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Validity of a brief self-report instrument for assessing compliance with physical activity guidelines amongst adolescents

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Abstract

Objectives: To examine the validity of a brief self-report questionnaire for assessing physical activity, and compliance and non-compliance with moderate-to-vigorous physical activity (MVPA) recommendations in Australian adolescents against accelerometry.

Design: Cross-sectional study.

Methods: MVPA of 203 adolescents (124 females, 79 males) aged 15-17 years was objectively assessed for 8 consecutive days using uni-axial accelerometers and calculated using age-specific cut-points. Adolescents self-reported the number of days (0-7) they were physically active for a total of at least 60 minutes per day 1) over the past 7 days and 2) over a typical week. Compliance with physical activity recommendations was defined as 1) five and 2) seven days of self-reported MVPA (of at least 60 mins/day), and 3) ≥60 mins MVPA per average day, and 4) >60 mins MVPA on every day according to accelerometry. Spearman’s Rho correlations analysed the association between accelerometry-derived MVPA/day and self-reported MVPA days/week for the whole sample, sex and weight status. Percent agreement determined the proportion of adolescents correctly identified as not meeting physical activity recommendations (specificity) or as meeting physical activity recommendations (sensitivity) according to the self-report questionnaire.

Results: Moderate to large correlations were found between the self-report and accelerometer data (0.2-0.51) across population subgroups. The percent agreement between the self-report and accelerometry data was good for specificity; however, the sensitivity was low, potentially due to poor compliance with recommendations.

Conclusions: Compared to accelerometry, the brief MVPA self-report questionnaire appears to have acceptable validity for measuring non-compliance with physical activity recommendations in 15-17 year old adolescents.
Key words: Acceleration; adolescents; health behaviour; overweight; questionnaires
Introduction

Self-report questionnaires are typically used to assess physical activity in population studies as objective measures are not usually practical. Self-report questionnaires are easy to administer, relatively low in cost, and acceptable to participants. A large number of questionnaires are available for use in a range of populations, the selection of which depends on the population of interest, the purpose of the study, and the required outcome variables. However, self-report is limited by social desirability, cognitive complexity of recalling physical activity and overestimation of physical activity engagement, particularly in youth. In addition, comparisons across studies are difficult because of the range of questionnaires available.

National physical activity guidelines state that Australian youth should engage at least 60 minutes of at least moderate-intensity activity per day, and similar recommendations have been released in several other countries. At a population level, investigating compliance with physical activity guidelines is needed to establish benchmarks, trends, and national and state-based health promotion priorities. While it is important to monitor progress towards national objectives for physical activity and compliance with recommendations, brief and valid tools in youth are lacking. As such, there is a need for simple measures capable of determining compliance with physical activity recommendations at a population level.

A brief moderate-to-vigorous physical activity (MVPA) self-report measure has been developed for use in adolescents, though it was initially developed as a screening tool for primary care settings. This measure assesses the number of days that adolescents participate in 60 minutes or more of MVPA in a typical week and over the past 7 days. The average
number of days is then calculated to determine compliance with physical activity recommendations.\textsuperscript{9} Acceptable validity ($r = 0.4$) and reliability (ICC = 0.77) was established in an ethnically diverse sample of 138 US adolescents\textsuperscript{9}, while similar results were obtained in Spanish adolescents.\textsuperscript{10} This questionnaire has recently been used in international research to examine differences in physical activity levels and compliance with physical activity guidelines between males and females, and non-overweight and overweight populations.\textsuperscript{11-12} However, Prochaska and colleagues\textsuperscript{9} did not validate the questionnaire for use in older adolescents or population subgroups (e.g. sex, non-overweight/overweight), and compliance with physical activity recommendations was defined as accumulating at least 60 minutes of MVPA on 5 or more days of the week,\textsuperscript{9,11-12} rather than current recommendations.\textsuperscript{4-6} There is a need to validate the measure in older adolescents and population subgroups using the most recent physical activity recommendations.

The purpose of this study, therefore, was to examine the validity of a brief self-report questionnaire for assessing physical activity, compliance and non-compliance with physical activity recommendations in Australian adolescents (overall, and by sex and weight status) against accelerometry.

**Methods**

Data were drawn from the final follow-up of the Children Living in Active Neighbourhoods (CLAN) study.\textsuperscript{13} Adolescents aged 15-17 years completed a survey and wore an accelerometer for 8 days. Ethical approval was provided by the Deakin University Human Research Ethics Committee, Department of Education and Training Victoria and the Catholic Education Office.
Informed written consent was obtained from all parents and adolescents participating in the project.

The final follow-up of participants in the CLAN study was conducted in 2006. At baseline (2001), 19 out of 24 primary schools in metropolitan Melbourne, selected using stratified random sampling proportionate to school size, consented to participate in the study. All children in Grades 5-6 (10-12 years) were invited to participate in baseline measures, and 926 (44% response rate) returned parental consent forms (under ethical guidelines it was necessary for parents to provide active consent). Families were asked whether they could be contacted for further research and those that agreed (n=695) were re-contacted in 2004 and 2006 for follow-up data collection. In total, 314 families consented to participate in 2006 (34% retention). Of these, two hundred and fifty-five adolescents (100 males, 152 females) completed all measures reported below.

Parents completed a questionnaire that assessed socio-demographic information about the adolescent (e.g. age, date of birth) and the family as a whole (e.g. maternal education). In this study, maternal education was used as a proxy-measure of socio-economic status, and was classed as low (some high school attendance or less), medium (high school/trade certificate completed) and high (tertiary education).

Stature (to the nearest 0.1 cm) and body mass (to the nearest 0.1 kg) were measured by trained research staff at school (n=222) or the participants’ home (n=16) using a portable stadiometer and digital scales, respectively, to determine the adolescents’ weight status. Adolescents wore light clothing and no shoes. For a small number of participants unable to
be visited (n=14) height and weight were measured by a parent (instructions were provided). Body mass index (BMI) was calculated and adolescents were classified as non-overweight or overweight (defined as overweight and obese) using BMI cut-off points developed by the International Obesity Taskforce.\textsuperscript{15}

All the adolescents completed the MVPA self-report questionnaire at home, which asked them to report the number of days (0-7 days) they were physically active for a total of at least 60 minutes per day 1) over the past 7 days and 2) over a typical or usual week.\textsuperscript{9} A definition of MVPA and examples of physical activities were provided and participants were instructed to sum the time spent in physical activities each day. Responses to the two items were averaged as recommended and used in subsequent analyses.\textsuperscript{9} To examine compliance with physical activity recommendations data were dichotomised to create two compliance variables: 1) <5 and \geq 5 days, and 2) <7 and 7 days of MVPA.

In addition to the self-report questionnaire, adolescents’ objective physical activity levels were measured for 8 consecutive days using a hip-mounted uni-axial accelerometer (7164 Actigraph, Fort Walton Beach, Florida, USA). The epoch length was set at 60 seconds. The accelerometer has been validated against indirect calorimetry and doubly labelled water in children and adolescents in both laboratory and free-living conditions.\textsuperscript{16} Furthermore, accelerometry is considered to be an acceptable criterion measure for the validation of self-report measures of physical activity.\textsuperscript{17} Adolescents were instructed to wear the accelerometer during all waking hours except during water-based activities, and provided with information concerning the correct wear and care of the monitor. On subsequent return to the research team, accelerometer data were initially downloaded and checked for compliance using
Actigraph software. Data were then processed using a customised Excel macro. A valid day was defined as ≥8 hours/day wear-time. Wear-time was computed by subtracting all periods of sustained bouts of zero counts of 20-minutes or more from total possible wear-time.

Accelerometer data were analysed using age-specific cut-points; moderate-intensity physical activity (MPA) was defined as ≥4 and ≤5.9 METS and vigorous physical activity (VPA) as ≥6 METS. A threshold of 4 METs was chosen to represent MPA as brisk walking, which is often used to identify MPA in calibration studies, has been associated with an energy cost of 4 METs. MPA and VPA were summed to compute the duration of MVPA for each valid day. The number of valid days that an adolescent engaged in 60 min or more of MVPA was computed and dichotomised at ≥5 days and at 7 days to examine compliance with the physical activity recommendations using the all days MVPA method, which is the most accurate interpretation of the recommendations. The average min/day of MVPA was also computed for valid days and dichotomised at 60 min/day to indicate compliance with the physical activity recommendations using the average MVPA per day method, which is commonly used in the literature. Lastly, total physical activity (mean counts per minute per day, CPM/day) was calculated by dividing total counts per day by the wear-time per day and determined across valid days.

Descriptive statistics were initially calculated for all variables. Differences between children with complete and incomplete accelerometry data at follow-up in 2006 were compared using independent t-tests. Spearman’s Rho was used to compare accelerometry (mins of MVPA, CPM) and self-report (average number of days) using ≥5 and 7 days of valid accelerometer days for the whole sample and according to sex and weight status. Spearman’s Rho
correlations of 0.1, 0.3 and 0.5 were considered as small, moderate and large, respectively.\textsuperscript{23} Consistency between the two measures of classification (i.e. meeting or not meeting physical activity recommendations) was determined using percent agreement. The sensitivity (defined as proportion of adolescent’s meeting physical activity recommendations that were correctly identified)\textsuperscript{17} and specificity (defined as the proportion of adolescent’s correctly identified as not meeting physical activity recommendations)\textsuperscript{17} were also determined using the accelerometry derived average MVPA per day and the all days MVPA methods for $\geq 5$ and 7 days of valid accelerometer days. All analyses were performed using SPSS v.17, and the significance level set at $p \leq 0.05$, where applicable. These analyses were performed for 203 adolescents with at least 5 days of valid accelerometry (79 males, 124 females), and repeated for 102 adolescents with 7 days of valid accelerometry (33 males, 69 females).

**Results**

The mean age of the sample (203 adolescents) was $15.8 \pm 0.7$ years, 30% and 41.4% of mother’s reported medium or high maternal education, respectively, and 31% of the adolescents were classed as overweight or obese. The sample mainly consisted of females. There were no significant differences for these descriptive data between adolescents who were initially included or excluded from the analyses.

Table 1 shows the physical activity levels of the sample and the compliance with physical activity recommendations for accelerometer data and self-report. Between 0-6% (accelerometry) and 9-28% (self-report) of adolescents met physical activity recommendations of 60 minutes MVPA every day of the week, depending on the method.
used to analyse data, the inclusion criteria, and the physical activity recommendation investigated.

[Insert Table 1 about here]

There were moderate to large correlations between the self-report and accelerometer data (Table 2). Stronger correlation coefficients were observed for females (0.38-0.43) and non-overweight (0.41-0.51) adolescents compared to males (0.20-0.35) and overweight adolescents (0.35-0.44), though these differences are not likely to be significant as the confidence intervals overlap. Less variation was observed between the average self-reported number of days of 60 minutes of MVPA and accelerometer-derived minutes of MVPA/day for girls and non-overweight participants compared to boys and overweight participants, respectively. A similar trend was observed for CPM/day and number of days reported.

[Insert Tables 2 & 3 about here]

Table 3 shows that the level of agreement between the accelerometry data analysed using the average method and the self-report questionnaire was moderate to high for both the ≥5 days (60-80%) and 7 days (76-94%) of valid accelerometer days. Using the all days method, the agreement was similar to the average method for the sample with ≥5 days of valid accelerometry data (61-79%), but lower for the subset with 7 days of valid data (52-78%). The specificity of the self-report questionnaire was highest using the average measure over 7 days (86-96%), and lowest for the all days method over 7 days (52-78%). The sensitivity of the self-report instrument was low.

Discussion

This study examined the validity of a brief MVPA self-report questionnaire for assessing physical activity, compliance, and non-compliance to physical activity recommendations in
Australian adolescents against accelerometry. This is the first study, to the best of our knowledge, to examine agreement between measures for classifying adolescents as engaging in sufficient physical activity using physical activity recommendations and to examine validity within population subgroups.

The moderate to large associations found between average number of self-reported days of ≥60 mins of PA and mins/day of MVPA and CPM/day are comparable to those reported in the literature in adolescent populations where a wide range of self-report measures that vary in length and different outcome variables have been examined against accelerometry. Notably, validity estimates from the current study are comparable to those reported by previous studies for the same questionnaire. No significant differences were observed between the correlations by sex or weight status, indicating relative validity of this measure for use at a population level.

A commonly reported limitation of self-report in youth is the overestimation of time spent in MVPA. Research suggests that the ability to accurately self-report increases with age; however, the age range of participants in the present study did not allow for comparison of questionnaire validity by age. The current study examined the ability of the self-report questionnaire to detect whether adolescents are engaging in the recommended levels of physical activity. The percentage agreement for this study varied depending on the way in which the accelerometer data were analysed and the physical activity recommendations used, though in general they were higher in this study compared to those reported by Prochaska and colleagues. In addition the agreement was generally higher for females and overweight adolescents compared to males and non-overweight adolescents, respectively,
suggesting that females and overweight adolescents are more accurate in self-reporting their physical activity levels. Sex differences in the accuracy of self-report physical activity levels have been found in previous studies using Australian adolescents.\(^{27}\)

The specificity of the self-report questionnaire was good though the sensitivity was low; that is, more adolescents were correctly identified as not complying with the physical activity recommendations as were correctly identified as meeting the recommendations. This may be attributable, in part, to low number of participants who met the recommendations, particularly when the all days method was used, and may also be due to the use of accelerometry to determine compliance with the guidelines. We used two methods to determine compliance with recommendations as these different methods have been used in the literature to date.\(^{22}\) The average MVPA per day method,\(^{22}\) which is commonly used in the physical activity literature\(^{28}\) due to the challenges in collecting seven complete days of accelerometry data, had higher specificity compare to the all days method, which is the direct application of the recommendations. It is possible that the average MVPA per day method had greater sensitivity than the all days method as adolescents classified as meeting the recommendations based on the average method may not have achieved at least 60 minutes of at least MPA on ≥5 days or 7 days, and days where they did not engage in sufficient MVPA would be reflected in the self-report. There is also considerable variation in the use of accelerometer cut-points to define MVPA in youth, which affects whether participants are identified as meeting physical activity recommendations.\(^{29}\) In our study, MVPA was defined as ≥4 METS, which was higher than the thresholds used by previous studies.\(^{9,24-25}\) This may explain, in part, the lower MVPA recorded (~30 min/day) compared to other studies (e.g. 49-115 min/day)\(^{9,24-25}\) and may lower the sensitivity of the measure as few adolescents met the
guidelines according to the accelerometry data. This highlights the difficulty of determining validity of self-report questionnaires for measuring compliance with physical activity recommendations in youth, as there is currently no gold standard for measuring free-living physical activity in daily life and estimates of compliance with recommendations are affected by the criteria used to define the analytical sample and method used to analyse the data. Arguably, the specificity of the measure is more important for physical activity research, as this examines the proportion of individual’s identified as not complying with physical activity guidelines. This suggests, therefore, that the Prochaska and colleagues MVPA self-report questionnaire has moderate validity determining non-compliance with physical activity guidelines in older adolescents.

There are several limitations that should be acknowledged. Firstly, as a range of accelerometer cut-points and MET values have been published in the literature to define MPA and VPA in youth, these findings are only applicable to the cut-points and the definition of MPA (>4 METs) used in this study. Secondly, depending on the inclusion criteria used, a relatively high number of adolescents were excluded from the analyses (20-60%), though the final sample size was similar to previous validation studies. Third, few adolescents met physical activity guidelines, which affected sensitivity estimates of the self-report questionnaire.

Conclusion

Compared to accelerometry, the brief MVPA self-report questionnaire appears to have acceptable validity for determining older adolescent’s non-compliance with physical activity recommendations. Further research is needed to determine its validity for assessing
compliance with physical activity recommendations, as few adolescents met the guidelines in this study. It should be noted, however, that this measure does not provide any detail concerning frequency, duration or mode of specific or types of physical activities. As such, this measure should be used in conjunction with other questionnaires if a more detailed picture of adolescents’ habitual physical activity is required.

Practical Implications

- The brief MVPA self-report questionnaire\(^9\) has acceptable validity for determining non-compliance with current physical activity guidelines in older adolescents and population-subgroups.

- The questionnaire is valid for use in population subgroups for the assessment of physical activity.

- A high proportion of adolescents in this sample are not meeting physical activity recommendations, indicating that interventions are needed in this population.

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