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A Youth Compendium of Physical Activities: Activity Codes and Metabolic Intensities

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Abstract

Purpose—A Youth Compendium of Physical Activities (Youth Compendium) was developed to estimate the energy costs of physical activities using data on youth only.

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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 results of the present study do not constitute endorsement by American College of Sports Medicine. 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.

Methods—Based on a literature search and pooled data of energy expenditure measurements in youth, the energy costs of 196 activities were compiled in 16 activity categories to form a Youth Compendium of Physical Activities. To estimate the intensity of each activity, measured oxygen consumption ($\dot{V}O_2$) was divided by basal metabolic rate (Schofield age-, sex- and mass-specific equations) to produce a youth MET (MET_y). A mixed linear model was developed for each activity category to impute missing values for age ranges with no observations for a specific activity.

Results—This Youth Compendium consists of MET_y values for 196 specific activities classified into 16 major categories for four age groups, 6–9, 10–12, 13–15, and 16–18 years. MET_y values in this Youth Compendium were measured (51%) or imputed (49%) from youth data.

Conclusion—This Youth Compendium of Physical Activities uses pediatric data exclusively, addresses the age-dependency of MET_y and imputes missing MET_y values and thus represents advancement in the physical activity research and practice. This Youth Compendium will be a valuable resource for stakeholders interested in evaluating interventions, programs, and policies designed to assess and encourage physical activity in youth.

Keywords

physical activity; metabolic equivalents (MET); sedentary activity; light activity; moderate activity; vigorous activity; children; energy cost

Introduction

Physical activity is a major component of daily energy expenditure, and the most variable among young individuals. An understanding of its relationship to growth and development is of paramount importance to the health and well-being of children (1). Physical activity is a complex construct often classified qualitatively into major categories based on function (occupation, recreation, sports, locomotion, self-care) or quantitatively based on intensity of effort (sedentary, light, moderate and vigorous) (2). Knowing the intensity level of the physical activities in which youth participate can help researchers and practitioners understand patterns of physical activity and prescribe and encourage an amount of activity for optimal health.

Assessment of physical activity and estimation of its energy costs in children has many applications for clinical practice, public health, and applied research. Valid methodology is needed to assess compliance with physical activity guidelines and test effectiveness of programs and interventions. In epidemiologic studies and clinical practice, self-report questionnaires, direct observation and monitoring devices are common tools to assess physical activity (3,4). In these approaches, reported or observed physical activity data are converted to energy expenditure using previously determined metabolic equivalents (MET).

MET values are available from the Adult Compendium of Physical Activities (Adult Compendium) that classifies activities by function, specific type of activity, and intensity (5). METs are used to express the energy costs of physical activities as multiples of resting metabolic rate (RMR) (6). By convention, in adults 1 MET is taken to be an oxygen uptake of 3.5 $mL \cdot kg^{-1} \cdot min^{-1}$ or 1 $kcal \cdot kg^{-1} \cdot hr^{-1}$. The Adult Compendium has 21 major activity categories and 821 specific activities (6,7). In the Adult Compendium, 68% of the MET values are based on referenced measurements and the remainder on expert opinion.

Adult MET values, however, are not applicable to children (8–10). Children have higher basal metabolic rates (BMR) per unit body mass than adults that decline gradually as children grow and mature. Sex-specific developmental changes in organ weights, organ specific metabolic rates, muscle mass and adiposity differentially affect BMR and are responsible for the decline in BMR (11,12). BMR averages ~6.5 $mL \cdot kg^{-1} \cdot min^{-1}$ or 1.9 $kcal \cdot kg^{-1} \cdot min^{-1}$ in a typical 6-year-old and approaches the adult value of 3.5 $mL \cdot kg^{-1} \cdot min^{-1}$ or 1 $kcal \cdot kg^{-1} \cdot min^{-1}$ in a typical 18-year-old. Use of the standard adult MET equivalency would underestimate BMR of children.

Also, young children compared to adolescents or adults have disproportionately higher energy expenditure per unit body mass for physical activities. The energy cost of performing submaximal activities increases with age when expressed as kcal/min but decreases with age when expressed relative to body mass ($kcal \cdot kg^{-1} \cdot min^{-1}$) (10). In addition to the developmental changes in body size and composition discussed above, children become more skilled and efficient at performing certain activities. Consequently, the energy costs of physical activities are not constant throughout childhood.

To address these problems, Ridley and colleagues developed a Compendium of Energy Expenditures for Youth in 2008 (Ridley Compendium) that provided MET values for 244 activities, 38% of which were based on METs measured in children (13). The range of the number of data points used to assign an energy cost to an activity was 8 to 510. The remainder of the MET values were taken from the Adult Compendium (7), with the recommendation to multiply METs by child BMR when calculating total energy cost. Also, prediction equations for the energy costs of walking and running based on age and speed were provided. This was an important first step forward, especially in light of the available literature on youth energy expenditure at the time. However, the Ridley Compendium had several limitations: 1) small sample sizes in many studies, 2) a limited number of physical activities assessed, 3) only 19 pediatric published sources and 4) a constant MET value for each activity provided for all children aged 5–17 y. As with the Adult Compendium, the Ridley Compendium had 1) limited ability to precisely estimate energy expenditure of individuals, and 2) inherent errors for activities that can be performed at varying intensities.

To address these limitations, the Youth Energy Expenditure Workshop was convened by the Centers for Disease Control and Prevention (CDC), the National Cancer Institute (NCI), and the National Collaborative for Childhood Obesity Research (NCCOR) on April 19–20, 2012 in Atlanta, GA. The Expert Panel agreed that an updated, expanded, and web-accessible compendium (named Youth Compendium of Physical Activities, henceforth referred to as Youth Compendium) would be a valuable contribution to the field and that two tasks would be necessary to accomplish this objective. The first was to conduct a systematic literature review in order to locate studies published since 2007 (the latest date covered in the Ridley Compendium). This search would broaden the scope of the Ridley Compendium by widening the age range and expanding the databases used to search for relevant studies. The second task was to commission a workgroup of the Expert Panel to review and analyze existing data on the energy costs of physical activity in children.

The workgroup arrived at the conclusion that youth MET (MET_y) presented by age groups was the preferred metric for presentation of the energy costs of physical activities in this Youth Compendium after a thorough evaluation of several options (9). Metrics of absolute oxygen uptake ($ml \cdot min^{-1}$), oxygen uptake per kilogram body mass ($\dot{V}O_2$ in $ml \cdot kg^{-1} \cdot min^{-1}$), net oxygen uptake ($\dot{V}O_2$ - resting metabolic rate), allometric scaled oxygen uptake ($\dot{V}O_2$ in $ml \cdot kg^{-0.75} \cdot min^{-1}$) and MET_y ($\dot{V}O_2 \cdot [\text{resting } \dot{V}O_2]^{-1}$) were evaluated based on pooled data of 947 children ages 5 to 18 years, who engaged in 14 different activities. No metric completely eliminated the influence of age, height, body mass, or sex for all 14 activities. Of the metrics examined, the MET_y displayed the least age dependency for sedentary and low-intensity activities. $\dot{V}O_{2ALLOMETRIC}$ was the best for reducing age-dependency for moderate-to-vigorous intensity activities. Although $\dot{V}O_{2ALLOMETRIC}$ appeared to work well for ambulatory activities, it did not work as well for activities that require additional equipment or more skills such as playing basketball. $\dot{V}O_{2ALLOMETRIC}$ coefficients are complex to calculate and a different mass exponent may be required for each activity, making it challenging to directly compare activities. Based on these findings and considerations, the workgroup recommended the use of the MET_y.

Consistent with observations by Harrell et al. (14) and Trost et al. (15), the age-dependency of MET_y values was a function of the type and intensity of the activity (9). MET_y values for sedentary and light-intensity standing activities were not statistically influenced by age. For moderate-to-vigorous activities, MET_y was positively correlated with age (r=.28 to .59). To account for the age-dependency in this Youth Compendium, MET_y values are presented for short, discrete age groups - 6–9, 10–12, 13–15, and 16–18 years. The errors in using a constant MET_y value versus age groups or specific ages were evaluated in a separate paper by Pfeiffer et al. (16). The percent error reduction ranged from −0.2 to 21.7% for age groups and −0.23 to 18.2% for age in years compared to a constant MET_y value.

This paper describes the development of a Youth Compendium, which presents the energy costs of 196 physical activities derived from pediatric data only, expressed in terms of MET_y for age categories 6–9, 10–12, 13–15, and 16–18 years. This Youth Compendium, which will be housed on the NCCOR website at www.nccor.org/nccor-tools/youthcompendium will be a valuable resource for researchers and practitioners interested in improving the health of children and adolescents through physical activity.

METHODS

Data sources for this Youth Compendium included:

1. Systematic Reviews of the Literature (Ridley 2013, 2016 at www.nccor.org/nccor-tools/youthcompendium): a) energy costs of physical activities excluding walking and running in children from 90 studies; and b) energy costs of walking and running in children from 75 studies (some studies overlap);

2. Pooled Dataset: energy costs of physical activities including walking and running derived from four publications (14,17–19);
3. 2016 JPAH Supplement: energy costs of physical activities in children including walking and running from 12 studies (20).

In these three data sources, BMR was predicted using age-, sex- and mass-specific Schofield equations (21) for calculation of MET_y values. Schofield equations (21) were based upon 2060 children, ages 3–18 y, from 44 published studies. Experimental conditions used for study inclusion stipulated true basal metabolism: 1) absence of gross muscular activity; 2) ≥12-h post-absorptive state; 3) thermoneutrality; 4) emotional repose; and 5) stable nutritional status. No departure from goodness of fit was found when the equations were tested on a validation dataset. For ages 3–18 y, height did not contribute significantly to BMR, once weight had been taken into account.

The Schofield equations for boys, ages 3–10 y and 10–18 y, are as follow:

$$3-10\,\mathrm{y}\ \mathrm{BMR}\ (\mathrm{kcal/min}) = [22.706 \times \mathrm{Weight}\ (\mathrm{kg}) + 504.3]/1440$$

$$10-18\,\mathrm{y}\ \mathrm{BMR}\ (\mathrm{kcal/min}) = [17.686 \times \mathrm{Weight}\ (\mathrm{kg}) + 658.2]/1440$$

The Schofield equations for girls, ages 3–10 y and 10– 18 y, are as follows:

$$3-10\,\mathrm{y}\ \mathrm{BMR}\ (\mathrm{kcal/min}) = [20.315 \times \mathrm{Weight}\ (\mathrm{kg}) + 485.9]/1440$$

$$10-18\,\mathrm{y}\ \mathrm{BMR}\ (\mathrm{kcal/min}) = [13.384 \times \mathrm{Weight}\ (\mathrm{kg}) + 692.6]/1440.$$

Development of this Youth Compendium involved five steps 1) classification of the physical activities into 16 major categories; 2) profile plots constructed for 16 major categories; 3) multiple imputation of missing MET_y values; 4) review of the observed and imputed MET_y values; 5) smoothing observed and imputed MET_y values; and 6) development of a coding scheme for this Youth Compendium.

Data Sources

1. Systematic Reviews of the Literature—Ridley and colleagues conducted two systematic literature reviews of the energy cost of physical activities in children (www.nccor.org/nccor-tools/youthcompendium). Study eligibility criteria included: full-text article, thesis/dissertation, or data provided from authors from a published conference abstract; data on children and adolescents; energy cost/expenditure of specific physical activities measured; energy cost/expenditure of walking and running measured at specific set speeds; and energy cost data measured using indirect calorimetry or direct calorimetry. Study exclusion criteria were: systematic reviews or meta-analysis and participant enrollment based on illness, with the exception of overweight and obesity. If studies compared a control of healthy participants to a sample based on a specific pathology, data were extracted for the control sample only. The aim of the first search, completed in 2013, was to locate pediatric studies where the energy cost of specific physical activities excluding walking and running was measured. The aim of the second search, completed in 2016, was to locate pediatric studies where the energy cost of walking and running at selected speeds was measured. The following databases were searched: CINAHL, Cochrane library, EMBASE, Medline, Proquest, PsychINFO, SCOPUS, SportDiscus, and Web of Science. Where multiple metrics were provided for the energy cost of the activity, the following hierarchy was used to extract data: 1) $\dot{V}O_2$, 2) energy expenditure (kJ), 3) energy expenditure (kcal), and 4) MET_y calculated using the child's BMR. Where possible, energy cost data not provided as $\dot{V}O_2$ ($ml \cdot kg^{-1} \cdot min^{-1}$) were converted to this base metric for comparative purposes. Data not provided per unit mass were converted using the mean mass provided. Data presented in kcals were first converted to kJs using the conversion factor of 1 kcal = 4.18 kJ and then converted to $\dot{V}O_2$ using a standard energy equivalent for oxygen uptake (20.9 $kJ \cdot L^{-1}$ O_2). The MET_y cost was calculated by dividing the measured energy cost by the estimated mean BMR calculated using the age-, sex- and mass-specific Schofield prediction equations (21). The extracted dataset contained sampling schemes, methodology, and mean data for participant descriptive variables (sample size, age, weight, height) and energy costs of the activity (see Table, Supplemental Digital Content 1, Activity-specific references for MET_y values).

2. Pooled Dataset—To supplement the literature review, MET_y values for specific activities were compiled from a pooled dataset of energy costs of physical activities in 933 children, ages 5 to 18 y (9). Based on participant characteristics (age, sex, body mass) and activity-related oxygen uptake (ml $O_2 \cdot min^{-1}$), BMR was estimated by the Schofield prediction equation (21) and used to compute MET_y values. Studies by Crouter et al. (19), Trost et al. (17), and Harrell et al. (14) were located in the Ridley literature reviews; it should be noted, however, that MET_y values from these studies were not duplicated in this Youth Compendium.

3. 2016 JPAH Supplement—Energy costs of physical activities were extracted from recent publications in JPAH (22–33). BMR was estimated by the Schofield prediction equation (21) and used to compute MET_y values. Data from Ridley et al. (34) were included in the 2013 literature review and the study by Trost et al. (15) were included in the pooled dataset and therefore not duplicated in this Youth Compendium.

Development of this Youth Compendium

Step 1. Classification of the Physical Activities into 16 Major Categories—Specific activities from the literature review, the pooled dataset and the JPAH supplement were classified into 16 major categories taking into consideration body position (sitting, standing, lying down), upper or lower body movement, locomotion, weight or non-weight bearing, and intensity of effort. Because of the differences in child development and age dependency of MET_y (9), the observations were then classified into one of four *a priori* defined age groups, 6–9, 10–12, 13–15, and 16–18 years, based on the study mean age (median age when the mean was not provided).

Step 2. Profile Plots Constructed for 16 Major Categories—Age group specific-mean MET_y values were calculated for each specific activity. Profile plots were constructed for each of the 16 activity categories to show the missing data pattern for the different activities within the category. For the profile plots, each specific activity in a category was treated as a single observation, which meant one line per activity in each plot. Additionally, the percent of missing observations was calculated for each activity category within each age group.

Step 3. Multiple imputation of Missing MET_y Values—Multiple imputation of missing MET_y values was performed to maximize the utility and comprehensiveness of the Youth Compendium by providing MET_y values across all age groups for each activity. First, linear and quadratic regression models were computed to study the structure of the relationship between age and MET_y cost for each activity with a sufficient number of observations using Proc GLM in SAS. Adjusted R^2 was used to compare the fits of the linear and quadratic models to determine which model should be used to impute MET_y cost in age ranges without observations. The linear component was significant for all specific activities and therefore the linear not the quadratic term was used in the imputations.

Next, a multiple imputation mixed model was used to impute missing values for age ranges in which there were no observations for a given activity. To take advantage of similar types of movement, a mixed model was used to properly account for the clustering in the data by specific activity within each activity category. The mixed model "borrowed" data from similar activities within a major category allowing for imputation of activities that had fewer observations. A previously published macro was used to perform the multiple imputation (35). A different imputation model was fit for each activity category to predict MET_y values from a linear age term and included random intercepts for the different activities in a category. Each missing value was imputed 20 times. The midpoint of each age range was used to calculate the imputed values. After the imputed values were generated, they were bounded with a lower bound of 1 and an upper bound of 3 standard deviations above the mean for the category. These bounds replaced any imputed values that were outside the predetermined range (1.1% of imputed MET_y values were below 1.0 and 0.8% were above 3 SD, with no apparent clustering). Both the upper and lower bound adjustments took place after all imputations were performed, meaning that no imputations were skipped. Any abnormal imputed value that was changed was flagged in the imputed dataset.

Step 4. Review of the Observed and Imputed MET_y Values—From the completed dataset, a table of the average MET_y values of each activity for each age group was generated, showing both observed and imputed values. Profile plots for each major activity category were created using the mean observed and imputed values. The table and plots of the average MET_y values were reviewed for consistency among activities within the major activity categories and across age groups within each specific activity. Similar to the criterion for the imputed values, outlying values were defined as values 3 standard deviations above or below the mean for the category or contrary trends across age groups. A total of 4.6% of the mean MET_y values were replaced by linear regression based on the age coefficient from the mixed model.

Step 5. Smoothing Observed and Imputed MET_y Values—In order to smooth the observed and imputed MET_y values, mixed models for each of the major activity categories were conducted from the completed dataset to obtain model-based parameter estimates predicting MET_y from age treated as a continuous variable. The activity- and age group-specific MET_y values were predicted using the fixed and random coefficients for the intercept and slope at the midpoint for each of the age groups. Profile plots for each major activity category were created using the model-based values. Similar to adjustments of the age-specific observed and imputed mean MET_y values, approximately 6% of model-based MET_y values were adjusted to be consistent within the major activity categories and across age groups within each specific activity.

Step 6. Development of a Coding Scheme for the Youth Compendium—To facilitate data coding, a six-digit coding scheme was developed for MET_y values in this Youth Compendium. In the coding scheme, the first two digits (1–16) represent the major activity category, the next three digits represent the specific activity, and the last digit represents 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). In Tables 1–4, the age group is designated by the placeholder X. For example, the activity codes for Aerobic Dance are 601002, 601003, 601004 and 601005 for the age groups 6–9 y, 10–12 y, 13–15 y, and 16–18 y, respectively. The corresponding MET_y values are 3.3, 3.8, 4.8, and 4.0.

RESULTS

In total, energy costs of 196 physical activities were extracted from 137 pediatric studies representing more than 37,000 observations on children, aged 11.5 ± 2.6 y, with mean weight 44.8 ± 14.4 kg and height 146.1 ± 21.6 cm (see Table, Supplemental Digital Content 1, Activity-specific references for MET_y values). The literature review yielded energy cost values for 121 specific activities for children 6 years and older, excluding walking and running. The pooled dataset of 36 activities provided mean energy cost data of 14 additional activities and the JPAH supplement data of 78 activities provided mean energy costs of 34 additional activities. For walking and running activities, the mean energy costs of walking (12 levels) and running (15 levels) at various speeds available from all three sources were grouped by 0.5 mph increments (walking 0.5 to 5.0 mph; running 3.0 to 8.0 mph) where available. When speed was not provided, walking and running activities were classified by effort (e.g., slow, fast, self-paced).

The 196 specific activities were classified into 16 major categories. Most sports games were simulated and self-paced, in the sense that they were modified games imitating the typical movement patterns of the game (i.e., dribbling a soccer ball through cones to simulate movements in a soccer game). The Computer/Video Games (sitting) category reflected sedentary behaviors such as computer games, mobile phone games, Nintendo, and PS2 & 3, which do not require children to stand or do much movement other than moving a joystick or pushing controls with hands or fingers. For the Active Video Games, the children performed some sort of movement, whether it was standing and imitating a sport such as swinging a tennis racket or performing a dance movement. The energy costs for Active

Video Games varied substantially and therefore were split into Active Video Games (Full Body) and Active Video Games (Upper Body) to distinguish the energy costs.

Youth Compendium database resulted in 397 observed mean MET_y values (51%) and 380 imputed mean MET_y values (49%) in the four age groups for 196 specific activities (see Table, Supplemental Digital Content 2, Table of observed and imputed MET_y values by activity and age group). The imputed and observed MET_y values for the specific activities within each major category were graphically examined to identify inconsistencies (see Figure, Supplemental Digital Content 3, Activity-specific youth MET_y values by age groups for each major activity category).

The final model-based MET_y values in the four age groups for 196 specific activities are presented in Tables 1–4 and as a supplemental file (see Table, Supplemental Digital Content 4. Table of model-based MET_y values by activity and age group). The tables display the activity code, major activity category, specific activity and the model-based MET_y values for the four age groups. The model-based MET_y values are graphically illustrated for the specific activities within four of the major categories (Figure 1). Figure 1 shows that the MET_y values for quiet play/schoolwork/television and housekeeping/work that are independent of age, in contrast to dance/aerobics/steps and running, where the age-dependency for MET_y values and wider range of MET_y intensities are evident. In general, the MET_y values of the more sedentary activities were similar across age groups, and the MET_y values of the more intense activities increased with age.

An estimate of the energy cost of a physical activity can be computed based on the MET_y value from the Youth Compendium, a measured or computed BMR, and duration of the specific activity, as follows:

$$\text{Energy cost (kcal)} = \text{MET}_\text{y} \times \text{BMR (kcal/min)} \times \text{duration (min)}$$

where the BMR for boys and girls is predicted using age-, sex- and mass-specific Schofield equations (21).

DISCUSSION

This paper describes a Youth Compendium of Physical Activities based completely on empirical energy expenditure measurements in children. This Youth Compendium consists of MET_y values for 196 specific activities classified into 16 major categories for four age groups - 6–9, 10–12, 13–15 and 16–18 y. The methods used in formulating this Youth Compendium sought to address the unique developmental challenges in determining the energy costs of physical activities in children. First, all MET_y values were measured or derived from pediatric data only. Second, missing MET_y data were predicted using a specific imputation mixed model for each major activity category. Third, MET_y values for each activity were provided for the four age groups to address the age-dependency of MET_y values (9).

Past studies have shown that the age-dependency of MET_y values is a function of the type and intensity of the activity. In our study, the MET_y values for sedentary and light-intensity standing activities were not appreciably influenced by age, whereas for moderate-to-vigorous activities, MET_y values were positively correlated with age (9). These observations were reinforced by the profile plots of this Youth Compendium which showed consistent overall trends within major activity categories. In general, the low intensity categories display no slope, and the higher intensity categories a positive slope across age groups.

The energy costs of many specific activities were not available from the literature search for all age groups. Therefore, we used a specific multiple imputation mixed model for each major activity category to fill-in missing data, resulting in 49% of the MET_y values in the database. This approach maximized use of all the data and simultaneously considered linear trends across age groups and patterns within age-groups for similar activities. Presentation of the imputed values in the Supplemental Digital Content allowed for identification of gaps in the literature that may be filled with future research on the energy costs of physical activities in youth.

In the compilation and profile plots of the measured and imputed data on the energy cost of physical activities, variability within specific activities was evident. Variability in the measured values across physical activities and age groups can be attributed to different study designs, participant characteristics, procedures and equipment among studies, developmental changes in body size and composition, age-dependent levels of skill and efficiency, and participant self-selected pace and effort for uncontrolled activities. Some activities were controlled (e.g., walking and running at set speeds on a treadmill); whereas others were performed at self-selected intensities. These volitional activities would be expected to have greater variation in MET_y values among children because of differences in: 1) the fitness level of the child; 2) the child's perceptions of intensity; 3) the child's motivation; 4) previous experience with the activity; and 5) experimental conditions and instructions given.

To reconcile the irregularities in MET_y values within the major activity categories and across age groups within each specific activity, the observed and imputed values were smoothed producing more physiologically consistent MET_y values. While these values may be refined and expanded with future research, they currently represent the best estimates of the energy costs of physical activities in youth.

The comprehensive tables of model-based MET_y values can serve as a valuable resource for estimating energy costs of physical activities in research and clinical studies from self-report questionnaires, direct observation, and monitoring devices. This Youth Compendium also may assist in assessing physical activity guidelines such as the 2008 Physical Activity Guidelines for Americans (www.health.gov/paguidelines) and estimating physical activity levels for applications that estimate energy requirements of children such as Choose My Plate (https://www.choosemyplate.gov/) or Dietary Reference Intakes (https://www.nal.usda.gov/fnic/dietary-reference-intakes). Because application of MET_y values requires tailoring to the child's BMR computed based on age, sex and body weight, the MET_y values presented here can be applied to a wide range of children and adolescents thus making them generalizable to healthy pediatric populations, ages 6 to 18 years.

Caveats of this Youth Compendium are not unlike the limitations acknowledged for the Ridley Compendium (13) and the Adult Compendium (5–7). In all cases, the MET values are averages, and therefore do not reflect individual variability due to body composition, fitness, effort, mechanical efficiency, or environmental conditions under which the activity is performed. Some activities in this Youth Compendium can be performed at varying intensities and therefore are inherently more variable than prescribed activities such as walking and running at set speeds. MET_y values will be more accurate at the group than the individual level. In cases where individual estimation is desired, users should realize that energy expenditure can be influenced by many factors not captured by the mean MET_y values presented here. Users should appreciate that these values are estimates and are not recommended to be used for precise estimation of energy balance.

In calculating MET_y values, the denominator BMR is computed based on age, sex, and body weight. Although incorporation of BMR greatly reduces the weight dependency, MET_y values are not completely independent of body weight, especially for locomotive activities. Average MET_y values can underestimate energy costs in children with obesity and overestimate them in children with underweight (36). Factors such as body composition, body shape, cross-sectional area of the primary muscles, leg length, and efficiency of body movement may influence the relationship of energy expenditure to body weight (9). For this Youth Compendium, data were not excluded on the basis of weight status. In fact, many studies did not provide information on the BMI status of their participants. Therefore, the average MET_y values in this Youth Compendium are applicable to all healthy children with the caveat that overestimation or underestimation of energy costs of some activities may occur with subgroups of children based on BMI status.

The breadth of child and adolescent activities in this Youth Compendium is incomplete. The majority of MET_y values were measured in mid-childhood, and therefore more data are needed in very young children and older adolescents. The energy costs of specific activities such as transport, gardening, and certain sports (e.g., kayaking, sailing, ice skating, skateboarding, water polo, horseback riding, martial arts, lacrosse, rugby, rock climbing, and softball) are not available. Particularly lacking in the current Youth Compendium are MET_y values for occupational work, self-care, lawn and garden activities. We envisage this Youth Compendium will be updated and refined over time as more measured values are published. Future research efforts could solicit certain types of activities in specific age groups to fill the gaps. In addition, this Youth Compendium is not applicable to children with illnesses or disabilities that alter movement or mechanical efficiency and thereby the energy cost of activities. Research is needed to fill the paucity of energy expenditure data in special populations.

In conclusion, this Youth Compendium of Physical Activities presents MET_y values for 196 activities across four age groups - 6–9, 10–12, 13–15, and 16–18 years. The new Youth Compendium can be used to standardize the scoring and interpretation of youth physical activity data in research and public health surveillance applications. It will be a valuable resource to standardize the scoring and interpretation of youth physical activity data in research and public health surveillance applications.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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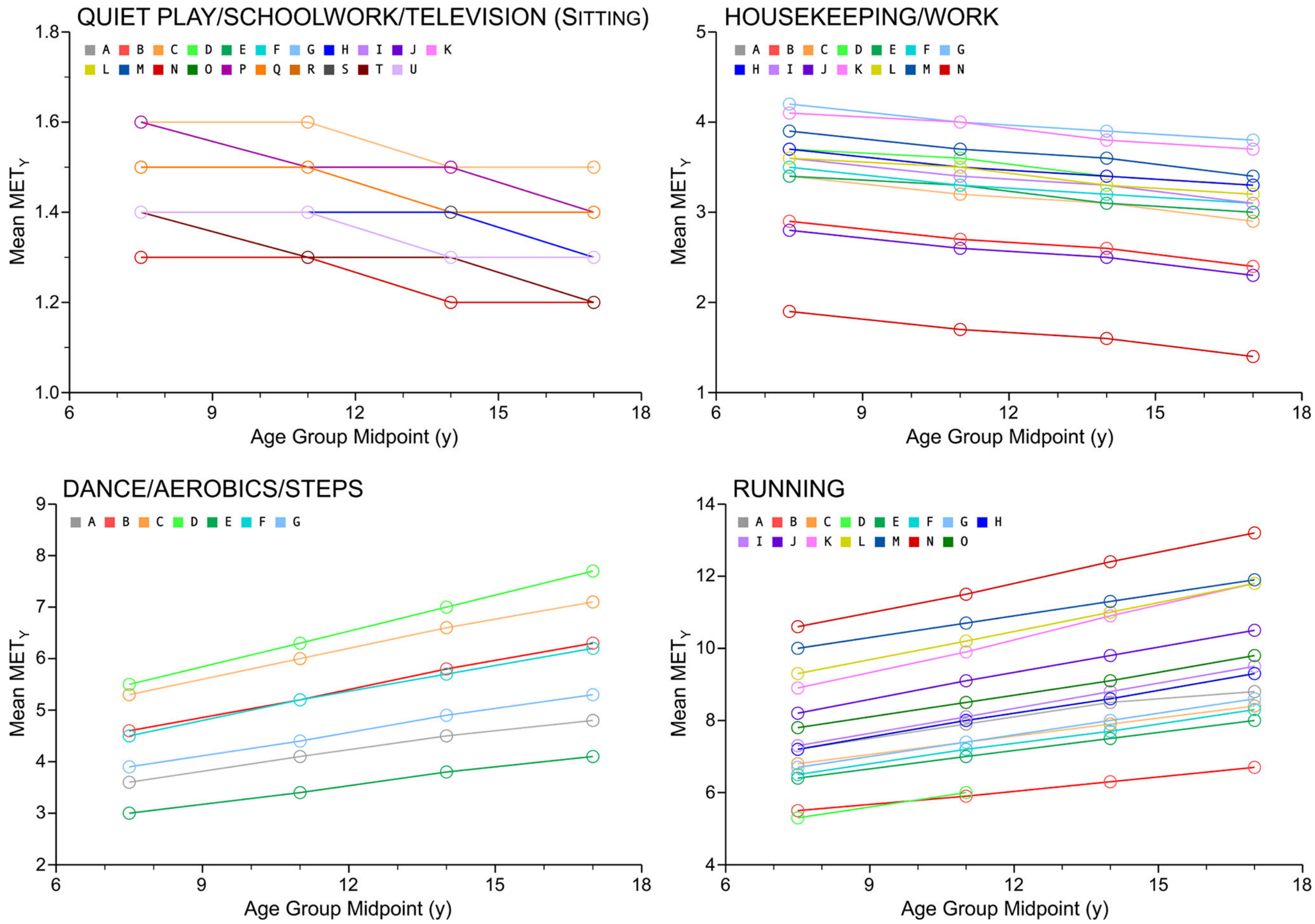

Figure 1.

Youth METs (MET_y) are plotted by age groups – midpoint (y) for the following activity categories: **Quiet Play/Schoolwork/Television** (sitting) including the specific activities: A=arts and crafts; B=board games; C=coloring, reading, writing, internet; D=computer work; E=giving a speech; F=listening to radio; G=listening to story; H=playing quietly; I=playing stringed instrument; J=playing with bricks; K=playing with toys (cards, puzzles, cars, trains); L=puzzles; M=quietly sitting; N=reading; O=reading a book and listening to music; P=schoolwork; Q=sewing; R=singing; S=talking with friend; T=watching TV/DVD; U=writing; **Housekeeping/Work** including the specific activities: A=bedmaking; B=carpentry; C=dressing and undressing; D=dusting; E=dusting and sweeping; F=hanging out washing; G=housework; H=laundry; I=loading/unloading; j=setting the table; J=setting the table; K=shoveling; L=sweeping; M=vacuuming; N=washing the dishes; **Dance/ Aerobics/Step** including the specific activities: A=aerobic dance/dance; B=stair walking-ascending; C=stair walking -ascending 80 steps/min; D=stair walking – ascending/ descending; E= stair walking – descending; F=step board; G=stepping – height 30–50% leg length; **Running** including the specific activities: A=jog-fast; B=jog-slow; C=jog self-paced; D=run 3.0 mph; E=run 3.5 mph; F=run 4.0 mph; G=run 4.5 mph; H=run 5.0 mph; I=run 5.5 mph; J=run 6.0 mph; K=run 6.5 mph; L=run 7.0 mph; M=run 7.5 mph; N=run 8.0 mph; O=run self-paced.

Table 1

Model-based youth MET (MET_y) values for activities while lying and sitting for the Youth Compendium of Physical Activities

Code	Activity Category	Specific Activity	Youth MET (MET_y) by Age Group (years)			
			6–9	10–12	13–15	16–18
50100X	LYING	QUIETLY LYING	1.2	1.2	1.1	1.1
50120X		WATCHING TV/DVD - LYING	1.2	1.1	1.1	1.0
55100X	QUIET PLAY/SCHOOLWORK/TELEVISION (SITTING)	ARTS AND CRAFTS	1.6	1.6	1.5	1.5
55120X		BOARD GAMES	1.5	1.5	1.4	1.4
55140X		COLORING, READING WRITING, INTERNET	1.6	1.6	1.5	1.5
55160X		COMPUTER WORK	1.5	1.5	1.4	1.4
55180X		GIVING A SPEECH	1.5	1.5	1.4	1.4
55200X		LISTENING TO RADIO	1.4	1.4	1.3	1.3
55220X		LISTENING TO STORY	1.4	1.4	1.3	1.3
55240X		PLAYING QUIETLY	1.5	1.5	1.5	1.4
55260X		PLAYING STRINGED INSTRUMENT	1.4	1.3	1.3	1.3
55280X		PLAYING WITH BRICKS	1.3	1.3	1.2	1.2
55300X		PLAYING WITH TOYS (CARDS, PUZZLES, CARS, TRAINS)	1.5	1.5	1.4	1.4
55320X		PUZZLES	1.3	1.3	1.2	1.2
55340X		QUIETLY SITTING	1.4	1.3	1.3	1.2
55360X		READING	1.3	1.3	1.2	1.2
55380X		READING A BOOK AND LISTENING TO MUSIC	1.4	1.3	1.3	1.3
55400X		SCHOOLWORK	1.6	1.5	1.5	1.4
55420X		SEWING	1.5	1.5	1.4	1.4
55440X		SINGING	1.4	1.4	1.3	1.3
55460X		TALKING WITH FRIEND	1.4	1.4	1.4	1.3
55480X		WATCHING TV/DVD - SITTING	1.4	1.3	1.3	1.2
55500X		WRITING	1.4	1.4	1.3	1.3
35100X	COMPUTER/VIDEO GAMES (SITTING)	COMPUTER GAMES (COMPILATION OF GAMES)	1.4	1.5	1.5	1.5
35120X		VIDEO GAMES - BOWLING	1.4	1.5	1.5	1.5
35140X		VIDEO GAMES - DRIVING SIMULATOR	1.4	1.5	1.5	1.5

Code	Activity Category	Specific Activity	Youth MET (MET_y) by Age Group (years)			
			6–9	10–12	13–15	16–18
35160X		VIDEO GAMES - GAMEBOY	1.4	1.5	1.5	1.5
35180X		VIDEO GAMES - GAMEPAD	1.4	1.5	1.5	1.5
35200X		VIDEO GAMES - HANDHELD	1.4	1.5	1.5	1.5
35220X		VIDEO GAMES - MOBILE PHONE	1.4	1.5	1.5	1.5
35240X		VIDEO GAMES - NINTENDO	1.4	1.5	1.5	1.5
35260X		VIDEO GAMES - PS2	1.4	1.5	1.5	1.5
35280X		VIDEO GAMES - PS3	1.4	1.5	1.5	1.5
35300X		VIDEO GAMES - XBOX360	1.4	1.5	1.5	1.5
35320X		VIDEO GAMES (COMPILATION OF GAMES)	1.4	1.5	1.5	1.5

Age group is designated by the placeholder X; age ranges are represented by 2 (6–9 y), 3 (10–12 y), 4 (13–15 y), and 5 (16–18 y).

Table 2

Model-based youth MET (MET_y) for activities while standing, doing housework, and playing active video games for the Youth Compendium of Physical Activities

Code	Activity Category	Specific Activity	Youth MET (MET_y) by Age Group (years)			
			6–9	10–12	13–15	16–18
70100X	STANDING	ARCADE GAMES - TABLE FOOTBALL	1.9	1.9	1.9	1.8
70120X		BOARD GAMES - STANDING	2.0	2.0	1.9	1.9
70140X		DRAWING, COLORING - STANDING	1.8	1.7	1.7	1.7
70160X		SINGING - STANDING	1.8	1.8	1.7	1.7
70180X		STACKING CUPS	1.6	1.5	1.5	1.5
70200X		STANDING	1.7	1.7	1.7	1.6
70220X		VIDEO GAMES - STANDING	1.8	1.8	1.7	1.7
70240X		WATCHING TV/DVD - STANDING	1.8	1.8	1.8	1.8
45100X	HOUSEKEEPING/WORK	BEDMAKING	3.4	3.3	3.1	3.0
45120X		CARPENTRY	2.9	2.7	2.6	2.4
45140X		DRESSING AND UNDRESSING	3.4	3.2	3.1	2.9
45160X		DUSTING	3.7	3.6	3.4	3.3
45180X		DUSTING AND SWEEPING	3.4	3.3	3.1	3.0
45200X		HANGING OUT WASHING	3.5	3.3	3.2	3.1
45220X		HOUSEWORK	4.2	4.0	3.9	3.8
45240X		LAUNDRY	3.7	3.5	3.4	3.3
45260X		LOADING/UNLOADING BOXES	3.6	3.4	3.3	3.1
45280X		SETTING THE TABLE	2.8	2.6	2.5	2.3
45300X		SHOVELLING	4.1	4.0	3.8	3.7
45320X		SWEEPING	3.6	3.5	3.3	3.2
45340X		VACUUMING	3.9	3.7	3.6	3.4
45360X		WASHING THE DISHES	1.9	1.7	1.6	1.4
15100X	ACTIVE VIDEO GAMES (FULL BODY)	ACTIVE VIDEO GAMES - ACTION RUNNING	4.8	5.9	6.8	7.7
15120X		ACTIVE VIDEO GAMES - BASEBALL	3.7	4.7	5.7	6.6
15140X		ACTIVE VIDEO GAMES - BOXING	3.0	4.0	4.9	5.8

Code	Activity Category	Specific Activity	Youth MET (MET_y) by Age Group (years)			
			6–9	10–12	13–15	16–18
15160X		ACTIVE VIDEO GAMES - CATCHING TARGETS	2.6	3.6	4.5	5.4
15180X		ACTIVE VIDEO GAMES - DANCE	2.3	3.3	4.1	5.0
15200X		ACTIVE VIDEO GAMES - HOVERBOARD	1.8	1.8	2.6	3.4
15220X		ACTIVE VIDEO GAMES - KINECT ADVENTURE GAMES AND SPORTS	3.1	4.2	5.1	5.9
15240X		ACTIVE VIDEO GAMES - LIGHTSPACE	3.2	4.2	5.1	6.0
15260X		ACTIVE VIDEO GAMES - OLYMPIC GAMES	2.6	3.6	4.5	5.4
15280X		ACTIVE VIDEO GAMES - SPORTWALL	3.8	4.8	5.7	6.6
15300X		ACTIVE VIDEO GAMES - TRAZER	2.8	3.8	4.7	5.5
15320X		ACTIVE VIDEO GAMES - WALKING ON TREADMILL AND BOWLING	2.8	3.9	4.8	5.7
15340X		ACTIVE VIDEO GAMES - WATCHING TV/DVD - WALKING	2.2	3.2	4.0	4.9
15360X		ACTIVE VIDEO GAMES - WII AEROBICS	2.2	3.2	4.1	4.9
15380X		ACTIVE VIDEO GAMES - WII BOXING/TENNIS	2.1	3.1	3.9	4.8
15400X		ACTIVE VIDEO GAMES - WII HOCKEY	1.4	2.4	3.2	4.0
15420X		ACTIVE VIDEO GAMES - WII MUSCLE CONDITIONING	1.3	2.2	3.0	3.8
15440X		ACTIVE VIDEO GAMES - WII SKIING	1.7	2.6	3.5	4.3
15460X		ACTIVE VIDEO GAMES - WII STEP	2.5	3.6	4.4	5.3
15480X		ACTIVE VIDEO GAMES - WII TENNIS	1.6	2.5	3.2	4.0
15500X		ACTIVE VIDEO GAMES - WII YOGA	1.9	1.9	2.7	3.5
15520X		ACTIVE VIDEO GAMES - XAVIX	4.2	5.3	6.2	7.1
15540X		ACTIVE VIDEO GAMES (COMPILATION OF GAMES)	3.9	4.9	5.8	6.7
15560X		ARCADE VIDEO GAME - AIR HOCKEY	2.4	3.4	4.3	5.1
15580X		ARCADE VIDEO GAME - HORSE RIDING SIMULATION	4.1	5.2	6.1	7.0
20100X	ACTIVE VIDEO GAMES (UPPER BODY)	ACTIVE VIDEO GAMES - BOWLING	2.1	2.3	2.4	2.5
20120X		ACTIVE VIDEO GAMES - DRIVING SIMULATOR	2.1	2.2	2.3	2.5
20140X		ACTIVE VIDEO GAMES - WII (COMPILATION OF GAMES)	2.3	2.4	2.6	2.7
20160X		ACTIVE VIDEO GAMES - WII BALANCE	2.2	2.3	2.5	2.6
20180X		ACTIVE VIDEO GAMES - WII BASKETBALL	2.2	2.3	2.4	2.6
20200X		ACTIVE VIDEO GAMES - WII GOLF	2.0	2.2	2.3	2.4
20220X		ARCADE VIDEO GAME - DRIVING SIMULATION	2.0	2.2	2.3	2.4

Code	Activity Category	Specific Activity	Youth MET (MET_y) by Age Group (years)			
			6–9	10–12	13–15	16–18
20240X		ARCADE VIDEO GAME - SHOOTING HOOPS	2.3	2.5	2.6	2.8

Age group is designated by the placeholder X; age ranges are represented by 2 (6–9 y), 3 (10–12 y), 4 (13–15 y), and 5 (16–18 y).

Table 3

Model-based youth MET (MET_y) for play and sports activities for the Youth Compendium of Physical Activities

Code	Activity Category	Specific Activity	Youth MET (MET_y) by Age Group (years)			
			6–9	10–12	13–15	16–18
30100X	CALISTHENICS/GYMNASTICS	ACTIVE CLASSROOM INSTRUCTION	4.3	4.4	4.4	4.5
30120X		BROADCAST CALISTHENICS - 'COLOURFUL SUNSHINE'	4.0	4.1	4.1	4.1
30140X		BROADCAST CALISTHENICS - 'FLOURISHING YOUTH'	4.1	4.2	4.2	4.3
30160X		BROADCAST CALISTHENICS - 'FLYING IDEAL'	3.6	3.7	3.7	3.7
30180X		BROADCAST CALISTHENICS - 'HOPEFUL SAIL'	3.8	3.8	3.9	3.9
30200X		CALISTHENICS - LIGHT	4.0	4.1	4.1	4.2
30220X		GYMNASTICS	2.7	2.7	2.7	2.7
30240X		JUMPING JACKS	4.6	4.7	4.7	4.8
30260X		RADIO GYMNASTICS	3.5	3.5	3.5	3.6
30280X		STRENGTH EXERCISES - CURL-UPS	2.4	2.4	2.4	2.4
30300X		STRENGTH EXERCISES - PUSH-UPS	3.9	4.0	4.0	4.1
85100X	WEIGHT LIFTING *	HAND WEIGHTS EXERCISES	3.0	3.0	2.9	2.9
85120X		STRENGTH EXERCISES - BENCH PRESS	2.0	2.0	1.9	1.8
85140X		STRENGTH EXERCISES - LEG PRESS	2.6	2.7	2.7	2.7
65100X	SPORTS/GAMES	BASKETBALL - GAME	6.7	7.0	7.2	7.5
65120X		BASKETBALL - SHOOTING AND RETRIEVING A BASKETBALL, CONTINUOUSLY, WITHOUT STOPPING	5.9	6.2	6.4	6.6
65140X		BASKETBALL GAME (MINI BASKETBALL)	4.9	5.0	5.1	5.2
65160X		BOWLING - GAME	5.2	5.4	5.6	5.7
65180X		BOXING - PUNCHING BAG AND GLOVES	4.9	5.0	5.0	5.1
65200X		CATCH/THROW BALL	4.1	4.1	4.1	4.1
65220X		GOLF - GAME (MINI GOLF)	4.0	3.9	3.9	3.9
65240X		HANDBALL	5.4	5.6	5.7	5.8
65260X		HOCKEY - GAME (MINI FLOOR HOCKEY)	3.8	3.7	3.7	3.6
65280X		JUGGLING	6.2	6.4	6.6	6.8
65300X		KICKBALL, CONTINUOUS MOVEMENT	8.2	8.3	8.4	8.6

Code	Activity Category	Specific Activity	Youth MET (MET_y) by Age Group (years)			
			6–9	10–12	13–15	16–18
65320X		ROLLERBLADING	5.2	5.2	5.3	5.4
65340X		SKIING	5.6	5.8	6.0	6.2
65360X		SLIDE BOARD - 40 SLIDES/MIN	4.9	5.0	5.0	5.1
65380X		SLIDE BOARD - 50 SLIDES/MIN	5.4	5.5	5.7	5.8
65400X		SLIDE BOARD - 60 SLIDES/MIN	5.6	5.8	5.9	6.1
65420X		SLIDE BOARD - 70 SLIDES/MIN	6.0	6.2	6.3	6.5
65440X		SLIDE BOARD - 80 SLIDES/MIN	5.9	6.1	6.3	6.4
65460X		SOCCER - AROUND CONES	5.4	5.6	5.7	5.8
65480X		SOCCER - GAME	7.7	8.1	8.4	8.7
65500X		TABLE TENNIS	4.2	4.2	4.2	4.2
65520X		TENNIS PRACTICE AND GAMES	6.1	6.3	6.5	6.7
65540X		ULTIMATE FRISBEE	5.6	5.8	5.9	6.1
65560X		VOLLEYBALL	5.0	5.1	5.2	5.3
40100X	DANCE/AEROBICS/STEPS	AEROBIC DANCE/DANCE	3.6	4.1	4.5	4.8
40120X		STAIR WALKING - ASCENDING	4.6	5.2	5.8	6.3
40140X		STAIR WALKING - ASCENDING 80 STEPS/MIN	5.3	6.0	6.6	7.1
40160X		STAIR WALKING - ASCENDING/DESCENDING	5.5	6.3	7.0	7.7
40180X		STAIR WALKING - DESCENDING	3.0	3.4	3.8	4.1
40200X		STEP BOARD	4.5	5.2	5.7	6.2
40220X		STEPPING - HEIGHT 30%–50% LEG LENGTH	3.9	4.4	4.9	5.3
25100X	BIKE/SCOOTER RIDING	RIDING A BIKE - FAST SPEED	--[a]	6.5	7.3	8.1
25120X		RIDING A BIKE - MEDIUM SPEED	4.7	5.3	5.8	6.4
25140X		RIDING A BIKE - SELF PACED	4.6	5.3	5.8	6.4
25160X		RIDING A BIKE - SLOW SPEED	3.7	3.9	4.0	4.2
25180X		RIDING A MINI - SCOOTER	5.7	6.7	7.6	8.4
25200X		RIDING SCOOTER	4.9	5.6	6.2	6.8
10100X	ACTIVE PLAY	BALL GAMES - BOUNCING, KICKING, DRIBBLING BALL, REACTION BALL (MODERATE INTENSITY)	6.0	6.2	6.3	6.5

Code	Activity Category	Specific Activity	Youth MET (MET_y) by Age Group (years)			
			6–9	10–12	13–15	16–18
10120X		BALL GAMES - BOUNCING, KICKING, DRIBBLING BALL, REACTION BALL (VIGOROUS INTENSITY)	6.1	6.3	6.4	6.6
10140X		DODGEBALL TYPE GAMES (E.G., CASTLES, HOT FEET)	5.8	6.0	6.1	6.3
10160X		FREE PLAY (BASKETBALL, ROPE, HOOP, CLIMB, LADDER, FRISBEE)	5.7	5.9	6.0	6.1
10180X		FREEZE/ZONE TAG (MODERATE INTENSITY)	6.3	6.5	6.6	6.7
10200X		FREEZE/ZONE TAG (VIGOROUS INTENSITY)	6.4	6.6	6.7	6.9
10220X		HIKING	5.8	6.0	6.1	6.2
10240X		HOPSCOTCH	6.3	6.5	6.7	6.8
10260X		JUMP ROPE	6.9	7.1	7.2	7.4
10280X		MARCHING - 75M.MIN INSTRUMENTS	5.0	5.2	5.3	5.5
10300X		MARCHING - 75M.MIN NO INSTRUMENTS	3.9	4.1	4.2	4.4
10320X		MARCHING - 91M.MIN NO INSTRUMENTS	5.1	5.3	5.4	5.6
10340X		MISCELLANEOUS GAMES - VIGOROUS (E.G., SLAP THE BALL, BUILDERS AND BULLDOZERS, CLEAN THE ROOM)	6.4	6.6	6.7	6.9
10360X		MISCELLANEOUS GAMES - MODERATE (E.G., SIMON'S SPOTLIGHT)	6.9	7.1	7.3	7.4
10380X		OBSTACLE/LOCOMOTOR COURSE - MODERATE	5.9	6.1	6.2	6.4
10400X		OBSTACLE/LOCOMOTOR COURSE - VIGOROUS	7.2	7.4	7.6	7.7
10420X		PLAYING GAMES (CATCH AND THROW BALLS, JUMPING JACKS)	5.9	6.1	6.2	6.4
10440X		PLAYING TAG - MODERATE	6.1	6.3	6.4	6.6
10460X		PLAYING TAG-VIGOROUS	7.4	7.6	7.8	7.9
10480X		RELAY	6.8	6.9	7.1	7.3
10500X		SHARKS AND MINOOWS	5.8	6.0	6.1	6.2
10520X		TRAMPOLINE	7.0	7.1	7.3	7.5
75100X	SWIMMING	SWIMMING - 200M	10.6	10.4	10.3	10.1
75120X		SWIMMING - FRONT CRAWL 0.9 M.SEC	9.7	9.4	9.1	8.8
75140X		SWIMMING - FRONT CRAWL 1.0 M.SEC	10.0	9.7	9.4	9.2
75160X		SWIMMING - FRONT CRAWL 1.1 M.SEC	10.6	10.4	10.2	10.1
75180X		SWIMMING - SELF-SELECTED PACE	9.5	9.1	8.9	8.6
75200X		SYNCHRONISED SWIMMING	10.1	9.9	9.7	9.5

Age group is designated by the placeholder X; age ranges are represented by 2 (6–9 y), 3 (10–12 y), 4 (13–15 y), and 5 (16–18 y).

[*] Energy cost of anaerobic activities may be underestimated by MET values

[a] Activity not deemed reasonable for this age group

Table 4

Model-based youth MET (MET_y) for walking and running activities for the Youth Compendium of Physical Activities

Code	Activity Category	Specific Activity	Youth MET (MET_y) by Age Group (years)			
			6–9	10–12	13–15	16–18
80100X	WALKING	WALK 0.5	2.5	2.5	2.6	2.6
80120X		WALK 1.0	2.5	2.6	2.7	2.8
80140X		WALK 1.5	2.5	2.7	2.9	3.1
80160X		WALK 2.0	2.8	3.0	3.2	3.4
80180X		WALK 2.5	3.3	3.5	3.6	3.7
80200X		WALK 3.0	3.8	4.1	4.3	4.5
80220X		WALK 3.5	4.6	5.0	5.3	5.5
80240X		WALK 4.0	4.8	5.2	5.6	6.0
80260X		WALK 4.5	--[a]	--[a]	6.6	7.2
80280X		WALK 5.0	--[a]	--[a]	7.2	7.8
80300X		WALK SELF-PACED BRISK	4.6	4.9	5.1	5.4
80320X		WALK SELF-PACED CASUAL	3.6	3.9	4.2	4.4
60100X	RUNNING	JOG - FAST	7.2	7.9	8.5	8.8
60120X		JOG - SLOW	5.5	5.9	6.3	6.7
60140X		JOG SELF-PACED	6.8	7.4	7.9	8.4
60160X		RUN 3.0	5.3	6.0	--[a]	--[a]
60180X		RUN 3.5	6.4	7.0	7.5	8.0
60200X		RUN 4.0	6.5	7.2	7.7	8.3
60220X		RUN 4.5	6.7	7.4	8.0	8.6
60240X		RUN 5.0	7.2	8.0	8.6	9.3
60260X		RUN 5.5	7.3	8.1	8.8	9.5
60280X		RUN 6.0	8.2	9.1	9.8	10.5
60300X		RUN 6.5	8.9	9.9	10.9	11.8
60320X		RUN 7.0	9.3	10.2	11.0	11.8
60340X		RUN 7.5	10.0	10.7	11.3	11.9
60360X		RUN 8.0	10.6	11.5	12.4	13.2

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Code	Activity Category	Specific Activity	Youth MET (MET_y) by Age Group (years)			
			6–9	10–12	13–15	16–18
60380X		RUN SELF-PACED	7.8	8.5	9.1	9.8

Age group is designated by the placeholder X; age ranges are represented by 2 (6–9 y), 3 (10–12 y), 4 (13–15 y), and 5 (16–18 y).

[a]Activity not deemed reasonable for this age group