

Children's Physical Activity: Using Accelerometers to Validate a Parent Proxy Record

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ABSTRACT

BENDER, J. M., R. C. BROWNSON, M. B. ELLIOTT, and D. L. HAIRE-JOSHU. Children's Physical Activity: Using Accelerometers to Validate a Parent Proxy Record. *Med. Sci. Sports Exerc.*, Vol. 37, No. 8, pp. 1409–1413, 2005. **Introduction:** The purpose of this study was to validate a parent proxy record of children's physical activity with CSA Model 7164 accelerometers. **Methods:** A parent proxy record was developed to record children's activity after school on weekdays and all day long on weekends for 7 d. Parents recorded both duration and intensity of activity (light, medium, hard and very hard). Children simultaneously wore a CSA-7164 accelerometer around their right hip, which served as the objective measurement against which the proxy record was validated. Sixty-five parent/child dyads participated in the study. **Results:** The overall activity level of the children was low (<3 METs). Spearman-rho analyses indicated that the accelerometer and proxy record showed poor to fair agreement for the entire monitoring period, with parents consistently overreporting their child's activity levels. Correlation between the two instruments was highest at midday on weekends (0.383) and immediately after school on weekdays (0.267). **Conclusion:** Due to the low correlation between this proxy record and the accelerometer, the need still exists for a valid measurement of child physical activity that is both inexpensive and easy to employ in larger community-based interventions. **Key Words:** MEASUREMENT, VALIDITY, EXERCISE, YOUTH, OBSERVATION, MOTION SENSOR

Physical activity is important to the health of both children and adults and is a factor in the etiology, prevention, and treatment of obesity (29). The assessment of physical activity patterns in children has been of growing concern to researchers in light of the recent obesity epidemic. Not only are obese children at greater risk of being obese in adulthood (28,30), but they also run the risk of developing diabetes, cardiovascular disease, coronary artery disease, hypertension, and osteoporosis (4,16). It has been shown that low levels of activity in youth may persist into adulthood (14,24); therefore, public health interventions have targeted youth in order to intervene in physical activity patterns early in life (23,26).

To carry out and evaluate interventions to promote physical activity in youth, researchers need valid and reliable instruments (27). Several methods of physical activity assessment have been validated in children and serve as gold standards in the field, such as heart rate monitoring, doubly labeled water and accelerometry (3,6,10,25). However, these methods are expensive to implement and can only be used on a relatively small number of participants in con-

trolled settings. Large community-based interventions have often utilized self-reported questionnaires to assess physical activity levels in their participants. These methods are less expensive and can be administered on larger populations (22). The disadvantage of using self-report measures and questionnaires with young children lies within their inherent difficulty with accurately recalling past physical activity behavior, their wide variation in levels of activity and their difficulty in estimating the duration of their activities (5,7). In fact, researchers recommend only using self-report in children older than 10 yr of age (19).

Therefore, programs targeting younger children have utilized parents and teachers to report physical activity information (17) where direct observation is neither practical nor ideal. However, none of these studies used objective physical activity measures to validate the reports (8). The need exists, therefore, for an instrument to collect physical activity behaviors in young children that is both inexpensive and valid (12,27), which at the same time, can be used in large community-based interventions. The present study was designed to validate a parent proxy record of physical activity in children against an objective accelerometer measurement, as accelerometers provide a reliable, unobtrusive and minimally invasive means of recording physical activity (15).

METHODS

Setting and participants. Data for this study were collected as part of Project PARADE (Partners of All Ages Reading About Diet and Exercise), a community-based intervention designed to decrease cardiovascular disease and

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TABLE 1. Demographic and socioeconomic characteristics of sample.

Children (N = 65)	
Age	Percentage
5	2
6	12
7	17
8	17
9	16
10	22
11	9
12	5
Gender	
Male	48
Female	52
Ethnicity	
Caucasian	77
African-American	21
Other	2
Parents (N = 54)	
Household income	
Less than \$15,000	22
\$15,000–30,000	19
\$30,000–50,000	28
More than \$50,000	30
Don't know/not sure	1
Marital Status	
Single	24
Married	52
Divorced	19
Separated	4
Living with partner	1
Education level	
Less than high school	10
High school graduate	32
Some college	30
Technical school	2
College graduate	17
Graduate school	9

obesity in children and increase physical activity and fruit and vegetable consumption, through the use of tailored storybooks in after-school community tutoring/mentoring programs. Participants recruited for this study were 97 parent/child dyads with children ranging in ages from 5 to 12 yr. Informed consent was provided by parents and children participating in this study, which was approved by the institutional review board of Saint Louis University. A single CSA Model 7164 activity monitor and a parent proxy record were mailed to the home along with detailed instructions for participation. As compensation for participation, each child was sent a storybook and parents were sent a gift certificate to the local grocery store. After deletions for monitor failure ($N = 1$), monitor loss ($N = 9$), or incomplete monitoring data ($N = 22$), the final sample consisted of 65 children. Descriptive data for these subjects are summarized in Table 1.

Instrument. The Computer Science and Applications (CSA) Model 7164 activity monitor was used to measure physical activity levels of children in this study. The CSA activity monitor is a small ($2.0 \times 1.6 \times 0.6$ inches), lightweight (1.5 ounces) uniaxial accelerometer that can be worn at the wrist, waist, or ankle to detect motion on the vertical plane. The size of the instrument and robust features were of importance in studying young children, given that children are less likely to wear an instrument that is obtrusive or an impediment to normal everyday activities. The activity

monitor has good potential for documenting the natural physical activity patterns of children (2) and has been evaluated for use with children in both controlled and free-living laboratory settings, as well as in field settings (3,6,10,25). In addition, the CSA activity monitor provides data in user-specified epochs (1 min for the current study) and filters out accelerations that lie beyond normal human movement.

Parent proxy record. Given that young children cannot accurately recall the type, duration, and intensity of their past activities, a proxy record was designed as a method to collect physical activity information via the parent or guardian. Researchers have reported that proxy records appear promising and would be suitable for large study populations if a valid and reliable instrument could be developed (17). Therefore, this study aimed to validate a parent proxy record that instructed parents to document physical activity information on their child when they were observant of the child's activity—after school on weekdays and all day long on weekends. The parent proxy record was a 7-d record that gave a list of 31 common activities and pictorial descriptions of which activities would fall into light, medium, hard and very hard categories. For each day the child wore the activity monitor, the parent was instructed to document: 1) what the child was doing, 2) what time the child was doing the activity (in half-hour increments), and 3) how hard the child was performing the activity, on a scale of light, medium, hard, and very hard. This proxy record was a slightly modified version of the SAPAC and SPARK surveys (20,21).

Study design. Data collection occurred from January 2002 to May 2003. During this time, parents were recruited by phone to participate in the physical activity portion of Project PARADE. After verbal consent by the primary guardian, an activity monitor and a parent proxy record were immediately mailed to the home. To reliably assess physical activity patterns in children, a minimum of 4 d of monitoring has been recommended (11,27); however, 7 d of monitoring give an even more detailed documentation of usual activity. Therefore, inclusion criteria for participants at the end of the study were those who wore the monitor between 4 and 7 d. Instructions were given both verbally to parents over the phone and sent in writing regarding the care and use of the monitors, and to place the monitor around the child's waist over the right hip, using a provided pouch and expandable belt. The right hip was selected to provide consistency across participants as well as consistency with previous studies (9,18,26). Before each monitoring period, the activity monitor was initialized according to the manufacturer's specifications and synchronized to the time of the personal computer on which data would be downloaded. For the present study, the epoch duration was set at 1 min and output was expressed as METs per hour. At the end of the monitoring period, the CSA accelerometer was interfaced with a personal computer and data were edited to match the recorded time on the parent proxy record. Days and times that the monitor and proxy record did not correspond were excluded from analyses.

Accelerometer MET values for participants

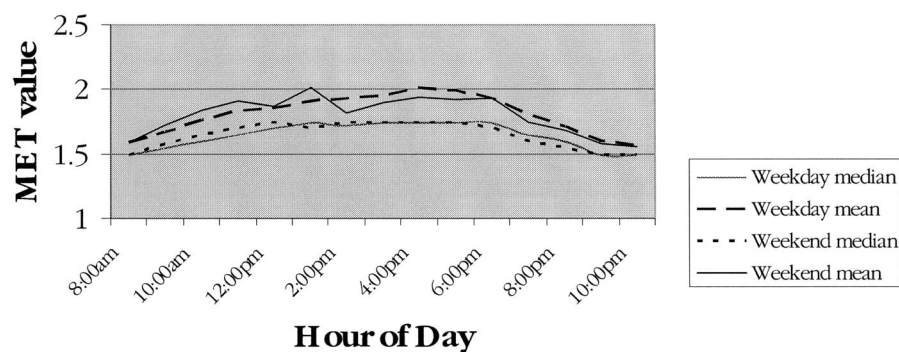


FIGURE 1—Accelerometer MET values for participants.

Analysis. Minutes per hour spent in light, medium, hard, and very hard activity, as determined by activity counts, were downloaded from the accelerometers. Similar data were obtained from the proxy surveys, although only available in half-hour increments. The accelerometer data were then transformed into a MET (metabolic equivalent time) value per hour, by multiplying the minutes spent at each activity level by the midpoint of the METs per minute range for that activity level and summed across the levels. Both the accelerometer measure of activity and the proxy measure of activity were recoded into a three-level variable corresponding to light activity, medium activity, and hard or very hard activity. These two measures were compared using Spearman rho. As a rough guide in interpreting results, the adjectival ratings suggested by Landis and Koch (13) were used in the following categories to describe correlations: 1.0 to 0.8 (almost perfect agreement), 0.8 to 0.6 (substantial agreement), 0.6 to 0.4 (moderate agreement), 0.4 to 0.2 (fair agreement), and 0.2 to 0.0 (poor agreement).

RESULTS

The overall activity level of children in the study was relatively low. The median and mean MET levels recorded by the accelerometer did not reach above 2 METs (Fig. 1) over the course of the week, where the light category was quantified from 0 to 3 METs. Spearman correlations between the accelerometer and proxy record were poor to fair agreement for the entire monitoring period, using the guidelines previously outlined (13). Hour-specific correlations for weekday and weekend reports are provided in Table 2. Correlation between the two instruments was highest at midday on weekends (0.383) and immediately after school on weekdays (0.267). Stratification by sociodemographic variables (age, ethnicity, or gender of child; income, marital status, or educational level of parent) did not result in similar variation in correlation coefficients—all correlations remained in the poor to fair range.

DISCUSSION

This study indicates that the parent proxy record is not a valid instrument to measure the physical activity levels of

children, even for children over 10 yr of age. Several reasons may be given as to why the parent proxy record may not be a valid method for assessing child physical activity levels. Filling out the proxy record accurately took time and parents have little extra time to devote to filling out an extensive record, as indicated by verbal and written comments from parents. Therefore, they may have filled it out in haste and several days after the time that the activity occurred, in order to complete the assignment quickly and receive the incentive. In addition, parents may not have always been with their school-aged child, (e.g., playing with friends, playing out in the yard, etc.), thereby guessing their child's activity based on the child's response. Though the accelerometer recorded activity in 1-min increments, the proxy record would have been too burdensome to fill out to this degree of detail, so the reporting interval for the proxy record was increased to half-hour increments. In doing so, the spontaneity and variety of the child's activity may have been lost from the parent proxy record. In addition, parents were not given formal hands-on training to be able to visually discern between varying levels of activity. The pictorial descriptions of activities representative of each of the four categories may not have been adequate, as overreporting of activity levels was evident in the parent proxy records. For instance, when the child was riding a bicycle,

TABLE 2. Hour-specific correlations aggregated between proxy report and accelerometer (Spearman rho).

Hour	Weekday	Weekend
8:00 a.m.		
9:00 a.m.		0.287
10:00 a.m.		0.206
11:00 a.m.		0.178
12:00 p.m.		0.084
1:00 p.m.		0.383*
2:00 p.m.		
3:00 p.m.	0.267***	0.00
4:00 p.m.	0.248***	0.188
5:00 p.m.	0.169**	0.00
6:00 p.m.	0.193***	0.138
7:00 p.m.	0.171**	0.011
8:00 p.m.	0.161**	
9:00 p.m.	0.00	
10:00 p.m.	0.286	

* $P \leq 0.05$.

** $P \leq 0.01$.

*** $P \leq 0.001$.

the average MET value recorded by the accelerometer was 1.4 METs whereas the parent proxy record reported a value of 2.3 METs. As child activity levels were low, with most children remaining in the “light” activity level, there was little room for variation. Therefore, when parents noted some type of activity, they tended to place the child in higher (moderate to hard) levels, when in fact the child was still engaged in light activity according to the accelerometer (less than 3 METs). This overestimation of physical activity has been documented among adults (1).

Stratifying the sample by sociodemographic variables did not improve the correlations. Specifically, they were not noticeably different between ethnicities of families, gender of children, family income, marital status, or educational level of parents. Additionally, physical activity priorities of parents failed to yield an improvement in the correlation between the proxy record and accelerometer.

CONCLUSION

The need still exists for a valid measurement of children’s physical activity that is inexpensive and easy to employ in larger community-based interventions. The accelerometer has been shown to yield accurate results; however, it is yet a relatively expensive instrument and may be difficult to

retrieve in community-based studies, as can be evidenced by the loss of almost two thirds of the instruments ($N = 9$) throughout the course of the study. Future parent proxy reports that are developed should be explained verbally to parents and examples of various levels of activities should be demonstrated in person, so as to ensure proper discretion between the four levels of activity. Research is still needed to identify the most accurate process or time frame for collecting physical activity levels of children by their parents—that takes into consideration the tradeoff of accuracy versus burden.

In addition, whereas many past studies used a variety of self-report formats to gather physical activity information from children, few employed empirically based principles in their design or for selecting recall formats (22). Therefore, future self-reports used for young children must have roots in the existing body of literature and utilize evidence-based criteria in their design.

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