

Physical activity assessment in American Indian schoolchildren in the Pathways study¹⁻³

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ABSTRACT The objective of the Pathways physical activity feasibility study was to develop methods for comparing type and amount of activity between intervention and control schools participating in a school-based obesity prevention program. Two methods proved feasible: 1) a specially designed 24-h physical activity recall questionnaire for assessing the frequency and type of activities and 2) use of a triaxial accelerometer for assessing amount of activity. Results from pilot studies supporting the use of these methods are described. Analyses of activity during different segments of the day showed that children were most active after school. The activities reported most frequently (eg, basketball and mixed walking and running) were also the ones found to be most popular in the study population on the basis of formative assessment surveys. Both the physical activity recall questionnaire and the triaxial accelerometer methods will be used to assess the effects of the full-scale intervention on physical activity. *Am J Clin Nutr* 1999;69(suppl):788S–95S.

KEY WORDS Physical activity, assessment, American Indians, children, obesity, energy expenditure, accelerometers, Pathways study, recall questionnaire

INTRODUCTION

The Pathways study is a 2-phase, multicenter study of obesity prevention in third- to fifth-grade American Indian children. A school- and family-based program aimed at promoting increased physical activity and healthy eating behaviors was developed during the feasibility phase of the study. Protocols for measuring several mediating variables associated with obesity, including physical activity and eating behavior, were also developed in this preliminary phase. Measurement of these mediating variables is an important aspect of the full-scale study, in which the efficacy of the intervention will be assessed.

There are few quantitative data on the activity levels of children, and even less is known about the activity levels of different ethnic groups (1). It is commonly assumed that children today are less active than their predecessors because of increased time spent in sedentary activities (1, 2) and that this inactivity has contributed to the rise in childhood obesity. Although these assumptions are plausible, there is conflicting information on children's levels of activity (3, 4) and on the link between physical activity and obesity in children (5), most likely because of

the difficulties associated with assessing physical activity levels in children (6–8).

Reliable and valid methods for assessing physical activity in children and youth are needed. Although several methods have been proposed, few have been tested, especially in children from minority populations. We describe the rationale and implementation of the methods developed for assessing physical activity in American Indian schoolchildren in the Pathways study.

PHYSICAL ACTIVITY ASSESSMENT IN CHILDREN AND YOUTH

A consistent problem in epidemiologic and intervention studies of physical activity in children is the need for valid and reliable methods of measuring or recording the children's actual activity throughout the day. Methods used to assess physical activity in children include use of heart rate monitors (9–14), use of motion sensors (15–22), direct observation (12, 23), the doubly labeled water method (24–26), and self-report through interviews, questionnaires, or diaries (9, 22, 27–35). Various methodologic difficulties have been reported with use of each of these approaches.

Heart rate monitors

Heart rate is a relatively common index of activity that has been used as a reference method in some studies (19–21). However, the use of heart rate as an unbiased indicator of physical activity has been questioned by Freedson (10) because such use is based on the assumption that heart rate is linearly related to

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energy expenditure. Riddoch and Boreman (36) reviewed 13 studies that used heart rate to determine activity levels in children and concluded that heart rate monitoring can provide valid estimates of energy expenditure at higher exercise intensities, when heart rates tend to be high. However, the method is less accurate at lower exercise intensities, when heart rates can be significantly affected by fear, excitement, and other emotional states. Heart rate is also affected by training; children who are physically fit have lower resting heart rates and less of an exercise response than children who are less fit. Thus, heart rate monitoring is probably best used to assess vigorous activity or to test fitness, not activity, particularly if measurement of moderate-intensity activities is a goal. The use of heart rate monitoring in young children is limited because these children commonly perform a wide range of activities in the lower heart rate zones (3, 4, 36).

Motion sensors

Researchers have tended to use motion sensors along with other methods to quantify physical activity in children, particularly when many children must be monitored (17). The first motion sensor used to record physical activity was the actometer (18, 37). More recently, accelerometers such as the large-scale integrated sensor were used by LaPorte et al (38) and Klesges et al (39). These researchers found correlations between the large-scale integrated sensor and measures of self-reported activity or measures of fitness ranging from $r = 0.16$ to $r = 0.40$. The Caltrac activity monitor (Muscle Dynamics, Inc, Torrance, CA) is another accelerometer used recently in physical activity research (10). The Caltrac accelerometer is an axial motion sensor that "counts" the vertical acceleration of the subject. In children aged 8–13 y, Sallis et al (40) found correlations of $r = 0.82$ between the Caltrac accelerometer and oxygen consumption during treadmill testing. The major disadvantage of the Caltrac accelerometer is its inability to accurately record activities in the horizontal plane, such as cycling, climbing, pushing, and pulling (41).

Janz (42) evaluated a new accelerometer developed by Computer Science and Applications (CSA, Shalimar, CA). Like the Caltrac accelerometer, the CSA accelerometer measures frequency, duration, and intensity of movement; is lightweight; and can be worn on the waist, ankle, or wrist. In addition, it can turn itself on and off during a 24-h period so that activities during and after school can be separated. Janz (42) found correlations of $r = 0.55$ – 0.70 between the CSA accelerometer and heart rate telemetry; the higher correlations were found for more vigorous activities. Like the Caltrac accelerometer, the CSA accelerometer is sensitive only to movement on the vertical plane. The disadvantages of most accelerometers are a potential for tampering, especially when used with children, and an inability to record motion while the subject is seated (10, 42). In addition, accelerometers are not waterproof and therefore cannot be used to measure activities such as swimming.

The Tritrac-R3D (Hemokinetics, Inc, Madison, WI) is a triaxial accelerometer that has several advantages over earlier models. Because this accelerometer is sensitive to motion in all 3 planes, it is more likely to accurately record activities that include extensive horizontal motion. Also, the lack of external controls reduces the possibility of tampering. In a study of college students, Mathews and Freedson (43) compared results with the Tritrac accelerometer with self-reports of activity on a 3-d log ($r = 0.82$) and a 7-d recall ($r = 0.77$). They concluded that although the Tritrac accelerometer underestimated daily energy

expenditure, it provided better results than the Caltrac accelerometer. The Tritrac accelerometer correctly classified 84% of the students into 2 groups: low active and high active. Welk and Corbin (20, 21) were the first to report the use of the Tritrac accelerometer in children. They studied 35 boys and girls aged 9–11 y and found moderate to high correlations with heart rate monitors ($r = 0.58$) and with the Caltrac accelerometer ($r = 0.88$). The correlations with the heart rate monitor were higher during free play and lowest when activity was more limited or structured. The ability of the Tritrac accelerometer to measure activity in 1-min intervals makes it possible to analyze data from specific time segments and greatly enhances the usefulness of this motion sensor in physical activity research (21).

Direct observation

Although objective data about physical activity can be collected by direct observation, times and places available to observe children are limited. Thus, observation studies are done more often on preschoolers (9, 17, 30, 44, 45) than on schoolchildren (20, 46, 47). Direct observation studies require intensive training of observers and place a heavy burden on the observers.

Doubly labeled water method

The doubly labeled water method is a form of indirect calorimetry that calculates carbon dioxide production over time from the difference in isotope elimination rates after an oral dose of $^2\text{H}_2^{18}\text{O}$. Although the ^2H label is eliminated from the body only as water, the ^{18}O label is eliminated as water and as carbon dioxide. Thus, carbon dioxide production can be calculated from the difference in the elimination rates of ^2H and ^{18}O (26).

The advantages of this method are simplicity of sample collection, safety ($^2\text{H}_2$ and ^{18}O are stable, nonradioactive isotopes present in small concentrations in regular water), and accuracy (25, 26). Widespread application of the doubly labeled water method is limited by its high cost and the requirement to ingest small amounts of an isotope, which may not be acceptable in some cultures.

Self-report methods

Children have difficulties with self-report questionnaires because of their limited ability to recall over long periods of time, their wide variation in levels of daily activity, and their difficulty in estimating the duration of activities. Sallis et al (31) found that both reliability and validity improved with increasing age and concluded that recall instruments should be used only with children who are ≥ 10 y old and when the time from the physical activity to the report (ie, the recall interval) is as short as possible to enhance validity.

An additional difficulty with self-report measures is that children expend energy in a wide range of physical activities that cannot be considered as organized sports or an exercise routine (48). Thus, it is difficult to adequately sample the wide range of physical activities on questionnaires that are brief enough for children's shorter attention spans.

Interviews

Sallis et al (31) tested 3 self-report measures of physical activity in youth in the 5th, 8th, and 11th grades: an interviewer-administered 7-d physical activity recall and 2 questionnaires. The physical activity recall was validated with heart rate data.



These investigators found that elementary school children had difficulty recalling activities on specific days, and that boys were more reliable in their reports than girls, perhaps because boys had a wider variation in activity levels. Furthermore, Sallis et al (31) found that reliabilities across days were higher when the time between the interviews was short; they concluded that recall is best on the day after the activity and suggested that "repeated 24-hour activity recalls would provide the most reliable reports from children."

Simons-Morton et al (19) assessed the ability of children in the third and fifth grades to recall and report the amount and type of their physical activity the previous day in a physical activity interview. Interviewers were instructed to account for all of the child's time before, during, and after school and after supper, placing special emphasis on moderate and vigorous activities. These self-reports were validated with both a Caltrac accelerometer and a heart rate monitor. Correlations with monitored minutes were between $r = 0.50$ and 0.72 for the heart rate monitor and between $r = 0.55$ and 0.80 for the Caltrac accelerometer. Total minutes spent in vigorous activities were higher with the interview-reported method than with use of either the heart rate monitor or the Caltrac accelerometer for both grades, indicating that overreporting may have occurred. Another problem noted by the investigators was the tendency for the children to report all the minutes they spent in an activity, not just the minutes in which they were physically active; for example, time spent at the pool, not just time actively swimming. A notable problem with this interview method for large studies is the increased cost to pay for the interviewers' time.

Questionnaires

Questionnaires are the most common instruments used in large-scale studies because of their low cost and ease of administration in large groups of subjects. Sallis et al (31) tested a global physical activity rating and the Godin-Shephard Physical Activity Survey. The Physical Activity Survey is a brief questionnaire that has the advantage of being self-administered; it is used to assess usual activity. Test-retest reliability with the Physical Activity Survey was higher than with the physical activity rating in each age group. The investigators concluded that the Physical Activity Survey was a promising physical activity self-report measure for children because it provides reliable quantitative data at low cost. However, the survey should be validated further before it is widely used. The global physical activity rating probably measures different aspects of physical activity than the Physical Activity Survey; additionally, children tend to overestimate their physical activity with the physical activity rating because few report being less active than usual.

In another study by Sallis et al (34), interviewer-administered and self-administered versions of the same 1-d recall were compared in fifth-grade children. Children reported the minutes spent in different activities for 3 segments of the day (before, during, and after school). Physical activity minutes were significantly overestimated by both versions of the questionnaire compared with heart rate monitoring, and children reported more activity minutes on the self-administered version than on the interviewer-administered version. Nevertheless, the correlation coefficients of both versions were similar and significant when compared with heart rate monitoring. The self-administered physical activity checklist was clearly the more cost-effective method of the 2 and the study showed that children's physical activity recalls are acceptable as relative indicators, although children give inaccurate

reports of absolute minutes of physical activity.

Diaries

Few studies have examined the use of diaries to assess activity in children. Bouchard et al (49) developed a 3-d activity record for children and adults, suggesting that such a diary could be useful in population studies if the children are ≥ 10 y old. Sallis (50) concluded that diary measures have strong validity but that the burden on subjects is high and compliance varies with the population being studied. Diaries are not considered feasible in young children.

FEASIBILITY AND SELECTION CRITERIA

Methods for assessing physical activity were selected for Pathways based primarily on their appropriateness for a large-scale field study. In addition, the ability to assess activity during specific times of the day was a desirable attribute. A time-segmented analysis had the advantage of providing maximum information for addressing ancillary questions that may arise during the development and conduct of Pathways. For example, the question of whether children become less active after school to compensate for increased activity during the school day was raised during the development of the intervention. Finally, it was desirable to assess how frequently children engage in various types of activities because these may change either as the children age or as a result of the intervention.

The feasibility of a method was also judged on the basis of the method's reliability, affordability, complexity, and intrusiveness and on the amount of burden placed on the children and the schools. In addition, the method had to be acceptable to all American Indian communities participating in Pathways.

Many methods were deemed infeasible for Pathways (Table 1). The doubly-labeled water method, for example, the only method available for estimating energy expenditure directly, is costly, and ingestion of the isotope, although nonradioactive, may have been unacceptable to some communities. Similarly, heart rate monitoring, which is correlated with energy expenditure and useful for time-segmented analysis, was judged as overly intrusive and rejected by some communities where parents objected to children's wearing the electrodes and telemetry unit, which are held against the skin with surgical tape. Direct observation was rejected because of its intrusiveness, especially at home, and the staff time required to observe activity in a large sample, whereas activity diaries were considered overly burdensome and of questionable accuracy in children of this age.

METHODS AND PROTOCOLS ADOPTED IN PATHWAYS

Two methods, recall questionnaires and use of motion sensors, were found to be acceptable to all tribal communities and satisfied the other feasibility criteria and, in combination, provided the desired information.

Physical activity recall questionnaire

The Pathways physical activity recall questionnaire (PAQ) was modeled after existing questionnaires used in studies of children and adolescents (34, 35). It was designed to assess activity during the preceding 24 h by using a checklist format and was self-administered in groups with assistance from trained staff members. Children were asked to examine a standard list of



TABLE 1
Feasibility criteria for activity assessment methods

Method	Noninvasive	Cost	Useful in field study	Participant burden	Staff burden	r_{EE}^1
Heart rate monitor	Yes	Moderate	Yes	Low to moderate	Moderate	Yes
Motion sensor	Yes	Moderate	Yes	Low to moderate	Moderate	Yes
Activity recall	Yes	Low	Yes	Moderate	Moderate	?
Diary	Yes	Low	Yes	High	Low	?
Interview	Yes	Moderate	Yes	Moderate	High	?
Observation	Yes	Moderate	Yes	Low	High	?
Doubly labeled water	No	High	Yes	Low	Low	Yes

¹Indicates whether method is correlated with energy expenditure (EE) by indirect calorimetry or the doubly labeled water method.

common activities developed from past surveys (34, 35, 51) and from the Pathways formative assessment, as described elsewhere in this supplement (52). A section for reporting whether the children participated in physical education and recess and whether they watched television or videos or played video and computer games was also included. For each activity, children indicated whether they engaged in it “none,” “a little,” or “a lot” during 3 segments of the day: before school, during school, and after school. Each segment was considered in turn, and the activity lists varied slightly according to the segment being recalled. This approach was consistent with our interest in examining the type and amount of activity during different segments of the day.

Several types of information were available from the PAQ. The simplest was the number of activities reported before school, during school, after school, and for the entire day. It was possible to examine the frequency of different types of activities, for example, sports and running games compared with more sedentary activities. The intensity of activities could also be estimated by using published metabolic equivalent unit values for each activity, with duration of activity weighted as none = 0, a little = 1, and a lot = 2. Although it is desirable to estimate total activity from measures of duration and intensity, we developed this alternative approach because duration and intensity are difficult for young children to estimate reliably.

Motion sensor

The Tritrac accelerometer was selected to obtain a more objective estimate of total activity at baseline and after the intervention. Unlike its uniaxial predecessors, the Tritrac accelerometer can measure acceleration in 3 planes, making it more sensitive to horizontal movement. It has several other advantages including small size (10.9 × 6.8 × 3.3 cm), light weight (168 g), and solid-state circuitry with no external controls, rendering it more tamper-proof than its predecessors. Most importantly, the Tritrac accelerometer provides up to 14 d of minute-by-minute recordings that can be downloaded directly to a computer for analysis. Thus, it provides the necessary data for objective, user-defined, time-segmented analysis of activity.

PILOT STUDY

The PAQ was tested in a pilot study of 117 third-grade American Indian children from 6 communities participating in the Pathways study and the Tritrac accelerometer was tested in a subsample (n = 80) of the same children. Data were collected over 2 consecutive days according to a standard protocol as outlined in a written administrators' manual. The PAQ was administered after 1 d of measurement with the Tritrac accelerometer

to compare the 2 methods. All data were collected by trained staff who completed a 1-d training session in which the protocol, data collection forms, and Tritrac accelerometer operation were reviewed and practiced. Written, informed consent from parents and assent from children were obtained. The study protocol was approved by the institutional review boards of all Pathways institutions, school boards, and tribal authorities.

During the first class period of day 1, Tritrac accelerometers were put on students who had returned informed consent forms. The instruments were “locked” with an electrical tie in a fanny pack, which was worn around the waist during the measurement period. All children in a classroom received a fanny pack, some containing a dummy instrument. Children were unaware of which device they had received.

The children were instructed to wear the fanny pack throughout the day, except while bathing, until going to bed. They were further instructed to put the pack back on in the morning after dressing and to wear it back to school on day 2. A letter was sent home to the parents or guardians with the same instructions. The pack was retrieved by study staff on day 2 and the data were downloaded to a computer for analysis. Standard tracking forms were used to record instrument initialization time, the time the accelerometer was placed on the subject on day 1, and the time it was removed from the subject on day 2. The times of students' participation in physical education and recess were also noted on this form.

The PAQ was self-administered in the classroom with the help of trained staff. Activity lists were read to the children by a staff member while a second staff member circulated throughout the room to provide assistance. The children were asked to first recall activities engaged in before school on the day of the recall, followed by activities after school and during school on the preceding day. This procedure was followed to test the notion that more recent activities would be more accurately reported and hence better correlated with the Tritrac accelerometer results.

All data were coded by subject, school, and field-center identification numbers that were assigned by the study coordinating center. The Tritrac accelerometer data were downloaded by staff members in the field. PAQ responses were entered in the field with use of laptop computers and software developed for the study. Both Tritrac accelerometer and PAQ data were downloaded to computer disks and shipped to the study coordinating center for data analysis. Statistical analyses were performed with SAS (version 6; SAS Institute Inc, Cary, NC).

RESULTS OF THE PILOT STUDY

Complete PAQ data were obtained for all children (n = 117) for whom consent for participation was obtained. The children



had little difficulty understanding the PAQ and could complete it in the classroom setting in ≈ 30 min. The activities in which children participated a lot are indicated in **Table 2**. Walking and running were the most common activities engaged in before school, along with basketball and outdoor play and games. Running, mixed walking and running, and basketball were the most commonly reported activities during school, with games such as tag, chase, and hopscotch also commonly reported. Running and walking, bicycling, basketball, and horseback riding were popular activities after school. Sedentary activities such as watching television or videos and playing video games were also common before school and after school. In general, the frequencies for participation in various activities were similar across the different communities of the study.

Representative Tritrac accelerometer outputs for 2 children are shown in **Figures 1** and **2**. Each figure displays the activity of one child, quantified as the average vector magnitude per minute, over an ≈ 24 -h period. Differences in activity levels between the children are apparent. Child 1 (Figure 1), for example, was more active overall than child 2 (Figure 2), especially during the afternoon after school, as is reflected in the greater amplitudes of the minute-by-minute recordings of vector magnitudes. Also, child 1 was active for a longer duration than child 2, playing until approximately 2200, whereas child 2 removed the Tritrac for bed sometime before 2100.

Minute-by-minute vector magnitudes for a child who failed to comply with instructions to wear the fanny pack until bedtime are shown in **Figure 3**. As is evident from the plot, this child removed the fanny pack at ≈ 1600 and did not put it back on until ≈ 0630 the next day. The opportunity to examine minute-by-minute outputs and identify noncompliers is an advantage of the Tritrac accelerometer over other accelerometers that give only a cumulative index of activity. Although activity can be estimated for the period of time the child wore the instrument, estimates of average or total activity over the entire data collection period are artificially low and unrepresentative of energy expenditure.

Poor subject compliance, due to failure to wear the instrument for the prescribed time, failure to return the Tritrac accelerometer to school, return of the accelerometer by the wrong child, or

TABLE 2
Number of children participating "a lot" in various activities¹

	Before school	During school	After school
Bicycling	8	3	33
Exercise (pushups, sit-ups, jumping jacks)	12	10	17
Basketball	23	32	37
Baseball or softball	7	6	16
Volleyball	8	5	11
Ball playing (dodge ball, kick ball)	12	8	20
Games (chase, tag, hopscotch)	19	26	25
Outdoor play (climb trees, hide-and-seek)	21	12	21
Jump rope	8	1	10
Outdoor chores	7	—	21
Indoor chores	10	—	25
Mixed walking and running	29	32	35
Walking	35	22	42
Running	35	43	14
Horseback riding	12	—	39
Watching television or videos	31	—	30
Playing video games	21	—	12

¹Total n = 117.

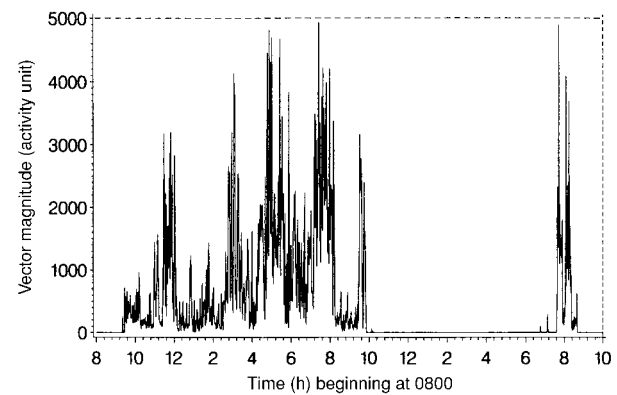


FIGURE 1. Vector magnitude over 24 h for an active child in the Pathways pilot study. Activity was assessed with use of a Tritrac-R3D accelerometer (Hemokinetics, Inc, Madison, WI).

opened fanny packs, was the main cause of missing data ($n = 17$ cases). Data were lost in another 11 cases because of failure to create or properly download data files, which may have been the result of equipment or operator error.

The average vector magnitudes and PAQ activity indexes for the 3 segments of the day are given in **Table 3**. Both methods ranked after school as the most active time of day. In contrast, more activity occurred during school than before school by Tritrac accelerometer assessment whereas the PAQ results suggested that more activity occurred before school than during school. The PAQ ranked activity for different segments of the day similarly with Tritrac accelerometer data for the total sample and for the subsample ($n = 52$). There was considerable interindividual variability in activity with CVs (SD/\bar{x}) for average vector magnitude and PAQ activity index ranging from $\approx 53\%$ to 69% , except during school, for which activity was more homogeneous (CV: 23%).

Spearman rank-order correlations were calculated between average vector magnitudes and PAQ activity indexes for the 52 children with both Tritrac accelerometer and PAQ data. The correlations were low and nonsignificant for the periods before and after school, averaging $r = 0.15$, and somewhat higher for the period of time during school ($r = 0.41$). In previous studies in older children, correlations between self-reports of activity and more objective measures such as use of heart rate monitors or

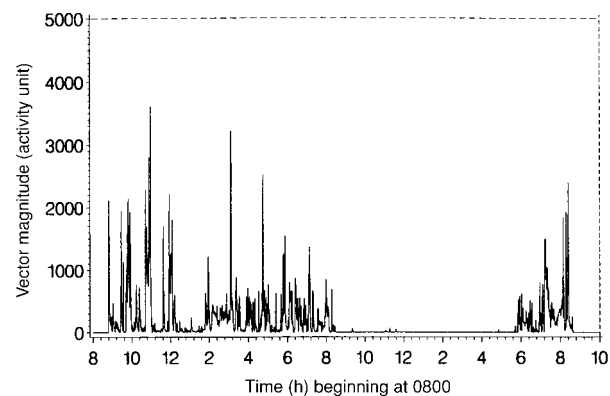


FIGURE 2. Vector magnitude over 24 h for an inactive child in the Pathways pilot study. Activity was assessed with use of a Tritrac-R3D accelerometer (Hemokinetics, Inc, Madison, WI).

TABLE 3
Average vector magnitude and activity index for 3 segments of the day¹

	Average vector magnitude (n = 52)	PAQ activity index (n = 117)
	activity unit	
Before school	413.9 ± 260.0	53.70 ± 36.84
During school	480.3 ± 111.8	43.54 ± 26.65
After school	591.8 ± 310.1	69.88 ± 42.36

¹ $\bar{x} \pm SD$. PAQ, physical activity recall questionnaire. For average vector magnitude, activity units were calculated from vector magnitudes integrated over 3 dimensions. For the PAQ activity index, activity units were calculated as the sum of the products of published metabolic equivalent unit values for the activity and the duration of the activity as described in the text.

accelerometers ranged from $r = 0.3$ to $r = 0.4$ (36). The lower correlations in the younger children in this study are not surprising. The PAQ was designed primarily to identify specific activities and not to quantify frequency and duration of activity. Although poorly correlated with Tritrac accelerometer measurements, the PAQ met its primary objective.

LESSONS LEARNED AND IMPLICATIONS FOR THE FULL-SCALE STUDY

The results of the pilot study support the feasibility of assessing physical activity in American Indian children in the Pathways study by using the Tritrac accelerometer and a self-administered 24-h PAQ. Both instruments met the feasibility criteria and together provided the information required to assess the effects of the intervention on the frequencies of various activities, the overall level of physical activity, and the amount of activity during different segments of the day. Despite some implementation difficulties, the results of the pilot study suggest that the measures will be adequate for capturing differences in activity among children and between intervention and control schools in the second phase of the Pathways study.

The instruments and procedures were accepted by both parents and children in all communities. Moreover, all children in school on the day of testing consented to completing the PAQ and wearing the fanny packs containing the Tritrac accelerometer or dummy instrument.

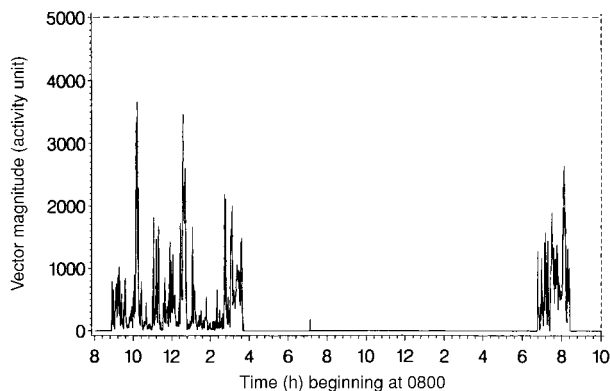


FIGURE 3. Vector magnitude over 24 h for a noncompliant child in the Pathways pilot study. Activity was assessed with use of a Tritrac-R3D accelerometer (Hemokinetics, Inc, Madison, WI).

Comparison of Tritrac accelerometer and PAQ estimates of activity in children having both measures supported the validity of the PAQ for group estimates of activity because both instruments ranked after school as the most active time of day. However, the correlations between the 2 instruments for different segments of the day were generally low, showing that individuals were ranked differently and supporting the need for both measures (22). Although questionnaires give useful qualitative information about the frequency of different types of activities and may be useful for comparisons of activity levels among groups, they have limited precision for identifying individual differences in activity. In contrast, the Tritrac accelerometer gives objective estimates of the amount of activity, but not the type of activity, and could prove useful for examining changes in activity among individuals as well as among schools.

The major limitation of the Tritrac accelerometer is that children can easily remove the fanny pack during data collection. For this reason it is necessary to assess compliance and to exclude noncompliers from the calculation of summary variables such as average vector magnitude. Otherwise, artificially low values would be retained that confound attempts to use the Tritrac accelerometer to reflect group energy expenditure. Noncompliers are easily identified by visual inspection of the minute-by-minute plots of vector magnitude. However, with large data sets, such as will be obtained in phase 2 of Pathways, use of computer algorithms to identify noncompliers is preferred. To this end, we considered the typical duration of sleep for children of this age plus an estimated time spent in bathing and dressing to be a reasonable estimate of the potential number of minutes with zero vector magnitude. We identified noncompliers as children having zero values for vector magnitude for $\geq 65\%$ of the minutes of the total collection period (6 of the 17 noncompliers noted above). Although this approach worked well in this group of third-grade children, a different estimate will likely be needed in the older children who will participate in phase 2 of the study.

On the basis of our experience in the pilot study, a follow-up study was done on 76 children and several new procedures were identified to reduce data loss. Instrument initialization and file downloading procedures were emphasized in the second training workshop. To encourage compliance, incentives were given to children who returned unopened fanny packs at the designated time, and teachers and parents were asked to more closely monitor the children at school and at home and to encourage them to wear the instrument throughout the data collection period. With these procedures in place, compliance was improved, fewer data were lost during downloading, and overall missing data were reduced from 35% to 20%.

In summary, we showed the feasibility of assessing the type and amount of activity in American Indian children by using a combination of a 24-h questionnaire and the Tritrac accelerometer. The methods were acceptable in different American Indian communities, imposed little burden on the schools and the children, and could be administered by trained staff in relatively short periods of time. The methods are being used in the full-scale Pathways study.

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