Original Article

Reliability and Validity of a Culturally Adaptive Version of the International Physical Activity Questionnaire in Indian Subcontinent: A Cross-sectional Study

Rabbanie Tariq Wani, Sheikh Sahila Nabi

Department of Community Medicine, Government Medical College, Srinagar, Kashmir, India

Abstract

Background: Physical activity (PA) is one of the prime public health problems occurring globally. Regular PA is associated with a decrease in all-causes of mortality irrespective of gender. The study was conducted to investigate the validity and an aspect of reliability of a modified version of the International Physical Activity Questionnaire (IPAQ) in the Indian subcontinent (InS). **Methods:** Cross-sectional study, to evaluate the validity and reliability of the InS IPAQ-LF compared with a range of biological variables. In total, 198 participants (50% women) with a mean age of 35.6 (SD = 10.3) years selected from neighborhoods with variable socioeconomic status and PA. **Results:** The InS IPAQ-LF demonstrated good test-retest reliability for total PA (Intraclass correlation coefficient [ICC] =0.79, 95% CI 0.65 to 0.82), occupational PA (ICC = 0.77, 95% CI 0.68 to 0.82), active transportation (ICC = 0.82, 95% CI 0.75 to 0.87), and vigorous-intensity activities (ICC = 0.82, 95% CI 0.76 to 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 in women, but domestic PA (ICC = 0.38) and sitting time (ICC = 0.71) demonstrated more substantial reliability coefficients in women than in men. **Conclusions:** The InS IPAQ-LF demonstrated considerate evidence of test-retest reliability and may be valid for evaluating context specific PA mannerisms of adults in InS.

Keywords: *Exercise, Indian, International Physical Activity Questionnaire, lifestyle medicine, non-communicable diseases, physical activity*

Introduction

Physical activity (PA) provides a broad spectrum of benefits related to health, including risk reduction for a variety of diseases and improvements in functional ability.[1,2] PA is effective in preventing as well as slowing down numerous lifestyle-related diseases, such as cardiovascular diseases, diabetes, and hypertension.[3] PA is important for health promotion as well as preventing disease and this fact is already established,[4,5] but for effective promotion of health and PA surveillance and monitoring, it is prerequisite to have standardized and reliable tools that can be used to precisely elaborate population levels and dynamics of PA all over the countries.[6,7] In the above backdrop, the International Physical Activity Questionnaire (IPAQ) was developed to obtain and compare data internationally on PA related to the health of adults (18–65 years).[8] Two different versions of the IPAQ have been developed. The short form (SF-IPAQ) was designed for population surveillance of PA behaviors; while the long form (LF) was designed to be used in research that requires meticulous information on different domains of PA, including PA at work, household, transportation, leisure, and the duration in sedentary activities.[9]

From the initial assessment of the IPAQ from almost 12 countries, there has been acceptable supporting evidence of validity as well as reliability, which were as good as other self-report measures of PA.[8] For increasing the utility of IPAQ and to further evaluate its psychometrics globally, lots of efforts have been made to modify the IPAQ in many other countries so as to inculcate the cultural aspects in the IPAQ, but most of the research in this context were from the developed Western part of the world,[6,10,11] and those who are non-English speaking in the Indian subcontinent (InS) are left out.

In InS, the psychometric analysis of IPAQ have only been evaluated in South India[12] and has not been reframed as per the

How to cite this article: Wani RT, Nabi SS. Reliability and validity of a culturally adaptive version of the International Physical Activity Questionnaire in Indian subcontinent: A cross-sectional study. Int J Prev Med 2020;11:40.

Address for correspondence:
Dr. Rabbanie Tariq Wani, R/O: H#39, Lane 3rd, Ibrahim Colony, Hyderpora, Srinagar, Kashmir, India.
E-mail: drrabbanietariq@gmail.com

Access this article online

Website: www.ijpvmjournal.net/www.ijpm.ir

DOI: 10.4103/ijpvm.IJPVM_120_19

Quick Response Code:

cultural adaptations and predominantly using accelerometers only[13] because the major burden of lifestyle diseases is predominant in low-income countries, and the brunt is faced not only by the middle class but also by the lower class too with a very minimal understanding of evidence-based work that can be utilized for increasing PA, PA continues to remain poor,[14-17] therefore, improving research on PA is a top priority in these countries.[18] However, to advance PA research in India, it is important to first develop standardized measures to be culturally aligned to PA behaviors of people in different regions of the country. Because India is the most populous country in Asia with multicultural, multiethnic multilinguistic origins similar to other Asian countries, it is a relevant choice to evaluate the IPAQ for cultural and psychometric relevance in this South Asian region.

Recently, a modification of the IPAQ-SF was conducted among adults in India,[12] with good support for test-retest reliability similar to findings in some other studies.[19-21] However, because the IPAQ-SF is not domain specific and does not provide context-specific information on PA behavior, it is important to evaluate the IPAQ-LF for relevance in India. Psychometric evaluation of a modified version of the IPAQ-LF in Asian countries can impact PA research in the Asian region where the prevalence of inactivity related lifestyle disease is on the increase.[18] The aim of this study was to investigate the validity and reliability of a modified version of the IPAQ-LF among adults in Urdu speaking population of InS.

Methods

Participants

In total, 210 participants from three districts namely Anantnag, Baramulla, and Srinagar, which were chosen from three zones-North, South, and Central divisions with diverse socioeconomic status and walk ability in Kashmir were recruited for the study. However, 12 participants were lost to follow-up in the study and thus were excluded. Ethical committee clearance has been sought and approved in May 2019.

Study area

Districts Srinagar, Anantnag, and Baramulla as per North, South, and Central divisions of Kashmir valley were taken. The study population was selected from these 3 districts during the study period from July 2018 to December 2018. After line listing, the wards as per the 3 districts 148 wards as allocated by Census department on the basis of population distribution.

Selection of wards: In the first stage, we recruited 30 wards by using probability proportionate to size sampling method.

Selection of households: In the second stage, households were selected by using systematic random sampling.

After the investigator introduced him/herself, the person in the household was explained the objectives of the study. After certain subjects from the household qualified the inclusion criteria, one person among them was randomly selected for the interview. Written informed consent was taken from the person in a household who affirmed to participate in the study. Two visits were made to the household to interview the respondent in person. Inclusion and exclusion criteria for local residents and key informants were according to International Physical activity and Environment Network protocol (IPEN-protocol) for NEWS adaptation and studies conducted in Nigeria,[22] China,[23] and Brazil.[24] Eligibility criteria for residents included (i) current residents of the Kashmir for at least 12 months; (ii) above 18 years of age; (iii) able and willing to respond to questions in Urdu; (iv) not suffering from any disability that can prevent from independent walking; and (v) no visible symptoms/signs of cognitive impairment. All the study participants were informed of the study protocol and requested to sign informed consent. The study synopsis was approved by the Ethical Committee of Government Medical College, Srinagar.

Measures

The modified IPAQ—(LF) long form InS version. Several cultural modifications were made to the original version to reflect the reality in the InS.[3]

Further, post adaptation, the questionnaire was independently translated from English language into Urdu by two speakers of Urdu language who also spoke English, and who were able to read and write in both languages. Among the translators, one was familiar with the questionnaire and another one was an expert in Urdu. The back-translated version was checked again by the researchers for any discrepancies and to ensure that the construct measures by IPAQ had not been lost during the adaptation and translation process.

The adapted questionnaire (available in Urdu), viz., InS version of the long InSIPAQ-LF contains 31 questions that ask about PA in the past 7 days in terms of frequency (days/week) and duration (mins/day) The metabollic equivalents intensity values used to score the InSIPAQ-LF questions in the current study were 3.3 metabollic equivalents (METs) for walking, 8 METs for vigorous activity, and 4 METs for moderate activity.[5,9] One MET equals the energy expended, while sitting calmly at rest and is equivalent to 3.5 mL/kg/min of VO_2 Max.[25] To assess the test-retest reliability of the In SIPAQ-LF, participants had to complete all items on the study instrument twice, with a gap of 1 week between administrations.

Socio demographic characteristics

Data on age, marital status, gender, religion, income, educational level, and employment status were elicited from the participants.

Anthropometrical and biological parameters

Body weight (calibrated to near 0.5 kg) and height (calibrated 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 in kilograms divided by the square of height in meters (kg/m^2). The cut-off points as recommended by the World Health Organization were used to create the categories.[26] The construct validity in this study was examined by investigating the association from the InSIPAQ-LF with anthropometric indices and systolic BP (SBP) and diastolic BP (DBP) measurements, and also in part by comparing the variability in the duration of PA and sitting, across socio demographic groups. These diverse types of validation for PA measures have been also known as indirect or construct validity in earlier studies.[6,27]

Data analysis

Descriptives were reported as mean, standard deviation, and percentages. Mean differences for the continuous variables by gender were examined by independent t test and for dichotomous variables by χ^2 statistics. The reliability analyses were executed by two different strategies. First, the two-way mixed model (single measure) intraclass correlation coefficient (ICC) with 95% CI between the continuous scores obtained on first and second administration of the InSIPAQ-LF was calculated. The ICCs were calculated by gender, socioeconomic status, and overall, and their grading was done accordingly.[28] Second, the Bland and Altman method was used to assess the agreement on scores of PA from the first and second administrations.[29] The construct validity was assessed using the non-parametric Spearman correlation coefficients (r) to explore the relationship between MET-min/week of PA from the InS IPAQ-LF, resting blood pressure, and BMI. Data were analyzed using SPSS, V.25.0 for Windows and the level of significance were set at $P < 0.05$.

Results

The socio demographic variables of the study participants are shown in Table 1. The participants comprised equally of women and men, with a mean age of 50.1 ± 15, 3 years and BMI of 24.5 ± 3.6 kg/m^2.

Reliability

Table 2 shows the test-retest reliability of the modified InSIPAQ-LF. Overall, reliability coefficients were good (ICC >90) for total PA, occupational PA, domestic PA, leisure PA, sitting PA, moderate PA, and vigorous intensity (very hard) PA. Domestic PA and walking PA intensity demonstrated moderate reliability (ICC ranges from 0.51 to 0.71). While the reliability coefficients of active transportation (ICC = 0.84, 95% CI 0.78 to 0.89), and leisure time PA (ICC = 0.93, 95% CI 0.90 to 0.95) were substantially higher among men than women, reliability coefficients for sitting time PA (ICC = 0.99, 95% CI 0.99 to 0.99) were higher among women than men. According to the intensity of PA, ICCs ranged between 0.62 and 0.99, with the lowest value recorded for walking

Table 1: Descriptive characteristics of the study participants (*n*=198)

Variables	Total sample (*n*=198)	Men (*n*=109, 55%)	Women (*n*=89, 45%)
Age (years)			
Mean(±SD)	50.1±15.3	49.5±15.0	50.9±15.6
Marital Status (*n*, %) *			
Not married	34 (17.2)	23 (21.1)	11 (12.4)
Married	156 (78.8)	86 (78.9)	70 (78.7)
Separated/Divorced	8 (4.0)	0	8 (9.0)
Body Mass Index (kg/m^2)			
Mean (±SD)	24.5 (3.6)	23.5 (2.9)	25.8 (3.9)
BMI Category (*n*, %)			
Underweight	3 (1.5)	3 (100)	0
Normal weight	91 (46.0)	56 (61.5)	35 (38.5)
Overweight/Obese	104 (52.5)	50 (48.1)	54 (51.9)
Ethnicity			
Kashmiri	156 (78.8)	89 (57.1)	67 (42.9)
Gujjar	42 (21.2)	20 (47.6)	22 (52.4)
Educational Level*			
<High School	147 (74.2)	75 (51.0)	72 (49.0)
Higher Secondary-II	14 (7.1)	5 (35.7)	9 (64.3)
>Higher Secondary-II	37 (18.7)	29 (78.4)	8 (21.6)
Occupation Status (*n*, %)*			
Unemployed	70 (35.4)	8 (11.4)	62 (88.6)
Student	20 (10.1)	13 (65.0)	7 (35.0)
Blue collar	83 (41.9)	69 (83.1)	14 (16.9)
White collar	25 (12.6)	19 (76.0)	6 (24.0)

*Significant difference between samples (P<0.001)

intensity PA and the highest value for vigorous-intensity (very hard) PA. The socioeconomic status differences were observed in the reliability coefficients of the modified InS IPAQ-LF [Table 3]. Nearly all domains of PA, reliability coefficients were substantially higher among participants with less than high school education [ICC from 0.82 (active transport) to 0.98 (sitting activity)] compared to those with higher secondary education [ICC from 0.76 (leisure PA) to 0.98 (sitting activity)] and those with higher than higher secondary education ICC from 0.88(active transport) to 0.97 (sitting)].

Figures 1-3 (Bland-Altman plots) portray the agreement in the scores (mins/week) of total PA, moderate to vigorous physical activity, and sitting between the first and second administrations of InSIPAQ-LF. For total PA, the mean difference was –79.8 min/week, with wide 95% limits of agreement (−174.8 to 15.0 min/week). For MVPA, the mean difference was about one and half hours per week (–38.6 min/week) −121.0 to 43.6, and also demonstrating wide 95% limits of agreement (−121.0 to 43.6 min/week). For sitting time, the mean difference was small (–29.5 min/week) and the 95% limits of agreement ranged from −58.7 to –0.3 min/week.

Table 4 shows the patterns of PA with respect to socio demographic subgroups during the first (IPAQ1) and second (IPAQ2) administrations of the modified InSIPAQ-LF. Overall and across all stratified variables, time spent in PA reported during the second administration usually tended to be higher than that reported during the first administration. At both time points, men reported significantly ($P < 0.001$) higher mean time (min/week) in active transportation than women. However, women spent significantly ($P < 0.001$) more time (min/week) in sitting PA than men (IPAQ1 = 5872.1 vs. 5652.0, IPAQ2 = 5850.8 vs. 5615.6). Men spent significantly ($P < 0.001$) more time (min/week) in walking than women (IPAQ1 = 338.0 vs. 278.5, IPAQ2 = 381.7 vs. 334.4).

While participants who were unemployed reported statistically significant ($P < 0.05$) greater time (min/week) against students in active transportation (IPAQ1 = 214.0 vs. 275.9, IPAQ2 = 230.2 vs. 305.5) and sitting PA (IPAQ1 = 6032.0 vs. 5631.2, IPAQ2 = 6007.0 vs. 5585.1) than those who were unemployed, the unemployed reported statistically significant ($P < 0.05$) higher time in walking intensity PA (IPAQ1 = 265.5 vs. 321.4, IPAQ2 = 307.0 vs. 371.9) than the students.

While participants who belonged to blue-collar category reported statistically significant ($P < 0.05$) greater time

Table 2: Test-retest reliability according to intraclass correlation for InSIPAQ-LF, overall and by gender

	Total (*n*=180)				
	Mean (SD)		ICC (95% CI)	ICC (95% CI)	
	Test 1	Test 2		Women (n=90)	Men (n=90)
PA Measure (MET x min/week)					
Total PA, all domain	6365.5 (3702.9)	6445.3 (3550.8)	0.98 (0.97-0.98)	0.98 (0.97-0.98)	0.98 (0.97-0.98)
Occupation	2974.3 (2003.0)	2998.8 (1987.1)	0.99 (0.99-0.99)	0.99 (0.99-0.99)	0.99 (0.99-0.99)
Active transport	259.2 (106.7)	284.8 (120.1)	0.84 (0.80-0.88)	0.80 (0.72-0.87)	0.84 (0.78-0.89)
Domestic	2959.9 (1992.2)	2985.5 (1895.1)	0.96 (0.95-0.97)	0.96 (0.94-0.97)	0.96 (0.95-0.97)
Leisure	172.0 (160.4)	176.1 (155.8)	0.94 (0.92-0.95)	0.91 (0.87-0.94)	0.93 (0.90-0.95)
Sitting	5750.9 (1361.7)	5721.4 (1394.6)	0.98 (0.98-0.99)	0.99 (0.99-0.99)	0.97 (0.97-0.98)
PA by intensity (MET x min/week)					
Walking	311.3 (101.8)	360.0 (137.5)	0.62 (0.52-0.70)	0.56 (0.40-0.69)	0.63 (0.50-0.73)
Moderate	2457.5 (1562.5)	2463 (1502.8)	0.98 (0.97-0.98)	0.98 (0.97-0.98)	0.98 (0.97-0.98)
Vigorous	2195.9 (1900.7)	2207.5 (1860.0)	0.99 (0.99-0.99)	0.99 (0.99-0.99)	0.99 (0.99-0.99)

MET=Metabolic energy turnover, PA=Physical activity

Table 3: Socioeconomic status difference in test-retest reliability of the InSIPAQ-LF (*n*=198)

Socioeconomic Status	Overall PA	Active transport	Occupation PA	Leisure PA	Domestic PA	Sitting
Educational qualification						
Less than high school	0.98 (0.97-0.98)**	0.82 (0.76-0.86)**	0.95 (0.93-0.96)**	0.93 (0.91-0.95)**	0.96 (0.94-0.97)	0.98 (0.97-0.98)**
Less than HSE	0.94 (0.82-0.98)**	0.78 (0.44-0.92)**	0.95 (0.94-0.98)**	0.76 (0.40-0.91)**	0.93 (0.80-0.97)**	0.98 (0.97-0.99)**
More than HSE	0.95 (0.90-0.97)**	0.88 (0.79-0.93)**	0.96 (0.94-0.98)**	0.93 (0.88-0.96)**	0.94 (0.88-0.96)**	0.97 (0.98-0.99)**
Employment Category						
Unemployed	0.98 (0.97-0.99)**	0.84 (0.76-0.90)**	0.96 (0.93-0.97)**	0.76 (0.64-0.84)**	0.96 (0.94-0.97)**	0.98 (0.97-0.99)**
Student	0.97 (0.95-0.98)**	0.76 (0.65-0.84)**	0.98 (0.98-0.99)**	0.92 (0.88-0.95)**	0.96 (0.93-0.97)**	0.97 (0.96-0.98)**
Blue collar	0.93 (0.83-0.97)**	0.91 (0.79-0.96)**	0.96 (0.91-0.98)**	0.92 (0.82-0.97)**	0.89 (0.75-0.95)**	0.98 (0.98-0.99)**
White collar	0.96 (0.91-0.98)**	0.85 (0.69-0.93)**	0.98 (0.97-0.99)**	0.91 (0.81-0.96)	0.94 (0.88-0.97)**	0.98 (0.98-0.99)**

PA=Physical activity, HSE=Higher Secondary Part II,**=*P*=<0.001

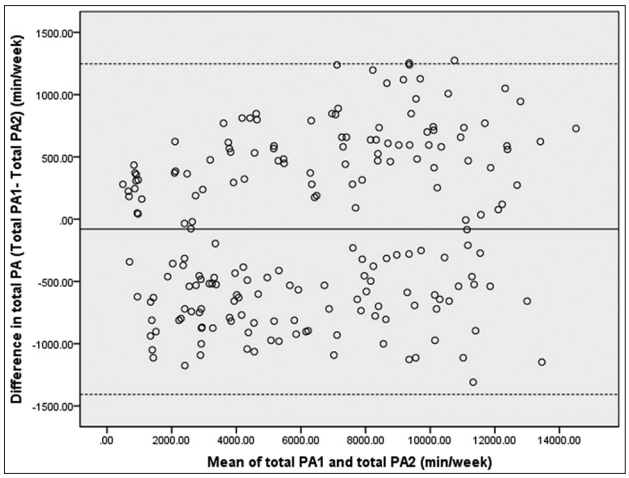

Figure 1: Bland-Altman plot min/week reported in total physical activity (PA) for the first and second administrations of InS IPAQ-LF. Mean difference: −79.8±2 SD= −174.8 to 15.0

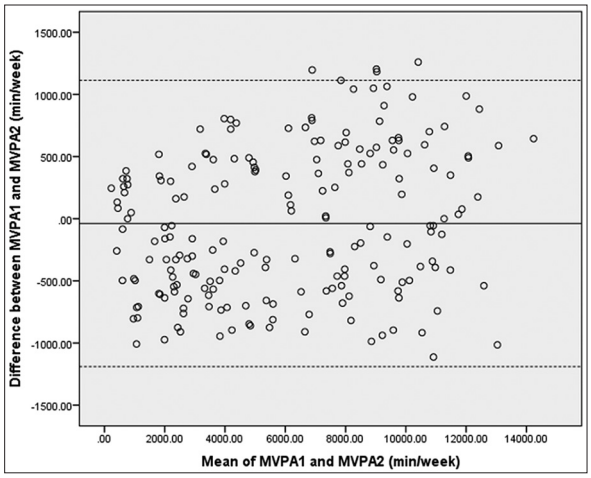

Figure 2: Bland-Altman plot min/week reported in Moderate to Vigorous physical activity (MVPA) for the first and second administrations of InS IPAQ-LF. Mean difference: −38.6 ± 2 SD= −121.0 to 43.6

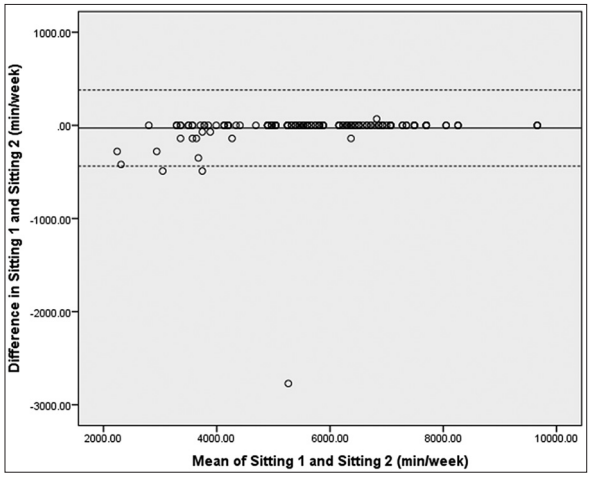

Figure 3: Bland-Altman plot min/week reported in Sitting for the first and second administrations of InS IPAQ-LF. Mean difference: −29.5 ± 2 SD= −58.7 to −0.3

(min/week) against white-collar category in walking intensity PA (IPAQ1 = 450.4 vs. 294.5, IPAQ2 = 508.5 vs. 353.9).

Construct validity

The correlations between energy expenditure (MET-min/week) according to the modified InSIPAQ-LF and biological measures were found statistically significant in the expected direction for all domains and intensities of PA [Table 5]. In the full sample, total PA was mainly related with BMI (r = –0.33, $P < 0.001$) and SBP (r = −0.36, $P < 0.001$), while occupation PA (r= -0.33, $P < 0.001$) with BMI was related with SBP (r = −0.38 $P < 0.001$), leisure PA with BMI (r = −0.39, $P < 0.001$), and with SBP (r = –0.56, $P < 0.001$). The moderate-intensity PA was mainly related with SBP (r = −0.16, $P < 0.05$) and DBP (r = −0.21, $P < 0.01$), but vigorous-intensity PA was related with SBP (r = −0.35, $P < 0.001$). In the gender-based analyses, total PA, occupational PA, and sitting time were more consistently related with anthropometric and biological variables. The strongest r value (−0.53) was found for the relationship between sitting PA, walking intensity PA, and SBP for the female subgroup. In men, leisure PA significantly related with DBP (r = −0.45), BMI (r = −0.32), and SBP (r=−0.61). Walking intensity PA (r = −0.57) for SBP and with DBP (r= –0.56, $P < 0.001$). The rho value for the relationship between leisure time and BMI was slightly higher in women (r = 0.27) than in men (r = 0.32).

Discussion

The findings in this study generally indicated acceptable test-retest reliability and modest construct validity for items of the modified IPAQ-LF among InS adults. We found evidence for good reliability with relatively higher correlations between the test-retest for total PA, occupational PA, sitting, and vigorous-intensity activity. Our results show that except for active transport and walking intensity PA, ICC values for domains of PA were consistently above 0.90; a level of reproducibility that has been considered acceptably good for IPAQ data.[12,30]

The highest and strongest reliability coefficients (0.99) were found for occupational PA as well as vigorous-intensity activity. Perhaps occupational PA was more stable, consistent and reproducible over time than other PA domains because it is a common and ubiquitous PA behavior in the InS. Our finding of higher ICC value for vigorous-intensity PA is consistent with findings of contemporary studies that found the reliability of vigorous-intensity activity to be higher than that of moderate-intensity activity[19,27,30,31] compared to structured vigorous PAs such as sports and exercise, which can be more easily recalled, moderate intensity PA is often of low pre-eminence, incidental, and probably may not be easily remembered by people.[32,33] 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 InS.

Table 4: Difference in time spent in physical activity overall and by gender and socioeconomic status sub groups

	Total	Gender		Education			Employment			
	Mean±SD	Men Mean±SD	Women Mean±SD	LTHS Mean±SD	LHSE Mean±SD	MHSE Mean±SD	Unemployed Mean±SD	Students Mean±SD	Blue collar Mean±SD	White collar Mean±SD
PA by domain (min/week)										
Total PA, all domain										
IPAQ1	6365.5 (3702.9)	6830.1 (3709.2)	5796.5 (3635.2)	7244.9 (3745.5)	4742.5 (1706.6)	3485.8 (2092.6)*	5587.5 (3804.9)	8479.1 (3048.9)	3781.0 (1711.2)	3594.3 (2462.8)
IPAQ2	6445.0 (3550.8)	6917.9 (3554.8)	5866.5 (3478.6)	7264.8 (3613.3)	4993.0 (1647.9)	3739.3 (1994.6)	5578.8 (3680.9)	8537.9 (2860.7)	4027.8 (1660.7)	3858.4 (2284.7)
Active transport										
IPAQ1	259.8 (106.7)**	289.7 (116.6)**	221.8 (79.1)**	246.2 (95.5)**	235.0 (79.3)	319.7 (135.8)**	214.0 (81.1)*	275.9 (97.0)**	343.0 (153.0)	263.2 (105.5)**
IPAQ2	284.8 (120.1)	315.0 (128.7)	247.7 (97.2)	269.4 (108.1)	257.0 (107.2)	356.4 (144.6)	230.2 (96.9)	305.5 (106.9)	361.9 (157.4)	307.1 (130.9)
Work										
IPAQ1	2974.3 (2003.0)	3398.7 (1992.1)	2454.4 (1901.3)	3419.4 (2048.6)	2567.5 (1435.2)*	1359.7 (799.4)*	2266.0 (1968.3)	4343.7 (1547.3)	1575.0 (771.3)	1530.7 (1180.8)**
IPAQ2	2998.8 (1987.1)	3422.9 (1976.3)	2479.4 (1884.4)	3421.8 (2040.3)	2674.5 (1518.9)	1440.8 (791.8)	2258.3 (1910.6)	4354.5 (1591.6)	1657.9 (744.3)	1644.1 (1207.6)
Domestic										
IPAQ1	2959.9 (1992.2)	2907.5 (2012.8)	3024.1 (1976.1)	3436.1 (1977.2)	1795.0 (1115.9)	1508.7 (1340.2)	3038.0 (1991.4)	3662.7 (1918.1)	1513.7 (944.2)	1565.2 (1550.8)
IPAQ2	2985.5 (1895.1)	2943.7 (1920.5)	3036.7 (1873.0)	3427.5 (1888.1)	1906.0 (1078.4)	1638.0 (1287.7)	3016.2 (1957.8)	3677.6 (1774.8)	1652.3 (988.4)	1668.5 (1405.9)
Leisure										
IPAQ1	172.0 (160.4)	234.0 (167.2)	96.1 (112.5)	143.0 (139.6)	145.0 (86.6)	297.5 (197.7)	69.5 (56.6)	196.7 (153.8)	349.3 (195.5)	235.2 (166.3)
IPAQ2	176.1 (155.8)	236.2 (165.5))	102.6 (103.9)	145.9 (133.1)	155.5 (105.8)	304.0 (190.2)	74.1 (56.9)	200.2 (146.5)	355.6 (191.2)	238.5 (156.0)
Sitting										
IPAQ1	5750.9 (1361.7)*	5652.0 (1316.2)	5872.1 (1413.5)*	5781.4 (1338.3)	6110.0 (2012.6)	5494.0 (1139.5)	6032.0 (1422.8)*	5631.2 (1370.2)	4893.0 (808.3)	6048.0 (1217.8)
IPAQ2	5721.4 (1394.6)	5615.6 (1340.3)	5850.8 (1455.4)	5743.5 (1381.5)	6110.0 (2012.6)	5486.4 (1150.0)	6007.0 (1475.4)	5585.1 (1398.1)	4886.0 (819.6)	6042.4 (1226.2)
PA by intensity min/week)										
Walking										
IPAQ1	311.3 (101.8)**	338.0 (98.2)**	278.5 (96.9)**	294.1 (94.1)**	330.0 (69.6)	372.5 (117.8)**	265.5 (95.0)**	321.4 (87.1)**	450.4 (89.8)*	294.5 (62.5)*
IPAQ2	360.5 (137.5)	381.7 (141.3)	334.4 (128.6)	339.8 (126.5)	386.0 (134.6)	433.0 (156.7)	307.0 (122.0)	371.9 (126.6)	508.5 (134.3)	353.9 (127.2)
Moderate										
IPAQ1	2457.7 (1502.8)	2659.4 (1615.5)	2210.2 (1466.3)	2833.4 (1566.5)	1860.0 (536.4)*	1190.1 (968.2)	2040.5 (1557.0)	3427.6 (1224.6)	1167.6 (641.3)*	1436.4 (1176.7)
IPAQ2	2463.7 (1502.8)	2662.8 (1561.9)	2219.9 (1397.3)	2806.9 (1514.1)	2016.5 (647.1)	1269.4 (940.3)	2012.9 (1464.7)	3413.8 (1197.6)	1276.1 (617.9)	1521.8 (1162.5)
Vigorous										
IPAQ1	2195.9 (1900.7)	2609.2 (1863.2)	1689.8 (1832.0)	2617.1 (1957.4)	1300.0 (1077.0)	861.7 (972.3)*	1681.0 (1790.6)	3321.6 (1749.1)	1132.2 (985.3)	751.8 (971.0)*
IPAQ2	2207.5 (1860.0)	2619.3 (1822.5)	1703.2 (1789.3)	2618.5 (1921.6)	1324.0 (1019.1)	909.0 (925.1)	1684.1 (1756.8)	3320.3 (1708.5)	1153.2 (930.5)	822.3 (927.7)

*P= <0.05, **P<0.001, PA=physical activity, LTHS=Less than high school, LHSE=Less than higher secondary, GHSE=More than higher secondary

Table 5: Construct validity of IPAQ LF for Indian Subcontinent Population: Spearman correlations between energy expenditure (METx min/week) from IPAQ-LF and anthropometric and biological variables (*n*=198)

METxmin/week	Overall (*n*=198)			Female (*n*=89)			Male (*n*=109)		
	BMI	DBP	SBP	BMI	DBP	SBP	BMI	DBP	SBP
PA domains									
Total PA	-0.33***	-0.16**	-0.36***	-0.28***	-0.20	-0.48***	-0.30***	-0.14	-0.20**
Occupation PA	-0.33***	-0.10	-0.38***	-0.21**	-0.02	-0.48***	-0.29***	-0.16	-0.24**
Active transport PA	-0.27***	-0.25**	-0.26***	-0.11	-0.08	-0.05	-0.28***	-0.42***	-0.38***
Domestic PA	-0.24***	-0.17*	-0.24***	-0.28***	-0.35***	-0.43***	-0.25***	-0.41	-0.07
Leisure PA	-0.39***	-0.22**	-0.53***	-0.27*	-0.06	-0.43***	-0.32***	-0.45***	-0.61***
Sitting	0.26***	0.30	0.49	0.38**	0.21**	0.53***	0.18	0.38	0.45***
PA intensity									
Walking	-0.50***	-0.38**	-0.56***	-0.48**	-0.23**	-0.53***	-0.47***	-0.56***	-0.57***
Moderate	-0.27***	-0.10	-0.35***	-0.23*	-0.13	-0.51***	-0.23***	-0.09	-0.20**
Vigorous	-0.34***	-0.09	-0.33***	-0.23*	-0.01	-0.38***	-0.32***	-0.14	-0.20***

***P= <0.001, **P= <0.05, BMI=Body Mass Index, SBP=Systolic Blood Pressure, DBP=Diastolic Blood Pressure

The large differences in PA scores between the two administrations would indicate that at least one of the two measurements is not accurate. However, similar to the finding of a Mexican study,[34] scores on the InSIPAQ-LF were consistently higher during the second administration of the questionnaire than the first administration. Because the acceptability with the IPAQ questions may improvise with multiple exposures to the questionnaire, it is possible that participants in our study might have over-reported their PA levels during the second administration of the InS IPAQ-LF. These kind of findings may have implications for the utility of IPAQ for surveillance. In general, owing to the issues of social desirability phenomenon and over-reporting of PA that has been associated with the IPAQ,[35,36] it may be necessary to start considering the need for multiple measurements when using the IPAQ for evaluating PA, especially in developing InS 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 anticipated direction between subgroups of our sample.

In the absence of specific criteria and standards for evaluating an absolute estimate of PA, the consistency of items on IPAQ with variables known to be related to PA, such as blood pressure, heart rate, BMI, indicators of lipid and glucose metabolism, and fitness index have been used as important construct validity measures.[6,19,20] 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 slight evidence of the construct validity for the modified IPAQ-LF in InS. However, observed correlations were comparable with the values in other studies that have evaluated the IPAQ-LF.[6,8] Because better validity coefficients have been reported for other PA measures above those of the IPAQ,[35,37] with the present InS finding, it is possible that the IPAQ-LF only has modest evidence of construct validity. However, our findings on the relationships between PA 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,[5] cross-sectional associations of PA, and BMI or SBP/DBP could also occur in the opposite direction and may not be that relevant as the indicators of construct validity of PA measures.

Strengths and limitations

The strength of this study is the systematic adaptation and tailoring of items on the IPAQ-LF to reflect the common PA behaviors of people in InS. This is the first study in Indo-Pak culture 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 InS population. In addition, this study is also very critical in understanding the studies of ecological models of health behaviors that emphasize the significance of multiple levels of influence on health behaviors including PA.[22,38,39] However, built environment characteristics are expected to be strongly related to specific PA types rather than overall PA.[40,41]

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 was utilized as a common objective standard to validate the IPAQ in the most of the studies[6,8,20,27] 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.[8,42,43]

One more limitation of the study is the use of non-probability sampling technique. The study finding may have limited generalizability to other samples of InS that have different characteristics from this sample.[44]

Conclusions

Our study suggests that the InSIPAQ-LF demonstrated sufficient supporting evidence of test-retest reliability and may be valid for assessing context specific PA behaviors of adults in InS. Adaptation and criterion evaluation of the IPAQ-LF in other Asian countries could further contribute to our understanding of the impact of multiple levels of influence on PA behaviors of people in the InS region.

List of Abbreviations

PA = Physical activity
InS = Indian subcontinent
IPAQ LF = International Physical Activity Questionnaire Long form
SBP = Systolic blood pressure
DBP = Diastolic blood pressure

Declarations

Ethical Approval and Consent to participate

The study was approved by Ethical committee, Government Medical College, Srinagar. The participants were asked for informed consent before proceeding for the data collection.

Consent for publication

All participants gave consent before proceeding for the interview.

Availability of data and supporting materials section

Please contact author for data requests.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Received: 09 Apr 19 **Accepted:** 08 Aug 19
Published: 16 Mar 20

References

1. Adams EJ, Goad M, Sahlqvist S, Bull FC, Cooper AR, Ogilvie D, *et al.* Reliability and validity of the transport and physical activity questionnaire (TPAQ) for assessing physical activity behaviour. PLoS One 2014;9:e107039.
2. Powell KE, Paluch AE, Blair SN. Physical activity for health: What kind? How much? How intense? On top of what? Annu Rev Public Health 2011;32:349-65.
3. Helou K, El Helou N, Mahfouz M, Mahfouz Y, Salameh P, Harmouche-Karaki M. Validity and reliability of an adapted Arabic version of the long international physical activity questionnaire. BMC Public Health 2018;18:49.
4. World Health Organization. More active people for a healthier world [Internet]. 2018 [cited 2019 Jan 14]. Available from: http://apps.who.int/iris/bitstream/handle/10665/272722/9789241514187-eng.pdf.
5. World Health Organization. Global recommendations on physical activity for health [Internet]. 2010 [cited 2019 Jan 14]. Available from: http://apps.who.int/iris/bitstream/handle/10665/44399/9789241599979_eng.pdf?sequence=1.
6. Hagströmer M, Oja P, Sjöström M. The International Physical Activity Questionnaire (IPAQ): Astudy of concurrent and construct validity. Public Health Nutr 2006;9:755-62.
7. Akka V. World Health Organization and Physical Activity: Progress in Preventive Medicine [Internet]. March. 2018. [cited 2019 Jan 14]. Available from: https://journals.lww.com/progprevmed/FullText/2018/01000/World_Health_Organization_and_Physical_Activity.1.aspx.
8. Craig CL, Marshal AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, *et al.* International physical activity questionnaire: 12-country reliability and validity. Med Sci Sport Exerc 2003;35:1381-95.
9. Downloadable questionnaires-International Physical Activity Questionnaire [Internet]. [cited 2019 Jan 14]. Available from: https://sites.google.com/site/theipaq/questionnaire_links.
10. Nicaise V, Marshall S, Ainsworth BE. Domain-specific physical activity and self-report bias among low-income latinas living in San Diego county. J Phys Act Heal 2011;8:881-90.
11. Loney T, Standage M, Thompson D, Sebire SJ, Cumming S. Self-report vs. objectively assessed physical activity: Which is right for public health? J Phys Act Health 2011;8:62-70.
12. Anjana RM, Sudha V, Lakshmipriya N, Subhashini S, Pradeepa R, Geetha L, *et al.* Reliability and validity of a new physical activity questionnaire for India. Int J Behav Nutr Phys Act 2015;12:40.
13. Krishnaveni G V, Mills IC, Veena SR, Wootton SA, Wills AK, Coakley PJ, *et al.* Accelerometers for measuring physical activity behavior in Indian children. Indian Pediatr 2009;46:1055-62.
14. Thiel A, Thedinga HK, Barkhoff H, Giel K, Schweizer O, Thiel S, *et al.* Why are some groups physically active and others not? A contrast group analysis in leisure settings. BMC Public Health 2018;18:377.
15. McNeill LH, Kreuter MW, Subramanian SV. Social environment and physical activity: A review of concepts and evidence. Soc Sci Med 2006;63:1011-22.
16. Yu G, Renton A, Schmidt E, Tobi P, Bertotti M, Watts P, *et al.* A multilevel analysis of the association between social networks and support on leisure time physical activity: Evidence from 40 disadvantaged areas in London. Health Place 2011;17:1023-9.
17. Carlson JA, Sallis JF, Conway TL, Saelens BE, Frank LD, Kerr J, *et al.* Interactions between psychosocial and built environment factors in explaining older adults' physical activity. Prev Med (Baltim) 2012;54:68-73.
18. Katapally TR, Goenka S, Bhawra J, Mani S, Krishnaveni GV, Kehoe SH, *et al.* Results from India's 2016 report card on physical activity for children and youth. J Phys Act Heal 2016;13 (11 Suppl 2):S176-82.
19. Kurtze N, Rangul V, Hustvedt B-E. Reliability and validity of the international physical activity questionnaire in the Nord-Trøndelag health study (HUNT) population of men. BMC Med Res Methodol 2008;8:63.
20. Graff-Iversen S, Anderssen SA, Holme IM, Jenum A, Raastad T. An adapted version of the long International Physical Activity Questionnaire (IPAQ-L): Construct validity in a low-income, multiethnic population study from Oslo, Norway. Int J Behav Nutr Phys Act 2007;4:13.
21. Chun MY. Validity and reliability of Korean version of international physical activity questionnaire short form in the elderly. Korean J Fam Med 2012;33:144.
22. Oyeyemi AL, Sallis JF, Deforche B, Oyeyemi AY, De Bourdeaudhuij I, Van Dyck D. Evaluation of the

neighborhood environment walkability scale in Nigeria. Int J Health Geogr 2013;12:16.
23. Cerin E, Sit CH, Cheung M, Ho S, Lee L, Chan W. Reliable and valid NEWS for Chinese seniors: Measuring perceived neighborhood attributes related to walking. Int J Behav Nutr Phys Act 2010;7:84.
24. Parra DC, Hoehner CM, Hallal PC, Ribeiro IC, Reis R, Brownson RC, *et al.* Perceived environmental correlates of physical activity for leisure and transportation in Curitiba, Brazil. Prev Med (Baltim) 2010;52:234-8.
25. Haskell WL, Lee I-M, Pate RR, Powell KE, Blair SN, Franklin BA, *et al.* Physical activity and public health. Med Sci Sport Exerc 2007;39:1423-34.
26. WHO | Obesity: Preventing and managing the global epidemic. WHO; 2015.
27. Vasheghani-Farahani A, Tahmasbi M, Asheri H, Ashraf H, Nedjat S, Kordi R. The Persian, last 7-day, long form of the International Physical Activity Questionnaire: Translation and validation study. Asian J Sports Med 2011;2:106-16.
28. Portney L WM. Foundations of Clinical Research. Applications to Practice. New Jersey: Pearson Education Inc; 2009.
29. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. Lancet (London, England) 1986;1:307-10.
30. Macfarlane D, Chan A, Cerin E. Examining the validity and reliability of the Chinese version of the International Physical Activity Questionnaire, long form (IPAQ-LC). Public Health Nutr 2011;14:443-50.
31. Papathanasiou G, Georgoudis G, Papandreou M, Spyropoulos P, Georgakopoulos D, Kalfakakou V, *et al.* Reliability measures of the short International Physical Activity Questionnaire (IPAQ) in Greek young adults. Hellenic J Cardiol 2009;50:283-94.
32. Sallis JF, Saelens BE. Assessment of physical activity by self-report: Status, limitations, and future directions. Res Q Exerc Sport 2000;71 (Suppl 2):1-14.
33. Washburn RA, Heath GW, Jackson AW. Reliability and validity issues concerning large-scale surveillance of physical activity. Res Q Exerc Sport 2000;71 (2 Suppl):S104-13.
34. Medina C, Barquera S, Janssen I. Validity and reliability of the International Physical Activity Questionnaire among adults in Mexico. Rev Panam Salud Publica 2013;34:21-8.
35. Johnson-Kozlow M, Sallis JF, Gilpin EA, Rock CL, Pierce JP. Comparative validation of the IPAQ and the 7-Day PAR among women diagnosed with breast cancer. Int J Behav Nutr Phys Act 2006;3:7.
36. Rzewnicki R, Auweele Y Vanden, Bourdeaudhuij I De. Addressing overreporting on the International Physical Activity Questionnaire (IPAQ) telephone survey with a population sample. Public Health Nutr 2003;6:299-305.
37. Ainsworth BE, Macera CA, Jones DA, Reis JP, Addy CL, Bowles HR, *et al.* Comparison of the 2001 BRFSS and the IPAQ Physical Activity Questionnaires. Med Sci Sport Exerc 2006;38:1584-92.
38. Bauman AE, Reis RS, Sallis JF, Wells JC, Loos RJ, Martin BW, *et al.* Correlates of physical activity: Why are some people physically active and others not? Lancet 2012;380:258-71.
39. Glanz K, Rimer BK, Viswanath K (Kasisomayajula). Health Behavior and Health Education: Theory, Research, and Practice [Internet]. Jossey-Bass; 2008. 552 p. Available from: https://espace.library.uq.edu.au/view/UQ: 175068.
40. Giles-Corti B, Timperio A, Bull F, Pikora T. Understanding physical activity environmental correlates: Increased specificity for ecological models. Exerc Sport Sci Rev 2005;33:175-81.
41. Sallis JF, Cervero RB, Ascher W, Henderson KA, Kraft MK, Kerr J. AN ecological approach to creating active living communities. Annu Rev Public Health 2006;27:297-322.
42. Oyeyemi AL, Umar M, Oguche F, Aliyu SU, Oyeyemi AY. Accelerometer-determined physical activity and its comparison with the International Physical Activity Questionnaire in a sample of Nigerian adults. PLoS One 2014;9:e87233.
43. Sobngwi E, Mbanya JC, Unwin NC, Aspray TJ, Alberti KG. Development and validation of a questionnaire for the assessment of physical activity in epidemiological studies in Sub-Saharan Africa. Int J Epidemiol 2001;30:1361-8.
44. Knell G, Gabriel KP, Businelle MS, Shuval K, Wetter DW, Kendzor DE. Ecological momentary assessment of physical activity: Validation study. J Med Internet Res 2017;19:e253.