Published in final edited form as:

Int J Behav Med. 2011 September ; 18(3): 209–215. doi:10.1007/s12529-010-9118-5.

A Measurement Model of Youth Physical Activity Using Pedometer and Self, Parent, and Peer Reports

Nigel Chaumeton,

Oregon Research Institute, 1703 SE 51st Ave, Portland, OR 97215, USA

Susan C. Duncan,

Oregon Research Institute, 1715 Franklin Blvd, Eugene, OR 97403, USA

Terry E. Duncan, and

Oregon Research Institute, 1715 Franklin Blvd, Eugene, OR 97403, USA

Lisa A. Strycker

Oregon Research Institute, 1715 Franklin Blvd, Eugene, OR 97403, USA

Nigel Chaumeton: nigelc@ori.org

Abstract

Background—Because no single measure is able to accurately assess all types of physical activity (PA), some researchers advocate use of multiple methods and multiple informants to measure PA. However, little research has tested the validity of proxy reports of youth PA.

Purpose—The current study determined whether peer, parent, and self-reports reflects a latent measure of youth PA. As a test of construct validity, pedometer data were included in the model and covaried with the second-order target youth PA factor to determine the relationship between the youth PA factor and an objective measure of PA.

Method—Participants included 291 target youth (ages 10, 12, or 14 years), a peer, and a parent of each target child ($N=873$). Each participant reported about target children's vigorous PA during the past 7 days, days of PA in a typical week, and PA compared to others the same age and sex. Pedometers recorded the average number of steps taken per day by target youth over 7 days.

Results—Analyses indicated an acceptable fit of the model to the data, as all variables loaded significantly on their respective factors, and all factors had significant loadings on the higher-order target PA factor. A moderate correlation was observed between the higher-order youth PA factor and the pedometer measure.

Conclusion—Combining multiple reports of youth PA has the potential to yield a more comprehensive measure of youth PA but may not be practical for all studies.

Keywords

Adolescent; Health behavior; Physical activity

Introduction

Researchers conducting studies of adolescent physical activity (PA) require practical and accurate methods of assessing this important behavior. Physical activity that occurs in

natural contexts is a complex set of recreational and instrumental behaviors that are conducted at varied levels of physiological intensity, for varied durations, and with differing frequencies both within a day and across the seasons of the year. Additionally, adolescent PA occurs in varied environmental contexts and involves different body parts that render measures of PA more effective in some circumstances than in others. Because of the multidimensional nature of free-living PA, no single measure of PA is ideal for all purposes [1].

Self-report questionnaires are the most frequently used means of assessing PA in epidemiologic research because they are relatively inexpensive to administer and are feasible in large samples [2]. However, self-report surveys have well-recognized limitations [3, 4]. Inaccurate self-reports of PA are likely when the task of recalling is complex [5], when participants have limited memory and recall skills, and when ambiguous terms such as “moderate intensity” are included in questions [6]. Younger children, in part because they typically engage in repeated short bouts of activity, have difficulty accurately recalling the amount of time they spend in PA and are challenged by the cognitive tasks of summing or averaging multiple periods of activity over time (e.g., number of days in the past week with a total of 30 or more minutes of moderate PA). Instruments that ask participants to recall their specific physical activities they engaged in during the previous day are likely to be most accurate, but these formats require collection of records for multiple days in order to account for day-to-day variations in physical activity [1, 7, 8]. Additionally, social desirability bias results in over-reporting of PA [9]. Response biases are problematic because they can be a source of common method bias, which may mask true relations or produce spurious relations among variables [10].

Because no single measure of PA is able to accurately assess all types of PA, some researchers advocate use of multiple methods (e.g., motion sensors, observation, survey instruments) and multiple informants (e.g., self and proxy reports) when assessing PA [3, 11–13]. Proxy reports have been used in behavioral research when it has not been possible to obtain valid reports from targets because they were too young [e.g., 14], developmentally disabled [e.g., 15], or incapacitated [e.g., 16]. Proxy reports have been used to assess a broad array of behaviors and cognitions including performance of activities of daily living [16], aggression [17], victimization [18], health-related quality of life [19], and psychological adjustment [14]. In PA research, teacher and parent reports of young children’s PA [20–23] and caretakers’ reports of intellectually disabled adults’ PA [15] have been associated with mechanically recorded activity levels. These findings suggest the potential utility of proxy reports for the measurement of adolescent PA.

Parents and peers are important social agents in the PA of youth [24]. In one of the few studies to use multiple PA reports, Duncan and colleagues [25] used reports from a child and a parent in each family to examine the PA of siblings. The results indicated that siblings within families engage in generally similar levels of PA, and significant variations in PA were observed between families. Further, family support for PA was associated with between-families differences in PA, illustrating the dependence among family members’ PA.

Peers have not previously been used to assess youth PA. Obtaining reports from friends may be especially relevant for older youth because as children age, they spend increasing amounts of time with friends compared with family [26] and dyadic friendships assume greater importance [27]. While parents continue to influence adolescents’ health behaviors, the role of peer influence is believed to increase with age [28, 29]. Peers have access to target children in some contexts, such as during school and in informal peer group activities,

which parents generally do not observe. Therefore, peers may be able to report about adolescents' PA in ways that complement information provided by parents.

The purpose of the current study was to determine whether peer, parent, and self reports reflect a latent measure of youth PA. The study also aimed to determine the extent to which the measurement model of youth PA was similar across three age cohorts (10, 12, and 14 years) and both genders. Specifically, it was hypothesized that (a) multiple items from each reporter would comprise three latent first-order factors representing source of the report (target self-report, parent report, and peer report), (b) the three first-order factors would load significantly on a second-order factor representing target youth PA, and (c) there would be no significant differences by age or gender. As a test of validity, pedometer data (average daily number of steps) also were included in the model, and covaried with the second-order target youth PA factor to determine the relationship between the second-order youth PA factor and a more objective measure of PA.

Methods

Participants

Data are from a study conducted in a Northwestern metropolitan area. A random stratified sample of 360 target youth (male and female from 10-, 12-, to 14-year-old cohorts) was recruited for the study. Participation by a parent or guardian was a condition for inclusion in the study. Recruitment of the target families was conducted primarily by telephone and spaced over a year so that approximately equal numbers were recruited in each season. A detailed description of the recruitment for the project has been previously published [30]. "Best friends" were nominated by the target youth at the time of the first data collection when participants were given a pedometer to wear for 1 week. Participants were asked to nominate a friend with whom they frequently spent time, and they provided contact information for this person. Target children were asked to name an alternate person if they named a peer who was already a participant in the study. Peers were subsequently recruited by telephone. Peer participation was attained for 86.5% of the targets.

Procedures

Data collection occurred in the homes of target and peer families. All participants aged 11 years and younger were administered the questionnaire as an interview in a private space at the home. Participants 12 years and older completed self-administered surveys with a research assistant present to answer questions and review surveys for completeness. Participants were paid for their participation. Target youth were paid \$25, parents \$20, and peers \$10. Appropriate Institutional Review Board approval for research with human subjects was obtained; informed consent (adult) and assent (youth) was obtained for all participants.

Measures

Target youth, parents, and peers each acted as sources of information about the target youth's PA.

Youth survey—Target youth were surveyed about their PA in the previous 7 days, their typical level of PA, and their PA level relative to that of their peers. Items were based on previously validated measures [31, 32]. Specifically, targets were asked:

1. On how many of the past 7 days did you exercise or take part in hard physical activities that made you sweat and breathe hard for at least 20 min without stopping

(such as basketball, jogging, swimming laps, tennis, fast bicycling, or similar aerobic activities)?

2. In a typical week, how many days do you take part in any regular physical activity long enough to work up a sweat (heart beats rapidly)?
3. Compared to others the same age and sex, how much physical activity do you get? (1 = *much less than others*; 5 = *much more than others*)

Parent and peer surveys—Parents and best friends responded to the same PA survey questions as the target youth, except they answered about the target youth rather than themselves. For example, to measure vigorous PA, parents were asked, “On how many of the past 7 days did your child (target child’s name) exercise or take part in hard physical activities that made them sweat and breathe hard for at least 20 min without stopping (such as basketball, jogging, swimming laps, tennis, fast bicycling, or similar aerobic activities)?”

Pedometer—At the first assessment visit, target youth were shown how to wear a pedometer and record the number of steps taken each day for 7 days. Participants were instructed to clip the pedometer to the waistline above the right knee each morning, to wear the pedometer all day while doing usual activities, and to remove the pedometer and record the day’s steps at night before resetting the device and going to bed. All pedometers were unsealed [33, 34]. The Yamax Digiwalker SW-701 (Optimal Health Products and Services, San Antonio, TX; \$20.00 US) was chosen for the study because a similar model (SW-200) performed best in a research study when compared to other pedometers [35]. From the pedometer data, an average steps/day variable was computed by summing the number of steps for the week and dividing by 7.

Statistical Analysis

Analyses were conducted to determine the viability of a measurement model for target youth PA using three reports (target self-report, parent report, and peer report). A second- or higher-order confirmatory factor analysis or measurement model was specified with the nine PA variables (three variables $\times$ three reports). It was hypothesized that: (a) the three items from each reporter would comprise three latent factors (first-order factors) representing source of report (target self-report, parent report, and peer report) and (b) the three first-order factors all would load significantly on a second- or higher-order factor representing target PA. In addition, as a measure of the higher-order factor’s validity, a covariance was estimated between the target youth PA latent factor and the pedometer data variable to determine the extent of relationship between these measures. The average daily number of daily steps was divided by 10,000 to reduce problems related to variance discrepancies across measures in the structural equation model [36].

The specification of this hypothesized model is illustrated in Fig. 1. In line with structural modeling conventions, squares denote observed variables, circles denote latent variables, and double-headed arrows denote covariances. As shown in the figure, error covariances among the same items across reports were estimated in the model.

To determine viability of the measurement across age cohorts and genders, a multiple-sample structural model was specified. Use of this approach allows a test of whether a common model exists and whether significant differences exist across the six youth groups in this study: 10-year-old boys, 10-year-old girls, 12-year-old boys, 12-year-old girls, 14-year-old boys, and 14-year-old girls.

All models were conducted using EQS statistical software [37]. As recommended by Bentler and Wu [37], model testing started with the assumption that a common model encompassed

the six groups. Constraints were specified to detect gender and cohort differences, as well as gender $\times$ age cohort interactions, in the parameters of interest (regression coefficients for first- and second-order factors, and covariances between the pedometer data and the higher-order youth PA factor). Lagrange multiplier (LM) tests were used as a guide to evaluate the statistical appropriateness of the cross-group constraints [38].

Results

The current analyses were based on complete data collected from 291 target youth ages 10–14 years ($M=12.04$, $SD=1.61$), a peer ($M=12.16$, $SD=1.81$), and a parent of each child (81% female) ($N=873$). Target youth were 51% female, 79% White, 11% African American, 4% Hispanic, 2% Native American, 2% Asian, and 3% other ethnic backgrounds. Participating peers were of similar racial/ethnic composition (75% White, 15% African American, 4% Hispanic, 3% Native American, and 2% Asian). Target children generally nominated same gender peers (93% target/peer gender match). For the multiple-group analysis (age cohort $\times$ gender), the group sizes were as follows: 10-year-old boys ($n=40$), 12-year-old boys ($n=52$), 14-year-old boys ($n=49$), 10-year-old girls ($n=49$), 12-year-old girls ($n=50$), and 14-year-old girls ($n=51$).

Several significant cross-group LM tests indicated gender $\times$ cohort differences in the model's parameters. Where significant differences in model parameters existed, constraints were relaxed and the model re-estimated. The final model-fitting procedures resulted in a chi-square test statistic of $\chi^2(279, N=291)=324.68$, $p=0.03$, Non-Normed Fit Index=0.94, Comparative Fit Index=0.95, and Root Mean Square Error of Approximation=0.02, 90% CI [.008, .034]. These results indicate an acceptable fit of the model to the data [37, 39]. Table 1 shows the first-order and second-order factor loadings (unstandardized regression coefficients and t values) for this model.

All variables loaded significantly on their respective factors, and all factors had significant loadings on the higher-order target PA factor, thus providing initial support for use of the three reports for measuring youth PA. As further support, the higher-order youth PA factor (F4) correlated significantly with the more objective measure of PA, namely, the pedometer data (V10). The correlation was Pearson $r=0.27$, $p<0.01$, indicating that the higher-order PA factor and pedometer data both shared variance and possessed unique variance. This correlation did not differ significantly across the six age and gender groups.

As shown in Table 1, several interaction effects (age $\times$ gender) emerged in the model.

The oldest group of boys (14-year-olds) differed significantly from all other groups with lower, although still significant, loadings for self-report of typical number of days per week of PA (V2) on the self-report factor (F1). There also was an interaction effect of age $\times$ gender for parent-report of typical number of days per week of PA (V5) on the parent-report factor (F2). The loading for 14-year-old girls was significant, but lower than all other groups.

Again, for 14-year-old boys, compared to all other groups, peer report of the target youth's PA compared to others (V9) had a significantly higher loading on the peer factor (F3). On the second-order factor (F4: Target Youth Physical Activity), the peer-report factor (F3) had a significantly higher loading for the oldest group of girls (14-year-olds) compared to all other groups. In both cases, the loadings were significant for all groups, but higher for 14-year-old boys and girls, respectively.

Overall, there were few significant differences across age cohorts and gender, indicating the viability of the measurement model for 10- to 14-year-old boys and girls. Across all six

groups, the higher-order target PA factor (F4) explained an average 94%, 36%, and 20% of the variance in the self-report (F1), parent-report (F2), and peer-report (F3) factors.

Discussion

To date, few studies have used multiple informants to assess adolescent PA, and no studies have used peer reports about youth PA. The ability of proxies to provide accurate reports is limited by the degree to which reporters observe the behaviors in question. The utility of parents and peers as proxy reports of PA are therefore limited by time spent with the target. Parents typically monitor how their children use their time and talk with them about what they do. As children become older and more independent, they spend more time with friends and less time with family [26]. Hence, peers may be viable alternates for proxy reporting. In this study, the higher-order youth PA factor explained significant amounts of the variance in both the parent-report and peer-report factors, suggesting that both parents and peers may be able to provide useful reports of adolescent PA. However, the higher-order target PA factor (F4) explained an average 36% and 20% of the variance in the parent-report (F2) and peer-report (F3) factors, respectively, suggesting that, within the age range of children included in this study, 10 to 14 years, parents may provide more useful reports than peers. Combining three reports has the potential to yield a more comprehensive estimate of PA [3] than any single measure alone. Specifically, the substantial amount of variance not shared by different measures of PA may reflect that the measures assess different aspects of PA behavior.

The significant correlation between the pedometer data and the higher-order youth PA factor supports the validity of the higher-order youth PA factor. Pedometers provide an objective estimate of the total number of steps taken by a person in a given period of time. A limitation of pedometer data is that it does not account for the manner in which steps are accumulated. Some steps are recorded during vigorous activities, such as playing competitive sports. These vigorous activities typically take place for relatively short periods of time. Youths also accumulate steps by engaging in activities of living throughout the day. Habitual behavior, such as walking, may not be particularly salient or memorable. Pedometer data as used in this study may reflect variations in low-intensity PA. In contrast, self-report measures of PA may better reflect more-intense activities. Since the different measures may provide different information, it is not surprising that the correlation between the higher-order youth PA factor and the pedometer data was significant yet of moderate magnitude.

This study also tested the extent to which the measurement model was stable across genders and three age cohorts (10-, 12-, and 14-year-olds). Several significant age $\times$ gender interaction effects emerged in the model that reflected a difference in size only (i.e., loadings were significant for all groups but higher for specific cohorts). Most notably, significant differences were found for the oldest groups only. The peer report of the target youth's PA compared to others had a significantly higher loading on the peer factor for 14-year-old boys, suggesting increased relevance of social comparison as a source of information when making judgments about others' PA as boys become older. The loading for parent report of number days of target PA in a typical week on the first-order parent report factor was lower for 14-year-old girls than all other groups, possibly indicating lesser parental knowledge of moderate PA in this group. In addition, the peer-report factor had a significantly higher loading on the second-order factor for the oldest group of girls compared to all other groups. Thus, peer reports may be of particular value in defining a youth PA factor for older adolescent girls.

There are several limitations to the present study. The data collection was conducted in a single metropolitan area, and in a predominantly White sample, limiting generalizability of the findings to other, more ethnically diverse populations. There may also be characteristics that distinguish those participants in the study for whom it was possible to recruit a peer from those participants for whom a peer was not recruited; thus, results may not generalize to youth for whom a peer was not recruited. Third, the majority of parent reports were from a female parent or guardian (81% female). Future research might examine potential differences between male and female parents' reports of children's PA. Additionally, measures used in this study are but few of many available. The suitability of each measure depends on the type of research, the type of PA under study, the age and number of research participants, and pragmatic considerations such as the resources available to the researcher [40]. Finally, the amount of time proxies spent with target children was not assessed in this study. Future studies might examine the relationship between the amount of time spent with targets and the accuracy of proxy reports.

Strengths of the study include approximately equal representations of girls and boys in 10-, 12-, and 14-year-old cohorts; multiple reports of youth PA (peer, parent, and self); a large percentage (86.5%) of peer participation; use of survey and more objective (pedometer) measures of PA; and analytic techniques that incorporated all variables of interest in one model.

For this study, the recruitment and assessment of best friends of 10-, 12-, and 14-year-old children required, on average, about 3 h of staff time per family—a considerable investment of resources that may not be available to many researchers. Nevertheless, results of this study indicate that proxies represent a viable and largely untapped resource of additional information about youth PA and a potentially fruitful area for investigation. Future research that compares multiple reports of children's PA with more comprehensive objective PA measures (e.g., accelerometers and heart rate monitors) and with other age groups is, therefore, warranted.

Acknowledgments

This research was supported by Grant HD 35873 from the National Institute of Child Health and Human Development.

References

1. Welk GJ, Corbin CB, Dale D. Measurement issues in the assessment of physical activity in children. *Res Q Exerc Sport*. 2000; 71:49–73.
2. DuRant RH, Baranowski T, Puhl J, Rhodes T, Davis H, Greaves KA, et al. Evaluation of the Children's Activity Rating Scale (CARS) in young children. *Med Sci Sports Exerc*. 1993; 25:1415–21. [PubMed: 8107551]
3. Ainsworth, BE.; Montoye, HJ.; Leon, AS. Methods of assessing physical activity during leisure and work. In: Bouchard, C.; Shephard, RJ.; Stephens, T., editors. *Physical activity, fitness, and health: international proceedings and consensus statement*. Champaign: Human Kinetics; 1994. p. 146-59.
4. Sallis JF, Saelens P. Assessment of physical activity by self-report: status, limitations, and future directions. *Res Q Exerc Sport*. 2000; 71:1–14. [PubMed: 10763516]
5. Brener ND, Billy JOG, Grady WR. Assessment of factors affecting the validity of self-reported health-risk behavior among adolescents: evidence from the scientific literature. *J Adolesc Health*. 2003; 33:436–57. [PubMed: 14642706]
6. Baranowski T. Validity and reliability of self-report physical activity: an information processing perspective. *Res Q*. 1988; 59:314–27.

7. Marshall, SJ.; Welk, GJ. Definitions and measurement. In: Smith, AL.; Biddle, SJH., editors. Youth physical activity and sedentary behavior: challenges and solutions. Champaign: Human Kinetics; 2008. p. 3-29.
8. Sirard JR, Pate RR. Physical activity assessment in children and adolescents. *Sports Med.* 2001; 31:439–54. [PubMed: 11394563]
9. Warnecke RB, Johnson TP, Chavez N, Sudman S, O'Rourke DP, Lacey L, et al. Improving question wording in surveys of culturally diverse populations. *Ann Epidemiol.* 1997; 7:334–42. [PubMed: 9250628]
10. Ganster DC, Hennessey HW, Luthans F. Social desirability response effects: three alternative models. *Acad Manage J.* 1983; 26:321–31.
11. Dishman RK, Darracott CR, Lambert LT. Failure to generalize determinants of self-reported physical activity to a motion sensor. *Med Sci Sports Exerc.* 1992; 24:904–40. [PubMed: 1406176]
12. Wood TM. Issues and future directions in assessing physical activity: an introduction to the conference proceedings. *Res Q Exerc Sport.* 2000; 7:ii–vii.
13. Treuth, MS. Applying multiple methods to improve the accuracy of activity assessment. In: Welk, GJ., editor. Physical activity assessments for health-related research. Champaign: Human Kinetics; 2002. p. 213-25.
14. Van Roy B, Veenstra M, Clench-Aas J. Construct validity of the five-factor Strengths and Difficulties Questionnaire (SDQ) in pre-, early, and late adolescence. *J Child Psychol Psychiatry.* 2008; 49:1304–12. [PubMed: 19120709]
15. Temple VA, Walkley JW. Physical activity of adults with intellectual disability. *J Intellect Dev Disabil.* 2003; 28:342–52.
16. Cotter EM, Burgio LD, Roth DL, Gerstle J, Richardson P. Comparison of caregiver and occupational therapist ratings of dementia patients' performance of activities of daily living. *J Appl Gerontol.* 2008; 27:215–25.
17. An J, Phillips MR, Conner KR. Validity of proxy-based reports of impulsivity and aggression in chinese research on suicidal behavior. *Crisis.* 2010; 31:137–42. [PubMed: 20573607]
18. Finkelhor D, Hamby SL, Ormrod R, Turner H. The Juvenile Victimization Questionnaire: reliability, validity, and national norms. *Child Abuse Negl.* 2005; 29:383–412. [PubMed: 15917079]
19. Laaksonen C, Aromaa M, Heinonen OJ, Suominen S, Salanterä S. Paediatric health-related quality of life instrument for primary school children: cross-cultural validation. *J Addict Nurs.* 2007; 59:542–50.
20. Halverson CF Jr, Waldrop MF. The relations of mechanically recorded activity level to varieties of preschool behavior. *Child Dev.* 1973; 44:678–81.
21. Harro M. Validation of a questionnaire to assess physical activity of children ages 4–8 years. *Res Q Exerc Sport.* 1997; 68:259–68. [PubMed: 9421838]
22. Telford A, Salmon J, Jolley D, Crawford D. Reliability and validity of physical activity questionnaires for children: the Children's Leisure Activities Study Survey (CLASS). *Pediatr Exerc Sci.* 2004; 16:64–78.
23. Manios Y, Kafatos A, Markakis G. Physical activity of 6-year-old children: validation of two proxy reports. *Pediatr Exerc Sci.* 1998; 10:176–88.
24. Wold B, Anderssen N. Health promotion aspects of family and peer influences on sport participation. *Int J Sport Psychol.* 1992; 23:343–59.
25. Duncan SC, Duncan TE, Strycker LA, Chaumeton NR. A multilevel analysis of sibling physical activity. *J Sport Exerc Psychol.* 2004; 26:57–68.
26. Montemayor R. Parents and adolescents in conflict: all families some of the time and some families most of the time. *J Early Adolesc.* 1983; 3:83–103.
27. Parker, JG.; Gottman, JM. Social and emotional development in a relational context: friendship interaction from early childhood to adolescence. In: Berndt, TJ.; Ladd, GW., editors. Peer relationships in child development. Wiley series on personality processes. New York: Wiley; 1989. p. 95-131.
28. Eccles JS. The development of children ages 6 to 14. *Future Child.* 1999; 9(2):30–44. [PubMed: 10646256]

29. Smith AL. Peer relationships in physical activity contexts: a road less traveled in youth sport and exercise psychology research. *Psychol Sport Exerc.* 2003; 4:25–39.
30. Duncan SC, Strycker LA, Duncan TE, Chaumeton NR. Telephone recruitment of a random stratified youth sample for a physical activity study. *J Sport Exerc Psychol.* 2002; 4:347–58.
31. Heath GW, Pate RR, Pratt M. Measuring physical activity among adolescents. *Public Health Rep.* 1993; 108:42–6. [PubMed: 8210274]
32. Sallis JF, Buono MJ, Roby JJ, Micale FG, Nelson JA. Seven-day recall and other physical activity self-reports in children and adolescents. *Med Sci Sports Exerc.* 1993; 25:99–108. [PubMed: 8423762]
33. Rowe DA, Mahar MT, Raedeke TD, Lore J. Measuring physical activity in children with pedometers: reliability, reactivity, and replacement of missing data. *Pediatr Exerc Sci.* 2004; 16:343–54.
34. Ozdoba R, Corbin C, Le Masurier G. Does reactivity exist in children when measuring activity levels with unsealed pedometers? *Pediatr Exerc Sci.* 2004; 16:158–66.
35. Crouter SE, Schneider PL, Karabulut K, Bassett DR Jr. Validity of 10 electronic pedometers for measuring steps, distance, and energy cost. *Med Sci Sports Exerc.* 2003; 35:1455–60. [PubMed: 12900704]
36. Gustafsson, J.; Rosén, M.; Stahl, PA. STREAMS user's guide (version 2.5). Mölndal: Multivariate Ware; 2002.
37. Bentler, PM.; Wu, E. EQS structural equations program manual. Encino: Multivariate Software; 1995.
38. Bentler, PM. Lagrange multiplier and Wald tests for EQS and EQS/PC. Berkeley: BMDP Statistical Software; 1986.
39. Browne, M.; Cudeck, R. Alternative ways of assessing model fit. In: Bollen, KA.; Long, JS., editors. *Testing structural equation models*. Newbury Park: Sage; 1993. p. 136–62.
40. Sallis, JF.; Owen, N. *Physical activity and behavioral medicine*. Newbury Park: Sage; 1999.

Fig. 1.

Hypothesized confirmatory higher-order factor model (measurement model) for the three reports of target youth physical activity. Covariances among same items across reports were estimated as indicated by the *double-headed arrows*. The covariance of the pedometer data with the higher-order target youth physical activity factor is shown by the *double-headed arrow* between V10 and F4

Table 1

Effects and *t* values for six-group multiple-sample model

	Group 1 (boys 10)		Group 2 (boys 12)		Group 3 (boys 14)		Group 4 (girls 10)		Group 5 (girls 12)		Group 6 (girls 14)	
	Effect	<i>t</i> value	Effect	<i>t</i> value	Effect	<i>t</i> value	Effect	<i>t</i> value	Effect	<i>t</i> value	Effect	<i>t</i> value
Target												
V1, F1	1.00		1.00		1.00		1.00		1.00		1.00	
V2, F1	1.03	8.16	1.03	8.16	.50	2.73	1.03	8.16	1.03	8.16	1.03	8.16
V3, F1	.35	7.49	.35	7.49	.35	7.49	.35	7.49	.35	7.49	.35	7.49
Parent												
V4, F2	1.00		1.00		1.00		1.00		1.00		1.00	
V5, F2	1.23	8.93	1.23	8.93	1.23	8.93	1.23	8.93	1.23	8.93	.63	2.31
V6, F2	.35	8.19	.35	8.19	.35	8.19	.35	8.19	.35	8.19	.35	8.19
Peer												
V7, F3	1.00		1.00		1.00		1.00		1.00		1.00	
V8, F3	.98	10.92	.98	10.92	.98	10.92	.98	10.92	.98	10.92	.98	10.92
V9, F3	.34	9.04	.34	9.04	.52	5.80	.34	9.04	.34	9.04	.34	9.04
Higher-order												
F1, F4	1.00		1.00		1.00		1.00		1.00		1.00	
F2, F4	.67	4.51	.67	4.51	.67	4.51	.67	4.51	.67	4.51	.67	4.51
F3, F4	.41	3.59	.41	3.59	.41	3.59	.41	3.59	.41	3.59	1.02	3.90

t Values equal or greater than 1.96 are significant at $p < 0.05$ or greater. Numbers in bold signify significant differences