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Utility of the Youth Compendium of Physical Activities

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Abstract

Purpose.—The purposes of this paper are to: (1) describe the rationale and development of the Youth Compendium of Physical Activities (Youth Compendium); and (2) discuss the utility of the Youth Compendium for audiences to include research, education, community, healthcare, public health, and the private sector.

Methods.—The Youth Compendium provides a list of 196 physical activities (PA) categorized by activity types, specific activities, and metabolic costs (Youth METs, MET_y) as measured by indirect calorimetry. The utility of the Youth Compendium was assessed by describing ways in which it can be used by a variety of audiences.

Results.—Researchers can use MET_y values to estimate PA levels and determine changes in physical activity in intervention studies. Educators can ask students to complete PA records to determine time spent in physical activities and to identify health-enhancing activities for classroom PA breaks. Community leaders, parents, and healthcare professionals can identify activity types that promote healthful behaviors. Public health agencies can use the MET_y values

Conflicts of Interest

None of the authors has conflicts or potential conflicts of interest, including relevant financial interests, activities, relationships, and affiliations related to this research. The results of the study are presented clearly, honestly, and without fabrication, falsification, or inappropriate data manipulation.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention. The contents of this publication do not necessarily reflect the views or policies of the USDA, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government.

for surveillance and as a resource to inform progress toward meeting national physical activity guidelines. Applications for the private sector include the use of MET_y in PA trackers and other applications.

Conclusion.—The National Collaborative on Childhood Obesity Research (NCCOR) website presents the Youth Compendium and related materials to facilitate measurement of the energy cost of nearly 200 physical activities in children and youth. The Youth Compendium provides a way to standardize energy costs in children and youth and has application for a wide variety of audiences.

Keywords

Adolescent; Children; Energy Expenditure; MET

Introduction

Since the development of the President's Council on Sports, Fitness, and Nutrition in 1956, educators and healthcare professionals have been interested in improving levels of physical activity and physical fitness of America's children and youth (U.S. Department of Health and Human Services, 2018). Despite this interest, changes in access to physical education in schools, physical activity in communities along with increased opportunities for sedentary behaviors have paralleled the rise in child and youth overweight and obesity (Commission on Ending Childhood Obesity, 2016). Accordingly, experts have led efforts to identify the amount of physical activity children and youth obtain on a daily basis and to understand the relationships between physical activity and health outcomes in youth (U.S. Department of Health and Human Services, 2008). In 2008, the Physical Activity Guidelines for Americans identified physical activity goals for youth to include 60 minutes per day of physical activity, with vigorous-intensity activities, muscle strengthening, and bone-loading activities performed at least 3 days per week (Office of Disease Prevention and Health Promotion, 2018a).

In addition to monitoring guidelines in high school students at a national level (Office of Disease Prevention and Health Promotion, 2018b), cross-sectional and longitudinal studies show the proportion of children and youth who meet these guidelines (Barr-Anderson, 2017; Fakhouri, 2014; Gahche, 2014; Katzmarzyk, 2016). Experimental trials demonstrate effective ways to increase physical activity occurring during school, home, and community settings and as part of transportation activities (Beets, 2016; van Sluijs, 2007).

There are several methods available to estimate physical activity in children and youth. Systematic observation systems can identify physical education teacher behaviors and related student physical activity engagement in classrooms (T. McKenzie, Smith NJ, 2017) and can scan physical activity behaviors in play spaces (Ward, 2014). Questionnaires can identify the type, frequency, intensity, and setting of physical activities completed. These questionnaires require children and youth to identify their activities or have parents serve as a proxy reporter for their young children. Wearable monitors record body movements to estimate frequency, duration, and intensity of activities performed and can identify the time spent in light-, moderate-, and vigorous-intensity physical activities. Regardless of the method used, knowing the intensity level of the physical activities in which children

and youth participate can help researchers and practitioners understand patterns of physical activity, prescribe an optimal amount of physical activity, and encourage participation in physical activity. The Youth Compendium provides such a resource to ascribe physical activity intensity levels to nearly 200 activities in which children and youth participate. Therefore, the purposes of this paper are to: (1) describe the rationale and development of the Youth Compendium of Physical Activities (Youth Compendium); and (2) discuss the utility of the Youth Compendium for audiences to include research, education, community, healthcare, public health, and the private sector.

Rationale for the Youth Compendium of Physical Activities

Knowledge about the amount of energy that is required to carry out various types of physical activities, from watching TV to running a race, is an important resource for physical activity researchers and practitioners. The values used to express energy expenditure are a vital tool for connecting physical activity behavior and health. In 1993, the Adult Compendium of Physical Activities (referred to as the Adult Compendium) (Ainsworth, 2011) was released as a source to standardize adult energy expenditure. The Adult Compendium is a comprehensive list of the energy cost of physical activities and sedentary behaviors. Initially published in 1993 and revised in 2000 and 2011, the Adult Compendium is a reference for physical activity intensity values of activities listed in questionnaires, diaries, and logs. However, the Adult Compendium is inappropriate to use with children and youth as it defines one MET (Metabolic Equivalent of Task) as the ratio of the activity metabolic rate in ml/kg/min to a standard resting metabolic rate (RMR) of 3.5 ml/kg/min. As the RMR in children and youth is higher than in adults and children, youth, and adults differ in their body mass and movement economy applying adult MET values will likely underestimate the energy cost of physical activities in children and youth. In addition, the types of physical activities performed by children and youth differ from those of adults (e.g., four square, hopscotch, kickball), rendering the Adult Compendium inappropriate for use in children and youth.

In 2008, Ridley et al. published a Compendium of Physical Activities for Youth (referred to here as the Ridley Compendium) that presented MET values for 244 activities (K. Ridley, Ainsworth BE, Olds TS, 2008). The Ridley Compendium used MET values from a literature review of child- and youth-specific energy costs where only 35% of values were taken from empirical studies of children and youth energy expenditure and the remaining data were taken from the Adult Compendium. The Ridley Compendium also reported a single MET value per activity for children and youth ranging in age from 6 to18 years. Although the Ridley Compendium was a good first attempt to standardize energy costs, because of these limitations, there was a need for an improved version.

Development of the Youth Compendium of Physical Activities

In 2012, the Centers for Disease Control and Prevention (CDC), the National Cancer Institute (NCI), and the National Collaborative for Childhood Obesity Research (NCCOR) convened the Youth Energy Expenditure Workshop to address the lack of standardized physical activity intensity values for children and youth. The workshop attendees consisted of international experts in the assessment of physical activity and children and youth

physical activity. Meeting participants presented the state of the science about assessment of physical activity in children and youth and how to measure energy expenditure. The meeting outcome resulted in an agreement that an updated, expanded, and web-accessible compendium would be a valuable contribution to the field. The Youth Energy Expenditure workgroup was established and set about to develop methods and measures feasible to create standardized values for common activities performed by children and youth. To accomplish this, the workgroup developed three goals.

The first goal was to develop a metric to express the energy cost of specific physical activities. The ideal metric needed to be age independent, mass specific, have a low variance among measured values, simple to use, and composed of existing measurements found in the literature. Of the criteria identified as ideal, it was essential that the metric be independent of the effects of age on the RMR (S. Herrmann, McMurray RG, Kim Y, Willis EA, Kang M, McCurdy T, 2017; McMurray, 2015). A literature search identified eight metrics used in studies to express the RMR in children and youth (McMurray, 2015). Three metrics (allometric scaling, VO_2 net, and a youth MET value) accounted for the smallest amount of total variance (R^2) for the age and physical characteristics, indicating that these metrics were least associated with age and sex. For practical reasons such as translation and generalizability, the work group selected the youth MET value (MET_y), computed as the measured oxygen cost in ml/kg/min of an activity divided by a child-specific RMR value as the recommended metric for the Youth Compendium.

Recognizing that even the recommended metric was still dependent on age, the group next sought to determine how best to account for the dependency of age. Using the same data, the group examined the accuracy of accounting for age dependency through incorporating age groups (6–9, 10–12, 13–15, and 16–18 years) and through using age in years compared to using a constant for all ages to express energy costs (Pfeiffer, 2018). The four age groups represent pre-, early, mid- and late adolescence. The scarcity of published data in children less than 6 years of age precluded a younger age group. Age groups and age in years had similar and lower errors in the regression models than using a constant age; therefore, the use of age groups was more practical for potential Compendium users and was the recommended approach adopted by the working group.

The second goal was to conduct a systematic literature review to identify studies that measured the intensity of physical activities in ml/kg/min with indirect calorimetry in children and youth ages 6–18 years. Investigators conducted two literature searches that yielded 21,921 hits. After removing 11,606 duplicate articles, 75 studies were included in the review of walking and running at various speeds, while 90 studies were included in the review of specific activities. Investigators reviewed abstracts for inclusion and exclusion criteria and, as needed, contacted the article authors to clarify or obtain missing data. For quality assurance, investigators double coded about 40% of the studies to assure they extracted the correct information. Results gleaned 101 new studies not included in the Ridley Compendium. For these activities MET_y values were calculated by dividing the published mean energy cost for the activity by a mean BMR for the sample, predicted using age-,sex-, and mass-specific Schofield equations (Schofield, 1985). The physical activity intensity values were entered into a database to enable the construction of the new Youth

Compendium of Physical Activities. The final report for the systematic literature review is published on the NCCOR website (K. Ridley, 2013, 2016).

The third goal was to solicit unpublished data on energy expenditure in children and youth performing physical activity. In 2015, the working group broadcast a call for papers to attract submissions for a special supplement in the *Journal of Physical Activity and Health.* Studies were required to measure the energy expenditure of activities with indirect calorimetry or whole-room calorimetry. The supplement was published in 2016 (S. Herrmann, Pfeiffer KA 2016) with 17 manuscripts that included nearly 250 separate activities among children and youth ages 3–18 years.

The resulting Youth Compendium of Physical Activities includes sixteen major activity categories to reflect body position (sitting, standing, lying down), upper or lower body movement, locomotion, and weight or non-weight bearing of 196 activities (Butte, 2018). Table 1 presents a list of the 16 categories. The MET_y values have four age groups (6–9, 10–12, 13–15, and 16–18 years) to reflect differences in the BMR (and resulting MET_y values) by age. Modeled after the 5-digit code used in the Adult Compendium, each activity in the Youth Compendium has a 6-digit code. The first two digits identify the activity category (e.g., walking), the next three digits identify a specific activity (e.g., walking at 3.0 mph), and the last digit identifies the age group (1, reserved for 2–5 y; 2 for 6–9 y; 3 for 10–12; 4 for 13–15; and 5 for 16–18 y). Because some age groups did not have measured oxygen uptake values, MET_y were imputed using multilevel modeling methods (Butte, 2018). To assure each imputed MET_y value was consistent with measured values, researchers smoothed the data using the regression of imputed and observed MET_y values on age to obtain model-based estimates from multilevel regression equations available (Butte, 2018). Tables for the smoothed, imputed, and observed MET_y values are available at https://www.nccor.org/tools-youthcompendium/downloads/. A description of the development of the MET_y values is available (Butte, 2018).

Utility of the Youth Compendium of Physical Activities

The Youth Compendium is a valuable resource for a variety of audiences to include research, education, community, healthcare, public health, and the private sector. For these audiences, the Youth Compendium can provide standardized MET_y values and allows for consistency of estimates across a variety of methodologies. The following descriptions provide examples of the utility of the Youth Compendium for research, education, community, healthcare, public health, and private sectors to assess the intensity of types of physical activities performed by children and youth.

Research

Research studies use various methods to quantify the frequency, intensity, duration, and types of physical activities performed by children and youth in research settings (R. Pate, McIver KL, Colabianchi N, Troiano RP, Reis JP, Carroll DD, Fulton JE, 2015). Many studies also have children and youth wear devices (e.g., step counters or accelerometers) to measure movement. These devices however are usually unable to detect physical activity type without sophisticated modeling techniques (Strath, 2013). Knowing the physical

activity type and intensity are important parameters for researchers who are designing interventions to increase physical activity among children and youth or who are examining the associations between physical activity and health or social and physical environments (G. Dunton, Berrigan D, Ballard-Barbash R, Perna F, Graubard BI, Atienza AA, 2012).

The Youth Compendium provides a way to standardize the energy costs of physical activities across a variety of measurement methods such as questionnaires, direct observation, ecological momentary assessment, and time use surveys and recalls (Table 2, Figure 1) (G. Dunton, Liao Y, Intille S, Wolch J, Pentz MA, 2011; Kelly, 2015; Matthews, 2018; T. McKenzie, Marshall SJ, Sallis JF, Conway TL, 2000; R. Pate, Ross R, Dowda M, Trost SG, Sirard JR, 2003; K. Ridley, Olds TS, Hill A, 2006; Tudor-Locke, 2009). For example, Figure 1 lists the activities performed between 9:00 AM and 12:30 PM by a 10 year old youth. The youth spent 499.5 MET-minutes engaged in activities in which the body position moved. By having a choice of different methods, researchers can use the physical activity assessment most appropriate for their work while still having the ability to translate to common measures. Researchers can assign intensity levels or MET_y minutes to activities listed in the instruments to derive estimates such as daily minutes of moderate- to vigorous-intensity physical activity, average MET_y-minutes per day, or physical activity level.

The usefulness to the research setting extends beyond obtaining physical activity estimates from different assessment methods for use in research studies. It can also play a role in designing some areas for future research activities. There is a need to increase the number of activities and the age groups listed in the Youth Compendium since it does not include all activities in which children and youth perform. A useful research activity is to measure the energy cost of physical activities performed by children and youth, to expand the list of activities with energy costs in the Youth Compendium. Critical areas for further measurement of energy costs include: 1) energy cost of activities in very young children and older youth and 2) energy costs of specific activities such as transport, occupational work, gardening, and certain sports such as ice skating, skateboarding, water polo, and softball) which are not available. In addition, the Youth Compendium is not applicable to children with illnesses or disabilities that alter movement or mechanical efficiency and thereby the energy cost of activities. For older youth, measurements of occupational activity are a notable gap. This is particularly important for applications of the Compendium worldwide since recent estimates indicate almost 220 million children from ages 5 to 17 years are employed (http://www.ilo.org/global/topics/child-labour/lang--en/index.htm).

Education

The Youth Compendium has several applications in educational settings from K-12 grade to graduate level projects. Unique to the Youth Compendium is a systematic organization of intensity levels of sedentary behaviors and physical activities performed by children and youth 6–18 years. K-12 physical education teachers can use the Youth Compendium to develop lesson plans aimed at meeting national physical activity guidelines. For example, teachers can focus on moderate-intensity types of activities (e.g., active video games ranging 4.2–7.1 MET_y) for in-class activity periods. Physical education teachers also can use the Youth Compendium to identify the intensity level of physical activities used to

increase physical fitness or motor skills during class or structured play periods. NCCOR has developed a set of fact sheets for physical education teachers as a resource to select activities aimed at accumulating 60 minutes of physical activity per day (www.nccor.org).

Classroom teachers can use the Youth Compendium in class assignments to teach students about the energy costs of physical activities. For example, students may complete an activity diary of all activities performed during an afterschool period or recall activities performed from a prior period (see Figure 1 for an example of an activity diary). The students can record the time they perform specific activities and use the Youth Compendium to identify the MET_y value for each activity. By multiplying the MET_y with time in minutes, one can compute a metric to show the time spent in an activity standardized to a single intensity (i.e., MET-minutes and/or MET-hours). By multiplying the MET-minutes by students BMR in kilograms per minute, one can estimate the kilocalorie energy expenditure of an activity. Table 3 provides an example of calculations used to compute these metrics. For example, a 12-year-old male student who weighs 40 kg would expend 92.4 kilocalories playing hopscotch. First we estimate the BMR using Schofield's equation for 10–18y boys (10–18y BMR (kcal/min) = [17.686 × Weight (kg) + 658.2]/1440). The predicted BMR for the 40 kg 12-year-old boy is as follows:

$$\text{Predicted BMR} = [17{:}686 \times 40\ \text{kg} + 658\,.2]/1440 = 0.948\ \text{kcal min}^{-1}.$$

Given a METy of 6.5 for 10–12 years for hopscotch for 15 minutes for a 40 kg 12-year-old boy who has a BMR of 0.948, the estimated kilocalories is 92.4.Such lessons may be important in science, math, health, or physical education class settings to discuss the importance of physical activity in weight management and health outcomes. Students also can become aware of how much time they spent in sedentary behaviors or in physical activities deemed sufficient to meet national physical activity guidelines.

Community

Parents, recreation professionals, public health employees, and other community members often seek opportunities to provide children and youth with appropriate and enjoyable physical activity experiences. Parents, in conjunction with their health care practitioner, can use the Youth Compendium to identify the energy cost of children's physical activities for use in increasing physical activities, or promoting activity at higher intensities. Recreation professionals, public health professionals, and other community members also can use MET_y values when selecting intensity- and age-appropriate activities for programs to increase physical activity among children and youth. The Youth Compendium provides a list of activities commonly performed by children and youth that may be useful in programming health-enhancing activities for children and youth.

Healthcare

The Youth Compendium can inform health professionals about the types of physical activities sufficient to promote health and prevent disease in children and youth. Although the evidence about how healthcare professionals should counsel child and youth patients

about physical activity is inconclusive, interventions and messages to increase physical activity should be developmentally appropriate and be grounded in theories of health behavior. As such, tailoring the physical activity messages to include age- and intensity-appropriate activities and perceived as fun by the patient, may increase the likelihood of physical activity participation (Centers for Disease Control and Prevention, 2015; Meriwether, 2008). Healthcare professionals can use the Youth Compendium to identify intensity appropriate activities as part of the tailoring process. Healthcare professionals may also find the Youth Compendium useful in determining physical activity level, as it is one of the factors considered when determining the number of calories children and youth need each day (U.S. Department of Health and Human Services and U.S. Department of Agriculture, December 2015).

Public Health

The Youth Compendium may be useful to public health audiences interested in monitoring and tracking physical activity and in reporting on the association between energy expenditure and other factors. MET_y values and duration of activity may be translated to an estimate of the prevalence of children and youth meeting the aerobic component of global physical activity guidelines (60 minutes of moderate- to vigorous-intensity physical activity daily and vigorous-intensity and strengthening/bone building activities at least 3 days per week) (World Health Organization, 2010) or minutes engaged in recreational screen time. The Canadian government 24-hour movement and activity guidelines for children and youth 5 years and older recommend no more than 2 hours per day of recreational screen time (Canadian Society for Exercise Physiology, 2018). An example of where the Youth Compendium may be useful to examine associations between energy costs and other factors is for use in national surveys at a national level is with the that captures activity types such as the 2005–2006 National Health and Nutrition Examination Survey. MET_y values from the Youth Compendium could be assigned to the individual activities performed in the past 30 days as reported by children and youth 12 years and older (National Center for Health Statistics, 2006) to examine the association among energy costs, dietary intake, and obesity.

Private Sector

Commercial activity trackers, energy balance websites, and electronic activity records rely on published MET values to determine the intensity of physical activity types within the system. Historically, commercial trackers and websites have used the Adult Compendium to assign MET values to their activities listed. This can be a concern if one uses 3.5 ml/kg/min in children and youth to assign MET values, as it will underestimate the energy cost of the activity in children and youth. To improve their accuracy, the physical activity intensity values used in commercial activity trackers and energy balance websites may wish to consider using the MET_y values presented in the Youth Compendium.

Limitations of the Youth Compendium of Physical Activities

The MET_y values for the Compendium are based on measured metabolic data from children and youth. As such, all activities could not be included, nor does the Compendium represent all ages of children and youth. In addition, there is a need for more data collection of energy

costs of specific subpopulations such as children with illnesses or disabilities that influence the energy cost of activities. We encourage users of the Youth Compendium to bear in mind that the reported MET scores represent average values, individual energy expenditures will vary, sometimes widely, especially for nominally more intense activities. Thus, great care should be exercised when attempting to estimate and interpret individual level energy expenditures based on self-reported physical activity and MET score linkages.

Website and Resources

NCCOR maintains the website for the Youth Compendium (https://www.nccor.org/tools-youthcompendium/). The website provides links to the background and methods used to develop the MET_y values, an excel file with the Youth Compendium data, tips on how to access and use the data, and frequently asked questions. The NCCOR website also provides reports and copies of published manuscripts that describe stages of the development of the Youth Compendium.

Summary and Conclusions

Information on energy expenditure is important for promoting physical activity in children and youth for their health, well-being, and to reduce the future risk of developing adult diseases. The Youth Compendium of Physical Activities provides MET_y values that reflect the energy cost of physical activities and sedentary behaviors in children and youth 6–17 years. The new Youth Compendium will be a valuable resource to standardize the scoring and interpretation of physical activity data from children and youth to be used by anyone or agency working with a variety of audiences to include research, education, community, healthcare, public health, and the private sector.

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TIME BEGAN (circle AM or PM)	**TIME ENDED** (circle AM or PM)	**BODY POSITION** (circle one)	**DESCRIPTION** (write your activity)	**HOW HARD?** (circle one)	**ACTIVITY GROUP** (insert from list)	**6-DIGIT COMPENDIUM CODE** (insert from list)	**MET VALUE** (for your age group)	**MINUTES IN ACTIVITY**	**MET-MINUTES** (METs x minutes)
9:00 (AM) PM	9:15 (AM) PM	Recline Sitting Standing (Moving)	Hopscotch with little sister	Light (Moderate) Vigorous	Active Play	102403	6.5	15	97.5
9:15 (AM) PM	10:15 (AM) PM	(Recline) Sitting Standing Moving	Did homework on computer	(Light) Moderate Vigorous	Quiet Play/ Schoolwork /Television (Sitting)	551603	1.5	60	90.0
10:15 (AM) PM	11:00 (AM) PM	Recline Sitting Standing (Moving)	Soccer game	Light (Moderate) Vigorous	Sports/ Games	654803	8.1	45	364.5
11:00 (AM) PM	11:30 (AM) PM	Recline Sitting Standing (Moving)	Went for walk (3 mph)	Light (Moderate) Vigorous	Walking	802003	4.1	30	123.0
11:30 (AM) PM	12:00 AM (PM)	(Recline) Sitting Standing Moving	Watched TV	(Light) Moderate Vigorous	Quiet Play/ Schoolwork /Television (Sitting)	554803	1.3	30	39.0
						TOTAL MOVING (add min & add MET-min)		90	585.0
						TOTAL RECLINE/SIT/STAND (add min & add MET-min)		90	129

Figure 1.

An example of a physical activity diary to record the time spent in types of physical activities and sedentary behaviors

Note: For exemplar purposes, diary entries start after the 10 year old youth has arisen from bed, got dressed, and had breakfast and end before youth had lunch; Diary activities match activities in Table 3

Table 1.

List of the 16 categories included in the Youth Compendium of Physical Activities

Number	Category
1	Active Play
2	Active Video Games (Full Body)
3	Active Video Games (Upper Body)
4	Bike/Scooter Riding
5	Calisthenics/Gymnastics
6	Computer/Video Games (Sitting)
7	Dance/Aerobics/Steps
8	Housekeeping/Work
9	Lying
10	Quiet Play/Schoolwork/Television (Sitting)
11	Running
12	Sports/Games
13	Standing
14	Swimming
15	Walking
16	Weightlifting

Table 2.

Application of the Youth Compendium of Physical Activities to common physical activity measurement methods

Method	Questionnaire
Example	Three Day Physical Activity recall (3DPAR)
Description	• Includes seven activity categories (eating, work, afterschool and spare time hobbies, transportation, sleep and bathing, school, and physical activities and sports) • Each category lists 50 activities from which to select • Respondent lists activity and relative intensity (performed every half hour in light, moderate, hard, or very hard intensity)
How Used	• METy assigned to each activity • Summary score combines the duration and intensity of each activity performed over three days
Reference	R. Pate, Ross R, Dowda M, Trost SG, Sirard JR, 2003
Method	Direct Observation
Example	System for Observing Play and Leisure Activity in Youth (SOPLAY)
Description	Directly observes physical activity and associated environmental characteristics in free play settings, such as recess
How Used	• Observers scan play areas and record the predominant type of activity (e.g., aerobics, volleyball, basketball) in specific areas using one of 16 codes, an activity category (sedentary, walking, or very active) and the duration of activity performed • Summary scores reflect the type, duration, and intensity category of activities observed • See compendium website for how to handle groups of children with overlapping age groups
Reference	T. McKenzie, Marshall SJ, Sallis JF, Conway TL, 2000
Method	Ecological Momentary Assessment (EMA)
Example	Customized mobile data collection tool
Description	• Application uploaded to cell phone technology to message (beep) respondents for data entry • Beeps occur at varying frequencies throughout the day
How Used	• EMA query is a survey with four screens that identify the types of behaviors performed just before the beep occurred • A series of screens prompts the user to identify activity type (e.g., walking, running or jogging, weight lifting or strength training, using cardiovascular equipment, bicycling, or other activities) and body position (e.g., recline, sitting, standing, or moving). • MET_y values can be assigned to activities list to create a composite score (e.g., MET_y-minutes or minutes in moderate- or vigorous-intensity activity)
Reference	G. Dunton, Liao Y, Intille S, Wolch J, Pentz MA, 2011
Method	Time Use Surveys / 24-hour Recalls
Example	Multimedia Activity Recall for Children and Adolescents (MARCA)
Description	• A computer-delivered use-of-time instrument • Recall of time spent in activities of >=5 minutes • Child selects time points (segments) during the day as an anchor (e.g., before, school, after school, or after dinner) • During each segment, child selects from activity from 7 activity categories (200 activities in all to choose from)
How Used	MET_y values for activity recall can be assigned to activities list to create a composite score, e.g., minutes engaged in moderate-to-vigorous activity or MET_y-minutes
Reference	K. Ridley, Olds TS, Hill A, 2006

Table 3.

Variables Used and Equations to Estimate Basal Metabolic Rate (BMR), METy-minutes, MET_y-hours, and Kilocalories Expended in Various Activities.

Activity	METy[a]	BMR[b] (kcal·min^{-1})	Minutes	Hours	METy-minutes (MET_y × minutes)	METy-hours (MET_y × hours)	Estimated kilocalories[c] (MET_y × BMR × minutes)
Hopscotch	6.5	0.948	15	0.25	97.5	1.63	92.4
Computer for schoolwork	1.5	0.948	60	1.00	90.0	1.50	85.3
Soccer	8.1	0.948	45	0.75	364.5	6.08	345.5
Walking (3.0 mph)	4.1	0.948	30	0.50	123.0	2.05	116.6
Watching TV	1.3	0.948	30	0.50	39.0	0.65	37.0
Total			**180**	**3.00**	**714.0**	**11.91**	**676.8**

[a] MET_y is listed for ages 10–12, taken from the Youth Compendium of Physical Activities

[b] This example is for a 12-year old boy with a body mass of 40 kg. BMR is estimated from the Schofield et al. equation for 10–18 year old boys. Hence, BMR is predicted as follows: [17.686 × 40 kg + 658.2]/1440 = 0.948 kcal·min^{-1}.

[c] Kilocalories = MET_y × BMR (kcal·min^{-1}) × Minutes