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Energy Expenditure for 70 Activities in Children and Adolescents

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Background: Thirty-five percent of the activities assigned MET values in the *Compendium of Energy Expenditures for Youth* were obtained from direct measurement of energy expenditure (EE). The aim of this study was to provide directly measured EE for several different activities in youth. **Methods:** Resting metabolic rate (RMR) of 178 youths (80 females, 98 males) was first measured. Participants then performed structured activity bouts while wearing a portable metabolic system to directly measure EE. Steady-state oxygen consumption data were used to compute activity MET_{standard} (activity VO₂/3.5) and MET_{measured} (activity VO₂/measured RMR) for the different activities. **Results:** Rates of EE were measured for 70 different activities and ranged from 1.9 to 12.0 MET_{standard} and 1.5 to 10.0 MET_{measured}. **Conclusion:** This study provides directly measured energy cost values for 70 activities in children and adolescents. It contributes empirical data to support the expansion of the *Compendium of Energy Expenditures for Youth*.

Keywords: youth, physical activity, measurement, physical activity assessment

Physical activity has been widely associated with many health outcomes throughout the lifespan. In children and adolescents, physical activity is associated with improved lipid profile, lower risks for hypertension, overweight/obesity, metabolic syndrome and depression.¹ However, this association is not always consistent. To improve the understanding of these relationships, a standardized method for translating activity type into activity volume requires evidence-based quantification of physical activity intensity and energy expenditure.

To date, most large-scale studies rely on self-report instruments to assess physical activity in children and adolescents.² With these types of instruments, activity intensity is often classified based on values from compendia of energy costs.³ However, in the *Compendium of Energy Expenditures for Youth*,³ only 35% of the activity MET values were obtained from direct measurement of energy expenditure (EE) in youth, while the remaining activity METs were taken from the *Compendium of Physical Activities for Adults*.³ The compendium for youth can be improved through expanding the number of activities where EE is directly measured.

In the current study, we provide energy expenditure (ie, oxygen consumption and METs) for several activities performed by children

and adolescents during free-living simulated routines in a laboratory or gymnasium.

Methods

The current dataset is a combination of metabolic data from 3 different studies with similar protocols: 1) Novel Analytic Techniques to Assess Physical Activity (Location: University of Massachusetts Amherst); 2) Development of an Integrated Measurement System to Assess Physical Activity (Locations: University of Massachusetts Amherst and University of Tennessee at Knoxville); and 3) Physical Activity Measurement Study (Locations: University of Massachusetts Amherst and Ohio University). A detailed description of these studies can be found elsewhere.⁴⁻⁶ The studies and their protocols were approved by each university's institutional review board.

Participants Recruitment—Visit 1

Children and adolescents aged 8 to 18 years were recruited from 1) Amherst, MA; 2) Knoxville, TN; and 3) Athens, OH, via word of mouth, media advertisement (eg, radio), flyers, and researcher visits to schools. After phone contact, children visited the laboratory with parents and received a verbal explanation about the study and its objectives. Children and adolescents who agreed to participate in the study signed the university's institutional review board approved assent forms, and parents read and signed the approved informed consent form. During the first visit, participants were also familiarized with treadmill and cycle ergometer activities.

Activity Protocol—Visit 2

Before their visit to the laboratory, participants were instructed to fast for 3 hours, refrain from engaging in exercise, and avoid the use of caffeine and nicotine. In the laboratory, resting heart rate, and

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blood pressure were measured according to standard procedures. Body weight and height were measured, to the nearest 0.1 cm and 0.1 kg, using a weight scale and stadiometer, respectively. Subsequently, participants rested in the supine position for 10 to 15 minutes in a dimly lit-temperature-controlled room. Resting metabolic rate (RMR) was determined using the MedGem indirect calorimeter (MedLife, USA; Dunedin, FL), a lightweight handheld device that estimates EE by measuring oxygen consumption and applying a modified Weir equation using a fixed 'respiratory exchange ratio' value of 0.85. The MedGem collects expired air via a mouthpiece for a period of 5 to 10 minutes and uses steady-state VO_2 data for estimating VO_2 ($\text{ml of O}_2 \cdot \text{min}^{-1}$) and $\text{kcal} \cdot \text{day}^{-1}$. Validity and reliability of the MedGem have been reported in previous studies.⁷ After RMR measurement, participants consumed a 150 kcal snack (eg, cereal bar and juice) and had a 10-minute break.

Participants were then fitted with the Oxycon Mobile (CareFusion, San Diego, CA), an indirect open-circuit portable metabolic system comprised of facemask, flow turbine, electronic transmission cable, sampling line, and 2 small units (sensor box containing O_2 and CO_2 sensors, and data exchange unit) mounted in a backpack harness assembly. The Oxycon Mobile is a valid and reliable system for measuring oxygen consumption.⁸ Before testing, the Oxycon flowmeter and gas analyzers were calibrated using a 3-L air syringe and a known gas mixture (16% O_2 and 4% CO_2). Ventilation data were collected breath-by-breath and when data collection exceeded 1 hour, the sampling line was changed and the Oxycon was recalibrated before continuing the protocol.

Participants were provided time to become familiar with the equipment and then performed an activity routine consisting of 7 to 12 activities. Each activity was performed for 6 to 7 minutes with a 4 to 5 minute rest period between activities. The activities were performed in the laboratory (eg, activities of daily living, treadmill activities, board games) and in a gymnasium (eg, basketball, gator tag, capture the flag). The activity routines included the following activities, which have been described in detail in our previous studies^{4,5}:

1. Novel Analytic Techniques to Assess Physical Activity (Activity duration: 7 minutes per activity)

Activities: Basketball, playing board games, self-paced walk with a 4.5 kg backpack, self-paced walk with a 6.8 kg backpack, crafts, playing Wii, riding a bike, treadmill 2.0 mph 0% grade, treadmill 2.0 mph 3% grade, treadmill 3.0 mph 0% grade, treadmill 3.5 mph, treadmill 3.5 mph 3% grade, and treadmill 5.0 mph 0% grade

2. Development of an Integrated Measurement System to Assess Physical Activity (Activity duration: 7 minutes per activity)

Activities: Basketball, playing board games, cleaning the room, cycling 300 $\text{kg} \cdot \text{min}^{-1}$, cycling 600 $\text{kg} \cdot \text{min}^{-1}$, jumping jacks, playing Wii, self-paced walk, self-paced walk with a 6.8 kg backpack, soccer, treadmill 3.0 mph, treadmill 3.0 mph 5% grade, treadmill 3.5 mph 5% grade, treadmill 4.0 mph 0% grade, treadmill 4.0 mph 5% grade, treadmill 5.0 mph 0% grade, and treadmill 6.0 mph 0% grade

3. Physical Activity Measurement Study (Activity duration: 6 minutes per activity)

Activities: 1-on-1 showdown, Angels and Devils, Barker's Hoopla, Blob Relay, Builders and Bulldozers, Can't Touch This, Capture the Flag, Cardio Course, Castles, Circuit Training, Cleaning the Room, Computer Virus, Couple Tag, Crazy

Soccer, Crows and Cranes, Domino Relay, Dragon's Tail, Dribblers and Shooters, Eagles and Sparrows, Fitness Tag, Fox & Hound, Gator Tag, Great Escape, Hibernation, Hoop Stations, Hot Feet, Hot Spot, I'm a New Skunk, Joker's Wild, Jump the Circuit, Lumos, Me and My Shadow, Mini Kick-ball, Monkey in the Middle, Pass the Bacon, Pass the Hat, Pirate's Treasure, Race Day, Rat Tail, Scatter Ball, Shark's and Minnows, Shooting Stars, Simon's Spotlight, Slap Ball, Soccer, Steal the Bacon, Stop and Go, Treadmill.

Data Processing and Analysis

Body mass index (BMI) was calculated dividing weight in kilograms by the square of height in meters. Participants were defined as normal weight if their BMI was below the 85th percentile, and overweight/obese if their BMI was equal to or above the 85th percentile. VO_2 data were smoothed by averaging values on a minute-by-minute basis. The first 2 minutes for each activity were discarded to obtain steady-state VO_2 data. Activity VO_2 for each participant was determined by averaging the remaining 4 or 5 minutes of VO_2 data expressed as $\text{ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$. Metabolic Equivalents of Task (METs) for the different activities were expressed according to 3 methods: 1) Standard MET values ($\text{MET}_{\text{standard}}$), which were calculated by dividing activity VO_2 by 3.5, 2) Predicted METs ($\text{MET}_{\text{predicted}}$), which were obtained by dividing activity VO_2 by predicted RMR obtained using the Schofield equations,⁹ and 3) Measured METs ($\text{MET}_{\text{measured}}$), which were calculated by dividing activity VO_2 by measured RMR, assessed with the MedGem.

Results

Table 1 presents participant characteristics according to age group and BMI classification group (normal: <85th percentile; overweight/obese: ≥85th percentile). Rates of EE and participant characteristics for each activity are shown in Table 2. Energy expenditure was measured for 70 different activities: 18 structured/locomotive activities, 1 household activity, and 52 game/sport activities. $\text{MET}_{\text{standard}}$ values ranged from 1.9 to 12.0, $\text{MET}_{\text{predicted}}$ ranged from 1.5 to 9.1, and $\text{MET}_{\text{measured}}$ ranged from 1.5 to 9.6.

Discussion

The current study provides directly measured EE for 70 different activities commonly performed by children and adolescents. These data can be used to inform self-report tools commonly used by physical activity epidemiologists and exercise physiologists. For example, they can be used to improve the *Compendium of Energy Expenditures for Youth* by 1) updating current energy cost values estimated from adult measurements with objective data measured directly in children and adolescents, and 2) expanding the content to include games and activities that are ecologically relevant to children and adolescents.

With overweight/obesity rates continue to rise and chronic conditions previously seen only in adults becoming more prevalent in today's youth, it is essential that physical activity researchers use the most appropriate methods to measure physical activity exposure. Use of directly measured energy cost values will facilitate the accurate scoring of self-report instruments, which remain a popular tool for assessing physical activity in large-scale studies.² For example, when intensity values (expressed as multiples of RMR) derived from adult data are used in place of directly measured values from

Table 1 Participant Characteristics

	All participants (n = 178)	Age group		BMI classification*	
		Children (≤11 years) (n = 110)	Adolescents (12–18 years) (n = 68)	NW (<85th percentile) (n = 135)	OW (≥85th percentile) (n = 43)
Gender	80 F, 98 M	48 F, 62 M	32 F, 36 M	63 F, 72M	17 F, 26 M
Age (years)	11.5 ± 2.5	9.4 ± 1.1	14.4 ± 2.1	11.7 ± 2.9	10.0 ± 2.4
Height (cm)	151.1 ± 14.6	139.6 ± 8.2	165.7 ± 9.8	150.9 ± 16.3	145.2 ± 11.7
Weight (kg)	45.5 ± 14.2	35.8 ± 9.2	58.3 ± 12.6	42.3 ± 14.4	50.8 ± 16.1
BMI (kg·m ⁻²)	19.5 ± 3.9	18.3 ± 3.8	21.1 ± 3.7	18.0 ± 2.5	23.5 ± 4.8
Measured RMR (VO ₂ ml·kg ⁻¹ ·min ⁻¹)	5.1 ± 1.1	5.5 ± 1.1	4.0 ± 0.8	5.1 ± 1.3	4.4 ± 1.0
Predicted RMR (VO ₂ ml·kg ⁻¹ ·min ⁻¹)	4.9 ± 0.7	5.2 ± 0.6	4.2 ± 0.4	5.0 ± 0.7	4.6 ± 0.6

* Classification was based on the body mass index (BMI) growth charts from the Centers for Disease Control and Prevention.

Abbreviations: NW, normal weight; OW, overweight/obese; RMR, resting metabolic rate.

youth, researchers are likely to overestimate the intensity of a given activity due to the inverse association between age and RMR.^{3,4} In addition, activity EE values in adults and youth differ because of factors related to body size, economy of movement, and different skill levels.

An important aspect of our study is that we used the MedGem to measure RMR and this allowed us to express EE in MET_{measured} (activity VO₂/measured RMR). We also used the Schofield method⁹ to predict RMR and the values were close to measured RMR, indicating that predicting RMR based on ‘three easy-to-obtain variables’ (sex, age, and body weight) is an alternative to measuring RMR with an indirect calorimeter equipment, which usually involves costs, time, and burden to participants. Energy cost of activities expressed as multiples of measured or estimated RMR may help researchers to establish more accurate relationships between physical activity and health outcomes in youth, as it can be observed that RMR in this age group is higher than the standard MET value of 3.5 ml of O₂·kg⁻¹·min⁻¹ (Table 1).

We encourage other research groups to continue publishing and sharing their data on activity EE in children and adolescents to create a more complete and standardized resource for translating self-report activity data into activity volume measures.

Acknowledgments

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Table 2 Activity Energy Expenditure

Activity*	N	Age range (years)	BMI classification	VO ₂ (ml·kg ⁻¹ ·min ⁻¹)	MET _{standard}	MET _{predicted}	MET _{measured}
Structured/Locomotive activities							
Treadmill 2.0 mph 0% grade	31 (15 F, 16 M)	8–11	23 NW, 8 OW	15.6 ± 1.8	4.5 ± 0.5	3.0 ± 0.3	2.9 ± 0.4
Treadmill 2.0 mph 3% grade	32 (15 F, 17 M)	8–11	23 NW, 9 OW	17.7 ± 2.0	5.1 ± 0.6	3.4 ± 0.3	3.3 ± 0.4
Treadmill—self-selected speed	27 (12 F, 15 M)	8–10	16 NW, 11 OW	18.2 ± 4.3	5.2 ± 1.2	3.5 ± 0.8	3.3 ± 0.9
Self-Paced walk overground	19 (7 F, 12 M)	10–18	19 NW	16.4 ± 4.2	4.7 ± 1.2	3.6 ± 0.7	3.5 ± 0.9
Self-paced walk with 6.8kg backpack	26 (13 F, 13 M)	12–16	21 NW, 5 OW	14.7 ± 2.6	4.2 ± 0.7	3.5 ± 0.5	3.6 ± 0.7
Self-paced walk with 4.5 kg backpack	53 (27 F, 26 M)	8–18	41 NW, 12 OW	18.5 ± 3.0	5.3 ± 0.8	3.8 ± 0.5	3.8 ± 0.7
Treadmill 3.0 mph 0% grade	70 (35 F, 35 M)	8–16	55 NW, 15 OW	18.3 ± 3.6	5.2 ± 1.0	3.9 ± 0.5	3.8 ± 0.7
Riding a bike	54 (27 F, 27 M)	8–16	41 NW, 13 OW	20.4 ± 5.9	5.8 ± 1.7	4.3 ± 1.2	4.3 ± 0.9
Treadmill 3.5 mph 0% grade	67 (36 F, 31 M)	8–16	57 NW, 10 OW	21.4 ± 4.8	6.1 ± 1.4	4.5 ± 0.7	4.5 ± 0.9
Cycling 300 kgm·min ⁻¹	30 (14 F, 16 M)	10–18	27 NW, 3 OW	20.1 ± 7.0	5.7 ± 2.0	4.4 ± 1.0	4.6 ± 1.4
Treadmill 4.0 mph 0% grade	08 (1 F, 7 M)	15–18	8 NW	19.3 ± 4.1	5.5 ± 1.2	5.0 ± 1.0	5.0 ± 1.0
Cycling 600 kgm·min ⁻¹	09 (3 F, 6 M)	10–18	9 NW	22.5 ± 9.3	6.4 ± 2.7	5.3 ± 1.9	5.1 ± 1.6
Treadmill 3.5 mph 3% grade	28 (15 F, 13 M)	12–16	23 NW, 5 OW	22.3 ± 2.9	6.4 ± 0.8	5.3 ± 0.5	5.5 ± 1.1
Treadmill 3.0 mph 5% grade	09 (5 F, 4 M)	10–18	7 NW, 2 OW	22.0 ± 2.4	6.3 ± 0.7	5.5 ± 0.6	5.8 ± 0.7
Treadmill 4.0 mph 5% grade	07 (1 F, 6 M)	15–18	7 NW	25.9 ± 5.11	7.4 ± 1.5	6.7 ± 1.4	6.8 ± 1.3
Treadmill 3.5 mph 5% grade	10 (4 F, 6 M)	10–14	9 NW, 1 OW	25.9 ± 5.7	7.4 ± 1.6	5.5 ± 1.2	5.3 ± 1.5
Treadmill 5.0 mph 0% grade	36 (21 F, 15 M)	10–16	34 NW, 2 OW	34.6 ± 5.8	9.9 ± 1.7	7.7 ± 1.2	7.5 ± 1.5
Treadmill 6.0 mph 0% grade	08 (4 F, 4 M)	15–18	7 NW, 1 OW	38.0 ± 5.1	10.9 ± 1.5	9.6 ± 1.1	10.0 ± 1.7
Household							
Cleaning the room	42 (16 F, 26 M)	8–18	33 NW, 9 OW	28.5 ± 9.6	8.1 ± 2.7	5.7 ± 1.7	5.8 ± 1.8
Games and Sports							
Crafts	32 (15 F, 17 M)	8–11	23 NW, 9 OW	8.4 ± 1.1	2.4 ± 0.3	1.6 ± 0.2	1.5 ± 0.2
Playing Board Games	47 (22 F, 25 M)	10–18	42 NW, 5 OW	6.6 ± 2.7	1.9 ± 0.8	1.5 ± 0.5	1.5 ± 0.4
Playing Wii	80 (40 F, 40 M)	8–18	63 NW, 17 OW	10.4 ± 3.3	3.0 ± 1.0	2.2 ± 0.6	2.2 ± 0.6
Domino Relay	07 (3 F, 4 M)	8–9	5 NW, 2 OW	25.7 ± 6.0	7.3 ± 1.7	4.7 ± 1.0	4.3 ± 1.3
Hibernation	09 (4 F, 5 M)	8–9	5 NW, 4 OW	25.0 ± 7.5	7.1 ± 2.1	4.9 ± 1.2	4.3 ± 0.8
Crows and Cranes	09 (4 F, 5 M)	8–9	6 NW, 3 OW	26.2 ± 5.6	7.5 ± 1.6	5.0 ± 0.9	4.4 ± 0.7
Hoop Stations	12 (3 F, 9 M)	8–13	9 NW, 3 OW	23.4 ± 4.9	6.7 ± 1.4	4.3 ± 0.5	4.4 ± 0.7
Eagles and Sparrows	08 (4 F, 4 M)	9	3 NW, 5 OW	24.9 ± 7.0	7.1 ± 2.0	4.8 ± 0.9	4.6 ± 0.5
Cardio Course	08 (3 F, 5 M)	8–9	5 NW, 3 OW	28.1 ± 7.5	8.0 ± 2.1	5.4 ± 1.3	4.7 ± 1.0
Great Escape	08 (3 F, 5 M)	8–9	5 NW, 3 OW	27.6 ± 5.1	7.9 ± 1.4	5.1 ± 0.7	4.7 ± 1.0
Circuit Training	12 (3 F, 9 M)	8–12	8 NW, 4 OW	24.0 ± 7.1	7.0 ± 2.0	4.7 ± 1.3	4.7 ± 1.5
Fitness Tag	10 (5 F, 5 M)	8–9	7 NW, 3 OW	26.9 ± 7.4	7.7 ± 2.1	5.2 ± 1.1	4.8 ± 1.2
Castles	09 (4 F, 5 M)	8–10	5 NW, 4 OW	26.3 ± 4.7	7.5 ± 1.3	5.0 ± 1.0	4.9 ± 1.3
Capture the Flag	09 (4 F, 5 M)	8–9	6 NW, 3 OW	29.2 ± 6.1	8.3 ± 1.7	5.6 ± 1.0	4.9 ± 1.0

(continued)

Table 2 (continued)

Activity*	N	Age range (years)	BMI classification	VO ₂ (ml·kg ⁻¹ ·min ⁻¹)	MET _{standard}	MET _{predicted}	MET _{measured}
Games and Sports (continued)							
Monkey in the Middle	23 (9 F, 14 M)	8–12	12 NW, 11 OW	24.2 ± 8.8	6.9 ± 2.5	4.8 ± 1.5	4.9 ± 1.6
Pass the Hat	09 (4 F, 5 M)	8–13	6 NW, 3 OW	29.4 ± 4.4	8.4 ± 1.3	5.5 ± 0.9	5.1 ± 1.2
Can't Touch This	09 (4 F, 5 M)	8–10	5 NW, 4 OW	29.4 ± 5.5	8.4 ± 1.6	5.6 ± 0.9	5.4 ± 1.3
Steal the Bacon	10 (5 F, 5 M)	8–9	7 NW, 3 OW	30.8 ± 8.5	8.8 ± 2.4	5.9 ± 1.3	5.4 ± 1.4
Blob Relay (tag)	08 (3 F, 5 M)	8–9	5 NW, 3 OW	31.0 ± 4.3	8.9 ± 1.2	5.8 ± 0.8	5.4 ± 1.2
Pirate's Treasure	22 (11 F, 11 M)	8–11	16 NW, 6 OW	28.7 ± 8.2	8.2 ± 2.3	5.6 ± 1.4	5.5 ± 1.6
Hot Feet	13 (4 F, 9 M)	8–13	9 NW, 4 OW	29.0 ± 4.7	8.4 ± 1.4	5.5 ± 0.7	5.5 ± 0.7
Stop and Go	27 (11 F, 16 M)	8–12	20 NW, 7 OW	29.2 ± 8.0	8.3 ± 2.4	5.6 ± 1.2	5.6 ± 1.4
Barker's Hoopla	21 (7 F, 11 M)	8–13	13 NW, 8 OW	29.7 ± 7.6	8.6 ± 2.2	5.7 ± 1.4	5.6 ± 1.4
Mini Kickball	08 (4 F, 4 M)	9	3 NW, 5 OW	30.3 ± 7.2	8.7 ± 2.0	5.9 ± 0.8	5.6 ± 0.4
Simon's Spotlight	15 (5 F, 10 M)	8–12	12 NW, 3 OW	30.1 ± 8.5	8.4 ± 2.4	5.7 ± 1.5	5.8 ± 1.6
Dribblers and Shooters	09 (4 F, 5 M)	8–10	5 NW, 4 OW	31.1 ± 5.3	8.9 ± 1.5	5.9 ± 1.0	5.8 ± 1.3
Jump the Circuit	13 (4 F, 9 M)	8–11	9 NW, 4 OW	29.4 ± 5.0	8.2 ± 1.4	5.8 ± 0.9	5.9 ± 1.3
Scatter Ball	12 (4 F, 8 M)	8–12	10 NW, 2 OW	30.2 ± 2.6	8.7 ± 0.8	6.0 ± 0.6	5.9 ± 0.9
Fox & Hound	20 (7 F, 13 M)	8–12	15 NW, 5 OW	33.1 ± 6.7	9.4 ± 1.9	6.1 ± 1.1	5.9 ± 1.3
Builders and Bulldozers	09 (4 F, 5 M)	8–9	6 NW, 3 OW	35.6 ± 5.1	10.2 ± 1.5	6.7 ± 0.8	6.0 ± 0.8
Couple Tag	20 (7 F, 13 M)	8–13	15 NW, 5 OW	33.0 ± 5.2	9.3 ± 1.5	6.2 ± 0.7	6.0 ± 1.0
Shooting Stars	12 (4 F, 8 M)	8–13	8 NW, 4 OW	28.6 ± 9.0	8.2 ± 2.6	5.7 ± 1.6	6.1 ± 2.0
Sharks and Minnows	22 (10 F, 12 M)	8–12	15 NW, 7 OW	30.3 ± 8.1	8.7 ± 2.3	5.8 ± 1.4	6.1 ± 1.7
Pass the Bacon	14 (4 F, 10 M)	8–13	9 NW, 5 OW	31.4 ± 5.0	9.1 ± 1.8	6.2 ± 1.1	6.1 ± 1.3
Race Day	09 (4 F, 5 M)	8–10	6 NW, 3 OW	34.9 ± 8.8	10.0 ± 2.5	6.6 ± 1.6	6.1 ± 1.7
Hot Spot	24 (10 F, 14 M)	8–12	17 NW, 7 OW	32.7 ± 7.5	9.2 ± 2.1	6.2 ± 1.3	6.2 ± 1.5
Lumos	13 (5 F, 8 M)	8–13	10 NW, 3 OW	32.8 ± 6.1	9.2 ± 2.0	6.3 ± 0.9	6.2 ± 1.3
Angels and Devils	11 (5 F, 6 M)	8–12	8 NW, 3 OW	32.0 ± 6.4	9.4 ± 1.9	6.3 ± 1.3	6.5 ± 1.7
I'm a New Skunk	22 (9 F, 13 M)	8–11	17 NW, 5 OW	33.1 ± 7.1	9.3 ± 2.0	6.3 ± 1.3	6.3 ± 1.8
Slap Ball	11 (3 F, 8 M)	8–12	8 NW, 3 OW	32.9 ± 5.4	9.3 ± 1.4	6.3 ± 0.8	6.5 ± 0.9
Computer Virus	22 (8 F, 14 M)	8–12	14 NW, 8 OW	35.0 ± 8.6	10.1 ± 2.4	6.7 ± 1.3	6.5 ± 1.2
Crazy Soccer	23 (10 F, 13 M)	8–13	13 NW, 10 OW	32.6 ± 10.2	9.3 ± 2.9	6.3 ± 1.7	6.6 ± 1.9
Dragon's Tail	23 (9 F, 14 M)	8–13	17 NW, 6 OW	34.9 ± 7.3	10.0 ± 2.1	6.6 ± 1.2	6.6 ± 1.6
1-on-1 showdown	12 (5 F, 7 M)	9–13	7 NW, 5 OW	31.5 ± 6.7	9.2 ± 2.1	6.5 ± 1.2	6.8 ± 1.4
Rat Tail	13 (6 F, 7 M)	8–12	10 NW, 3 OW	32.7 ± 5.5	9.3 ± 1.5	6.5 ± 1.0	6.8 ± 1.2
Joker's Wild	13 (6 F, 7 M)	8–12	9 NW, 4 OW	33.7 ± 5.5	9.6 ± 1.5	6.6 ± 1.2	6.9 ± 1.6
Soccer	27 (12 F, 15 M)	8–18	23 NW, 4 OW	34.1 ± 10.0	9.7 ± 2.8	7.2 ± 2.0	7.1 ± 2.2
Basketball	68 (33 F, 35 M)	8–18	54 NW, 14 OW	34.9 ± 9.0	10.0 ± 2.6	7.6 ± 2.0	7.5 ± 1.9
Gator Tag	11 (5 F, 6 M)	8–12	9 NW, 2 OW	36.9 ± 5.8	10.5 ± 1.7	7.2 ± 0.9	7.4 ± 1.2
Me and My Shadow	12 (6 F, 6 M)	8–12	10 NW, 2 OW	38.4 ± 9.7	11.0 ± 2.8	7.4 ± 1.9	7.7 ± 2.3
Jumping Jacks	14 (7 F, 7 M)	10–18	12 NW, 2 OW	42.1 ± 4.0	12.0 ± 1.1	9.1 ± 1.0	9.6 ± 2.5

* For descriptions of the activities, see references.^{4,5}

Abbreviations: F, female; M, male; NW, normal weight; OW, overweight.

Note. MET_{standard} = activity VO₂/3.5; MET_{predicted} = activity VO₂/predicted resting metabolic rate (Schofield equations); MET_{measured} = activity VO₂/measured resting metabolic rate.