NRC Research Press

CLINICAL CORNER

A pilot study: Validity and reliability of the CSEP–PATH PASB-Q and a new leisure time physical activity questionnaire to assess physical activity and sedentary behaviours

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Abstract: The purpose of this study was to evaluate the accuracy of 2 newly developed physical activity questionnaires: the Canadian Society for Exercise Physiology (CSEP) Physical Activity and Sedentary Behaviour Questionnaire (PASB-Q) and a newly modified Leisure-Time Physical Activity Questionnaire (mLTPA-Q). These questionnaires were compared with objective measurements of physical activity and fitness (accelerometry and physiological assessments) in 35 adults, before and after a week of daily living activity. Objectively measured moderate- to vigorous-intensity aerobic physical activity (MVPA) was moderately correlated with the PASB-Q's physical activity vital sign (PAVS) ($r = 0.50$, $p = 0.004$) and the mLTPA-Q ($r = 0.56$, $p = 0.001$). Bland–Altman plots suggest minimal bias from self-reported to objective measures of MVPA. The ability of PAVS to accurately distinguish who does and does not achieve Canadian physical activity guidelines was 83% and 60%, respectively, compared with 82% and 73% of the mLTPA-Q. Self-reported sedentary time was greatly underestimated in the PASB-Q compared with the objective measure (6.4 ± 3.5 vs 12.2 ± 1.2 h/day). The results of this study suggest the PASB-Q and mLTPA-Q are valid and reliable measures of adult physical activity and provide reasonable indication of those individuals who meet physical activity guidelines. Future questionnaire development should take into account the underestimation of time spent engaging in sedentary activities.

Key words: physical activity, sedentary behaviour, accelerometry, physical activity questionnaires, validity, reliability.

Résumé : Cette étude a pour objectif d'évaluer la précision de deux nouveaux questionnaires au sujet de l'activité physique : le Questionnaire en matière d'activité physique et de comportement sédentaire (« PASB-Q ») de la Société canadienne de physiologie de l'exercice (SCPE) et la modification toute récente du Questionnaire sur l'activité physique durant les loisirs (« mLTPA-Q »). On compare les résultats des questionnaires aux mesures objectives de l'activité physique et de la condition physique (accélérométrie et évaluations physiologiques) chez 35 adultes avant et après une semaine d'activités journalières. La mesure objective de l'activité physique aérobie d'intensité modérée à vigoureuse (« MVPA ») est corrélée modérément au signe vital de l'activité physique (« PAVS ») du PASB-Q ($r = 0{,}50$, $p = 0{,}004$) et au mLTPA-Q ($r = 0{,}56$, $p = 0{,}001$). Le graphique Bland–Altman suggère un biais minime des données autodéclarées aux mesures objectives de MVPA. La capacité du PAVS à bien distinguer les personnes qui se conforment de celles qui ne se conforment pas aux directives canadiennes en matière d'activité physique est de 83 % et 60 % respectivement comparativement aux valeurs de 82 % et 73 % dans le mLTPA-Q. Le temps de sédentarité autodéclaré est fortement sous-estimé dans le PASB-Q comparativement à la mesure objective (6,4 ± 3,5 vs 12,2 ± 1,2 h/jour). Les résultats de cette étude suggèrent que le PASB-Q et le mLTPA-Q sont des mesures valides et fiables de l'activité physique des adultes et procurent des indications raisonnables des personnes qui se conforment aux directives en matière d'activité physique. Le prochain questionnaire devrait prendre en compte la sous-estimation du temps consacré aux activités sédentaires. [Traduit par la Rédaction]

Mots-clés : activité physique, comportement sédentaire, accélérométrie, questionnaires sur l'activité physique, validité, fiabilité.

Introduction

Canadian Physical Activity Guidelines recommend 150 min of moderate- to vigorous-intensity aerobic physical activity (MVPA) per week to achieve health benefits (Tremblay et al. 2011). Brief self-report questionnaires offer a simple and practical way for clinicians, allied health providers, and exercise professionals to assess an individual's physical activity behaviour compared with objective measures (e.g., accelerometer, fitness assessment), but the accuracy of such evaluations is an issue when used in the context of quantifying clinical or behavioural outcomes. A systematic review of physical activity questionnaires (PAQs) identified 96 existing PAQs (such as the International Physical Activity Questionnaire (IPAQ) and Godin) and 34 newly developed PAQs, of which very few show good results on both reliability and validity, with median reliability coefficients of 0.62–0.71 for existing PAQs and 0.74–0.76 for new PAQs, and validity coefficients ranging from 0.30–0.39 for existing PAQs and 0.25–0.41 for new PAQs (Helmerhorst et al. 2012).

The Canadian Society for Exercise Physiology (CSEP) has implemented the Physical Activity and Sedentary Behaviour Questionnaire (PASB-Q) into their 2013 version of the Physical Activity

Received 22 July 2016. Accepted 30 January 2017.

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Training for Health (PATH) manual (CSEP 2013; Supplement S1[1]). The first component of the PASB-Q asks participants "How many days do you do 'moderate-intensity (like brisk walking) to vigorous-intensity (like running) aerobic physical activity." Multiplying days per week and the minutes per day of MVPA identifies an individual's Physical Activity Vital Sign (PAVS). A similar Exercise Vital Sign (EVS) (the difference being the use of the terms "exercise" vs "physical activity" when phrasing the question) has been shown in Exercise is Medicine evaluations to have good face and discriminant validity (Coleman et al. 2012). The PASB-Q also measures frequency of muscle strengthening exercises per week, perceived aerobic fitness, and sedentary behaviours (work, leisure time, and breaks) to inform about an individual's physical capacity and activity behaviour across the entire spectrum of physical activity. The modified Leisure-Time Physical Activity Questionnaire (mLTPA-Q), newly developed and modified from a Godin–Shephard leisure-time exercise questionnaire (Godin and Shephard 1985), asked individuals to recall their strenuous, moderate, and mild physical activity of more than 10 min each day of the past week (Supplement S2[1]). The new mLTPA-Q offers more specific physical activity information than the number of 15 min bouts of exercise per week in the Godin, but less detailed information than the commonly used, but highly variable and less valid International Physical Activity Questionnaire Short Form (IPAQ-SF) (Helmerhorst et al. 2012).

The primary purpose of this pilot study was to evaluate the validity and reliability of the PASB-Q and the new mLTPA-Q relative to objective measures of physical activity and fitness (accelerometry and physiological assessments).

Materials and methods

A total of 35 participants were recruited from Acadia University to participate in this pilot study. All subjects provided informed consent in accordance with the Ethics Review Board at Acadia University. Three participants were removed from validity analysis because of invalid wear time but were included in questionnaire reliability analysis. The majority of subjects were female (26 female, 6 male). Female participants had an average age of 55 ± 10 years, body mass index (BMI) of 31 ± 6 kg/m^2, waist circumference of 94 ± 15 cm, and estimated $\dot{V}O_{2max}$ of 30 ± 7 mL·kg^{-1}·min^{-1} (i.e., 8.5 METs). Male participants had an average age of 63 ± 9 years, BMI of 26 ± 3 kg/m^2, waist circumference of 96 ± 10 cm, and estimated $\dot{V}O_{2max}$ of 31 ± 7 mL·kg^{-1}·min^{-1} (i.e., 8.9 METs).

On the first visit participants were given an initialized ActiGraph GT3X accelerometer (ActiGraph, Pensacola, Fla., USA) and completed both the CSEP–PATH PASB-Q and the mLTPA-Q. Within the first visit, participants underwent physical fitness testing, including assessments of anthropometrics (height, weight, waist circumference), muscular fitness (push-ups, grip strength), and aerobic fitness. Aerobic fitness was assessed by modified Bruce maximal test for those cleared for maximal exercise, depending on existing health conditions, or through a 6-min walk test or submaximal treadmill protocol, depending on orthopedic limitations and comfort with a treadmill. Testing protocols were completed according to published guidelines (CSEP 2013; Heyward and Gibson 2014) and administered by CSEP–Certified Exercise Physiology candidates. Participants wore the accelerometer for the intervening 7 days over the right hip, with instructions to wear it for at least 10 waking hours per day during activities of daily living. On the second laboratory visit (7 days later), subjects returned the accelerometer and completed both the PASB-Q and mLTPA-Q for reliability analysis. The ActiGraph accelerometer data was computed using Actilife Software (version 5; ActiGraph Pensacola, Fla., USA) according to published guidelines (Freedson et al. 1998), with a valid week consisting of at least 4 days worn with 1 weekend day per week, for a minimum of 10 h per day. If worn for 4–6 days, the days were averaged and multiplied by a respective factor to equal 1 full week. The PAVS was calculated by multiplying the days engaged in MVPA by minutes engaged at the level. mLTPA-Q MVPA was calculated by adding the self-reported minutes of strenuous and moderate activity over the past 7 days. Wear time was calculated by subtracting nonwear time from 24 h. Nonwear time was defined as at least 60 consecutive minutes of zero counts, with allowance for 1 to 2 min of counts between 0 and 100, consistent with Colley et al (2011). Objectively measured sedentary time was calculated by subtracting total physical activity (≥1.5 METs) from wear time. Total self-reported sedentary time was calculated by adding self-reported work and leisure time sitting time. Sedentary breaks were calculated as the number of interruptions (counts/min > 100) of sedentary behaviours lasting 2-min or longer divided by daily sedentary behaviour.

Data analysis

Questionnaires' test–retest reliability was assessed through correlations between day 1 and day 2 responses. To evaluate PASB-Q and mLTPA-Q convergent validity, Pearson's correlations were calculated between the objective measure and the questionnaires self-reported MVPA, and between objectively measured and self-reported sedentary time. Spearman rank-order correlation coefficients were calculated for PASB-Q days of muscle strengthening activities versus both push-ups and grip strength. Spearman rank-order correlations were also calculated for objectively measured versus self-reported sedentary breaks and perceived aerobic fitness versus assessed aerobic fitness categorized by CSEP's aerobic fitness Health Benefit Ratings (CSEP 2013). Sensitivity (ability of the PAVS and mLTPA-Q to accurately identify subjects not meeting guidelines) and specificity (ability of the PAVS and mLTPA-Q to accurately identify subjects meeting guidelines) was measured by comparing participants' who did not meet physical activity guidelines (<150 min of MVPA per week) and who met physical activity guidelines (>150 min of MVPA per week) between self-reported and objective MVPA measures. The level of agreement between the objective measure and self-report measures was identified by Bland–Altman plots using the ActiGraph as the criterion assessment tool. Limits of agreement were set at 1.96 SD of the difference scores. Statistical analysis was completed in IBM SPSS Statistics for Macintosh (version 23; IBM Corp., Armonk, N.Y., USA). Statistical significance was set at $p < 0.05$.

Results

From the ActiGraph accelerometer, 56% of participants met physical activity guidelines. The sensitivity values of the PASB-Q's PAVS and mLTPA-Q in identifying subjects who did not meet physical activity guidelines by the ActiGraph were 60% and 73%, respectively. The specificity values of the PAVS and mLTPA-Q in identifying subjects who did meet physical activity guidelines were 83% and 82%. The average intensity-related physical activity measures across the 3 devices are presented in Table 1. Compared with the criterion measure of MVPA, the PASB-Q's PAVS and mLTPA-Q had moderate positive correlations of 0.50 ($p = 0.004$) and 0.56 ($p = 0.001$). The accelerometer recorded moderate physical activity (MPA) was moderately correlated with the mLTPA-Q self-reported MPA ($r = 0.53$; $p = 0.002$) (see Table 2).

There were no significant correlations ($r = 0.29$, $p = 0.13$) between self-reported and objectively measured sedentary time as there was a large difference between average self-reported sedentary activity (6.4 ± 3.5 h/day) and average measured sedentary activity (12.2 ± 1.2 h/day). There was no significant correlation between self-reported and objectively measured sedentary breaks

[1]Supplementary data are available with the article through the journal Web site at http://nrcresearchpress.com/doi/suppl/10.1139/apnm-2016-0412.

Table 1. Intensity-related physical activity measured by the ActiGraph, PASB-Q, and mLTPA-Q.

	ActiGraph	PASB-Q	mLTPA-Q
MVPA (min/wk)	196±133	146±105	176±130
MPA (min/wk)	176±115		94±86
VPA (min/wk)	19±32		82±115
TPA (min/wk)	361±207		332±256
SedA (h/d)	12.2±1.2	6.4±3.5	

Note: mLTPA-Q, modified Leisure-Time Physical Activity Questionnaire; MPA, moderate physical activity; PASB-Q, physical Activity and Sedentary Behaviour Questionnaire.

Table 2. Validity and reliability of the PASB-Q and mLTPA-Q.

	Reliability (*r*)	Validity (*r*)
PASB-Q		
Aerobic physical activity		
1. Frequency	0.87***	
2. Time or duration	0.68***	
PAVS	0.83***	0.50*
Muscle-strengthening physical activity		
3. Frequency	0.92***	0.36
Perceived aerobic fitness		
4. Aerobic fitness	0.55*	0.24
Sedentary behaviour		
5. Work sitting	0.88***	
6. Leisure sitting	0.66***	
7. Total sedentary time	0.85***	0.29
8. Sedentary breaks	0.86***	0.02
mLTPA-Q		
1. Strenuous physical activity	0.45*	0.18
2. Moderate physical activity	0.49*	0.53*
MVPA	0.66***	0.56***
3. Mild physical activity	0.04	

Note: mLTPA-Q, modified Leisure-Time Physical Activity Questionnaire; MVPA, moderate- to vigorous-intensity physical activity; PASB-Q, physical Activity and Sedentary Behaviour Questionnaire; PAVS, physical activity vital sign. *, $p < 0.05$; ***, $p < 0.001$.

($r = 0.02$) with participants rarely breaking up sedentary activity (every 2.8 ± 0.9 h/day). Analysis of sedentary breaks did not take into account the length by which breaks were taken for (i.e., breaking up sedentary activity to go exercise for 2 h).

The PASB-Q had reliability coefficient's ranging from $r = 0.55$ (perceived aerobic fitness) to $r = 0.92$ (number of muscle strengthening activities per week) (Table 2). Within the PASB-Q there was a low–moderate positive correlation ($r = 0.36$) between frequency of muscle strengthening activities and number of push-ups that approached significance ($p = 0.08$). There was no significant correlation between muscle-strengthening activities and grip strength. There was no significant correlation between measured aerobic fitness and perceived aerobic fitness. The mLTPA-Q had statistically significant moderate–strong reliability coefficients across physical activity domains, with the exception of mLTPA-Q time spent performing mild physical activity over the last week. Ninety-seven percent of the participants were within the upper and lower limits of agreement between the ActiGraph and PAVS of 288 and –188 min, respectively. Ninety-seven percent were also within the limits of agreement between the ActiGraph and mLTPA-Q was 262 and –223 min; see Supplement S3[1].

Discussion

The primary finding from this study was that both the PASB-Q and mLTPA-Q are valid measures of assessing MVPA in this small sample of adults, exceeding the acceptable standard in the literature of $r > 0.50$ for objective physical activity measuring devices. The PASB-Q's PAVS had high reliability ($r = 0.83$), exceeding the mLTPA-Q ($r = 0.66$) and over 120 other PAQs that have reliability ranges of $r = 0.62$–0.76 (Helmerhorst et al. 2012). Both questionnaires' MVPA scores approximated those assessed objectively and both questionnaires strongly identified participants who achieved and did not achieve physical activity guidelines. The Bland–Altman plots revealed few outliers beyond the limits of agreement for both the PASB-Q and LTPA-Q. The sensitivity and specificity of the PAVS for participants meeting physical activity guidelines in the current study are slightly higher than previous literature that used the EVS (Fitzgerald et al. 2015), suggesting it may be a useful patient physical activity screening tool among exercise professionals and clinicians.

The PASB-Q had a high test–retest reliability across most questions except perceived aerobic fitness. The PASB-Q was not a valid assessment of muscle strength ($r = 0.36$; $p = 0.08$), aerobic fitness, or sedentary behaviours. This could be due to the fact that PASB-Q asks frequency of strengthening activities not strength; perceived aerobic fitness had low reliability and used indirect methods to estimate aerobic fitness; and self-rated sedentary activity was far below objectively measured sedentary activities, which were 1–2 h/day higher than published norms (Colley et al. 2011). The PAVS and the mLTPA-Q's ability to accurately measure MVPA were similar; however, the PAVS is simpler and more reliable, reinforcing the importance of its use as a means of assessing an individual's physical activity behaviour to initiate physical activity counselling in a time-pressured clinical context. The mLTPA-Q may be more beneficial for exercise professionals who are interested in detailed physical activity patterns, as it differentiates between the amount of mild, moderate, and vigorous physical activity, which all have different implications to health and fitness, and therefore can inform more specific and individualized exercise prescriptions.

The average MVPA reported in the PASB-Q's PAVS and mLTPA-Q were below that measured objectively in this study; the Bland–Altman plots identified a small systematic bias to underestimation of self-reported physical activity with these instruments. The construct of these questionnaires seem to address the typical overestimations of physical activity from brief questionnaires compared with objective measures (Troiano et al. 2008). For example, according to the Canadian Health Measures Survey, approximately 52% of Canadians report meeting physical activity guidelines (Statistics Canada 2009) but only 15% meet objectively measured thresholds (Colley et al. 2011). The ActiGraph versus PAVS limits of agreement are more narrow than previous research comparing ActiGraph and EVS (349 and –217 min) (Fitzgerald et al. 2015).

The low correlation between self-reported and objectively measured *sedentary* behaviour in this study ($r = 0.29$, $p = 0.13$) is consistent with both the long ($r = 0.33$) and short version ($r = 0.34$) of the IPAQ (Rosenberg et al. 2008). These findings suggest the need for further research and development of appropriate sedentary behaviour questions to gain a complete picture of an individual's sedentary activities. A limitation of accelerometry is its inability to distinguish standing and sitting, potentially overestimating sedentary behaviour; however, this would not account for the large observed differences between self-reported and objectively measured sedentary time in this study. Another limitation with this being a pilot study is the small sample size with high MVPA and high sedentary behaviour, potentially impacting the statistical power and affecting the generalizability of the results.

In conclusion, both the PASB-Q and newly developed mLTPA-Q are valid measures of MVPA compared with accelerometry and provide a strong indication of those meeting and not-meeting physical activity guidelines. Future work should validate questions of perceived aerobic and muscular fitness and should also explicitly measure or be more specific in addressing sedentary behaviour as the vast majority of participants in this study severely underestimated their sitting behaviours.

Take-home points

- The CSEP-PATH PASB-Q's PAVS is a valid and reliable measure of MVPA in adults.
- Perceived aerobic fitness and involvement in strength activities were not correlated with objective submaximal estimates of aerobic fitness and muscular fitness, respectively.
- Adults drastically underestimate their sedentary time using the PASB-Q relative to their true objectively measured sedentary time (i.e., by half).

Conflict of interest statement

J.R.F. has received an unrestricted research grant from Steps Count. J.R.F. was the scientific lead for the Canadian Society for Exercise Physiology Physical Activity Training for Health Manual for which the PASB-Q was developed. The authors report no other conflicts of interest associated with this manuscript.

Acknowledgements

Support was provided by the Acadia University Research Fund.

References

Coleman, K.J., Ngor, E., Reynolds, K., Quinn, V.P., Koebnick, C., Young, D.R., et al. 2012. Initial validation of an exercise "vital sign" in electronic medical records. Med. Sci. Sports Exerc. **44**(11): 2071–2076. doi:10.1249/MSS.0b013e3182630ec1. PMID: 22688832.

Colley, R.C., Garriguet, D., Janssen, I., Craig, C.L., Clarke, J., and Tremblay, M.S. 2011. Physical activity of Canadian adults: accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. Health Rep. **22**(1): 7–14. PMID:21510585.

CSEP. 2013. Canadian Society for Exercise Physiology-Physical Activity Training for Health (CSEP-PATH). CSEP, Ottawa, Ont., Canada.

Fitzgerald, L., Ozemek, C., Jarrett, H., and Kaminsky, L.A. 2015. Accelerometer validation of questionnaires used in clinical settings to assess MVPA. Med. Sci. Sports Exerc. **47**(7): 1538–1542. doi:10.1249/MSS.0000000000000565. PMID:25380474.

Freedson, P.S., Melanson, E., and Sirard, J. 1998. Calibration of the Computer Science and Applications, Inc. accelerometer. Med. Sci. Sports Exerc. **30**(5): 777–781. doi:10.1097/00005768-199805000-00021. PMID:9588623.

Godin, G., and Shephard, R.J. 1985. A simple method to assess exercise behavior in the community. Can. J. Appl. Sport Sci. **10**(3): 141–146. PMID:4053261.

Helmerhorst, H.H.J., Brage, S., Warren, J., Besson, H., and Ekelund, U. 2012. A systematic review of reliability and objective criterion-related validity of physical activity questionnaires. IJBNPA, **9**(1): 103. doi:10.1186/1479-5868-9-103. PMID:22938557.

Heyward, V.H., and Gibson, A. 2014. Advanced fitness assessment and exercise prescription. Human Kinetics, Champaign, Ill.

Rosenberg, D.E., Bull, F.C., Marshall, A.L., Sallis, J.F., and Bauman, A.E. 2008. Assessment of sedentary behavior with the International Physical Activity Questionnaire. J. Phys. Act. Health, **5**: S30–S44. doi:10.1123/jpah.5.s1.s30. PMID: 18364524.

Statistics Canada. 2009. Physical activity during leisure time, 2009. Statistics Canada. Ottawa, Ont., Canada.

Tremblay, M.S., Warburton, D.E., Janssen, I., Paterson, D.H., Latimer, A.E., Rhodes, R.E., et al. 2011. New Canadian physical activity guidelines. Appl. Physiol. Nutr. Metab. **36**(1): 36–46. doi:10.1139/H11-009. PMID:21326376.

Troiano, R.P., Berrigan, D., Dodd, K.W., Mâsse, L.C., Tilert, T., and McDowell, M. 2008. Physical activity in the United States measured by accelerometer. Med. Sci. Sports Exerc. **40**(1): 181–188. doi:10.1249/mss.0b013e31815a51b3. PMID:18091006.