VALIDATION OF THE PHYSICAL ACTIVITY INTERVIEW
WITH THIRD AND FIFTH GRADE CHILDREN
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This study investigated the validity of the Physical Activity Interview (PAI) for assessing children's self-reported physical activity. Third and fifth graders wore an accelerometer and were interviewed using the PAI to determine 12-hour recall accuracy for activity expressed as energy expenditure (EE). Caltrac estimates of EE for the 12-hour day (12-HEE) and activity EE were the validation criteria. 12-HEE correlations were significant ($p < .001$) between Caltrac and PAI for third ($r = .79$) and fifth grade ($r = .80$). Caltrac and PAI Total Activity were significant for fifth grade ($r = .82$, $p < .001$) but not for third grade ($r = .36$, $p < .021$). Analysis of tertiles based on the Caltrac demonstrated that the PAI significantly ($p < .002$) discriminated between activity levels for fifth graders but not for third. The use of PAI may be age-dependent.

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VALIDATION OF THE PHYSICAL ACTIVITY INTERVIEW
WITH THIRD AND FIFTH GRADE CHILDREN

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INTRODUCTION

Low levels of physical activity and fitness are a health dilemma in the United States with up to 250,000 adult deaths per year reported due to a sedentary lifestyle (Hahn, Teutsch, Rothenberg, & Marks, 1990). Low activity levels have been associated with risk factors (e.g., hyperlipidemia, hypertension, obesity) which are related to cardiovascular disease (CVD) and an increase in obesity (Blair, Kohl, Paffenbarger, Clark, Cooper, & Gibbons, 1989; Israel, 1993; Rowland, 1991; Sallis, Patterson, Buono, & Nader, 1988). CVD is the leading cause of death in the United States and the role of physical activity in the prevention of CVD is of major importance. The U. S. Public Health Service's Healthy People 2000 (U. S. Public Health Service, 1991) cautions that those who are inactive are two times as likely to develop coronary heart disease as those who engage in regular physical activity and that there is a growing number of people at risk for CVD due to physical inactivity.

The National Children and Youth Fitness Study II has indicated that obesity is on the rise in U. S. children and youth. A comparison of skinfolds between 1963 and 1987 indicates that average skinfold measurements had increased 2-4 mm (Ross, Pate, Lohman, & Christensen, 1987). A study

of 6-11 year olds demonstrated that between 1963-1980 the prevalence of obesity, defined as a triceps skinfold at or above 85% of the population mean, and superobesity, defined as a triceps skinfold at or above 95% of the population mean, had increased by 54% and 98%, respectively (Gortmaker, Dietz, Sobol, & Wehler, 1987). This rise in obesity has been attributed to a lack of physical activity and poor dietary habits. Obesity, in turn, may lead to low fitness levels (Israel, 1993; Rowland, 1991). There is much controversy regarding physical activity and resulting fitness levels of children in regard to the promotion of health or prevention of the onset of disease (Blair, 1992; Blair, Clark, Cureton, & Powell, 1989; Corbin & Pangrazi, 1992). Research with adults supports the notion that an increase in physical activity is associated with a decrease in risk factors that cause CVD and may also promote increased caloric expenditure, possibly leading to a reduced level of obesity (Leon, Connett, Jacobs, & Rauramaa, 1987; Powell, 1987; Raithel, 1988).

The assessment of physical activity levels to determine their impact upon health has largely focused on adults while relatively little research has been conducted in this area with children and adolescence. However, growing attention has focused on the levels of physical activity in children because of the apparent relationship between

activity and health. There is an increasing awareness of the importance of childhood activity levels as they have the potential to track into adulthood (Dennison, Strauss, Mellits, & Charney, 1988). Many lifelong habits such as physical activity have been found to have their genesis in childhood (Kelly, 1977).

The importance of increased physical activity for children is emphasized in the Public Health Service's Healthy People 2000 goals (U.S. Public Health Service, 1991). The goals regarding physical activity in children aged six and older include increasing to thirty percent all children that engage in light to moderate activity and increasing to seventy-five percent all children that engage in vigorous physical activity. An additional goal is to decrease to fifteen percent the percentage of the population that engage in no leisure time physical activity. Increasing muscular strength, muscular endurance, flexibility, participation in physical education classes, and monitoring dietary fat intake are just a few of the additional goals listed for children and adolescents.

Precise measurement of physical activity is necessary to evaluate the exact relationship between childhood physical activity and various indices of health. There are many forms of assessment of physical activity with few being

validated with children and adolescents. Heart rate monitoring, accelerometers, and self report measures are a few of the field methods developed to estimate activity levels. Heart rate monitors and accelerometers require considerable cost for mass testing as well as being time consuming.

There are many types of self report measures: self-administered, interview-administered, diary, and proxy report (Sallis, 1991). However, there is concern about the validity of self report measures for children as they demand a great amount of cognitive effort and/or ability on the child's part. Many self report measures require children to estimate the duration of activity even though they may be unable to tell time or to even estimate it. Similar concerns exist about the ability of children to report frequency and intensity of physical activity (Baranowski, 1988). When Baranowski et al. (1984) looked at a variety of self report forms for children there was little evidence to support the notion that children can accurately recall aerobic activity. In fact, third and fourth grade children had difficulty remembering events happening the previous day and all children tested reported difficulty estimating the duration of physical activity. Simons-Morton, Taylor, and Huang (1994) reported third and fifth graders consistently overreported physical activity during a self report

interview despite the interviewer's effort to obtain precise times. Children tended to report physical activity as time spent involved in the activity rather than time actually spent participating. Correlations between self reported moderate-to-vigorous physical activity (MVPA) and a motion sensor were greater for the fifth graders ($r = .63$) than for third graders ($r = .47$) which may indicate that ability to recall is a function of age.

Once the validity of self report questionnaires have been established, they may be considered the most cost-effective way to mass test groups of children. The purpose of this study is to validate the Physical Activity Interview (PAI) as an assessment tool of children's physical activity using the Caltrac (Muscle Dynamics, Torrance, CA) as the criterion measure of energy expenditure (EE). The PAI uses a 24-hr segmented day approach to determine physical activity which has been shown to enhance recall accuracy; however, the validity of the PAI without the use of a memory aid has not been established with children or adolescence.

Methods

Subjects

Third and fifth grade children from a local elementary school participated in the study. Two physical education teachers agreed to participate in the study and a brief assembly with all third and fifth graders was held to generate interest. Those students that returned their permission slips were contacted to set up a day for them to participate in the study. Thirty-five fifth and thirty-five third graders participated in the study. Approval was granted from the University Institutional Review Board and informed consent was obtained from each subject and their parents/guardians prior to participation (See Appendix A).

Caltrac Assessment of Physical Activity

The Caltrac accelerometer is a pocket size accelerometer that detects movement occurring in the vertical plane and translates the movement into arbitrary "activity counts" or energy expenditure (EE). When programmed to assess EE, the Caltrac measures vertical movement and converts the movement into EE based on age, weight, height, and gender. The Caltrac can be used to estimate total EE and/or EE during activity. Estimated EE for the time the Caltrac is worn consists of activity EE and EE associated with resting metabolic rate. Energy expended during activity is referred to as ACTM which means "calories

used during activity" (Muscle Dynamics, 1993, p. 11). The Caltrac ACTM defines activity as all movement "from the most mild to the most vigorous". For the purpose of this study total 12-hr energy expenditure (12-HEE) and ACTM EE were recorded and used as the standard with which to evaluate self-reported physical activity.

The Caltrac has shown to be a valid field measure of physical activity for adults (Ballor, Burke, Knudson, Olson, & Montoye, 1989; Balogun, Martin, & Clendenin, 1989; Klesges, Klesges, Swenson, & Pheley, 1985; Pambianco, Wing, & Robertson, 1990) and children (Klesges & Klesges, 1987; Klesges et al., 1985; Maliszewski, Freedson, & Ebbeling, 1991; Mukeshi, Gutin, Anderson, Zybert, & Basch, 1990; Sallis, Buono, Roby, Carlson, & Nelson, 1990). The inter-instrument reliability was shown to be high ($r \geq .89$) (Bray & Morrow, 1993; Bray, Morrow, Pivarnik, & Bricker, 1992; Pambianco et al., 1990; Sallis et al., 1990). The estimated Caltrac values for EE have been validated with children during walking, running, and at rest with an average overestimate of 7-25% (Bray et al., 1992; Bray & Morrow, 1993; Pambianco et al., 1990). It can be concluded that the Caltrac accelerometer is valid in assessing daily activity in children. The use of the Caltrac involves expense and can be time consuming (depending upon the length of time it is worn). Therefore, self-reported measures may provide the

best means with which to validly, yet feasibly, determine children's activity levels with large groups.

Assessment of Physical Measurements

The subjects were met at school prior to the start of their academic day. The subject's height (in) and weight (lbs) were assessed while wearing their normal school attire (without shoes) using a standard physician's scale. The subject's age, height, weight, and gender were entered into the Caltrac accelerometer, the Caltrac was set to record energy expenditure, and then attached to the subject's nondominant hip. The subjects were instructed to go about normal daily activities excluding swimming.

Assessment of Self-Report Physical Activity

Physical Activity Interview. At the end of a 12-hr period each subject was met in the home, the Caltrac removed, and 12-HEE and ACTM EE recorded. The subjects were then interviewed by a trained technician using a modified 12-hr form of the PAI (See Appendix B). The PAI contains columns to record Total Minutes, True Minutes, and Vigorous Minutes for each activity listed. Total Minutes are assessed first, followed by True Minutes and Vigorous Minutes. Total minutes is designed to assess the total number of minutes a subject perceived as participating in an

activity. However, subjects tend to report total number of minutes they are involved in an activity (e.g., getting organized, waiting in line) instead of actual minutes of participation. Therefore, a column titled "True Minutes" was added to the modified PAI to give the subject the opportunity to reevaluate and report the actual minutes spent participating in an activity. Then, if the subject determined that their heart rate was increased, their breathing frequency increased, and/or they began to perspire during the activity, the intensity of the activity was considered vigorous and the number of minutes of vigorous activity for each activity was recorded under Vigorous Minutes.

The PAI is designed to assist subjects in recalling the amount of physical activity for the day by segmenting the day into the following time periods: from 8 a.m. to 12 p.m., from 12 p.m. to 4 p.m., and from 4 p.m. to 8 p.m. A segmented day recall instrument has been shown to aid recall ability (Baranowski et al., 1984). During the interview the subjects were able to follow along on their copy of the questionnaire to assist them with accurate recall. Parents/Guardians were invited to attend the interview but were asked not to provide prompts or comments to assist the child's recollection of physical activity.

All reported activities were assigned an activity code, a lower MET value indicating moderate participation in the activity, and a higher MET value indicating vigorous participation in the activity (See Appendix C). For example, soccer has a lower MET level of 5.0 and a higher MET level of 6.5. Total Minutes were given a MET value of 2.0 indicating a higher EE than the resting metabolic rate but lower than that for organized physical activity. Caloric values for Total Minutes, True Minutes, Vigorous Minutes, and Total Activity were calculated using the equations in Table 1.

Insert Table 1 About Here

EE from the PAI for the time which the subject did not report activity but was wearing the Caltrac was calculated by multiplying the hours the subject did not report activity by body weight and a MET level of 1.5. The resulting number, when added to the Total Activity EE, gives 12-HEE (See Table 1). Blair (1984) suggests a set MET level of 1.5 for nonactive waking hours when estimating EE.

Physical Activity Questionnaire. In an effort to determine if several comparison-type Likert questions would be as valid as a self-report conducted by interview, the Physical Activity Questionnaire (PAQ) was designed (See

Appendix D). Questions on the PAQ relate to the amount of total physical activity for the day, amount and intensity of physical activity performed outdoors, and time spent watching television. The subjects were also given a copy of the PAQ to assist them in choosing the most representative response.

All questions on the PAQ relating to amount of physical activity were assigned numerical values with five indicating the most physical activity and one indicating the least physical activity. Questions designed to estimate intensity were scored similarly. The comparison (COMP) question and question relating to time spent watching television (TV) were scored individually. The TV question was scored inversely with those watching the most television receiving a score of one and those watching the least television receiving a score of five. A total score for time and intensity of activity outdoors was derived by multiplying time outdoors (T01) and intensity outdoors (I01) before and after dinner (T02; I02) and then adding the resulting numbers. This score is referred to as Time Intensity Outside (TIO).

Quality Control and Data Management

To determine interinstrument reliability of the Caltracs used, all Caltracs were tested by technicians prior

Statistical Methods

Pearson-Product moment correlations were performed between the Caltrac and PAI and Caltrac and PAQ. Two error measures were calculated using Jackson's (1989) models to estimate each subject's recall ability (See Table 2).

Error₁ is the standard error of estimate from the correlation between PAI and Caltrac. Error₂ (total error) is based on each subject's distance from the line of identity for the Caltrac EE and PAI EE. If a participant's self-reported EE falls on the line of identity then the participant can accurately report activity as measured by EE.

Insert Table 2 About Here

To further determine if the PAI and PAQ COMP question could discriminate between activity levels of children, tertiles were developed based on the EE recorded by the Caltrac. The ten subjects with the highest Caltrac EE values were placed in Tertile 1 (T1) and the ten subjects with the lowest Caltrac EE were placed in Tertile 3 (T3). The remaining twelve subjects were placed in Tertile 2 (T2). The means of the self-reported PAI 12-HEE and PAQ COMP question were then grouped by tertiles to determine if the PAI could significantly discriminate between self-reported activity levels. This was done for both grade levels for

12-HEE as well as Total Activity EE and Total Minutes of reported activity.

Results

Participants

Thirty-two third and thirty-two fifth graders were used in the data analysis. Fifty-six percent of third grade participants were female while fifty percent of fifth graders were female. The majority of the participants were caucasian (seventy-seven percent) with ten percent Afro-Americans. Descriptive data for subjects (N = 64) are found in Table 3.

Insert Table Three About Here

When comparing mean values, the subjects underestimated mean EE as reported using the PAI. Third graders underestimated mean 12-HEE twenty-two percent and mean Total Activity thirty-six percent. Fifth graders underestimated mean 12-HEE twelve percent and mean Total Activity fifteen percent.

Insert Figures 1 & 2 About Here

The mean caloric expenditure for all subjects during the 12-

hour period was 1052 calories. This is comparable to the 1171 calories reported in a similar study with children of similar age (Bray et al., 1991). Caltrac 12-HEE and ACTM and PAI EE are presented in Table 4.

Insert Table 4 About Here

Validation

Physical Activity Interview. Regression analyses were used to determine the concurrent validity of self-report physical activity and Caltrac total EE with the Caltrac measures as the criterion. The correlation between Caltrac and PAI 12-HEE was high for both third ($r[30] = .79, p < .001$) and fifth ($r[30] = .80, p < .001$) grade. Gender did not effect this relationship.

Insert Figures 3 & 4 About Here

The correlations between Caltrac and fifth grade self-reported Total Minutes, True Minutes, and Vigorous Minutes were higher than for the third grade. There was a significant difference ($p < .001$) in the correlation between ACTM EE and PAI Total Activity EE for fifth grade ($r[30] = .82$) and third grade ($r[30] = .36$). The correlations did not vary as a function of gender.

Insert Figures 5 & 6 About Here

Paired t-tests indicated there was a significant difference between the means of PAI 12-HEE and Caltrac 12-HEE for third ($t[31] = 9.99, p < .001$) and fifth ($t[31] = 3.25, p < .003$) grade. Additional t-tests between the means of PAI Total Activity EE and Caltrac ACTM confirmed there was a significant difference for both third ($t[31] = 5.44, p < .001$) and fifth ($t[31] = 2.28, p < .03$) grade.

Insert Table 5 About Here

When taking into account the subject's weight, correlations for PAI 12-HEE and Total Activity EE were somewhat lower indicating that weight does affect caloric expenditure. Once again, third graders were consistently less able to report Total Activity EE than fifth graders suggesting that ability to report physical activity is a function of age.

Error₁ for Caltrac and PAI 12-HEE for subjects in the third and fifth grade were 111 and 233 calories, respectively. The third grade total error of 230 calories is similar to the fifth grade total error of 270 calories. Error₁ for Total Activity EE for third and fifth grade was

to the study. The technicians wore four Caltracs concurrently for four hours. Caltrac EE was subsequently recorded and no Caltrac produced results that were outside of ten percent of the mean values.

To insure correct interview techniques, each technician received interview training conducted by a Interview Trainer from the University of Houston Health Science Center. During two three-hour practice sessions technicians were given a training manual, taught how to assess physical activity using the PAI, and how to elicit responses from participants without leading (See Appendix E). The technicians practiced interviewing using adults and adolescence volunteers. The technicians subsequently conducted three audiotaped interviews with third through sixth graders that were analyzed to determine the appropriateness of their techniques. Feedback was then given followed by discussion of the taped interviews to assure correct interviewing techniques were being utilized. Furthermore, the initial three subjects from each grade level were used as field interview training and were not included in data analysis. Both technicians were then determined qualified to conduct interviews using the PAI as attested by the Interview Trainer.

112 and 170 calories, respectively. Total error scores for Total Activity EE were 180 calories for both third and fifth grade.

Several one-way ANOVAs revealed that the PAI could discriminate between third grade T1 (highest) and T2 (middle) ($p < .05$) and T1 and T3 (lowest) ($p < .05$) for 12-HEE but failed to discriminate between T2 and T3 as well as all tertiles for Total Minutes of reported activity and Total Activity EE. Fifth grade use of the PAI demonstrated the PAI could differentiate between T1 and T2 ($p < .05$) and T1 and T3 ($p < .05$) but not T2 and T3 for 12-HEE. The PAI could also be used to differentiate between T1 and T3 ($p < .05$) and T2 and T3 ($p < .05$) for Total Minutes of Activity. Finally, the PAI was found to differentiate between all tertiles for Total Activity EE when used with fifth graders.

Insert Figures 7 & 8 About Here

Analysis by gender for third grade suggests that PAI 12-HEE could only identify females in T₁ and Total Activity EE could not be used to discriminate between any tertiles. Analysis by gender for fifth grade suggests that PAI 12-HEE may be used to identify males and females in T₁ and Total Activity EE may be used to identify females in T₁ and males in T₃.

Insert Table 6 About Here

Physical Activity Questionnaire. There were no significant correlations for third grade PAQ comparison, TV, or TIO responses when correlated with Caltrac and ACTM (See Table 7). Two significant correlations for fifth grade were found between COMP and Caltrac ($r[31] = .60$, $p < .001$) and COMP and ACTM ($r[31] = .60$, $p < .001$). When weight was taken into account (by dividing Caltrac and ACTM by kilograms) there were significant correlations for third grade between TIO with Caltrac ($r[31] = .38$, $p < .03$) and ACTM ($r[31] = .38$, $p < .03$). When weight was taken into account for fifth grade, the COMP question was significantly correlated with the Caltrac ($r[30] = .58$) and ACTM ($r[30] = .72$).

Insert Table 7 About Here

Analysis by tertile indicated that the PAQ could not differentiate between any tertile for third grade 12-HEE or Total Activity EE. However, use of the PAQ with fifth grade was found to differentiate between T_1 and all other tertiles for 12-HEE and between all tertiles for Total Activity EE.

Insert Figures 9 & 10 About Here

Analysis by gender suggests that the PAQ could not identify any tertile for third grade males or females. Analysis of the PAQ by gender for fifth grade suggests that the PAQ could only differentiate between T_1 and T_3 for males and could differentiate between T_1 all other tertiles for females.

Discussion

The relationship between physical activity and health has long been studied in the adult population but is just now emerging as an important field of research in children. Once feasible, valid measures of physical activity are identified then the relationships between physical activity and various indices of health can be studied in children. The purpose of this research was to investigate the validity of the PAI as an accurate assessment tool for children's physical activity using the Caltrac as the criterion.

The correlation between Caltrac 12-HEE and total self-report PAI 12-HEE was high (i.e., .79 & .80) for third and fifth grade. A high correlation might lead to the conclusion that the PAI is a valid assessment tool for activity in children. However, this high correlation may be because the majority of the 12-HEE estimated from PAI was largely a result of the subject's body weight and a set MET

level of 1.5 (i.e., subjects were generally sedentary).

The difference in correlation of Total Activity EE and ACTM EE by grade level suggests that fifth graders are more accurate in their recall of MVPA throughout a 12-hr period. However, when analyzing their ability to accurately report their activity (as demonstrated by Total Activity EE total error) the fifth and third grade underestimated their physical activity by fifteen and thirty-six percent, respectively.

While Caltrac ACTM EE and PAI Total Activity EE correlations are significant for the third and fifth grade, error measures suggest that fifth graders are more accurate than third and both have difficulty reporting Total Activity expressed as EE. There are several possible explanations why both fifth and third graders tended to underestimate their physical activity. The subjects may have merely failed to recall the activity for the 12-hr period. In a similar study by Simons-Morton et al. (1994), third and fifth graders using the PAI to recall activity for the previous 24 hrs overestimated their physical activity. However, their subjects used the Physical Activity Record (PAR), a memory aid, to assist in their recall of activity. Thus, the overestimation may have resulted because the subjects recorded activity on the PAR that was not physical

activity, estimated a longer period of activity than what actually occurred, or reported movement associated with the physical activity (i.e., getting organized) and not merely the actual minutes of activity.

Caltrac ACTM measures "calories you use each day moving around and they include the calories you burn during activity: from the mild to the most vigorous" (Muscle Dynamics, 1993, p. 11) while the PAI was designed to assess moderate-to-vigorous caloric expenditure. Therefore, the Caltrac ACTM caloric measurement includes movement between 1.5 and 2.9 METS that may not be recorded as moderate-to-vigorous physical activity (MVPA) on the PAI. To minimize this discrepancy, those minutes of activity recorded as Total Minutes on the PAI were assessed a value of 2 METS as they likely indicated a period of increased activity but not MVPA. All subjects were probed regarding the activities they participated in that could be described as physical activity as well as the minutes that were spent in vigorous participation of the activity. This could account for some of the caloric expenditure not reported by the students demonstrated by total error scores.

It is highly probable that the subjects themselves may be a source of error. Recall ability is thought to be a function of age and very little evidence exists supporting

the ability of children to accurately recall physical activity (Baranowski, 1988; Sallis, 1991; Simons-Morton et al., 1994). Sallis (1991) suggests that children younger than ten years of age should not be expected to accurately recall physical activity. Sallis (1993) also stated that fifth graders can accurately self-report activity. This is supported by the difference in correlation reported here between third and fifth grade self-report MVPA energy expenditure.

Recall of activity is also thought to be affected by time, importance of activity, and lack of motivation to remember (Baranowski, 1988). By interviewing the subjects on the day the activity occurred it was expected there would be a high correlation between recall and the criterion. The correlation obtained here is similar to the correlation reported by Simons-Morton et al. (1994) in a similar test of recall ability using the PAI even though the students in their study received recall training sessions. Not only is recall ability a problem, but children may classify intensity of exercise according to their perception of effort and rather than using the classification specified by PAI protocol procedures as to the description of vigorous activity. What may be recalled as vigorous activity to one student may not be recalled as vigorous by another student.

Not only does it appear that subjects, especially third graders, may be unable to utilize the PAI for accurately recalling activity EE, but the PAI may not be a valid tool to determine activity levels for third graders. The PAI was able to discriminate between activity levels in fifth graders only and between the 12-HEE of third and fifth graders that were in the most active tertile but was unable to discriminate between the 12-HEE of third and fifth graders that were moderately active and least active. Therefore, the PAI would only be a valid tool for comparing 12-HEE for both third and fifth graders when determining the most active subjects and would be useful for comparing activity levels for individuals in grade five only.

The PAQ was not more effective than the PAI in eliciting physical activity self-report. Third graders were unable to accurately assess and report amount of physical activity occurring during a 12-hr period using the Likert-type COMP question or TIO. Time spent watching television, a sedentary activity, was unrelated to EE.

When comparing fifth grade Caltrac 12-HEE and ACTM with self-report PAI and PAQ COMP question, PAI was an overall better indicator of self-report physical activity than PAQ. However, the PAQ COMP question did show a modest correlation for fifth graders for Caltrac 12-HEE ($r[30] = .60, p < .001$)

and ACTM ($r[30] = .60, p < .001$). When analyzed by tertiles, the PAQ COMP question was as valid as the PAI in discriminating between activity levels. TIO was not a good indicator of 12-HEE and TV time did not relate to 12-HEE.

Results from the PAQ suggest that the PAQ is not as valid as the PAI for assessing physical activity. Neither third or fifth graders seemed able to use the PAQ better than the PAI to improve their recall or self-report abilities. This again demonstrates the importance of the segmented day and the necessity of eliciting specific details of physical activity to enhance recall. However, comparison by tertiles indicates that the PAQ COMP question, less time-consuming and costly, was as valid as the PAI. The PAQ COMP question needs further validation with various age groups and in the future may prove to be a valuable tool for assessing physical activity in older children and adolescents.

More research is needed to further validate children's abilities to self-report activity using the PAI. This study suggests that fifth graders are more accurate in their abilities to recall physical activity than third graders when reporting Total Activity EE using the PAI and PAQ and that a survey asking children to compare their physical activity to others their age showed a moderately high

correlation for fifth graders. Both PAI Total Activity EE and PAI COMP question were able to identify between all tertile of activity levels. The use of the PAI to establish Total Activity EE or activity levels with children younger than fifth grade may be questionable. A valid self-report tool to assess physical activity and in children will greatly enhance efforts to link physical activity with health-related fitness in children and youth.

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Table 1. Equations for Estimating Caloric Expenditure from the Physical Activity Interview for the Validation of the Physical Activity Interview

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Caloric Expenditure for Total Minutes = (# of Minutes of Activity/60) * 2 METS * Body Weight in Kilograms

Caloric Expenditure for True Minutes = (# of Minutes of Activity/60 m/hr) * Lower MET Level for Activity * Body Weight in Kilograms

Caloric Expenditure for Vigorous Minutes = (# of Minutes in Activity/60 m/hr) * Higher MET Level for Activity * Body Weight in Kilograms

Caloric Expenditure for Total Activity = Caloric Expenditure for Total Minutes + Caloric Expenditure for True Minutes + Caloric Expenditure for Vigorous Minutes

Caloric Expenditure for 12-HEE = (Total time Caltrac was worn - [# of True Minutes of Activity/60] * 1.5 METS) + Caloric Expenditure for Total Activity

---

MET Levels Found in Appendix C

Table 2. Equations for Calculating Error Scores for the Validation of The Physical Activity Interview

---

$$\text{Error}_1 = S_y \sqrt{1 - r^2}$$

$$\text{Total Error (Error}_2\text{)} = \sqrt{\frac{\sum (\text{Caltrac 12-HEE} - \text{PAI 12-HEE})^2}{N}}$$

Table 3. Descriptive Data for Subjects for the Validation of the Physical Activity Interview

	Third Grade (n = 32)	Fifth Grade (n = 32)
Age (yrs)	9.4	11.4
Std Dev	.4	.9
Range	8.8-10.5	10.8-12.4
Weight (lbs)	72.3	94.7
Std Dev	18.9	27.7
Range	52-142	52-202
Height (in)	53.4	57.5
Std Dev	2.3	3.6
Range	49-62	48-63
Gender		
Male	14 (44%)	16 (50%)
Female	18 (56%)	16 (50%)
Ethnicity		
Caucasian	25 (78%)	29 (91%)
Afro-American	5 (16%)	2 (6%)
Hispanic	2 (6%)	0
Other	0	1 (3%)

Table 4. Descriptive Values for Caltrac and Physical Activity Interview Data for the Validation of the Physical Activity Interview

Caltrac Estimated EE

	<u>Third Grade</u> (n = 32)	<u>Fifth Grade</u> (n = 32)
Time Worn (hrs)	11.6	11.9
Std Dev	.6	.6
Range	10.1-12.5	10.4-12.8
12-HEE ^a (EE)	932 ^c	1171.62 ^e
Std Dev	166.3	357.6
Range	622-1383	817-2286
ACTM ^b (EE)	354.2 ^d	466.8 ^f
Std Dev	111	251.4
Range	128-630	182-1278

PAI Reported EE

	<u>Third Grade</u>	<u>Fifth Grade</u>
12-HEE (EE)	731.1 ^c	1035.7 ^e
Std Dev	182.7	388.2
Range	409.6-1342.4	656.1-2587.3
Total Activity (EE)	228.2 ^d	398.3 ^f
Std Dev	120.5	300.7
Range	5.4-467.3	32.7-1366.1

^a 12-HEE is energy expenditure for the total day (12 hrs).

^b ACTM is total caloric expenditure during activity.

^c $t(31) = 9.99$, $p < .001$ for Caltrac 12-HEE versus PAI 12-HEE

^d $t(31) = 5.44$, $p < .001$ for Caltrac ACTM versus PAI Total Activity

^e $t(31) = 3.24$, $p < .003$ for Caltrac 12-HEE versus PAI 12-HEE

^f $t(31) = 2.28$, $p < .03$ for Caltrac ACTM versus PAI Total Activity

Table 5. Pearson Product-Moment Correlations for the Validation of the Physical Activity Interview

---

<u>Caltrac 12-HEE</u>		
	<u>Third Grade</u> (n = 32)	<u>Fifth Grade</u> (n = 32)
<u>PAI</u>		
12-HEE	.79	.80
Wtkg	.73	.64
12-HEE/kg	.52	.62

<u>Caltrac ACTM</u>		
	<u>Third Grade</u>	<u>Fifth Grade</u>
<u>PAI</u>		
Total Activity	.36 *	.82 *
Wtkg	.63	.62
Total Activity/kg	.48	.71

---

* $p < .001$ for the difference in correlation between 3rd and 5th grade

12-HEE is total caloric expenditure.

Wtkg is weight measured in kilograms.

12-HEE/kg is total caloric expenditure expressed per kg.

Total Activity is derived activity caloric expenditure from the PAI.

Total Activity/kg is Total Activity expressed per kg.

Table 6. Means of Tertiles Based on Caltrac Energy Expenditure Values^a for the Validation of the Physical Activity Interview

---

Third Grade			
<u>Tertile</u>	<u>1</u>	<u>2</u>	<u>3</u>
PAI 12-HEE	890	<u>689</u>	<u>627</u>
Total Activity EE	<u>240</u>	<u>258</u>	<u>178</u>
Total Minutes	<u>75</u>	<u>111</u>	<u>81</u>

Fifth Grade			
<u>Tertile</u>	<u>1</u>	<u>2</u>	<u>3</u>
PAI 12-HEE	1437	<u>872</u>	<u>829</u>
Total Activity EE	672	375	152
Total Minutes	<u>167</u>	<u>135</u>	51

---

^a Any means connected by a common line are not significantly different at $\alpha = .05$.

Table 7. Pearson Product Moment Correlations for the Physical Activity Questionnaire for the Validation of the Physical Activity Interview

Third Grade (n=32)

	Caltrac			
	<u>12-HEE</u>	<u>ACTM</u>	<u>12-HEE/KG</u>	<u>ACTM/KG</u>
<u>PAQ</u>				
COMPARISON	.10	.11	.17	.19
TV	.06	.12	.06	.19
TIO	.14	.18	*.38	*.38

Fifth Grade (n=32)

	Caltrac			
	<u>12-HEE</u>	<u>ACTM</u>	<u>12-HEE/KG</u>	<u>ACTM/KG</u>
<u>PAQ</u>				
Comparison	***.60	***.60	***.58	***.72
TV	.17	.02	.25	.04
TIO	.06	.05	** .51	.29

* $p < .05$

** $p < .01$

*** $p < .001$

Figure 1. Means of Third Grade Energy Expenditure for the Validation of the Physical Activity Interview

Figure 2. Means of Fifth Grade Energy Expenditure for the Validation of the Physical Activity Interview

Figure 3. Third Grade Physical Activity Interview vs. Caltrac 12 Hour Energy Expenditure for the Validation of the Physical Activity Interview

Figure 4. Fifth Grade Physical Activity Interview vs. Caltrac 12 Hour Energy Expenditure for the Validation of the Physical Activity Interview

Figure 5. Third Grade Physical Activity Interview vs. Caltrac Total Activity Energy Expenditure for the Validation of the Physical Activity Interview

Figure 6. Fifth Grade Physical Activity Interview vs. Caltrac Total Activity Energy Expenditure for the Validation of the Physical Activity Interview

Figure 7. Third Grade Tertiles for the Physical Activity Interview for the Validation of the Physical Activity Interview

Figure 8. Fifth Grade Tertiles for the Physical Activity Interview for the Validation of the Physical Activity Interview

Figure 9. Third Grade Tertiles for the Physical Activity Questionnaire
for the Validation of the Physical Activity Interview

Figure 9. Fifth Grade Tertiles for the Physical Activity Questionnaire for the Validation of the Physical Activity Interview

Mean Response

APPENDIX A
Consent Forms

PARENTAL CONSENT FORM

Dear Parents:

We will be conducting a research project designed to study the ability of children to accurately assess their activity level for a twelve hour period. We request permission for your child to participate. The study consists of one 5-10 minute morning session designed to inform your child of the expectations as a participant and one 10-15 minute evening session designed to interview your child about his/her perceived activity level throughout the day. During the day your child will wear a CALTRAC accelerometer that is designed to estimate energy expenditure. This will assist in determining the accuracy of your child's prediction.

Children usually enjoy being a part of special projects so we expect that your child will be enthusiastic about participating. One of the researchers will meet your child on a designated morning at school to attach the CALTRAC accelerometer and give some preliminary instructions. The CALTRAC will be worn throughout the day. The CALTRAC device is small and attaches to the waistband of the child's clothing and it will in no way interfere with or hamper the child's ability to participate normally in activities throughout the day. Twelve hours after the attachment of the CALTRAC your child will be interviewed and the CALTRAC device removed. The interview will consist of a series of questions that are designed to determine the intensity and duration of your child's activity level throughout the day. The interview will be conducted by one of the researchers. You are encouraged to be present during the evening interview. Your child's responses will be reported as group results only. Your child will not be identified by name but rather randomly assigned an identification number. If at any time your child expresses a desire not to participate, that desire will be honored.

Your decision whether or to not to allow your child to participate in this project will in no way effect his/her standing in the class/school. At the conclusion of the study, a summary of the results will be made available to all interested participants/parents. Should you have any questions or would like additional information concerning the project, please call Dr. James Morrow, Jr., Bruce or Sloan Schultes at 565-2651. Thank you for your cooperation and support of this research project.

Sincerely,

Bruce A. Schultes

S. Sloan Schultes

THIS PROJECT HAS BEEN REVIEWED BY UNIVERSITY OF NORTH TEXAS COMMITTEE FOR THE PROTECTION OF HUMAN SUBJECTS. (PHONE:565-3940)

Please return to the Physical Education teacher.

Please indicate whether or not you wish to have your child participate in this project by filling out the statement below and returning it to your child's teacher as quickly as possible.

I do grant permission for my child, _____, to participate in this project.

_____
Parent/Guardian Signature

_____
Home Phone

_____
Date

STUDENT CONSENT FORM

Dear Student,

We are conducting a study on children's activity levels. If you choose to participate you will have the opportunity to wear a device called the "CALTRAC." With this device we can determine how active you are during the day. In the morning when you go arrive at school we will put the CALTRAC on your belt. The device does not hurt or bother you in any way. The CALTRAC simply clips on just like a pager that your Mom or Dad may wear. As a matter of fact you will probably forget you have it on. The CALTRAC has a small tool inside that moves when you move. This tool monitors your activity level during the day and records it on a small computer. During the day you simply do everything that you would normally do, go to class, eat lunch, play at recess, etc. At the end of the day we will come back to pick up the CALTRAC and ask you some questions about what you did during the day. This will take about 10-15 minutes.

You will be given an identification number so that you and your parent's names will not be used in the study. All of the results will be reported as group scores so no one but you will know your results. Participation in this study is voluntary and to be included you must sign this permission slip. Your decision to be included in this study will in no way affect your grades at school. The group results will be made available to you and your parents if you so wish. Any questions should be referred to Dr. J. R. Morrow, Jr. at the University of North Texas, 565-2651.

I, _____, voluntarily give consent to participate in the study. I understand I may withdraw my consent at any time.

_____
Student's signature

_____
Date

_____
Witness

_____
Date

APPENDIX B

Modified Physical Activity Interview

Note: Check (✓) PE/RS columns for all PAs of interest during PE/recess. Circle the PA code of the 1st PA of interest after school ends.

APPENDIX C

Physical Activity Codes and MET Values

PROJECT HEARTBEAT! -- PHYSICAL ACTIVITY DATABASE

PA CODE	MET CODE	ACTIVITY
01	H	Apparatus - bars, balance beam, cargo nets, monkey bars, rings, slide, swing, trampoline, etc. /Gymnastics/Hula hoop/Tumbling/Rythmic movements with props
02	VH	Athletics - all organized team sports <u>excluding baseball/softball or volleyball</u>
03	H	Ball playing - Four square, dodge ball, kickball, tetherball, toss & catch, etc.
04	M	Baseball/Softball
05	H	Basketball
06	M	Bicycling
07	M	Bowling
08	M	Calisthenics/Exercise/Stretching
09	VH	Cheerleading/Marching band/Drill team
10	VH	Circuit exercises
11	H	Climbing stairs for exercise
12	VL	*Computer/Video games
13	H	Dancing/Aerobic dance/Workout equipments
14	H	Field events: broad jump, ball tossing, etc.
15	M	Fishing
16	H	Football
17	H	Frisbee
18	H	Games involving chasing, running, jumping (e.g. Simon says, red rover, hopscotch, tag)
19	M	Gardening/Yardwork/Mowing lawn with self-propelled mower
20	M	Golfing
21	H	Hiking
22	L	House cleaning involving mopping/scrubbing/ sweeping/vacuuming
23	VH	Jumping rope
24	VH	Martial arts/Karate/Wrestling/Pillow fighting
25	H	Mowing lawn with non-self-propelled mower
26	H	Outdoor play - digging, fighting, rambo, shooting, war, turtle, etc.
27	M	Ping Pong/Table tennis
28	H	Racquet sports: badminton, paddle ball, squash, tennis, etc.
29	VH	Running activities: chasing, jogging, running, racing, relays, etc.
30	H	Skate boarding
31	H	Skiing/Skating(ice/roller)
32	H	Soccer
33	VL	*Studying/Homework/Reading
34	H	Swimming/Scuba diving/Water volleyball
35	VL	*TV watching
36	M	Volleyball
37	L	Walking at regular pace/Walking up stairs/ Shopping/Waiter/Waitress/Hunting for rocks, things or catching bugs, etc.
38	M	Weight lifting
99		Other(Requires full description of the reported moderate or vigorous PA)

MET Values for Activity

<u>Met Code</u>	<u>Mets for True Minutes</u>	<u>Mets for Vigorous Minutes</u>
Very Low (VL)	1.5	
Low (L)	2.0	
Moderate (M)	3.0	4.5
High (H)	5.0	6.5
Very High (VH)	7.0	8.5

Examples:

<u>ACTIVITY</u>	<u>Mets for True Minutes</u>	<u>Mets for Vigorous Minutes</u>
Sweeping (L)	2.0	
Softball (M)	3.0	4.5
Badminton (H)	5.0	6.5
Jumping Rope (VH)	7.0	8.5

APPENDIX D
Physical Activity Questionnaire

Physical Activity Questionnaire

Answer the following questions based on your physical activity level today.

How active were you compared to other children your age (for example, those in your class)?

- much more active
- more active
- as active
- less active
- much less active

From the time you got out of school until dinner, how much time did you play outside?

- nearly all of the time
- most of the time
- some of the time
- very little of the time
- none of the time

If you did play outside, how much of the time that you were outside did your heart beat fast, were you out of breath, or did you sweat?

- nearly all of the time
- most of the time
- some of the time
- very little of the time
- none of the time

From dinner until the start of the interview, how much time did you play outside?

- nearly all of the time
- most of the time
- some of the time
- very little of the time
- none of the time

If you did play outside, how much of the time that you were outside did your heart beat fast, were you out of breath, or did you sweat?

- nearly all of the time
- most of the time
- some of the time
- very little or the time
- none of the time

How much time did you spend watching T. V. compared to other children your age?

- much more time
- more time
- same amount of time
- less time
- much less time

APPENDIX E
Physical Activity Interview
Training Manual

A. INTRODUCTION

Physical activity is defined as bodily movement produced by skeletal muscles which results in caloric expenditure. Activities involving little bodily movement are categorized as sedentary activity. Physical activities involving large bodily movement resulting in increased caloric expenditure are categorized as moderate or vigorous physical activity (MVPA).

In common usage the term "physical activity" is used to mean MVPA. In this manual we use the term "physical activity" to mean MVPA.

The purpose of the physical activity interview (PAI) is to collect information from each participant about his/her physical activities and selected sedentary activities (playing computer/video games, TV watching, studying/homework/reading) occurring during the previous 24 hours.

Energy expenditure levels will be calculated using the information collected.

A.1. Schedule of Assessment

A 24-hour PAI is done once a year as part of the anniversary assessment at the participant's home or Field Center.

A.2. Selection of Participants

All participants in all three age cohorts receive the PAI.

A.3. Special Requirements for Assessment

One of the parents or a care-giver must be available to assist with the 24-hour PAI for the 8- to 10-year-old participants.

B. MATERIALS NEEDED

- PAI Manual of Operations
- PAI Forms
- PA Database
- List of School Schedules
- #2 pencils
- Audio Tape Recorder
- Audio Cassette Tapes

C. DATA ITEMS TO BE COLLECTED

Physical activities according to the categories listed in the database.

Minutes spent in each activity.

Minutes spent actively participating in the activity.

Minutes spent vigorously participating (causing hard-breathing, out-of-breath, faster heart beating or sweating) in each moderate or vigorous physical activity.

Some time points.

D. INTERVIEWER QUALIFICATIONS

A trained and certified interviewer conducts each interview session to collect information about physical activities. The interviewer guides the participant's recall over the designated time period.

E. INSTRUCTIONS FOR DATA COLLECTION

E.1. Recording Format and Transferring Data

During the PAI, the information collected is manually recorded on the PAI forms using a #2 pencil. The information will be entered into the computer using a PAI computer program at the Field Office by trained staff.

E.2. The PA Database

A Physical Activity Database is in APPENDIX A. The interviewer uses the database to find an activity which corresponds to the description of the reported activity, then enters the PA CODE on the PAI Forms.

Each of the activities included in the PA DATABASE has been precoded according to estimated energy expenditure. Some activities are listed specifically (e.g. Bowling), others are included in categories (e.g. Racket sports: badminton, paddle ball, squash, tennis, etc.)

The interviewer probes to identify any moderate or vigorous activities described by the participant that are not in the PA DATABASE. If you can not find an activity in the PA DATABASE which corresponds to the reported activity, CODE IT AS 99 and write down as reported (describe fully so that it can be coded later).

E.3. Time Segments of the Day

The PAI guides the participant to recall all of his/her moderate or vigorous physical activities and selected sedentary activities in chronological order from morning until bedtime. To help the process of recall, the day is segmented into blocks of time. The number of segments in a day varies depending on whether it is a school day or a non-school day.

E.3.1. School Day

A school day is divided into five time segments:

1. Out-of-Bed until School Starts

Account for the period starting from getting out of bed until school starts. This includes time spent in travelling from home to school.

2. School Starts - 12 Noon

Account for the period from school starts until 12 noon.

3. 12 Noon - 4 PM

Account for the period from 12 noon until 4PM. This includes time spent in travelling from school to home.

4. 4 PM - 8 PM

Account for the period from 4PM until 8PM.

5. 8 PM - Bedtime

Account for the period from 8PM until bedtime.

E.3.2. Non-School Day

A non-school day is divided into four time segments:

1. Before Noon:

Account for the period from getting out-of-bed until noon.

2. 12 Noon - 4 PM:

Account for the period from noon to 4PM.

3. 4 PM - 8 PM:

Account for the period from 4PM to 8PM.

Account for the period from 8PM to bedtime.

E.4. Layouts of Periods to recall

Since the time of the PAI varies, the following layouts present the method of counting back 24 hours for a 24-hour recall.

If the interview is conducted after 12 noon, start from the morning of the interview day to the last complete time segment before the time of the interview.

For example, if the interview begins at 6PM on Thursday, the PAI starts from Thursday morning and continues to 4PM Thursday, and then from 4PM to bedtime on Wednesday.

If the interview is conducted in the morning before noon, then simply interview the previous day.

Example 1: If a PAI is conducted after school on Friday at 5:30PM, the interview covers the morning of the interview until 4PM, and then from 4PM until bedtime on Wednesday.

TIME\DAY OF WEEK	SUN	MON	TUE	WED	THU	FRI	SAT
Out-of-Bed						-	
12 Noon							
4 PM					-	*	
8 PM							
Bedtime					-		

* Interview time

Example 2: If a PAI is conducted after school on Monday at 8PM, the interview covers the morning of the interview until 8PM and then from 8PM until bedtime on Sunday.

TIME\DAY OF WEEK	SUN	MON	TUE	WED	THU	FRI	SAT
Out-of-Bed		-					
12 Noon							
4 PM							
8 PM	-	*					
Bedtime							

* Interview time

Example 3: If a PAI is conducted on Saturday morning before noon, the interview covers all day Friday.

TIME\DAY OF WEEK	SUN	MON	TUE	WED	THU	FRI	SAT
Out-of-Bed						-	*
12 Noon							
4 PM							
8 PM							
Bedtime						-	

* Interview time

E.5. The PAI Forms

The PAI Form - School Day (Appendix B) and the PAI Form - Non-School Day (Appendix C) are used to collect information on the participant's moderate or vigorous physical activities and selected sedentary activities which occurred during a school day or a non-school day, respectively.

Components of the PAI Forms:

1. Interviewer ID: This is a 3-digit ID pre-assigned to each interviewer before the interview.
2. Subject ID: This is a 6-digit ID (PIN) pre-assigned to each participant before the interview.
3. Today's Date: The date of the interview. For example: 06/20/91 for June 20, 1991.
4. Start Time: The time the interview started. This is the time you start the Specific PAI Procedures. Circle A or P.
5. Finish Time: The time the interview finished. Circle A or P.
6. Time/Duration: The time and duration of PE, recess, and the time each school starts or ends and the lunchtime can be obtained from the List of School Schedules (collected by the field coordinator at the beginning of each semester).

The interviewer needs to verify this information with the participant during the interview. The time of out-of-bed, supper, and go-to-bed can be obtained from the participant or the parent/care-giver.

The recording of the time the school starts/ends, the time the participant gets out-of-bed and the bedtime is mandatory.

7. Time: Interviewer writes down the time of the occurrence of certain events to help tracking of physical activities. It is optional.

Remember: The recording of the time the school starts/ends, the time the participant gets out-of-bed and the bedtime is mandatory.

8. DESCRIPTION OF ACTIVITIES: A full description of activities not found on the PA Database will be entered here.
  9. PA CODE: The PA codes from the PA Database will be entered here.

The interviewer circles the PA_CODE to indicate the first physical activity of interest after the school ends. For example: The child read a book for 15 minutes while waiting for his ride home.
  10. DESCRIPTOR OF ACTIVITIES: The descriptors of each activity are be entered here. (Optional)
  11. PE: Make a check mark in this column to indicate that the physical activities occurred during PE.

NOTE: This column is not available on the NON-SCHOOL DAY PAI FORM.
  12. RS: Make a check mark in this column to indicate that the physical activities occurred during recess.

NOTE: This column is not available on the NON-SCHOOL DAY PAI FORM.
  13. TOTMINS (See Section F)
  14. TRUMINS (See Section F)
  15. VIGMINS (See Section F)
  16. INTERVIEW EVALUATION (on the back of the PAI form)
- F. TOTMINS/TRUMINS/VIGMINS
- F.1. TOTMINS (Total Minutes).

For all activities, record the total number of minutes (TOTMINS) the participant reports being in the activity; this is the total period of time taken up by the activity. Help the participant with time by reminding him/her how long events normally last, e.g. PE is 30 minutes, a TV show is usually 30 or 60 minutes.

"During PE, how much of the time did you play ____?"

"Did it last about as long as the Cosby TV show?"

F.2. TRUMINS (True Minutes).

For each activity, record the TRUMINS, the time the participant participated during the activity period (TOTMINS). This is normally a subset (but can be the equivalent) of the activity period.

For example, baseball practice may involve time spent in preparation of equipment, listening to instructions, and skills training, as well as the time actually spent engaged in playing the game. A soccer game may last 60 minutes, but the participant may play only one or two quarters. Thus, it is important to determine the amount of time the participant actually participated.

Use the questions below to probe and remind the participant. Give the participant time to respond, prompting as necessary.

"You said that you played basketball for two hours. How much of the time did you actually play?"

F.3. VIGMINS (Vigorous minutes).

For each reported moderate or vigorous activity, determine how many of the TRUMINS were minutes of vigorous participation (VIGMINS). This could be all or part of TRUMINS. Sometimes the participant will indicate a proportion such as 10% or half the time; convert this to minutes.

Vigorous physical activities are ones that make our hearts beat faster or make us breathe hard, or feel out of breath or sweat (NOTE: You may not sweat when it is cold.)

"How many of the (TRUMINS) minutes were you breathing hard or feeling out of breath or sweating or was your heart beating faster?"

G. CONDUCTING THE PHYSICAL ACTIVITY INTERVIEW

1. Conduct the interview in a quiet room away from distractions such as the TV, constant interruptions, or other children.
2. For 8- to 10-year-olds, conduct interviews with the participant and one parent/care-giver. Address questions to the participant. Request assistance from the parent or care-giver as needed. For 11-year-old and older

participants, parent/care-giver participation during the conduct of the interview is optional; however, parent/care-giver needs to be available as needed.

3. Take a few moments to establish rapport with the participant and the parent/care-giver at the beginning of the interview.
4. Set a rapid pace, moving the participant along rapidly from one time segment to the next.
5. Complete each segment of the day before moving to the next; probe for activities in a chronological sequence. Account for as much time as possible so that activities of interest are not overlooked and so you can judge how reasonable the child's time estimates are.
6. Write down the activities of interest using the PA Codes in the PA database.
7. Give the participant all the help you can so that s/he can make a good time estimation. Use all the information available to you and your judgement to guide the participant. Do not allow him or her to make an illogical estimation, for example, running the entire 30 minutes during Physical Education class. In the end, however, write down the duration the participant finally indicates.
8. The usual level of precision is to the nearest 5 minutes, rather than to the minute. However, if the participant volunteers a more specific time, that is acceptable. For instance, if the participant says s/he ran for 3 minutes, you may record that.
9. Employ the interviewing techniques provided in the "FOOD FREQUENCY QUESTIONNAIRE MANUAL OF PROCEDURES."

G.1. General Interview Procedure

1. Proceed chronologically through each segment of the day asking the following questions:

"What kinds of activities did you do?"

"Did you do any physical activity?"

"How long did you do this?" or "How many minutes?"
(This is probing for TOTMINS.)

"What did you do then?"

"Did you watch TV, play computer games or Nintendo, do homework, study or read?"

2. For each time segment, if the participant has difficulties recalling activities, use the following probes:

Where were you?

Were you doing something outdoors or indoors?

Were you alone or with someone?

3. For each MVPA:

"How many of the   (TOTMINS)   minutes were you actually participating in   (the activity)   ?"

(This is probing for TRUMINS.)

"How many of the   (TRUMINS)   minutes were you breathing hard or feeling out of breath or sweating or was your heart beating faster?"

(This is probing for VIGMINS.)

4. For sedentary activity, probe for TOTMINS and TRUMINS.

G.2. Specific Procedures for A School Day

1. Fill out Interviewer ID, PIN, and Today's Date. Information on the school schedule including the time School Starts/Ends and the time/duration of PE/recess/lunch may be obtained from the List of School Schedules. **Verify the information with the participant during the conduct of the interview.**
2. When you meet with the participant -- Introduce yourself as follows:

"Hello!   (participant's name)   ,   Ms/Mrs/Mr. (name)   , I am   (name)   and thank you both for making time for this interview."

Then, tell the parent/care-giver of the 8- to 10-year-olds:

"The interview will be conducted with ____
(participant's name)____. If s/he is not able to
answer the question then I'll need your
assistance."

Or, tell the parent/care-giver of the 11-year-old
and older participants:

"The interview will be conducted with ____
(participant's name)____. You are welcome to leave.
If questions come up, I would like to be able to
talk to you at the end of the interview."

Then address to the participant as follows:

"____ (Participant's name)____, I want to know how
much physical activity you had and how much time
you watched TV, played computer games or Nintendo,
did homework, studying or reading yesterday (or
from this morning until XX o'clock and XX o'clock
until you went to bed yesterday.)"

3. Fill in the Start time of the interview.

4. Questioning Procedure and Technique (School Day)

Q1. "Think about today (yesterday)."

"When did you get up this(yesterday) morning?"

"Did you do any physical activity after getting up
this (yesterday) morning and before going to
school?"

"Did you watch TV, play computer games or Nintendo,
do homework, study or read before going to school?"

Q2. "How did you get to school?"

Q3. "School starts at xx:xx. Did you do any physical
activity at school before class?"

"Did you watch TV, play computer games or Nintendo,
do homework, study or read at school before class?"

Q4. If PE was in the morning,

"When did you have PE today(yesterday)?"

"How long was PE?"

"What did you do during PE?"

"What did you do then(next)?"

Q5. If recess was in the morning,

"When did you have recess today(yesterday)?"

"How long was recess?"

"What did you do during recess?"

"What did you do then(next)?"

NOTE: If PE/recess was in the afternoon, find out what the participant did as above.

Q6. "Did you do any physical activity during school other than PE/recess before noon today(yesterday)?"

Q7. "When did you have lunch?"

"How long was lunch (period)?"

"Did you do any physical activity after eating lunch before class started?"

NOTE: Remember to finish probing for activities occurring up to 12 Noon for this time segment.

Q8. "Did you do any physical activity at school other than PE/recess (if PE/recess was in the afternoon) in the afternoon before school was out today(yesterday)?"

Q9. "The school was out at xx:xx. Where did you go after the school was out today(yesterday)?"

Q10. "How did you get back home(day care/neighbor's house, etc.)?"

NOTE: Watch for unrealistic discrepancy between the length of time "from home to school" and "from school to home".

Q11. If the participant waited for his/her ride,

"Did you do any physical activity while waiting for your ride?"

"What did you do?"

"Did you do homework or study or read while waiting for your ride?"

NOTE: Remember to circle the PA_CODE on the PAI form for the first PA after school was out. This includes the time spent for travelling back home or waiting for a ride.

Q12. "Did you do any physical activity after you got home (day care/neighbor's house, etc.)? What did you do?"

"Did you watch TV, play computer games or Nintendo, do homework, study or read after you got home (day care/neighbor's house, etc.)?"

NOTE: Remember to finish probing for activities occurring up to 4PM for this time segment.

Q13. "When did you eat supper today(yesterday)?"

"Did you do any physical activity after supper?"

"What did you do?"

"Did you watch TV, play computer games or Nintendo, do homework, study or read after supper?"

NOTE: Remember to finish probing for activities occurring up to 8PM and between 8PM and bedtime for these time segments.

Q14. "When did you go to bed?"

5. Review the PAI for any missing and/or questionable information and correct as needed.
6. Fill in the Finish time of the interview.
7. Thank the participant(parent/care-giver) for participation.
8. Complete the INTERVIEW EVALUATION after leaving the interview but within one hour of the interview. Provide additional interviewer comments as needed such as environmental distractions that may have

impeded a good interview, or an apparent lack of understanding on the part of the participant.

G.3. Specific Procedures for A Non-School Day

1. Fill out Interviewer ID, Subject ID, Today's Date.

2. When you meet with the participant -- Introduce yourself as follows:

"Hello!   (participant's name)   ,
Ms/Mrs/Mr. (name), I am   (name)   and
 thank you both for making time for this
 interview."

Then, tell the parent/care-giver of the 8- to 10-year-olds:

"The interview will be conducted with
(participant's name). If s/he is not able
 to answer the question then I'll need your
 assistance."

Or, tell the parent/care-giver of the 11-year-old and older participants:

"The interview will be conducted with
(participant's name). You are welcome to
 leave. If questions come up, I would like to
 be able to talk to you at the end of the
 interview."

Then address to the participant as follows:

"   (participant's name)   , I want to know
 how much physical activity you had and how
 much time you watched TV, played computer
 games or Nintendo, did homework, studying or
 reading yesterday (or from this morning until
 XX o'clock and XX o'clock until you went to
 bed yesterday.)"

3. Fill in the Start time of the interview.
  4. Questioning Procedure and Technique (Non-School Day).
- Q1. "Think about today(yesterday)."

"When did you get up this(yesterday) morning?"

"Did you do any physical activity after getting up this(yesterday) morning and before noon?"

"Did you watch TV, play computer games or Nintendo, do homework, study or read before noon?"

Q2. "When did you have lunch today(yesterday)?"

NOTE: Remember to finish probing for activities occurring up to 12 Noon for this time segment.

Q3. "Did you do any physical activity in the afternoon before 4PM today(yesterday)?"

"Did you watch TV, play computer games or Nintendo, do homework, study or read in the afternoon before 4PM?"

NOTE: Remember to finish probing for activities occurring up to 4PM for this time segment.

Q4. "When did you eat supper today(yesterday)?"

"Did you do any physical activity after supper?"

"What did you do?"

"Did you watch TV, play computer games or Nintendo, do homework, study or read after supper?"

NOTE: Remember to finish probing for activities occurring up to 8PM and between 8PM and bedtime for these time segments.

Q5. "When did you go to bed?"

5. Review the PAI for any missing and/or questionable information and correct as needed.

6. Fill in the Finish time of the interview.

7. Thank the participant(parent/care-giver) for participation.

8. Complete the INTERVIEW EVALUATION after leaving the interview but within one hour of the interview. Provide additional interviewer comments as needed such as environmental distractions that may have impeded a good interview, or an apparent lack of

understanding on the part of the participant.

H. INTERVIEW EVALUATION

To be completed after leaving the interview but within one hour of the interview:

- a) Rate the attentiveness of the subject/parent, the subject's/parent's ability to recall activities, the subject's/parent's ability to estimate time and the overall quality of the interview with the subject/parent.
- b) Record the amount of time the parent was present: none, $\leq 1/2$ or $> 1/2$
- c) Provide any additional interviewer comments as needed such as environmental distractions that may have impeded a good interview, or an apparent lack of understanding on the part of the participant.

I. PROBING

Probing is the technique used by the interviewer to obtain more specific information when the subject's response is not clear or is not meaningful or is incomplete.

The following is a list of possible reasons for the need to probe:

1. The subject thinks s/he is answering the question when s/he is simply repeating full or part of the given question.

Question 1: "What was the first physical activity you did in PE?"

Answer 1: "We had PE."

Probe: Repeat the question:
"What was the first physical activity you did in PE?"

Answer: "We did exercise."

Question 2: "You said that you did exercise, how long did you exercise?"

Answer 2: "We did exercise."

Probe: Repeat the question:
 "You said that you did exercise, how long did you exercise?"

Answer: "Five minutes."

2. The subject misses the point of the question.

Question 1: "What was the first physical activity you did in PE?"

Answer 1: "We did different things in PE."

Probe: Repeat the subject's response:
 "So you did different things in PE. Tell me, what was the first thing you did in PE?"

Answer: "Exercise."

Question 2: "You said that you did exercise, how long did you exercise?"

Answer 2: "Only in PE."

Probe: Repeat the subject's response:
 "You only exercise in PE. How long did you exercise?"

Answer: "Five minutes."

3. The subject does not realize how specific the response needs to be. For example,

Question 1: "How long did you do 'exercise' in PE?"

Answer 1: "About five to ten minutes."

Probe: "Could you be more specific about it?"

Answer: "Five minutes."

Therefore, a good probing provides the following two functions:

1. Helps the subject focus on the specific question asked.

2. Directs the subject to answer the question specifically.

However, it is important to note that all of these must be done without introducing bias or antagonizing the subject.

USE NEUTRAL PROBES

It is very important to always use neutral probes. A non-neutral probe suggests specific answers to the subject thus incorrectly lead the subject toward one of the suggested answers instead of letting the subject provide an answer of his/her own.

In this project, one exception is made regarding the use of neutral probes for the selected sedentary activities. However, neutral probes should be used to probe for MVPA.

For example,

Question 1: "Did you do any moderate or vigorous activity after you went home yesterday?"

Answer 1: "Yes, I went outside to play ball with friends."

Neutral Probe: "Tell me about it. What did you play?"

Non-Neutral Probe: "Did you play baseball or other balls?"

Question 2: "How long did you play 'Simon Says' in PE?"

Answer 2: "All the rest of the PE."

Neutral Probe: "I see. How many minutes was that?"

Non-Neutral Probe 1: "The PE was 40 minutes and you just said that you did exercise for 10 minutes. So you mean you played 'Simon Says' for 30 minutes?"

Non-Neutral Probe 2: "Was it 20 or 30 minutes?"

a) NEUTRAL PROBES:

1. An expression of interest and understanding. Use reactions like "uh-huh" or "I see" or "Yes," to indicate that the interviewer heard the response with interest and is expecting more.

2. An expectant pause. When the subject starts to answer the question, the interviewer should pause with an expectant look or a nod of the head to allow the subject time to gather his/her thoughts. Eye contact is important here.
3. Repeat the question. Repeat the question when the subject does not seem to understand the question, or misinterprets it, or hesitates uncomfortably. Many people, when hearing for the second time, understand the question more clearly.
4. Repeat the subject's response. Hearing his/her response often helps the subject realize what response he/she has given thus more specific information may be stimulated.
5. A neutral question or comment. Neutral questions or comments are often used to obtain clearer and more complete responses. The following are some suggestions for probing question:

a.1) PROBES FOR CLARITY:

"What do you mean exactly?"

"What do you mean by...?"

"Could you please explain that a little more? I don't think I quite understand."

a.2) PROBES FOR SPECIFICITY:

"Could you be more specific about that?"

"Tell me about it. What/How...?"

a.3) PROBES FOR RELEVANCE:

"I see. Well, let me ask you again...(REPEAT EXACT QUESTION)."

"Would you tell me what you mean by that?"

a.4) PROBES FOR COMPLETENESS:

"What else?"

"What else can you think of?"

"What other things can you think of?"

b) NON-NEUTRAL PROBES:

Questions with leading words.

This kind of probe suggests the answers thus limits the subject's response. Example:

"You said you played ball. Did you play baseball or basketball or other balls?"

The Don't Know (DK) or Don't Remember (DR) Response.

The "I don't know" or "I don't remember" response may mean a number of things:

1. The subject doesn't understand the question and says DK or DR to avoid saying he/she doesn't understand;
2. The subject is thinking about how to answer the question and says DK or DR to give himself/herself more time to think;
3. The subject may not want to answer the question or is unsure about the answer;
4. The subject really doesn't know or doesn't remember.

The interviewer should try to decide which of the above may be the case then use appropriate neutral probes described in the previous session to obtain a reply.

Always try at least once to get a response to a DK or DR case before accepting it as the final answer.

Be careful not to antagonize the subject or force an answer. When the subject says the second time that he/she DK or DR, proceed to the next question after coding the response as "DR".

When to stop probing.

When you have obtained all necessary information, with sufficient clarification from the subject, related to the question then the interviewer can stop probing. It is important to keep in mind that at any time should the subject becomes irritated or annoyed, stop probing for that question and proceed to the next question.

Handling Refusals

Please refer to the "FOOD FREQUENCY QUESTIONNAIRE MANUAL FOR INTERVIEWERS".

APPENDIX F
Review of Literature

Review of Literature

The American Heart Association has recently suggested that lack of physical activity is a primary risk factor for heart disease (Fletcher et al., 1992). This move was in the face of compelling evidence suggesting the amount of physical activity is associated with increased risk of coronary heart disease (CHD). This is not a recently discovered concept but was posed by Morris, Heady, Raffle, Robert, and Parks (1953) in a classic study comparing job-related activity of conductors and bus drivers which found that the more active conductors had less risk of CHD. Blair, Clark, Cureton, and Powell (1989) stated that "physical activity is an important component of the cardiovascular disease risk profile" and may be associated with CHD independent of all other risk factors. Heart disease is a lifelong process in which blockage of the coronary arteries may start long before symptoms of the disease appear. Therefore, it is of interest to determine the effect of physical activity on the coronary disease process in children. Before this can be determined, a valid, reliable measure to determine children's physical activity levels must be established for use in mass testing. Once established, the relationship between childhood physical activity and CHD may be further explored.

Relationship Between Childhood and Adult Health and Physical Activity

Blair et al. (1989) proposed the following diagram to demonstrate the relationship between adult fitness and health and childhood fitness and health.

There is mounting evidence that physical activity levels are associated with adult risk of CHD. Sallis, Patterson, Buono, and Nader (1988) compared adult and children's fitness levels, as measured by a submaximal cycle test, with various health factors (blood pressure, high density lipoproteins, low density lipoproteins, cholesterol, and body mass index [BMI]). The subjects were asked to recall caloric expenditure for the previous seven days as well as complete a seven-day activity recall. Results suggest that cardiovascular fitness was significantly related to blood pressure, lipid levels, and BMI and the activity recall was associated with BMI and either HDL and/or the cholesterol ratio. Results were similar in both children and adults.

In a longitudinal study Blair, Kohl, Paffenbarger,

Clark, Cooper, and Gibbons (1989) concluded that for subjects in higher fitness categories there was a lower mortality rate due to CHD and cancer. In fact, eight years following initial fitness testing it was found that men in the least fit group had a death rate of 64 deaths per 10,000 person-years while the men in the most fit group had a death rate of only 18 deaths per 10,000 person-years.

In providing a foundation for the 1990 American College of Medicine guidelines for exercise prescriptions, Haskell (1994) noted that established guidelines have been changed from the need for improving physical fitness to the need for improving health and preventing disease. The new standards promote the notion that even mild-to-moderate exercise can have health and/or prevention benefits and that some exercise is better than none at all for improving health. Paffenbarger (1994), in his review of the literature for the past forty years, summed up the benefit of physical activity stating that physical activity is not merely associated with, but has a direct causal relationship with increased risk of CHD. Physical activity is an important component of the cardiovascular disease risk profile; therefore, what influences adults' activity levels is of great importance.

Several studies have indicated adult physical activity patterns may have their genesis in childhood (Dennison,

Straus, Mellitis, & Charney, 1988; Kelder, Perry, Klepp, & Lytle, 1994; Kelly, 1977; Sallis et al., 1992). Dennison et al. (1988) found adult physical activity levels to be significantly related to childhood fitness scores. Four hundred fifty-three subjects' activity levels were assessed and Dennison et al. found that those subjects with higher adult physical activity levels had significantly better childhood fitness scores and fewer coronary heart disease risk factors. The six-hundred yard run performance was found to be the best predictor of adult physical activity level.

Participation in leisure time physical activity has also been shown to have origins in childhood. While interviewing adults from various cultural orientations and educational backgrounds about leisure activities participated in, Kelly (1977) found that approximately fifty percent of all adult leisure time physical activities were started in childhood. Additionally, sixty-five percent of daily activities were started in a family setting thus emphasizing the importance of the family in initiating physical activity. Not only are physical activity habits in childhood related to physical activity habits in adulthood, but physical activity in childhood may be indirectly associated with adult health. For this relationship to be established there must be a feasible, valid field test to

assess physical activity in large populations of children.

Assessment of Physical Activity

There have been an increasing number of assessment forms for physical activity developed in the past decade as researchers continue to establish a relationship between physical activity and health. Some methods of assessing activity require laboratory equipment, others require mechanical devices, and still others rely on the subject's memory to accurately recall physical activity. There are advantages as well as disadvantages in using each method of assessment.

Doubly Labeled Water. Doubly labeled water is water containing nonradioactive isotopes of oxygen 18 and deuterium (Groves, 1988). After being consumed by the subject, the subject waits approximately twelve hours for a urine sample analyzed by spectrometry to determine baseline oxygen and hydrogen levels. The subject then has an additional urinalysis at the end of a set number of days. The difference between the original amount of isotopes given and those lost through excretion is calculated. The resulting number represents the amount of isotope lost through carbon dioxide production and carbon dioxide production is used to estimate total energy expenditure (EE). Doubly labeled water has been shown to be a valid

method of assessing free-living total EE with an overestimation of eight percent when tested with adults for a five-day period (Schoeller & Webb, 1984). Only recently has this method of energy assessment been used with children due to cost of the isotopes and laboratory equipment needed to determine EE. Fontvieille, Harper, Ferraro, Spraul, and Ravussin (1993) assessed the activity level of five-year-olds using doubly labeled water. Results indicated that the subjects' EE was twenty-four percent lower than currently recommended and physical activity only accounted for a mean of sixteen percent of daily EE. Although an accurate measurement of total EE, doubly labeled water only provides an overall estimate of EE for an entire observational period and does not provide an account of type, duration, or intensity of activities in which the subject participated.

Calorimetry. Direct calorimetry measures EE through heat production, is highly accurate, but usually requires subjects to be in special rooms where activity may be limited (LaPorte, Montoye, & Caspersen, 1985). The error associated with direct calorimetry is about one percent, but due to cost of needed equipment and time requirement on the part of the subject, direct calorimetry is not considered practical for use in mass testing.

Indirect calorimetry measures oxygen consumption which

is related to heat production. Whole-room calorimetry has been used to measure oxygen consumption but requires a sealed-off room with a controlled atmosphere. This can be quite costly to set up and the subject's freedom of movement outside the room is restricted. Until recently, measurement of EE using portable, indirect calorimetry assessment tool required subjects to wear a face mask or mouthpiece connected to an apparatus usually worn on the back used to collect expired air. Hambraeus et al. (1994) perfected a suit calorimeter similar to a wetsuit that can be worn while performing vigorous physical activity. The suit calorimeter measures body heat loss, oxygen uptake, and carbon dioxide output. A one-to-three percent difference between the indirect and direct calorimetry measurement was found using the suit. Although this may be an accurate method of assessment, the use of the suit calorimeter in a field setting would be cost-prohibitive. However, it may be used to validate other forms of physical activity assessment.

Heart Rate Monitors. A nonrestrictive indirect method of assessing physical activity is through heart rate recording. This assessment is based on the linear relationship between heart rate and VO_2 . Heart rate monitors can record heart rate measurements on a wrist worn computer or can send the information via a transmitter to a nearby receiver. The linear relationship between heart rate

and VO_2 holds true for heart rates during light-to-moderate activity and becomes nonlinear during very light and vigorous activity (McArdle, Katch, & Katch, 1991). There are several disadvantages of using heart rate to predict EE and estimate physical activity. Increased heart rate is not always a product of physical activity, but may be due to psychological stress or response to the environment (Groves, 1988). Activation of different muscle groups can cause the heart rate to respond differently (Montoye & Taylor, 1984). For example, the energy cost of leg exercise tends to be greater than arm exercise but heart rate is usually higher during arm exercise. Other factors affecting the relationship include type of contraction, training status, and ambient temperature.

Although many factors can affect the heart rate relationship with EE, it has been used to validate self-report questionnaires and determine physical activity levels. Strand and Reeder (1993) concluded that middle school students who wore a heart rate monitor during physical education classes did not participate in sufficient activity to maintain their heart rate in their training zone for fifteen consecutive minutes. Strand and Reeder did note that thirty-eight percent of the subjects did maintain their heart rate at the lower end of the training zone for fifteen minutes throughout the entire day. The heart rate EE

relationship is generally considered to be valid and heart rate monitors have been used as the criterion for physical activity assessment in a number of studies involving children (Durant et al., 1988; Sallis, Buono, Roby, Carlson, & Nelson, 1990; Sallis, Buono, Roby, Micale, & Nelson, 1993; Sheffield, Morrow, Simons-Morton, & Pivarnik, 1991; Simons-Morton, Taylor, & Huang, 1994).

Direct Observation. Used quite frequently with children, direct observation requires trained individuals to observe activity, assess type, duration, and/or intensity, and record what is observed. Several observational instruments have been validated for use with children. The Fargo Activity Timesampling Survey (FATS) records activity in intervals of ten seconds using eight activity categories from sleeping to exercise (Klesges et al., 1984). The FATS categorizes exercise into three intensity levels. The Children's Physical Activity Form (CPAF) assesses four levels of movement from stationary to rapid trunk movement and was validated using a heart rate monitor with a mean correlation of .64 (O'Hara, Baranowski, Simons-Morton, Wilson, & Parcel, 1989). The Children's Activity Rating Scale (CARS) measures physical activity in one minute intervals using five categories (Puhl, Greaves, Hoyt, & Baranowski, 1990). Other observational forms have been used to assess physical activity ranging from a one-hour

videotaped play session to all day observation (Klesges & Klesges, 1987; Noland, Danner, DeWalt, McFadden, & Kotchen, 1990). Although observation can record type, intensity, duration, physical environment, social environment, and many other characteristics of activity, the time required to train observers and collect data is impractical for obtaining activity levels of large populations.

Self-Report. One of the most feasible methods of assessing physical activity for large groups is by self-report. There are a variety of self-report forms including diary, self-administered, interview-administered, and proxy (Sallis, 1991). It is thought that the individual experiencing the activity would be the most accurate record of the physical activity they experienced. Adults are thought to be fairly accurate in their ability to recall physical activity. However, Klesges (1990) found that after only one hour of activity, adults' recall abilities, when compared to direct observation using Baranowski's four-category method of quantifying physical activity based on MET levels, was only modest ($r=.62$). Subjects overestimated aerobic activity approximately three hundred percent for merely one hour of activity! If adults may be erroneous in their recall of physical activity, then the ability of children to accurately self-report physical activity may be questionable.

Sheffield et al. (1991) found that third graders had difficulty reporting activity. Correlations between self-report and a heart rate monitor ($r=.03$) and direct observation ($r=.09$) were low. It was concluded self-report was not a valid tool for assessing physical activity in third grade children.

Sallis et al. (1993) found that fourth grade students, when administered four different self-report measures of physical activity, possessed recall reliabilities ranging from .51-.74. Using the Caltrac as the criterion only one recall format, the Yesterday Activity Checklist, correlated significantly ($r=.33$, $p<.01$) with the Caltrac. The low correlation indicates there may be some limitation in fourth graders' recall abilities. When reviewing current literature, Saris (1986) came to the same conclusion saying that ten-to-twelve year-olds can provide only limited information when asked to recall physical activity.

Smith (1990) also came to a similar conclusion stating that fourth graders could not accurately report intensity or duration of physical activity. It was suggested that when children are asked to recall intensity, the children may have quantified intensity as to how "hard" the skill was to perform (e.g., with a more difficult skill being given a higher intensity rating) and not merely the energy cost

associated with performing the activity (e.g., basing intensity on energy output). Although fourth graders were found to be unable to report intensity or duration, they were found to be seventy-five percent accurate in reporting type of activity. The inaccuracy of children's abilities to determine duration may be a result of their inability to tell time or the fact that children are not required to be time conscious since their day is organized for them.

Sallis, Buono, et al. (1993) concluded that fifth graders can accurately self-report physical activity and noted that correlations between heart rate monitors and self-report increased with age. It was also concluded that children younger than ten years of age should not be expected to accurately recall physical activity. Sallis (1991) came to the same conclusion concerning inability of ten-year-olds to self-report physical activity in an earlier analysis of various self-report physical activity forms for children.

In a study assessing third and fifth graders' abilities to report physical activity, Simons-Morton et al. (1994) used the Physical Activity Interview (PAI) as their assessment tool. Subjects were given two thirty-minute instruction sessions on describing type and duration of physical activity and also provided the Physical Activity

Record, a diary type memory aid, to record physical activity throughout the day. When self-report was compared with minutes of heart rate occurring above one hundred-eighty percent of resting heart rate, fifth graders ($r=.72$) were found more accurate in recalling physical activity than third graders ($r = .57$). Subjects were found to overestimate their physical activity using PAI-reported MVPA. It was hypothesized the subject was reporting time they thought they were involved in an activity (i.e., getting organized to participate, waiting for a turn) not merely time they were actively participating in the activity. The PAI was subsequently modified to include time the subjects estimate they were actually involved in physical activity (i.e., True minutes of activity).

Physical activity of eleven-to-thirteen year-old boys at summer camp was observed by the counselors (Wallace, McKenzie, & Nader, 1985). Subjects were then asked to recall activity for their previous seven days at camp using a segmented day recall form. Observations and self-report of physical activity were converted into energy expended. Some subjects failed to recall details of activities occurring more than four days prior to the recall interview and all subjects could recall approximately 46% of activities participated in the previous seven days. However, it was concluded that subjects could report average

daily energy expenditure although subjects generally underestimated caloric expenditure.

In a classic study by Baranowski et al. (1984) six forms of self-report were analyzed to determine the best method to obtain accurate recall of physical activity from third to sixth graders. Conclusions stated that most children can remember approximately 55-65% of the activity that occurs, third and fourth graders had more difficulty recalling physical activity than fifth or sixth graders, and all grades had trouble estimating the duration of physical activity. Recall forms dividing the day into segments were found to elicit much greater accuracy in recall than those asking the subjects to recall the day as a whole.

Horn and Weiss (1991) studied the ability of children to self-assess activity in the physical domain and found developmental patterns with older children being more accurate in their assessment. This study only further supports the notion that children's ability to self-report physical activity varies with chronological age as well as developmental age.

The following conclusions have been reached regarding children's ability to recall physical activity:

1. Children may have difficulty recalling events since

their day is organized for them (Baranowski et al., 1984; Smith, 1990).

2. Lack of time consciousness may result in children's inabilities to accurately estimate duration of physical activity (Sallis, 1991; Sallis, Condon et al., 1993; Smith, 1990).
3. A segmented day form aids in children's recall ability (Baranowski et al., 1984; Wallace et al., 1985).
4. Recall ability improves with age (Baranowski et al., 1984; Horn & Weiss, 1991; Sallis, 1991; Sallis, Buono et al., 1993)

Motion Sensors. The current assessment tool used in research to assess physical activity is an accelerometer. However, the precursor to the accelerometer, the pedometer, is not new but was fashioned by Leonardo da Vinci (Gibbs-Smith, 1978). A pedometer is designed to measure distance by counting number of steps. The pedometer accomplishes this by measuring movement using an arm balanced by a spring that when displaced, records displacement. It can be calibrated to the length of a subject's stride. The validity of the pedometer was tested by Saris and Binkhorst (1977) with children and adults. Subjects walked and ran at varying speeds on a treadmill while wearing a pedometer. When compared to estimates of EE, the pedometer was found to

overestimate step rate during fast walking and running and underestimate step rate during slow walking. It was concluded that the pedometer does not reflect changes in EE due to changes in speed. Montoye and Taylor (1984), after reviewing various types of physical activity measurements, concluded that the pedometer is not a valid nor reliable research tool.

The Large Scale Integrated Activity Monitor (LSI) is a movement counter created by LaPorte et al. (1979) that was an improvement on the pedometer. The LSI contains a ball of mercury that when moved at least three degrees contacts a microswitch. One movement count is recorded when the microswitch has been contacted sixteen times. The LSI is a valid assessment tool but like the pedometer does not record speed of movement or distance covered (Groves, 1988).

Most physical activity requires movement of the trunk so a device that measures this movement, called an accelerometer, is thought to be more accurate for studying physical activity in populations. The first accelerometer was validated against measurements of oxygen consumption (VO_2) for fourteen different activities (Montoye et al., 1983). The accelerometer was considered to be a valid overall estimator of physical activity.

The Caltrac Accelerometer

The Caltrac accelerometer has been the subject of considerable research since being introduced as a field measurement of physical activity. The Caltrac contains an accelerometer which detects intensity of vertical movement using a transducer and translates the movement into activity counts (AC) or energy expenditure (EE) expressed as caloric output (Freedson, 1991). Activity counts are arbitrary units designed to indicate the amount of physical activity that occurs. Total EE obtained from the Caltrac is based on: 1) resting metabolic rate and 2) movement from activity measured by the transducer. All EE is estimated using height, weight, gender, and age. Several pressure sensitive buttons located on the Caltrac's front surface are used to enter data and output appears on a small liquid crystal screen above the buttons. The Caltrac is designed to be worn on either side of the waist.

During a two-year study using three-to-seven year olds, the Caltrac was found to be a feasible and inexpensive (cost = \$1.31 per day of successful monitoring) field tool for monitoring physical activity (Ellison et al., 1992). Much of the initial research using the Caltrac has used AC for validation or as a field assessment of physical activity. Only recently has the EE output function been utilized in research. Both AC and EE have been found to be a valid

measurement of physical activity in children and adults.

Validation With Adults. Gretebeck, Montoye, and Porter (1991) compared Caltrac estimates of 28 male subjects with the "gold standard" of field measurement for activity, doubly labeled water. After assessing EE for a seven day period they found the Caltrac to underestimate energy expenditure by 4.1%. A t-test showed no significant difference between the Caltrac estimated EE and doubly labeled water EE.

Several studies have investigated the use of VO_2 and resulting respiratory exchange ratio (RER) to determine validity of the Caltrac. Balogun, Martin, and Clendenin (1989) measured VO_2 in adults walking at four treadmill speeds (54, 81, 104, & 130 m/min) while wearing the Caltrac and found a correlation between Caltrac AC and VO_2 ($r=.76$) as well as with the RER ($r=.92$). The Caltrac AC was found to overestimate energy expenditure during walking. In a similar study, Caltrac estimated EE was also found to overestimate EE during treadmill walking by nine-to-thirteen percent with correlations between .68 and .74 when compared with VO_2 (Pambianco, Wing, & Robertson, 1990). Pambianco et al. found that the Caltrac's overestimation of EE was more pronounced in normal weight subjects at higher speeds (4.8-6.4 m.p.h.) and obese subjects at slower speeds (3.2-4.8

m.p.h.). However, it was concluded that overall the Caltrac accurately reflected differences in estimated EE due to sex, weight, and speed of walking and had interinstrument reliability of .87-.98.

Washburn and LaPorte (1988) found Caltrac AC to be a reliable measurement of activity across two walking speeds. Subjects (age, M=28 yrs) performed four timed walks at either a fast or slow pace and wore the Caltrac as well as the LSI. Results showed the Caltrac was more reliable than the LSI and was able to distinguish between walking speeds. While testing walking speed (2.4, 3.2, 4.0, 4.8, 5.6, and 6.4 km/h), the Caltrac was also tested to determine if placement on the body in young (age, M=26 yrs) and older (age, M=64 yrs) adults effected the validity or reliability (Nichols, Patterson, & Early, 1992). AC were found to correlate (back: $r=.88$, hip: $r=.89$) with VO_2 measured by indirect calorimetry during treadmill walking in young adults but hip placement on older adults resulted in lower overall correlations (back: $r=.73$, hip: $r=.25$). The lower hip correlation may be a result of the biomechanical differences in gait between young and older adults or possibly a decrease in walking efficiency with age. The test-retest reliability was found to be between .95-.98 and it was concluded that the Caltrac was able to detect changes in walking speeds.

Maliszewski, Freedson, Ebbeling, Crussemeyer, and Kastango (1991) had adults and children walk at three speeds on a treadmill while wearing the Caltrac and measuring VO_2 based EE. The Caltrac was found to be most accurate at the fastest walking speed ($r=.81$) for adults while the mean difference in EE for children showed the Caltrac overestimated EE at medium speeds and underestimated EE at slow and fast speed. The study supported the use of Caltrac AC to monitor physical activity during walking as well as Caltrac EE to discriminate between activity levels for children and adults.

Self-report questionnaires have been generally found to be a fairly accurate and cost-effective field measurement used to assess physical activity in adults. Bray and Morrow (1993) tested the validity and reliability of the Caltrac using a self-report of physical activity with adults (ages 19-45 yrs). Subjects wore two Caltracs for twelve hours after which EE was recorded and self-report physical activity was estimated from a daily activity log. The interinstrument reliability of the Caltrac for a 12-hour free-living day was found to be .99. The correlation between Caltrac EE and self-report physical activity was .82. However, the Caltrac was found to underestimate EE by up to thirty-four percent when compared to self-report.

Gretebeck and Montoye (1990) compared the accuracy of both Caltrac AC and EE with a variety of self-report questionnaires. It was found that self-report correlated with Caltrac AC and EE from .40 to .87. The questionnaire with the highest correlation was a survey developed by Paffenbarger which correlated with the Caltrac AC at .69 and EE at .87. Miller, Freedson, and Kline (1994) compared five self-report questionnaires to the Caltrac. The highest correlation with the Caltrac and a self-report questionnaire was the seven-day recall ($r=.79$).

Caltrac AC and EE are both valid and accurate methods of assessing physical activity in adults. This validity has been established using objective, laboratory measures such as measurement of VO_2 and subjective, field measures such as self-report physical activity.

Validation With Children. There has been some controversy as to the validity of the Caltrac with preschool children due to the variability and unpredictability of preschoolers' movement. Most studies using preschool children as subjects have compared Caltrac estimates of AC with some type of observational measure of activity.

Noland et al. (1990) contained preschoolers in a playroom for one hour and their physical activity was

videotaped and analyzed. Activity was assessed using a five-point behavior scale and was found to correlate moderately with Caltrac AC ($r=.86$). Danner, Noland, McFadden DeWalt, and Kotchen (1991) also looked at physical activity in preschoolers during a two-year period and found that the correlation for Caltrac AC and a single observational period of physical activity was higher for outdoor than indoor activity. Conversely, Mukeshi, Gutin, Anderson, Zybert, and Basch (1990) found that Caltrac AC were more accurate for assessing indoor activity.

Klesges and Klesges (1987) suggest that the Caltrac AC is accurate for preschoolers as correlations between observed all day physical activity using the FATS and the Caltrac ranged from .62-.95. It was also concluded that longer periods of observation of physical activity were associated with higher correlations with the Caltrac. Difficulty of assessing preschoolers' random physical activity was stated to be a factor that could cause a low correlation between the Caltrac and observations of physical activity with preschoolers.

Mukeshi et al. (1990) used the Caltrac to measure EE and found it to be an inaccurate measurement of physical activity for preschoolers when compared with direct observation. They concluded the Caltrac measures lower body movement and total body movement but fails to measure upper

body movement occurring alone which may account for its decrease in accuracy with preschoolers. Therefore, the validity of the Caltrac with preschoolers is questionable and more research is needed before using the Caltrac as a criterion measure of physical activity with preschoolers.

Although studies with preschoolers may not support the use of the Caltrac, the Caltrac has been shown to be a valid measurement of physical activity with school-aged children and adolescents. The use of the Caltrac for estimating total daily EE in children and adolescents was tested by Bray, Wong, Morrow, Butte, and Pivarnik (1993). Subjects (age, M=12 yrs) were confined in a whole-room calorimeter for twenty-four hours during which they rode a cycle ergometer for two thirty-minute sessions. The Caltrac was found to underestimate EE an average of fourteen percent but correlated with indirect calorimetry during waking hours ($r=.81$) and for the total day ($r=.88$).

Bray, Morrow, Pivarnik, and Bricker (1992) also tested the validity of Caltrac EE in children (9-12 yrs) comparing it to VO_2 measured on a treadmill at various walking speeds. The Caltrac was correlated with rest ($r = .53$), slow walking ($r = .89$) and brisk walking ($r = .85$). The Caltrac overestimated EE during rest (7%), slow (17%) and brisk (25%) walking. However, Maliszewski et al. (1991) found

that the Caltrac slightly underestimated EE at slow and fast treadmill speeds while overestimating EE during medium treadmill speeds.

Sallis et al. (1990) found the Caltrac interinstrument reliability to range from .89-.96 in a study conducted with school-aged children (age, M=10 yrs) comparing Caltrac AC, heart rate, and oxygen uptake. Caltrac AC was correlated with the heart rate monitor ($r=.54$) as well as with VO_2 ($r=.82$). The study supported the use of the Caltrac AC as a physical activity measure for children.

Heart rate was used as a criterion for measuring the validity of the Caltrac with third and fifth graders physical activity (Simons-Morton et al., 1994). Students wore a heart rate monitor and Caltrac, programmed to record AC, for twelve hours. Correlations between Caltrac AC and heart rate minutes greater than one hundred-eighty percent above resting heart rate was .55 and .70 and greater than two hundred percent above resting heart rate was .80 and .62 for third and fifth graders, respectively.

The most compelling evidence to support the use of Caltrac EE was found while studying the accuracy of Caltrac EE in adolescents for free-ranging activity. Ballor, Burke, Knudson, Olson, and Montoye (1989) found that Caltrac EE was

not significantly different than actual EE as measured by VO_2 . In fact, Caltrac estimates of EE were closer to actual EE than either a heart rate monitor or recorded observation.

Only a few studies were found that used Caltrac EE in preschoolers or school-aged children. This may be due to the ease of using arbitrary units to assess physical activity instead of specific EE during activity. Thus, much research using the Caltrac has been found to preferentially use AC rather than EE. In the few studies using EE in adults and children there appears to be a high correlation with Caltrac EE and various criterion measures. It can be concluded that the Caltrac is an overall valid measure of physical activity in both children and adults.

APPENDIX G

References (Review of Literature)

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