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Original Article

Criterion validity and agreement of the brazilian version of the sedentary behavior questionnaire against the ActiGraph accelerometer

MATEUS ASSIS BENFICA[1], MAYARA LOPES DE JESUS ARAÚJO[2], LOUIZE CARVALHO MOREIRA SILVA[3], JENIFFER DE ANDRADE BRITO[4], LUCIANA ARAÚJO DOS REIS[5], DIEGO GIULLIANO DESTRO CHRISTOFARO[6], RANIERE SOUZA DE JESUS[7], DAVID OHARA[8]
[1,2,3,4,7]Department of Health Sciences, State University of Santa Cruz, Ilhéus, BRAZIL.
[5,8]Department of Health I, State University of Southwestern Bahia, Jequié, BRAZIL
[6]Department of Physical Education, Paulista State University, "Júlio de Mesquita Filho", Presidente Prudente, BRAZIL

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Abstract
Objective: This study aimed to assess the criterion validity of the Sedentary Behavior Questionnaire in college students by comparing it with data from an accelerometer. **Methods:** A convenience sample of 80 university students (73.7% female), from a public university in Brazil participated in the study. Participants wore an ActiGraph (wGT3X-BT) accelerometer for 7 consecutive days and completed the Sedentary Behavior Questionnaire via Google Forms. Additionally, to evaluate the reliability of the questionnaire, 20 participants completed the questionnaire again after a two-week interval for test-retest analysis. Descriptive analysis was performed for both continuous and categorical variables. Data distribution was evaluated using the Kolmogorov-Smirnov test. The paired t-test was performed to compare the reference method with the questionnaire, the intraclass correlation coefficient to assess reliability of the Sedentary Behavior Questionnaire, the Spearman's correlation coefficient to verify the relationship between methods, and the Bland-Altman´s plot to assess the agreement between the values of both methods. **Results:** High test-retest reliability was found for weekdays (0.78), weekends (0.89), and total values (0.90). No significant statistical correlations were found in total values between the Sedentary Behavior Questionnaire and ActiGraph for cutoff points of <100 cpm (rho = -0.033, p = 0.774) and <150cpm (rho = 0.140, p = 0.216). Moreover, the questionnaire underreported sedentary behavior when adopting a cutoff point of <100 cpm and overreported it when the cutoff point was <150 cpm. Conclusions: The Sedentary Behavior Questionnaire showed high reliability for measuring sedentary behavior in a 14-day test-retest time period. However, a weak correlation and low agreement were found between the questionnaire and Actigraph, with the self-report overestimating and underestimating the sedentary behavior. Further research should be carried out to improve the correlation and agreement between the Sedentary Behavior Questionnaire and measuring devices, reducing the frequently attributed biases.
Keywords: Sedentary Behavior, Reliability, Physical inactivity, College students.

Introduction

Sedentary behavior (SB) is a common condition characterized by a waking behavior with an energy expenditure of less than 1.5 metabolic equivalents (METs) while sitting, reclining, or lying positions (in occupational, educational, home, and transportation contexts) (Bull et al., 2020; Tremblay et al., 2017). Many studies have reported that prolonged time spent in SB is related to several health problems, including cardiovascular disease, cancer, type 2 diabetes, obesity, mental health disorders, and increased mortality (de Rezende et al., 2014; Mclaughlin et al., 2020; Wu et al., 2023), impacting the quality of life and wellbeing (Boberska et al., 2018). Additionally, SB represents a significant cost to healthcare systems. For example, in the United Kingdom, prolonged SB between 2016 and 2017 incurred £0.7 billion (Heron et al., 2019).

In this context, the World Health Organization recommends that adults decrease sedentary time (Bull et al., 2020). However, what is observed is an increase in the time spent by adults in SB over the years. For example, a cross-sectional series study with 27,343 participants reported higher SB among Americans from 5.7 hours per day in 2007–2008 to 6.4 hours per day in 2015–2016 (Du et al., 2019). Besides that, another cross-sectional study has shown that most Brazilian adults, in a sample of 88,531, did not meet the recommendations for the leisure time of PA and the reduction in SB, with 59.5% being physically inactive (Oliveira et al., 2023). In addition, the global pandemic of COVID-19 significantly increased SB with a reduced level of PA worldwide, due to social distancing recommendations (Stockwell et al., 2021).

Many instruments are described in the literature to evaluate SB. They can be categorized into subjective (e.g., questionnaires) and objective (e.g., accelerometers, inclinometers, pedometers) assessments (Castillo-Retamal & Hinckson, 2011, 2011; Hart et al., 2011; Prince et al., 2020). The accelerometer has been one of the most

Corresponding Author: DAVID OHARA, E-mail: david.ohara@uesb.edu.br

commonly used objective tools. It can strictly evaluate the axial and appendicular body movements, quantifying the frequency and intensity of the PA and SB, through a measure of counts (Intille et al., 2012), with different cutoff points being described to define sedentary time, such as <100 and <150 counts per minute (cpm) (Freedson et al., 1998; Kozey-Keadle et al., 2011). Nonetheless, the tool presents some limitations (e.g., incapacity to detect postures, high price) (Hart et al., 2011).

These high costs of the accelerometer contribute to inequalities in its use. A scoping review reported that while developed countries such as the United States, the United Kingdom, and Japan are the primary users of accelerometers, there are relatively few studies on the African continent (Evenson et al., 2022). In this case, subjective measures can be useful to verify the SB of different populations. Despite the limitations, the self-reported questionnaires can provide more information about the behavioral context (e.g., watching TV, playing games, working on the computer). Additionally, questionnaires have low costs and are easy to administer. Moreover, when combined with accelerometers or other measurement devices, they can provide richer data and more information regarding human behavior (Sattler et al., 2021). Nevertheless, validation of these instruments is recommended.

Some questionnaires are widely used, including, the International Physical Activity Questionnaire (IPAQ), Global Physical Activity Questionnaire (GPAQ), and Sedentary Behavior Questionnaire (SBQ) (Armstrong & Bull, 2006; Hallal & Victora, 2004; Rosenberg et al., 2010). The SBQ was developed to assess the total time spent on nine behaviors, separately for weekdays and weekends, and validated for the first time in the English language in overweight adults (Rosenberg et al., 2010). Furthermore, it has been validated in other populations, such as European older adults, in English, Spanish, German, and Danish versions (Sansano-Nadal et al., 2022), in an Arabic version (Alahmadi et al., 2023), a German version (Kalisch et al., 2022), a Turkish version (Bakar et al., 2018) and in an Asian version (Chu et al., 2018).

Many SB and PA questionnaires have been validated for Brazilians, as previously reported by a systematic review (Silva et al., 2020). However, knowledge of the SBQ in the Brazilian population is scarce. Therefore, considering the disparities in accelerometer use, the cost-effectiveness and easy administration of the SBQ, the significant increase of SB in Brazilians, and the need for questionnaire validation in this population, this study aimed to examine the criterion validity of the SBQ in Brazilian college students older than 18 years through the accelerometer.

Methods

Ethical aspects

The present study uses partial data from the research entitled "Physical activity, sedentary behavior and sleep: 24-hour movement behaviors and health indicators in adults" approved by the Research Ethics Committee of the State University of Santa Cruz (UESC) under opinion nº 4.832.080. The study protocol was carried out following the Declaration of Helsinki. After being informed of the procedures to which they would be submitted, all participants signed the Informed Consent Form. The study was conducted between June and December 2021, during the COVID-19 pandemic. All social distancing, mask-wearing, and equipment sanitization protocols in effect were strictly adhered to.

Participants

The convenience sample consisted of 80 college students, both sexes, aged 18 or older and from different undergraduate and graduate courses (Physical Education, Biomedicine, Nursing, Medicine, Biological Sciences, Literature, History, Administration, Mathematics, Geography) at State University of Santa Cruz, Ilhéus, Bahia, Brazil.

Sedentary Behavior (Accelerometry)

The accelerometer ActiGraph wGT3X-BT (ActiGraph, Pensacola, FL) was used as a reference for measuring sedentary time. Participants received the equipment in their homes or work properly sanitized. In addition, in the delivery and collection of equipment by the members of the research evaluators team, the recommended safety measures were adopted, such as the use of a mask and alcohol gel. Participants also received a folder with information on use and a diary where they should record the days and periods of non-use of the equipment. The equipment was worn around the waist (right hemibody), affixed by an adjustable elastic strap for 7 consecutive days. The participants were instructed to use the equipment during waking hours, removing it only to carry out activities in a liquid environment and during sleep. The equipment was initialized in the ActiLife v.6.8.2 software (ActiGraph LLC, Pensacola) for measurements at a frequency of 30Hz in epochs of 15s, later reintegrated in the 60s. For analysis purposes, valid data were those with measurements of at least 10 hours a day, with 4 or more days a week, with at least 1 day on the weekend. Sedentary time was established from the cutoff point of <100 counts/min (AG100) (Freedson et al., 1998) and <150 counts/min (AG150) (Kozey-Keadle et al., 2011).

Sedentary Behavior Questionnaire (SBQ)

Participants completed the Sedentary Behavior Questionnaire (SBQ) (Rosenberg et al., 2010) on Google Forms, in the week following the return of the accelerometers. A subgroup of 20 participants was invited to

answer the questionnaire again 14 days after the first one, to assess the instrument's reliability analysis. The SBQ evaluates the time spent in SB on a typical weekday and on a typical weekend day, in 9 activities, namely: "Watching TV (including videos on DVD or Digital Media"); "Playing games on the computer, video games, tablet or cell phones"; "Sitting listening to music on the radio, CDs or other digital media"; "Sitting and talking on the phone"; "Working with documents or on the computer (office work, emails, paying bills, etc.)"; "Sitting reading books or magazines"; "Playing a musical instrument"; "Doing handicrafts or crafts (embroidery, crochet, knitting, tapestry, etc.)" and "Sitting and/or driving a car, bus or train".

The answers for each of the activities are: "None"; "15 min. or less"; "30 min.; "1h"; "2h"; "3h"; "4h"; "5h" and "6h or more".

The sedentary time in minutes was obtained from the sum of the time spent in each of the 9 activities, for a weekday and a weekend day. The calculation of the weekly average, considering weekdays and weekend days, was calculated from the equation: (weekday * 5 + weekend day * 2)/7

Statistical Analysis

Descriptive analysis was applied based on mean and standard deviation values for continuous variables and absolute and relative frequency for categorical variables. The Kolmogorov-Smirnov test was used to verify the data distribution. The comparison between the reference method and the SBQ was performed using the t-test for paired samples.

The intraclass correlation coefficient (ICC) was used to identify the test-retest reliability of the questionnaire. The agreement between the reference method and the SBQ was verified in the Bland-Altman plot. The relationship between the values obtained by both methods was verified by Spearman's correlation coefficient. Analyses were performed using the statistical package IBM SPSS v.25.0 and MedCalc v.14.8.1. For all analyses, a significance level of 5% was adopted.

Results

A total of 80 college students answered all SBQ items and used AG for at least 4 days. Most participants were female (73.7%), students of health courses (57.5%), and black or brown (80.1%) (Table 1).

Table 1. Characteristics of college students (n=80)

Variables	Values
Sex, n (%)	
Male	21 (26.3)
Female	59 (73.7)
Age, years	26.0 (6.2)
Weight, kg	63.0 (13.4)
Height, m	1.64 (0.08)
BMI, kg/m^2	23.1 (4.2)
Graduate course, n (%)	
Health	46 (57.5)
Other	34 (42.5)
Race, n (%)	
Black/Brown	64 (80.1)
White/Yellow	16 (19.9)

Table 2 presents test-retest ICC values of the SBQ items for weekdays, weekends, and total (week). All ICC values showed high reliability ranging from 0.78 (weekday) to 0.90 (total).

Table 2. Sedentary time reliability estimated by SBQ.

	n	Test	Retest	ICC	*p*
SQB, sedentary time, min/day					
Weekday	20	483,0 (274.2)	526.3 (310.2)	0.899	<0.001
Weekend	20	449.2 (197.0)	483.0 (286.1)	0.784	0.001
Total	20	473.3 (227.4)	513.9 (295.3)	0.908	<0.001

Note. SBQ = Sedentary Behavior Questionnaire; ICC = Intraclass correlation coefficient.

Table 3 presents the Spearman's correlation coefficient for SBQ and AG for weekday, weekend, and total time. We found no statistical correlation between the SBQ and AG average sedentary time, except for AG150 on weekend days.

Table 3. Sedentary time estimated by SBQ and measured by AG (n=80)

Method	Time	Spearman correlation coefficient		
		Rho	CI95%	*p*-value
SQB, sedentary time, min/day				
Weekday	523.6 (269.1)	-	-	-
Weekend	508.3 (236.8)	-	-	-
Total	519.2 (243.8)	-	-	-
AG100, mean (SD), min/day				
Weekday	600.2 (91.1)	-0.015	-0.234;0.206	0.898
Weekend	597.3 (105.1)	0.116	-0.106;0.328	0.304
Total	599.4 (82.4)	-0.033	-0.250;0.189	0.774
AG150, mean (SD), min/day				
Weekday	269.5 (79.4)	0.103	-0.119;0.316	0.362
Weekend	254.5 (95.8)	0.267	0.050;0.460	**0.017**
Total	265.2 (71;9)	0.140	-0.085;0,349	0.216

SBQ=Sedentary Behavior Questionnaire; SD=standard deviation.

SB was underestimated by SBQ at 24.5% (76.6 min/weekday) and 24% (89.1 min/weekend) when the cutoff point was <100cpm (AG100) (Figure 1A and 1B). On the other hand, SB was overestimated by SBQ in 51.1% (254.1 min./weekday) and 60.4% (253.8 min/weekend) when the cutoff point was <150 cpm (AG150) (Figure 1C and 1D). In general, the agreement values in the Bland-Altman plot can be considered satisfactory.

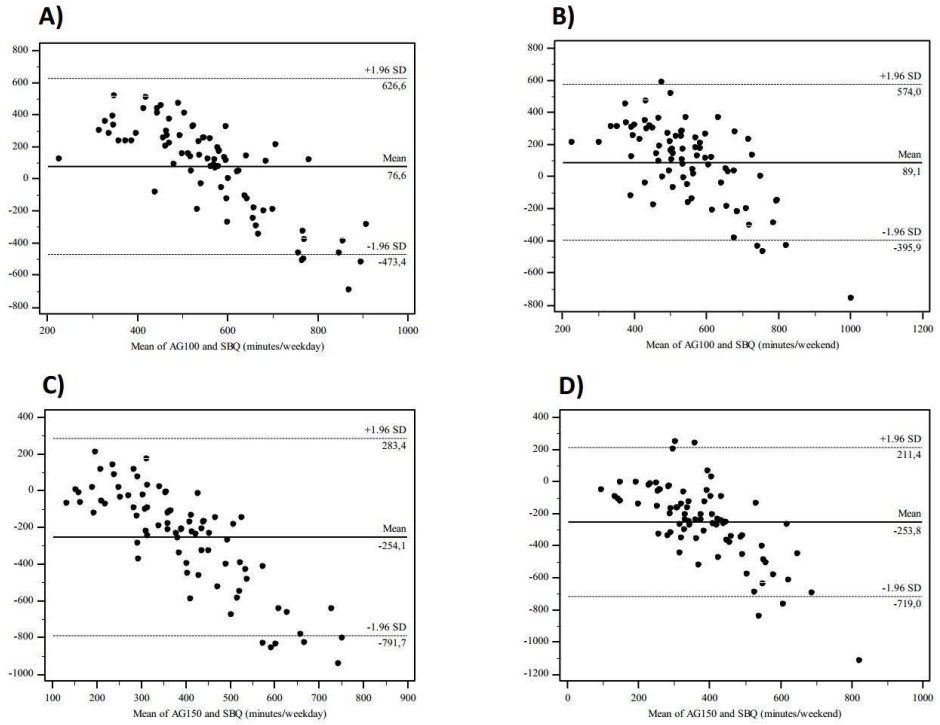

Figure 1. Bland Altman plot of the sedentary time by a weekday (2A and 2C), weekend (2B and 2D) measured with ActiGraph AG100 (2A and 2B), AG150 (2C and 2D) and estimated by SBQ.

As shown in Figures 2A and 2B, SBQ is underestimated in 23.1% (80.2 min.) with a cutoff point <100cpm and overestimated in 54.9% (254.0 min.) with <150 cpm cutoff point for a total time spent in sedentary time in a week.

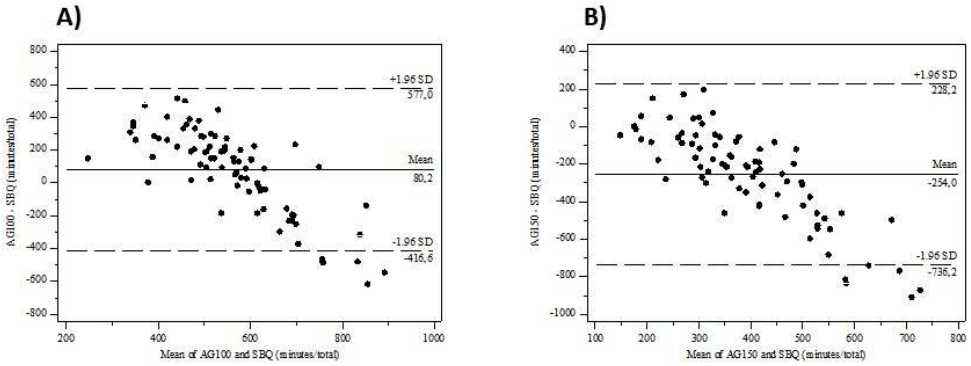

Figure 2. Bland Altman plot of the total sedentary time (min/week) measured with ActiGraph AG100 (2A), AG150 (2B) and estimated by SBQ.

Discussion

We aimed to examine the criterion validity of SBQ against accelerometry (ActiGraph wGT3X-BT), in Brazilian college students, older than 18 years. In an overview, our results showed high levels of reliability in total (ICC = 0.90, p <0.001), weekdays (ICC = 0.89, p <0.001), and weekends (ICC = 0.78, p <0.001), in twenty test retest participants. Additionally, no significant correlation between SBQ and ActiGraph was found, except for the weekend in a cutoff point of <150cpm (AG150) (p = 0.017, *rho* = 0.267). Moreover, SB was over- or underestimated by SBQ.

Most previous findings showed moderate-to-good/excellent reliability of the SBQ (Alahmadi et al., 2023; Bakar et al., 2018; Bull et al., 2020; Rosenberg et al., 2010). This present study showed high levels of reliability (weekday = 0.78 to total = 0.90). Considering the effect of SBQ application mode on response, some studies reported a face-to-face interview, as in the article of Alahmadi et al. (2023), while some reported a self-administered response (Rosenberg et al., 2010), as in our study. Although the interview is considered the gold standard mode (Leeuw et al., 2008), the study of Chu et al. (2018) detected moderate-to-good reliability in both self- and interview administration.

When regarding test-retest time, some protocols performed a one-week interval (Alahmadi et al., 2023; Bakar et al., 2018; Chu et al., 2018), in counterpoint with our study that used a two-week interval to assess the reliability of SBQ. Note that the better time interval in test-retest reliability depends on the measured construct, target population, and the stability of the instrument, even so, the 2-week interval is the most frequently recommended (Streiner et al., 2014). This question is important, as an insufficient period might allow participants to recall their initial answers (Frost et al., 2007). Furthermore, we considered the original study of the reliability and validity of the questionnaire (Rosenberg et al., 2010).

The weak correlation found in our study (rho= -0.015, p= 0.898) was similarly reported in preceding articles (Kalisch et al., 2022; Kastelic & Šarabon, 2019; Rosenberg et al., 2010; Sansano-Nadal et al., 2022). The study of Sansano-Nadal et al. (2022) found a weak positive correlation between SBQ and activPAL/Axivity, except for the moderate correlation in the Danish version. In addition, Kalisch et al. (2022) did not find significant correlations between the questionnaire and data from the accelerometer in both subgroups assessed in the German population (rho ≤ 0.281, p ≥ 0.174). Besides, a low correlation for males was reported in the primary study of SBQ (Rosenberg et al., 2010).

The nature of the instruments can partially explain this weak correlation between the SBQ and the accelerometer. While the accelerometer assesses sitting and lying behaviors, the SBQ specifically assesses sitting time in 4 of 9 context-specific behaviors (Sansano-Nadal et al., 2022). Furthermore, SBQ did not consider, for example, that "watching TV", "playing games" or "reading books" items are also possible during other activities (eg., transportation, breaks, waiting times, meals, etc) (Kalisch et al., 2022). Another factor that probably influenced this weak correlation in our study was the non-adaptation of some SBQ items for this specific population. However, a weak correlation was also described by Kalisch et al. (2022), where adaptations were made (ie., "doing paperwork or computer work" to "handwriting").

This weak correlation was also reported to other objective measures, as in the Spanish version of SBQ for patients with fibromyalgia against the SenseWear Pro3 Armband (SWA) (rho -0.06 to -0.03) (Munguia-Izquierdo et al., 2013). The opposite example is that when the SBQ is compared with the International Physical Activity Questionnaire - Short Form (IPAQ-SF), a high correlation was found between both, in most of the items in the study of Alahmadi et al. (2023). Moreover, the study of Bakar et al. (2018) also used the IPAQ-SF to validate the SBQ for the Turkish population, in contrast with our study which used a device. In both studies, the lack of an accelerometer to measure PA or physical inactivity may have influenced the results, as reported by the authors.

Regarding the agreement between the accelerometer and SBQ, two cutoff points with a threshold of 100cpm and 150cpm were considered given the remaining uncertainty in the definition of sedentary time. Although Actigraph studies tend to use a cut-point of <100cpm, there is short evidence of the validity of this cutoff point for adults (Clarke-Cornwell et al., 2016). Additionally, Kozey-Keadle et al. (2011), suggested that the <150cpm may be more appropriate to define SB in this population. Furthermore, some SBQ validation articles used a <100cpm (Rosenberg et al., 2010) or a <150cpm (Chu et al., 2018; Kastelic & Šarabon, 2019) to define sedentary time. Chu et al. (2018) also considered the thresholds of 100cpm and 200cpm, but only presented <150cpm as the main findings.

Therefore, our results showed an underestimation of the SB by SBQ when the cutoff point was <100cpm (AG100) (76.6 min/weekday) in the Bland Altman plot and were similarly found in another study with 801 European adults (72.90 mins/day) using activePAL3c and Axivity AX3 devices (Sansano-Nadal et al., 2022). The Slovenian version of SBQ also underestimated the SB (on average −181 min/day) compared to activPAL (Kastelic & Šarabon, 2019). But when the cutoff point was <150cpm (AG150) our results were in concordance with Kalisch et al. (2022), which showed an overestimation in SB by SBQ, using the ActiGraph wGT3X-BT device. Thus, higher cutoff points are related to overreported results.

This self-reported bias concerning SB questionnaires is present in other studies. A meta-analysis showed an underestimation of SB by IPAQ-SF (Mean difference = -161.67 min/day) and GPAQ (Mean difference = -219.85 min/day) against the accelerometer (Evenson et al., 2022). Strengthening this statement, another systematic review with meta-analysis showed that self-report underestimated by ~1.74 hours/day the sedentary time compared to device measures (Prince et al., 2020). In addition, a very recent cross-sectional study with 23,993 Norwegian adults reported that 61% of them overreported or underestimated their sitting time of more than 120 minutes in a day (Kongsvold et al., 2023).

Reporting errors seems a common consequence of self-reports since sedentary individuals may be unaware of their PA or SB levels (Ronda et al., 2001). Therefore, it is essential to understand the limitations of questionnaires, i.e., recall and social desirability bias, specific population and culture needs, and low validity to incidental or lifestyle PA assessments. Nonetheless, the measure devices also have limitations (e.g., they cannot account for all activities) (Strath et al., 2013). Thus, validation of both constructs is recommended before their use in epidemiological studies.

To our knowledge, this is the first study to validate the SBQ against the accelerometer in Brazilian college students. However, there are some limitations in this study. First, self-reported bias is commonly present in questionnaires, surveys, or interviews, particularly recall and social desirability bias. Second, the convenience sample probably partially caused the sex (female = 73.7%) and race (black or brown = 80.1%) differences. These questions limit the generalizability of our results.

As strengths of the present study, we consider the optimal scenario for PA and SB research corresponds to the use of both objective and subjective measures. The combined strengths of these methodologies can promote a holistic image of PA and SB (Sattler et al., 2021). However, considering the inequalities in the use of accelerometers, especially for low-income countries (Evenson et al., 2022), questionnaires such as the SBQ could help understand the 24-hour movement behaviors in different populations. Thus, given the lack of evidence related to SBQ, further research should be conducted to improve the construct and reduce biases.

As practical applications of the present study, we emphasize that the SBQ can be used with caution to estimate the SB of university students, mainly where more accurate methods such as accelerometry are not available. Such procedures are encouraged mainly on a large scale and in developing countries such as Brazil, where this tool (accelerometer) is less available when compared to North American and European countries, for example.

Conclusions

The present study showed that SBQ is highly reliable but weakly correlated with the accelerometer in Brazilian college students, similar to the previous SBQ validation articles. The weak correlation may be explained by the differences found between the two measures, particularly the limitation of the SBQ in accurately capturing SB. Additionally, SBQ underreported SB when the cutoff point was less than 100 cpm, while it overreported SB when the cutoff point was less than 150 cpm.

The results suggest that although the SBQ offers convenience and is useful in certain contexts, it still faces challenges in accurately assessing these behaviors, especially when compared to the accelerometer. Therefore, future research should focus on validating the SBQ in different populations with more representative samples. This will help improve the correlation and agreement between the objective measures and SBQ, and reduce the biases often associated with self-reports. In the meantime, we recommend that measurement devices continue to be the preferred instruments for assessing sedentary behavior and physical activity until these improvements are achieved.

Conflicts of interest: The authors have no conflicts of interest to declare.

References

Alahmadi, M. A., Almasoud, K. H., Aljahani, A. H., Alzaman, N. S., Nozha, O. M. A., Alahmadi, O. M., Jalloun, R. A., Alfadhli, E. M., Alahmadi, J. M., Zuair, A. A., Alzahrani, N. S., Alahmdi, A. A., Alghamdi, M. A., Zoudji, B., Aldayel, A. A., & Al-Daghri, N. M. (2023). Validity and reliability of the Arabic sedentary behavior questionnaire among university students aged between 18–30 years old. *BMC Public Health*, *23*(1), 128. https://doi.org/10.1186/s12889-023-15030-1

Armstrong, T., & Bull, F. (2006). Development of the World Health Organization Global Physical Activity Questionnaire (GPAQ). *Journal of Public Health*, *14*(2), 66–70. https://doi.org/10.1007/s10389-006-00

Bakar, Y., Tugral, A., Ozel, A., Altuntas, Y. D., & Yakut, Y. (2018). Reliability and Validity of Sedentary Behavior Questionnaire in Turkish Population: Evaluation of Psychometric Properties. *Middle East Journal of Rehabilitation and Health*, *5*(2), Article 2. https://doi.org/10.5812/mejrh.63576

Boberska, M., Szczuka, Z., Kruk, M., Knoll, N., Keller, J., Hohl, D. H., & Luszczynska, A. (2018). Sedentary behaviours and health-related quality of life. A systematic review and meta-analysis. *Health Psychology Review*, *12*(2), 195–210. https://doi.org/10.1080/17437199.2017.1396191

Bull, F. C., Al-Ansari, S. S., Biddle, S., Borodulin, K., Buman, M. P., Cardon, G., Carty, C., Chaput, J.-P., Chastin, S., Chou, R., Dempsey, P. C., DiPietro, L., Ekelund, U., Firth, J., Friedenreich, C. M., Garcia, L., Gichu, M., Jago, R., Katzmarzyk, P. T., … Willumsen, J. F. (2020). World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *British Journal of Sports Medicine*, *54*(24), 1451–1462. https://doi.org/10.1136/bjsports-2020-102955

Castillo-Retamal, M., & Hinckson, E. A. (2011). Measuring physical activity and sedentary behaviour at work: A review. *Work*, *40*(4), 345–357. https://doi.org/10.3233/WOR-2011-1246

Chu, A. H. Y., Ng, S. H. X., Koh, D., & Müller-Riemenschneider, F. (2018). Domain-Specific Adult Sedentary Behaviour Questionnaire (ASBQ) and the GPAQ Single-Item Question: A Reliability and Validity Study in an Asian Population. *International Journal of Environmental Research and Public Health*, *15*(4), 739. https://doi.org/10.3390/ijerph15040739

Clarke-Cornwell, A. M., Farragher, T. M., Cook, P. A., & Granat, M. H. (2016). Empirically derived cut-points for sedentary behaviour: Are we sitting differently? *Physiological Measurement*, *37*(10), 1669–1685. https://doi.org/10.1088/0967-3334/37/10/1669

de Rezende, L. F. M., Rodrigues Lopes, M., Rey-López, J. P., Matsudo, V. K. R., & Luiz, O. do C. (2014). Sedentary Behavior and Health Outcomes: An Overview of Systematic Reviews. *PLoS ONE*, *9*(8), e105620. https://doi.org/10.1371/journal.pone.0105620

Du, Y., Liu, B., Sun, Y., Snetselaar, L. G., Wallace, R. B., & Bao, W. (2019). Trends in Adherence to the Physical Activity Guidelines for Americans for Aerobic Activity and Time Spent on Sedentary Behavior Among US Adults, 2007 to 2016. *JAMA Network Open*, *2*(7), e197597. https://doi.org/10.1001/jamanetworkopen.2019.7597

Evenson, K. R., Scherer, E., Peter, K. M., Cuthbertson, C. C., & Eckman, S. (2022). Historical development of accelerometry measures and methods for physical activity and sedentary behavior research worldwide: A scoping review of observational studies of adults. *PLOS ONE*, *17*(11), e0276890. https://doi.org/10.1371/journal.pone.0276890

Freedson, P. S., Melanson, E., & Sirard, J. (1998). Calibration of the Computer Science and Applications, Inc. Accelerometer. *Medicine & Science in Sports & Exercise*, *30*(5), 777.

Frost, M. H., Reeve, B. B., Liepa, A. M., Stauffer, J. W., Hays, R. D., & Mayo/FDA Patient-Reported Outcomes Consensus Meeting Group; (2007). What is sufficient evidence for the reliability and validity of patient-reported outcome measures? *Value in Health: The Journal of the International Society for Pharmacoeconomics and Outcomes Research*, *10 Suppl 2*, S94–S105. https://doi.org/10.1111/j.1524-4733.2007.00272.x

Hallal, P. C., & Victora, C. G. (2004). RELIABILITY AND VALIDITY OF THE INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE (IPAQ). *Medicine & Science in Sports & Exercise*, *36*(3), 556. https://doi.org/10.1249/01.MSS.0000117161.66394.07

Hart, T. L., Ainsworth, B. E., & Tudor-Locke, C. (2011). Objective and Subjective Measures of Sedentary Behavior and Physical Activity. *Medicine & Science in Sports & Exercise*, *43*(3), 449. https://doi.org/10.1249/MSS.0b013e3181ef5a93

Heron, L., O'Neill, C., McAneney, H., Kee, F., & Tully, M. A. (2019). Direct healthcare costs of sedentary behaviour in the UK. *J Epidemiol Community Health*, *73*(7), 625–629. https://doi.org/10.1136/jech-2018-211758

Intille, S. S., Lester, J., Sallis, J. F., & Duncan, G. (2012). NEW HORIZONS IN SENSOR DEVELOPMENT. *Medicine and Science in Sports and Exercise*, *44*(1 Suppl 1), S24–S31. https://doi.org/10.1249/MSS.0b013e3182399c7d

Kalisch, T., Theil, C., Gosheger, G., Schwarze, J., Voss, K., Schoenhals, I., & Moellenbeck, B. (2022). Validation of a Modified Version of the German Sedentary Behavior Questionnaire. *Healthcare*, *10*(5),

807. https://doi.org/10.3390/healthcare10050807

Kastelic, K., & Šarabon, N. (2019). Comparison of Self-Reported Sedentary Time on Weekdays with an Objective Measure (activPAL). *Measurement in Physical Education and Exercise Science*, *23*(3), 227–236. https://doi.org/10.1080/1091367X.2019.1603153

Kongsvold, A., Flaaten, M., Logacjov, A., Skarpsno, E. S., Bach, K., Nilsen, T. I. L., & Mork, P. J. (2023). Can the bias of self-reported sitting time be corrected? A statistical model validation study based on data from 23 993 adults in the Norwegian HUNT study. *The International Journal of Behavioral Nutrition and Physical Activity*, *20*, 139. https://doi.org/10.1186/s12966-023-01541-y

Kozey-Keadle, S., Libertine, A., Lyden, K., Staudenmayer, J., & Freedson, P. S. (2011). Validation of Wearable Monitors for Assessing Sedentary Behavior. *Medicine & Science in Sports & Exercise*, *43*(8), 1561. https://doi.org/10.1249/MSS.0b013e31820ce174

Leeuw, E. D. D., Hox, J., & Dillman, D. (2008). *International Handbook of Survey Methodology* (1st edition). Routledge.

Mclaughlin, M., Atkin, A. J., Starr, L., Hall, A., Wolfenden, L., Sutherland, R., Wiggers, J., Ramirez, A., Hallal, P., Pratt, M., Lynch, B. M., & Wijndaele, K. (2020). Worldwide surveillance of self-reported sitting time: A scoping review. *The International Journal of Behavioral Nutrition and Physical Activity*, *17*, 111. https://doi.org/10.1186/s12966-020-01008-4

Munguia-Izquierdo, D., Segura-Jiménez, V., Camiletti-Moirón, D., Alvarez-Gallardo, I. C., Estévez-López, F., Romero, A., Chillon, P., Carbonell-Baeza, A., Ortega, F. B., Ruiz, J. R., & Delgado-Fernández, M. (2013). Spanish adaptation and psychometric properties of the Sedentary Behaviour Questionnaire for fibromyalgia patients: The al-Andalus study. *Clinical and Experimental Rheumatology*, *31*(6 Suppl 79),

Oliveira, A. B. de, Katzmarzyk, P. T., Dantas, W. S., Benseñor, I. J. M., Goulart, A. de C., & Ekelund, U. (2023). Profile of leisure-time physical activity and sedentary behavior in adults in Brazil: A nationwide survey, 2019. *Epidemiologia e Serviços de Saúde*, *32*, e2023168. https://doi.org/10.1590/S2237-96222023000200016

Prince, S. A., Cardilli, L., Reed, J. L., Saunders, T. J., Kite, C., Douillette, K., Fournier, K., & Buckley, J. P. (2020). A comparison of self-reported and device measured sedentary behaviour in adults: A systematic review and meta-analysis. *The International Journal of Behavioral Nutrition and Physical Activity*, *17*, 31. https://doi.org/10.1186/s12966-020-00938-3

Ronda, G., Van Assema, P., & Brug, J. (2001). Stages of change, psychological factors and awareness of physical activity levels in the Netherlands. *Health Promotion International*, *16*(4), 305–314. https://doi.org/10.1093/heapro/16.4.305

Rosenberg, D. E., Norman, G. J., Wagner, N., Patrick, K., Calfas, K. J., & Sallis, J. F. (2010). Reliability and Validity of the Sedentary Behavior Questionnaire (SBQ) for Adults. *Journal of Physical Activity and Health*, *7*(6), 697–705. https://doi.org/10.1123/jpah.7.6.697

Sattler, M. C., Ainsworth, B. E., Andersen, L. B., Foster, C., Hagströmer, M., Jaunig, J., Kelly, P., Kohl, H. W., Matthews, C. E., Oja, P., Prince, S. A., & van Poppel, M. N. M. (2021). Physical Activity Self-Reports: Past or Future? *British Journal of Sports Medicine*, *55*(16), 889–890. https://doi.org/10.1136/bjsports-2020-103595

Silva, F. G., Oliveira, C. B., Hisamatsu, T. M., Negrão Filho, R. F., Rodrigues, C. R. D., Franco, M. R., & Pinto, R. Z. (2020). Critical evaluation of physical activity questionnaires translated to Brazilian-Portuguese: A systematic review on cross-cultural adaptation and measurements properties. *Brazilian Journal of Physical Therapy*, *24*(3), 187–218. https://doi.org/10.1016/j.bjpt.2019.04.002

Stockwell, S., Trott, M., Tully, M., Shin, J., Barnett, Y., Butler, L., McDermott, D., Schuch, F., & Smith, L. (2021). Changes in physical activity and sedentary behaviours from before to during the COVID-19 pandemic lockdown: A systematic review. *BMJ Open Sport — Exercise Medicine*, *7*(1), e000960. https://doi.org/10.1136/bmjsem-2020-000960

Strath, S. J., Kaminsky, L. A., Ainsworth, B. E., Ekelund, U., Freedson, P. S., Gary, R. A., Richardson, C. R., Smith, D. T., & Swartz, A. M. (2013). Guide to the Assessment of Physical Activity: Clinical and Research Applications. *Circulation*, *128*(20), 2259–2279.

Streiner, D. L., Norman, G. R., & Cairney, J. (2014). *Health Measurement Scales: A practical guide to their development and use*. Oxford University Press. https://doi.org/10.1093/med/9780199685219.001.0001

Tremblay, M. S., Aubert, S., Barnes, J. D., Saunders, T. J., Carson, V., Latimer-Cheung, A. E., Chastin, S. F. M., Altenburg, T. M., & Chinapaw, M. J. M. (2017). Sedentary Behavior Research Network (SBRN) – Terminology Consensus Project process and outcome. *The International Journal of Behavioral Nutrition and Physical Activity*, *14*, 75. https://doi.org/10.1186/s12966-017-0525-8

Wu, J., Fu, Y., Chen, D., Zhang, H., Xue, E., Shao, J., Tang, L., Zhao, B., Lai, C., & Ye, Z. (2023). Sedentary behavior patterns and the risk of non-communicable diseases and all-cause mortality: A systematic review and meta-analysis. *International Journal of Nursing Studies*, *146*, 104563. https://doi.org/10.1016/j.ijnurstu.2023.104563