Pedometers:

Answers to FAQs from Teachers

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Pedometers offer an attractive means for student motivation and program accountability, but as with any innovation, questions abound.

In Japan, pedometers are so popular that most households there now have several. While pedometers have not yet reached this level of popularity in the United States, the media commonly discuss monitoring physical activity with pedometers. This discussion has focused both on its use as a monitoring device and as a means of physical activity motivation. With the inactivity of youths and adults raising concerns among health and fitness professionals, these professionals often ask questions about the validity and reliability of pedometers and the best ways to use them. This article, therefore, provides answers to teachers and health professionals' frequently asked questions about pedometers.

What do pedometers measure?

Early, mechanical pedometers used a swinging lever arm to count steps. Today's electronic pedometers count steps by tallying vertical motions at the hip. Small and unobtrusive, pedometers can be easily fastened to a belt or waistband. In their most basic form, pedometers measure the number of steps a person takes. Counting steps is an effective way to measure how active a person is throughout the day, even though pedometers cannot measure all types of activity. For example, since the pedometer is not waterproof, it cannot measure swimming activity. Also, the pedometer does not accurately measure activities on wheels such as bicycling, skateboarding, and rollerblading. Since people generally accumulate activity on land, pedometers are one of the best means of measurement, and their use for measuring the physical activity levels of youths is widely accepted by researchers and practitioners (Beighle, Pangrazi, & Vincent, 2001; Crouter, Schneider, Karabulut, & Bassett, 2003; Kilanowski, Consalvi, & Epstein, 1999).

What can pedometers measure other than steps?

A number of pedometers on the market do more than just count steps. Some can convert the step count into distance and caloric expenditure. In both cases, a person must first input his or her step length into the pedometer. The pedometer then multiplies the step length by the number of steps to give the distance. For caloric expenditure, the pedometer also needs the user's weight to be input before calculating the number of kilocalories expended. A few brands of pedometers also measure exercise time. This differs from the use of an ordinary watch or a stopwatch, because the pedometer's timing function records activity time in a cumulative start-and-stop fashion. In other words, the pedometer will count the activity time, stop recording when movement ceases, and resume counting when activity begins again. This gives a person the total hours and minutes of exercise time accumulated throughout the day.
Are pedometers accurate?

Activity recommendations in terms of daily minutes of physical activity for youths (Corbin & Pangrazi, 2004) and adults (United States Department of Health and Human Services, 2000) have created an interest in accurately measuring personal movement. When people are asked to recall and self-report the amount of activity they performed throughout the previous day, most find it difficult to quantify how active they were. Additionally, it may be that the recall was done on a day that is not typical, resulting in an inaccurate estimation of physical activity (Sallis, 1991). With children, some type of objective measuring tool is helpful for documenting activity levels, because it avoids dependency on recollection and the reading of questionnaires.

The pedometer is an objective activity-measuring instrument that has been studied by a number of researchers. A recent study (Crouter et al., 2003) evaluated the validity of 10 different electronic pedometers and found them to be “most accurate.” A similar study (Schneider, Crouter, Lukacijc, & Bassett, 2003) examined the reliability and accuracy of 10 pedometers over a 400-meter walk with similar results.

A limitation of pedometers is that they are less accurate when people move slowly (less than 4 kilometers, or 2.5 miles, per hour) or walk with an uneven gait (Crouter et al., 2003). Pedometers depend on a fairly consistent up and down motion with each step; so, an uneven or slow gait may not create enough movement for the pedometer to measure. In the study by Crouter et al., pedometers overestimated distance covered at slower speeds and underestimated actual distance at higher speeds. The researchers also found that caloric expenditure was most often overestimated. These errors in distance and energy expenditure are not surprising since they are all based on consistency of step length and walking speed. Throughout a day of activities, it is most likely that both step length and walking speed will vary. Another factor that contributes to the error is that some pedometers require the stride length to be entered in three-inch intervals.

Undercounting errors may also occur with highly obese students because of the placement of the pedometer. On these students, the orientation of the pedometer is often turned away from the vertical plane and moved toward the horizontal plane by excess body fat around the waist. If the pedometer is not parallel with the upright plane of the body, its accuracy is affected. In spite of these limitations, pedometers are still one of the most accurate and reasonably priced tools for measuring physical activity.

Where is the best placement for accuracy?

Pedometers are designed to be worn at the waistline directly in line with the midpoint of the front of the thigh and kneecap. This positioning will be accurate for the majority of users. However, it will not be the best placement for 20 to 30 percent of users. Therefore, the first step that should be taught to students is to find the placement where the pedometer measures most accurately. The following protocol will assure that the pedometer is measuring accurately.

1. Place the pedometer on the waistband in line with the midpoint of the thigh and kneecap. Open the pedometer without removing it from the waistband and reset it to zero steps. Begin walking at a normal cadence while counting the number of steps taken. Stop immediately when 100 steps are reached. Open the pedometer and check the step count. If the step count is within three steps of 100, this placement is an accurate location for the pedometer. If the step count is less accurate, try the next step.

2. Move the pedometer toward the outside of the body so it is positioned slightly in front of or over the hip. Open the pedometer, clear it, and take 100 steps as described in step one. Again, if the step count is within three steps of 100, this new placement will be the most accurate measurement spot. If not, try another placement (see the next step) and repeat the step test. This placement seems to work better for some females and overweight students.

3. Pedometers must remain in an upright plane (with the pedometer display perpendicular to the floor and parallel to the body) in order to accurately register step counts. Another factor that confounds accuracy is loose-fitting clothing because it absorbs the slight vertical force that occurs with each step. In these cases, placement at waist level behind the hip and on the back is often accurate. Another alternative is to use a Velcro belt to assure that the pedometer is maintained in an upright position. Repeat the 100-step process until an accurate placement has been identified.

Do pedometers measure the intensity of physical activity?

Pedometers measure weight-bearing activities including walking, jogging, and running. Most people have experienced activities that range in intensity from easy to difficult. Students have often been taught that not all activity is worthwhile and that some types of physical activity seem to be valued more than others. For example, joggers may look down their nose at a person who is walking. However, soon the joggers may come across marathon runners who look down their nose at the joggers. Instead of worrying about this hierarchy, the message to be communicated to students is that all types of physical activity are beneficial and contribute to health and wellness. Pedometers measure most activity counts regardless of intensity, so students learn that all activity is beneficial.

In the hierarchy example above, intensity of activity was the factor used to justify the notion that one activity was better than another. Individuals who choose to exercise at a high intensity will certainly benefit from their choice. However, for the vast majority of children and adults, intense activity is not the most desirable form of physical activity. Most children choose not to participate in high-intensity activities (Corbin and Pangrazi, 2004). That is the reason current NASPE physical activity guidelines for children (Corbin and Pangrazi, 2004) call for 60 or more minutes of moderate to vigorous activity nearly every day.
dometers that record only steps, individuals can see how many steps have been taken, but the step count does not provide an indication of intensity. Newer pedometers measure exercise time and steps, which can offer an indirect look at intensity. On an individual basis, if a person takes more steps in a specified amount of time, the activity is probably more intense for that person. Based on data gathered by the authors, it appears that moderate to vigorous walking is in the range of 100 to 110 steps per minute. This range could be used as a general indicator of the number of steps per minute required to maintain a moderate walking speed.

**How many daily steps should be accumulated?**

There is no single answer to this question. A number of alternatives are possible for making such a determination. A common approach is a "one standard fits all" approach. Application of this approach is based on a single standard and assumes that it will work for all types of people regardless of age, gender, or health. The most often referenced standard is 10,000 steps per day (Hatano, 1993). This standard was designed for cardiovascular disease prevention, but it has grown in popularity. It is a simple and quick way to tell people what their goal should be. A standard for children that is often mentioned is 11,000 steps per day for girls and 13,000 steps per day for boys. This standard is used for the Presidential Active Lifestyle Award (President's Council on Physical Fitness and Sports, 2004), which is awarded to students who meet these daily standards over a six-week period.

The problem with a single-standard goal is that it fails to take into account the substantial individual differences between people based on age and gender. A predisposition to be active may make it much easier for some students to reach the step criteria, while others may find it next to impossible because they are naturally less active. How many steps should we set for a standard? Should it be set high so only those already active individuals can reach it? Should it be set low so the majority of people are able to reach the goal? Should it be set high enough to provide a proven health-related benefit? If you accumulate more than 11,000 steps, is there any point in moving beyond the 11,000-step threshold? If you accumulate 4,000 steps each day, does 11,000 steps seem an impossible goal? Setting one goal that applies with equivalent efficacy to a large population is a difficult proposition at best.

Another approach is the baseline and goal-setting technique (Pangrazi, Beighle, & Sidman, 2003). This method requires that each individual identify his or her average daily activity (baseline) level. For elementary school students, this requires four days of monitoring pedometer step counts (or activity time). For adolescents and adults, it requires eight days of activity monitoring (Trost, Pate, Freedson, Sallis, & Taylor, 2000). There is a longer period of monitoring for older individuals because their days are much more variable than young children. Since older students and adults have more control over the use of their time, eight days offers a more accurate baseline level. Baseline data can be entered in a chart similar to the one shown in figure 1.

After the baseline level of activity has been established, each individual has a reference point for setting a personal goal. The personal goal is established by taking the baseline activity level and adding 10 percent more steps to that level. For example, assume someone has a baseline of 6,000 steps per day. The personal goal would be 6,600 steps plus 600 (10 percent) more steps for a total of 6,600 steps. This will be the personal goal for the next two weeks. If the goal is reached for a majority of the days during this two-week period, another 10 percent (600 steps) is added to the goal and the process is repeated. For most people, a top goal of 4,000 to 6,000 steps above their baseline level is a reasonable expectation. Using the example of 6,000 baseline steps here, a goal of 10,000 to 12,000 steps would be the ultimate activity level.

This baseline and goal-setting approach takes into consideration the fact that all individuals are unique. It gradually increases personal goals so they seem achievable even to inactive individuals. Most individuals are interested in establishing their baseline levels of activity and this can be a good way to increase activity levels among young and old individuals.

A third way to establish step levels for youths is to define a healthy activity zone (HAZ). In this method, there is not one standard that each student has to reach. This approach has been utilized by Fitnessgram (Cooper Institute for Aerobic Research, 2004) for specifying a range of scores (the healthy fitness zone) where students should score on fitness test items. Some of the Fitnessgram test items (e.g., PACER run and skinfolds) are based on health-related criteria, while others are based on improvement due to training. Applied to physical activity, a range of steps (or activity time) that would serve as the HAZ can be established for each gender. This method requires further research, but it may be an acceptable way to establish a range of scores that can apply to the vast majority of children and adults. It is also possible that a combination of methods such as baseline and goal setting and HAZ standards will ultimately be the best solution.

**Can pedometers assure program accountability?**

A common responsibility for physical education teachers is to find criteria for which they can be held accountable. Some teachers have chosen fitness or skill development as outcomes they are willing to use as a measure of their success. There are a number of issues that teachers should consider before choosing fitness or skill development as their success criteria.

Fitness is most commonly used because fitness tests have long been administered in the school setting. However, such tests may not be a good choice, particularly for teachers of preadolescent children. Fitness scores have not significantly improved over the past 40 to 50 years in the United States (Corbin & Pangrazi, 1992). Furthermore, with the increasing number of overweight and obese youths, fitness scores are actually decreasing because obesity lowers fitness.
Figure 1. Setting Personal Activity Goals with Pedometers

Step 1. Calculate Your Baseline Step Counts

<table>
<thead>
<tr>
<th>Elementary School Students</th>
<th>Middle/High School Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1 Step Counts ________</td>
<td>Day 1 Step Counts ________</td>
</tr>
<tr>
<td>Day 2 Step Counts ________</td>
<td>Day 2 Step Counts ________</td>
</tr>
<tr>
<td>Day 3 Step Counts ________</td>
<td>Day 3 Step Counts ________</td>
</tr>
<tr>
<td>Day 4 Step Counts ________</td>
<td>Day 4 Step Counts ________</td>
</tr>
<tr>
<td>Total Step Counts ________ divided by 4</td>
<td>Total Step Counts ________ divided by 8</td>
</tr>
<tr>
<td>equals ________</td>
<td>equals ________</td>
</tr>
<tr>
<td>This number is your baseline activity and will be used to determine your personal activity goal.</td>
<td>This number is your baseline activity and will be used to determine your personal activity goal.</td>
</tr>
</tbody>
</table>

The next step is to calculate your personal step count goal. A couple of examples are shown below. The first person discovered they had a baseline step count of 4,000 steps. After 10 weeks, their step count goal increases to 6,000 steps. For the person who had a baseline of 6,000 steps, their step count goal will increase to 9,000 steps by the 9th and 10th week. Thus, both individuals will increase their number of step counts by one third. However, the more active person will have to improve more steps.

Step 2. Calculate your Step Count Goal

<table>
<thead>
<tr>
<th>Baseline</th>
<th>Personal Goal (10% of your baseline plus your baseline)</th>
<th>Weeks</th>
<th>Total Step Counts</th>
</tr>
</thead>
<tbody>
<tr>
<td>6,000 steps</td>
<td>6,000 X .10=600 steps + 6,000</td>
<td>1 &amp; 2</td>
<td>6,600</td>
</tr>
<tr>
<td>Every two weeks thereafter, the goal will be increased by 600 steps.</td>
<td>3 &amp; 4</td>
<td>7,200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 &amp; 6</td>
<td>7,800</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7 &amp; 8</td>
<td>8,400</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9 &amp; 10</td>
<td>9,000</td>
<td></td>
</tr>
</tbody>
</table>

test performance. Common sense indicates that aerobic endurance and various strength measures are directly affected by the increase in body fat among youths. In addition, genetics strongly influences the ability to respond to training (Bourchard, 1999); consequently, some individuals show little or no improvement with training. Finally, the amount of time currently available for physical activity during the school day limits chances of improving fitness to an extent measurable by fitness testing. Although elementary school children will improve on fitness test scores purely as a result of maturation, this is not an accurate representation of the teacher's contribution to student fitness. Using fitness as the focal indicator of actual teaching success may be inviting failure.

Skill development is an important assessment outcome for physical education. However, a large part of skill performance is genetically endowed, much in the same way that some students are born better artists or musicians. Additionally, physical skills can be difficult to evaluate due to time constraints and the overall numbers of students seen by the physical education teacher.

Perfection is never reached in the performance of physical skills. For example, even the best basketball and soccer players in the world miss as many shots as they make. Baseball players make an "out" three times out of every 10 at bat. Rugby players fumble the ball and miss kicks. This does not imply that skills should not be emphasized or assessed, but since the nature of physical skill performance is one of imperfection, it is asking a lot of teachers to base the success of their program on the skill performance of students. Also, for the evaluation of skill development, there are few instruments available that are valid, reliable, and easy to adminis-
ter in a limited-time environment. Teachers are aware of this “catch-22.” If they take a lot of time to observe skill performance, they will have little time left to teach these same skills.

A suggestion is to base program success on an average school increase in physical activity. What could be more important for health and wellness than increasing the amount of activity that children accumulate on a daily basis? All students can move and be physically active in settings both in and out of school. Unless there is a physical disability, all students can monitor their physical activity levels using pedometers. Most parents would be delighted if their children were taught to live an active lifestyle. That could be one of the best legacies a physical education program could leave students.

Pedometers can be used to evaluate the baseline activity levels of students at or near the start of the school year and then used to monitor their activity a number of times throughout the school year. Goals for increasing daily physical activity can be increased by all students regardless of genetic predisposition. Physical education teachers can establish goals for a number of sub-groups, including classes, grade levels, and gender. School administrators might accept a two percent increase in physical activity accumulated as a school-wide goal over an 18-week period. Activity levels both in and out of schools could be used as separate outcomes. Out-of-school activity can be regarded as physical education homework. A program designed to increase the amount of physical activity that students accumulate on a daily basis makes a valuable contribution to all students in the school environment.

How can pedometers be used in a daily class setting?

After deciding to use pedometers in a class, the first necessity is to obtain the devices. Pedometers can cost between $11 and $22 apiece, depending on the type, so the outlay for a class of 36 would be between $400 and $800. In many cases, parent-teacher associations have agreed to fund pedometers after learning about their value from a presentation made to the group. Another way to obtain funds is through a “shareware” program, in which a company wholesales the pedometers to the school. The school can then pay for the pedometers (and even make a profit) by selling them to parents and others. This form of fundraising has the added advantage of being healthier than a bake sale. If the full funding is unavailable, a limited number of pedometers could be purchased and shared by students (e.g., with groups of students using the pedometers on alternate days).

In view of the cost of pedometers, it is especially important that they are not damaged, lost, or stolen. In addition, teachers will want to minimize the time involved in the mechanical aspects of their use, such as distributing them, putting them on, resetting them, and so forth. To deal with these concerns, teachers must establish a set of procedures and teach these procedures to the students. Morgan, Pangrazi, and Beighle (2003) have detailed the recommended procedures for implementing pedometers in physical education.

The specific application of pedometers in class depends both on the grade level and the content of the unit. In addition to their use for measuring activity levels in a unit on health and fitness, they can be incorporated into a variety of critical-thinking and cross-disciplinary activities. For example, students could conduct their own research project on a wide range of questions: do students take more steps during a basketball class or during a soccer class, are parents or children more active, and what is the relationship between a person’s height and stride length? A popular cross-disciplinary activity is “Moving Across Our Country,” which integrates math, social studies, and English, as students use their daily step count to plot an imaginary journey across a map of the region, state, or nation.

A good way to increase enthusiasm for pedometer use is with a school-wide steps contest. The step counts of all students in each class, including the teacher, are added and then divided by the number of students. Finding the average number of steps for the entire class makes this a group competition and avoids putting down students who are less active. A gentle reminder here is that students should not have to reveal their step count unless they choose to do so. A sensitive approach is to have the students place their step counts anonymously on a tally sheet.

Detailed descriptions of these and other applications appear in a variety of sources, including Beighle et al. (2001), Morgan et al. (2003), and a resource book entitled Pedometer Power (Pangrazi, Beighle, & Sidman, 2003).

Making use of pedometers does not require a wholesale change in the curriculum. Their greatest value lies in their use as a teaching tool that can be applied in many different units of the existing curriculum. By giving students feedback about their personal activity levels, pedometers have the power to motivate them to think about and do more moving.

References


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