Directly Measured and Self-Reported Physical Activity in a Sample of Finnish Secondary School Students

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Introduction

Recent evidence from the World Health Organization (2012) reinforces the strong link between physical activity (PA) and continuing positive benefits to health, well-being and weight control. According to the recommendations of health experts, all secondary school-aged students should be physically active for at least 60 minutes on a daily basis. The specific aim of the study was to analyze the relationship between directly measured and self-reported PA in a cross-sectional sample of Finnish secondary school students. Moreover, how large proportion of adolescents accumulate at least 60 minutes of moderate to vigorous PA on a daily basis using self-reports and direct measure scores.

Methods:
Participants were recruited from a secondary school located in Northeast Finland. The sample comprised 96 students (58 girls, 38 boys) aged between 12- to 16-years (M = 15.03, SD = .94). Students’ directly measured PA was collected using accelerometers over a seven-day period. The self-reported PA data was gathered during the school’s allotted 90-minute lessons. Results indicated that girls and boys were similarly physically active, based on PA measured using both accelerometers and questionnaires. Grade 7 students were physically more active than Grade 9 students when PA was assessed using self-reports but no significant difference was found when direct measure scores were used. Self-reported PA emerged as the significant positive predictor for students’ directly measured PA within Grade 8 (p < .001), and Grade 9 students (p < .01). The results highlighted that only 10% of adolescents met the recommendation of 60 minutes moderate to vigorous PA daily, while PA was measured using self-reports. On the contrary, a portion of 85% of students met the recommendation, when direct measure scores were used. Conclusion: Because the current and previous findings indicated substantial differences in the assessments results for similarly aged samples, continuing studies using directly assessed techniques are required to gain detailed information concerning the PA behavior of Finnish children and adolescents.

Keywords: Physical Activity; Accelerometers; Self-Reports; Secondary School

Background: Previous studies based on self-reports show that a majority of children and adolescents in Western countries fail to achieve the recommendation of 60 minutes moderate to vigorous physical activity (PA) on a daily basis. The specific aim of the study was to analyze the relationship between directly measured and self-reported PA in a cross-sectional sample of Finnish secondary school students. Moreover, how large proportion of adolescents accumulate at least 60 minutes of moderate to vigorous PA on a daily basis using self-reports and direct measure scores. Methods: Participants were recruited from a secondary school located in Northeast Finland. The sample comprised 96 students (58 girls, 38 boys) aged between 12- to 16-years (M = 15.03, SD = .94). Students’ directly measured PA was collected using accelerometers over a seven-day period. The self-reported PA data was gathered during the school’s allotted 90-minute lessons. Results: Results indicated that girls and boys were similarly physically active, based on PA measured using both accelerometers and questionnaires. Grade 7 students were physically more active than Grade 9 students when PA was assessed using self-reports but no significant difference was found when direct measure scores were used. Self-reported PA emerged as the significant positive predictor for students’ directly measured PA within Grade 8 (p < .001), and Grade 9 students (p < .01). The results highlighted that only 10% of adolescents met the recommendation of 60 minutes moderate to vigorous PA daily, while PA was measured using self-reports. On the contrary, a portion of 85% of students met the recommendation, when direct measure scores were used. Conclusion: Because the current and previous findings indicated substantial differences in the assessments results for similarly aged samples, continuing studies using directly assessed techniques are required to gain detailed information concerning the PA behavior of Finnish children and adolescents.

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Directly Measured PA

Accelerometers (Polar Active) were used for the direct assess-
ment of students’ PA. The monitors were light, small, and worn on the wrist. Daily activity was detected automatically, including intensity (MVPA) and duration (minutes). The total minutes represented adolescents’ MVPA. In the first validation study (Virtanen, 2011), conducted for a sample of Finnish 6 - 15 year old children and adolescents (n = 20), Polar Active’s assessment in METs for playing games, walking and running had a high correlation to METs assessed using indirect calorimetry (r = .91), whereas the correlation was low for sitting activities (r = .31). In another validation study (Virtanen, 2011), the correlation between Polar Active and indirect calorimetry (r = .86) was similar to the correlation between Actigraph accelerometers and indirect calorimetry (r = .84) in seven different activities (sitting quietly, seated playing a video game, a standing warm-up, walking, jumping rope, video-led kickboxing, running for a total of 30 min) in a sample of 23 Finnish 11 - 17 year-old children and youth.

Self-reported PA

Self-reported PA was assessed using the Health Behavior in School-aged Children Research Protocol (Currie et al., 2002) which incorporated a modified version of the Moderate to Vigorous Physical Activity (MVPA) measure (Prochaska, Sallis, & Long, 2001). The introduction preceding the items was: “In the next two questions physical activity means all activities which raises your heart rate or momentarily get you out of breath for example in doing exercise, playing with your friends, going to school, or in school physical education. Sport also includes for example jogging, intensive walking, roller skating, cycling, dancing, skating, skiing, soccer and baseball.” The items required students to summarize their time spent in physical activity each day in the following way: 1) “How many days were you physically active for a total of 30 min) in a sample of 23 Finnish 11 - 17 year-old children and youth.

Design of the Study

The current cross-sectional data was compiled as part of a research project for promoting PA and health among children and youth. Self-report PA data was collected by the researchers during the school’s allotted 90-minute lessons in April 2011. The participants had the procedures explained to them verbally, including a brief overview of possible physical discomfort that could be caused from wearing an accelerometer. The students were told that their involvement was voluntary and to ask if confused concerning the instructions, or if they required clarification of a particular item. To address the possibility of students’ giving socially desirable responses, students were encouraged to answer honestly and were assured that their responses were confidential. Directly measured PA data was obtained during a seven-day period. The instructions for the use of the accelerometers were given by the researchers during the school PE lessons. Students provided demographic information associated with age, gender, height, and weight. The participants were asked to wear the accelerometers for 24 hours a day over a seven-day period. The monitors were collected by the PE teachers, and the data was downloaded to a computer by the researchers.

Statistical analyses

Prior to statistical analyses, normality, missing values, and outliers of the data were examined. The graphics and values of skewness (−.168 to .571) indicated that the data was within accepted limits to be considered normally distributed. The outliers were analyzed using standardized values (± 3.29), and Mahalanobis distance (p < .001) (Tabachnick & Fidell, 2007). One unit containing missing value and three outliers in directly measured PA were removed. No further modifications were required. The scores for both directly measured and self-reported PA were summarized using descriptive statistics. Pearson’s correlation coefficients were examined to allow comparison with previous studies. Gender and grade differences were analyzed using MANOVA and Tukey’s HSD-test. Prior to the MANOVA, the homogeneity of variance-covariance matrices was examined using Box’s M test which revealed no violation either in self-reported (F = .790, p > .05) or directly measured data (F = .135, p > .05). Because of the nature of this study, general linear model of regression analysis was used to investigate the predictive strength of self-reported PA on directly measured PA (Yang & Miller, 2008). The distributions of regression residuals were analyzed using the Kolmogorov-Smirnov test which showed that the studentized residuals distributed normally within all grades (p > .05). Statistical analyses were conducted using SPSS 19.0 software.

Results

Descriptive Statistics, Differences, and Correlation Coefficients

Descriptive statistics are presented in Table 1. The MANOVA yielded a significant main effect for grade in directly measured PA (Wilks’s Λ = .89, F(1, 96) = 4.32, p < .05; r2 = .04) and self-reported PA (Wilks’s Λ = .89, F(1, 96) = 10.86, p < .001; r2 = .11). Tukey’s HSD-test revealed that Grade 7 students were significantly more physically active than Grade 9 students when PA was measured using self-reports (p < .01). No further differences were found. Additionally, the Pearson’s correlation coefficient between self-reported and directly measured PA scores was moderate in Grade 8 students (r = .66, p < .001), whereas the correlations were low in both Grade 9 (r = .44, p < .01), and Grade 7 students (r = .32, p > .05).

Linear Regression Analysis

The results of the linear regression analyses conducted for each grade level indicated (Table 2) that self-reported PA emerged as the significant positive predictor for students’ directly measured PA within Grade 8 students (p < .001), and Grade 9 students (p < .01), accounting for 41.6% and 17.3% of variance. Self-reported PA was not a significant contributor for Grade 7 students’ direct PA.

Achievement of the Recommendation of Daily PA

Results for self-reported PA indicated that only 11% of adolescents met the requirement for minimum 60 minutes of MVPA
Table 1
Descriptive statistics of directly measured and self-reported PA.

|                | N  | Min   | Max   | M    | SD   |
|----------------|----|-------|-------|------|------|
| Girls          |    |       |       |      |      |
| Grade 7        | 19 | 63.57 | 223.57| 119.90| 34.08|
| Boys           | 6  | 74.43 | 150.14| 113.50| 27.58|
| Total          | 25 | 63.57 | 223.57| 118.36| 32.21|
| Grade 8        |    |       |       |      |      |
| Girls          | 16 | 38.00 | 169.14| 101.48| 44.17|
| Boys           | 13 | 28.20 | 206.57| 108.88| 56.25|
| Total          | 29 | 36.57 | 216.43| 95.68 | 51.67|
| Grade 9        |    |       |       |      |      |
| Girls          | 19 | 55.14 | 162.12| 94.90 | 35.66|
| Boys           | 13 | 28.20 | 206.57| 104.80| 49.14|
| Total          | 29 | 36.57 | 216.43| 95.33 | 44.62|

Table 2
Results of regression analysis on students’ directly measured PA (N = 96).

|                | β  | R²  | t-value |
|----------------|----|-----|---------|
| Direct PA      |    |     |         |
| Grade 7        | .520| .064| 1.62    |
| Grade 8        | .661| .416| 4.57*** |
| Grade 9        | .480| .173| 3.10**  |

Self-reported PA

|                | β  | R²  | t-value |
|----------------|----|-----|---------|
| Grade 7        |    |     |         |
| Grade 8        | .520| .064| 1.62    |
| Grade 9        | .661| .416| 4.57*** |

*p < .01, **p < .001

per day. In contrast, 85% met the recommendation based on direct measure scores. Self-report data indicated that a minimally larger portion of Grade 8 students (13.1%) achieved the recommendation than either Grade 7 (12.0%) or 9 students (9.3%). Conversely, a higher percentage of Grade 7 students (92.0%) met the requirement of 60 minutes daily PA when assessed by direct measures than either Grade 8 (76.3%) or 9 (85.2%) students.

Discussion

Currently, no studies that incorporate both direct and self-reported measures of PA with samples of Finnish adolescents have been undertaken. The current study revealed that girls and boys were similarly physically active, based on PA measured using both accelerometers and questionnaires. Results also indicated that Grade 7 students were physically more active than Grade 9 students when PA was assessed using self-reports but no significant difference was found when direct measure scores were used. In addition, the associations between self-report and accelerometer scores were stronger for Grade 8 and 9 students than those in Grade 7. Unexpectedly, a majority of the students achieved 60 minutes of MVPA per day when PA was measured directly. In turn, self-reports revealed a smaller portion of students who met the recommendation.

The results of current study revealed that no significant gender differences were found for either self-reported or directly measured PA. This unexpected finding was not in line with previous research that showed boys were physically more active than girls based on both self-reports (Duncan et al., 2004; Finnish Board of Education, 2011; Yli-Piipari, 2011; World Health Organization, 2004; 2008) and direct measure scores (Sherar et al., 2007; Trost et al., 2002). The key strength of the current study was that both direct measures and self-reports were used, compared to the preceding national and international results. The present data was collected in a relatively small town, where walking, biking, and snow based activities are common, and local community and school facilities, including sport and exercise settings, parks, trails, and pathways may promote both girls and boys to be more physically active (Sallis et al., 2006). Many earlier studies were conducted in bigger cities where opportunities for PA are a lesser focus of the community structure. The school-based and environmental possibilities for PA could be considered to be very good for the current sample constituting a possible reason for the difference between present and previous findings. Additionally, the most recent PA study by the Finnish Board of Education (2011) found that the difference between Grade 9 girls’ and boys’ participation in organized and non-structured sport during leisure time narrowed over the time period of 2003–2010. Similarly, Sherar et al. (2007) reported that gender differences in PA decline across adolescence, because as children mature they tend to lower their engagement in PA. Girls reach biological maturity earlier than boys, and therefore the gender differences in PA observed in early adolescence are reduced as boys attain biological maturity. Overall, the patterns of the current and several previous PA assessments (e.g., Sherar et al., 2007; Thompson et al., 2003) indicated a trend in which the gender differences in overall PA disappeared or were consistently smaller during this age period. However, Sherar et al. (2007) concluded that to fully understand gender disparities in PA, consideration must be given to the confounding effects of physical development.

The present results showed that Grade 7 students were physically more active than Grade 9 students when PA was assessed using self-reports. This pattern was in line with earlier studies which indicated that PA declines over the secondary school years (Corbin et al., 2004; World Health Organization, 2004;
2008; Yli-Pitpiari, 2011). In contrast, a significant grade difference was not found when direct measure scores were examined. Sherar et al. (2007) reported that the age-related decline in objective PA has been shown to be associated with early puberty rather than late biological maturity. The present sample comprised students aged between 12- to 16-years, therefore, some of the participants were likely prepubertal. When students reach puberty within the secondary school years, they may develop new interests and pursuits. Many of these changes, getting a motorbike licence or starting to date, for example, reduce the time available for PA. This pattern has also been observed in other adolescent samples (Allison et al., 2007). Many investigators have advocated (e.g., Bates, 2006; de Vries et al., 2006; Trost, 2000; Sherar et al., 2007) that direct measures provide more accurate measures of PA than self-reported methods in children and adolescents. Overall, the results did not fully support the expectation for grade differences. Therefore, the use of self-report measures requires careful scrutiny by researchers when used to observe age-related decline in PA, particularly secondary school students.

The results of the current study highlighted a trend in which the prediction of adolescents’ directly measured PA by self-reported PA scores strengthened non-linearly across the secondary school years, whereby, the shared variance was greater at Grade 8 than either Grade 7 or Grade 9. This was the first attempt to examine the predictive relationship between self-reported and directly measured PA within Finnish secondary school students. An additional strength of the current study was that the direct data was collected for 24 hours per day over a seven-day period. Trost et al. (2000) recommended that at least a seven-day monitoring protocol is needed in order to provide reliable estimates of the usual PA behavior of children and adolescents. Adolescents may purposely under-report or over-report health and well-being behaviors including PA, because they believe engaging in these behaviors is socially undesirable or desirable (Brener, Billy, & Grady, 2003). Taken together, the results of this study indicated that Grade 8 and 9 students managed to self-report their daily PA with a higher level of association to their directly measured PA than the Grade 7 students.

Based on the current and previous findings (Prochaska, Sallis, & Long, 2001; Shephard, 2003), researchers need to be cautious when determining actual PA by self-report with adolescent samples because the scores may only provide basic estimates of the actual behavior irrespective of the method used (Marshall & Welk, 2008).

A larger portion of the current student sample met the recommendation of 60 minutes MVPA per day (World Health Organization, 2012) on the basis of their directly measured PA results than in relation to their self-reported PA. Only 11% of these adolescents met the daily recommendation of 60 minutes MVPA as assessed by the self-report measure. This result was consistent with the findings of the Finnish Board of Education’s Physical Education Evaluation (2011) but not with other nationally representative studies (Ministry of Social Affairs and Health, 2007; National Institute for Health and Welfare, 2010). These studies reported that approximately 40% of Finnish adolescents achieve the recommendation by self-reported methods. The present study also revealed that 85% of students met the recommendation when direct measure scores were used. This finding is in contrast to previous research (Shiely, & MacDonncha, 2009; Slootmaker et al., 2012), that reported that objectively measured PA determined smaller percentages of adolescents that meet the recommendation of daily PA. No previous studies incorporating directly measured methods are available in the samples of Finnish children or adolescents. When compared to the sample of US adolescents (Troiano et al., 2008), in which only 8% of adolescents met the recommendation of MVPA daily by direct measures, the percentage of physically active Finnish adolescents could be considered to be relatively high. Similarly, in a large European study (involving 2185 children and adolescents in Denmark, Portugal, Estonia, and Norway), the majority of boys (82%) and girls (62%) at age 15 achieved the current recommendation of PA, when PA was measured using accelerometers worn on the hip over a seven-day period (Riddoch et al., 2004). Possible reasons for differences between US and European studies may be due to cultural influences or the duration of the monitoring. The US study included all ethnic groups, while ethnic differences have been observed in PA behavior (Biddle, Gorely, & Stensel, 2004; Brodersen et al., 2007). The participants for present analysis were drawn from a native population of Finland. Furthermore, the US data was collected from participants who provided either one or four days of accelerometer data, whereas a seven-day monitoring was used in the present study. Because the current and previous findings indicated substantial differences in the assessments results for similarly aged samples, continuing studies using directly assessed techniques are required to gain detailed information concerning the PA behavior of Finnish children and adolescents. This will extend the limited resource of directly measured PA data gathered from research involving school-aged students. Furthermore, no clear reasons for the large differences observed between the present accelerometer and questionnaire scores have as yet been fully determined.

A key limitation of this study is related to the techniques used for PA assessment. Dale, Welk and Matthews (2002) asserted that any one technique may not detect the full range of dimensions of PA such as frequency, type, intensity or duration. The accelerometer intensity levels selected may be a reason why a larger portion of students met the recommendation of 60 minutes PA per day in the current study. The manufacturer’s level for moderate PA was 3.5 MET (e.g., walking at 5.6 kph) whereas in a study conducted with 8-18 year old American children and youth (Harrell et al., 2005) using indirect calorirometry, a level of 3.8 MET was considered to represent moderate PA. Furthermore, the current cross-sectional sample of 96 students was relatively small due the available economic resources. Therefore, conclusions regarding national trends are restricted based on these findings without additional information.

In future studies, the main focus should be towards the continuing assessment of representative samples of children and adolescents of different ages using direct techniques. Additionally, longitudinal data collection incorporating both self-report and objective measures should be used in combination to optimize and enrich the quality of the data collected from respondents in daily PA. This information could be utilized in various practical applications, such as promoting children’s and adolescents’ PA in school PE and leisure time. Following the suggestion of Bates (2006), self-report and objective measures should be used in combination to optimize and enrich the quality of the data collected from respondents in daily PA. This information could be utilized in various practical applications, such as promoting children’s and adolescents’ PA in school PE and leisure time, PE teacher training, and the professional progress of existing PE teachers by providing a clearer understanding development of students’ PA across the secondary school years.
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