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Cultural Adaptation and Psychometric Testing of The Modified Sedentary Behavior Questionnaire (MSBQ) in Indonesian for Young Adults

Adaptación cultural y evaluación psicométrica del Cuestionario Modificado de Comportamiento Sedentario (MSBQ) en adultos jóvenes indonesios

Farid Rahman[1], **Nanda Maulana Riszki**[1], **Muhammad Raihan Ishad**[1], **Annya Shakty Indraprastha**[1], **Azliyana Azizan**[2]

[1] *Department of Physiotherapy, University of Muhammadiyah Surakarta, Sukoharjo, Indonesia*

[2] *Department of Physiotherapy, Universiti Teknologi MARA, Shah Alam, Selangor, Malaysia*

Correspondence
Farid Rahman.
Email: fr280@ums.ac.id

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The authors declare no conflicts of interest.

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Ethics statement
This study was approved by the Health Research Ethics Committee of the Faculty of Health Sciences, University of Muhammadiyah Surakarta (approval no. 657/KEPK-FIK/XI/2024). All participants provided written informed consent prior to participation.

Abstract

Introduction. Sedentary behavior was associated with increased health risks and therefore requires valid tools for monitoring. However, culturally adapted and psychometrically validated instruments for assessing sedentary behavior among Indonesian young adults are limited.

Objective. This study aimed to evaluate the validity and reliability of the Indonesian version of the Modified Sedentary Behavior Questionnaire.

Method. A cross-sectional study was conducted involving 337 young adults in the Greater Solo area. The questionnaire was evaluated for content validity, construct validity, criterion validity, internal consistency, and test–retest reliability. Criterion validity was assessed by comparison with the International Sedentary Assessment Tool and objective physical activity data from fitness-tracking devices.

Results. The findings demonstrated that the Indonesian MSBQ possesses strong overall psychometric qualities. Its construct validity supported a single-factor structure, while criterion validity indicates a moderate correlation with the ISAT (r=0.43) and a strong correlation with fitness tracker data (r=0.73). Reliability is high, demonstrated by excellent internal consistency (Cronbach's α = 0.87), test-retest reliability (ICC = 0.88), and stability over time (r = 0.81). Content validity was likewise excellent, with an S-CVI/Ave of 0.92.

Conclusion. The Indonesian version of the Modified Sedentary Behavior Questionnaire is a culturally adapted, valid, and reliable tool for assessing sedentary habits, especially among young adults at universities. Nonetheless, additional validation

Data availability
All data supporting the findings of this study are available within the article. For additional details, please contact the corresponding author.

Author Contributions
Farid Rahman: conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, supervision, validation, visualization, writing – original draft, writing – review & editing.
Nanda Maulana Riszki: data curation, formal analysis, software, writing – review & editing.
Muhammad Raihan Ishad: data curation, formal analysis, software, writing – review & editing.
Annya Shakty Indraprastha: data curation, formal analysis, software, writing – review & editing.
Azliyana Azizan: supervision, validation.

Generative AI declaration
The authors declare that no generative AI tools were used in the writing, editing, data analysis, or any other part of the preparation of this manuscript.

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studies are necessary before deploying it more broadly across Indonesia's diverse demographic and regional populations.

Keywords

Cultural adaptation; physical activity; sedentarism; young adults.

Resumen

Introducción. El comportamiento sedentario se ha asociado con un mayor riesgo para la salud y, por lo tanto, requiere instrumentos válidos para su monitoreo. Sin embargo, los instrumentos culturalmente adaptados y psicométricamente validados para evaluar el comportamiento sedentario en adultos jóvenes indonesios son limitados.

Objetivo. Este estudio tuvo como objetivo evaluar la validez y la fiabilidad de la versión indonesia del Modified Sedentary Behavior Questionnaire (MSBQ).

Métodos. Se realizó un estudio transversal que incluyó a 337 adultos jóvenes de la región del Gran Solo. El cuestionario fue evaluado en términos de validez de contenido, validez de constructo, validez de criterio, consistencia interna y fiabilidad test–retest. La validez de criterio se evaluó mediante la comparación con el International Sedentary Assessment Tool (ISAT) y con datos objetivos de actividad física obtenidos mediante dispositivos de seguimiento de la condición física.

Resultados. Los resultados muestran que el MSBQ indonesio presenta, en general, sólidas propiedades psicométricas. La validez de constructo confirma una estructura de unifactorial, mientras que la validez de criterio indica una correlación moderada con el ISAT (r = 0,43) y una correlación fuerte con los datos de los dispositivos de seguimiento de la actividad física (r = 0,73). La confiabilidad es alta, como lo demuestran una excelente consistencia interna (α de Cronbach = 0,87), una fiabilidad prueba-reprueba (ICC = 0,88) y una adecuada estabilidad temporal (r = 0,81). La validez de contenido también obtuvo muy buenos resultados, con un S-CVI/Ave de 0,92.

Conclusión. La adaptación indonesia del Modified Sedentary Behavior Questionnaire demuestra ser un instrumento culturalmente adaptado, válido y confiable para evaluar el comportamiento sedentario, especialmente entre los adultos jóvenes universitarios. No obstante, se requieren estudios de validación adicionales antes de que pueda aplicarse de manera más amplia en las diversas poblaciones demográficas y regionales de Indonesia.

Palabras clave

Adaptación cultural; actividad física; sedentarismo; adultos jóvenes.

Introduction

Sedentary behavior and physical activity continue to be widely discussed in public health research, especially regarding whether sedentary behavior should be considered equivalent to physical inactivity. However, these are distinct constructs. Sedentary behavior is defined as any waking behavior characterized by an energy expenditure of ≤1.5 metabolic equivalents (METs) while in a sitting, reclining, or lying

posture. Consequently, a person can meet the recommended levels of moderate-to-vigorous physical activity while simultaneously accumulating prolonged periods of sedentary behavior. Therefore, sedentary behavior and moderate-intensity physical activity are not mutually exclusive and should be assessed independently [1]. In general, sedentary behavior refers to activities involving prolonged sitting or minimal body movement, resulting in very low energy expenditure [2,3].

The World Health Organization (WHO) estimates that worldwide, approximately 35% of adults will be physically inactive by 2030 [4,5]. Similarly, data from the Indonesian Ministry of Health's survey indicate that 37.4% of Indonesians aged 10 and above have low physical activity levels [6,7], failing to meet the minimum recommendation of 150 minutes of moderate physical activity per week [8]. Sedentary lifestyles and low activity levels are major risk factors for non-communicable diseases (NCDs) like diabetes mellitus [9-11]. Furthermore, the healthcare costs linked to obesity and diabetes among working-age adults are significant, totaling around Rp. 32 Triliun [12,13].

Young adulthood plays a vital role in establishing long-term lifestyle habits [14,15]. As individuals shift from education to employment, they often engage prolonged sitting associated with academic work, office tasks, digital device use, and screen leisure activities [16-19]. These habits can continue into later life and increase the risk of cardiometabolic and mental health issues [14,15]. Many young adults also view themselves as healthy and overlook the impact of sedentary behavior, even when they comply with physical activity recommendations [15,20,21]. Therefore, accurately measuring sedentary behavior in this group is crucial for detecting risk trends, guiding preventative measures, and providing essential data for public health and workplace wellness initiatives [22-25].

Several questionnaires are available to measure sedentary behavior, among which the Sedentary Behavior Questionnaire (SBQ) is one of the most widely used. The SBQ assesses the amount of time spent in nine common sedentary activities, including watching TV, playing video games or streaming online, sitting and talking on the phone, doing office work while sitting, reading, playing musical instruments, doing hobbies, sitting and driving certain vehicles, considering both weekdays and weekends. This questionnaire has been tested for validity and reliability and has shown satisfactory agreement with other commonly used sedentary behavior measures, including the International Sedentary Assessment Tool (ISAT), the sitting-time domain of the IPAQ, and BMI [26-28]. Nevertheless, adapting the Sedentary Behavior Questionnaire (SBQ) to the Indonesian context is necessary because its original version was developed within a Western cultural setting and may not adequately reflect culturally specific sedentary activities. For instance, leisure activities such as playing musical instruments, doing crafts, or other culturally common seated leisure activities should be classified as sedentary hobbies. To date, no study has evaluated the validity and reliability of the Indonesian version of the SBQ among young adults.

Compared with broader surveillance instruments such as the IPAQ and ISAT, the SBQ offers several methodological advantages for assessing sedentary behavior. Unlike these, the SBQ includes specific items that assess different sedentary patterns, such as watching TV, reading, using digital devices, passive transport, and other leisure activities. This detailed approach provides a more comprehensive characterization of sedentary patterns, improves measurement accuracy, and reduces overlap with physical activity assessments [29]. Additionally, the SBQ is sensitive to behavioral changes, such as decreasing screen time or increasing light physical activity, making it useful for detecting intervention effects. Overall, the SBQ is practical and well-suited for epidemiological studies, intervention evaluations, and monitoring diverse population groups [30-33].

This study offers a twofold novel contribution. First, it provides the cultural adaptation and psychometric validation of the Indonesian version of the Modified Sedentary Behavior Questionnaire (MSBQ), incorporating culturally relevant modifications to better capture sedentary behaviors commonly observed among Indonesian young adult [34,35]. Second, it strengthens criterion validity assessment by combining subjective self-report measures with objective physical activity information obtained from wearable fitness-tracking devices, an approach that has been recommended in recent validation studies [36,37]. Therefore, this research aims to assess the validity and reliability of the Indonesian version of the Modified-Sedentary Behavior Questionnaire (MSBQ) among young adults. We hypothesized that the Indonesian MSBQ would demonstrate satisfactory content validity, construct validity, criterion validity, internal consistency, and test–retest reliability, consistent with findings reported for previous international adaptations.

Method

Study design

This study employed a methodological validation design incorporating both cross-sectional and test–retest components [38]. Data collection was conducted between December 2024 and May 2025 with the objective of evaluating the validity and reliability of the Indonesian adaptation of the Modified Sedentary Behavior Questionnaire (MSBQ).

The study was conducted in the Greater Solo area, primarily through Universitas Muhammadiyah Surakarta, which facilitated participant recruitment from diverse academic and community backgrounds while ensuring standardized data collection procedures. Participant recruitment and baseline assessments were performed from November to December 2024. The test-retest assessment was carried out within two weeks of baseline data collection. Data verification, cleaning, and confirmation of incomplete responses were completed before statistical analyses, which were performed between May and August 2025.

Participants

Participants were recruited according to the following inclusion criteria: (1) residence in the Greater Solo area, confirmed by an official identity card; (2) age between 18 and 30 years; and (3) ability to communicate fluently in written and spoken Indonesian. Exclusion criteria included (1) the presence of cognitive or psychological disorders that could interfere with questionnaire completion and (2) acute illness during the data collection period.

Participants were recruited using consecutive sampling, whereby all eligible individuals encountered during the recruitment period were invited to participate, thereby reducing selection bias and improving representativeness. The sampling frame comprised young adults residing in the Greater Solo region. A total of 337 participants fulfilled the eligibility criteria and were included in the final analyses.

Procedure

The Indonesian adaptation of the Sedentary Behavior Questionnaire followed the cross-cultural adaptation guidelines proposed by Beaton et al., consisting of five sequential stages: (1) forward translation by two independent bilingual translators (one with a health background and one with a linguistic background); (2) synthesis of the translated versions into a single consensus version; (3) back-translation by two independent translators blinded to the original questionnaire; (4) expert committee review to evaluate semantic, idiomatic, experiential,

and conceptual equivalence while identifying culturally relevant modifications; and (5) pre-testing of the pre-final version in 35 young adults to assess item comprehension and detect potential ambiguities. This process ensured that the Indonesian version was both linguistically equivalent and culturally appropriate while preserving the conceptual content of the original instrument The primary outcome of this study was the psychometric performance of the Indonesian version of the Modified Sedentary Behavior Questionnaire (MSBQ). Psychometric properties were evaluated following the COSMIN recommendations, including content validity, construct validity, criterion validity, internal consistency, test-retest reliability, and measurement error.

The test-retest reliability was assessed using a two-week interval to ensure that the stability of sedentary behavior was not affected by memory. To maximize consistency between measurements, the questionnaire was administered using the same online platform at both time points, and participants confirmed that no substantial changes had occurred in their health status, physical activity level, or daily routines during the interval.

Sample size determination was based on COSMIN recommendations: structural validity. The number of participants successfully recruited was 337, so the overall sample size in this study met the standards for structural validity and reliability. All variables are quantitative, including age, BMI, sedentary behavior, and daily step data, with the data scale analyzed as continuous. The mean and standard deviation are also reported in this study. Furthermore, for respondent characteristic data, sedentary lifestyle data, and body mass index are then categorized as follows:

1. Sedentary lifestyle classification is divided based on the duration of sedentary activities: low (≤ 2 hours), moderate (2-5 hours), and high (≥ 5 hours).

2. Daily step classification <5000 steps per day: sedentary behavior; 5000-7499 steps per day: less active category; 7500-9999 steps per day: moderately active; 10,000-12,499 steps per day: active category; ≥ 12,500 steps/day: very active.

To minimize bias during the validation process, this study implemented several measures to control study quality. Content validity was independently evaluated by five experts representing physiotherapy, sports sciences, and linguistics. Experts completed their evaluations independently and were blinded to both the study hypotheses and the ratings of the other panel members. Each item was rated using a four-point relevance scale, from which the Item-level Content Validity Index (I-CVI) and Scale-level Content Validity Index (S-CVI/Ave) were calculated. Acceptable thresholds were predefined as I-CVI ≥0.78 and S-CVI/Ave ≥0.90. Items that did not meet the threshold value were revised and reassessed until consensus was reached.

Before participating, all respondents received written information about the study's goals, procedures, potential risks, and benefits. They provided electronic informed consent before completing the questionnaire and were told that participation was voluntary and they could withdraw at any time without consequences. To ensure confidentiality, all records were anonymized using unique identification codes and stored in password-protected databases accessible only to the research team. Fitness-tracker information was used exclusively for research purposes and contained no personally identifiable information. The study was approved by the Health Research Ethics Committee of the Faculty of Health Sciences, Universitas Muhammadiyah Surakarta (No. 657/KEPK-FIK/XI/2024).

All participants completed a standardized digital questionnaire with standard instructions and controlled conditions (including relatively similar completion times, a quiet environment, and devices that allowed full-screen display). To reduce recall bias, respondents were instructed to report their sedentary behavior during the previous seven days without consulting personal records. In the test-retest measurement, respondents were confirmed to be in stable health and routine conditions before completing the questionnaire again. Collectively, these procedures enhanced measurement consistency and reduced potential methodological bias.

Instrument

The Modified Sedentary Behavior Questionnaire (MSBQ) is a domain-specific self-report instrument designed to quantify sedentary behavior across several daily contexts, including screen use, occupational sitting, transportation, and leisure activities. Because each item represents a distinct sedentary domain, the questionnaire should be interpreted as a composite measure of overall sedentary exposure rather than as interchangeable indicators of a single latent construct.

The total sedentary score is calculated by summing the reported sedentary hours during weekdays (multiplied by five) and weekends (multiplied by two), dividing the total by seven to obtain the average daily sedentary time. Final scores are categorized into low, moderate, and high sedentary behavior according to predefined duration thresholds.

As a comparative measurement instrument, this study used the International Sedentary Assessment Tool (ISAT), a sedentary lifestyle questionnaire that has been proven to be valid and reliable globally. Physical activity was assessed with a wearable fitness tracker worn on the participant's non-dominant wrist for seven consecutive days. The device continuously tracked daily step count, energy expenditure, and heart rate. Participants were advised to wear it for at least 10 hours each day, excluding water activities and charging times. The data was synchronized using a mobile app and progressively entered into a data table for analysis. Although not a pure research accelerometer, the triaxial acceleration sensor feature makes it a reliable objective proxy for assessing sedentary behavior. Criterion validity (concurrent) was assessed by comparing wearable parameters and questionnaire scores using convergent correlations, with the expectation of a negative correlation between daily steps and sedentary scores.

Quality control and data collection procedures

To enhance reproducibility and minimize measurement bias, several quality control steps were implemented in this study. All participants were provided with standard written instructions before completing the questionnaire. Data collection was conducted using the same online platform to ensure consistency in questionnaire presentation and response documentation.

For the objective assessment, participants were instructed to use a fitness tracker continuously in accordance with the predetermined protocol. The research team monitored data completeness and verified synchronization before analysis. Duplicate questionnaires, missing responses, and implausible values were systematically identified during data cleaning, and participants were contacted whenever clarification was required.

To ensure test-retest consistency, reassessment was conducted only for respondents who reported no significant changes in their physical condition, level of physical activity, or daily routines over two weeks. Finally, all datasets underwent verification and cleaning before statistical analyses to ensure data integrity and consistency.

Statistical analysis

Descriptive statistics are presented as means and standard deviations for continuous variables and frequencies with percentages for categorical variables. Participant characteristics included sex, age, body weight, height, body mass index, sedentary behavior classification, and daily step-count categories, based on the Modified Sedentary Behavior Questionnaire (MSBQ), adapted into Indonesian.

Construct validity

Construct validity was evaluated through exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). Sampling adequacy was verified with the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity. Factor loadings of 0.40 or higher were deemed acceptable.

Criterion validity

Criterion validity was evaluated by comparing MSBQ scores with objective data on physical activity and sedentary behavior from wearable devices and smartphone monitoring systems. Pearson's or Spearman's correlation coefficients were calculated according to data distribution.

Reliability and measurement error

Test-retest reliability was determined by calculating the intraclass correlation coefficient (ICC) with a two-way mixed-effects model and absolute agreement. Internal consistency was checked using Cronbach's alpha for descriptive purposes. Measurement error was measured with the standard error of measurement (SEM) and the minimal detectable change (SDC). The agreement between repeated measurements was further analyzed with Bland-Altman plots.

Results

The study initially identified 546 potential participants, who were screened for eligibility between November and December 2024. Of these, 209 individuals were excluded, including 88 who declined participation, 106 who met the exclusion criteria because of potential cognitive or psychological disorders, and 15 who withdrew before completing the study procedures. The participant selection process is summarized in Figure 1.

A total of 337 participants fulfilled the eligibility criteria and completed all study procedures. The final sample size exceeded the minimum recommended by the COSMIN guidelines for psychometric validation studies, providing adequate statistical power for both factor analysis and reliability estimation.

Table 1 presents the demographic characteristics and sedentary behavior classification of the participants. A total of 337 respondents participated in the study. Based on gender, the majority of participants were female (76%), while male respondents accounted for 24%. Furthermore, based on the age distribution data, it was found that the majority of participants were in the 18-20 age range, with a percentage of 69.7%, followed by the 21-23 age group, with a percentage of 30%, and only 0.3% of participants were over 23 years old. Based on body mass index (BMI) categories, the majority of participants were in the ideal category, at 65.88%. In comparison, underweight participants accounted for 15.13%, the overweight category for 15.13%, and the obese category for around 3.86%.

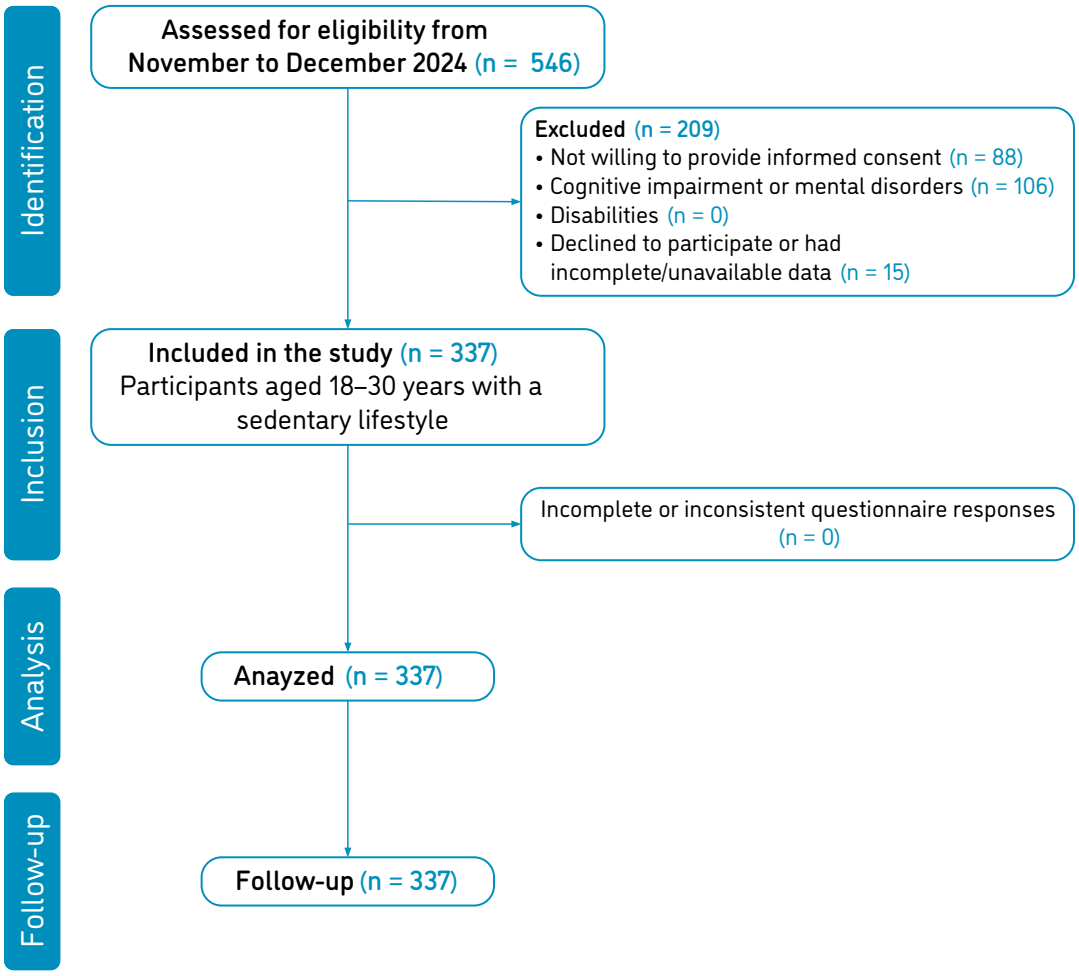

Figure 1. A flowchart showcasing the recruitment process, eligibility screening, exclusion steps, and the final inclusion of 337 respondents in the psychometric analysis.

Table 1. Demographic characteristics, sedentary behavior categories, and daily step counts for young adult participants (N = 337).

Demographic Variables	Category	n	%
Gender	Male	81	24%
	Female	256	76%
Age	18–20 years	235	69.7%
	21–23 years	101	30%
	>23 years	1	0.3%
Body Mass Index	Underweight	51	15.13%
	Ideal	222	65.88%
	Overweight	51	15.13%
	Obesity	13	3.86%

Sedentary Level based on MSBQ	Low	31	9.2%
	Moderate	83	24.6%
	High	223	66.3%
Average Daily Steps (Fitness Tracker)	Basal activity	81	24.0%
	Sedentary	86	25.5%
	Low active	100	29.7%
	Somewhat active	18	5.3%
	Active	52	15.4%
	Highly active	0	0%

Note. *BMI classification was based on the Asia-Pacific criteria: underweight (<18.5 kg/m^2), normal (18.5-22.9 kg/m^2), overweight (23.0-24.9 kg/m^2), and obesity (≥25.0 kg/m^2). Sedentary behavior levels were assigned according to mean daily sedentary time measured by the MSBQ: low (<4 hours/day), moderate (4-8 hours/day), and high (>8 hours/day). Daily step categories were determined through fitness tracker data: basal activity (<2,500 steps/day), sedentary (2,500-4,999), low active (5,000-7,499), somewhat active (7,500-9,999), active (10,000-12,499), and highly active (≥12,500).

Referring to sedentary data measured using a sedentary behavior adaptation questionnaire, the majority of respondents are in the heavy sedentary category (66.3%), followed by the moderate category (24.6%), and only 9.2% are in the light sedentary category. This section presents the research results and discussion in a straightforward manner.

Table 2 presents the results of the validity and reliability tests of the questionnaire. This study underwent a series of validity and reliability tests. The content validity analysis demonstrated excellent agreement among the expert panel, yielding an Item-Level Content Validity Index (I-CVI) of 0.83 and a Scale-Level Content Validity Index (S-CVI/Ave) of 0.92, both exceeding the recommended COSMIN thresholds.

Table 2. Psychometric properties of the Indonesian version of the Modified Sedentary Behavior Questionnaire (MSBQ).

Type of Test	Indicator/Method	Result	Criteria/Cut-off	Confidence Interval (95%)
Content Validity	CVI-S CVI/Ave	.92	≥ ,90	-
	CVI-I-CVI Range	.83	≥ .78	-
Construct Validity	*Kaiser–Meyer–Olkin* (KMO)	.977	.6 = Acceptable .8 = Very good < .5= Not eligible for EFA	-
	Bartlett's Test of Sphericity	.000	P< .05	-
	Faktor Loading	> .5	≥ .30 = minimum ≥ .40 = good ≥ .50 = excellent	-
	Parallel Analysis	Factor 1: Actual eigenvalue: 12.25 Random average: 1.63	Actual eigenvalue > random average	-

	Communalities	.573-.764	≥ .70: Very good .50–.69: Good	-
Criterion Validity	Pearson r (vs. Gold Standard (ISAT))	.426	≥ .107	344 – .510
	Pearson r (Vs. Fitness Tracker	.732	≥ .107	678 – .778
Internal Consistency Intra-rater Reliability	Cronbach's Alpha	.869	≥ .70	840 – .890
	ICC	.875	0.75 – 0.90	840 – .910
	Pearson r (Test-Retest)	.810	≥ .107	.770 – .844
Standard Error of Measurement (SEM)	-	.551	-	-
Smallest Detectable Change (SDC)	-	1.526	-	-
Bland-Altman	Mean Difference	.31 hours		-
	Upper LOA	+2.1 hours		-
	Lower LOA	-1.48 hours		-

Note. CVI = Content Validity Index; KMO = Kaiser-Meyer-Olkin measure of sampling adequacy; ICC = Intraclass Correlation Coefficient; SEM = Standard Error of Measurement; SDC = Smallest Detectable Change; LOA = Limits of Agreement. Higher values of Cronbach's Alpha and ICC suggest greater reliability. Parallel analysis confirmed a single factor, indicating the questionnaire has a unidimensional structure.

Based on the results of the construct validity analysis, the initial KMO indicator was 0.9777 (excellent), indicating that the sample is sufficient for factor analysis. A very high KMO value indicates excellent sampling adequacy. However, if it exceeds 0.90, it might suggest that the items are somewhat redundant; nonetheless, the questionnaire items capture different aspects of sedentary behavior, such as screen use, reading, transport, and work-related sitting. This supports the idea that a high KMO reflects significant shared variance in sedentary behavior rather than merely duplicated content. Furthermore, Bartlett's Test of Sphericity is significant ($\chi^2 \approx 7183.33$; $p < .001$), indicating that the correlation matrix among items is approximately the identity matrix, making it feasible to proceed with factor analysis. Figure 2 demonstrates that only a single factor has an eigenvalue exceeding the random eigenvalue from the simulation, confirming the unidimensional structure of the MSBQ Indonesian version. This finding supports the idea that all questionnaire items assess a single core construct—sedentary behavior—and enhances the instrument's construct validity.

Factor rotation shows a good, consistent loading pattern with no cross-loading across all items, with good-to-perfect communalities, thus supporting a unidimensional structure. Overall, the EFA results show that the Indonesian version of the MSBQ has good construct validity and a stable factor structure. Furthermore, the criterion validity test using the gold-standard ISAT and Fitness Tracker yields correlation coefficients of 0.426 and 0.732, indicating moderate and vigorous validity, respectively.

In terms of reliability, the data were analyzed using Cronbach's alpha, which yielded a score of 0.869, exceeding the 0.70 threshold, so the instrument was deemed reliable. Although Cronbach's alpha indicates high internal consistency, the MSBQ is designed to assess

multiple domains of sedentary behaviour. Therefore, its reliability and stability are primarily supported by test-retest reliability (ICC = 0.875) and criterion-related validity. The test-retest correlation of 0.810 is considered very strong.

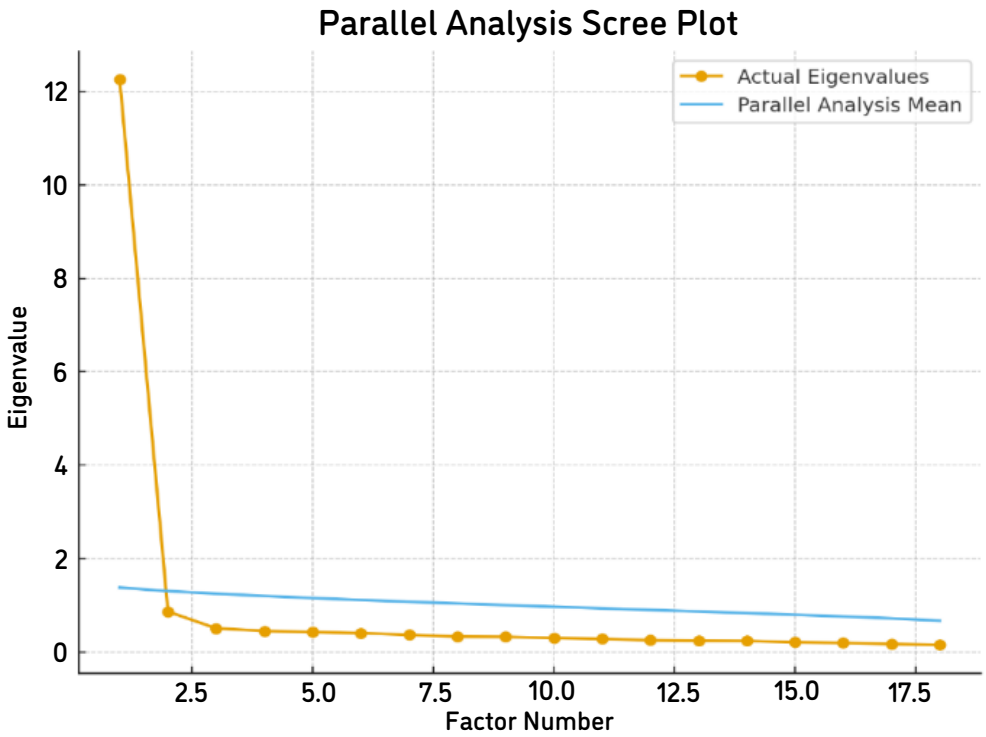

Figure 2. Parallel analysis scree plot indicating that only the first factor surpasses the simulated eigenvalue, confirming a unidimensional factor structure of the MSBQ Indonesia.

Measurement error analysis showed a standard error of measurement (SEM) of 0.551 hours and a smallest detectable change (SDC) of 1.526 hours. These values indicate that changes smaller than approximately 0.55 hours are likely attributable to measurement error, whereas individual changes exceeding 1.53 hours may be interpreted as true changes in sedentary behavior.

Discussion

This study is among the first to conduct a thorough psychometric evaluation of the modified Sedentary Behavior Questionnaire (MSBQ) among young adults. A key strength is its successful combination of subjective and objective methods to assess criterion validity, complemented by a systematic cultural adaptation process that includes forward-backward translation and expert review. This approach enhances the linguistic precision and cultural relevance of the instrument.

Overall, this study's results support its research goals by demonstrating adequate content, construct, and criterion validity, as well as reliability. However, some points need careful consideration. The sample mainly included university students from urban areas, which might

restrict the generalization of these findings can be applied. Additionally, although the validity coefficients are acceptable, the differences observed between subjective and objective measures indicate that these approaches might assess different facets of sedentary behavior.

Based on this study, the SBQ questionnaire was found to be valid and reliable among young adults. This is consistent with Alahmadi's study [36], which reported moderate-to-good levels of validity and reliability among university students in Saudi Arabia. The high rate of severe sedentary behavior among respondents (66.3%) aligns with previous reports on sedentary habits in academic environments. The Indonesian MSBQ captures the extensive sitting time associated with computer use and leisure activities. While earlier research has linked sedentary behaviour to environmental and sociocultural factors such as urbanisation, transport, and climate [39-41], this study did not measure these variables. As a result, any conclusions about their impact are speculative and beyond the aim of this validation research. Future studies should explore the determinants of sedentary behaviour and better understand how contextual factors influence it.

Another similarity lies in its consistency when measured twice on both weekdays and weekends. This is understandable because the instrument is a questionnaire, which tends to have low observer bias and relies on self-perception (self-report) [42]. In this context, the SBQ questionnaire relies on memory or personal perception, which is naturally relatively consistent because it is still within a short period. However, this does not mean it always has a high level of accuracy, as findings from the South American Youth/Child Cardiovascular and Environmental study, which ranged from adequate to moderate, depending on the respondents' characteristics [43].

Alvarez et al. [26] reported that validity testing may be influenced by cultural adaptation through expert assessment. Several items were therefore adjusted to reflect the local context and traditions related to physical activity in Indonesia by replacing or removing terms as needed. In this study, further adaptations were made to the use of technological platforms, such as video viewing, music listening, and streaming, in line with ongoing technological modernization and the optimization of digital media [44,45].

The modification of the item 'playing games' to 'hobbies in general' was based on input and feedback from the expert panel during the cultural adaptation phase; on the one hand, this specific activity was considered insufficiently representative of the leisure activities of the majority of young adults in Indonesia. This contextual adaptation phase has been empirically shown to minimize interpretive bias in cross-cultural questionnaire adaptation studies [46,47], resulting in excellent content validity (S-CVI/Ave=0.92) and higher reliability (Cronbach's alpha = 0.869) compared with studies in other regions that retained the original items. Because the MSBQ evaluates different types of sedentary behavior rather than a single, interchangeable type, its internal consistency should be interpreted with caution. In this context, indicators such as temporal stability and criterion validity provide more meaningful insights into how well the measurement performs than merely relying on Cronbach's alpha.

Furthermore, the results of this study differ from those reported by Moraes et al. [43], which found low criterion validity despite acceptable reliability. This difference is likely attributable to the age of the respondents in the Moraes study, which included children and adolescents aged 6–18 years. The SBQ questionnaire includes sedentary activities generally related to occupational routines (attending meetings, working at a computer, or reading magazines). Meanwhile, this questionnaire contains relatively few items reflecting leisure activities commonly performed by children and adolescents, and children and adolescents generally have limited recall (memory) to accurately remember how long they performed certain activities in

a week [48]. The findings of this study are consistent with those reported by Rosenberg et al. [32], who developed this questionnaire as a self-report measure for adults. The questionnaire items require quantitative cognitive reflection.

The complexity and range of sedentary activities can influence research results, including automation and remote work. However, technology also increases life expectancy through medical advances. As a result, many individuals live longer but with a decline in functional capacity and health [49,50]. The difference in the results of this study lies in the validity of the criteria. An interesting aspect of this study is the variation in criterion validity coefficients when comparing the ISAT (r = 0.426) with fitness tracker data (r = 0.732). Several reasons may account for this difference. First, both the MSBQ and the ISAT are self-report tools, which can be influenced by recall bias and inaccuracies in estimating activity duration [51]. Variations in recall methods and item formats between the two may reduce the correlation. Second, the MSBQ captures sedentary behavior through multiple context-specific items [26], while the ISAT offers a global assessment. As a result, despite both measuring sedentary behavior, they may focus on different aspects of the construct. The higher correlation with objective data indicates that the MSBQ's detailed domain approach might better mirror actual sedentary patterns.

Accurate comparisons can be made using accelerometers or fitness trackers [43]. However, the validity results were low due to the respondents' age (children and adolescents) and to the measurement of sedentary lifestyle using the SBQ. An accelerometer is an objective measuring device that can detect even the slightest human movement and measure physical activity levels. This objective instrument can verify the accuracy of subjective measurement results, namely the MSBQ. The low validity results may be due to recall bias experienced by the research respondents (children and adolescents). Furthermore, another factor is the possibility of misjudging the duration of activities, such as watching television, which can be misperceived as only watching television when, in fact, participants may also engage in activities such as streaming videos, or estimate their viewing time as 30 minutes when the actual duration is closer to 90 minutes.

Practical implications

The practical implications of this study include its potential application to physical activity promotion programs, using baseline data on sedentary lifestyles in Indonesia. This study indicates that the Indonesian MSBQ could serve as an affordable and simple tool for measuring sedentary behavior in population research. Nonetheless, broader use, especially in public health surveillance, requires additional validation studies across more diverse populations and geographic areas. Hence, this application should be viewed as a future goal rather than an immediately established practice.

In intervention studies, the validated instrument may provide a reliable baseline and an outcome measure for behavioral change. Researchers conducting RCTs focused on decreasing sitting time among young adults can utilize the MSBQ instrument. Notably, this study indicates that a Smallest Detectable Change (SDC) of 1.526 hours provides a precise benchmark. An SDC value of 1.526 hours offers a useful clinical reference point in intervention research. For instance, a decrease in sedentary time to under 1.5 hours daily after the intervention should be interpreted with caution, as it might reflect measurement error. In contrast, a reduction greater than this threshold more reliably indicates real behavioral change [50,52].

This study represents the first cultural adaptation and psychometric validation of the Indonesian version of the SBQ and a pioneering study that accounts for adaptations to Indonesian

traditions and culture. Furthermore, this study used content validity stages based on the Delphi approach, with justification grounded in local Indonesian culture. In addition, the validity of this questionnaire adaptation has been tested against the ISAT, a questionnaire used globally to measure sedentary activity.

Limitations and Future Research Directions

The homogeneity of the sample, which consisted primarily of university students engaged in scheduled academic activities, could limit the instrument's external validity when applied to young adults who are either in full-time employment or not engaged in academic pursuits. Additionally, focusing on the urban Solo Raya area may overlook critical sociocultural and infrastructural differences found in rural regions, potentially introducing biases—either overestimating or underestimating—particularly related to work, transportation, and sedentary behaviors. Relying on commercial fitness trackers as objective references can reduce detection accuracy because their built-in algorithms may misinterpret low-intensity movements. The limited ability of these sensors to accurately distinguish activity levels may bias the correlation between criteria, making it appear stronger due to activity misclassification rather than the true validity of the MSBQ questionnaire. From a methodological standpoint, using a subjective instrument like the International Sedentary Assessment Tool (ISAT) still carries a risk of recall bias.

Given these limitations, this study focuses on young adults aged 18–30. The cultural adaptation framework, initially designed for local interests, provides a solid foundation for applying the MSBQ to wider populations. Future validation studies might include high-risk, sedentary groups such as office workers, active teenagers, and elderly populations in various regions, including suburban and rural areas. Evaluating the instrument's psychometric properties across different demographics will enhance its usefulness for national health assessments. Although this study used two comparison tools, namely subjective questionnaires and objective devices, further evaluation is still needed to assess the consistency of results obtained with higher-sensitivity objective monitoring devices over longer monitoring durations. Therefore, research accelerometers should be used as the primary comparison tool in future studies, as they are the gold standard for measuring sedentary behavior. In addition, subsequent research should explore behavioral factors that influence sedentary lifestyle tendencies, thereby enhancing the understanding of sedentary determinants across various community groups.

Conclusions

The study finds that the Indonesian version of the Modified Sedentary Behavior Questionnaire (MSBQ) is culturally appropriate, valid, and reliable for self-assessment of sedentary habits among young adults. Its adaptation process reflects local lifestyle specifics, showing excellent content validity (S-CVI/Ave = 0.92) and a strong unidimensional structure. High correlations with fitness tracker data (r = 0.732) highlight good concurrent validity compared to traditional single-question measures.

A notable strength of this research is the integration of a rigorous cross-cultural adaptation process with both subjective and objective validation methods. However, the results' applicability is limited because the sample mainly comprises university students from urban areas, potentially underestimating variations in sedentary behavior observed in peri-urban or rural regions. Although fitness trackers offer reliable data, they are less accurate than research-grade accelerometers.

The low measurement error has practical advantages for public health. It enables researchers to collect baseline data, monitor trends, and evaluate interventions in a cost-effective, user-friendly way. Future studies should validate this tool across diverse populations —spanning ages, occupations, and regions— and employ accelerometers as the gold standard.

References

1. Moraru L, Perieanu V, Burlibașa M, Burcea CC, Perieanu MV, Malița MA, et al. Theoretical and practical aspects of sedentary behavior among medical professions in the field of dentistry – Part I. Rom Med J [Internet]. 2021;68(2):179-87. doi: https://doi.org/10.37897/RMJ.2021.2.9

2. Tjahjono CT, Arthamin MZ. Sedentary lifestyle as a leading cause of some diseases and disabilities. Clin Res J Intern Med [Internet]. 2024;5(1):60-85. doi: https://doi.org/10.21776/ub.crjim.2024.005.01.09

3. Rahayu WB, Kusuma DA. Profil gaya hidup sedentary pada remaja umur 15-17 tahun (studi di Kabupaten Lamongan). J Prest Olahraga [Internet]. 2022;5(2):114-21. Available from: https://ejournal.unesa.ac.id/index.php/jurnal-prestasi-olahraga/article/view/45082

4. World Health Organization [WHO] [Internet]. Geneva: World Health Organization; c2026. Physical activity; 2024 Jun 6 [cited 2025 Dec 4]; [about 5 screens]. Available from: https://www.who.int/news-room/fact-sheets/detail/physical-activity

5. Hills AP, Jayasinghe S, Arena R, Byrne NM. Global status of cardiorespiratory fitness and physical activity – are we improving or getting worse? Prog Cardiovasc Dis [Internet]. 2024;83:16-22. doi: https://doi.org/10.1016/j.pcad.2024.02.008

6. Anindya K, Marthias T, Zulfikar Biruni M, Hage S, Ng N, Laverty AA, et al. Low physical activity is associated with adverse health outcome and higher costs in Indonesia: a national panel study. Front Cardiovasc Med [Internet]. 2022;9:972461. doi: https://doi.org/10.3389/fcvm.2022.972461

7. Hanifah L, Nasrulloh N, Sufyan DL. Sedentary behavior and lack of physical activity among children in Indonesia. Children (Basel) [Internet]. 2023;10(8):1283. doi: https://doi.org/10.3390/children10081283

8. Badarali M, Rungsihirunrat K. Factors on affecting engagement of physical activity: Anderson behaviour model. Research Square [Preprint]. 2024. Available from: https://doi.org/10.21203/rs.3.rs-5306155/v1

9. Prambudi A, Rofi'ah IA. Sedentary lifestyle and comorbidities: overview of updated evidence of potential health risk. IJNMS [Internet]. 2025;9(1):49-60. doi: https://doi.org/10.29082/IJNMS/2025/Vol9/Iss1/702

10. Sheikholeslami S, Ghanbarian A, Azizi F. The impact of physical activity on non-communicable diseases: findings from 20 years of the Tehran Lipid and Glucose Study. Int J Endocrinol Metab [Internet]. 2018;16(4 (Suppl)):e84740. doi: https://doi.org/10.5812/ijem.84740

11. Jilani UA, Othman ZB, Jilani SA. Role of physical inactivity and high body mass index in the causation and primary prevention of non-communicable diseases. MJPHM [Internet]. 2022;22(1):295-302. doi: https://doi.org/10.37268/mjphm/vol.22/no.1/art.1516

12. Wulansari A, Martianto D, Baliwati YF. Estimasi kerugian ekonomi akibat obesitas pada orang dewasa di Indonesia. J Gizi Pangan [Internet]. 2017;11(2):159-68. Available from: https://journal.ipb.ac.id/jgizipangan/article/view/14690

13. Kementerian Kesehatan RI, Badan Penelitian dan Pengembangan Kesehatan. Laporan Riskesdas 2018 Nasional [Internet]. Jakarta: Kementerian Kesehatan RI; 2019. p. 235-57. [cited 2025 Dec 17]. Available from: https://repository.kemkes.go.id/book/1323

14. Rizwan M, Alam MM, Akhtar MW, Inam F, Yaseen F, Alam S, et al. Association between sedentary lifestyle and quality of life among young adults. JHRR [Internet]. 2024;4(1):774-9. doi: https://doi.org/10.61919/jhrr.v4i1.491

15. Healy GN, Winkler EAH, Owen N, Anuradha S, Dunstan DW. Replacing sitting time with standing or stepping: associations with cardio-metabolic risk biomarkers. Eur Heart J [Internet]. 2015;36(39):2643-9. doi: https://doi.org/10.1093/eurheartj/ehv308

16. Fennell C, Glickman EL, Lepp A, Kingsley JD, Barkley JE. The relationship between cell phone use, physical activity, and sedentary behavior in United States adults above college-age. Int J Hum Mov Sports Sci [Internet]. 2018;6(4):63-70. doi: https://doi.org/10.13189/saj.2018.060401

17. World Health Organization (WHO). WHO guidelines on physical activity and sedentary behaviour [Internet]. Geneva: WHO; 2020 [cited 2025 Dec 4]. 93 p. Available from: https://iris.who.int/handle/10665/336656

18. Edwardson CL, Biddle SJH, Clemes SA, Davies MJ, Dunstan DW, Eborall H, et al. Effectiveness of an intervention for reducing sitting time and improving health in office workers: three arm cluster randomised controlled trial. BMJ [Internet]. 2022;378:e069288. doi: https://doi.org/10.1136/bmj-2021-069288

19. Stiglic N, Viner RM. Effects of screentime on the health and well-being of children and adolescents: a systematic review of reviews. BMJ Open [Internet]. 2019;9:e023191. doi: https://doi.org/10.1136/bmjopen-2018-023191

20. Silva GO, Cunha PM, Oliveira MD, Christofaro DGD, Tebar WR, Gerage AM, et al. Patterns of sedentary behavior in adults: a cross-sectional study. Front Cardiovasc Med [Internet]. 2023;10:1116499. doi: https://doi.org/10.3389/fcvm.2023.1116499

21. Peterson NE, Sirard JR, Kulbok PA, DeBoer MD, Erickson JM. Sedentary behavior and physical activity of young adult university students. Res Nurs Health [Internet]. 2018;41(1):30-8. doi: https://doi.org/10.1002/nur.21845

22. Marconcin P, Júdice PB, Ferrari G, Werneck AO, Marques A. Methods of assessing sedentary behaviour. In: Marques A, Rubio Gouveia E, editors. Sedentary Behaviour - A Contemporary View [Internet]. London: IntechOpen; 2021. doi: https://doi.org/10.5772/intechopen.99567

23. Chaput JP, Dutil C, Featherstone R, Ross R, Giangregorio L, Saunders TJ, et al. Sleep duration and health in adults: an overview of systematic reviews. Appl Physiol Nutr Metab [Internet]. 2020;45:S218-31. doi: https://doi.org/10.1139/apnm-2020-0034

24. Soderlund A. Sedentary lifestyle–ongoing pandemic with no "vaccine"–editorial. European Journal of Physiotherapy [Internet]. 2023;25(6):305. doi: https://doi.org/10.1080/21679169.2023.2284580

25. Weber B, Wechsler K, Hermanns-Truxius I, Ellegast R. Proposal for sensor-based assessment of physical activity and sedentary behavior at the workplace. In: PREMUS 2025. 12th International Scientific Conference on the Prevention of Work-Related Musculoskeletal Disorders [Internet]; 2025 Sep 9-12; Tübingen, Germany. Düsseldorf: German Medical Science GMS Publishing House; 2025. p. Doc159. doi: https://doi.org/10.3205/25premus159

26. Álvarez CV, Claros JAV, Arenas AA, Palma BEP, Villamil YAR. Adaptation and validation of content of the sedentary behavior questionnaire. Hacia Promoc Salud [Internet]. 2021;26(1):148-62. doi: https://doi.org/10.17151/hpsal .2021.26.1.12

27. Wshah A, Madi M, Al-Nassan S, Al-Wardat M, Oliveira A, Brooks D. Cross-cultural adaptation and validation of the sedentary behaviour questionnaire among Arabic speaking healthy adults. Int J Health Promot Educ [Internet]. 2025;63(5):315-28. doi: https://doi.org/10.1080/14635240.2024.2431495

28. Zakiyatul Fuadah D, Siswoaribowo A, Diniaty E. Sedentary lifestyle with social interaction in adolescents. J Appl Nurs Health [Internet]. 2021;3(2):71-6. doi: https://doi.org/10.55018/janh.v3i2.9

29. Bakar Y, Tugral A, Ozel A, Devran Altuntas Y, Yakut Y. Reliability and validity of sedentary behavior questionnaire in Turkish population: evaluation of psychometric properties. Middle East J Rehabil Health Stud [Internet]. 2018;5(2):e63576. doi: https://doi.org/10.5812/mejrh.63576

30. Bacsne Baba E, Muller A, Pfau C, Balogh R, Bartha E, Szabados G, et al. Sedentary behavior patterns of the Hungarian adult population. Int J Environ Res Public Health [Internet]. 2023;20(3):2702. doi: https://doi.org/10.3390/ijerph20032702

31. Montoya Gonzalez S, Mera-Mamian AY, Mondragón Barrera MA, Muñoz Rodriguez DI, Gonzalez-Gomez D. Propiedades psicométricas del cuestionario de comportamiento sedentario (SBQ-s) en universitarios colombianos. Retos [Internet]. 2022;46:745-57. doi: https://doi.org/10.47197/retos.v46.94103

32. Rosenberg DE, Norman GJ, Wagner N, Patrick K, Calfas KJ, Sallis JF. Reliability and validity of the sedentary behavior questionnaire (SBQ) for adults. J Phys Act Health [Internet]. 2010;7(6):697-705. doi: https://doi.org/10.1123/jpah.7.6.697

33. Liem SG. Physical activity, sedentary behavior, and fitness: a cross-sectional study. Maj Ilm Fisioter Indones [Internet]. 2025;13(3):504-11. doi: https://doi.org/10.24843/mifi.000000363

34. Prince SA, LeBlanc AG, Colley RC, Saunders TJ. Measurement of sedentary behavior in population health surveys: a review and recommendations. PeerJ [Internet]. 2017;5:e4130. doi: https://doi.org/10.7717/peerj.4130

35. Aunger J, Wagnild J. Objective and subjective measurement of sedentary behavior in human adults: a toolkit. Am J Hum Biol [Internet]. 2022;34(1):e23546. doi: https://doi.org/10.1002/ajhb.23546

36. Alahmadi MA, Almasoud KH, Aljahani AH, Alzaman NS, Nozha OM Al. Validity and reliability of the Arabic sedentary behavior questionnaire among university students aged between 18 and 30 years old. BMC Public Health [Internet]. 2023;23:128. doi: https://doi.org/10.1186/s12889-023-15030-1

37. Bakker EA, Hartman YAW, Hopman MTE, et al. Validity and reliability of subjective methods to assess sedentary behaviour in adults: a systematic review and meta-analysis. Int J Behav Nutr Phys Act [Internet]. 2020;17:75. doi: https://doi.org/10.1186/s12966-020-00972-1

38. Bakhtari Aghdam F, Aziz-Zadeh S, Musavi S, Abbasalizad-Farhangi M. Psychometric properties of the last-7-day sedentary time questionnaire (SIT-Q-7d): testing the validity and reliability among the general population. BMC Public Health [Internet]. 2022;22:1880. doi: https://doi.org/10.1186/s12889-022-14262-x

39. Muller AM, Chen B, Wang NX, et al. Correlates of sedentary behavior in Asian adults: a systematic review. Obes Rev [Internet]. 2020;21(4):e12976. doi: https://doi.org/10.1111/obr.12976

40. Annear M. Sedentary behavior and physical inactivity in the Asia-Pacific region: current challenges and emerging concerns. Int J Environ Res Public Health [Internet]. 2022;19(15):9351. doi: https://doi.org/10.3390/ijerph19159351

41. Kim MJ, Sung JH, Park KS. Effect of high temperature on walking among residents of rural and urban communities. Yonsei Med J [Internet]. 2022;63(12):1130-7. doi: https://doi.org/10.3349/ymj.2022.0167

42. Ashton MC, Lee K. Self- and observer reports of personality. Annu Rev Psychol [Internet]. 2025;76:771-95. doi: https://doi.org/10.1146/annurev-psych-020124-115044

43. De Moraes ACF, Nascimento-Ferreira MV, Forjaz CLDM, Aristizabal JC, Azzaretti L, Nascimento Júnior WV, et al. Reliability and validity of a sedentary behavior questionnaire for South American pediatric population: SAYCARE study. BMC Med Res Methodol [Internet]. 2020;20:5. doi: https://doi.org/10.1186/s12874-019-0893-7

44. Huaman NJC, Escobar LG, Contreras-Morales D. Use of streaming platforms in the perception of aging among older adults. In: Proceedings of the 2024 IEEE 4th International Conference on Advanced Learning Technologies on Education & Research (ICALTER) [Internet]. Tarma (PE): IEEE; 2024. p. 1-4. doi: https://doi.org/10.1109/ICALTER65499.2024.10819215

45. Edwards E, Ireland J, Lezina B, Omarali SB, Schallert H, Robertson J, et al. Radio and audio in 2018. J Radio Audio Media [Internet]. 2019;26(2):351-9. doi: https://doi.org/10.1080/19376529.2019.1678806.

46. Gatti-Reis L, Alvarenga RN, Abreu LG, Paiva SM. Semantic equivalence of the Brazilian version of the Patient Satisfaction Questionnaire (B-PSQ). Braz Dent J [Internet]. 2023;34(1). doi: https://doi.org/10.1590/0103-6440202305074

47. Weng W, Zhi X, Jia Z, et al. The adaptation of the Sport Assessment-Patella Questionnaire into a simplified Chinese version: cross-cultural adaptation, reliability, and validity. Health Qual Life Outcomes [Internet]. 2020;18:269. doi: https://doi.org/10.1186/s12955-020-01525-7.

48. Trost SG. Population-level physical activity surveillance in young people: are accelerometer-based measures ready for prime time? Int J Behav Nutr Phys Act [Internet]. 2020;17(1):28. doi: https://doi.org/10.1186/s12966-020-00929-4.

49. Goyal J, Rakhra G. Sedentarism and chronic health problems. Korean J Fam Med [Internet]. 2024;45(5):239-57. doi: https://doi.org/10.4082/kjfm.24.0099.

50. Woessner MN, Tacey A, Levinger-Limor A, Parker AG, Levinger P, Levinger I. The evolution of technology and physical inactivity: the good, the bad, and the way forward. Front Public Health [Internet]. 2021;9:655491. doi: https://doi.org/10.3389/fpubh.2021.655491.

51. Kastelic K, Rakic M, Suc A, Sarabon N. 81 Correction of bias in self-reported 24-hour movement behaviours: How well can the bias be removed? Eur J Public Health [Internet]. 2024;34(Suppl 2):ckae114.051. doi: https://doi.org/10.1093/eurpub/ckae114.051

52. Magnon V, Vallet GT, Dutheil F, Auxiette C. Sedentary lifestyle matters as past sedentariness, not current sedentariness, predicts cognitive inhibition performance among college students: an exploratory study. Int J Environ Res Public Health [Internet]. 2021;18(14):7649. doi: https://doi.org/10.3390/ijerph18147649.