (Min week<sup>-1</sup>) in total PA (IPAQ1=441.1 vs 285.1, IPAQ2=359.4 vs 141.0), active transportation (IPAQ1=43.8 vs 21.1, IPAQ2=36.9 vs 18.3) and work PA (IPAQ1=195.5 vs 41.8, IPAQ2=164.1 vs 40.1) than those who were unemployed, the unemployed reported statistically significant (p<0.05) higher time in domestic activity (IPAQ1=210.6 vs 132.1, IPAQ2=205.0 vs 112.6) compared to the employed.

## **DISCUSSION**

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This study examined aspects of reliability and validity of a modified version of the IPAO-LF in Nigeria. The findings generally indicated acceptable test-retest reliability and construct validity for items of the modified IPAQ-LF among Nigerian adults. To the best of our knowledge, the present study is the only one to examine the reliability and validity of the long version of IPAQ that has been modified specifically to an indigenous African culture and language. 

We found evidence for good reliability with high correlations between the test-retest for total PA, occupational PA, active transportation and vigorous intensity activity. Our results shows that except for domestic PA and sitting time, ICC values for domains of PA were consistently above 0.70, a level of reproducibility that has been considered acceptably good for IPAQ data.[32,33] Similar to a previous IPAQ-LF study in Hong Kong,[33] domestic activity demonstrated the lowest ICC value in our study. However, it is possible that the infrequent nature of household activities undertaken, especially by men may account for the low reliability reported for domestic PA in our study. In addition to the traditional African patriarchal belief that make most African men to rarely engage in indoor household activities, men in the high socioeconomic group in Nigeria may also not engage in outdoor domestic activities like gardening and outdoor home, appliances and equipment maintenance because they are able to employ the services of domestic helpers and repair men. Our findings of lower reliability for domestic activity among men, those with more than secondary school education and those who were employed compared to their counterparts seem to support this assumption.

The highest and strongest reliability coefficients (0.82) were found for both active transportation and vigorous intensity activity. Perhaps, active transportation was more stable, consistent and reproducible overtime than other PA domains because it is a common and ubiquitous PA behaviour in the African region. Mostly, the performance of active transportation especially walking is often out of necessity rather than choice within the African context. Our finding of higher ICC value for vigorous intensity PA is consistent with those of other studies that found the reliability of vigorous intensity activity to be higher compared to that of moderate intensity activity.[10, 30, 33, 34] Compared to structured vigorous physical activities like sports and exercise that can be more easily recalled, moderate intensity PA are often of low salience, 

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 incidental and may not easily be remembered by people.[35, 36] Further our finding that the reliability of vigorous intensity physical activity was meaningfully higher among men than women seem to confirm our previous findings with the IPAQ-SF.[21] Plausibly men in Nigeria are more consistent than women when responding to PA items that pertained to intense vigorous PA than other intensities of activity. Overall, the moderate to good evidence of reliability found for all items indicates that the modified IPAQ-LF is reproducible, internally consistent and is promising for research in Nigeria.

In the absence of objective criterion standards for evaluating an absolute estimate of PA, the consistency of items on IPAQ with variables known to be related to PA such as body mass index (BMI), blood pressure, heart rate, indicators of lipid and glucose metabolism, and fitness index have been used as important construct validity measures. [7, 10, 21, 24] In the present study, the correlations of the PA domains and intensities with biological and anthropometric variables were mostly significant in the expected direction, but they were low suggesting a modest evidence of construct validity for the modified IPAQ-LF in Nigeria. However, observed correlations were comparable with the values in other studies that have evaluated the IPAQ-LF. [5, 7, 8, 24, 30, 33, 37] Because better validity coefficients have been reported for other PA measures above that of the IPAQ, [37, 38] with the present African finding, it is possible that the IPAQ-LF only have modest evidence of construct validity Worldwide. 

One interesting finding was that total PA was strongly and inversely related with BMI of men and women. This is biologically plausible because total energy expenditure would be expected to have the strongest effects on BMI. Similarly, domestic PA was related with resting blood pressure and BMI in the expected direction, and this was mainly among women. Contrarily, no such gender based associations of domestic PA with health variables were found in previous studies of the western developed countries.[10, 24] It is possible that African women are accumulating domestic related PA at sufficient intensities needed to circumvent deleterious health outcomes. This kind of finding has implications for intervention strategies formulation, considering that domestic activities are common and dominant PA behaviour among women in Africa. In the present study, only in the domains of sitting and domestic PA did women 

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accumulate more time than men. Perhaps, promotion of the typical domestic related activities like households chores, sweeping of compound and pounding of grains as integral components of health enhancing PA (HEPA) of women in Nigeria could be an important public health strategy for controlling the rising incidence of NCDs in this country, where current estimates indicate the prevalence of overweight/obesity as 33.3% (37.7% women and 28.8% men) and that NCDs already account for 27% (28.5% in women; 25.45 in men) of all deaths.[39]

Similar to the finding of a Mexican study, [40] we found scores on the modified IPAQ-LF to be consistently lower during the second administration of the questionnaire compared to the first administration. Because familiarity with the IPAQ questions may improve over multiple exposures to the questionnaire, it is possible that participants in our study might have over-reported their PA levels during the first administration of the IPAQ. This kind of findings may have implication for the utility of IPAQ for surveillance. Generally, due to issues of social desirability phenomenon and over reporting of PA that has been associated with the IPAQ,[37,41] it may be necessary to start considering the need for multiple measurements when using the IPAQ for evaluating PA, especially in developing African countries. However, patterns of PA as measured by the modified IPAQ-LF during both administrations were consistently similar, and both administrations were able to discriminate PA in the expected direction between subgroups of our sample. For example, at both measurement time points, and consistent with hypothesis, men reported more time in active transportation, occupational PA and leisure PA than women, while women reported more time in domestic PA and sedentary activity than men. These suggest an additional support for evidence of construct validity for the modified IPAQ-LF in Nigerian adults. 

#### 399 Strengths and limitations

A strength of this study is the systematic adaptation and tailoring of items on the IPAQ-LF to reflect the common PA behaviours of people in Nigeria. This is the first study in an African country to explore the cultural adaptation and translation of the IPAQ-LF, and its findings demonstrated the feasibility of using the IPAQ-LF to reliably collect PA data in a diverse segment of the Nigerian population. In the Africa region, the importance of a valid and BMJ Open: first published as 10.1136/bmjopen-2014-005820 on 1 December 2014. Downloaded from http://bmjopen.bmj.com/ on June 8, 2025 at Agence Bibliographique de Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

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established PA scale like the modified IPAO-LF is not only important to monitoring the domain in which activity is performed, but also very critical to understanding studies of ecological models of health behaviours, that emphasize the importance of multiple levels of influence on health behaviours including PA.[18,42] In Nigeria, emerging evidence from studies using ecological models indicate that favourable built environmental attributes are promising for improving total and moderate-to-vigorous PA and controlling obesity among adults.[26, 43-45] However, built environment characteristics are expected to be strongly related to specific PA types rather than overall PA.[46, 47] For example, different environmental variables can be related to walking for leisure or transportation and to moderate PA for household, occupation, recreation or transportation. Thus, a study of adaptation of the IPAQ-LF is very important to understanding the domain specific nature of ecological model research in the African region. One additional strength was the exploration of PA patterns by gender, educational level and employment status, the findings of which were consistent with general hypothesis on social patterns of inactivity in low-income countries. [20, 48] 

However, the findings of this study should be interpreted in the light of some important limitations. Direct comparison of our validity findings with previous studies should be made with caution, because unlike in our study, the accelerometer or PA diary were utilized as a common objective criterion standard to validate the IPAO in the majority of the studies [5, 7, 8, 24, 30, 33, 37] Despite this issue, the validity coefficients in our study were remarkably similar to those reported in these other studies. Because the choice and availability of appropriate criterion measures are particular issues of concern for the validation of PA questionnaires in low-income countries of Africa, [5, 49, 50] the use of simple and less expensive measures like biological and anthropometric variables may represent a useful alternative. Another limitation of the study is the use of non-probability sampling technique. The study finding may have limited generalizability to other samples of Nigerians that have different characteristics from this sample. In addition, the majority of participants have more than secondary school education with potentially higher comprehension and recall ability than may be found in the general population. However, recruitment from diverse neighbourhoods and settings allowed for a sample with

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1 2		
2 3 4 5 6 7	434	reasonable heterogeneity in age, occupational status, and ethnic backgrounds and made it
5	435	possible to stratify the analyses by sociodemographic characteristics.
	436	
8 9	437	Conclusions
10 11	438	Overall, the present study suggests that the modified IPAQ-LF demonstrated sufficient evidence
12 13	439	of test-retest reliability and may be valid for assessing context specific PA behaviours of adults
14	440	in Nigeria. Adaptation and criterion evaluation of the IPAQ-LF in other African countries could
15 16	441	further contribute to our understanding of the impact of multiple levels of influence on physical
17 18	442	activity behaviours of people in the African region.
19 20	443	
21	444	
21 22 23	445	Acknowledgments
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26 27	447	with questionnaire translations, and to the participants for their help $for taking part in the study.$
28 29 30	448	
30	449	Contributors
31 32	450	ALO conceived and designed the study, conducted the statistical analysis and interpretation of
33 34	451	data and drafted the manuscript. UMB and STP managed participants' recruitment and data
35 36	452	collection and revised the manuscript for important intellectual contents. HBN and RDM
37 38	453	contributed to cultural adaptation and translations of the measure and revised the manuscript for
39	454	important intellectual contents. AYO contributed to study design, acquisition and interpretation
40 41	455	of data and critically revised the manuscript for important intellectual contents. All authors read
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51 52	461	
53 54	462	Competing interests
55	463	Authors declare there is no competing interest associated with this study.
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2 3 4	464	
4 5 6	465	Ethics approval
7	466	Research and Ethic Committee of the University of Maiduguri Teaching Hospital, Nigeria
8 9	467	(ADM/TH/EC/75).
10 11	468	
12	469	Data sharing process
13 14 15	470	Dataset for this study available upon request from the corresponding author.
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Women (n=90, 50%)
35.5 ± 11.9
26(28.9) 64(71.1)
$23.8 \pm 4.4$
10 (11.1) 49 (54.4) 31 (34.5)
11(12.2) 3(3.3) 4(4.4) 21(23.3) 51(56.7)
17(19.5) 28(32.5) 42(48.2)
47(52.2) 17(18.9) 26(28.9)

Men

(n=90, 50%)

 $35.7 \pm 8.3$ 

48(53.3)

42(46.7)

 $23.8 \pm 3.5$ 

4(4.4)

58 (64.4)

28 (31.2)

10.1(11.1)

5(5.6)

6(6.7)

23(25.6) 46 (51.1)

11 (12.2)

10(11.1)

69 (76.7)

16(17.8)

28(31.1)

46(51.1)

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Variables

Age (years) Mean  $(\pm SD)$ 

Not Married

BMI ( $Kg/m^2$ )

Mean  $(\pm SD)$ 

Underweight

Normal weight

Overweight/obese

Ethnicity (n, %) Hausa/Fulani

Kanuri/Shuwa Arab

> Secondary School

<Secondary School

Educational level (n, %)\*

**Occupational Status (n, %)\*** 

**BMI-** Body Mass Index

Igbo

Yoruba

Others

Secondary

Unemployed

White Collar

Blue Collar

Married

Marital status (n, %)\*

BMI Category (n, %)

Total sample

(N=180)

 $35.6 \pm 10.3$ 

74(41.1)

106(58.9)

 $23.8 \pm 3.9$ 

14(7.8)

107 (59.4)

59 (32.8)

21(11.7)

8(4.4)

10(5.6)

44(24.4)

97(53.9)

111 (62.7)

38 (21.5)

28 (15.8)

63(35)

45(25)

72(40)

\*- Significant difference between samples (p < 0.05)

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Table 2: Test-reliability based on intra-class correlation coefficient for Hausa IPAQ- LF, overall and by gender

		Total (N=180)		Women (n=90)	Men (n=90)
PA Measure (MET×min/wk)	Test 1 (Mean (SD))	Test 2 (Mean (SD))	ICC (95%CI)	ICC (95%Cl)	ICC (95%Cl)
Total PA, all domain	2160.6 (2691.1)	1612.8 (1612.8)	0.76 (0.65-0.82)	0.45 (0.08-0.67)	0.80 (0.69- 0.87)
Occupation	619.1(1671.5)	497.5 (1332.9)	0.77 (0.68-082)	0.64 (0.46-0.77)	0.78 (0.66 -0.85)
Active Transport	468.1 (684.7)	440.5 (605.7)	0.82 (0.75-0.87)	0.63 (0.40-0.77)	0.83 (0.73 - 0.89)
Domestic	597.6 (754.6)	473.4 (673.7)	0.50 (0.32-0.62)	0.38 (0.01-0.57)	0.33 (-0.01-0.56)
Leisure	377.0 (1096.3)	196.7 (920.2)	0.71 (0.60-0.78)	0.69 (0.53-0.79)	0.75 (0.63-0.84)
Sitting	2263.0 (715.8)	2235.4 (818.9)	0.62 (0.42-0.75)	0.71 (0.46-0.85)	0.48 (0.06-0.72)
PA by Intensity (MET×min/wk)					
Walking	613.6 (635.6)	534.6 (449.1)	0.63 (0.48-0.74)	0.57 (0.29-0.74)	0.65 (0.44-0.78)
Moderate	986.9 (1365.9)	716.1 (1164.6)	0.61 (0.46-0.71)	0.42 (0.11-0.62)	0.67 (0.49-0.78)
Vigorous	526.5 (1543.7)	394.1 (1431.1)	0.82 (0.76-0.87)	0.55 (0.30-0.71)	0.86 (0.78-0.91)

PA= Physical Activity

MET= Metabolic Energy Turnover

Table 3: Socioeconomic status differences in test- retest reliability of the Hausa IPAQ- LF (N= 180)

Socioeconomic Status	Overall PA	Active Transport	Occupation PA	Leisure PA	Domestic PA	Sitting	
<b>Educational</b> <b>Qualification</b> More than secondary	0.42 (0.08-0.63)	0.67 (0.43-0.78)	0.32 (-0.06-0.57)	0.33 (-0.05-0.57)	0.58 (0.35-0.73)	0.23 (-0.63-0.63)	
school (n=111)			· · · · ·	, , , , , , , , , , , , , , , , , , ,			
Secondary School (n=38)	0.55 (0.22-0.74)	0.28 (-0.21-0.57)	0.58 (0.33-0.74)	0.54 (0.25-0.71)	0.50 (0.19-0.69)	0.51 (-0.04-0.76)	
Less than Secondary school (n=28)	0.89 (0.67-0.96)	0.90 (0.74-0.96)	0.82 (0.61-0.92)	0.92 (0.83-0.96)	0.90 (0.78-0.95)	0.77 (0.45-0.90)	
<b>Employment Category</b> Employed (117)	0.80 (0.67-0.96)	0.83 (0.74-0.88)	0.79 (0.70-0.86)	0.79 (0.69-0.85)	0.36 (0.08-0.56)	0.56 (0.23-0.75)	
	0.00 (0.07-0.90)	0.05 (0.74-0.00)	0.75 (0.70-0.00)	0.77 (0.07-0.03)	0.30 (0.08-0.30)	0.50 (0.25-0.75)	
Unemployed (63)	0.09 (-8.86-0.56)	0.68 (0.44-0.82)	0.16 (-0.39-0.49)	0.25 (-0.24-0.55)	0.65 (0.43-0.79)	0.68 (0.36-0.80)	
PA= Physical Activity				von			
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	<b>Overall (N = 180)</b>			Female (n = 90)			Male (n = 90)		
MET×min/wk	BMI	DBP	SBP	BMI	DBP	SBP	BMI	DBP	SBP
PA Domains									
Total PA	-0.29**	-0.17*	-0.09	-0.09	-0.23**	-0.04	-0.41**	-0.08	-0.14
Occupation PA	-0.12	-0.09	-0.01	-0.02	-0.02	-0.05	-0.22**	-0.17	-0.08
Active transport PA	-0.05	-0.04	-0.01	-0.10	-0.13	-0.02	-0.04	-0.02	-0.80
Domestic PA	-0.07	-0.17*	-0.26**	-0.23**	-0.20*	-0.31**	0.04	-0.14	-0.04
Leisure PA	0.09	-0.08	-0.16*	-0.11	0.02	0.08	-0.39**	-0.12	-0.0
Sitting	0.16	-0.09	0.04	0.19	0.12	0.05	0.15	-0.09	0.0
PA Intensity									
Walking	0.90	-0.09	-0.03	0.19	-0.05	0.08	-0.05	-0.11	-0.1
Moderate	-0.02	0.21*	0.16*	0.02	-0.14	-0.08	0.02	-0.25**	-0.1
Vigorous	-0.11*	-0.06	-0.03	-0.16	-0.01	-0.02	-0.13*	-0.12	-0.1

Table 4: Construct validity of Hausa IPAQ-LF: Spearman correlations between energy expenditure (MET×min/wk) from Hausa IPAQ-LF, and anthropometric and biological variables (N=180)

BMI= Body Mass Index

DBP= Diastolic Blood Pressure

SBP= Systolic Blood Pressure

PA= Physical activity

\*=p<0.05, \*\*=p<0.01

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Table 5: Differences in time spent in physical activity overall, and by gender and socioeconomic status sub groups

Gender		er	Education			Employment		
	<b>Total</b> Mean ± SD	Men Mean ± SD	<b>Women</b> Mean ± SD	>Secondary Mean ± SD	<b>Secondary</b> Mean ± SD	<b>Secondary</b> Mean ± SD	<b>Employed</b> Mean $\pm$ SD	<b>Unemployed</b> Mean ± SD
PA by domai	n (min/wk)				· · · · · · · · · · · · · · · · · · ·	······································		
Total PA, all o	domain							
IPAQ1	405.2 (507.8)	460.7 (582.9)	326.8 (367.8)	334.0 (400.8)	384.8 (514.8)	849.2 (764.1)**	441.1 (530.2)	285.1 (408.6
IPAQ2	308.4 (440.3)	319.7 (522.8)	291.9 (282.9)	285.1 (295.1)	184.8 (264.4)	803.0 (929.6)**	359.4 (481.6)	141.0 (185.2
Active Transp				~ /		× /	× /	
IPAQ1	35.8 (89.7)	52.4 (127.7)	19.5 (17.7)*	28.3 (47.7)	28.9 (45.02)	76.4 (198.7)*	43.8 (109.4)	21.1 (21.9)*
IPAQ2	30.4 (76.7)	41.2 (106.3)	19.3 (17.5)*	23.6 (30.6)	20.3 (30.9)	74.3 (182.6)*	36.9 (94.1)	18.3 (14.7)*
Work	()			()	()			
IPAQ1	160.1 (380.8)	217.5 (466.8)	79.1 (179.9)*	114.8 (291.0)	122.9 (365.6)	546.7 (615.7)**	195.5 (418.8)	41.8 (162.2)*
IPAQ2	135.3 (310.3)	172.5 (372.8)	80.6 (171.9)*	104.1 (232.2)	160.9 (196.1)	531.6 (595.8)**	164.1 (341.7)	40.1 (133.0)*
Domestic	()				()		(0,111)	()
IPAQ1	159.6 (202.2)	82.3 (120.6)	236.9 (235.8)**	* 141 2 (182 4)	173.3 (238.5)	165.4 (159.4)	132.1 (170.7)	210.6 (243.8)
IPAQ2	123.9 (163.9)	52.4 (74.9)	195.5 (190.1)*		107.6 (130.4)	147.3 (189.1)	112.6 (163.9)	205.0 (163.3
Leisure	125.5 (105.5)	<i>c2</i> . ( <i>ij</i> )	190.0 (190.1)	151.5 (102.5)	107.0 (120.1)	11,	112.0 (105.5)	200.0 (105.5)
IPAQ1	62.4 (159.1)	75.0 (211.1)	10.5 (27.3)**	47.0 (97.3)	92.7 (209.4)	38.2 (160.1)	69.7 (157.6)	48.7 (162.3)
IPAQ2	30.5 (118.2)	50.6 (160.7)	10.1 (38.5)**	23.4 (51.4)	24.7 (91.4)	71.5 (256.5)	43.1 (143.5)	17.0 (28.7)*
Sitting	50.5 (110.2)	50.0 (100.7)	10.1 (50.5)	25.1 (51.1)	21.7 (91.1)	(1.5 (250.5)	15.1 (115.5)	17.0 (20.7)
IPAQ1	2263.0 (715.8)	2188 8 (759 7)	2330 7 (674 8)	2280.0 (618.7)	2433.9 (693.7)	2180.9 (760.8)	2159.4 (775.9)	2337 6 (667
IPAQ2	2235.4 (819.9)	· · · · · · · · · · · · · · · · · · ·		· · · · · ·		2160.0 (1111.4)	2170.6 (870.5)	· · · · · · · · · · · · · · · · · · ·
111122	2255.1 (017.5)	2200.7 (910.9)	2239.0 (720.1)	2120.7 (050.7)	2213.5 (005.1)	2100.0 (1111.1)	2170.0 (070.5)	2202.0 (705.
PA by Intens	ity (min/wk)							
Walking								
IPAQ1	178.5 (221.5)	241.1 (271.9)	128.2 (100.8)*	· · · ·	133.4 (85.6)	266.9 (285.4)*	192.0 (245.7)	133.3 (96.2)*
IPAQ2	142.5 (141.8)	148.5 (137.9)	133.7 (147.9)	151.7 (138.4)	103.6(94.7)	200.3 (209.1)*	150.7 (146.6)	115.4 (122.7)
Moderate	/							
IPAQ1	201.9 (326.9)	193.0 (214.5)	214.5 (247.8)	187.3 (266.5)	194.9 (386.5)	309.7 (381.7)	221.2 (347.4)	137.7 (239.9)
IPAQ2	133.9 (238.5)	114.2 (276.9)	162.7 (165.6)	132.9 (177.8)	88.0 (197.2)	319.0 (482.1)*	153.9 (266.2)	68.0 (76.4)*
Vigorous								
IPAQ1	94.1 (211.8)	123.7 (249.6)	52.2 (133.2)*	32.9 (81.9)	129.5 (208.2)	268.0 (459.7)**	90.2 (214.6)	127.1 (204.6
IPAQ2	78.4 (206.9)	86.8 (227.4)	46.2 (73.4)	52.2 (140.2)	55.2 (127.0)	292.8 (461.5)**	92.8 (226.9)	130.9 (107.8)
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### Examining the reliability and validity of a modified version of the International Physical Activity Questionnaire, long form (IPAQ-L) in Nigeria: A cross-sectional study

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3 4	1	Examining the reliability and validity of a modified version of the International Physical
5 6	2	Activity Questionnaire, long form (IPAQ-L) in Nigeria: A cross-sectional study
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8 9 10	4	Adewale L. Oyeyemi* <sup>1</sup> , Umar M. Bello <sup>1</sup> , Saratu T. Philemon <sup>2</sup> , Habeeb N. Aliyu <sup>1</sup> , Rebecca W.
11	5	Majidadi <sup>1</sup> , Adetoyeje Y. Oyeyemi <sup>1</sup>
12 13	6	
14 15	7	<sup>1</sup> Department of Physiotherapy, College of Medical Sciences, University of Maiduguri,
16	8	Nigeria
17	9	<sup>2</sup> Department of Physiotherapy, Jos University Teaching Hospital, Nigeria
18 19	10	
20	11	
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22 23	13	*Correspondence to Dr. Adewale L. Oyeyemi, Department of Physiotherapy, College of
24 25	14	Medical Sciences, University of Maiduguri, Nigeria. Email: <u>alaoyeyemi@yahoo.com;</u>
26 27	15	Telephone: +234-802-945-8230
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#### 33 ABSTRACT

 Objectives: To investigate the reliability and aspect of validity of a modified version of the long
 International Physical Activity Questionnaire (Hausa IPAQ-LF) in Nigeria.

36 Design: Cross-sectional study, examining the reliability and construct validity of the Hausa

37 IPAQ-LF compared with anthropometric and biological variables.

38 Setting: Metropolitan Maiduguri, the capital city of Borno State in Nigeria.

39 Participants: 180 Nigerian adults (50% women) with a mean age of 35.6 (SD=10.3) years,

40 purposively selected from neighbourhood with diverse socioeconomic status and walkability.

Outcome measures: Domains (domestic physical activity [PA], occupational PA, leisure-time
PA, active transportation and sitting time) and intensities of PA (vigorous, moderate and
walking) were measured with the Hausa IPAQ-LF on two different occasions, eight days apart.
Outcomes for construct validity were measured BMI, SBP and DBP.

**Results:** The Hausa IPAQ-LF demonstrated good test-retest reliability (ICC>75) for total PA (ICC=0.79, 95% CI=0.65-0.82), occupational PA (ICC=0.77, 95% CI=0.68-0.82), active transportation (ICC=0.82, 95% CI=0.75-0.87) and vigorous intensity activities (ICC=0.82, 95% CI=0.76-0.87). Reliability was substantially higher for total PA (ICC=0.80), occupational PA (ICC=0.78), leisure-time PA (ICC=0.75) and active transportation (ICC=0.80) in men than women, but domestic PA (ICC=0.38) and sitting time (ICC=0.71) demonstrated substantial reliability coefficients in women than men. For the construct validity, domestic PA was significantly related mainly with SBP ( $\rho = -0.27$ ) and DBP ( $\rho = -0.17$ ), and leisure-time PA and total PA were significantly related only with SBP ( $\rho = -0.16$ ) and BMI (( $\rho = -0.29$ ), respectively. Similarly, moderate-intensity PA was mainly related with SBP ( $\rho = -0.16$ , p< 0.05) and DBP ( $\rho$ = -0.21, p< 0.01), but vigorous-intensity PA was only related with BMI ( $\rho$  = -0.11, p< 0.05). 

Conclusions: The modified Hausa IPAQ-LF demonstrated sufficient evidence of test-retest
 reliability and may be valid for assessing context specific PA behaviours of adults in Nigeria.

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The importance of physical activity (PA) for promoting health and preventing disease is well established.[1-3] However, for effective health promotion and PA surveillance and monitoring, it is important to have standardized, reliable and valid instruments that can be used to accurately describe population levels and patterns of PA within and across countries.[4, 5] In this context, the international physical activity questionnaire (IPAQ) was developed to obtain internationally comparable data on health-related PA of adults (18-65 years).[5, 6] Two versions of the IPAO that could be administered by interview or self-completed were developed. The short form (SF) was designed for population surveillance of PA; while the long form (LF) was designed to be appropriate for use in research that requires detailed information on different PA domains, including PA at work, household, during leisure and transportation, and time spent in sedentary activities.[6] 

The initial evaluation of the IPAQ across 12 countries produced acceptable evidence of reliability and validity that are as good as other self-report measures of PA.[5] Consequently, in order to enhance the utility of IPAQ and to further evaluate its psychometrics worldwide, efforts have been made to translate and adapt the IPAQ in many other countries, but most of the research in this context were from the Western developed countries.[7-14] In Africa, the psychometric properties of IPAO have only been tested in South-Africa as part of the initial development process of the questionnaire, [5] and in older adults. [15] Because the largest increases and burden of non-communicable diseases (NCDs) are in the low-income countries where the understanding of evidence-based strategies for increasing PA remains poor,[16-19] improving PA research is a top priority for low-income countries.[20] However, to advance PA research in Africa, it is important to first develop or tailor standardized measures to be culturally sensitive to PA behaviours of people in the region countries. Because Nigeria is the most populous country in Africa with culture and languages similar to most of the other West African countries, it is a good choice to evaluate the IPAQ for cultural and psychometric relevance in this country.

Recently, a cultural adaptation study of the IPAQ-SF was conducted among adults in Nigeria,[21] with good evidence of test-retest reliability similar to findings in some other studies.[10, 22-24] However, because the IPAQ-SF is not domain specific and does not provide context specific information on PA behaviour, it is important to evaluate the IPAQ-LF for relevance in Nigeria. Psychometric evaluation of a culturally modified version of the IPAQ-LF in sub-Saharan African countries can impact PA research and surveillance in the African region where the prevalence of inactivity related NCDs is on the increase. [20, 25] The aim of the present study was to investigate the reliability and an aspect of validity of a modified version of the IPAQ-LF among adults in Nigeria. 

#### 146 METHODS

3 147

#### **Participants**

A purposive sample of 180 adults from eight neighbourhoods that varied in socioeconomic status and walkability in Maiduguri city were recruited for the study. The sampling and neighbourhood selection strategy have been described in details elsewhere.[26] Maiduguri with an estimated population of 749,123 people is the largest and capital city of Borno State in North-Eastern Nigeria.[27] The city attracts immigrants from neighbouring countries of Cameroon, Niger and Chad Republic, and Hausa language is the common means of communication for commercial activities among the diverse inhabitants of Maiduguri. [27, 28] Participants were eligible for this study if they were willing to self-complete a written survey twice in either Hausa or English Language. However, researchers (UMB and STP) were in attendance to provide translation and interpretation assistance to participants (n=11) who were unable to independently complete the survey. Additional eligibility criteria included living within the identified neighbourhood categories in the last 12 months, being adults (18-65 years) and not having any disability that prevented independent walking. All participants were fully informed of the study protocol and provided signed informed consent. The study protocol was approved by the Research and Ethic Committee of the University of Maiduguri Teaching Hospital, Maiduguri, Nigeria. Data were collected between March and May, 2012.

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#### Measures

#### The adapted international physical activity questionnaire-long Hausa version

The cultural adaptation, translation and back translation of the Hausa version of IPAQ-LF is similar to that of the Hausa IPAQ-SF that has been described in details elsewhere.[21] Briefly, interviews were conducted with public health experts, exercise scientists and not highly educated local people to identify the items and examples of PA on the original questionnaires that needed to be culturally adapted. Several cultural adaptations were made to the original items to reflect the reality in Nigeria. First, adjustments to English words like vigorous and moderate activity that can be misunderstood and not associated with PA behaviours in Nigeria were replaced with words that are more representative of the language used in Nigeria, like 'very hard' and 'hard' respectively. Second, examples of various intensities of activity that were common in the Nigerian culture were added, and those already on the questionnaire but not common in the Nigerian context were replaced with culturally applicable examples that are equivalent in energy intensity (METs) with the original items and examples. Third, concepts like physical activity and walking for transportation that were misconstrued outside the health context were refined to indicate they were referring to health behaviours.

After adaptation, the questionnaire was independently translated from English into Hausa language by two native speakers of Hausa who also speaks English, and able to read and write in both languages. One of the translators was familiar with the questionnaire and the second was an expert in Hausa language. The translated questionnaires were mutually revised by the translators and the research team for consistency and then back translated into English language by a third bilingual person who was familiar with the construct measured by IPAQ. The back translated version was checked by the research team for any discrepancies and to ensure that the construct measures by IPAQ had not been lost during the adaptation and translation process. 

The modified questionnaire (available in both Hausa and English language), hereafter referred to as the Hausa version of the long international physical activity questionnaire (Hausa IPAQ-LF), contains thirty-one questions that asked about physical activity done in the last 7-days in terms of frequency (days/week) and duration (minutes/day) spent in four activity domains (transportation,

occupation, domestic and leisure time), and included sections on walking, moderate- and vigorous- intensity activities, and time spent in sedentary behaviours (sitting during leisure and motorized transportation). The Hausa IPAQ-LF data were presented as the MET-minute/week for total walking, moderate, and vigorous intensity activity and overall physical activity across the four domains, and in each of the domains. The MET intensity values used to score the Hausa IPAQ-LF questions in this study were 8 METs for vigorous activity, 4 METs for moderate activity and 3.3 METs for walking, [2, 6] One MET represents the energy expended while sitting quietly at rest and is equivalent to 3.5 ml/kg/min of VO<sub>2</sub> Max.[3] To assess the test-retest reliability of the Hausa IPAQ-LF, participants self-completed all items on the measure twice, with an interval of one week between administrations. 

#### Anthropometrical and biological measurements

Body weight (to nearest 0.5 kg) and Height (to nearest 0.1 cm) were measured in light clothing using a digital scale and stadiometer. Body mass index (BMI) was calculated as body weight divided by the square of height  $(kg/m^2)$ . The principal cutoff points as recommended by WHO were used to create the categories: underweight (< 18.5 kg/m<sup>2</sup>), normal weight (18.5 - < 25 kg/m<sup>2</sup>), overweight  $(25 - \langle 30 \text{ kg/m}^2)$  and obese  $(\geq 30 \text{ kg/m}^2)$ .[29] Resting blood pressure and heart rate were measured with Digital Sphygmomanometer (Diagnostic Advanced Wrist Blood Pressure Monitor, Model 6016, USA). Body mass index and resting diastolic blood pressure (DBP) have previously been used for validating the IPAQ.[7,24] Similarly, for this study, construct validity was evaluated by investigating the relationship of outcomes from the Hausa IPAQ-LF with anthropometric (BMI) and biological (SBP and DBP) measurements, and also in part by comparing the differences in time spent in PA and sitting across sociodemograpic subgroups. These types of validation for PA measures have been referred as indirect or construct validity in previous studies.[7,24,30] 

 Sociodemographic Characteristics 

Information on age, gender, marital status, religion, income, educational level and employment status were elicited from the participants. Marital status was classified as married or not married. Educational level was classified as more than secondary school education, secondary school 

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education and less than secondary school education. Employment status was classified into white
collar (government or private employed), blue collar (self- employed, trader, artisan etc) and
unemployed (homemaker, student, retired, or unable to find job).

230 Data Analysis

Descriptive data were reported as mean, standard deviation and percentages. Mean group differences for continuous variables by gender were examined by independent t-test, and for dichotomous variables by chi-square statistics. The reliability analyses were performed using 2 strategies. First, the two- way mixed model (single measure) intraclass correlation coefficient (ICC) with 95% confidence interval (CI) between the continuous scores obtained on 1<sup>st</sup> and 2<sup>nd</sup> administration of the Hausa IPAQ-LF was calculated. The ICCs were calculated overall, and by gender and socioeconomic status. ICC estimates >0.75 were considered as good reliability scores, between 0.50 and 0.75 as moderate reliability and <0.50 as poor reliability.[31] Second, the Bland and Altman Method was used to assess agreement on scores of PA from the 1<sup>st</sup> and 2<sup>nd</sup> administrations.[32] Variables used for the Bland and Altman analysis were weekly time spent in moderate-to-vigorous activity (MVPA), total PA and sitting. MVPA was computed by summing the total minutes/week of reported physical activity of moderate and vigorous- intensities across all four domains. For total PA, the total minutes/week of activities in each domain were summed (total work + total transport + total domestic + total leisure-time min/week scores) to gain an overall estimate of physical activity in a week. Also, the independent t-test and one-Way ANOVA were used as appropriate to compare the time spent (minutes/week) in PA at both administrations across sociodemographic subgroups. To assess construct validity, the non-parametric Spearman correlation coefficients  $(\rho)$  were utilized to explore the relationship between MET-min/week of PA from the Hausa IPAQ- LF, and resting blood pressure and body mass index. Data were analyzed using Statistical Package for the Social Science (SPSS), version 15.0 for windows (SPSS Inc., Chicago, Illinois, USA) and the level of significance was set at p<0.05. 

**RESULTS** 

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 The socio-demographic characteristic of the participants are shown in Table 1. The participants comprised 50% women and men, with a mean age of  $35.6 \pm 10.3$  years and body mass index of  $23.8 \pm 3.9$ kg/m<sup>2</sup>. Majority of the participants were married (58.9%, n=106), had more than secondary school education (62.7%, n=111) and were employed (75%, n=117). Compared to men, the women were more likely to be married (71.1% vs 46.7%, p=0.001) and unemployed (52.2% vs 17.8%, p<0.001), but men were more likely to have more than secondary school education (76.7% vs 48.2%, p<0.001).

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#### 263 Reliability

Table 2 shows the test-retest reliability of the modified IPAQ-LF. Overall, reliability coefficients were good (ICC >75) for total PA, occupational PA, active transportation and vigorous intensity (very hard) PA. Domestic PA, sitting activity and leisure PA demonstrated moderate reliability (ICC ranges from 0.51- 0.71). While, the reliability coefficients of total PA (ICC=0.80, 95% CI=0.69-0.87), active transportation (ICC=0.83, 95% CI=0.73-0.89), occupational PA (ICC=0.78, 95% CI=0.66-0.85) and leisure time PA (ICC=0.75, 95% CI=0.63-0.84) were substantially higher among men than women, reliability coefficients for domestic PA (ICC=0.38, 95%, CI=0.01-0.57) and sitting time (ICC=0.71, 95% CI=0.46-0.85) were higher among women than men. According to the intensity of PA, ICCs range between 0.61 and 0.82, with the lowest value recorded for moderate intensity (hard) PA and the highest value for vigorous intensity (very hard) PA. The reliability coefficients for walking, moderate-intensity (hard) and vigorous intensity (very hard) activities were substantially greater in men than women. 

Similarly, socioeconomic status differences were observed in the reliability coefficients of the modified IPAQ-LF (Table 3). Across all domains of PA, reliability coefficients were substantially higher among participants with less than secondary school education (ICC from 0.77 [sitting activity] to 0.92 [leisure activity]) compared to those with secondary school education (ICC from 0.28 [active transport] to 0.58 [occupational activity]) and those with higher than secondary school education (ICC from 0.23 [sitting activity] to 0.67[active transport]). While reliability coefficients were higher for overall PA (ICC=0.80, 95% CI=0.71- 0.86), active transport (ICC=0.83, 95% CI=0.74- 0.88), occupational PA (ICC=0.79, 95% CI=0.70- 0.86) and 

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leisure-time PA (ICC= 0.79, 95% CI= 0.69- 0.85) among participants that were employed compared to their unemployed counterparts, it was higher for domestic PA (ICC=0.65, 95% CI=0.43- 0.79) and sitting time (ICC= 0.68, 95% CI= 0.36- 0.83) among participants that were unemployed than in the employed subgroup. 

Figures 1, 2 and 3 (Bland-Altman plots) illustrate the agreement in the scores (minutes/week) of total PA, MVPA and sitting between the first and second administrations of Hausa IPAQ-LF. For total PA, the mean difference was 106.7 minutes/week, with a wide 95% limits of agreement (-762.2 to 965.6 minutes/week). For MVPA, the mean difference was about one and half hour per week (91.6 minutes/week), and also demonstrating a wide 95% limits of agreement (-744.5 to 927.7 minutes/week). For sitting time, the mean difference was small (26 minutes/week) and the 95% limits of agreement range from -2178.1 to 2230.9 minutes/week. 

Table 4 shows the patterns of PA across sociodemographic subgroups during the first (IPAO1) and second (IPAQ2) administrations of the modified IPAQ-LF. Overall and across all stratified variables, time spent in PA reported during the first administration tends to be higher than those reported during the second administration. At both time points, men reported significantly (p<0.05) higher mean time (minute/week) in active transportation, occupational PA, and leisure-time PA than women. However, women spent significantly (p<0.001) more time (minutes/week) in domestic PA than men (IPAQ1=236.9 vs 82.3, IPAQ2=195.5 vs 52.4). For educational status, participants that had lower than secondary school education compared to those with at least secondary school education reported statistically significant higher mean time (minutes/week) at both time points for total PA, active transport, occupational PA, walking and vigorous intensity activity compared to those with at least secondary school education. While participants that were employed reported statistically significant (p<0.05) more time (minutes/week) in total PA (IPAO1=441.1 vs 285.1, IPAO2=359.4 vs 141.0), active transportation (IPAO1=43.8 vs 21.1, IPAQ2=36.9 vs 18.3) and work PA (IPAQ1=195.5 vs 41.8, IPAQ2=164.1 vs 40.1) than those who were unemployed, the unemployed reported statistically significant (p<0.05) higher time in domestic activity (IPAQ1=210.6 vs 132.1, IPAQ2=205.0 vs 112.6) compared to the employed. 

## **Construct Validity**

Overall, correlations between energy expenditure (MET-Minutes/week) according to the modified IPAQ-LF and anthropometric and biological measures were statistically significant in the expected direction for all domains and intensities of PA, except for occupation and active transport domains and walking (table 5). In the full sample, domestic PA was mainly related with SBP ( $\rho = -0.27$ , p< 0.01) and DBP ( $\rho = -0.17$ , p< 0.05), while leisure PA and total PA were only related with SBP ( $\rho = -0.16$ , p< 0.05) and BMI ( $\rho = -0.29$ , p< 0.01), respectively. Similarly, moderate-intensity PA was mainly related with SBP ( $\rho = -0.16$ , p< 0.05) and DBP ( $\rho = -0.21$ , p< 0.01), but vigorous-intensity PA was only related with BMI ( $\rho = -0.11$ , p< 0.05). In the gender based analyses, total PA, domestic PA and sedentary time were more consistently related with anthropometric and biological variables. The strongest rho value (-0.41) was found for the relationship between total PA and BMI for the male subgroup. The rho values of -0.23 was reached between total PA and DBP for the women subgroup. Only in women was domestic PA significantly related with BMI ( $\rho = -0.23$ ), DBP ( $\rho = -0.20$ ) and SBP ( $\rho = -0.31$ ). Leisure-time PA ( $\rho = -0.39$ ) and occupational PA ( $\rho = -0.22$ ) were significantly related with BMI only in men. The rho value for the relationship between sitting time and BMI was slightly higher in women (p = 0.19) than men ( $\rho = 0.15$ ). 

## 333 DISCUSSION

This study examined the reliability and an aspect of validity of a modified version of the IPAQ-LF in Nigeria. The findings generally indicated acceptable test-retest reliability and modest construct validity for items of the modified IPAQ-LF among Nigerian adults. To the best of our knowledge, the present study is the only one to examine the reliability and validity of the long version of IPAQ that has been modified specifically to an indigenous African culture and language.

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We found evidence for good reliability with high correlations between the test-retest for total PA, occupational PA, active transportation and vigorous intensity activity. Our results shows that except for domestic PA and sitting time, ICC values for domains of PA were consistently above 0.70, a level of reproducibility that has been considered acceptably good for IPAQ data.[33,34] BMJ Open: first published as 10.1136/bmjopen-2014-005820 on 1 December 2014. Downloaded from http://bmjopen.bmj.com/ on June 8, 2025 at Agence Bibliographique de Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

Similar to a previous IPAO-LF study in Hong Kong, [34] domestic activity demonstrated the lowest ICC value in our study. However, it is possible that the infrequent nature of household activities undertaken, especially by men may account for the low reliability reported for domestic PA in our study. In addition to the traditional African patriarchal belief that make most African men to rarely engage in indoor household activities, men in the high socioeconomic group in Nigeria may also not engage in outdoor domestic activities like gardening and outdoor home. appliances and equipment maintenance because they are able to employ the services of domestic helpers and repair men. Our findings of lower reliability for domestic activity among men, those with more than secondary school education and those who were employed compared to their counterparts seem to support this assumption. 

The highest and strongest reliability coefficients (0.82) were found for both active transportation and vigorous intensity activity. Perhaps, active transportation was more stable, consistent and reproducible overtime than other PA domains because it is a common and ubiquitous PA behaviour in the African region. Mostly, the performance of active transportation especially walking is often out of necessity rather than choice within the African context. Our finding of higher ICC value for vigorous intensity PA is consistent with those of other studies that found the reliability of vigorous intensity activity to be higher compared to that of moderate intensity activity.[10,30,34,35] Compared to structured vigorous physical activities like sports and exercise that can be more easily recalled, moderate intensity PA are often of low salience, incidental and may not easily be remembered by people.[36,37] Further our finding that the reliability of vigorous intensity physical activity was meaningfully higher among men than women seem to confirm our previous findings with the IPAQ-SF.[21] Plausibly men in Nigeria are more consistent than women when responding to PA items that pertained to intense vigorous PA than other intensities of activity. Overall, the moderate to good evidence of reliability found for all items indicates that the modified IPAQ-LF is reproducible, internally consistent and is promising for research in Nigeria. 

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Except for sitting time, the limits of agreement in the mean scores of total PA and MVPA between the first and second administrations were wide, suggesting an evidence of bias between Page 13 of 57

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 administrations. Large difference in PA scores between the 2 administrations would indicate that at least one of two measurements is not accurate. However, similar to the finding of a Mexican study,[38] scores on the Hausa IPAQ-LF were consistently lower during the second administration of the questionnaire compared to the first administration. Because familiarity with the IPAQ questions may improve over multiple exposures to the questionnaire, it is possible that participants in our study might have over-reported their PA levels during the first administration of the Hausa IPAQ-LF. This kind of findings may have implication for the utility of IPAQ for surveillance. Generally, due to issues of social desirability phenomenon and over reporting of PA that has been associated with the IPAO.[39,40] it may be necessary to start considering the need for multiple measurements when using the IPAQ for evaluating PA, especially in developing African countries. However, patterns of PA as measured by the modified IPAQ-LF during both administrations were consistently similar, and both administrations were able to discriminate PA in the expected direction between subgroups of our sample. For example, at both measurement time points, and consistent with hypothesis, men reported more time in active transportation, occupational PA and leisure PA than women, while women reported more time in domestic PA and sedentary activity than men.

In the absence of objective criterion standards for evaluating an absolute estimate of PA, the consistency of items on IPAO with variables known to be related to PA such as body mass index (BMI), blood pressure, heart rate, indicators of lipid and glucose metabolism, and fitness index have been used as important construct validity measures. [7,10,21,24] In the present study, the correlations of the PA domains and intensities with biological and anthropometric variables were mostly significant in the expected direction, but they were low suggesting a modest evidence of construct validity for the modified IPAQ-LF in Nigeria. However, observed correlations were comparable with the values in other studies that have evaluated the IPAQ-LF.[5,7,8,24,30,33,39] Because better validity coefficients have been reported for other PA measures above that of the IPAQ.[39,41] with the present African finding, it is possible that the IPAQ-LF only have modest evidence of construct validity. However, our findings on the relationships between physical activity and biological and anthropometric variables should be interpreted in the light of an important caution. Because hypertensive and obese people may get oriented to exercise,[3] cross-

sectional associations of physical activity and blood pressure or BMI could also occur in the opposite direction and may not represent much information as indicators of construct validity of physical activity measures.

#### Strengths and limitations

A strength of this study is the systematic adaptation and tailoring of items on the IPAO-LF to reflect the common PA behaviours of people in Nigeria. This is the first study in an African country to explore the cultural adaptation and translation of the IPAQ-LF, and its findings demonstrated the feasibility of using the IPAQ-LF to reliably collect PA data in a diverse segment of the Nigerian population. In the Africa region, the importance of a valid and established PA scale like the modified IPAO-LF is not only important to monitoring the domain in which activity is performed, but also very critical to understanding studies of ecological models of health behaviours, that emphasize the importance of multiple levels of influence on health behaviours including PA.[18,42] In Nigeria, emerging evidence from studies using ecological models indicate that favourable built environmental attributes are promising for improving total and moderate-to-vigorous PA and controlling obesity among adults.[26, 43-45] However, built environment characteristics are expected to be strongly related to specific PA types rather than overall PA.[46,47] For example, different environmental variables can be related to walking for leisure or transportation and to moderate PA for household, occupation, recreation or transportation. Thus, a study of adaptation of the IPAQ-LF is very important to understanding the domain specific nature of ecological model research in the African region. One additional strength was the exploration of PA patterns by gender, educational level and employment status, the findings of which were consistent with general hypothesis on social patterns of inactivity in low-income countries.[20,48] 

However, the findings of this study should be interpreted in the light of some important limitations. Direct comparison of our validity findings with previous studies should be made with caution, because unlike in our study, the accelerometer or PA diary were utilized as a common validate IPAO objective criterion standard to the in the majority of the studies. [5,7,8,24,30,33,39] Thus, examining the construct validity through the relationships of 

PA with BMI and resting blood pressure was an important limitation of our study. The choice and availability of appropriate criterion measures are particular issues of concern for the validation of PA questionnaires in low-income countries of Africa [5,49,50]. Despite these issues, the validity coefficients in our study were remarkably similar to those reported in other studies, [5,7,8,24,30,33,39] and the consistency of items on IPAQ with variables known to be related to PA such as BMI, blood pressure, heart rate, indicators of lipid and glucose metabolism, index have previously been used as important construct and fitness validity measures. [7,10,21,24] Another limitation of the study is the use of non-probability sampling technique. The study finding may have limited generalizability to other samples of Nigerians that have different characteristics from this sample. In addition, the majority of participants have more than secondary school education with potentially higher comprehension and recall ability than may be found in the general population. Nevertheless, recruitment from diverse neighbourhoods and settings allowed for a sample with reasonable heterogeneity in age, occupational status, and ethnic backgrounds and made it possible to stratify the analyses by sociodemographic characteristics. However, because some of the participants in the present study required assistance to complete the survey, interview administration rather than self-administration of the IPAQ-LF should be encouraged in any future national studies in the African region. 

## 454 Conclusions

 Overall, the present study suggests that the modified IPAQ-LF demonstrated sufficient evidence of test-retest reliability and may be valid for assessing context specific PA behaviours of adults in Nigeria. Adaptation and criterion evaluation of the IPAQ-LF in other African countries could further contribute to our understanding of the impact of multiple levels of influence on PA behaviours of people in the African region.

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46 47	489	Dataset for this study available upon request from the corresponding author.
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Table 2: Test-reliability based on intra-class correlation coefficient for Hausa IPAQ-LF, overall and by gender

		Total (N=180)		Women (n=90)	Men (n=90)
PA Measure (MET×min/wk)	Test 1 (Mean (SD))	Test 2 (Mean (SD))	ICC (95%CI)	ICC (95%Cl)	ICC (95%Cl)
Total PA, all domain	2160.6 (2691.1)	1612.8 (1612.8)	0.76 (0.65-0.82)	0.45 (0.08-0.67)	0.80 (0.69- 0.87)
Occupation	619.1(1671.5)	497.5 (1332.9)	0.77 (0.68-082)	0.64 (0.46-0.77)	0.78 (0.66 -0.85)
Active Transport	468.1 (684.7)	440.5 (605.7)	0.82 (0.75-0.87)	0.63 (0.40-0.77)	0.83 (0.73 - 0.89)
Domestic	597.6 (754.6)	473.4 (673.7)	0.50 (0.32-0.62)	0.38 (0.01-0.57)	0.33 (-0.01-0.56)
Leisure	377.0 (1096.3)	196.7 (920.2)	0.71 (0.60-0.78)	0.69 (0.53-0.79)	0.75 (0.63-0.84)
Sitting	2263.0 (715.8)	2235.4 (818.9)	0.62 (0.42-0.75)	0.71 (0.46-0.85)	0.48 (0.06-0.72)
PA by Intensity (MET×min/wk)					
Walking	613.6 (635.6)	534.6 (449.1)	0.63 (0.48-0.74)	0.57 (0.29-0.74)	0.65 (0.44-0.78)
Moderate	986.9 (1365.9)	716.1 (1164.6)	0.61 (0.46-0.71)	0.42 (0.11-0.62)	0.67 (0.49-0.78)
Vigorous	526.5 (1543.7)	394.1 (1431.1)	0.82 (0.76-0.87)	0.55 (0.30-0.71)	0.86 (0.78-0.91)

PA= Physical Activity 

MET= Metabolic Energy Turnover

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Table 3: Socioeconomic status differences in test- retest reliability of the Hausa IPAQ- LF (N= 180)

Socioeconomic Status	Overall PA	Active Transport	Occupation PA	Leisure PA	Domestic PA	Sitting
<b>Educational</b> <b>Qualification</b> More than secondary school (n=111)	0.42 (0.08-0.63)	0.67 (0.43-0.78)	0.32 (-0.06-0.57)	0.33 (-0.05-0.57)	0.58 (0.35-0.73)	0.23 (-0.63-0.63)
Secondary School (n=38)	0.55 (0.22-0.74)	0.28 (-0.21-0.57)	0.58 (0.33-0.74)	0.54 (0.25-0.71)	0.50 (0.19-0.69)	0.51 (-0.04-0.76)
Less than Secondary school (n=28)	0.89 (0.67-0.96)	0.90 (0.74-0.96)	0.82 (0.61-0.92)	0.92 (0.83-0.96)	0.90 (0.78-0.95)	0.77 (0.45-0.90)
<b>Employment Category</b> Employed (117)	0.80 (0.67-0.96)	0.83 (0.74-0.88)	0.79 (0.70-0.86)	0.79 (0.69-0.85)	0.36 (0.08-0.56)	0.56 (0.23-0.75)
Unemployed (63)	0.09 (-8.86-0.56)	0.68 (0.44-0.82)	0.16 (-0.39-0.49)	0.25 (-0.24-0.55)	0.65 (0.43-0.79)	0.68 (0.36-0.80)
PA= Physical Activity				200		
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Table 4: Differences in time spent in physical activity overall, and by gender and socioeconomic status sub groups

Gender				Education	Employment			
	<b>Total</b> Mean ± SD	<b>Men</b> Mean ± SD	<b>Women</b> Mean ± SD	>Secondary Mean ± SD	<b>Secondary</b> Mean ± SD	<b>Secondary</b> Mean ± SD	<b>Employed</b> Mean ± SD	Unemployed Mean ± SD
PA by domai	n (min/wk)							
Total PA, all o	domain							
IPAQ1	405.2 (507.8)	460.7 (582.9)	326.8 (367.8)	334.0 (400.8)	384.8 (514.8)	849.2 (764.1)**	441.1 (530.2)	285.1 (408.6
IPAQ2	308.4 (440.3)	319.7 (522.8)	291.9 (282.9)	285.1 (295.1)	184.8 (264.4)	803.0 (929.6)**	359.4 (481.6)	141.0 (185.2
Active Transp	· · · · · ·			× /				<sup>×</sup>
IPAQ1	35.8 (89.7)	52.4 (127.7)	19.5 (17.7)*	28.3 (47.7)	28.9 (45.02)	76.4 (198.7)*	43.8 (109.4)	21.1 (21.9)*
IPAQ2	30.4 (76.7)	41.2 (106.3)	19.3 (17.5)*	23.6 (30.6)	20.3 (30.9)	74.3 (182.6)*	36.9 (94.1)	18.3 (14.7)*
Work				( )	× ,	× ,		( )
IPAQ1	160.1 (380.8)	217.5 (466.8)	79.1 (179.9)*	114.8 (291.0)	122.9 (365.6)	546.7 (615.7)**	195.5 (418.8)	41.8 (162.2)*
IPAQ2	135.3 (310.3)	172.5 (372.8)	80.6 (171.9)*	104.1 (232.2)	160.9 (196.1)	531.6 (595.8)**	164.1 (341.7)	40.1 (133.0)*
Domestic				()				(100.0)
IPAQ1	159.6 (202.2)	82.3 (120.6)	236.9 (235.8)**	* 141 2 (182 4)	173.3 (238.5)	165.4 (159.4)	132.1 (170.7)	210.6 (243.8
IPAQ2	123.9 (163.9)	52.4 (74.9)	195.5 (190.1)**		107.6 (130.4)	147.3 (189.1)	112.6 (163.9)	205.0 (163.3)
Leisure	120.9 (100.9)	52.1 (71.5)	190.0 (190.1)	151.5 (102.5)	107.0 (150.7)	11/13 (10).1)	112.0 (105.7)	-00.0 (100.0
IPAQ1	62.4 (159.1)	75.0 (211.1)	10.5 (27.3)**	47.0 (97.3)	92.7 (209.4)	38.2 (160.1)	69.7 (157.6)	48.7 (162.3)
IPAQ2	30.5 (118.2)	50.6 (160.7)	10.1 (38.5)**	23.4 (51.4)	24.7 (91.4)	71.5 (256.5)	43.1 (143.5)	17.0 (28.7)*
Sitting	50.5 (110.2)	50.0 (100.7)	10.1 (50.5)	25.1 (51.1)	21.7 (91.1)	(200.0)	15.1 (115.5)	17.0 (20.7)
IPAQ1	2263.0 (715.8)	2188 8 (750 7)	2330 7 (674 8)	2280.0 (618.7)	2433.9 (693.7)	2180.0 (760.8)	2159.4 (775.9)	2337 6 (667
IPAQ2	2235.4 (819.9)		· · · ·	· · · ·		2160.0 (1111.4)	2170.6 (870.5)	· · · · · · · · · · · · · · · · · · ·
11 AQ2	2233.4 (017.7)	2200.7 (910.9)	2239.0 (720.1)	2420.7 (050.7)	2213.3 (003.1)	2100.0 (1111.4)	2170.0 (070.5)	2202.0 (705.
PA by Intens	ity (min/wk)							
Walking			100 0 (100 0) *					
IPAQ1	178.5 (221.5)	241.1 (271.9)	128.2 (100.8)*		133.4 (85.6)	266.9 (285.4)*	192.0 (245.7)	133.3 (96.2)*
IPAQ2	142.5 (141.8)	148.5 (137.9)	133.7 (147.9)	151.7 (138.4)	103.6(94.7)	200.3 (209.1)*	150.7 (146.6)	115.4 (122.7
Moderate								
IPAQ1	201.9 (326.9)	193.0 (214.5)	214.5 (247.8)	187.3 (266.5)	194.9 (386.5)	309.7 (381.7)	221.2 (347.4)	137.7 (239.9)
IPAQ2	133.9 (238.5)	114.2 (276.9)	162.7 (165.6)	132.9 (177.8)	88.0 (197.2)	319.0 (482.1)*	153.9 (266.2)	68.0 (76.4)*
Vigorous								
IPAQ1	94.1 (211.8)	123.7 (249.6)	52.2 (133.2)*	32.9 (81.9)	129.5 (208.2)	268.0 (459.7)**	90.2 (214.6)	127.1 (204.6
IPAQ2	78.4 (206.9)	86.8 (227.4)	46.2 (73.4)	52.2 (140.2)	55.2 (127.0)	292.8 (461.5)**	92.8 (226.9)	130.9 (107.8)
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	<b>Overall (N = 180)</b>			Female (n = 90)			Male (n = 90)		
MET×min/wk	BMI	DBP	SBP	BMI	DBP	SBP	BMI	DBP	SBP
PA Domains									
Total PA	-0.29**	-0.17*	-0.09	-0.09	-0.23**	-0.04	-0.41**	-0.08	-0.1
Occupation PA	-0.12	-0.09	0.01	0.02	0.02	-0.05	-0.22**	-0.17	-0.0
Active transport PA	-0.05	-0.04	-0.01	-0.10	-0.13	-0.02	-0.04	-0.02	-0.8
Domestic PA	-0.07	-0.17*	-0.26**	-0.23**	-0.20*	-0.31**	0.04	-0.14	-0.0
Leisure PA	0.09	-0.08	-0.16*	-0.11	0.02	0.08	-0.39**	-0.12	-0.
Sitting	0.16	-0.09	0.04	0.19	0.12	0.05	0.15	-0.09	0.0
PA Intensity									
Walking	0.90	-0.09	-0.03	0.19	-0.05	0.08	-0.05	-0.11	-0.1
Moderate	-0.02	0.21*	0.16*	0.02	-0.14	-0.08	0.02	-0.25**	-0
Vigorous	-0.11*	-0.06	0.03	-0.16	0.01	0.02	-0.13*	-0.12	-0.1

Table 5: Construct validity of Hausa IPAQ-LF: Spearman correlations between energy expenditure (MET×min/wk) from Hausa IPAQ-LF, and anthropometric and biological variables (N=180)

MET= Metabolic Energy Turnover

BMI= Body Mass Index

DBP= Diastolic Blood Pressure

SBP= Systolic Blood Pressure

PA= Physical activity

\*=p<0.05, 

\*\*=p<0.01

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11 12	5	Majidadi <sup>1</sup> , Adetoyeje Y. Oyeyemi <sup>1</sup>
13	6	
14 15	7	<sup>1</sup> Department of Physiotherapy, College of Medical Sciences, University of Maiduguri,
16	8	Nigeria <sup>2</sup> Description of Discription Lee University Translater University I. Nigeria
17 18	9 10	<sup>2</sup> Department of Physiotherapy, Jos University Teaching Hospital, Nigeria
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22 23	13	*Correspondence to Dr. Adewale L. Oyeyemi, Department of Physiotherapy, College of
24	14	Medical Sciences, University of Maiduguri, Nigeria. Email: <u>alaoyevemi@yahoo.com;</u>
25 26	15	Telephone: +234-802-945-8230
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Adetoyeje Y. Oyeyemi <sup>1</sup>
nt of Physiotherapy, College of Medical Sciences, University of Maiduguri,
ent of Physiotherapy, Jos University Teaching Hospital, Nigeria
ndence to Dr. Adewale L. Oyeyemi, Department of Physiotherapy, College of
iences, University of Maiduguri, Nigeria. Email: <u>alaovevemi@yahoo.com;</u>
+234-802-945-8230
Physical activity, measurements, public health, IPAQ, Nigeria
ts: 4338
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- ABSTRACT **Objectives:** To investigate the reliability and aspect of validity of a modified version of the long International Physical Activity Questionnaire (Hausa IPAQ-LF) in Nigeria. Design: Cross-sectional study, examining the reliability and construct validity of the Hausa IPAQ-LF compared with anthropometric and biological variables. Setting: Metropolitan Maiduguri, the capital city of Borno State in Nigeria. **Participants:** 180 Nigerian adults (50% women) with a mean age of 35.6 (SD=10.3) years, purposively selected from neighbourhood with diverse socioeconomic status and walkability. **Outcome measures:** Domains (domestic physical activity [PA], occupational PA, leisure-time PA, active transportation and sitting time) and intensities of PA (vigorous, moderate and walking) were measured with the Hausa IPAQ-LF on two different occasions, eight days apart. Outcomes for construct validity were measured BMI, SBP and DBP. **Results:** The Hausa IPAQ-LF demonstrated good test-retest reliability (ICC>75) for total PA (ICC=0.79, 95% CI=0.65-0.82), occupational PA (ICC=0.77, 95% CI=0.68-0.82), active transportation (ICC=0.82, 95% CI=0.75-0.87) and vigorous intensity activities (ICC=0.82, 95% CI=0.76-0.87). Reliability was substantially higher for total PA (ICC=0.80), occupational PA (ICC=0.78), leisure-time PA (ICC=0.75) and active transportation (ICC=0.80) in men than women, but domestic PA (ICC=0.38) and sitting time (ICC=0.71) demonstrated substantial reliability coefficients in women than men. For the construct validity, domestic PA was significantly related mainly with SBP ( $\rho = -0.27$ ) and DBP ( $\rho = -0.17$ ), and leisure-time PA and total PA were significantly related only with SBP ( $\rho = -0.16$ ) and BMI (( $\rho = -0.29$ ), respectively. Similarly, moderate-intensity PA was mainly related with SBP ( $\rho = -0.16$ , p< 0.05) and DBP ( $\rho$ = -0.21, p< 0.01), but vigorous-intensity PA was only related with BMI ( $\rho$  = -0.11, p< 0.05). Conclusions: The modified Hausa IPAQ-LF demonstrated sufficient evidence of test-retest
  - reliability and may be valid for assessing context specific PA behaviours of adults in Nigeria.

#### 

**ARTICLE SUMMARY** Strengths and limitations of this study. Systematic adaptation and tailoring of items on the original IPAQ-LF to reflect the common PA behaviours of adults in Nigeria. The first study to describe the cultural adaptation and translations of the IPAQ-LF and explore its psychometric relevance in an African country. Findings establish evidence to support the feasibility of using a modified IPAQ-LF to reliably collect context specific PA behaviours of adults in the African region. Exploring construct validity through the relationships of PA with BMI and resting blood pressure was an important limitation of this study. The use of non-probability sampling technique may limit generalizability of findings to other cha. samples of Nigerian adults with different characteristics from the study's sample.

The importance of physical activity (PA) for promoting health and preventing disease is well established.[1-3] However, for effective health promotion and PA surveillance and monitoring, it is important to have standardized, reliable and valid instruments that can be used to accurately describe population levels and patterns of PA within and across countries.[4, 5] In this context, the international physical activity questionnaire (IPAQ) was developed to obtain internationally comparable data on health-related PA of adults (18-65 years).[5, 6] Two versions of the IPAO that could be administered by interview or self-completed were developed. The short form (SF) was designed for population surveillance of PA; while the long form (LF) was designed to be appropriate for use in research that requires detailed information on different PA domains, including PA at work, household, during leisure and transportation, and time spent in sedentary activities.[6] 

The initial evaluation of the IPAQ across 12 countries produced acceptable evidence of reliability and validity that are as good as other self-report measures of PA.[5] Consequently, in order to enhance the utility of IPAQ and to further evaluate its psychometrics worldwide, efforts have been made to translate and adapt the IPAQ in many other countries, but most of the research in this context were from the Western developed countries.[7-14] In Africa, the psychometric properties of IPAO have only been tested in South-Africa as part of the initial development process of the questionnaire, [5] and in older adults. [15] Because the largest increases and burden of non-communicable diseases (NCDs) are in the low-income countries where the understanding of evidence-based strategies for increasing PA remains poor,[16-19] improving PA research is a top priority for low-income countries.[20] However, to advance PA research in Africa, it is important to first develop or tailor standardized measures to be culturally sensitive to PA behaviours of people in the region countries. Because Nigeria is the most populous country in Africa with culture and languages similar to most of the other West African countries, it is a good choice to evaluate the IPAQ for cultural and psychometric relevance in this country. 

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Recently, a cultural adaptation study of the IPAQ-SF was conducted among adults in Nigeria,[21] with good evidence of test-retest reliability similar to findings in some other studies.[10, 22-24] However, because the IPAQ-SF is not domain specific and does not provide context specific information on PA behaviour, it is important to evaluate the IPAQ-LF for relevance in Nigeria. Psychometric evaluation of a culturally modified version of the IPAQ-LF in sub-Saharan African countries can impact PA research and surveillance in the African region where the prevalence of inactivity related NCDs is on the increase. [20, 25] The aim of the present study was to investigate the reliability and an aspect of validity of a modified version of the IPAQ-LF among adults in Nigeria. 

#### 146 METHODS

3 147

#### 148 Participants

A purposive sample of 180 adults from eight neighbourhoods that varied in socioeconomic status and walkability in Maiduguri city were recruited for the study. The sampling and neighbourhood selection strategy have been described in details elsewhere.[26] Maiduguri with an estimated population of 749,123 people is the largest and capital city of Borno State in North-Eastern Nigeria.[27] The city attracts immigrants from neighbouring countries of Cameroon, Niger and Chad Republic, and Hausa language is the common means of communication for commercial activities among the diverse inhabitants of Maiduguri.[27, 28] Participants were eligible for this study if they were willing to self-complete a written survey twice in either Hausa or English Language. However, researchers (UMB and STP) were in attendance to provide translation and interpretation assistance to participants (n=11) who were unable to independently complete the survey. Additional eligibility criteria included living within the identified neighbourhood categories in the last 12 months, being adults (18-65 years) and not having any disability that prevented independent walking. All participants were fully informed of the study protocol and provided signed informed consent. The study protocol was approved by the Research and Ethic Committee of the University of Maiduguri Teaching Hospital, Maiduguri, Nigeria. Data were collected between March and May, 2012.

#### **BMJ Open**

#### Measures The adapted international physical activity questionnaire-long Hausa version The cultural adaptation, translation and back translation of the Hausa version of IPAQ-LF is similar to that of the Hausa IPAQ-SF that has been described in details elsewhere.[21] Briefly, interviews were conducted with public health experts, exercise scientists and not highly educated local people to identify the items and examples of PA on the original questionnaires that needed to be culturally adapted. Several cultural adaptations were made to the original items to reflect the reality in Nigeria. First, adjustments to English words like vigorous and moderate activity that can be misunderstood and not associated with PA behaviours in Nigeria were replaced with words that are more representative of the language used in Nigeria, like 'very hard' and 'hard' respectively. Second, examples of various intensities of activity that were common in the Nigerian culture were added, and those already on the questionnaire but not common in the Nigerian context were replaced with culturally applicable examples that are equivalent in energy intensity (METs) with the original items and examples. Third, concepts like physical activity and walking for transportation that were misconstrued outside the health context were refined to indicate they were referring to health behaviours.

After adaptation, the questionnaire was independently translated from English into Hausa language by two native speakers of Hausa who also speaks English, and able to read and write in both languages. One of the translators was familiar with the questionnaire and the second was an expert in Hausa language. The translated questionnaires were mutually revised by the translators and the research team for consistency and then back translated into English language by a third bilingual person who was familiar with the construct measured by IPAQ. The back translated version was checked by the research team for any discrepancies and to ensure that the construct measures by IPAQ had not been lost during the adaptation and translation process. 

 The modified questionnaire (available in both Hausa and English language), hereafter referred to as the Hausa version of the long international physical activity questionnaire (Hausa IPAQ-LF), contains thirty-one questions that asked about physical activity done in the last 7-days in terms of frequency (days/week) and duration (minutes/day) spent in four activity domains (transportation,

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occupation, domestic and leisure time), and included sections on walking, moderate- and vigorous- intensity activities, and time spent in sedentary behaviours (sitting during leisure and motorized transportation). The Hausa IPAQ-LF data were presented as the MET-minute/week for total walking, moderate, and vigorous intensity activity and overall physical activity across the four domains, and in each of the domains. The MET intensity values used to score the Hausa IPAQ-LF questions in this study were 8 METs for vigorous activity, 4 METs for moderate activity and 3.3 METs for walking, [2, 6] One MET represents the energy expended while sitting quietly at rest and is equivalent to 3.5 ml/kg/min of VO<sub>2</sub> Max.[3] To assess the test-retest reliability of the Hausa IPAQ-LF, participants self-completed all items on the measure twice, with an interval of one week between administrations. 

207 Anthropometrical and biological measurements

Body weight (to nearest 0.5 kg) and Height (to nearest 0.1 cm) were measured in light clothing using a digital scale and stadiometer. Body mass index (BMI) was calculated as body weight divided by the square of height  $(kg/m^2)$ . The principal cutoff points as recommended by WHO were used to create the categories: underweight (< 18.5 kg/m<sup>2</sup>), normal weight (18.5 - < 25 kg/m<sup>2</sup>), overweight  $(25 - \langle 30 \text{ kg/m}^2)$  and obese  $(\geq 30 \text{ kg/m}^2)$ .[29] Resting blood pressure and heart rate were measured with Digital Sphygmomanometer (Diagnostic Advanced Wrist Blood Pressure Monitor, Model 6016, USA). Body mass index and resting diastolic blood pressure (DBP) have previously been used for validating the IPAQ.[7,24] Similarly, for this study, construct validity was evaluated by investigating the relationship of outcomes from the Hausa IPAQ-LF with anthropometric (BMI) and biological (SBP and DBP) measurements, and also in part by comparing the differences in time spent in PA and sitting across sociodemograpic subgroups. These types of validation for PA measures have been referred as indirect or construct validity in previous studies.[7,24,30] 

 222 Sociodemographic Characteristics

Information on age, gender, marital status, religion, income, educational level and employment
 status were elicited from the participants. Marital status was classified as married or not married.
 Educational level was classified as more than secondary school education, secondary school

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education and less than secondary school education. Employment status was classified into white collar (government or private employed), blue collar (self- employed, trader, artisan etc) and unemployed (homemaker, student, retired, or unable to find job).

# 11230Data Analysis12

Descriptive data were reported as mean, standard deviation and percentages. Mean group differences for continuous variables by gender were examined by independent t-test, and for dichotomous variables by chi-square statistics. The reliability analyses were performed using 2 strategies. First, the two- way mixed model (single measure) intraclass correlation coefficient (ICC) with 95% confidence interval (CI) between the continuous scores obtained on 1<sup>st</sup> and 2<sup>nd</sup> administration of the Hausa IPAQ-LF was calculated. The ICCs were calculated overall, and by gender and socioeconomic status. ICC estimates >0.75 were considered as good reliability scores, between 0.50 and 0.75 as moderate reliability and <0.50 as poor reliability.[31] Second, the Bland and Altman Method was used to assess agreement on scores of PA from the 1<sup>st</sup> and 2<sup>nd</sup> administrations.[32] Variables used for the Bland and Altman analysis were weekly time spent in moderate-to-vigorous activity (MVPA), total PA and sitting. MVPA was computed by summing the total minutes/week of reported physical activity of moderate and vigorous- intensities across all four domains. For total PA, the total minutes/week of activities in each domain were summed (total work + total transport + total domestic + total leisure-time min/week scores) to gain an overall estimate of physical activity in a week. Also, the independent t-test and one-Way ANOVA were used as appropriate to compare the time spent (minutes/week) in PA at both administrations across sociodemographic subgroups. To assess construct validity, the non-parametric Spearman correlation coefficients  $(\rho)$  were utilized to explore the relationship between MET-min/week of PA from the Hausa IPAQ- LF, and resting blood pressure and body mass index. Data were analyzed using Statistical Package for the Social Science (SPSS), version 15.0 for windows (SPSS Inc., Chicago, Illinois, USA) and the level of significance was set at p<0.05. 

- **RESULTS**

The socio-demographic characteristic of the participants are shown in Table 1. The participants comprised 50% women and men, with a mean age of  $35.6 \pm 10.3$  years and body mass index of  $23.8 \pm 3.9$ kg/m<sup>2</sup>. Majority of the participants were married (58.9%, n=106), had more than secondary school education (62.7%, n=111) and were employed (75%, n=117). Compared to men, the women were more likely to be married (71.1% vs 46.7%, p=0.001) and unemployed (52.2% vs 17.8%, p<0.001), but men were more likely to have more than secondary school education (76.7% vs 48.2%, p<0.001).

**Reliability** 

Table 2 shows the test-retest reliability of the modified IPAQ-LF. Overall, reliability coefficients were good (ICC >75) for total PA, occupational PA, active transportation and vigorous intensity (very hard) PA. Domestic PA, sitting activity and leisure PA demonstrated moderate reliability (ICC ranges from 0.51- 0.71). While, the reliability coefficients of total PA (ICC=0.80, 95% CI=0.69-0.87), active transportation (ICC=0.83, 95% CI=0.73-0.89), occupational PA (ICC=0.78, 95% CI=0.66-0.85) and leisure time PA (ICC=0.75, 95% CI=0.63-0.84) were substantially higher among men than women, reliability coefficients for domestic PA (ICC=0.38, 95%, CI=0.01-0.57) and sitting time (ICC=0.71, 95% CI=0.46-0.85) were higher among women than men. According to the intensity of PA, ICCs range between 0.61 and 0.82, with the lowest value recorded for moderate intensity (hard) PA and the highest value for vigorous intensity (very hard) PA. The reliability coefficients for walking, moderate-intensity (hard) and vigorous intensity (very hard) activities were substantially greater in men than women. 

Similarly, socioeconomic status differences were observed in the reliability coefficients of the modified IPAQ-LF (Table 3). Across all domains of PA, reliability coefficients were substantially higher among participants with less than secondary school education (ICC from 0.77 [sitting activity] to 0.92 [leisure activity]) compared to those with secondary school education (ICC from 0.28 [active transport] to 0.58 [occupational activity]) and those with higher than secondary school education (ICC from 0.23 [sitting activity] to 0.67[active transport]). While reliability coefficients were higher for overall PA (ICC=0.80, 95% CI=0.71- 0.86), active transport (ICC=0.83, 95% CI=0.74- 0.88), occupational PA (ICC=0.79, 95% CI=0.70- 0.86) and 

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leisure-time PA (ICC= 0.79, 95% CI= 0.69- 0.85) among participants that were employed
compared to their unemployed counterparts, it was higher for domestic PA (ICC=0.65, 95%
CI=0.43- 0.79) and sitting time (ICC= 0.68, 95% CI= 0.36- 0.83) among participants that were
unemployed than in the employed subgroup.

Figures 1, 2 and 3 (Bland-Altman plots) illustrate the agreement in the scores (minutes/week) of total PA, MVPA and sitting between the first and second administrations of Hausa IPAQ-LF. For total PA, the mean difference was 106.7 minutes/week, with a wide 95% limits of agreement (-762.2 to 965.6 minutes/week). For MVPA, the mean difference was about one and half hour per week (91.6 minutes/week), and also demonstrating a wide 95% limits of agreement (-744.5 to 927.7 minutes/week). For sitting time, the mean difference was small (26 minutes/week) and the 95% limits of agreement range from -2178.1 to 2230.9 minutes/week. 

Table 4 shows the patterns of PA across sociodemographic subgroups during the first (IPAO1) and second (IPAQ2) administrations of the modified IPAQ-LF. Overall and across all stratified variables, time spent in PA reported during the first administration tends to be higher than those reported during the second administration. At both time points, men reported significantly (p<0.05) higher mean time (minute/week) in active transportation, occupational PA, and leisure-time PA than women. However, women spent significantly (p<0.001) more time (minutes/week) in domestic PA than men (IPAQ1=236.9 vs 82.3, IPAQ2=195.5 vs 52.4). For educational status, participants that had lower than secondary school education compared to those with at least secondary school education reported statistically significant higher mean time (minutes/week) at both time points for total PA, active transport, occupational PA, walking and vigorous intensity activity compared to those with at least secondary school education. While participants that were employed reported statistically significant (p<0.05) more time (minutes/week) in total PA (IPAO1=441.1 vs 285.1, IPAO2=359.4 vs 141.0), active transportation (IPAO1=43.8 vs 21.1, IPAQ2=36.9 vs 18.3) and work PA (IPAQ1=195.5 vs 41.8, IPAQ2=164.1 vs 40.1) than those who were unemployed, the unemployed reported statistically significant (p<0.05) higher time in domestic activity (IPAQ1=210.6 vs 132.1, IPAQ2=205.0 vs 112.6) compared to the employed. 

# **Construct Validity**

Overall, correlations between energy expenditure (MET-Minutes/week) according to the modified IPAQ-LF and anthropometric and biological measures were statistically significant in the expected direction for all domains and intensities of PA, except for occupation and active transport domains and walking (table 5). In the full sample, domestic PA was mainly related with SBP ( $\rho = -0.27$ , p< 0.01) and DBP ( $\rho = -0.17$ , p< 0.05), while leisure PA and total PA were only related with SBP ( $\rho = -0.16$ , p< 0.05) and BMI ( $\rho = -0.29$ , p< 0.01), respectively. Similarly, moderate-intensity PA was mainly related with SBP ( $\rho = -0.16$ , p< 0.05) and DBP ( $\rho = -0.21$ , p< 0.01), but vigorous-intensity PA was only related with BMI ( $\rho = -0.11$ , p< 0.05). In the gender based analyses, total PA, domestic PA and sedentary time were more consistently related with anthropometric and biological variables. The strongest rho value (-0.41) was found for the relationship between total PA and BMI for the male subgroup. The rho values of -0.23 was reached between total PA and DBP for the women subgroup. Only in women was domestic PA significantly related with BMI ( $\rho = -0.23$ ), DBP ( $\rho = -0.20$ ) and SBP ( $\rho = -0.31$ ). Leisure-time PA ( $\rho = -0.39$ ) and occupational PA ( $\rho = -0.22$ ) were significantly related with BMI only in men. The rho value for the relationship between sitting time and BMI was slightly higher in women (p = 0.19) than men ( $\rho = 0.15$ ). 

34 332

## 333 DISCUSSION

This study examined the reliability and an aspect of validity of a modified version of the IPAQ-LF in Nigeria. The findings generally indicated acceptable test-retest reliability and modest construct validity for items of the modified IPAQ-LF among Nigerian adults. To the best of our knowledge, the present study is the only one to examine the reliability and validity of the long version of IPAQ that has been modified specifically to an indigenous African culture and language.

We found evidence for good reliability with high correlations between the test-retest for total PA, occupational PA, active transportation and vigorous intensity activity. Our results shows that except for domestic PA and sitting time, ICC values for domains of PA were consistently above 0.70, a level of reproducibility that has been considered acceptably good for IPAQ data.[33,34]

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Similar to a previous IPAO-LF study in Hong Kong, [34] domestic activity demonstrated the lowest ICC value in our study. However, it is possible that the infrequent nature of household activities undertaken, especially by men may account for the low reliability reported for domestic PA in our study. In addition to the traditional African patriarchal belief that make most African men to rarely engage in indoor household activities, men in the high socioeconomic group in Nigeria may also not engage in outdoor domestic activities like gardening and outdoor home. appliances and equipment maintenance because they are able to employ the services of domestic helpers and repair men. Our findings of lower reliability for domestic activity among men, those with more than secondary school education and those who were employed compared to their counterparts seem to support this assumption. 

The highest and strongest reliability coefficients (0.82) were found for both active transportation and vigorous intensity activity. Perhaps, active transportation was more stable, consistent and reproducible overtime than other PA domains because it is a common and ubiquitous PA behaviour in the African region. Mostly, the performance of active transportation especially walking is often out of necessity rather than choice within the African context. Our finding of higher ICC value for vigorous intensity PA is consistent with those of other studies that found the reliability of vigorous intensity activity to be higher compared to that of moderate intensity activity.[10,30,34,35] Compared to structured vigorous physical activities like sports and exercise that can be more easily recalled, moderate intensity PA are often of low salience, incidental and may not easily be remembered by people.[36,37] Further our finding that the reliability of vigorous intensity physical activity was meaningfully higher among men than women seem to confirm our previous findings with the IPAQ-SF.[21] Plausibly men in Nigeria are more consistent than women when responding to PA items that pertained to intense vigorous PA than other intensities of activity. Overall, the moderate to good evidence of reliability found for all items indicates that the modified IPAQ-LF is reproducible, internally consistent and is promising for research in Nigeria. 

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 Except for sitting time, the limits of agreement in the mean scores of total PA and MVPA between the first and second administrations were wide, suggesting an evidence of bias between

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administrations. Large difference in PA scores between the 2 administrations would indicate that at least one of two measurements is not accurate. However, similar to the finding of a Mexican study, [38] scores on the Hausa IPAQ-LF were consistently lower during the second administration of the questionnaire compared to the first administration. Because familiarity with the IPAQ questions may improve over multiple exposures to the questionnaire, it is possible that participants in our study might have over-reported their PA levels during the first administration of the Hausa IPAQ-LF. This kind of findings may have implication for the utility of IPAQ for surveillance. Generally, due to issues of social desirability phenomenon and over reporting of PA that has been associated with the IPAQ, [39,40] it may be necessary to start considering the need for multiple measurements when using the IPAQ for evaluating PA, especially in developing African countries. However, patterns of PA as measured by the modified IPAQ-LF during both administrations were consistently similar, and both administrations were able to discriminate PA in the expected direction between subgroups of our sample. For example, at both measurement time points, and consistent with hypothesis, men reported more time in active transportation, occupational PA and leisure PA than women, while women reported more time in domestic PA and sedentary activity than men.

In the absence of objective criterion standards for evaluating an absolute estimate of PA, the consistency of items on IPAQ with variables known to be related to PA such as body mass index (BMI), blood pressure, heart rate, indicators of lipid and glucose metabolism, and fitness index have been used as important construct validity measures. [7,10,21,24] In the present study, the correlations of the PA domains and intensities with biological and anthropometric variables were mostly significant in the expected direction, but they were low suggesting a modest evidence of construct validity for the modified IPAQ-LF in Nigeria. However, observed correlations were comparable with the values in other studies that have evaluated the IPAQ-LF.[5,7,8,24,30,33,39] Because better validity coefficients have been reported for other PA measures above that of the IPAQ.[39,41] with the present African finding, it is possible that the IPAQ-LF only have modest evidence of construct validity. However, our findings on the relationships between physical activity and biological and anthropometric variables should be interpreted in the light of an important caution. Because hypertensive and obese people may get oriented to exercise,[3] cross-

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sectional associations of physical activity and blood pressure or BMI could also occur in the opposite direction and may not represent much information as indicators of construct validity of physical activity measures.

#### Strengths and limitations

A strength of this study is the systematic adaptation and tailoring of items on the IPAO-LF to reflect the common PA behaviours of people in Nigeria. This is the first study in an African country to explore the cultural adaptation and translation of the IPAQ-LF, and its findings demonstrated the feasibility of using the IPAQ-LF to reliably collect PA data in a diverse segment of the Nigerian population. In the Africa region, the importance of a valid and established PA scale like the modified IPAO-LF is not only important to monitoring the domain in which activity is performed, but also very critical to understanding studies of ecological models of health behaviours, that emphasize the importance of multiple levels of influence on health behaviours including PA.[18,42] In Nigeria, emerging evidence from studies using ecological models indicate that favourable built environmental attributes are promising for improving total and moderate-to-vigorous PA and controlling obesity among adults.[26, 43-45] However, built environment characteristics are expected to be strongly related to specific PA types rather than overall PA.[46,47] For example, different environmental variables can be related to walking for leisure or transportation and to moderate PA for household, occupation, recreation or transportation. Thus, a study of adaptation of the IPAQ-LF is very important to understanding the domain specific nature of ecological model research in the African region. One additional strength was the exploration of PA patterns by gender, educational level and employment status, the findings of which were consistent with general hypothesis on social patterns of inactivity in low-income countries.[20,48] 

However, the findings of this study should be interpreted in the light of some important limitations. Direct comparison of our validity findings with previous studies should be made with caution, because unlike in our study, the accelerometer or PA diary were utilized as a common validate IPAO objective criterion standard to the in the majority of the studies.[5,7,8,24,30,33,39] Thus, examining the construct validity through the relationships of 

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PA with BMI and resting blood pressure was an important limitation of our study. The choice and availability of appropriate criterion measures are particular issues of concern for the validation of PA questionnaires in low-income countries of Africa [5,49,50]. Despite these issues, the validity coefficients in our study were remarkably similar to those reported in other studies, [5,7,8,24,30,33,39] and the consistency of items on IPAQ with variables known to be related to PA such as BMI, blood pressure, heart rate, indicators of lipid and glucose metabolism, fitness index have previously been used as important construct validity and measures. [7,10,21,24] Another limitation of the study is the use of non-probability sampling technique. The study finding may have limited generalizability to other samples of Nigerians that have different characteristics from this sample. In addition, the majority of participants have more than secondary school education with potentially higher comprehension and recall ability than may be found in the general population. Nevertheless, recruitment from diverse neighbourhoods and settings allowed for a sample with reasonable heterogeneity in age, occupational status, and ethnic backgrounds and made it possible to stratify the analyses by sociodemographic characteristics. However, because some of the participants in the present study required assistance to complete the survey, interview administration rather than self-administration of the IPAQ-LF should be encouraged in any future national studies in the African region. 

#### 454 Conclusions

Overall, the present study suggests that the modified IPAQ-LF demonstrated sufficient evidence of test-retest reliability and may be valid for assessing context specific PA behaviours of adults in Nigeria. Adaptation and criterion evaluation of the IPAQ-LF in other African countries could further contribute to our understanding of the impact of multiple levels of influence on PA behaviours of people in the African region. 

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4 5 6 7 8 9 10 11 21 31 41 51 61 71 81 92 21 22 32 42 52 62 72 82 93 31 32 33 43 53 63 73 83 94 41 42 43 44 54 64 74 84 95 51 52 53 54 55 65 55 55 55 55 55 55 55 55 55 55 55	465	Acknowledgments
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	468	
	469	Contributors
	470	ALO conceived and designed the study, contributed to cultural adaptation and acquisition of
	471	data, conducted the statistical analysis and interpretation of data and drafted the manuscript.
	472	UMB and STP managed participants' recruitment and data collection and contributed to cultural
	473	adaptation. HBN and RDM contributed to cultural adaptation and translations of the measure.
	474	AYO contributed to study design, acquisition of data and critically revised the manuscript for
	475	important intellectual contents. All authors read and approved the final manuscript.
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	481	Competing interests
	482	Authors declare there is no competing interest associated with this study.
	483	
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	485	Research and Ethic Committee of the University of Maiduguri Teaching Hospital, Nigeria
	486	(ADM/TH/EC/75).
	487	
	488	Data sharing process
	489	Dataset for this study available upon request from the corresponding author.
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Women

(n=90, 50%)

 $35.5 \pm 11.9$ 

26(28.9)

64(71.1)

 $23.8 \pm 4.4$ 

10 (11.1)

49 (54.4)

31 (34.5)

11(12.2)

21(23.3)

51(56.7)

17(19.5)

28(32.5)

42(48.2)

47(52.2)

17(18.9)

26(28.9)

3(3.3)

4(4.4)

Men

(n=90, 50%)

 $35.7\pm8.3$ 

48(53.3)

42(46.7)

 $23.8 \pm 3.5$ 

4(4.4)

58 (64.4)

28 (31.2)

10.1(11.1)

5(5.6)

6(6.7)

23(25.6)

46 (51.1)

11 (12.2) 10(11.1)

69 (76.7)

16(17.8)

28(31.1)

46(51.1)

674 675	Variables	Total sample	M
676	variables	(N=180)	(n=90,
677		(11 100)	(II <i>)</i> 0,
578	Age (years)		
9	Mean (± SD)	$35.6 \pm 10.3$	35.7
)			
1	Marital status (n, %)*		
2	Not Married	74(41.1)	48(5
3	Married	106(58.9)	42(4
1			
	$BMI (Kg/m^2)$		22.0
5	Mean (± SD)	$23.8 \pm 3.9$	23.8
	BMI Category (n, %)		
3	Underweight	14 (7.8)	4 (4
)	Normal weight	107 (59.4)	58 (
	Overweight/obese	59 (32.8)	28 (
		05 (02.0)	20 (
3	Ethnicity (n, %)		
ŀ	Hausa/Fulani	21(11.7)	10.1
;	Igbo	8(4.4)	5(5.
	Yoruba	10(5.6)	6(6.
7	Kanuri/Shuwa Arab	44(24.4)	23(2
8	Others	97(53.9)	46 (
9			
0	Educational level (n, %) <sup>3</sup>		
1	> Secondary School	111 (62.7)	11 (
<u>2</u> 3	Secondary	38 (21.5)	10 (
	<secondary school<="" td=""><td>28 (15.8)</td><td>69 (</td></secondary>	28 (15.8)	69 (
	Dogunational Status ( (	)/ )*	
	Occupational Status (n, 9 Unemployed	63(35)	16(1
	Unemployed	05(55)	10(1

45(25)

72(40)

\*- Significant difference between samples (p < 0.05)

Blue Collar

White Collar

**BMI-** Body Mass Index

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Table 2: Test-reliability based on intra-class correlation coefficient for Hausa IPAQ-LF, overall and by gender

		Total (N=180)		Women (n=90)	Men (n=90)
PA Measure (MET×min/wk)	Test 1 (Mean (SD))	Test 2 (Mean (SD))	ICC (95%CI)	ICC (95%Cl)	ICC (95%Cl)
Total PA, all domain	2160.6 (2691.1)	1612.8 (1612.8)	0.76 (0.65-0.82)	0.45 (0.08-0.67)	0.80 (0.69- 0.87)
Occupation	619.1(1671.5)	497.5 (1332.9)	0.77 (0.68-082)	0.64 (0.46-0.77)	0.78 (0.66 -0.85)
Active Transport	468.1 (684.7)	440.5 (605.7)	0.82 (0.75-0.87)	0.63 (0.40-0.77)	0.83 (0.73 - 0.89)
Domestic	597.6 (754.6)	473.4 (673.7)	0.50 (0.32-0.62)	0.38 (0.01-0.57)	0.33 (-0.01-0.56)
Leisure	377.0 (1096.3)	196.7 (920.2)	0.71 (0.60-0.78)	0.69 (0.53-0.79)	0.75 (0.63-0.84)
Sitting	2263.0 (715.8)	2235.4 (818.9)	0.62 (0.42-0.75)	0.71 (0.46-0.85)	0.48 (0.06-0.72)
PA by Intensity (MET×min/wk)					
Walking	613.6 (635.6)	534.6 (449.1)	0.63 (0.48-0.74)	0.57 (0.29-0.74)	0.65 (0.44-0.78)
Moderate	986.9 (1365.9)	716.1 (1164.6)	0.61 (0.46-0.71)	0.42 (0.11-0.62)	0.67 (0.49-0.78)
Vigorous	526.5 (1543.7)	394.1 (1431.1)	0.82 (0.76-0.87)	0.55 (0.30-0.71)	0.86 (0.78-0.91)

PA= Physical Activity

MET= Metabolic Energy Turnover

Table 3: Socioeconomic status differences in test- retest reliability of the Hausa IPAQ- LF (N= 180)

Socioeconomic Status	Overall PA	Active Transport	Occupation PA	Leisure PA	Domestic PA	Sitting
<b>Educational</b> <b>Qualification</b> More than secondary school (n=111)	0.42 (0.08-0.63)	0.67 (0.43-0.78)	0.32 (-0.06-0.57)	0.33 (-0.05-0.57)	0.58 (0.35-0.73)	0.23 (-0.63-0.63)
Secondary School (n=38)	0.55 (0.22-0.74)	0.28 (-0.21-0.57)	0.58 (0.33-0.74)	0.54 (0.25-0.71)	0.50 (0.19-0.69)	0.51 (-0.04-0.76)
Less than Secondary school (n=28)	0.89 (0.67-0.96)	0.90 (0.74-0.96)	0.82 (0.61-0.92)	0.92 (0.83-0.96)	0.90 (0.78-0.95)	0.77 (0.45-0.90)
<b>Employment Category</b> Employed (117)	0.80 (0.67-0.96)	0.83 (0.74-0.88)	0.79 (0.70-0.86)	0.79 (0.69-0.85)	0.36 (0.08-0.56)	0.56 (0.23-0.75)
Unemployed (63)	0.09 (-8.86-0.56)	0.68 (0.44-0.82)	0.16 (-0.39-0.49)	0.25 (-0.24-0.55)	0.65 (0.43-0.79)	0.68 (0.36-0.80)
PA= Physical Activity						
						2
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Table 4: Differences in time spent in physical activity overall, and by gender and socioeconomic status sub groups

		Gende	er	Education			Employment	
	<b>Total</b> Mean ± SD	Men Mean ± SD	<b>Women</b> Mean ± SD	>Secondary Mean ± SD	<b>Secondary</b> Mean ± SD	<b>Secondary</b> Mean ± SD	<b>Employed</b> Mean ± SD	Unemployed Mean ± SD
PA by doma	in (min/wk)							
Total PA, all	domain							
IPAQ1	405.2 (507.8)	460.7 (582.9)	326.8 (367.8)	334.0 (400.8)	384.8 (514.8)	849.2 (764.1)**	441.1 (530.2)	285.1 (408.6
IPAQ2	308.4 (440.3)	319.7 (522.8)	291.9 (282.9)	285.1 (295.1)	184.8 (264.4)	803.0 (929.6)**	359.4 (481.6)	141.0 (185.2
Active Transp	port							
IPAQ1	35.8 (89.7)	52.4 (127.7)	19.5 (17.7)*	28.3 (47.7)	28.9 (45.02)	76.4 (198.7)*	43.8 (109.4)	21.1 (21.9)*
IPAQ2	30.4 (76.7)	41.2 (106.3)	19.3 (17.5)*	23.6 (30.6)	20.3 (30.9)	74.3 (182.6)*	36.9 (94.1)	18.3 (14.7)*
Work								
IPAQ1	160.1 (380.8)	217.5 (466.8)	79.1 (179.9)*	114.8 (291.0)	122.9 (365.6)	546.7 (615.7)**	195.5 (418.8)	41.8 (162.2)*
IPAQ2	135.3 (310.3)	172.5 (372.8)	80.6 (171.9)*	104.1 (232.2)	160.9 (196.1)	531.6 (595.8)**	164.1 (341.7)	40.1 (133.0)
Domestic	• *	× /			. ,		` '	. ,
IPAQ1	159.6 (202.2)	82.3 (120.6)	236.9 (235.8)**	* 141.2 (182.4)	173.3 (238.5)	165.4 (159.4)	132.1 (170.7)	210.6 (243.8
IPAQ2	123.9 (163.9)	52.4 (74.9)	195.5 (190.1)*	* 131.9 (182.5)	107.6 (130.4)	147.3 (189.1)	112.6 (163.9)	205.0 (163.3
Leisure	· · · ·				<b>`</b>			
IPAQ1	62.4 (159.1)	75.0 (211.1)	10.5 (27.3)**	47.0 (97.3)	92.7 (209.4)	38.2 (160.1)	69.7 (157.6)	48.7 (162.3)
IPAQ2	30.5 (118.2)	50.6 (160.7)	10.1 (38.5)**	23.4 (51.4)	24.7 (91.4)	71.5 (256.5)	43.1 (143.5)	17.0 (28.7)*
Sitting								
IPAQ1	2263.0 (715.8)	2188.8 (759.7)	2330.7 (674.8)	2280.0 (618.7)	2433.9 (693.7)	2180.9 (760.8)	2159.4 (775.9)	2337.6 (667.
IPAQ2	2235.4 (819.9)	2208.7 (916.9)	2259.6 (728.1)	2420.7 (638.7)	2215.3 (663.1)	2160.0 (1111.4)	2170.6 (870.5)	2282.0 (785.
PA by Intens	sity (min/wk)					0		
Walking								
IPAQ1	178.5 (221.5)	241.1 (271.9)	128.2 (100.8)*	194.4 (268.1)	133.4 (85.6)	266.9 (285.4)*	192.0 (245.7)	133.3 (96.2)*
IPAQ2	142.5 (141.8)	148.5 (137.9)	133.7 (147.9)	151.7 (138.4)	103.6(94.7)	200.3 (209.1)*	150.7 (146.6)	115.4 (122.7
Moderate		· •		· •			. ,	
IPAQ1	201.9 (326.9)	193.0 (214.5)	214.5 (247.8)	187.3 (266.5)	194.9 (386.5)	309.7 (381.7)	221.2 (347.4)	137.7 (239.9
IPAQ2	133.9 (238.5)	114.2 (276.9)	162.7 (165.6)	132.9 (177.8)	88.0 (197.2)	319.0 (482.1)*	153.9 (266.2)	68.0 (76.4)*
Vigorous								
IPAQ1	94.1 (211.8)	123.7 (249.6)	52.2 (133.2)*	32.9 (81.9)	129.5 (208.2)	268.0 (459.7)**	90.2 (214.6)	127.1 (204.6
IPAQ2	78.4 (206.9)	86.8 (227.4)	46.2 (73.4)	52.2 (140.2)	55.2 (127.0)	292.8 (461.5)**	92.8 (226.9)	130.9 (107.8

$1\\2\\3\\4\\5\\6\\7\\8\\9\\1\\1\\1\\2\\1\\2\\2\\3\\4\\5\\6\\7\\8\\9\\0\\1\\2\\2\\2\\2\\4\\5\\6\\7\\8\\9\\0\\1\\2\\2\\2\\2\\6\\7\\8\\9\\0\\1\\2\\3\\3\\4\\5\\6\\7\\8\\9\\3\\3\\3\\3\\5\\6\\7\\8\\9\\3\\3\\3\\3\\5\\6\\7\\8\\9\\3\\3\\3\\3\\5\\6\\7\\8\\9\\3\\3\\3\\3\\5\\6\\7\\8\\9\\3\\3\\3\\3\\3\\5\\6\\7\\8\\9\\3\\3\\3\\3\\3\\3\\3\\3\\3\\3\\3\\3\\3\\3\\3\\3\\3\\3$	PA= Physical Activity *=p<0.001	
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	<b>Overall (N = 180)</b>			F	Female (n = 90)			Male (n = 90)		
MET×min/wk	BMI	DBP	SBP	BMI	DBP	SBP	BMI	DBP	SBP	
PA Domains										
Total PA	-0.29**	-0.17*	-0.09	-0.09	-0.23**	-0.04	-0.41**	-0.08	-0.	
Occupation PA	-0.12	-0.09	0.01	0.02	0.02	-0.05	-0.22**	-0.17	-0.0	
Active transport PA	-0.05	-0.04	-0.01	-0.10	-0.13	-0.02	-0.04	-0.02	-0.8	
Domestic PA	-0.07	-0.17*	-0.26**	-0.23**	-0.20*	-0.31**	0.04	-0.14	-0.0	
Leisure PA	0.09	-0.08	-0.16*	-0.11	0.02	0.08	-0.39**	-0.12	-0.	
Sitting	0.16	-0.09	0.04	0.19	0.12	0.05	0.15	-0.09	0.	
PA Intensity										
Walking	0.90	-0.09	-0.03	0.19	-0.05	0.08	-0.05	-0.11	-0.	
Moderate	-0.02	0.21*	0.16*	0.02	-0.14	-0.08	0.02	-0.25**	-0	
Vigorous	-0.11*	-0.06	0.03	-0.16	0.01	0.02	-0.13*	-0.12	-0.1	
MET= Metabolic Ene BMI= Body Mass Ind DBP= Diastolic Blood SBP= Systolic Blood PA= Physical activity *=p<0.05, **=p<0.01	lex d Pressure Pressure									

Table 5: Construct validity of Hausa IPAQ-LF: Spearman correlations between energy expenditure (MET×min/wk) from Hausa IPAQ-LF, and anthropometric and biological variables (N=180)

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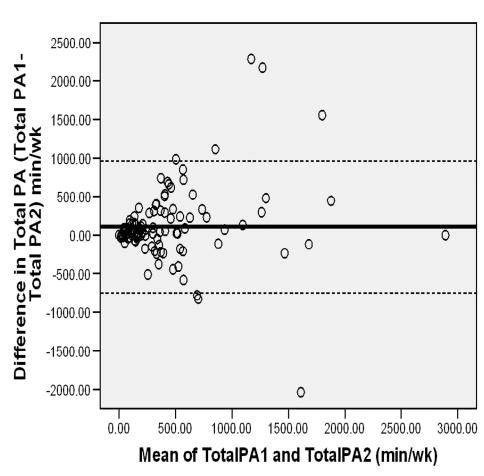


Figure 1: Bland-Altman plot min/wk reported in total physical activity (PA for the first and second administrations of Hausa IPAQ-LF. Mean difference:106.7 +/- 2SD (Standard deviation)= -762.2 to 965.6

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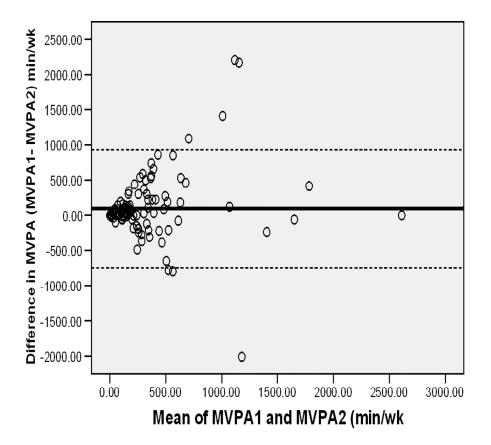
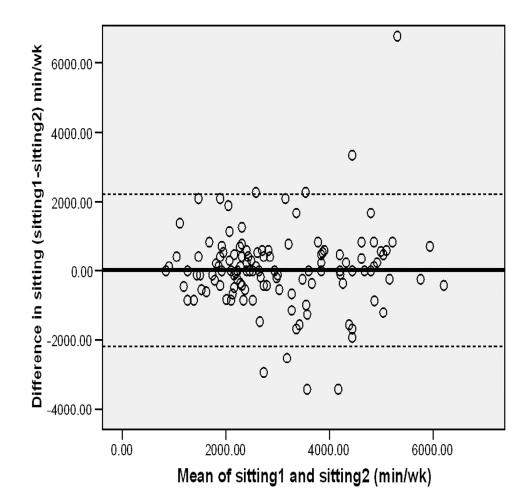


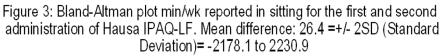
Figure 2: Bland-Altman plot for min/wk reported in moderate-to-vigorous physical activity (MVPA) for the first and second administrations of Hausa IPAQ-LF: Mean difference: 91.6 +/- 2SD (Standard Deviation)=-744.5 to 927

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# **BMJ Open**

# Examining the reliability and validity of a modified version of the International Physical Activity Questionnaire, long form (IPAQ-L) in Nigeria: A cross-sectional study

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Secondary Subject Heading:	Epidemiology, Sports and exercise medicine
Keywords:	PUBLIC HEALTH, SOCIAL MEDICINE, EPIDEMIOLOGY

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3 4	1	Examining the reliability and validity of a modified version of the International Physical
5 6	2	Activity Questionnaire, long form (IPAQ-L) in Nigeria: A cross-sectional study
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8 9 10	4	Adewale L. Oyeyemi <sup>*1</sup> , Umar M. Bello <sup>1</sup> , Saratu T. Philemon <sup>2</sup> , Habeeb N. Aliyu <sup>1</sup> , Rebecca W.
11	5	Majidadi <sup>1</sup> , Adetoyeje Y. Oyeyemi <sup>1</sup>
12 13	6	
14 15	7	<sup>1</sup> Department of Physiotherapy, College of Medical Sciences, University of Maiduguri,
16	8	Nigeria
17	9	<sup>2</sup> Department of Physiotherapy, Jos University Teaching Hospital, Nigeria
18 19	10	
20	11	
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22 23	13	*Correspondence to Dr. Adewale L. Oyeyemi, Department of Physiotherapy, College of
24 25	14	Medical Sciences, University of Maiduguri, Nigeria. Email: <u>alaovevemi@yahoo.com;</u>
26 27	15	Telephone: +234-802-945-8230
28	16	
29 30	17	
31 32	18	Key words: Physical activity, measurement, public health, IPAQ, Nigeria
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# 33 ABSTRACT

 Objectives: To investigate the reliability and aspect of validity of a modified version of the long
 International Physical Activity Questionnaire (Hausa IPAQ-LF) in Nigeria.

36 Design: Cross-sectional study, examining the reliability and construct validity of the Hausa

37 IPAQ-LF compared with anthropometric and biological variables.

38 Setting: Metropolitan Maiduguri, the capital city of Borno State in Nigeria.

39 Participants: 180 Nigerian adults (50% women) with a mean age of 35.6 (SD=10.3) years,

40 recruited from neighbourhood with diverse socioeconomic status and walkability.

Outcome measures: Domains (domestic physical activity [PA], occupational PA, leisure-time
PA, active transportation and sitting time) and intensities of PA (vigorous, moderate and
walking) were measured with the Hausa IPAQ-LF on two different occasions, eight days apart.
Outcomes for construct validity were measured BMI, SBP and DBP.

**Results:** The Hausa IPAQ-LF demonstrated good test-retest reliability (ICC>75) for total PA (ICC=0.79, 95% CI=0.65-0.82), occupational PA (ICC=0.77, 95% CI=0.68-0.82), active transportation (ICC=0.82, 95% CI=0.75-0.87) and vigorous intensity activities (ICC=0.82, 95% CI=0.76-0.87). Reliability was substantially higher for total PA (ICC=0.80), occupational PA (ICC=0.78), leisure-time PA (ICC=0.75) and active transportation (ICC=0.80) in men than women, but domestic PA (ICC=0.38) and sitting time (ICC=0.71) demonstrated substantial reliability coefficients in women than men. For the construct validity, domestic PA was significantly related mainly with SBP ( $\rho = -0.27$ ) and DBP ( $\rho = -0.17$ ), and leisure-time PA and total PA were significantly related only with SBP ( $\rho = -0.16$ ) and BMI (( $\rho = -0.29$ ), respectively. Similarly, moderate-intensity PA was mainly related with SBP ( $\rho = -0.16$ , p< 0.05) and DBP ( $\rho$ = -0.21, p< 0.01), but vigorous-intensity PA was only related with BMI ( $\rho$  = -0.11, p< 0.05). 

56 Conclusions: The modified Hausa IPAQ-LF demonstrated sufficient evidence of test-retest
57 reliability and may be valid for assessing context specific PA behaviours of adults in Nigeria.

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### 

The importance of physical activity (PA) for promoting health and preventing disease is well established.[1-3] However, for effective health promotion and PA surveillance and monitoring, it is important to have standardized, reliable and valid instruments that can be used to accurately describe population levels and patterns of PA within and across countries.[4, 5] In this context, the international physical activity questionnaire (IPAQ) was developed to obtain internationally comparable data on health-related PA of adults (18-65 years).[5, 6] Two versions of the IPAO that could be administered by interview or self-completed were developed. The short form (SF) was designed for population surveillance of PA; while the long form (LF) was designed to be appropriate for use in research that requires detailed information on different PA domains, including PA at work, household, during leisure and transportation, and time spent in sedentary activities.[6] 

The initial evaluation of the IPAQ across 12 countries produced acceptable evidence of reliability and validity that are as good as other self-report measures of PA.[5] Consequently, in order to enhance the utility of IPAQ and to further evaluate its psychometrics worldwide, efforts have been made to translate and adapt the IPAQ in many other countries, but most of the research in this context were from the Western developed countries.[7-14] In Africa, the psychometric properties of IPAO have only been tested in South-Africa as part of the initial development process of the questionnaire, [5] and in older adults. [15] Because the largest increases and burden of non-communicable diseases (NCDs) are in the low-income countries where the understanding of evidence-based strategies for increasing PA remains poor,[16-19] improving PA research is a top priority for low-income countries.[20] However, to advance PA research in Africa, it is important to first develop or tailor standardized measures to be culturally sensitive to PA behaviours of people in the region countries. Because Nigeria is the most populous country in Africa with culture and languages similar to most of the other West African countries, it is a good choice to evaluate the IPAQ for cultural and psychometric relevance in this country.

Recently, a cultural adaptation study of the IPAQ-SF was conducted among adults in Nigeria,[21] with good evidence of test-retest reliability similar to findings in some other studies.[10, 22-24] However, because the IPAQ-SF is not domain specific and does not provide context specific information on PA behaviour, it is important to evaluate the IPAQ-LF for relevance in Nigeria. Psychometric evaluation of a culturally modified version of the IPAQ-LF in sub-Saharan African countries can impact PA research and surveillance in the African region where the prevalence of inactivity related NCDs is on the increase. [20, 25] The aim of the present study was to investigate the reliability and an aspect of validity of a modified version of the IPAQ-LF among adults in Nigeria. 

# 146 METHODS

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# 148 Participants

A purposive sample of 180 adults from eight neighbourhoods that varied in socioeconomic status and walkability in Maiduguri city were recruited for the study. The sampling and neighbourhood selection strategy have been described in details elsewhere.[26] Maiduguri with an estimated population of 749,123 people is the largest and capital city of Borno State in North-Eastern Nigeria.[27] The city attracts immigrants from neighbouring countries of Cameroon, Niger and Chad Republic, and Hausa language is the common means of communication for commercial activities among the diverse inhabitants of Maiduguri.[27, 28] Participants were eligible for this study if they were willing to self-complete a written survey twice in either Hausa or English Language. However, researchers (UMB and STP) were in attendance to provide translation and interpretation assistance to participants (n=11) who required help to complete the survey. Additional eligibility criteria included living within the identified neighbourhood categories in the last 12 months, being adults (18-65 years) and not having any disability that prevented independent walking. All participants were fully informed of the study protocol and provided signed informed consent. The study protocol was approved by the Research and Ethic Committee of the University of Maiduguri Teaching Hospital, Maiduguri, Nigeria. Data were collected between March and May, 2012.

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#### Measures

#### The adapted international physical activity questionnaire-long Hausa version

The cultural adaptation, translation and back translation of the Hausa version of IPAQ-LF is similar to that of the Hausa IPAQ-SF that has been described in details elsewhere.[21] Briefly, interviews were conducted with public health experts, exercise scientists and not highly educated local people to identify the items and examples of PA on the original questionnaires that needed to be culturally adapted. Several cultural adaptations were made to the original items to reflect the reality in Nigeria. First, adjustments to English words like vigorous and moderate activity that can be misunderstood and not associated with PA behaviours in Nigeria were replaced with words that are more representative of the language used in Nigeria, like 'very hard' and 'hard' respectively. Second, examples of various intensities of activity that were common in the Nigerian culture were added, and those already on the questionnaire but not common in the Nigerian context were replaced with culturally applicable examples that are equivalent in energy intensity (METs) with the original items and examples. Third, concepts like physical activity and walking for transportation that were misconstrued outside the health context were refined to indicate they were referring to health behaviours.

After adaptation, the questionnaire was independently translated from English into Hausa language by two native speakers of Hausa who also speaks English, and able to read and write in both languages. One of the translators was familiar with the questionnaire and the second was an expert in Hausa language. The translated questionnaires were mutually revised by the translators and the research team for consistency and then back translated into English language by a third bilingual person who was familiar with the construct measured by IPAQ. The back translated version was checked by the research team for any discrepancies and to ensure that the construct measures by IPAQ had not been lost during the adaptation and translation process. 

The modified questionnaire (available in both Hausa and English language), hereafter referred to as the Hausa version of the long international physical activity questionnaire (Hausa IPAQ-LF), contains thirty-one questions that asked about physical activity done in the last 7-days in terms of frequency (days/week) and duration (minutes/day) spent in four activity domains (transportation,

occupation, domestic and leisure time), and included sections on walking, moderate- and vigorous- intensity activities, and time spent in sedentary behaviours (sitting during leisure and motorized transportation). The Hausa IPAQ-LF data were presented as the MET-minute/week for total walking, moderate, and vigorous intensity activity and overall physical activity across the four domains, and in each of the domains. The MET intensity values used to score the Hausa IPAQ-LF questions in this study were 8 METs for vigorous activity, 4 METs for moderate activity and 3.3 METs for walking, [2, 6] One MET represents the energy expended while sitting quietly at rest and is equivalent to 3.5 ml/kg/min of VO<sub>2</sub> Max.[3] To assess the test-retest reliability of the Hausa IPAQ-LF, participants self-completed all items on the measure twice, with an interval of one week between administrations. 

#### Anthropometrical and biological measurements

Body weight (to nearest 0.5 kg) and Height (to nearest 0.1 cm) were measured in light clothing using a digital scale and stadiometer. Body mass index (BMI) was calculated as body weight divided by the square of height  $(kg/m^2)$ . The principal cutoff points as recommended by WHO were used to create the categories: underweight (< 18.5 kg/m<sup>2</sup>), normal weight (18.5 - < 25 kg/m<sup>2</sup>), overweight  $(25 - \langle 30 \text{ kg/m}^2)$  and obese  $(\geq 30 \text{ kg/m}^2)$ .[29] Resting blood pressure and heart rate were measured with Digital Sphygmomanometer (Diagnostic Advanced Wrist Blood Pressure Monitor, Model 6016, USA). Body mass index and resting diastolic blood pressure (DBP) have previously been used for validating the IPAQ.[7,24] Similarly, for this study, construct validity was evaluated by investigating the relationship of outcomes from the Hausa IPAQ-LF with anthropometric (BMI) and biological (SBP and DBP) measurements, and also in part by comparing the differences in time spent in PA and sitting across sociodemograpic subgroups. These types of validation for PA measures have been referred as indirect or construct validity in previous studies.[7,24,30] 

 Sociodemographic Characteristics 

Information on age, gender, marital status, religion, income, educational level and employment status were elicited from the participants. Marital status was classified as married or not married. Educational level was classified as more than secondary school education, secondary school 

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education and less than secondary school education. Employment status was classified into white
collar (government or private employed), blue collar (self- employed, trader, artisan etc) and
unemployed (homemaker, student, retired, or unable to find job).

230 Data Analysis

Descriptive data were reported as mean, standard deviation and percentages. Mean group differences for continuous variables by gender were examined by independent t-test, and for dichotomous variables by chi-square statistics. The reliability analyses were performed using 2 strategies. First, the two- way mixed model (single measure) intraclass correlation coefficient (ICC) with 95% confidence interval (CI) between the continuous scores obtained on 1<sup>st</sup> and 2<sup>nd</sup> administration of the Hausa IPAQ-LF was calculated. The ICCs were calculated overall, and by gender and socioeconomic status. ICC estimates >0.75 were considered as good reliability scores, between 0.50 and 0.75 as moderate reliability and <0.50 as poor reliability.[31] Second, the Bland and Altman Method was used to assess agreement on scores of PA from the 1<sup>st</sup> and 2<sup>nd</sup> administrations.[32] Variables used for the Bland and Altman analysis were weekly time spent in moderate-to-vigorous activity (MVPA), total PA and sitting. MVPA was computed by summing the total minutes/week of reported physical activity of moderate and vigorous- intensities across all four domains. For total PA, the total minutes/week of activities in each domain were summed (total work + total transport + total domestic + total leisure-time min/week scores) to gain an overall estimate of physical activity in a week. Also, the independent t-test and one-Way ANOVA were used as appropriate to compare the time spent (minutes/week) in PA at both administrations across sociodemographic subgroups. To assess construct validity, the non-parametric Spearman correlation coefficients  $(\rho)$  were utilized to explore the relationship between MET-min/week of PA from the Hausa IPAQ- LF, and resting blood pressure and body mass index. Data were analyzed using Statistical Package for the Social Science (SPSS), version 15.0 for windows (SPSS Inc., Chicago, Illinois, USA) and the level of significance was set at p<0.05. 

**RESULTS** 

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 The socio-demographic characteristic of the participants are shown in Table 1. The participants comprised 50% women and men, with a mean age of  $35.6 \pm 10.3$  years and body mass index of  $23.8 \pm 3.9$ kg/m<sup>2</sup>. Majority of the participants were married (58.9%, n=106), had more than secondary school education (62.7%, n=111) and were employed (75%, n=117). Compared to men, the women were more likely to be married (71.1% vs 46.7%, p=0.001) and unemployed (52.2% vs 17.8%, p<0.001), but men were more likely to have more than secondary school education (76.7% vs 48.2%, p<0.001).

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### 263 Reliability

Table 2 shows the test-retest reliability of the modified IPAQ-LF. Overall, reliability coefficients were good (ICC >75) for total PA, occupational PA, active transportation and vigorous intensity (very hard) PA. Domestic PA, sitting activity and leisure PA demonstrated moderate reliability (ICC ranges from 0.51- 0.71). While, the reliability coefficients of total PA (ICC=0.80, 95% CI=0.69-0.87), active transportation (ICC=0.83, 95% CI=0.73-0.89), occupational PA (ICC=0.78, 95% CI=0.66-0.85) and leisure time PA (ICC=0.75, 95% CI=0.63-0.84) were substantially higher among men than women, reliability coefficients for domestic PA (ICC=0.38, 95%, CI=0.01-0.57) and sitting time (ICC=0.71, 95% CI=0.46-0.85) were higher among women than men. According to the intensity of PA, ICCs range between 0.61 and 0.82, with the lowest value recorded for moderate intensity (hard) PA and the highest value for vigorous intensity (very hard) PA. The reliability coefficients for walking, moderate-intensity (hard) and vigorous intensity (very hard) activities were substantially greater in men than women. 

Similarly, socioeconomic status differences were observed in the reliability coefficients of the modified IPAQ-LF (Table 3). Across all domains of PA, reliability coefficients were substantially higher among participants with less than secondary school education (ICC from 0.77 [sitting activity] to 0.92 [leisure activity]) compared to those with secondary school education (ICC from 0.28 [active transport] to 0.58 [occupational activity]) and those with higher than secondary school education (ICC from 0.23 [sitting activity] to 0.67[active transport]). While reliability coefficients were higher for overall PA (ICC=0.80, 95% CI=0.71- 0.86), active transport (ICC=0.83, 95% CI=0.74- 0.88), occupational PA (ICC=0.79, 95% CI=0.70- 0.86) and 

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leisure-time PA (ICC= 0.79, 95% CI= 0.69- 0.85) among participants that were employed
compared to their unemployed counterparts, it was higher for domestic PA (ICC=0.65, 95%
CI=0.43- 0.79) and sitting time (ICC= 0.68, 95% CI= 0.36- 0.83) among participants that were
unemployed than in the employed subgroup.

- Figures 1, 2 and 3 (Bland-Altman plots) illustrate the agreement in the scores (minutes/week) of total PA, MVPA and sitting between the first and second administrations of Hausa IPAQ-LF. For total PA, the mean difference was 106.7 minutes/week, with a wide 95% limits of agreement (-762.2 to 965.6 minutes/week). For MVPA, the mean difference was about one and half hour per week (91.6 minutes/week), and also demonstrating wide 95% limits of agreement (-744.5 to 927.7 minutes/week). For sitting time, the mean difference was small (26 minutes/week) and the 95% limits of agreement range from -2178.1 to 2230.9 minutes/week.
- Table 4 shows the patterns of PA across sociodemographic subgroups during the first (IPAO1) and second (IPAQ2) administrations of the modified IPAQ-LF. Overall and across all stratified variables, time spent in PA reported during the first administration tends to be higher than those reported during the second administration. At both time points, men reported significantly (p<0.05) higher mean time (minute/week) in active transportation, occupational PA, and leisure-time PA than women. However, women spent significantly (p<0.001) more time (minutes/week) in domestic PA than men (IPAQ1=236.9 vs 82.3, IPAQ2=195.5 vs 52.4). For educational status, participants that had lower than secondary school education compared to those with at least secondary school education reported statistically significant higher mean time (minutes/week) at both time points for total PA, active transport, occupational PA, walking and vigorous intensity activity compared to those with at least secondary school education. While participants that were employed reported statistically significant (p<0.05) more time (minutes/week) in total PA (IPAO1=441.1 vs 285.1, IPAO2=359.4 vs 141.0), active transportation (IPAO1=43.8 vs 21.1, IPAQ2=36.9 vs 18.3) and work PA (IPAQ1=195.5 vs 41.8, IPAQ2=164.1 vs 40.1) than those who were unemployed, the unemployed reported statistically significant (p<0.05) higher time in domestic activity (IPAQ1=210.6 vs 132.1, IPAQ2=205.0 vs 112.6) compared to the employed.

# **Construct Validity**

Overall, correlations between energy expenditure (MET-Minutes/week) according to the modified IPAQ-LF and anthropometric and biological measures were statistically significant in the expected direction for all domains and intensities of PA, except for occupation and active transport domains and walking (table 5). In the full sample, domestic PA was mainly related with SBP ( $\rho = -0.27$ , p< 0.01) and DBP ( $\rho = -0.17$ , p< 0.05), while leisure PA and total PA were only related with SBP ( $\rho = -0.16$ , p< 0.05) and BMI ( $\rho = -0.29$ , p< 0.01), respectively. Similarly, moderate-intensity PA was mainly related with SBP ( $\rho = -0.16$ , p< 0.05) and DBP ( $\rho = -0.21$ , p< 0.01), but vigorous-intensity PA was only related with BMI ( $\rho = -0.11$ , p< 0.05). In the gender based analyses, total PA, domestic PA and sedentary time were more consistently related with anthropometric and biological variables. The strongest rho value (-0.41) was found for the relationship between total PA and BMI for the male subgroup. The rho values of -0.23 was reached between total PA and DBP for the women subgroup. Only in women was domestic PA significantly related with BMI ( $\rho = -0.23$ ), DBP ( $\rho = -0.20$ ) and SBP ( $\rho = -0.31$ ). Leisure-time PA ( $\rho = -0.39$ ) and occupational PA ( $\rho = -0.22$ ) were significantly related with BMI only in men. The rho value for the relationship between sitting time and BMI was slightly higher in women (p = 0.19) than men ( $\rho = 0.15$ ). 

# 333 DISCUSSION

This study examined the reliability and an aspect of validity of a modified version of the IPAQ-LF in Nigeria. The findings generally indicated acceptable test-retest reliability and modest construct validity for items of the modified IPAQ-LF among Nigerian adults. To the best of our knowledge, the present study is the only one to examine the reliability and validity of the long version of IPAQ that has been modified specifically to an indigenous African culture and language.

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We found evidence for good reliability with high correlations between the test-retest for total PA, occupational PA, active transportation and vigorous intensity activity. Our results shows that except for domestic PA and sitting time, ICC values for domains of PA were consistently above 0.70, a level of reproducibility that has been considered acceptably good for IPAQ data.[33,34] BMJ Open: first published as 10.1136/bmjopen-2014-005820 on 1 December 2014. Downloaded from http://bmjopen.bmj.com/ on June 8, 2025 at Agence Bibliographique de Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

Similar to a previous IPAO-LF study in Hong Kong, [34] domestic activity demonstrated the lowest ICC value in our study. However, it is possible that the infrequent nature of household activities undertaken, especially by men may account for the low reliability reported for domestic PA in our study. In addition to the traditional African patriarchal norm that make most African men to rarely engage in indoor household activities, men in the high socioeconomic group in Nigeria may also not engage in outdoor domestic activities like gardening and outdoor home. appliances and equipment maintenance because they are able to employ the services of domestic helpers and repair men. Our findings of lower reliability for domestic activity among men, those with more than secondary school education and those who were employed compared to their counterparts seem to support this assumption. 

The highest and strongest reliability coefficients (0.82) were found for both active transportation and vigorous intensity activity. Perhaps, active transportation was more stable, consistent and reproducible overtime than other PA domains because it is a common and ubiquitous PA behaviour in the African region. Mostly, the performance of active transportation especially walking is often out of necessity rather than choice within the African context. Our finding of higher ICC value for vigorous intensity PA is consistent with those of other studies that found the reliability of vigorous intensity activity to be higher compared to that of moderate intensity activity.[10,30,34,35] Compared to structured vigorous physical activities like sports and exercise that can be more easily recalled, moderate intensity PA are often of low salience, incidental and may not easily be remembered by people.[36,37] Further our finding that the reliability of vigorous intensity physical activity was meaningfully higher among men than women seem to confirm our previous findings with the IPAQ-SF.[21] Plausibly men in Nigeria are more consistent than women when responding to PA items that pertained to intense vigorous PA than other intensities of activity. Overall, the moderate to good evidence of reliability found for all items indicate that the modified IPAQ-LF is reproducible, internally consistent and is promising for research in Nigeria. 

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Except for sitting time, the limits of agreement in the mean scores of total PA and MVPA between the first and second administrations were wide, suggesting an evidence of bias between Page 13 of 57

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 administrations. Large difference in PA scores between the 2 administrations would indicate that at least one of the two measurements is not accurate. However, similar to the finding of a Mexican study, [38] scores on the Hausa IPAQ-LF were consistently lower during the second administration of the questionnaire compared to the first administration. Because familiarity with the IPAQ questions may improve over multiple exposures to the questionnaire, it is possible that participants in our study might have over-reported their PA levels during the first administration of the Hausa IPAQ-LF. This kind of findings may have implication for the utility of IPAQ for surveillance. Generally, due to issues of social desirability phenomenon and over reporting of PA that has been associated with the IPAO.[39,40] it may be necessary to start considering the need for multiple measurements when using the IPAQ for evaluating PA, especially in developing African countries. However, patterns of PA as measured by the modified IPAQ-LF during both administrations were consistently similar, and both administrations were able to discriminate PA in the expected direction between subgroups of our sample. For example, at both measurement time points, and consistent with hypothesis, men reported more time in active transportation, occupational PA and leisure PA than women, while women reported more time in domestic PA and sedentary activity than men.

In the absence of objective criterion standards for evaluating an absolute estimate of PA, the consistency of items on IPAO with variables known to be related to PA such as body mass index (BMI), blood pressure, heart rate, indicators of lipid and glucose metabolism, and fitness index have been used as important construct validity measures. [7,10,21,24] In the present study, the correlations of the PA domains and intensities with biological and anthropometric variables were mostly significant in the expected direction, but they were low suggesting a modest evidence of construct validity for the modified IPAQ-LF in Nigeria. However, observed correlations were comparable with the values in other studies that have evaluated the IPAQ-LF.[5,7,8,24,30,33,39] Because better validity coefficients have been reported for other PA measures above that of the IPAQ.[39,41] with the present African finding, it is possible that the IPAQ-LF only have modest evidence of construct validity. However, our findings on the relationships between physical activity and biological and anthropometric variables should be interpreted in the light of an important caution. Because hypertensive and obese people may get oriented to exercise,[3] cross-

sectional associations of physical activity and blood pressure or BMI could also occur in the
 opposite direction and may not represent much information as indicators of construct validity of
 physical activity measures.

409 Strengths and limitations

 A strength of this study is the systematic adaptation and tailoring of items on the IPAO-LF to reflect the common PA behaviours of people in Nigeria. This is the first study in an African country to explore the cultural adaptation and translation of the IPAQ-LF, and its findings demonstrated the feasibility of using the IPAQ-LF to reliably collect PA data in a diverse segment of the Nigerian population. In the Africa region, the importance of a valid and established PA scale like the modified IPAO-LF is not only important to monitoring the domain in which activity is performed, but also very critical to understanding studies of ecological models of health behaviours, that emphasize the importance of multiple levels of influence on health behaviours including PA.[18,42] In Nigeria, emerging evidence from studies using ecological models indicate that favourable built environmental attributes are promising for improving total and moderate-to-vigorous PA and controlling obesity among adults.[26, 43-45] However, built environment characteristics are expected to be strongly related to specific PA types rather than overall PA.[46,47] For example, different environmental variables can be related to walking for leisure or transportation and to moderate PA for household, occupation, recreation or transportation. Thus, a study of adaptation of the IPAQ-LF is very important to understanding the domain specific nature of ecological models research in the African region. One additional strength was the exploration of PA patterns by gender, educational level and employment status, the findings of which were consistent with general hypothesis on social patterns of inactivity in low-income countries.[20,48] 

However, the findings of this study should be interpreted in the light of some important limitations. Direct comparison of our validity findings with previous studies should be made with caution, because unlike in our study, the accelerometer or PA diary were utilized as a common validate IPAO objective criterion standard to the in the majority of the studies. [5,7,8,24,30,33,39] Thus, examining the construct validity through the relationships of 

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PA with BMI and resting blood pressure was an important limitation of our study. The choice and availability of appropriate criterion measures are particular issues of concern for the validation of PA questionnaires in low-income countries of Africa [5,49,50]. Despite these issues, the validity coefficients in our study were remarkably similar to those reported in other studies, [5,7,8,24,30,33,39] and the consistency of items on IPAQ with variables known to be related to PA such as BMI, blood pressure, heart rate, indicators of lipid and glucose metabolism, index have previously been used as important construct and fitness validity measures. [7,10,21,24] Another limitation of the study is the use of non-probability sampling technique. The study finding may have limited generalizability to other samples of Nigerians that have different characteristics from this sample. In addition, the majority of participants have more than secondary school education with potentially higher comprehension and recall ability than may be found in the general population. Nevertheless, recruitment from diverse neighbourhoods and settings allowed for a sample with reasonable heterogeneity in age, occupational status, and ethnic backgrounds and made it possible to stratify the analyses by sociodemographic characteristics. However, because some of the participants in the present study required assistance to complete the survey, interview administration rather than self-administration of the IPAQ-LF should be encouraged in any future national studies in the African region. Administering the IPAQ through interview has been considered as a viable and preferred option in developing countries.[5] 

# 455 Conclusions

 Overall, the present study suggests that the modified IPAQ-LF demonstrated sufficient evidence of test-retest reliability and may be valid for assessing context specific PA behaviours of adults in Nigeria. Adaptation and criterion evaluation of the IPAQ-LF in other African countries could further contribute to our understanding of the impact of multiple levels of influence on PA behaviours of people in the African region. BMJ Open: first published as 10.1136/bmjopen-2014-005820 on 1 December 2014. Downloaded from http://bmjopen.bmj.com/ on June 8, 2025 at Agence Bibliographique de Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

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12 13	470	Contributors
14	471	ALO conceived and designed the study, contributed to cultural adaptation and acquisition of
15 16	472	data, conducted the statistical analysis and interpretation of data and drafted the manuscript.
17 18	473	UMB and STP managed participants' recruitment and data collection and contributed to cultural
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44 45	488	
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47 48 49	490	Dataset for this study available upon request from the corresponding author.
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Variables	Total sample (N=180)	Men (n=90, 50%)	Women (n=90, 50%
Age (years)			
Mean (± SD)	$35.6 \pm 10.3$	$35.7 \pm 8.3$	$35.5 \pm 11.9$
Marital status (n, %)*			
Not Married	74(41.1)	48(53.3)	26(28.9)
Married	106(58.9)	42(46.7)	64(71.1)
BMI (Kg/m <sup>2</sup> )			
Mean (± SD)	$23.8 \pm 3.9$	$23.8 \pm 3.5$	$23.8 \pm 4.4$
Mitun (= 5D)	23.0 - 5.9	23.0 - 3.3	23.0 - 1.1
BMI Category (n, %)			
Underweight	14 (7.8)	4 (4.4)	10 (11.1)
Normal weight	107 (59.4)	58 (64.4)	49 (54.4)
Overweight/obese	59 (32.8)	28 (31.2)	31 (34.5)
Ethnicity (n, %)		/	
Hausa/Fulani	21(11.7)	10.1(11.1)	11(12.2)
Igbo	8(4.4)	5(5.6)	3(3.3)
Yoruba	10(5.6)	6(6.7)	4(4.4)
Kanuri/Shuwa Arab	44(24.4)	23(25.6)	21(23.3)
Others	97(53.9)	46 (51.1)	51(56.7)
Educational level (n, %	)*		
<ul> <li>Secondary School</li> </ul>	, 111 (62.7)	11 (12.2)	17(19.5)
Secondary	38 (21.5)	10 (11.1)	28(32.5)
<secondary school<="" td=""><td>28 (15.8)</td><td>69 (76.7)</td><td>42(48.2)</td></secondary>	28 (15.8)	69 (76.7)	42(48.2)
	20 (1010)		.=(=)
<b>Occupational Status (n</b> ,	%)*		
Unemployed	63(35)	16(17.8)	47(52.2)
Blue Collar	45(25)	28(31.1)	17(18.9)
White Collar	72(40)	46(51.1)	26(28.9)
*- Significant difference	between samples (p<0.05	5)	
BMI- Body Mass Index			

Table 2: Test-reliability based on intra-class correlation coefficient for Hausa IPAQ-LF, overall and by gender

		Total (N=180)		Women (n=90)	Men (n=90)
PA Measure (MET×min/wk)	Test 1 (Mean (SD))	Test 2 (Mean (SD))	ICC (95%CI)	ICC (95%Cl)	ICC (95%Cl)
Total PA, all domain	2160.6 (2691.1)	1612.8 (1612.8)	0.76 (0.65-0.82)	0.45 (0.08-0.67)	0.80 (0.69- 0.87)
Occupation	619.1(1671.5)	497.5 (1332.9)	0.77 (0.68-082)	0.64 (0.46-0.77)	0.78 (0.66 -0.85)
Active Transport	468.1 (684.7)	440.5 (605.7)	0.82 (0.75-0.87)	0.63 (0.40-0.77)	0.83 (0.73 - 0.89)
Domestic	597.6 (754.6)	473.4 (673.7)	0.50 (0.32-0.62)	0.38 (0.01-0.57)	0.33 (-0.01-0.56)
Leisure	377.0 (1096.3)	196.7 (920.2)	0.71 (0.60-0.78)	0.69 (0.53-0.79)	0.75 (0.63-0.84)
Sitting	2263.0 (715.8)	2235.4 (818.9)	0.62 (0.42-0.75)	0.71 (0.46-0.85)	0.48 (0.06-0.72)
PA by Intensity (MET×min/wk)					
Walking	613.6 (635.6)	534.6 (449.1)	0.63 (0.48-0.74)	0.57 (0.29-0.74)	0.65 (0.44-0.78)
Moderate	986.9 (1365.9)	716.1 (1164.6)	0.61 (0.46-0.71)	0.42 (0.11-0.62)	0.67 (0.49-0.78)
Vigorous	526.5 (1543.7)	394.1 (1431.1)	0.82 (0.76-0.87)	0.55 (0.30-0.71)	0.86 (0.78-0.91)

PA= Physical Activity

MET= Metabolic Energy Turnover

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Table 3: Socioeconomic status differences in test- retest reliability of the Hausa IPAQ- LF (N= 180)

Socioeconomic Status	Overall PA	Active Transport	Occupation PA	Leisure PA	Domestic PA	Sitting
<b>Educational</b> <b>Qualification</b> More than secondary school (n=111)	0.42 (0.08-0.63)	0.67 (0.43-0.78)	0.32 (-0.06-0.57)	0.33 (-0.05-0.57)	0.58 (0.35-0.73)	0.23 (-0.63-0.63)
Secondary School (n=38)	0.55 (0.22-0.74)	0.28 (-0.21-0.57)	0.58 (0.33-0.74)	0.54 (0.25-0.71)	0.50 (0.19-0.69)	0.51 (-0.04-0.76)
Less than Secondary school (n=28)	0.89 (0.67-0.96)	0.90 (0.74-0.96)	0.82 (0.61-0.92)	0.92 (0.83-0.96)	0.90 (0.78-0.95)	0.77 (0.45-0.90)
<b>Employment Category</b> Employed (117)	0.80 (0.67-0.96)	0.83 (0.74-0.88)	0.79 (0.70-0.86)	0.79 (0.69-0.85)	0.36 (0.08-0.56)	0.56 (0.23-0.75)
Unemployed (63)	0.09 (-8.86-0.56)	0.68 (0.44-0.82)	0.16 (-0.39-0.49)	0.25 (-0.24-0.55)	0.65 (0.43-0.79)	0.68 (0.36-0.80)
PA= Physical Activity				200		
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Table 4: Differences in time spent in physical activity overall, and by gender and socioeconomic status sub groups

		Gende	r		Education		Employr	nent
	<b>Total</b> Mean ± SD	<b>Men</b> Mean ± SD	<b>Women</b> Mean ± SD	>Secondary Mean ± SD	<b>Secondary</b> Mean ± SD	<b>Secondary</b> Mean ± SD	<b>Employed</b> Mean ± SD	Unemployed Mean ± SD
PA by domai	n (min/wk)							
Total PA, all o	domain							
IPAQ1	405.2 (507.8)	460.7 (582.9)	326.8 (367.8)	334.0 (400.8)	384.8 (514.8)	849.2 (764.1)**	441.1 (530.2)	285.1 (408.6
IPAQ2	308.4 (440.3)	319.7 (522.8)	291.9 (282.9)	285.1 (295.1)	184.8 (264.4)	803.0 (929.6)**	359.4 (481.6)	141.0 (185.2
Active Transp				× /				<sup>×</sup>
IPAQ1	35.8 (89.7)	52.4 (127.7)	19.5 (17.7)*	28.3 (47.7)	28.9 (45.02)	76.4 (198.7)*	43.8 (109.4)	21.1 (21.9)*
IPAQ2	30.4 (76.7)	41.2 (106.3)	19.3 (17.5)*	23.6 (30.6)	20.3 (30.9)	74.3 (182.6)*	36.9 (94.1)	18.3 (14.7)*
Work				( )	× ,	× ,		( )
IPAQ1	160.1 (380.8)	217.5 (466.8)	79.1 (179.9)*	114.8 (291.0)	122.9 (365.6)	546.7 (615.7)**	195.5 (418.8)	41.8 (162.2)*
IPAQ2	135.3 (310.3)	172.5 (372.8)	80.6 (171.9)*	104.1 (232.2)	160.9 (196.1)	531.6 (595.8)**	164.1 (341.7)	40.1 (133.0)*
Domestic				()				(100.0)
IPAQ1	159.6 (202.2)	82.3 (120.6)	236.9 (235.8)**	* 141 2 (182 4)	173.3 (238.5)	165.4 (159.4)	132.1 (170.7)	210.6 (243.8
IPAQ2	123.9 (163.9)	52.4 (74.9)	195.5 (190.1)**		107.6 (130.4)	147.3 (189.1)	112.6 (163.9)	205.0 (163.3)
Leisure	120.9 (100.9)	52.1 (71.5)	190.0 (190.1)	151.5 (102.5)	107.0 (150.7)	11/13 (10).1)	112.0 (105.7)	-00.0 (100.0
IPAQ1	62.4 (159.1)	75.0 (211.1)	10.5 (27.3)**	47.0 (97.3)	92.7 (209.4)	38.2 (160.1)	69.7 (157.6)	48.7 (162.3)
IPAQ2	30.5 (118.2)	50.6 (160.7)	10.1 (38.5)**	23.4 (51.4)	24.7 (91.4)	71.5 (256.5)	43.1 (143.5)	17.0 (28.7)*
Sitting	50.5 (110.2)	50.0 (100.7)	10.1 (50.5)	25.1 (51.1)	21.7 (91.1)	(200.0)	15.1 (115.5)	17.0 (20.7)
IPAQ1	2263.0 (715.8)	2188 8 (750 7)	2330 7 (674 8)	2280.0 (618.7)	2433.9 (693.7)	2180.0 (760.8)	2159.4 (775.9)	2337 6 (667
IPAQ2	2235.4 (819.9)		· · · ·	· · · ·		2160.0 (1111.4)	2170.6 (870.5)	· · · · · · · · · · · · · · · · · · ·
11 AQ2	2233.4 (017.7)	2200.7 (910.9)	2239.0 (720.1)	2420.7 (050.7)	2213.3 (003.1)	2100.0 (1111.4)	2170.0 (070.5)	2202.0 (705.
PA by Intens	ity (min/wk)							
Walking			100 0 (100 0) *					
IPAQ1	178.5 (221.5)	241.1 (271.9)	128.2 (100.8)*		133.4 (85.6)	266.9 (285.4)*	192.0 (245.7)	133.3 (96.2)*
IPAQ2	142.5 (141.8)	148.5 (137.9)	133.7 (147.9)	151.7 (138.4)	103.6(94.7)	200.3 (209.1)*	150.7 (146.6)	115.4 (122.7
Moderate								
IPAQ1	201.9 (326.9)	193.0 (214.5)	214.5 (247.8)	187.3 (266.5)	194.9 (386.5)	309.7 (381.7)	221.2 (347.4)	137.7 (239.9)
IPAQ2	133.9 (238.5)	114.2 (276.9)	162.7 (165.6)	132.9 (177.8)	88.0 (197.2)	319.0 (482.1)*	153.9 (266.2)	68.0 (76.4)*
Vigorous								
IPAQ1	94.1 (211.8)	123.7 (249.6)	52.2 (133.2)*	32.9 (81.9)	129.5 (208.2)	268.0 (459.7)**	90.2 (214.6)	127.1 (204.6
IPAQ2	78.4 (206.9)	86.8 (227.4)	46.2 (73.4)	52.2 (140.2)	55.2 (127.0)	292.8 (461.5)**	92.8 (226.9)	130.9 (107.8)
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		Overall (N = 18	0)	Fe	male (n = 90)			Male (n = 90)	
MET×min/wk	BMI	DBP	SBP	BMI	DBP	SBP	BMI	DBP	SBP
PA Domains									
Total PA	-0.29**	-0.17*	-0.09	-0.09	-0.23**	-0.04	-0.41**	-0.08	-0.1
Occupation PA	-0.12	-0.09	0.01	0.02	0.02	-0.05	-0.22**	-0.17	-0.0
Active transport PA	-0.05	-0.04	-0.01	-0.10	-0.13	-0.02	-0.04	-0.02	-0.8
Domestic PA	-0.07	-0.17*	-0.26**	-0.23**	-0.20*	-0.31**	0.04	-0.14	-0.0
Leisure PA	0.09	-0.08	-0.16*	-0.11	0.02	0.08	-0.39**	-0.12	-0.
Sitting	0.16	-0.09	0.04	0.19	0.12	0.05	0.15	-0.09	0.0
PA Intensity									
Walking	0.90	-0.09	-0.03	0.19	-0.05	0.08	-0.05	-0.11	-0.1
Moderate	-0.02	0.21*	0.16*	0.02	-0.14	-0.08	0.02	-0.25**	-0
Vigorous	-0.11*	-0.06	0.03	-0.16	0.01	0.02	-0.13*	-0.12	-0.1

Table 5: Construct validity of Hausa IPAQ-LF: Spearman correlations between energy expenditure (MET×min/wk) from Hausa IPAQ-LF, and anthropometric and biological variables (N=180)

MET= Metabolic Energy Turnover

BMI= Body Mass Index

DBP= Diastolic Blood Pressure

SBP= Systolic Blood Pressure

PA= Physical activity

\*=p<0.05, 

\*\*=p<0.01

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4 5	2	Activity Questionnaire, long form (IPAQ-L) in Nigeria: A cross-sectional study
6 7	3	
8 9	4	Adewale L. Oyeyemi <sup>*1</sup> , Umar M. Bello <sup>1</sup> , Saratu T. Philemon <sup>2</sup> , Habeeb N. Aliyu <sup>1</sup> , Rebecca W
10	5	Majidadi <sup>1</sup> , Adetoyeje Y. Oyeyemi <sup>1</sup>
11 12		Majidadi , Adeloyeje T. Oyeyenn
13 14	6	
15	7 8	<sup>1</sup> Department of Physiotherapy, College of Medical Sciences, University of Maiduguri, Nigeria
16 17	9	<sup>2</sup> Department of Physiotherapy, Jos University Teaching Hospital, Nigeria
18	10	
19 20	11	
21	12	
22 23	13	*Correspondence to Dr. Adewale L. Oyeyemi, Department of Physiotherapy, College of
24 25	14	Medical Sciences, University of Maiduguri, Nigeria. Email: <u>alaoveyemi@yahoo.com;</u>
26	15	Telephone: +234-802-945-8230
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30 31	18	Key words: Physical activity, measurement, public health, IPAQ, Nigeria
32 33	19	
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onnaire, long form (IPAQ-L) in Nigeria: A cross-sectional study eyemi<sup>\*1</sup>, Umar M. Bello<sup>1</sup>, Saratu T. Philemon<sup>2</sup>, Habeeb N. Aliyu<sup>1</sup>, Rebecca W. f Physiotherapy, College of Medical Sciences, University of Maiduguri, of Physiotherapy, Jos University Teaching Hospital, Nigeria ice to Dr. Adewale L. Oyeyemi, Department of Physiotherapy, College of es, University of Maiduguri, Nigeria. Email: alaoyeyemi@yahoo.com; ysical activity, measurement, public health, IPAQ, Nigeria For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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**ABSTRACT Objectives:** To investigate the reliability and aspect of validity of a modified version of the long International Physical Activity Questionnaire (Hausa IPAQ-LF) in Nigeria. Design: Cross-sectional study, examining the reliability and construct validity of the Hausa IPAQ-LF compared with anthropometric and biological variables. Setting: Metropolitan Maiduguri, the capital city of Borno State in Nigeria. **Participants:** 180 Nigerian adults (50% women) with a mean age of 35.6 (SD=10.3) years, recruited from neighbourhood with diverse socioeconomic status and walkability. Outcome measures: Domains (domestic physical activity [PA], occupational PA, leisure-time PA, active transportation and sitting time) and intensities of PA (vigorous, moderate and walking) were measured with the Hausa IPAQ-LF on two different occasions, eight days apart. Outcomes for construct validity were measured BMI, SBP and DBP. **Results:** The Hausa IPAQ-LF demonstrated good test-retest reliability (ICC>75) for total PA (ICC=0.79, 95% CI=0.65-0.82), occupational PA (ICC=0.77, 95% CI=0.68-0.82), active transportation (ICC=0.82, 95% CI=0.75-0.87) and vigorous intensity activities (ICC=0.82, 95% CI=0.76-0.87). Reliability was substantially higher for total PA (ICC=0.80), occupational PA (ICC=0.78), leisure-time PA (ICC=0.75) and active transportation (ICC=0.80) in men than women, but domestic PA (ICC=0.38) and sitting time (ICC=0.71) demonstrated substantial reliability coefficients in women than men. For the construct validity, domestic PA was significantly related mainly with SBP ( $\rho = -0.27$ ) and DBP ( $\rho = -0.17$ ), and leisure-time PA and total PA were significantly related only with SBP ( $\rho = -0.16$ ) and BMI (( $\rho = -0.29$ ), respectively. Similarly, moderate-intensity PA was mainly related with SBP ( $\rho = -0.16$ , p< 0.05) and DBP ( $\rho$ = -0.21, p< 0.01), but vigorous-intensity PA was only related with BMI ( $\rho$  = -0.11, p< 0.05). 

Conclusions: The modified Hausa IPAQ-LF demonstrated sufficient evidence of test-retest reliability and may be valid for assessing context specific PA behaviours of adults in Nigeria. 

# 66 ARTICLE SUMMARY 67 68 Strengths and limitations of this study. 69

- Systematic adaptation and tailoring of items on the original IPAQ-LF to reflect the common PA behaviours of adults in Nigeria.
- The first study to describe the cultural adaptation and translations of the IPAQ-LF and
   explore its psychometric relevance in an African country.
- Findings establish evidence to support the feasibility of using a modified IPAQ-LF to
   reliably collect context specific PA behaviours of adults in the African region.
- Exploring construct validity through the relationships of PA with BMI and resting blood
   pressure was an important limitation of this study.
  - The use of non-probability sampling technique may limit generalizability of findings to other samples of Nigerian adults with different characteristics from the study's sample.

#### 106 INTRODUCTION

The importance of physical activity (PA) for promoting health and preventing disease is well established.[1-3] However, for effective health promotion and PA surveillance and monitoring, it is important to have standardized, reliable and valid instruments that can be used to accurately describe population levels and patterns of PA within and across countries.[4, 5] In this context, the international physical activity questionnaire (IPAQ) was developed to obtain internationally comparable data on health-related PA of adults (18-65 years).[5, 6] Two versions of the IPAO that could be administered by interview or self-completed were developed. The short form (SF) was designed for population surveillance of PA; while the long form (LF) was designed to be appropriate for use in research that requires detailed information on different PA domains, including PA at work, household, during leisure and transportation, and time spent in sedentary activities.[6] 

The initial evaluation of the IPAQ across 12 countries produced acceptable evidence of reliability and validity that are as good as other self-report measures of PA.[5] Consequently, in order to enhance the utility of IPAQ and to further evaluate its psychometrics worldwide, efforts have been made to translate and adapt the IPAQ in many other countries, but most of the research in this context were from the Western developed countries.[7-14] In Africa, the psychometric properties of IPAO have only been tested in South-Africa as part of the initial development process of the questionnaire, [5] and in older adults. [15] Because the largest increases and burden of non-communicable diseases (NCDs) are in the low-income countries where the understanding of evidence-based strategies for increasing PA remains poor,[16-19] improving PA research is a top priority for low-income countries.[20] However, to advance PA research in Africa, it is important to first develop or tailor standardized measures to be culturally sensitive to PA behaviours of people in the region countries. Because Nigeria is the most populous country in Africa with culture and languages similar to most of the other West African countries, it is a good choice to evaluate the IPAQ for cultural and psychometric relevance in this country. 

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Recently, a cultural adaptation study of the IPAQ-SF was conducted among adults in Nigeria,[21] with good evidence of test-retest reliability similar to findings in some other studies.[10, 22-24] However, because the IPAQ-SF is not domain specific and does not provide context specific information on PA behaviour, it is important to evaluate the IPAQ-LF for relevance in Nigeria. Psychometric evaluation of a culturally modified version of the IPAQ-LF in sub-Saharan African countries can impact PA research and surveillance in the African region where the prevalence of inactivity related NCDs is on the increase. [20, 25] The aim of the present study was to investigate the reliability and an aspect of validity of a modified version of the IPAQ-LF among adults in Nigeria. 

#### **METHODS**

#### **Participants**

A purposive sample of 180 adults from eight neighbourhoods that varied in socioeconomic status and walkability in Maiduguri city were recruited for the study. The sampling and neighbourhood selection strategy have been described in details elsewhere.[26] Maiduguri with an estimated population of 749,123 people is the largest and capital city of Borno State in North-Eastern Nigeria.[27] The city attracts immigrants from neighbouring countries of Cameroon, Niger and Chad Republic, and Hausa language is the common means of communication for commercial activities among the diverse inhabitants of Maiduguri.[27, 28] Participants were eligible for this study if they were willing to self-complete a written survey twice in either Hausa or English Language. However, researchers (UMB and STP) were in attendance to provide translation and interpretation assistance to participants (n=11) who required help to complete the survey. Additional eligibility criteria included living within the identified neighbourhood categories in the last 12 months, being adults (18-65 years) and not having any disability that prevented independent walking. All participants were fully informed of the study protocol and provided signed informed consent. The study protocol was approved by the Research and Ethic Committee of the University of Maiduguri Teaching Hospital, Maiduguri, Nigeria. Data were collected between March and May, 2012.

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#### The adapted international physical activity questionnaire-long Hausa version

The cultural adaptation, translation and back translation of the Hausa version of IPAQ-LF is similar to that of the Hausa IPAQ-SF that has been described in details elsewhere.[21] Briefly, interviews were conducted with public health experts, exercise scientists and not highly educated local people to identify the items and examples of PA on the original questionnaires that needed to be culturally adapted. Several cultural adaptations were made to the original items to reflect the reality in Nigeria. First, adjustments to English words like vigorous and moderate activity that can be misunderstood and not associated with PA behaviours in Nigeria were replaced with words that are more representative of the language used in Nigeria, like 'very hard' and 'hard' respectively. Second, examples of various intensities of activity that were common in the Nigerian culture were added, and those already on the questionnaire but not common in the Nigerian context were replaced with culturally applicable examples that are equivalent in energy intensity (METs) with the original items and examples. Third, concepts like physical activity and walking for transportation that were misconstrued outside the health context were refined to indicate they were referring to health behaviours.

After adaptation, the questionnaire was independently translated from English into Hausa language by two native speakers of Hausa who also speaks English, and able to read and write in both languages. One of the translators was familiar with the questionnaire and the second was an expert in Hausa language. The translated questionnaires were mutually revised by the translators and the research team for consistency and then back translated into English language by a third bilingual person who was familiar with the construct measured by IPAQ. The back translated version was checked by the research team for any discrepancies and to ensure that the construct measures by IPAQ had not been lost during the adaptation and translation process. 

 The modified questionnaire (available in both Hausa and English language), hereafter referred to as the Hausa version of the long international physical activity questionnaire (Hausa IPAQ-LF), contains thirty-one questions that asked about physical activity done in the last 7-days in terms of frequency (days/week) and duration (minutes/day) spent in four activity domains (transportation,

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occupation, domestic and leisure time), and included sections on walking, moderate- and vigorous- intensity activities, and time spent in sedentary behaviours (sitting during leisure and motorized transportation). The Hausa IPAQ-LF data were presented as the MET-minute/week for total walking, moderate, and vigorous intensity activity and overall physical activity across the four domains, and in each of the domains. The MET intensity values used to score the Hausa IPAQ-LF questions in this study were 8 METs for vigorous activity, 4 METs for moderate activity and 3.3 METs for walking, [2, 6] One MET represents the energy expended while sitting quietly at rest and is equivalent to 3.5 ml/kg/min of VO<sub>2</sub> Max.[3] To assess the test-retest reliability of the Hausa IPAQ-LF, participants self-completed all items on the measure twice, with an interval of one week between administrations. 

207 Anthropometrical and biological measurements

Body weight (to nearest 0.5 kg) and Height (to nearest 0.1 cm) were measured in light clothing using a digital scale and stadiometer. Body mass index (BMI) was calculated as body weight divided by the square of height  $(kg/m^2)$ . The principal cutoff points as recommended by WHO were used to create the categories: underweight (< 18.5 kg/m<sup>2</sup>), normal weight (18.5 - < 25 kg/m<sup>2</sup>), overweight  $(25 - \langle 30 \text{ kg/m}^2)$  and obese  $(\geq 30 \text{ kg/m}^2)$ .[29] Resting blood pressure and heart rate were measured with Digital Sphygmomanometer (Diagnostic Advanced Wrist Blood Pressure Monitor, Model 6016, USA). Body mass index and resting diastolic blood pressure (DBP) have previously been used for validating the IPAQ.[7,24] Similarly, for this study, construct validity was evaluated by investigating the relationship of outcomes from the Hausa IPAQ-LF with anthropometric (BMI) and biological (SBP and DBP) measurements, and also in part by comparing the differences in time spent in PA and sitting across sociodemograpic subgroups. These types of validation for PA measures have been referred as indirect or construct validity in previous studies.[7,24,30] 

 222 Sociodemographic Characteristics

Information on age, gender, marital status, religion, income, educational level and employment
 status were elicited from the participants. Marital status was classified as married or not married.
 Educational level was classified as more than secondary school education, secondary school

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education and less than secondary school education. Employment status was classified into white collar (government or private employed), blue collar (self- employed, trader, artisan etc) and unemployed (homemaker, student, retired, or unable to find job). 

#### **Data Analysis**

Descriptive data were reported as mean, standard deviation and percentages. Mean group differences for continuous variables by gender were examined by independent t-test, and for dichotomous variables by chi-square statistics. The reliability analyses were performed using 2 strategies. First, the two- way mixed model (single measure) intraclass correlation coefficient (ICC) with 95% confidence interval (CI) between the continuous scores obtained on 1<sup>st</sup> and 2<sup>nd</sup> administration of the Hausa IPAQ-LF was calculated. The ICCs were calculated overall, and by gender and socioeconomic status. ICC estimates >0.75 were considered as good reliability scores, between 0.50 and 0.75 as moderate reliability and <0.50 as poor reliability.[31] Second, the Bland and Altman Method was used to assess agreement on scores of PA from the 1<sup>st</sup> and 2<sup>nd</sup> administrations.[32] Variables used for the Bland and Altman analysis were weekly time spent in moderate-to-vigorous activity (MVPA), total PA and sitting. MVPA was computed by summing the total minutes/week of reported physical activity of moderate and vigorous- intensities across all four domains. For total PA, the total minutes/week of activities in each domain were summed (total work + total transport + total domestic + total leisure-time min/week scores) to gain an overall estimate of physical activity in a week. Also, the independent t-test and one-Way ANOVA were used as appropriate to compare the time spent (minutes/week) in PA at both administrations across sociodemographic subgroups. To assess construct validity, the non-parametric Spearman correlation coefficients  $(\rho)$  were utilized to explore the relationship between MET-min/week of PA from the Hausa IPAQ- LF, and resting blood pressure and body mass index. Data were analyzed using Statistical Package for the Social Science (SPSS), version 15.0 for windows (SPSS Inc., Chicago, Illinois, USA) and the level of significance was set at p<0.05. 

**RESULTS** 

The socio-demographic characteristic of the participants are shown in Table 1. The participants comprised 50% women and men, with a mean age of  $35.6 \pm 10.3$  years and body mass index of  $23.8 \pm 3.9$ kg/m<sup>2</sup>. Majority of the participants were married (58.9%, n=106), had more than secondary school education (62.7%, n=111) and were employed (75%, n=117). Compared to men, the women were more likely to be married (71.1% vs 46.7%, p=0.001) and unemployed (52.2% vs 17.8%, p<0.001), but men were more likely to have more than secondary school education (76.7% vs 48.2%, p<0.001).

**Reliability** 

Table 2 shows the test-retest reliability of the modified IPAQ-LF. Overall, reliability coefficients were good (ICC >75) for total PA, occupational PA, active transportation and vigorous intensity (very hard) PA. Domestic PA, sitting activity and leisure PA demonstrated moderate reliability (ICC ranges from 0.51- 0.71). While, the reliability coefficients of total PA (ICC=0.80, 95% CI=0.69-0.87), active transportation (ICC=0.83, 95% CI=0.73-0.89), occupational PA (ICC=0.78, 95% CI=0.66-0.85) and leisure time PA (ICC=0.75, 95% CI=0.63-0.84) were substantially higher among men than women, reliability coefficients for domestic PA (ICC=0.38, 95%, CI=0.01-0.57) and sitting time (ICC=0.71, 95% CI=0.46-0.85) were higher among women than men. According to the intensity of PA, ICCs range between 0.61 and 0.82, with the lowest value recorded for moderate intensity (hard) PA and the highest value for vigorous intensity (very hard) PA. The reliability coefficients for walking, moderate-intensity (hard) and vigorous intensity (very hard) activities were substantially greater in men than women. 

Similarly, socioeconomic status differences were observed in the reliability coefficients of the modified IPAQ-LF (Table 3). Across all domains of PA, reliability coefficients were substantially higher among participants with less than secondary school education (ICC from 0.77 [sitting activity] to 0.92 [leisure activity]) compared to those with secondary school education (ICC from 0.28 [active transport] to 0.58 [occupational activity]) and those with higher than secondary school education (ICC from 0.23 [sitting activity] to 0.67[active transport]). While reliability coefficients were higher for overall PA (ICC=0.80, 95% CI=0.71- 0.86), active transport (ICC=0.83, 95% CI=0.74- 0.88), occupational PA (ICC=0.79, 95% CI=0.70- 0.86) and 

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leisure-time PA (ICC= 0.79, 95% CI= 0.69- 0.85) among participants that were employed compared to their unemployed counterparts, it was higher for domestic PA (ICC=0.65, 95% CI=0.43- 0.79) and sitting time (ICC= 0.68, 95% CI= 0.36- 0.83) among participants that were unemployed than in the employed subgroup.

Figures 1, 2 and 3 (Bland-Altman plots) illustrate the agreement in the scores (minutes/week) of total PA, MVPA and sitting between the first and second administrations of Hausa IPAQ-LF. For total PA, the mean difference was 106.7 minutes/week, with a wide 95% limits of agreement (-762.2 to 965.6 minutes/week). For MVPA, the mean difference was about one and half hour per week (91.6 minutes/week), and also demonstrating wide 95% limits of agreement (-744.5 to 927.7 minutes/week). For sitting time, the mean difference was small (26 minutes/week) and the 95% limits of agreement range from -2178.1 to 2230.9 minutes/week. 

Table 4 shows the patterns of PA across sociodemographic subgroups during the first (IPAO1) and second (IPAQ2) administrations of the modified IPAQ-LF. Overall and across all stratified variables, time spent in PA reported during the first administration tends to be higher than those reported during the second administration. At both time points, men reported significantly (p<0.05) higher mean time (minute/week) in active transportation, occupational PA, and leisure-time PA than women. However, women spent significantly (p<0.001) more time (minutes/week) in domestic PA than men (IPAQ1=236.9 vs 82.3, IPAQ2=195.5 vs 52.4). For educational status, participants that had lower than secondary school education compared to those with at least secondary school education reported statistically significant higher mean time (minutes/week) at both time points for total PA, active transport, occupational PA, walking and vigorous intensity activity compared to those with at least secondary school education. While participants that were employed reported statistically significant (p<0.05) more time (minutes/week) in total PA (IPAO1=441.1 vs 285.1, IPAO2=359.4 vs 141.0), active transportation (IPAO1=43.8 vs 21.1, IPAQ2=36.9 vs 18.3) and work PA (IPAQ1=195.5 vs 41.8, IPAQ2=164.1 vs 40.1) than those who were unemployed, the unemployed reported statistically significant (p<0.05) higher time in domestic activity (IPAQ1=210.6 vs 132.1, IPAQ2=205.0 vs 112.6) compared to the employed. 

# **Construct Validity**

Overall, correlations between energy expenditure (MET-Minutes/week) according to the modified IPAQ-LF and anthropometric and biological measures were statistically significant in the expected direction for all domains and intensities of PA, except for occupation and active transport domains and walking (table 5). In the full sample, domestic PA was mainly related with SBP ( $\rho = -0.27$ , p< 0.01) and DBP ( $\rho = -0.17$ , p< 0.05), while leisure PA and total PA were only related with SBP ( $\rho = -0.16$ , p< 0.05) and BMI ( $\rho = -0.29$ , p< 0.01), respectively. Similarly, moderate-intensity PA was mainly related with SBP ( $\rho = -0.16$ , p< 0.05) and DBP ( $\rho = -0.21$ , p< 0.01), but vigorous-intensity PA was only related with BMI ( $\rho = -0.11$ , p< 0.05). In the gender based analyses, total PA, domestic PA and sedentary time were more consistently related with anthropometric and biological variables. The strongest rho value (-0.41) was found for the relationship between total PA and BMI for the male subgroup. The rho values of -0.23 was reached between total PA and DBP for the women subgroup. Only in women was domestic PA significantly related with BMI ( $\rho = -0.23$ ), DBP ( $\rho = -0.20$ ) and SBP ( $\rho = -0.31$ ). Leisure-time PA ( $\rho = -0.39$ ) and occupational PA ( $\rho = -0.22$ ) were significantly related with BMI only in men. The rho value for the relationship between sitting time and BMI was slightly higher in women (p = 0.19) than men ( $\rho = 0.15$ ). 

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#### 333 DISCUSSION

This study examined the reliability and an aspect of validity of a modified version of the IPAQ-LF in Nigeria. The findings generally indicated acceptable test-retest reliability and modest construct validity for items of the modified IPAQ-LF among Nigerian adults. To the best of our knowledge, the present study is the only one to examine the reliability and validity of the long version of IPAQ that has been modified specifically to an indigenous African culture and language.

We found evidence for good reliability with high correlations between the test-retest for total PA, occupational PA, active transportation and vigorous intensity activity. Our results shows that except for domestic PA and sitting time, ICC values for domains of PA were consistently above 0.70, a level of reproducibility that has been considered acceptably good for IPAQ data.[33,34]

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Similar to a previous IPAO-LF study in Hong Kong, [34] domestic activity demonstrated the lowest ICC value in our study. However, it is possible that the infrequent nature of household activities undertaken, especially by men may account for the low reliability reported for domestic PA in our study. In addition to the traditional African patriarchal norm that make most African men to rarely engage in indoor household activities, men in the high socioeconomic group in Nigeria may also not engage in outdoor domestic activities like gardening and outdoor home. appliances and equipment maintenance because they are able to employ the services of domestic helpers and repair men. Our findings of lower reliability for domestic activity among men, those with more than secondary school education and those who were employed compared to their counterparts seem to support this assumption. 

The highest and strongest reliability coefficients (0.82) were found for both active transportation and vigorous intensity activity. Perhaps, active transportation was more stable, consistent and reproducible overtime than other PA domains because it is a common and ubiquitous PA behaviour in the African region. Mostly, the performance of active transportation especially walking is often out of necessity rather than choice within the African context. Our finding of higher ICC value for vigorous intensity PA is consistent with those of other studies that found the reliability of vigorous intensity activity to be higher compared to that of moderate intensity activity.[10,30,34,35] Compared to structured vigorous physical activities like sports and exercise that can be more easily recalled, moderate intensity PA are often of low salience, incidental and may not easily be remembered by people.[36,37] Further our finding that the reliability of vigorous intensity physical activity was meaningfully higher among men than women seem to confirm our previous findings with the IPAQ-SF.[21] Plausibly men in Nigeria are more consistent than women when responding to PA items that pertained to intense vigorous PA than other intensities of activity. Overall, the moderate to good evidence of reliability found for all items indicate that the modified IPAQ-LF is reproducible, internally consistent and is promising for research in Nigeria. 

<sup>1</sup> 372

Except for sitting time, the limits of agreement in the mean scores of total PA and MVPA between the first and second administrations were wide, suggesting an evidence of bias between

administrations. Large difference in PA scores between the 2 administrations would indicate that at least one of the two measurements is not accurate. However, similar to the finding of a Mexican study,[38] scores on the Hausa IPAQ-LF were consistently lower during the second administration of the questionnaire compared to the first administration. Because familiarity with the IPAQ questions may improve over multiple exposures to the questionnaire, it is possible that participants in our study might have over-reported their PA levels during the first administration of the Hausa IPAQ-LF. This kind of findings may have implication for the utility of IPAQ for surveillance. Generally, due to issues of social desirability phenomenon and over reporting of PA that has been associated with the IPAQ,[39,40] it may be necessary to start considering the need for multiple measurements when using the IPAQ for evaluating PA, especially in developing African countries. However, patterns of PA as measured by the modified IPAQ-LF during both administrations were consistently similar, and both administrations were able to discriminate PA in the expected direction between subgroups of our sample. For example, at both measurement time points, and consistent with hypothesis, men reported more time in active transportation, occupational PA and leisure PA than women, while women reported more time in domestic PA and sedentary activity than men.

In the absence of objective criterion standards for evaluating an absolute estimate of PA, the consistency of items on IPAQ with variables known to be related to PA such as body mass index (BMI), blood pressure, heart rate, indicators of lipid and glucose metabolism, and fitness index have been used as important construct validity measures. [7,10,21,24] In the present study, the correlations of the PA domains and intensities with biological and anthropometric variables were mostly significant in the expected direction, but they were low suggesting a modest evidence of construct validity for the modified IPAQ-LF in Nigeria. However, observed correlations were comparable with the values in other studies that have evaluated the IPAQ-LF.[5,7,8,24,30,33,39] Because better validity coefficients have been reported for other PA measures above that of the IPAQ.[39,41] with the present African finding, it is possible that the IPAQ-LF only have modest evidence of construct validity. However, our findings on the relationships between physical activity and biological and anthropometric variables should be interpreted in the light of an important caution. Because hypertensive and obese people may get oriented to exercise,[3] cross-

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sectional associations of physical activity and blood pressure or BMI could also occur in the
 opposite direction and may not represent much information as indicators of construct validity of
 physical activity measures.

409 Strengths and limitations

A strength of this study is the systematic adaptation and tailoring of items on the IPAO-LF to reflect the common PA behaviours of people in Nigeria. This is the first study in an African country to explore the cultural adaptation and translation of the IPAQ-LF, and its findings demonstrated the feasibility of using the IPAQ-LF to reliably collect PA data in a diverse segment of the Nigerian population. In the Africa region, the importance of a valid and established PA scale like the modified IPAO-LF is not only important to monitoring the domain in which activity is performed, but also very critical to understanding studies of ecological models of health behaviours, that emphasize the importance of multiple levels of influence on health behaviours including PA.[18,42] In Nigeria, emerging evidence from studies using ecological models indicate that favourable built environmental attributes are promising for improving total and moderate-to-vigorous PA and controlling obesity among adults.[26, 43-45] However, built environment characteristics are expected to be strongly related to specific PA types rather than overall PA.[46,47] For example, different environmental variables can be related to walking for leisure or transportation and to moderate PA for household, occupation, recreation or transportation. Thus, a study of adaptation of the IPAQ-LF is very important to understanding the domain specific nature of ecological models research in the African region. One additional strength was the exploration of PA patterns by gender, educational level and employment status, the findings of which were consistent with general hypothesis on social patterns of inactivity in low-income countries.[20,48] 

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However, the findings of this study should be interpreted in the light of some important limitations. Direct comparison of our validity findings with previous studies should be made with caution, because unlike in our study, the accelerometer or PA diary were utilized as a common validate IPAO objective criterion standard to the in the majority of the studies. [5,7,8,24,30,33,39] Thus, examining the construct validity through the relationships of 

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PA with BMI and resting blood pressure was an important limitation of our study. The choice and availability of appropriate criterion measures are particular issues of concern for the validation of PA questionnaires in low-income countries of Africa [5,49,50]. Despite these issues, the validity coefficients in our study were remarkably similar to those reported in other studies, [5,7,8,24,30,33,39] and the consistency of items on IPAQ with variables known to be related to PA such as BMI, blood pressure, heart rate, indicators of lipid and glucose metabolism, index have previously been used as important construct and fitness validity measures. [7,10,21,24] Another limitation of the study is the use of non-probability sampling technique. The study finding may have limited generalizability to other samples of Nigerians that have different characteristics from this sample. In addition, the majority of participants have more than secondary school education with potentially higher comprehension and recall ability than may be found in the general population. Nevertheless, recruitment from diverse neighbourhoods and settings allowed for a sample with reasonable heterogeneity in age, occupational status, and ethnic backgrounds and made it possible to stratify the analyses by sociodemographic characteristics. However, because some of the participants in the present study required assistance to complete the survey, interview administration rather than selfadministration of the IPAQ-LF should be encouraged in any future national studies in the African region. Administering the IPAQ through interview has been considered as a viable and preferred option in developing countries.[5] 

#### **Conclusions**

456 Overall, the present study suggests that the modified IPAQ-LF demonstrated sufficient evidence 457 of test-retest reliability and may be valid for assessing context specific PA behaviours of adults 458 in Nigeria. Adaptation and criterion evaluation of the IPAQ-LF in other African countries could 459 further contribute to our understanding of the impact of multiple levels of influence on PA 460 behaviours of people in the African region.

1 2						
3 4	465					
5 6	466	Acknowledgments				
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8 9	468	with questionnaire translations, and to the participants for their help for taking part in the study.				
10 11	469					
12 13	470	Contributors				
14	471	ALO conceived and designed the study, contributed to cultural adaptation and acquisition of				
15 16	472	data, conducted the statistical analysis and interpretation of data and drafted the manuscript.				
17 18	473	UMB and STP managed participants' recruitment and data collection and contributed to cultural				
19 20	474	adaptation. HBN and RDM contributed to cultural adaptation and translations of the measure.				
21	475	AYO contributed to study design, acquisition of data and critically revised the manuscript for				
22 23	476	important intellectual contents. All authors read and approved the final manuscript.				
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33 34	482	Competing interests				
35	483	Authors declare there is no competing interest associated with this study.				
36 37	484					
38 39	485	Ethics approval				
40 41	486	Research and Ethic Committee of the University of Maiduguri Teaching Hospital, Nigeria				
42 43	487	(ADM/TH/EC/75).				
44	488					
45 46	489	Data sharing process				
47 48	490	Dataset for this study available upon request from the corresponding author.				
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Women

(n=90, 50%)

 $35.5 \pm 11.9$ 

Men

(n=90, 50%)

 $35.7\pm8.3$ 

75 76	Variables	Total sample	М
	Variables	(N=180)	(n=90,
	Age (years)		
	Mean (± SD)	$35.6 \pm 10.3$	35.7
	Marital status (n, %)*		
	Not Married	74(41.1)	48(5
	Married	106(58.9)	42(4
			(
	BMI ( $Kg/m^2$ )		
	Mean (± SD)	$23.8 \pm 3.9$	23.8
	BMI Category (n, %)		
	Underweight	14 (7.8)	4 (4
	Normal weight	107 (59.4)	58 (
	Overweight/obese	59 (32.8)	28 (
	Ethnicity (n, %)		
	Hausa/Fulani	21(11.7)	10.1
	Igbo	8(4.4)	5(5.
	Yoruba	10(5.6)	6(6. <sup>°</sup>
	Kanuri/Shuwa Arab	44(24.4)	23(2
	Others	97(53.9)	46 (
	Educational laws (m. 0/	)	
	Educational level (n, %		11 (
	> Secondary School Secondary	111 (62.7)	11 (
	<pre>Secondary <secondary pre="" school<=""></secondary></pre>	38 (21.5) 28 (15.8)	10 (
	-Secondary School	20 (13.0)	69 (
	Occupational Status (n.	0/.)*	
)6			

**Occupational Status (n, %)\*** 

BMI- Body Mass Index

63(35)

45(25)

72(40)

\*- Significant difference between samples (p < 0.05)

Unemployed

White Collar

Blue Collar

707

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48(53.3)	26(28.9)
42(46.7)	64(71.1)
23.8 ± 3.5	23.8 ± 4.4
4 (4.4)	10 (11.1)
58 (64.4)	49 (54.4)
28 (31.2)	31 (34.5)
10.1(11.1)	11(12.2)
5(5.6)	3(3.3)
6(6.7)	4(4.4)
23(25.6)	21(23.3)
46 (51.1)	51(56.7)
11 (12.2)	17(19.5)
10 (11.1)	28(32.5)
69 (76.7)	42(48.2)
16(17.8)	47(52.2)
28(31.1)	17(18.9)
46(51.1)	26(28.9)

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Table 2: Test-reliability based on intra-class correlation coefficient for Hausa IPAQ-LF, overall and by gender

		Total (N=180)	Women (n=90)	Men (n=90)	
PA Measure (MET×min/wk)	Test 1 (Mean (SD))	Test 2 (Mean (SD))	ICC (95%CI)	ICC (95%Cl)	ICC (95%Cl)
Total PA, all domain	2160.6 (2691.1)	1612.8 (1612.8)	0.76 (0.65-0.82)	0.45 (0.08-0.67)	0.80 (0.69- 0.87)
Occupation	619.1(1671.5)	497.5 (1332.9)	0.77 (0.68-082)	0.64 (0.46-0.77)	0.78 (0.66 -0.85)
Active Transport	468.1 (684.7)	440.5 (605.7)	0.82 (0.75-0.87)	0.63 (0.40-0.77)	0.83 (0.73 - 0.89)
Domestic	597.6 (754.6)	473.4 (673.7)	0.50 (0.32-0.62)	0.38 (0.01-0.57)	0.33 (-0.01-0.56)
Leisure	377.0 (1096.3)	196.7 (920.2)	0.71 (0.60-0.78)	0.69 (0.53-0.79)	0.75 (0.63-0.84)
Sitting	2263.0 (715.8)	2235.4 (818.9)	0.62 (0.42-0.75)	0.71 (0.46-0.85)	0.48 (0.06-0.72)
PA by Intensity (MET×min/wk)					
Walking	613.6 (635.6)	534.6 (449.1)	0.63 (0.48-0.74)	0.57 (0.29-0.74)	0.65 (0.44-0.78)
Moderate	986.9 (1365.9)	716.1 (1164.6)	0.61 (0.46-0.71)	0.42 (0.11-0.62)	0.67 (0.49-0.78)
Vigorous	526.5 (1543.7)	394.1 (1431.1)	0.82 (0.76-0.87)	0.55 (0.30-0.71)	0.86 (0.78-0.91)

PA= Physical Activity

MET= Metabolic Energy Turnover

Table 3: Socioeconomic status differences in test- retest reliability of the Hausa IPAQ- LF (N= 180)

Socioeconomic Status	Overall PA	Active Transport	Occupation PA	Leisure PA	Domestic PA	Sitting
<b>Educational</b> <b>Qualification</b> More than secondary school (n=111)	0.42 (0.08-0.63)	0.67 (0.43-0.78)	0.32 (-0.06-0.57)	0.33 (-0.05-0.57)	0.58 (0.35-0.73)	0.23 (-0.63-0.63)
Secondary School (n=38)	0.55 (0.22-0.74)	0.28 (-0.21-0.57)	0.58 (0.33-0.74)	0.54 (0.25-0.71)	0.50 (0.19-0.69)	0.51 (-0.04-0.76)
Less than Secondary school (n=28)	0.89 (0.67-0.96)	0.90 (0.74-0.96)	0.82 (0.61-0.92)	0.92 (0.83-0.96)	0.90 (0.78-0.95)	0.77 (0.45-0.90)
<b>Employment Category</b> Employed (117)	0.80 (0.67-0.96)	0.83 (0.74-0.88)	0.79 (0.70-0.86)	0.79 (0.69-0.85)	0.36 (0.08-0.56)	0.56 (0.23-0.75)
Unemployed (63)	0.09 (-8.86-0.56)	0.68 (0.44-0.82)	0.16 (-0.39-0.49)	0.25 (-0.24-0.55)	0.65 (0.43-0.79)	0.68 (0.36-0.80)
PA= Physical Activity						
						2
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Table 4: Differences in time spent in physical activity overall, and by gender and socioeconomic status sub groups

<b>PA by domain</b> Total PA, all do IPAQ1 IPAQ2 Active Transpo	omain 405.2 (507.8)	Men Mean ± SD	<b>Women</b> Mean ± SD	>Secondary Mean ± SD	<b>Secondary</b> Mean ± SD	<secondary< th=""><th>Employed</th><th>Unemployed</th></secondary<>	Employed	Unemployed
Total PA, all de IPAQ1 IPAQ2	omain 405.2 (507.8)					Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD
IPAQ1 IPAQ2	405.2 (507.8)							
IPAQ2								
IPAQ2 Active Transpo		460.7 (582.9)	326.8 (367.8)	334.0 (400.8)	384.8 (514.8)	849.2 (764.1)**	441.1 (530.2)	285.1 (408.6)
Active Transpo	308.4 (440.3)	319.7 (522.8)	291.9 (282.9)	285.1 (295.1)	184.8 (264.4)	803.0 (929.6)**	359.4 (481.6)	141.0 (185.2
rictive ritanope	ort							
IPAQ1	35.8 (89.7)	52.4 (127.7)	19.5 (17.7)*	28.3 (47.7)	28.9 (45.02)	76.4 (198.7)*	43.8 (109.4)	21.1 (21.9)*
IPAQ2	30.4 (76.7)	41.2 (106.3)	19.3 (17.5)*	23.6 (30.6)	20.3 (30.9)	74.3 (182.6)*	36.9 (94.1)	18.3 (14.7)*
Work								
IPAQ1	160.1 (380.8)	217.5 (466.8)	79.1 (179.9)*	114.8 (291.0)	122.9 (365.6)	546.7 (615.7)**	195.5 (418.8)	41.8 (162.2)*
IPAQ2	135.3 (310.3)	172.5 (372.8)	80.6 (171.9)*	104.1 (232.2)	160.9 (196.1)	531.6 (595.8)**	164.1 (341.7)	40.1 (133.0)
Domestic			Ň			· · · ·		~ /
IPAQ1	159.6 (202.2)	82.3 (120.6)	236.9 (235.8)**	* 141.2 (182.4)	173.3 (238.5)	165.4 (159.4)	132.1 (170.7)	210.6 (243.8
IPAQ2	123.9 (163.9)	52.4 (74.9)	195.5 (190.1)**		107.6 (130.4)	147.3 (189.1)	112.6 (163.9)	205.0 (163.3
Leisure	· · · ·	· · · · ·	· · · ·					× ·
IPAQ1	62.4 (159.1)	75.0 (211.1)	10.5 (27.3)**	47.0 (97.3)	92.7 (209.4)	38.2 (160.1)	69.7 (157.6)	48.7 (162.3)
IPAQ2	30.5 (118.2)	50.6 (160.7)	10.1 (38.5)**	23.4 (51.4)	24.7 (91.4)	71.5 (256.5)	43.1 (143.5)	17.0 (28.7)*
Sitting	· · · ·	· · · · ·		ì í				× ,
IPAQ1	2263.0 (715.8)	2188.8 (759.7)	2330.7 (674.8)	2280.0 (618.7)	2433.9 (693.7)	2180.9 (760.8)	2159.4 (775.9)	2337.6 (667.
IPAQ2	2235.4 (819.9)			( /		2160.0 (1111.4)	2170.6 (870.5)	
PA by Intensit	ty (min/wk)					0		
Walking	•							
IPAQ1	178.5 (221.5)	241.1 (271.9)	128.2 (100.8)*	194.4 (268.1)	133.4 (85.6)	266.9 (285.4)*	192.0 (245.7)	133.3 (96.2)*
IPAQ2	142.5 (141.8)	148.5 (137.9)	133.7 (147.9)	151.7 (138.4)	103.6(94.7)	200.3 (209.1)*	150.7 (146.6)	115.4 (122.7
Moderate	. /	. ,	. ,				. ,	
IPAQ1	201.9 (326.9)	193.0 (214.5)	214.5 (247.8)	187.3 (266.5)	194.9 (386.5)	309.7 (381.7)	221.2 (347.4)	137.7 (239.9
IPAQ2	133.9 (238.5)	114.2 (276.9)	162.7 (165.6)	132.9 (177.8)	88.0 (197.2)	319.0 (482.1)*	153.9 (266.2)	68.0 (76.4)*
Vigorous	. /	. ,	. ,		. ,	. ,		. /
IPAQ1	94.1 (211.8)	123.7 (249.6)	52.2 (133.2)*	32.9 (81.9)	129.5 (208.2)	268.0 (459.7)**	90.2 (214.6)	127.1 (204.6
IPAQ2	78.4 (206.9)	86.8 (227.4)	46.2 (73.4)	52.2 (140.2)	55.2 (127.0)	292.8 (461.5)**	92.8 (226.9)	130.9 (107.8)
	ເຂຍເບັດເດ	ແບວອາມຣົກໃນເຂດແຜງອາທ	wegnly chitp://	amionenyami.o	ana(ajte4about/si	by copyrightania high	ບອາວອາດາຊ	

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### **BMJ Open**

	<b>Overall (N = 180)</b>			Female (n = 90)			Male (n = 90)		
MET×min/wk	BMI	DBP	SBP	BMI	DBP	SBP	BMI	DBP	SBP
PA Domains									
Total PA	-0.29**	-0.17*	-0.09	-0.09	-0.23**	-0.04	-0.41**	-0.08	-0.
Occupation PA	-0.12	-0.09	0.01	0.02	0.02	-0.05	-0.22**	-0.17	-0.0
Active transport PA	-0.05	-0.04	-0.01	-0.10	-0.13	-0.02	-0.04	-0.02	-0.8
Domestic PA	-0.07	-0.17*	-0.26**	-0.23**	-0.20*	-0.31**	0.04	-0.14	-0.0
Leisure PA	0.09	-0.08	-0.16*	-0.11	0.02	0.08	-0.39**	-0.12	-0
Sitting	0.16	-0.09	0.04	0.19	0.12	0.05	0.15	-0.09	0.
PA Intensity									
Walking	0.90	-0.09	-0.03	0.19	-0.05	0.08	-0.05	-0.11	-0.
Moderate	-0.02	0.21*	0.16*	0.02	-0.14	-0.08	0.02	-0.25**	-0
Vigorous	-0.11*	-0.06	0.03	-0.16	0.01	0.02	-0.13*	-0.12	-0.1
MET= Metabolic Ene BMI= Body Mass Ind DBP= Diastolic Blood SBP= Systolic Blood PA= Physical activity *=p<0.05, **=p<0.01	lex d Pressure Pressure								

Table 5: Construct validity of Hausa IPAQ-LF: Spearman correlations between energy expenditure (MET×min/wk) from Hausa IPAQ-LF, and anthropometric and biological variables (N=180)

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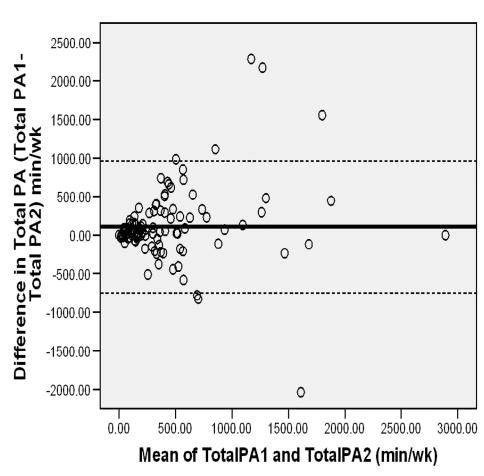


Figure 1: Bland-Altman plot min/wk reported in total physical activity (PA for the first and second administrations of Hausa IPAQ-LF. Mean difference:106.7 +/- 2SD (Standard deviation)= -762.2 to 965.6

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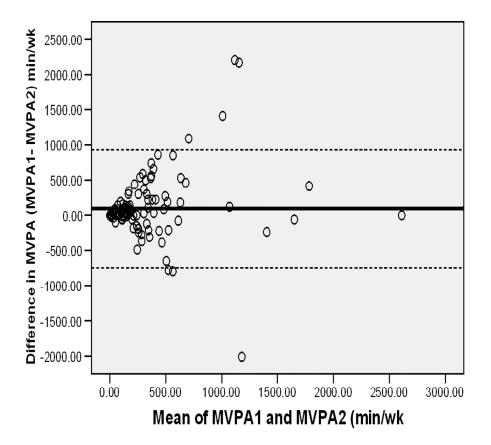
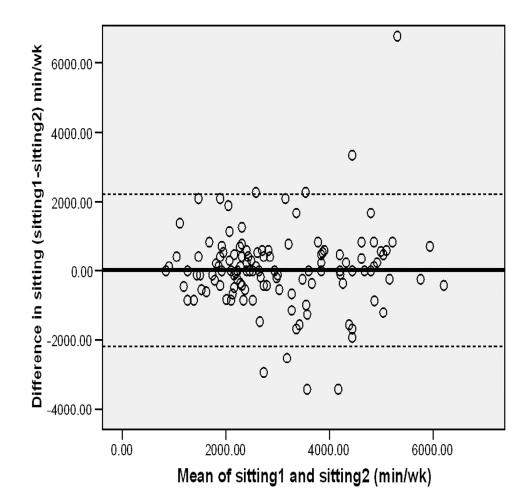


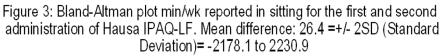
Figure 2: Bland-Altman plot for min/wk reported in moderate-to-vigorous physical activity (MVPA) for the first and second administrations of Hausa IPAQ-LF: Mean difference: 91.6 +/- 2SD (Standard Deviation)=-744.5 to 927

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