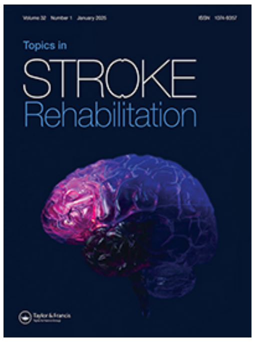

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Validity and stability of the international physical activity questionnaire short-form for stroke survivors with preserved walking ability

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ABSTRACT

Background: Stroke survivors usually present sedentary lifestyles and fail to comply with the World Health Organization physical activity recommendations. Reliable, low-cost, and fast tools are needed to monitor physical activity levels in this population.

Objectives: This study aimed to evaluate the content and face validity, construct validity, and test-retest stability of the International Physical Activity Questionnaire Short-Form (IPAQ-SF) in stroke survivors.

Methods: One hundred and twenty stroke survivors able to walk independently and preserved comprehension and communication abilities (61 ± 12 years, 35% female) were involved in this psychometric study. Participants completed the interview form of the IPAQ-SF via standardized videoconference twice, one week apart, under identical conditions, to evaluate test-retest stability. Correlations between IPAQ-SF and the caloric expenditure during the minutes of activity registered with the Fitbit Inspire 2 activity tracker wristband and 6-Metre Timed Walk (6MTW) were explored to assess construct validity.

Results: The IPAQ-SF showed good content and face validity. "Moderate" to "strong" correlations were found with the Fitbit Inspire 2 (rho: 0.40 to 0.63), while "weak" to "moderate" correlations were found with the 6MTW (rho: 0.35 to 0.50). Test-retest stability was "moderate" to "excellent" (κ: 0.844 to 0.881; ICC: 0.533 to 0.917).

Conclusions: The IPAQ-SF demonstrated satisfactory content and construct validity, and stability in stroke survivors, supporting its clinical and research utility when the data collection is conducted by trained evaluators using a standardized interview protocol in large samples.

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Stroke; questionnaire; physical activity; sedentary behavior; validity; reliability; psychometric properties

Introduction

The World Health Organization (WHO) recommends that adults living with disabilities engage in either 150–300 minutes of moderate-intensity physical activity (MPA) or 75–150 minutes of vigorous-intensity physical activity (VPA) per week or a combination of both (MVPA).[1] It is unquestionable that physical activity (PA) has benefits in primary prevention mitigating cerebrovascular risk factors,[1,2] as well as in secondary prevention and disease treatment.[3] Unfortunately, 33% of the global population remains physically inactive,[1] and this percentage increases to 81% among stroke survivors.[4] Notably, the levels of PA below WHO recommendations are especially detrimental for stroke survivors,[5] as physical inactivity is associated with a 20–30% increased risk of mortality.[2] Conversely, PA serves as a preventive intervention for stroke recurrence and premature mortality,[6] significantly reducing long-term negative consequences such as disability and dependence.[7]

The WHO has pledged to reduce the risk and mortality associated with non-communicable diseases such as stroke. In alignment with this goal, The European Stroke Organization and The Stroke European Alliance launched the Stroke Action Plan for Europe to optimize stroke care across the continent by 2030.[6] One of the key objectives of this plan is to encourage stroke survivors to meet the recommended levels of PA. This challenge requires a comprehensive analysis of the different PA parameters in stroke survivors, such as minutes

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of MVPA, using valid and reliable methods along with the potential for implementation in both clinical and research settings.

PA levels are assessed using self-reported questionnaires or objective devices such as pedometers, accelerometers, or activity monitoring devices. Nevertheless, self-reported questionnaires are simple and low-cost tools suitable for adults,[5,7,8] which could be valuable in clinical settings if they demonstrate robust psychometric properties. However, despite the availability of several self-reported questionnaires for assessing PA levels, only a limited number have been evaluated for their psychometric properties in stroke survivors.[9] Furthermore, none of these tools can specifically evaluate compliance with the WHO recommendations. In this regard, the International Physical Activity Questionnaire (IPAQ),[10] a commonly used questionnaire for assessing PA levels in adults, has recently been chosen through international consensus to provide data on MVPA time after stroke.[11] The short form (IPAQ-SF) and long form (IPAQ-LF) have equivalent psychometric properties,[12] and facilitate the assessment of compliance with WHO recommendations. Nevertheless, there is a lack of reports on its psychometric properties when used with stroke survivors.[13]

The present study aimed to assess the content and construct validity and the test-retest stability of the IPAQ short-form (IPAQ-SF) over a 7-day period in Spanish stroke survivors who have had a stroke more than 6 months ago were able to walk and preserved cognitive and speech abilities.

Materials and methods

This psychometric study was part of the Part&Sed-Stroke project, a multicentre research initiative on stroke survivors involving 20 collaborating centers from 8 different regions in Spain.[14] The project was conducted per the Helsinki Declaration approved by the Regional Ethics Committee (PI21/333). All participants provided informed consent before enrolling in the study. The present study was elaborated following the COnsensus-based Standards for the selection of health Measurement Instruments (COSMIN) recommendations.[15]

Participants

All stroke survivors who were receiving or had finished their treatment in rehabilitation centers and hospitals participating in the Part&Sed-Stroke project were recruited from January to December 2023. The inclusion criteria were 1) adults older than 18 years; 2) history of medical diagnosis of stroke for more than 6 months, regardless of its etiology; 3) living at home; 4) have preserved cognitive and speech abilities (i.e. no aphasia and a Mini-Mental Cognitive Test[16] score > 24); and 5) able to walk (i.e. Functional Ambulation Categories ≥ 3). The exclusion criteria were 1) no severe aphasia involving significant alterations in expression or comprehension interfering with data collection; and 2) living in institutions (e.g. nursing homes).

The COSMIN recommendations determined the sample size for calculating construct validity and test-retest properties, considering more than 100 participants to be an excellent sample size.[15] Therefore, after accounting for up to 20% of dropouts, a sample size of 120 participants was intended.

Study measures

Self-reported physical activity

Self-reported PA was evaluated using the interview version of the IPAQ-SF in Spanish, which can be administered via videoconference.[17] The IPAQ is a tool for public use that can be modified without the express authorization of the creators (Creative Commons license "CC BY 4.0") provided that no commercial use is made of it, as is the case here. The IPAQ-SF aims to determine the frequency and time spent on MVPA and walking in the last seven days, as well as the time spent sitting during a weekday as an indicator of time spent in sedentary activity. Activities covered by the IPAQ-SF include leisure-time PA, household and gardening activities, work-related PA, and transport-related PA. The final score is expressed in Metabolic Equivalents of Task (METs) minutes a week (MET-min/week) and categorizes PA levels into Low, Moderate, or High (Table 1).

In order to establish if the equivalent combination of minutes of MVPA throughout the week was below the lowest threshold of the WHO recommendations for adults living with and without disability (i.e. 150

Table 1. Physical activity levels categories according to the international physical activity questionnaire short-form (IPAQ-SF).

– High PA levels criteria achieved when reported one of the following criteria: ● ≥3 days of VPA achieving ≥ 1500 METs-min/week. ● ≥5 days of any combination of walking and MVPA achieving ≥ 3000 METs-min/week
– Moderate PA levels achieved when reported one of the following criteria: ● ≥3 days of VPA achieving ≥20 minutes/day. ● ≥5 days of MPA achieving ≥30 minutes/day. ● ≥5 days of any combination of walking and MVPA achieving ≥600 METs-min/week
– Low PA levels achieved when no meet the criteria for Moderate or High PA levels

PA: Physical activity; MET: Metabolic Equivalent of Task; VPA: vigorous PA; MPA: moderate PA; MVPA: equivalent combination of moderate and vigorous intensity PA.

minutes of MPA, 75 minutes of VPA, or an equivalent combination of 150 minutes of MVPA),[1] and MVPA minutes were calculated following the formula: MVPA = MPA + (VPA x 2).[18]

Objective physical activity

The activity tracking wristband Fitbit Inspire 2 (*Fitbit, United States, San Francisco, CA*) was used to assess PA level following the recommendations of the international consensus for stroke survivors.[11] The Fitbit wristbands are considered a valid and reliable device for monitoring PA and sleep hours,[19,20] which are considered a valid procedure for stroke survivors.[21]

This device has a 3-axis accelerometry system that allows monitoring of PA parameters. In this study, the average caloric expenditure during the minutes of activity over 7 consecutive days, expressed in kilocalories, was extracted as an indicator of PA.

Walking ability

The walking ability was assessed with 6-Meter Timed Walk (6MTW). For this purpose, the start and end points of the 10 meters as well as the first 2 meters and the last 2 meters were marked on the ground for acceleration and deceleration. The participants were asked to walk 6 meters at a comfortable and consistent speed using their usual support products (e.g. ankle-foot orthosis, walking sticks).[22]

Hypothesis for construct validity

Based on previous studies, it was hypothesized that stroke survivors reporting lower levels of PA would present slower walking speed.[23,24] Likewise, "moderate" to "strong" correlations were expected between the Fitbit Inspire 2 and IPAQ-SF total scores.[25]

Content and face validity

Before starting the data collection, an initial phase was undertaken with 7 professional collaborators (5 physiotherapists and 2 occupational therapists) assessing 7 stroke survivors to validate the content of the IPAQ-SF. The collaborating professionals were trained to unify the administration of the IPAQ-SF questionnaire. Subsequently, group interview sessions were held to review its administration, analyze the data collection process, and collect the peculiarities found when administering it to stroke survivors.[26] Information was collected from both professionals and stroke survivors.

Procedure

Due to the multicentricity of the research project and to standardize the data collection, an external evaluator (the principal researcher – CDA, experimented Occupational Therapist and Physiotherapist) collected data via standardized videoconference. The subjects were assigned to a videoconference by the Microsoft Teams platform (*Microsoft, Redmond, USA*), during which the IPAQ-SF questionnaire was administered according to the instructions in the manual. Furthermore, the 30 collaborating professionals (i.e. 19 physiotherapists and 11 occupational therapists conducting clinical care) were trained in implementing the face-to face assessment protocol for collecting data concerning sociodemographic and clinical characteristics, and the 6MTW scores. All the data were collected and saved through an encrypted data application.[27]

On the first day after enrollment, all participants provided sociodemographic information, and clinical data to the professionals' collaborators by face-to face interview. Each participant was equipped for continuous monitoring with the Fitbit Inspire 2 activity tracker wristband on the wrist of their least affected arm for a minimum of 7 days. At the end of the session, they completed the Spanish version of the IPAQ-SF by videoconference.

Approximately seven days later, concurrent with a 7-day period of monitoring with the Fitbit Inspire 2, each participant completed the IPAQ-SF for the second time through the same standardized protocol interview to analyze test-retest stability of the IPAQ-SF and assess the construct validity with the Fitbit device. The second interview was conducted on equal conditions to the first day, including any weekly rehabilitation dose received. After the second interview, the professionals' collaborators registered scores in the 6MTW.

Statistical analysis

Data distribution was assessed using the Kolmogorov–Smirnov test. Quantitative variables were expressed as mean and standard deviations (SD) or median and interquartile range (IQR) depending on the data distribution. Categorical variables were expressed as numbers and percentages.

Spearman's rank correlation was used to assess the construct validity for the IPAQ-SF with the Fitbit Inspire 2 and 6MTW. Correlations were considered as strong (rho ≥ 0.60), moderate (0.40 > rho < 0.59), weak (0.20 > rho < 0.39), and negligible (rho ≤ 0.20).[28]

The test-retest stability of categorical variables (i.e. compliance with WHO recommendations and IPAQ-SF categorical scoring) was evaluated by calculating the overall rate of agreement and using the kappa or weighted kappa coefficient. The level of agreement was defined as "*very good*" (κ ≥ 0.81), "*good*" (0.61 ≤ κ ≤ 0.80), "*moderate*" (0.41 ≤ κ ≤ 0.60), "*fair*" (0.21 ≤ κ ≤ 0.40), and "*poor*" (κ ≤ 0.20).[29] Continuous variables (i.e. self-reported PA minutes, MET-min /week, and sitting time) were evaluated for single measurement absolute agreement based on a two-way mixed model by computing intraclass correlation coefficients (ICC). An ICC above 0.90 was considered "*excellent*", 0.75–0.90 "*good*," 0.50–0.75 "*moderate*," and less than 0.50 "*poor*" reliability.[30] One-sample T-tests were used to detect an average bias (i.e. if a systematic error related to the first or the second interview existed).

Statistical analysis was performed using SPSS v.25 (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp), and statistical significance was accepted at $p < 0.050$.

Results

Table 2 presents the sociodemographic and clinical characteristics of 114 out of 120 participants who completed the study. Six participants were unable to attend the second day of assessments. The mean period between the first and second completion of the IPAQ-SF was 7.4 ± 0.3 days [range between 7 and 9 days]. Table 3 presents the self-reported IPAQ-SF scores collected by the same blinded external evaluator at the first and second interviews.

Content and face validity

The key aspects highlighted by collaborating professionals included the challenges faced by stroke survivors in accurately perceiving the time spent on PA and the effort expended. They noted that this could be influenced by factors such as metabolic responses affected by medication, post-stroke effects like fatigue, and sensorimotor alterations or difficulties in cognitive processing (i.e. lack of understanding); identifying that it is a self-reported questionnaire that has not been validated for people with comprehension and communication difficulties. Recognizing these challenges, collaborating professionals found it beneficial to provide examples for both VPA and MPA. Additionally, collaborating professionals emphasized the need to assist individuals in calculating the time spent on each activity. This was particularly important when considering time spent sitting, where they found it useful and necessary to review the day and inquire about the duration of each sitting activity. Finally, collaborating professionals identified misunderstandings when individuals were asked to indicate the time spent walking. It was important to clarify that "walking" referred specifically to ambulating without the aid of a support device such as a walking stick or assistance from another person.

Supplementary material contains a detailed information after the content and face validity phase.

Table 2. Socio demographic and clinical characteristics.

Age (years)	61.4 ± 12.4
Female (n, %)	40, 35%
Height (cm)	167.6 ± 8.3
Weight (kg)	75.6 ± 15.3
Time since stroke (years)	3.5 [1.7 – 6.9]
Stroke type (n, %)	
Hemorrhagic	49, 43%
Ischemic	65, 57%
Stroke hemisphere (n, %)	
Right	65, 57%
Left	45, 40%
Both	4, 3%
Receiving rehabilitation (n, %)	
Yes	99, 87%
No	15, 13%
Gait aid (n, %)	
None	77, 68%
Walking stick	35, 31%
Ankle-foot orthosis	4, 3%
FAC (n, %)	
3	13, 11%
4	28, 25%
5	73, 64%
Fitbit Inspire 2 (kcal during activity)	961 ± 582
6MTW (s)	7.5 [5.3 – 12.3]

N = 114. Data are expressed in Mean ± SD or median [IQR 25–75]. SD: Standard deviation; IQR: Interquartile range; 6MTW: 6-Metre Timed Walk.FAC: Functional ambulation categories

Table 3. International physical activity questionnaire short-form (IPAQ-SF) of participants during the first and second interview.

	First interview	Second interview
Vigorous PA (min*week)	15.4 ± 69.4	14.6 ± 61.4
Moderate PA (min*week)	75.7 ± 150.9	83.4 ± 138.7
MVPA (min*week)	106.6 ± 205.4	108.4 ± 203.9
Walking (min*week)	298.2 ± 255.7	305.7 ± 266.3
Sitting (hours)	6.9 ± 2.9	6.7 ± 2.8
Total (MET-min/week)	1410 ± 1236	1511 ± 1281
IPAQ-SF categories (n, %)		
Low	33, 29%	31, 27%
Moderate	70, 61%	73, 64%
High	11, 10%	10, 9%
WHO recommendations (n, %)		
No	91, 80%	88, 77%
Yes	23, 20%	26, 23%

N = 114. Data are expressed in mean and standard deviation otherwise specified. PA: Physical activity; MVPA: equivalent combination of moderate and vigorous intensity PA; MET: Metabolic Equivalent of Task; WHO: World Health Organization.

Construct validity

The coefficients for the correlations between the IPAQ-SF and the Fitbit Inspire 2 and the 6MTW to assess the construct validity are presented in Table 4.

For caloric expenditure during activity minutes registered with the Fitbit Inspire 2, a "strong" positive correlation was found with the total MET-min/week (rho = 0.63), and "moderate" positive correlations with accumulated minutes per week in MVPA and walking activities combined (rho > 0.40). For the 6MTW, "moderate" positive correlations were found with accumulated minutes in walking activities and total MET-min/week (rho > 0.41).

Test-retest stability

For categorical variables, kappa values indicated a "very good" agreement for compliance with WHO recommendations (agreement: 95%; $\kappa = 0.881$) and IPAQ-SF categorical scoring (agreement: 89%; $\kappa_w = 0.844$).

Table 4. Table of correlations between the international physical activity questionnaire short-form (IPAQ-SF), and the caloric expenditure during the minutes of activity registered with the Fitbit Inspire 2 and the time during the 6-metre timed walk (6MTW).

IPAQ-SF	6MTW	Fitbit Inspire 2
Vigorous PA	0.17	0.28*
Moderate PA	0.31*	0.29*
MVPA	0.35*	0.40*
Walking	0.41*	0.57*
Sitting hours	−0.32*	−0.39*
Total MET	0.50*	0.63*

Data are expressed in terms of Spearman correlation coefficients. PA: Physical activity; MET: Metabolic Equivalent of Task; MVPA: equivalent combination of moderate and vigorous intensity PA. *$p < 0.05$.

Table 5 presents mean differences error, limits of agreement, and ICC of IPAQ-SF continuous variables. The test-retest stability was "excellent" for accumulated minutes per week in total MET-min/week; good for accumulated minutes per week in MPA, equivalent combination of MVPA, and walking activities; and "moderate" for accumulated minutes per week in VPA and sitting time. Any of the outcomes presented an average bias ($p > 0.211$).

Discussion

This study investigated the content and face validity, construct validity, and test-retest stability of the IPAQ-SF in Spanish stroke survivors. The results indicated appropriate content and face validity, construct validity, and "moderate" to "excellent" test-retest stability.

Content and face validity

The IPAQ-SF has been recently suggested as a useful assessment questionnaire to collect information on PA time in stroke survivors.[11] Besides, a previous study highlighted the necessity of investigating this questionnaire's content and face validity.[25] The present study found that providing examples of activities involving VPA and MPA may be appropriate to obtain reliable results. Furthermore, it is important to consider that as a self-reported questionnaire, it is not indicated for people who have communication difficulties, or cognitive impairments. However, it is crucial to administer it with special attention to mitigate retrospective bias.[31] Moreover, the sequelae of stroke, such as fatigue[32] and the perception of the level of PA performed, may influence the types and adaptations in the PA undertaken,[33] as well as their perception of the intensity and duration of PA.[34]

Construct validity and test-retest stability

A recent study with stroke survivors demonstrated the validity of the long version of the IPAQ (IPAQ-LF), showing a "moderate" to "strong" correlation with the ActiGraph GT3X+ accelerometer.[25] Specifically, the IPAQ-LF indicated an excess of MVPA and a deficit of total PA compared to the accelerometer in stroke survivors with the highest levels of PA. Based on these results, the IPAQ-SF was considered a useful tool for screening both highly active and inactive stroke survivors after 6 months from their stroke with high functional capacity who require specific interventions to promote healthy habits. Meanwhile, IPAQ-LF overestimated the time spent in MVPA and underreported the time spent on sedentary behavior compared to the accelerometer.[25] Similar to the findings for the IPAQ-LF,[25] the IPAQ-SF correlated "moderate" with MVPA recorded with an objective device. It even demonstrated a "strong" correlation with the total METs-min/week. These findings suggest that in the absence of objective measurement devices in the clinical context, it is possible to obtain adequate correlated data with objective parameters by administering both the IPAQ-LF and IPAQ-SF in stroke survivors.

Table 5. Test-retest stability values for the international physical activity questionnaire short-form (IPAQ-SF): average bias, limits of agreement, and inter-class correlation (ICC).

	Average bias	Limits of agreement	ICC (95%CI)
Vigorous PA (min*week)	0.8 ± 36.6	−70,9 to 72,5	0.53 (0.09 – 0.76)
Moderate PA (min*week)	26.6 ± 113.1	−195,1 to 248,4	0.78 (0.60 – 0.88)
MVPA (min*week)	28.2 ± 92.5	−153,0 to 209,5	0.89 (0.79 – 0.94)
Walking (min*week)	−58.2 ± 152.1	−356,3 to 239,8	0.79 (0.64 – 0.89)
Sitting (hours)	−0.5 ± 2.3	−5,0 to 3,9	0.66 (0.43 – 0.81)
Total (MET-min/week)	−79 ± 525	−1108 to 950	0.92 (0.85 – 0.96)

PA: Physical activity; MET: Metabolic Equivalent of Task; MVPA: equivalent combination of moderate and vigorous intensity PA.

The "moderate" correlation between self-perceived PA measured with the IPAQ-SF and the walking ability measured with 6MTW reveals that individuals with higher PA levels tend to exhibit a faster walking speed. This may highlight the clinical relevance of influencing walking speed, given its association with sedentary behavior in stroke survivors.[23,24] However, the fact that the correlation was moderate also supports that other factors might influence the level of PA, such as sequelae of the stroke, the years of progression, the environment, and social support.[35–37] Therefore, there is a need for studies that looks at these multifactorial relationships.[38]

Previous research regarding the test-retest of IPAQ-SF among other populations with and without disease showed similar results to the presented study.[39] Furthermore, it indicated that self-reported questionnaires exhibit high test-retest reliability and can detect low activity thresholds.[40] However, this study highlights that the IPAQ-SF demonstrated adequate test-retest stability. Furthermore, the present study employed a high-quality methodological design to mitigate assessment bias, including training and standardization sessions for the interview, along with regular supervision of data collection.[14]

IPAQ-SF as a questionnaire for assessing compliance with WHO recommendations

Other tools, such as the Frenchay Activities Index or the Human Activity Profile, have been recommended for evaluating PA in stroke survivors.[9] However, neither provides information to assess compliance with WHO recommendations. Thus, the IPAQ-SF is considered a clinically useful and optimal tool for stroke survivors.[9] The IPAQ-SF questionnaire can be considered a low-cost, time-efficient resource that can reliably be used to screen for physical inactivity in stroke survivors, collecting the activity performed in blocks of 10 minutes or more and being able to aggregate their results for comparison with the WHO recommendations.

Clinical implications and future perspectives

This research provides pertinent information on the psychometric reliability properties of the IPAQ-SF and contributes to establishing a consensus on recommended assessment tools,[41] particularly those regarding the recording of PA parameters.[5] Defining these PA parameters is crucial for both clinical and research purposes to assess the effects of PA on health,[11] adhere to WHO recommendations, and identify significant predictors of physical inactivity.[42] Furthermore, it is recommended to complement these PA parameters with quantitative and qualitative information to understand the factors influencing PA levels in stroke survivors.

Around 70% of stroke survivors are able to walk,[43] among those 75% of them spend their waking time sitting.[23] Participants of the present study with an adequate functional level according to FAC ≥ 3 and no cognitive or communication impairment were considered part of this subgroup. We found that 77–80% did not meet the WHO recommendations. Future studies should investigate the factors influencing sedentary behavior below the WHO recommended levels in stroke survivors with good functional capacity,[14] as they have the greatest potential to achieve the PA levels proposed by the WHO.

Limitations

This study has some limitations. First, the data only provides results regarding the use of the IPAQ-SF in stroke survivors with high functional capacity who have had a stroke more than 6 months ago and cannot be extrapolated to stroke survivors in an earlier phase or with greater functional sequelae. Besides the error associated with the instrument, test-retest stability may be influenced by meteorological factors or natural variations in weekly PA that could have impacted self-reported PA levels, despite being administered under equal conditions.

Conclusion

The IPAQ-SF is a valid questionnaire for screening the PA levels of stroke survivors with preserved physical and cognitive functionality in both clinical and research contexts. This low-cost and rapidly administered tool appears to be useful as a screening questionnaire for compliance with the MVPA levels recommended by the WHO and correlated with objective device data.

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