Field Assessments for Obesity Prevention in Children and Adults: Physical Activity, Fitness, and Body Composition

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ABSTRACT

Nutrition and health educators work in community settings implementing lifestyle programs focused on obesity prevention and chronic disease risk reduction. These programs typically focus on improving diet and physical activity (PA) behaviors. Many nutrition educators may not be confident in their ability to select, administer, and interpret PA assessments to effectively evaluate their PA or lifestyle programs. This report will assist educators in identifying and selecting appropriate field-based assessments for measurement of PA, physical fitness, and body composition for children and adults. Specific guidelines, references, and resources are given for selecting assessment methods and test within these 3 areas.

Key Words: body fat, waist circumference, exercise, physical activity assessment, community nutrition
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INTRODUCTION

There is strong scientific evidence that physical activity (PA) increases health-related fitness and decreases risk for chronic and disabling diseases, including obesity, in active compared with inactive adults.[1] To achieve these benefits, adults need to participate in 150 min/wk of moderate or 75 min/wk of vigorous PA. For youth and children ages 6 years and older, there is also strong scientific evidence that PA substantially improves cardiorespiratory fitness, strengthens bones and muscles, helps to attain and maintain healthy weight, reduces risk of depression and anxiety, and decreases the likelihood of developing risk factors associated with chronic disease.[2] To achieve these benefits children and youth need to participate in 60 min/d or more of PA,[1] including aerobic and age-appropriate muscle and bone-strengthening activities.[2] In addition, the 2010 *Dietary Guidelines for Americans*[3] support engaging in PA to assist in balancing energy expenditure with energy intake for the maintenance of a healthy body weight and reduction of chronic disease.

Health and nutrition educators work in community settings implementing healthy lifestyle programs focused on obesity prevention and chronic disease reduction. These lifestyle programs typically emphasize improving diet and PA behaviors, which will result in improvements in health outcomes such as body size and fitness, or reduced chronic disease risk factors. To determine the effectiveness of these programs, nutrition educators must identify and measure outcomes related to their program goals. As part of the overall lifestyle program evaluation, assessing changes in diet, PA, or physical fitness (PF) is frequently done. Although nutrition educators are confident in their ability to assess dietary change, they may be less confident in their ability to select, administer, and interpret PA or PF assessments to measure the impact of a PA intervention. The goal of this report is to help nutrition educators, who are less familiar with exercise science, to identify and select appropriate field-based assessment tools for the measurement of change in PA, PF, and/or body composition. First, definitions of the PA and exercise science terms used within this report are given. Second, field assessments of PA and PF are given based on the measures each method or test provides, the audience for which they were designed and validated, the length of the assessment, the method description, and the advantages and disadvantages of the method. Within each of these areas, the method or test that would work best within a community-based setting with limited training and costs is identified. Third, field assessment measures of body composition are briefly addressed. Emphasis is placed on helping the educator identify the method or test that will work best in the field, based on the skills, time, and resources of the educator, the environment in which they are working, and the population they are evaluating.

DEFINITIONS

To understand the assessment measures of the PA and PF methods in this report, it is important to

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understand the meaning of the terms used. Physical activity refers to the body movement that enhances health and increases energy expenditure; PF is the capacity to perform PA based on various physiological indicators. An individual can be physically active and not physically fit, or have some increased measure of fitness and not be active. Other exercise science and PA terms used within this report are defined in Table 1.[1,2]

PHYSICAL ACTIVITY ASSESSMENT

Ideally, PA assessment should measure all dimensions of PA, including type, frequency, intensity, and duration.

Table 1. Terms and Definitions Used to Describe Physical Activity and Exercise[1]

Terms	Definitions
PA	Any body movement that enhances health and increases energy expenditure above basal levels
PF	Capacity to perform PA based on various physiological parameters. One can be physically active and not physically fit, or have some increases measure of fitness and not be active
Exercise	A subcategory of PA identified as planned, structured, and purposeful, designed for improvement or maintenance of PF (eg, sports, jogging, swimming, physical education classes). Exercise is sometimes referred to as programmed PA
ADL	Activities required for everyday living, including eating, walking, standing, cooking, dressing, getting up from chair, and activities associated with one's job, work, or school. There is clear research evidence that all PA, including ADL and planned exercise, can contribute to overall health, especially maintenance of healthy body weight and weight loss, or maintenance of weight loss after dieting
Duration	Length of time in which an activity or exercise is performed and is reported as minutes per day or week.
Frequency	Number of times an activity or exercise is performed and is reported as number of sessions or bouts per day or week
Intensity	Work that is being performed or magnitude of effort required to perform and activity or exercise, expressed in absolute or relative terms
Absolute intensity	Amount of work being performed, not taking into account physiological capacity of individual. Absolute intensity is reported as energy expenditure required per kilogram body weight per minute or amount of oxygen used by the body doing the activity, expressed using an MET level (eg, 1 MET at rest; 7 METs while running quickly). Absolute intensity is sometimes expressed as the speed in which an activity is performed (eg, walking at 3 mph)
Relative intensity	An individual's exercise capacity (eg, how PF they are). For aerobic activity, relative intensity is expressed as a percentage of an individual's total aerobic capacity, measured or estimated heart rate.
Sedentary behavior	A new measure of activity being assessed by some researchers, defined as the amount of inactivity an individual engages in each day (eg, sitting or lying down; typically 1–1.5 times the resting metabolic rate[37]). Sedentary behavior can be measured in 3 ways: time (minutes per day in inactivity), type (eg, TV or screen viewing, reading, sitting, motorized transport), and frequency (length [minutes per bout] and frequency [bouts per day] of sedentary behavior). Television viewing is the most frequently surveyed type of sedentary behavior in children.[38,39] The Youth Risk Behavior Survey designates $\geq$ 3 h/d of TV viewing as excessive, whereas the National Health and Nutrition Examination Survey 2001–2006 reports $\geq$ 2 h/d as excessive. When using accelerometers to define sedentary behavior, several cutoff points ($<$ 100 to $<$ 1,100 counts/min) have been applied to sedentary behavior[40]
Body composition	Health-related component of PF that applies to body weight and relative amounts of muscle, fat, bone, and other vital tissues of the body. Most often, the components are limited to fat and lean body mass (or fat-free mass) and expressed as relative (percentage) and absolute (kilograms)
Body size	Measured height (centimeters) and weight (kilograms); can be used to determine BMI (kilograms per square meter), a proxy measure for body fat. Body composition and size are frequently used as outcome measures to determine whether improvements in diet and PA are effective in weight management or obesity prevention
Aerobic capacity	Body's capacity to transport and use oxygen during maximal exertion involving dynamic contraction of large muscle groups, such as during running and cycling
Muscular strength	Health and performance component of physical fitness: ability of a muscle or muscle group to exert force
Muscular endurance	Health-related component of PF that applies to ability to produce force or torque repeatedly against submaximal external resistances
Flexibility	Health- and performance-related component of physical fitness: range of motion possible at a joint
MET	1 MET is the rate of energy expenditure while sitting at rest. It is taken by convention to be an oxygen uptake of 3.5 mL/kg body weight/min. Physical activities frequently are classified by their intensity using MET as a reference

ADL indicates activities of daily living; BMI, body mass index; MET, metabolic equivalent; PA, physical activity; PF, physical fitness; TV, television.

However, there are times when measuring only 1 or 2 dimensions of PA will be required or necessary. No single method provides a comprehensive assessment of PA;[4] thus, a combination of methods may be required to obtain the desired outcomes. Physical activity assessment methods can be divided into 2 general categories: (1) indirect measures using questionnaires, PA logs, or proxy reports (Table 2); or (2) direct measures using motion sensors (eg, accelerometers, pedometers, heart rate [HR] monitors) or observation (Table 3). The key factors that determine which method to select depend on the PA assessment measure that best evaluates the program (eg, minutes per week of PA, level or type of PA) and audience (age, skill in reading/writing or recall), while minimizing participant burden (time required) and cost and resources required to administer the assessment. The goal is to select a method that provides appropriate data to address program objectives with the least amount of time, effort, and money.

Indirect Measures of PA

These are the most widely used field assessment methods because they are validated, simple to use, and low in cost. Table 2 lists indirect PA outcome measures along with the method description, strengths and weaknesses of the method, the audience for which the method can be used, and the time period over which PA is being assessed. This table can be used to match PA outcome measures with assessment needs.

Direct Measures of PA

These methods provide real-time estimates of the frequency, intensity, and duration of free-living PA; however, they are more labor- and cost-intensive, and thus less frequently used in field settings. Table 3 lists direct PA measures categorized into 2 areas: (1) motion sensors and monitors (ie, accelerometers, pedometers, HR monitors); and (2) direct observation (eg, watching and recording playground use during school recess) (see Supplementary Data). These measures are best suited for small-scale research studies in which cost, participant burden, and specialized staff training can be better accommodated. However, these measures are useful for children, because they require no self-reports of PA, which can be difficult for children or parents to perform with accuracy.[5] Methods can be combined, sometimes within 1 device, to provide multiple data points for the overall assessment of PA. For example, an accelerometer combined with an HR monitor will measure both volume (steps) and intensity (HR) of PA. Global positioning system mapping technology is currently being added to better understand PA and movement patterns of children and adults.[6] As the cost decreases and ease of use increases, these devices will become more practical for field-based use.

PHYSICAL FITNESS ASSESSMENT

Physical fitness is typically assessed by challenging 1 or more health components (muscular strength, muscular endurance, cardiovascular endurance, and flexibility). To select the right PF assessment test, it is important to consider portability and cost (eg, field-based step tests or walking tests vs a graded exercise treadmill or bicycle protocol used in laboratories), validity and reliability (eg, choice and execution of specific protocol standards), test evaluation criteria (eg, cutoff criteria for levels of fitness vs normative reference standards), and the population being tested (eg, adults or children).[5,7] Although field-based tests are not as precise as laboratory tests, they provide a simple cost- and time-effective measurement of PF without expensive and technical equipment. They also allow for many participants to be tested simultaneously by research technicians with little training, and thus are the focus of this section.

Validity and Reliability

Physical fitness tests need to measure the desired changes in intervention behaviors associated with fitness outcomes; thus, test validity and reliability are critical. Test *validity* measures whether the test is accurately measuring what it purports to measure. Test *reliability* is the degree to which a test can be consistently repeated each time the test is used under the same conditions, with a clear test protocol and user training. It is essential to select a PF test that has concise methodology for repeatability of a score within the testing conditions and environment (eg, using the correct angle of bent knees for a sit-up test). Adherence to the protocol will ensure confidence in the results and the changes measured as the result of implementing a program or intervention.

Evaluation Criteria

Knowing the assessment scores or cutoffs associated with a participant's PF is essential to test selection. Cutoffs are based on criterion-referenced (CR) standards or normative data.[8] Criterion-referenced standards are frequently linked to indicators of health outcomes or health risk factors. Normative data are based on past performance of a representative group (eg, percentile rankings) and are effective for measuring pre/post-intervention results and motivating participants by using their personal improvements, but do not provide comparisons related to health outcomes or risk factor reduction. However, these tests must include a substantial database size, such as the *YMCA Adult Fitness Battery*, which has approximately 70,000 subjects in its database.[7,9]

Selecting a PF Test

When selecting a field-based PF test, the assumptions of the assessment tool need to match the population being tested and outcome measures selected. The 4 areas of PF measured include cardiovascular fitness, muscular strength (maximum strength), muscular endurance (strength over time), and flexibility. Some adult comprehensive tests include all areas of PF and can be adopted in their entirety; however, options to select single test items are also available (see Table 4 for adult fitness tests). References are provided for more in-depth explanation of the tests.

Table 2. Indirect Methods for Measuring PA

Measure	Method, Audience, and Time Frame	Description	Strengths	Weaknesses
Categorical PA score (low, moderate, or high PA) or continuous (MET [minutes per week])	IPAQ[41,42] Audience: Adults, 15–69 y Time: Previous 7 d of activity	IPAQ is composed of questions based on 5 activity domains: (1) job-related PA; (2) transportation PA; (3) housework, house maintenance, and caring for family; (4) recreation, sport, and leisure-time PA; (5) time spent sitting	Designed primarily for large-scale population surveillance of adult PA[44] Extensive reliability and validity studies[43] Free, no permission required for use Available in > 20 languages Researcher scoring protocols available Can be scored with continuous or categorical scale and estimate EE using METs	Not recommended for use as outcome measure in small-scale PA intervention studies Not recommended for older (> 65 y) or younger (< 15 y) groups Inconsistent validity findings[43] No technical support for scoring; statistical help required Self-reported PA bias
	IPAQ-SF[43] Audience: Adults, 15–69 y Time: Previous 7 d of activity	IPAQ-SF has 7 questions to estimate time walking, sitting, and doing MVPA Telephone or self-administered		
Categorical PA score based on 5-point scale, with 5 being highest PA	PAQ-A[45,46] Audience: 14-18 y Time: Previous 7 d of activity	Main questions assess PA habits by frequency; includes questions specific to school-related PA: during physical education, recess, at lunchtime, right after school, and evening and past weekend activities Checklist of 24 common leisure/sport PAs selected Designed to be used during school year rather than summer vacation or holiday periods	Designed for large-scale research surveillance of adolescent PA Supported by reliable and valid studies measure of PA levels among older youth (14–18 y)[46] 9 questions assessing PA frequency and type, during specific times of days per week Cost- and time-efficient; self-administered	Not recommended for small intervention studies No continuous scale variable; no estimate of EE Not appropriate to assess PA for summer or holiday periods Cannot identify specific PA intensities (MVPA); only provides summary activity score Self-reported PA bias
	PAQ-C[42,47] Audience: 6-13y Time: Previous 7 d of activity		Designed for large-scale population surveillance of PA in children Tool is reliable and valid measure of PA levels for younger children (8–13 y)[42] Cost- and time-efficient Easy to administer	Not recommended for small-scale PA intervention studies No discrimination of PA intensity in scoring scale Does not provide METs; no estimate of EE May miss short or sporadic bursts of PA common in younger children Self-reported PA bias Caution with self-reported PA for children ≤ 10 y

Total minutes PA per day; PA type, intensity, frequency, and duration	PDPAR and 3DPAR Audience: Adults or children Time: Previous day or 3 d of activity	PDPAR and 3DPAR are designed to report total PA time (every 30 min) and intensity PDPAR asks about PA on previous day, divided into 17 blocks, 30 min each. List of 35 activities and intensity of PA (very light, light, moderate, or vigorous) per block of time 3DPAR divides day into 34 time blocks (30 min/block). List of 59 PAs is provided; participant indicates level of intensity for each PA, which is translated to MET value METs per time block are converted to estimate EE	Validity and reliability have been tested in youth[48] and adolescents[49] Cost- and time-efficient; easy to administer Self-administered or in group setting to guided responses	Subject to recall bias Caution used when interpreting self-report instruments in children ≤ 10 y[50] Discrimination of PA intensity in scoring scale Provides estimate of PA EE
	PA diaries or log Audience: Adults or children Time: ≥ 1 d	Participant records daily PA in PA diary/log, including type, duration, and intensity at 15- to 30-min intervals Documentation of PA immediately after completion is preferred. Typically 3–7 d recorded, depending on audience	Less costly than direct PA measurement PA diary provides detailed report of PA Used as validation criterion for other types of PA questionnaires in adults and youth[51,52]	Participant burden high; frequent recording of PA in the diary may result in some missing data, especially in youth Participant and researcher training required before beginning diaries or logs Time-consuming to review and code diaries or logs Frequent diary reporting may not be feasible in time-constrained participants Self-reported PA bias
	PA proxy reports[53] Audience: Preschool children (< 10 y) or people with limited cognitive recall Time: ≥ 1 d	Another person (parent, teacher, or caregiver) reports type, duration, and intensity of PA. No specific timed observation is done. This approach is different from direct PA proxy reports shown in Table 2	Valid and reliable Flexible and allows researchers to quantify PA in relation to actual context or social environments	Expensive, labor-intensive, and time-consuming for reporter

3DPAR indicates 3-day PA recall; EE, energy expenditure; IPAQ, International PA Questionnaire; IPAQ-SF, IPAQ Short Form; MVPA, moderate (3–5 METs) to vigorous (> 6 METs) physical activity; PA, physical activity; PAQ-A, PA Questionnaire for Adolescents; PAQ-C, PA Questionnaire for Children; PDPAR, previous day PA recall; other abbreviations as in Table 1.

Note: One MET is the rate of energy expenditure while sitting; physical activities are classified by their intensity or MET level (eg, fast running = 7 METs. For IPAQs, MET minutes per week = MET level × minutes of activity × events per week.

Table 3. Methods for Direct Measurement of PA

Measures	Method, Audience, and Time Frame	Description	Strengths	Weaknesses
Total PA (minutes per day session); PA type, duration, and intensity	Observation Audience: Adults, children (< 10 y) or people with limited cognitive recall Time: ≥ 1 d	Another person (parent, teacher, or caregiver) monitors and records minutes spent in various types of PA; intensity can also be recorded	Valid and reliable[54] Flexible and allows researchers to quantify PA in relation to actual context or social environment[55] Stopwatch used to time PA	Expensive and labor-intensive[6,53] Not suitable for long periods of observation Time consuming for reviewer to code recall reports
Primary: Movement counts Secondary: PA frequency, duration, and intensity	Accelerometer Audience: Adults or children (> 3 y) Time: Multiple days (≥ 4 d)	Motion sensors that measure acceleration of body on several axes Worn at waist by strap or belt	Used to evaluate intensity and duration of PA over specified time (eg, days or weeks) Valid and reliable tool to estimate common types of human daily activities[56,57]	High cost (≥ $250 each plus software package ∼$600–$1,300) No clear cutoffs for light, MVPA[58] Data comparison from different accelerometers difficult[59] Extensive user training for data interpretation Not all PA detected (eg, upper-body PA, cycling, swimming)
Number of walking steps per day or session	Pedometers Audience: Adults or children Time: Multiple days (1–7 d)	Measures steps by using spring-suspended mechanical lever that moves up and down in response to vertical displacement	Cost-effective alternative to accelerometers. Simple and inexpensive method for valid assessment of relative volume of PA[8]	Does not provide PA intensity or duration[60] Not validated for measuring distance traveled, EE[61] Sensitivity decreases as pedometer is tilted away from vertical axis; possible in obese and pregnant population Slow walking can undercount steps
Time HR above designated cut points; PA frequency, duration, and intensity	HR monitor Audience: Adults or children Time: Multiple days (1–7 d)	Chest strap transmitter and small receiver watch provide real-time estimates of PA frequency, intensity, and duration	Validated to give reliable readings of HR at rest and during PA Validity and reliability uncertain in children	Monitoring is subject to both intra- and inter-individual variability[62] Cost (≥ $75/unit) Staff and subject training needed for use and data interpretation Other factors alter HR–PA relationship (eg, emotional stress, environment, temperature, fitness)

Distance traveled, time stamp, PA duration and movement speed	Global positioning system monitoring unit Audience: Adults or children Time: Multiple days (1–7 d)	Measures position, distance, and speed based on time taken to receive signal from orbiting satellites[63]	Measures travel distance during active transport, such as walking and cycling[63] Identifies environmental barriers encountered en route[63,64] Fair to good validity and reliability for distance (owing to varied gait); good validity for measured ground speed, bouts, and duration of PA Can be worn anywhere on body that allows unobstructed signal indoors and outdoors	Low validity between trials Validity affected by satellite signal lost (eg, atmospheric conditions and local signal obstructions) Inability to detect all PA, such as upper-body movement, PA intensity, or terrain Concurrent PA diary can increase subject burden Staff training for data interpretation

EE indicates energy expenditure; HR, heart rate; MVPA, moderate (3-5 metabolic equivalents) to vigorous (> 6 metabolic equivalents) physical activity; PA, physical activity.

PF Tests for Children

For children (kindergarten through 12th grade), the most frequently used field PF tests are the CR Fitnessgram[10-12] and the norm-referenced President's Council on Fitness, Sports, and Nutrition, President's Challenge Program.[9,13] Unfortunately, norm-referenced standards (such as the latter) are difficult to update and focus on performance rather than health, thus rewarding children who are already fit and discouraging those who are not. For some, PF evaluations can be perceived as punishment.[14] In an effort to move from norm-referenced standards, the President's Council on Fitness, Sports, and Nutrition partnered with the Cooper Institute and Fitnessgram to develop and promote the Presidential Youth Fitness Program.[15] This no-cost program gives the user access to the CR Fitnessgram standards, including training and resources for assessing and tracking Web-based support, test protocols, and aerobic capacity and body mass index (BMI) (kg/m^2) calculators. Results are gender and age specific. These tests require minimal equipment and training, are low cost, and are CR and field-based (Table 4).

Although participation in these PF tests is also encouraged for young children (ages 3–5 years), there are no reference points on most tests because no standard has been set for this age group. Furthermore, PF is not generally measured in young children. Nevertheless, assessing physical movement skills is important. Motor development is positively related to PA activity,[13,16-20] and children in primary grades who are proficient in motor skills are more likely to engage in vigorous PA as adolescents.[8,21] Because PA, specifically step counts, declines after age 6 years, measurement may be critical in preschoolers.[18,22] Although there are a number of tests for gross motor development (GMD), there are few simple and inexpensive field-based tests for measuring skill changes in young children. Gross motor development tests, which primarily focus on developmental motor skills, impairment, and developmental delays, are costly and require sophisticated training, equipment, and skilled therapists. Alternatively, the Test for GMD-2 (TGMD-2) is a widely used practical GMD test that requires less training.[19,23] Primary limitations of this test are that it focuses on object control and requires equipment and an outdoor area for testing.

BODY COMPOSITION

Body composition is frequently used as an outcome measure to determine the effectiveness of community-based obesity prevention strategies. This section briefly focuses on simple field-based methods for assessing body composition, including the advantages and disadvantages of each method based on the population being assessed (Table 5). All field methods for body composition are validated based on a CR method, such as dual-energy X-ray absorptiometry or computed tomography.[20,22,23]

Body Mass Index

Body mass index (kg/m^2) is 1 of the most frequently used field assessments of body size because it is simple and low-cost, and there are national cut points for defining overweight and obesity.[24] Overweight refers to weight in excess of standards, whereas obesity refers to excess body fat.[24,25] For United States (US) children (2–20 years of age), the definitions of overweight (85th to 95th percentile) and obese ($\geq$95th percentile) are based on the Centers for Disease Control and Prevention 2000 gender-specific BMI-for-age growth charts.[24-27] For children $<$ 2 years of age, a BMI $\geq$ 97.7th percentile is considered a high weight-for-recumbent length; there is no obesity classification for children this young.[24] In adults, regardless of age or sex, overweight is defined as a BMI between $>$ 25 and $\leq$ 29.9 kg/m^2, and obesity as a BMI $\geq$ 30 kg/m.[2,28]

Waist Circumference

A waist circumference (WC) measurement provides a surrogate estimation of intra-abdominal fat (fat located inside the peritoneal cavity).[29] Studies show that excess intra-abdominal fat in adults and children is closely linked with increased risk of adverse health outcomes, including heart disease, dyslipidemia, hypertension, insulin

Table 4. Adult Fitness Tests

Outcome (Measure)	Test	Test Length	Equipment	Description
Adult fitness tests[65]				
Aerobic capacity (recorded time)	1-mile[b] walk/run (outdoors)	5–15 min	1-mile marked area; stopwatch	Measure amount of time it takes to complete 1 mile
Aerobic capacity (recorded distance)	12-min walk/run tests (outdoors)	12 min	1-mile marked area; stopwatch	Measure distance covered after 12 min running and/or walking
Aerobic capacity (recorded post HR)	YMCA 3-ft step test (indoors)	3 min	12-in step bench; stopwatch; metronome	Step up and down for 3 min to metronome set at 96 bpm (24 steps/min) measure post-HR for 1 min
Aerobic capacity (recorded post-HR)	Queens College step test (indoors)	3–4 min	16.25-in step bench; stopwatch; metronome	Step up and down for 3 min to metronome set at 96 bpm for men/88 bpm for women; measure post-HR for 15 s
Muscular strength (pushups)	Pushup test	< 3 min	Metronome; mat	From "up" pushup position, perform pushups to metronome until failure
Muscular endurance (sit-ups)	Half sit-up test	1 min	Marked mat	Using mat with marked tape, raise shoulders and reach forward, touching mark as many times as possible in 1 min
Flexibility (recorded inches)	YMCA sit and reach test	< 1 min	Yardstick; tape	From seated position, legs straddled, fold forward and reach as far as possible, sliding fingers on yardstick
Children's (5–18 y) fitness tests[15,a]				
Aerobic capacity (recorded time)	1-mile run	5–15 min	1-mile marked area; stopwatch	Run mile as fast as possible; walk if needed
Aerobic capacity (recorded time; post-HR)	1-mile walk	5–15 min	1-mile marked area; stopwatch	Walk mile as fast as possible, post 1-min HR
Aerobic capacity/ agility/speed (recorded time)	20-m PACER[c]	5–15 min	20-m running lane, pacer CD; CD player	Run back and forth across 20-m space (or 15-m if preferred) at pace that gets faster each minute
Muscular strength (pushups)	90° pushup	< 3 min	Metronome	Complete as many as possible at cadence of 1 every 3 s
Muscular endurance (curl-ups)	Curl-up	< 3 min	Metronome	Complete as many as possible (up to 75) at cadence of 1 every 3 s
Flexibility (recorded inches)	Back saver sit and reach	< 3 min	12-in sturdy wooden box, tape	One leg straight, 1 leg bent, reaching as far as possible with 1 arm at a time

HR indicates heart rate; YMCA, Young Men's Christian Association.
[a]Aerobic tests were recommended for participation in age 5–9 years, but no standards were provided[15]; [b]1 mile = 1.6 kilometers (km). 1 inch = 2.54 centimeters (cm). A 3-ft step = 91.4 cm. A 12-in step = 28.8 cm. 1 meter (m) = 100 cm or 39.4 inches; [c]PACER (Progressive Aerobic Cardiovascular Endurance Run) is the aerobic capacity test used in Fitnessgram.[11]

resistance, metabolic syndrome, and type 2 diabetes.[29-31] Thus, WC is used to predict health risks and determine whether interventions improve chronic disease risk factors.[29] Unfortunately, no universally accepted WC anatomical site most effectively identifies health risks (Table 5).[29] The 2 most commonly used sites are measured immediately above the iliac crest or the narrowest point between the lowest rib and the iliac crest.[29] The cut point used for assessment will depend on the exact anatomical site used to measure WC. In the US, the WC cut points associated with increased chronic disease risk for adults are > 40 in for men and > 35 in for nonpregnant women.[29,32] These cut points are based on measuring WC immediately above the iliac crest.[31] For children and adolescents, percentiles are used to determine increased risk, but there are no universally accepted WC cutoff values. Research shows that ethnicity can affect the amount of body fat reflected in a certain WC or BMI measurement;[29] thus, standardized cut points should be used with caution in ethnic groups. It is now recommended that WC replace the measurement of waist-to-hip ratio.[29]

Bioelectrical Impedance Analysis

Bioelectrical impedance analysis (BIA) is a quick, portable, and noninvasive method for body fat assessment. This method is based on the relationship between the volume of a conductor (ie, the body), the conductor's length (ie, an individual's height), and the impedance (ie, the resistance of body tissues to the flow of a low-level

Table 5. Field-based Body Composition Assessment Methods

Measure	Method and Audience	Description	Strengths	Weaknesses
Proxy measure for body fat; national cut points based on BMI-for-age. Children and young adults (2–20 y) BMI cut points based on growth charts	BMI (kg/m^2) Audience: Adults and children	Used to define overweight and obesity in adults and children	Easy and inexpensive; national standards available High specificity for detecting excessive adiposity with higher BMI values in adults[66,67] Reasonable agreement when used to classify adiposity status in children and adolescents[68]	Does not provide direct body fat measure Poor estimates of body fat in some ethnic groups; BMI between 25 and 30 kg/m^2 [34,66] Overestimates body fat in muscular individuals (eg, athletes)
Proxy measure for intra-abdominal fat	WC (in) Audience: Adults and children	Two sites for measuring waist: immediately above iliac crest, and at narrowest point between lowest rib and iliac crest[29] National WC cut points established for adults; cut point for children (percentiles) still debated [29,31]	WC closely linked to increased risk for chronic disease in both adults and children[29-31] May provide better indicator of chronic disease risk than BMI, especially in individuals with normal BMI values	Does not directly measure intra-abdominal fat Technician needs to be trained; WC measured 2–3 times and values averaged
Estimation of FFM and total body water; % body fat and fat mass determined from these estimates	BIA Audience: Adults and children	Low-dose electrical current is passed through body. Current moves more quickly through FFM than body fat FFM estimated using impedance value, height squared, body weight, and age. Body fat (%) estimated from knowing FFM	Validated equation available for adults and children[33] Standard error estimates available for BIA published equations[33]	Equations less valid for identifying adiposity in individuals with high or low BMI values[69] Accuracy depends on following standardized procedures (normal hydration, fasting, and avoiding exercise[23,34])

BIA indicates bioelectrical impedance analysis; BMI, body mass index; FFM, fat-free mass; WC, waist circumference.

electrical current).[33] Using this principle, BIA can estimate fat-free mass and body fat using prediction equations.[20] The prediction equation selected should closely match a subject's characteristics (eg, age, gender, body size, health condition).[20,34] Validated BIA equations are published for all age groups, but the accuracy of BIA to estimate adiposity, especially in infants, elderly, and those with extreme BMI values, is still debated.[23,35,36]

IMPLICATIONS FOR RESEARCH AND PRACTICE

Nutrition and health educators rely on valid and reliable measurements to assess their community-based programs for effectiveness, areas for enhancement, and data to support sustainability. This overview provides a guide for selecting field-based evaluation tools to estimate PA and PF and measure changes in body composition. In addition, standardizing PA program evaluation measurement techniques allows for comparison between intervention programs and over time.

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SUPPLEMENTARY DATA

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