The Components of Physical Fitness: A Roundtable Statement by the American College of Sports Medicine

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ABSTRACT

RIEBE D., M. MAGAL, L. A. KAMINSKY, R. ROSS, S. M. PHILLIPS, S. ALHASSAN, R. ARENA, D. G. BEHM, S. M. CAMHI, T. S. CHURCH, E. M. EVANS, Y. FEITO, A. D. FAIGENBAUM, S. B. HEYMSFIELD, C. H. HILLMAN, C. M. JANKOWSKI, A. KONRAD, G. LIGUORI, L. E. ROBINSON, R. A. SHANELY, and C. E. GARBER. The Components of Physical Fitness: A Roundtable Statement by the American College of Sports Medicine. *Med. Sci. Sports Exerc.,* Vol. XX, No. X, pp. XXX-XXX, 2026. The American College of Sports Medicine has included a description of the components of physical fitness (PF) in their publications for 40 yr. Because new scientific evidence has emerged, the American College of Sports Medicine convened a scientific roundtable to reexamine the components of PF. The scientific roundtable agreed upon standardized definitions and an updated evidence-informed model of PF consisting of five interconnected components of PF: 1) cardiorespiratory fitness, 2) muscular fitness, 3) body composition, 4) neuromotor fitness, and 5) flexibility, with muscular fitness, body composition, and neuromotor fitness further separated into subcomponents. These components met four inclusion criteria: they 1) are changeable by exercise, 2) affect the ability to participate in physical activity or exercise, 3) contribute to health, and 4) can be feasibly assessed in professional practice. Additional overriding themes that emerged from the scientific roundtable included the complexity of PF and the interrelated nature of the components. Furthermore, it was agreed that when applied in practice, PF is best addressed in an individualized manner. Therefore, the components of PF should be considered dynamic as the focus on any given component can shift when considering individual needs, goals, health status, and priorities/interests.
Key Words: BODY COMPOSITION, CARDIORESPIRATORY, COMPONENTS, FLEXIBILITY, MUSCULAR FITNESS, NEUROMOTOR

Attaining and maintaining physical fitness (PF) is an important consideration given its critical association with improved physical and mental health, improved quality of life, reduced risks for chronic disease and disability, increased longevity, and improved performance of movement-based pursuits (1–10). Numerous components of PF have been identified, including agility, balance, body composition, cardiorespiratory fitness (CRF), coordination, flexibility, muscular endurance, muscular strength, power, reaction time, and speed

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(9,11–15). The American College of Sports Medicine (ACSM) has included the components of PF into their Guidelines for Exercise Testing and Prescription since 1986. The list of PF components has remained relatively stable since that time, although it was updated in 2009 when "muscular strength and endurance" were separated into the two distinct components of "muscular strength" and "muscular endurance" (12,13,16–22). The components of PF with definitions, as presented in the last five editions of ACSM's Guidelines for Exercise Testing and Prescription, are shown in Table 1 (12,13,16–22).

For more than 40 yr, the components of PF have been dichotomized into health-related and skill-related (also referred to as performance-related) PF (13,14,23). The dichotomized categorization was driven by seminal papers in the 1980s (14,23), reflecting the growing evidence that linked certain PF parameters (e.g., CRF, muscular strength, muscular endurance, body composition, and flexibility) with improvement in a wide range of health outcomes. Health-related PF has served as a blueprint for multiple physical activity (PA) guidelines and is often used within an exercise prescription framework to improve or maintain health and PF (5,9,11,13,15,24). Meanwhile, skill-related PF (e.g., agility, balance, coordination, reaction time, speed, and power) has been more commonly aligned with exercise training for sport performance or motor function (14,15,23). In the years since these papers were published, research has shown that some of the components considered to be skill based are also associated with health (e.g., balance is associated with mortality, physical function, and falling) (9,15,25).

Despite the widespread use of the term PF, there is no ubiquitous agreement on 1) the definition of PF or 2) which components should be included under the PF umbrella (9,11,15,24,26–28). The lack of consensus about the components of PF is apparent, even within the same publication. Several versions of ACSM's Guidelines on Exercise Testing and Prescription list the components of PF, as seen in Table 1, but also refer to neuromotor fitness as a component of fitness within the same text (12,18,19). There are also significant differences among other prominent publications. For example, the 2018 Physical Activity Guidelines for Americans Scientific Advisory Committee Report lists the components of PF as CRF, musculoskeletal fitness, flexibility, balance, and speed (9). Considering the inconsistencies among these and other documents, the lack of uniform definitions, and advances in science, it is appropriate to reexamine the components of PF. Therefore, the ACSM convened a scientific roundtable of experts (referred to as the expert panel for the remainder of the paper) to review and evaluate the scientific evidence concerning the long-standing and widely used components of the PF paradigm. The scientific roundtable consisted of experts vetted and appointed by the ACSM according to its rigorous procedures and represented a broad range of disciplines of ACSM membership (29).

EXPERT PANEL PROCESS

The scientific roundtable was proposed according to the operating codes, policies, and bylaws of ACSM's Scientific Integration and Leadership Committee (29). The proposal included the scientific rationale and scope for the project and the proposed members of the scientific roundtable, selected for their demonstrated expertise in a wide variety of topics relevant to the project. The final composition of the roundtable and project was approved by Scientific Integration and Leadership Committee and ACSM's Board of Trustees.

The expert panel followed procedures consistent with accepted practices for consensus papers (30). The full expert panel participated in a 2-d virtual meeting. Before the meeting, a broad list of components that might fall under the umbrella of PF, gathered from various guidelines and scientific statements, was compiled. Members of the expert panel were charged with completing an independent literature review in their area of expertise and synthesizing the best available evidence. During the meeting, existing definitions of PF and related terms in the literature were examined and discussed. Having achieved consensus on the definition of PF, topic experts presented findings from their review of literature and provided their expert opinions on potential components

TABLE 1. Physical fitness as described in ACSM's Guidelines for Exercise Testing and Prescription, 8th–12th editions.(12,13,16,18,19,21,22)

Health-related physical fitness components
- Cardiorespiratory endurance: the ability of the circulatory and respiratory system to supply oxygen during sustained physical activity
- Body composition: the relative amounts of skeletal muscle, fat, bone, and other elements of the body
- Muscular strength: the ability of the skeletal muscle to exert force
- Muscular endurance: the ability of skeletal muscle to continue to perform activities without undue fatigue
- Flexibility: the range of motion available at a joint

Performance-related physical fitness components
- Agility: the ability to change the position of the body in space with speed and accuracy
- Coordination: the ability to use the senses, such as sight and hearing, together with body parts in performing tasks smoothly and accurately
- Balance: the maintenance of equilibrium while stationary or moving
- Power: the ability or rate at which one can perform work
- Reaction Time: the time elapsed between stimulation and the beginning of the reaction to it
- Speed: the ability to perform a movement within a short period of time

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of PF. The committee made preliminary decisions about which components should be further considered for inclusion in the consensus paper using round-robin feedback and discussion (31,32). Each potential component was discussed among the panel; some were eliminated when the expert panel determined there was limited evidence of an independent effect of PA and exercise on the component. The committee recognized that the absence of scientific evidence or practical applications to support the inclusion of a component did not preclude its potential importance or the possibility that it could be reconsidered in the future.

The expert panel unanimously agreed upon a set of standardized criteria to guide the determination of which components and subcomponents should be included in this consensus statement:

- Can regular participation in PA or exercise alter the component?
- Is the component related to the ability to perform PA or exercise?
- Is the component associated with health or health-related outcomes?
- Are there valid and reliable assessments that can be feasibly used in professional practice?

Following the virtual meeting, smaller topic-specific working groups were formed and met independently to further investigate the components that passed the preliminary review. For each component, the evidence was evaluated according to the four criteria, and the working groups presented the rationale supporting the inclusion or exclusion of a component to the full group for final decision-making by consensus. The final step was to translate the recommendations from the panel into a usable model that could be applied to professional practice. During the writing process, the literature was regularly updated to reflect new scientific evidence. Further, as the paper developed, there was continued discussion of where components and subcomponents belonged, and which would be included in the final draft of the paper.

Each member of the expert panel independently reviewed several versions of the paper in its entirety and provided feedback. Following revisions, the final version was unanimously approved. In this consensus statement, we present an updated model of PF along with the scientific rationale for the proposed recommendations.

DEFINITION OF TERMS

An evaluation of PF necessitates standardized definitions of PF and related terms. PF has been defined in many ways, with considerable overlap among the definitions (9,13,23,24,33–38). After an extensive review and discussion of the available definitions and scientific literature, we propose adapting the definition of Caspersen (23) to this simple yet clear definition: PF is a set of interrelated and malleable attributes individuals have or achieve that relates to their ability to perform PA. PA and exercise are related to PF. PA is defined as any bodily movement produced by the contraction of skeletal muscles that results in energy expenditure above the resting level (23,24,33,39). Exercise is defined as a type of PA consisting of planned, structured, and repetitive movements done to improve or maintain one or more components of PF and to achieve a health benefit (23,33). While the outcomes of this consensus paper apply to both PA and exercise, the word exercise is used henceforth in this document because it connotes intentional PA for the purpose of improving health and fitness (9,33).

GUIDING PRINCIPLES

The expert panel adopted the following foundational principles to be applied to this consensus statement:

The findings from this statement are primarily intended for application to adults

The PF model presented here applies to all adults, including older adults and people living with disabilities and health conditions. While many of the concepts included in this paper can apply to children and adolescents, the youth literature was not reviewed. Developmental and physiological differences in children and adolescents should be considered when applying this information to the pediatric population.

PF is an applied concept to support health and fitness goals for adults of all ages, abilities, and health conditions

PF is central to athletic pursuits, but the training methods and aims for peak competitive athletic performance differ from those of individuals who adopt exercise or recreational sports for enjoyment, health, or other reasons. The fitness concepts presented here can apply to highly competitive athletes; however, our scientific review was focused on nonathletes. For that reason, high-level athletes deserve separate consideration and are not meant to be covered within the scope of this statement.

All components of PF are related to health and movement performance, negating the need for a dichotomous categorization

Distinguishing between health- and skill-related components of PF is no longer justified given mounting evidence demonstrating that components previously considered uniquely skill-related are now firmly established markers of numerous health outcomes, and all are related to the performance of exercise (40–43).

The components of PF are interrelated

The complex relationship among the components of PF suggests they may improve health and PF outcomes in an independent, additive, or synergistic manner. The components are closely linked with each other, often making it difficult to consider any given component in isolation. For example, improvements in muscular strength can improve balance (42,44) and body composition (45), underscoring the synergistic effects of resistance exercise on health- (46) and movement-related outcomes. The intersections and overlap between the components of PF reflect the integration of multiple physiological systems during exercise and reflect the principle of specificity-imposed demands (47). In this consensus statement, the components of PF are viewed on a continuum where often there is considerable overlap and interactional effects.

The relative importance of each PF component depends on the individual

The expert panel considers PF a personal attribute that is best understood when considered in the context of the individual's unique circumstances. Being "physically fit" varies across individuals based on biological factors (48,49), and it can be moderated by environmental, sociocultural, and psychological factors that can affect participation in PA (50–53). For example, for an older adult, being "physically fit" may mean having the ability to perform activities of daily living (ADLs) and instrumental activities of daily living, with the goal of maintaining independent living or to engage in desired leisure activities. Other individuals may have the goal of improving PF to attenuate health risks or to pursue lifestyle activities such as hiking or other recreational pursuits. People living with disabilities or chronic health conditions may have specific limitations to exercise, necessitating an individualized approach to PF. Meeting an individual's PF goals warrants consideration of the relative importance of each component of PF to that individual, and how they may be prioritized to reach individualized desired outcomes. Thus, one person may emphasize CRF, while another may prioritize the components of muscular strength or body composition, and these choices may change over time.

The components of PF can be feasibly assessed in practice

For the PF model to have relevance to professional practice, the components must be able to be feasibly assessed in most health and fitness settings. Therefore, only components that can be assessed with equipment and tests that are commonly available are included in the consensus statement. The assessments cited in this paper serve as examples that can be used in practice; it is not an exhaustive list, nor is it an endorsement of specific assessments.

AN UPDATED MODEL OF PHYSICAL FITNESS

In this section of the consensus statement, an updated model of PF, as it relates to health and fitness, is introduced. The components of PF model consist of five broad categories that meet the standardized inclusion criteria described earlier: 1) CRF, 2) muscular fitness, 3) body composition, 4) neuromotor fitness, and 5) flexibility, with muscular fitness, body composition, and neuromotor fitness further divided into subcomponents. Each component and subcomponent is defined in Table 2. Although multiple definitions for each component were available in the literature, the one presented effectively communicates the concept that is consistent with the four inclusion criteria established by the expert panel. A brief rationale for why each component was included in the updated PF model, based on the standardized criteria outlined earlier in the article, is presented.

Cardiorespiratory Fitness

CRF (Table 2) represents the functional capacity of an individual and is an accepted indicator of overall health (8,72). CRF reflects the integrated function of several bodily systems (e.g., cardiovascular, respiratory, and muscular) involved in the transport, uptake, and utilization of oxygen required to support physical exertion (8,73).

Exercise-induced changes. Systematic reviews and meta-analyses have consistently demonstrated a significant improvement in CRF following structured aerobic exercise interventions in adults with or without disease (74–78).

Ability to perform exercise. CRF is directly related to the ability to perform exercise (79,80). CRF must be sufficiently high to support the wide range of energy demands of daily activities, including ADLs/IADLs, occupation, transportation, and exercise in which an individual participates without excessive fatigue (81–85). Further, low CRF has been linked to poor lower extremity muscular strength (86).

Health-related benefits. Clear, consistent, and convincing evidence shows CRF is inversely associated with all-cause and disease-specific morbidity and mortality (4,87–94). A recent meta-analysis found that for every metabolic equivalent (MET) increase in CRF, there was a 14% and 16% decrease in all-cause and cardiovascular disease mortality, respectively (87). Clinically, low CRF is used as a prognostic indicator of surgical risks, mortality, and functional limitations (95–97). Low CRF also is associated with increased risk of falling (92), poorer lower extremity strength (86), reduced cognitive function (98), higher risk of dementia (98), and increased risk of

TABLE 2. Recommended standardized definitions of the components and subcomponents of physical fitness.

Cardiorespiratory fitness: the capacity of the circulatory and respiratory systems to deliver oxygen to the skeletal muscle mitochondria to meet the energy demands of sustained physical activity without undue fatigue (8,23).

Muscular fitness: a multidimensional construct composed of muscular strength, muscular endurance and muscular power that represents the structure, function and quality of skeletal muscles (54,55).

- Muscular strength: the ability of skeletal muscle to exert maximal force on an external object or resistance under a particular set of biomechanical conditions (54,55).
- Muscular endurance: the ability of skeletal muscle to complete repeated contractions against a submaximal resistance within a set time limit or to fatigue (56,57).
- Muscular power: the ability of skeletal muscle to exert force at a given velocity of movement; the product of force and velocity over a unit of time (58).

Body composition: the relative proportions of the total body mass divided into the two components of fat mass and fat-free mass (59,60,61).

- Fat mass (FM): the mass of body fat and other lipids in the body (60).
- Fat-free mass (FFM): the mass of all nonfat components of the body wherever they occur, including skeletal muscles, bones, organs, ligaments, tendons, and bodily fluids (60).

Neuromotor fitness: the ability of an individual to effectively execute a variety of motor tasks during physical activity that may include a combination of gross and fine motor skills of varying complexity (11,62,63,64).

- Agility: the ability to execute a change of speed or direction through a rapid movement of the body in response to a stimulus (65).
- Balance: the ability to maintain a specific body posture by maintaining, achieving or restoring the center of gravity within the base of support. Includes static and dynamic balance (66).
  - Static balance: the ability to sustain a specific position while the body is stationary (66).
  - Dynamic balance: the ability to sustain a specific position and orientation of the body while part or all of the body is in motion (66).
- Gait speed: the speed of ambulation performed with or without assistance (67,68).

Flexibility: the ability to move a joint through its maximal unrestricted range of motion without pain (69,70,71).

cardiovascular complications (86). Higher CRF is associated with better mental health, with studies reporting an inverse dose–response relationship between CRF and mental health disorders such as anxiety and depression (99,100).

Assessments. Cardiopulmonary exercise testing with the measurement of oxygen uptake (VO_2) and related variables (e.g., carbon dioxide production, pulmonary ventilation, and heart rate) is considered the gold-standard approach to assessing CRF (73,94,101–103), but it is not widely available in all health and fitness settings. Maximal or submaximal exercise tests or field tests using a variety of exercise modalities can estimate CRF by using one or more variables such as work rate, heart rate, time, and distance obtained during or following exercise (11–13,103–105). Additionally, several nonexercise equations can be used to predict CRF (103,106–109). These indirect methods to estimate CRF are more practical than gold-standard approaches and can be applied in a variety of settings. While indirect estimations of CRF are not optimal, they represent feasible ways to estimate CRF in settings that preclude other forms of assessment, and they are sufficiently sensitive to detect change (12,13,110).

Muscular Fitness

Muscular fitness is a collective term that includes the interrelated subcomponents of muscular strength, muscular endurance, and muscular power (Table 2) (13,111–114). All subcomponents of muscular fitness can be developed with consistent participation in resistance exercise (111,113). The improvements in muscular fitness consequent to training result from an array of physiological changes in the trained skeletal muscle that include neuromuscular adaptations; muscular hypertrophy (skeletal muscle cross-sectional area) (111,115,116); improved skeletal muscle quality (amount of strength and power per unit of muscle mass) (117–119); improved arterial function, blood flow, and blood pressure (120,121); and numerous molecular alterations in the skeletal muscle (122,123). The specific training-induced outcomes depend primarily on program design variables including load, repetitions, sets, selected exercises, velocity, duration of rest, and frequency (111,113,124–132).

Exercise-induced changes. Most well-designed resistance exercise programs that include appropriate variations in program design variables result in improvements in both muscular strength and muscular endurance (115,132–135). Resistance exercise specifically designed to increase muscular power improves the ability to generate higher power output (13,126,130,136,137). Further, a basis for developing muscular power is underpinned to a degree by the development of strength, since an individual cannot possess a high level of power without being relatively strong (115,58).

Ability to perform exercise. Higher levels of muscular fitness contribute to improved exercise performance. Muscular strength and muscular power are strongly correlated with jumping, sprinting, and change of direction, and improve recreational sport performance (138–141) including sports such as golf (142), pickleball (143), rowing (144), and running (145). Resistance training significantly improves physical function, the ability to perform ADLs, and gait speed in overweight and obese adults (146) and older adults (113,147–152).

Health-related benefits. Muscular fitness is directly associated with overall health and reduced risks of cardiovascular disease, cancer, disability, and other chronic conditions (45,153). Enhancing muscular fitness is independently associated with numerous health benefits including a reduced risk of all-cause mortality (154–157), positive changes in cardiometabolic disease biomarkers (158–163), reductions in blood pressure (164), improved mental health (165–172), improved cognitive function (173,174), increased bone density (9,175,176), reduced low back pain (177–179), reduced pain associated with osteoarthritis (9,180), reduced risk of type 2 diabetes (181–185), and improved insulin sensitivity and glucose control in people with type 2 diabetes (186–188). Resistance exercise improves muscular fitness in people with acute and chronic diseases such as people living with cancer (5), stroke (189), muscular dystrophy (190), and HIV (191,192). In older adults, the unique and well-established benefits of improved muscular strength and power are numerous and can mitigate the effects of sarcopenia and physical function declines, slow the progression of certain chronic diseases (e.g., osteoporosis), improve cognitive function and the performance of ADLs, and reduce the risk of falls (154,193–200).

Assessments. Numerous assessments exist to measure muscular fitness. Dynamic muscular strength can be assessed directly with a one-repetition maximum test for the upper body (e.g., chest press) or lower body (e.g., leg press) using free weights or selectorized machines (13,201,202). One-repetition maximum can also be estimated using prediction equations based on multiple repetitions at submaximal loads (203–211) or by using ratings of perceived exertion (205,212,213). Isometric tests of muscular fitness are less time-consuming and usually less complicated alternatives to repetition maximum tests, and these tests generally have good reliability and sensitivity to changes in strength (214). Common isometric test protocols include those using portable force cell (hydraulic) or electronic (force-sensitive resistor) dynamometers (e.g., handgrip or fixed dynamometer) to measure maximal voluntary contraction or rate of force development for measurement of strength or power, respectively, of hands, fingers, lower extremities, and other parts of the body (12,215–219). There are also functional isometric tests that measure muscular strength, endurance, or power that are appropriate for a wide array of adults with varying functional ability, such as the plank test (prone bridge test), wall sit test, and back strength test, among others (220). Submaximal tests of the subcomponents of muscular fitness include the YMCA bench press (strength and endurance), push-up and pull-up test (upper extremity strength and endurance), stair climb (power), chair stand test (lower extremity strength and power), and 30-s arm curl test (upper extremity strength and power) (210,211,221–225).

Body Composition

Body composition (Table 2) refers to the distribution of the components that constitute the human body. The primary components most often considered in the assessment of body composition use a two-component model of fat mass (FM) and fat-free mass (FFM). FFM is composed of the total body water mass, bone mineral mass, and protein mass, which collectively form a four-component model of body compositions (i.e., fat, water, protein, and bone), although the four-component model is used mainly in laboratory settings (226,227). The two-component model consisting of FM and FFM is the most easily applied body composition model in practice (33,227) and is used in this consensus paper. Bone mineral content and density (BMD) are both important components of body composition, as they are markers of bone health, with BMD having clinical relevance for the assessment of osteoporosis and fracture risk (228). Skeletal fitness was considered for inclusion as a subcomponent of body composition, but it was ultimately eliminated because there is a lack of valid and feasible assessment methods that can be used outside of a clinical setting at the current time (229–231).

Exercise-induced changes. Regular participation in exercise can change both FM and FFM. Several systematic reviews and scientific statements have established that clinically meaningful reductions in both total and abdominal FM are associated with exercise (232–240), with intra-abdominal or visceral FM being extremely responsive to exercise (241). Resistance exercise is recommended as the first-line therapy when increasing skeletal muscle mass is the primary objective and is appropriate to use throughout the lifespan (113,124,234,237,242,243). Indeed, resistance exercise can increase skeletal muscle mass independent of sex and age (45,111,234,244,245). Resistance exercise may also induce total and regional fat loss, particularly when combined with endurance training or as part of a multicomponent exercise regimen (45,237,239,246,247).

Ability to perform exercise. Body composition can both enhance and detract from the ability to perform exercise. Skeletal muscle mass represents a functional component of FFM in the body that is positively associated with strength and force production and, thus, improved capacity for physical work and performance. Conversely, FM is generally considered to be a nonfunctional component of body composition with increasing amounts of FM mechanically and metabolically hindering performance (59,248). Higher levels of body fat are associated with lower levels of VO_{2max} (249,250), and obesity is associated with lower physical function and PA (251).

Health-related benefits. A large body of evidence has established that the accumulation of excess FM is associated with increased risks of mortality and a wide range of morbidities (236,240,241,252–259), including elevated risks of developing cardiometabolic diseases, mental health disorders, some cancers, impaired postural stability, slower gait speed, and reduced physical function. However, it is now well established that excess accumulation of abdominal fat, especially visceral fat, and ectopic fat deposition in and around the liver, pancreas, and muscle (i.e., myosteatosis) is the obesity phenotype that conveys the greatest health risk and is associated with an increased incidence of type 2 diabetes, heart failure, stroke, kidney stones, and cancer (27,241,257–267). A sustained weight loss of 3–5% of initial body weight in individuals with excess body weight and adiposity results in clinical meaningful reductions in cardiovascular disease risk factors (13).

Reduced skeletal muscle mass, with or without excess adiposity, is associated with higher risks for all-cause mortality, cardiovascular disease, and cancer (133,174,268–273). Skeletal muscle carries essential roles in metabolism that are particularly important relative to cardiometabolic diseases through regulation of glucose uptake, insulin responses, and fatty acid metabolism (274–276). Age- and inactivity-related losses of skeletal muscle mass are linked premature death (277–279) and to a substantially higher risk of adverse health outcomes, including increased risk of falls and fractures, impaired ability to perform ADLs, cardiopulmonary disease, cognitive impairment, and mobility disorders (280,281). Further, it contributes to lowered quality of life, loss of independence, and the need for long-term care (280,281).

Assessments. Methods to assess weight status and body composition that are the most feasible across health and fitness practice settings with respect to cost, expertise needed for quality measures, and acceptable reliability and validity include anthropometry, skinfolds, and bioelectrical impedance analysis (BIA) (237). Anthropometric measures including height, weight, hip circumference, and waist circumference can be used to calculate indices such as BMI, waist-to-height ratio, and waist-to-hip ratio to classify obesity-related health risks (237,282). The combination of BMI and waist circumference or BMI and the waist-to-height ratio identifies adults at increased health risk better than either measure alone (27,237,282,283). Although used widely, there are limitations to the application of BMI for the estimation of body fatness, especially in women, older individuals, and some people living with chronic diseases, and more precise assessments of body composition are recommended whenever possible (237,282–284).

Skinfolds can be used to estimate body fatness given the known association between subcutaneous fat and total body adiposity (13,227). BIA devices have gained popularity given the reductions in cost, portability, and measurement features. Typically, BIA devices measure the impedance, resistance, and reactance to the flow of an extremely low-strength electrical current passed through one or more body regions based on electrode configuration. Depending on the BIA system, measured components include not only FM and FFM but also fluid spaces such as total body, intracellular, and extracellular water and can estimate regional and total body adiposity and skeletal muscle (285,286).

Field methods (e.g., skinfolds, circumferences, and girths) can also be used to estimate skeletal muscle mass (287–290). Field measures have inherent limitations with respect to validity and reliability that should be considered when using these techniques in practice.

Neuromotor Fitness

Neuromotor fitness (Table 2) encompasses a variety of motor skills including locomotor, object manipulation, and stabilizing skills. These skills engage multiple body segments and form the foundation of physical activities, exercise, and recreational sports (291,292). Variables that have been proposed to fall under the construct of neuromotor fitness (previously termed skill-related fitness) are balance, agility, gait, coordination, speed of movement, and reaction time (9,11–13,15–19,21,22,24,62); however, a lack of precision in definitions and assessment techniques presents challenges to include all of these as subcomponents of neuromotor fitness. Currently, there is sufficient scientific evidence supporting each of the four inclusion criteria to include balance, agility, and gait speed as distinct subcomponents of neuromotor fitness in this consensus paper, as presented below. Coordination, speed of movement, and reaction time are recognized as important aspects of motor function and control—and they are identifiable parts of balance, gait, and agility—but, at the current time, there is insufficient evidence in adults supporting them as distinct subcomponents meeting all of the four inclusion criteria (293–298). For that reason, coordination, speed of movement, and reaction time are not considered separately and are not currently included in the updated model of PF, but they can be considered in the future as research evolves.

Exercise-induced changes. Neuromotor fitness can be enhanced by exercise training. Balance improves by participation in balance exercises (299–301), resistance exercise (301–303), core skeletal muscle strengthening (44), aerobic exercise (301,304), and dance (305,306). Balance exercises improve static and dynamic balance in healthy younger and older adults, and there is evidence of a dose–response association with greater frequency and duration of balance exercise practice (307,308). Studies of older adults have evaluated agility exercises alone (309), or as part of multicomponent exercise programs (309–312), and these training methods have improved agility, balance, gait speed, strength, physical function (e.g., chair rise), and working memory (309–313). Gait speed is improved by exercise training involving ambulation, resistance exercises, and multicomponent exercise (314–319). Multicomponent exercise programs, such as tai chi and yoga, and those that include combinations of exercise modalities (e.g., neuromotor, resistance, aerobic, or stretching exercises) result in improvements in several neuromotor fitness attributes (i.e., gait speed, balance, and agility), in addition to beneficial changes in muscular strength, body composition, flexibility, physical function, quality of life, and the risk of falling in younger and older adults, including those experiencing frailty (119,320–335).

Ability to perform exercise. Balance is a crucial component of movement control and stability for activities ranging from the performance of ADLs to participation in recreational activities and sport (40,336–339). Maintaining stability during changes to the base of support (e.g., dynamic balance) during movement or while walking, running, and climbing stairs is critical in preventing falls and injuries that can lead to loss of mobility (340–344). Agility allows for smooth and efficient movement while changing direction and assists in maintaining proper alignment and balance during movement. While typically associated with sport, agility may also apply to other relevant movement domains such as functional mobility (143,311,313,345). There is an inverse relationship between agility and the fear of falling (346), which, in turn, is associated with a decrease in self-reported and performance-based physical function (310,311,346–348) and lower total daily PA (349,350).

Health-related benefits. Neuromuscular fitness is inversely associated with risks of cardiovascular diseases, hypertension, cognitive function (339,351–356), and psychological health (357,358). Neuromotor fitness and the subcomponents of balance, agility, and gait speed are associated with better health and functional outcomes in middle-aged and older adults (299,301,359–365).

Studies of exercise interventions including neuromotor and multicomponent exercises can improve ability to engage in ADLs, reduce frailty and depression, increase strength, improve cognition and quality of life, and reduce cardiovascular and inflammatory biomarkers in older adults (174,346,366–369). Interventions of multicomponent exercise programs of neuromotor exercise combined with aerobic exercise have resulted in improvements in cardiometabolic disease risk factors such as blood pressure, lipoprotein profile, vascular function, and glucose levels (370–372). However, there is a paucity of studies evaluating the physiological effects of neuromotor exercise alone.

Neuromotor exercises have been shown to result in changes of brain function and structure, and these adaptations are thought to underlie the observed changes in cognition, and executive and motor function (373). For example, activation of the posterior parietal network of the brain occurs with neuromotor exercise and this is associated with better movement activation, visual–spatial processing, and enhanced attention function (373–376). Additionally, the changes in the structure function of the motor areas of the brain (e.g., the cortico-striatal and the cortico-cerebellar systems) have been observed (373,376).

Impaired balance, agility, and gait are associated with elevated risks of falling (41,301,359,365,377,378). Declines in balance increase the risks of all-cause mortality, morbidity, and disability in middle-aged and older adults and in individuals with chronic diseases (362,365,377–380). Although many hypothesize that better agility may reduce musculoskeletal injuries, there is insufficient evidence in nonathletes and athletes to support this benefit (359,381). Agility training improves gait speed, lower limb power, static balance, and cognitive performance in older adults (311). A systematic review and meta-analysis of multimodal agility training revealed large overall effects on strength, mobility, and endurance and moderate effects on balance (312). Gait speed is linked to better health-related outcomes in adults ranging from 35 yr to older adults and in people living with disability. Slow gait speed is associated with increased risks of frailty, obesity, cognitive impairment, and increased cardiovascular disease morbidity and all-cause mortality (314,316,362,377,67,382–385).

Assessments. There is no one test to measure neuromotor fitness, but rather, a variety of tests are available to measure subcomponents of neuromotor fitness. Gait speed is measured as the time elapsed to walk a distance, such as in the 10-meter walk and 6-minute walk tests. Balance is measured in response to internal and external perturbations by static and dynamic tests such as the Functional Reach Test, Berg Balance Scale, Fullerton Advanced Balance Scale, Y Balance Test, and Four Stage Balance Test (386–391). Agility tests often measure only some aspects of agility, such as the physical component of change of direction and speed, or the cognitive components of anticipation and pattern recognition, with fewer comprehensive tests that include a contextual component (i.e., stimulus) (65,392). Measures of agility involving a change of direction or speed in response to a stimulus include the Timed Up and Go Test, various obstacle course tests, for example, Agility T-test and Illinois Agility Test (65,392). There is a need to expand agility testing to include more tests designed specifically for application to adults, because many neuromotor fitness tests are designed for athletes (65,392).

Flexibility

Flexibility (Table 2) refers to the range of motion (ROM) around a joint. It is a function of several factors that affect the skeletal muscles, joints, and tissues involved in moving the joint such as distensibility of the joint capsule, and tightness of ligaments and tendons, temperature, and viscoelastic properties of the skeletal muscle (393–395).

Exercise-induced changes. It is universally accepted that chronic stretch training will increase joint ROM (321,69,396). The beneficial effects of stretch training on flexibility are enhanced with higher frequency (number of days of exercise) and total duration of the stretching exercises (i.e., ≥5 min) (56). Recently, other effective strategies to increase flexibility, such as foam rolling (396,397) or resistance training (398), have been supported in the literature.

Ability to perform exercise. Higher levels of flexibility may contribute to improved performance of recreational sports including marathon running in women

(399) and golf (400). Adequate levels of flexibility may be important for the safe and effective participation of ADLs (401,402). For example, healthy middle-aged and older adults who participated in flexibility exercises were 24% less likely to report functional limitations compared with individuals who reported no stretch training (403). Flexibility is also associated with the ability to sit and rise from the floor in adults of all ages (404). However, flexibility typically declines with aging, and can be adversely affected by injuries, and a variety of diseases and conditions such as obesity, osteoarthritis, back pain, and inflammatory conditions (405–410). Impairments of joint ROM can lead to injuries, pain, and disability (403,405,411), which can compromise engagement in exercise (401,404,412–414). Participation in exercises that improve joint flexibility can reduce pain (401,405,415) improve physical functioning and facilitate engagement in PA (416–418).

Health-related benefits. Enhanced flexibility improves balance (401), and the risks of falling are decreased with better flexibility of the hip (419). A recent meta-analysis showed that stretching exercise interventions reduced the odds of muscular injuries by 37% without any significant differences in the odds of experiencing a tendinous injury in healthy adults (420). Stretch training reduces musculotendinous injuries in military personnel (421), or when engaging in activities involving explosive muscular contractions and changes of direction (401,402). Poor flexibility of the hamstring muscles has been proposed as a contributor to low back pain, but there is a dearth of high-quality research to determine if such a singular relationship between hamstrings flexibility and low back pain exists (422). However, two meta-analytical studies have supported that decreased hamstring flexibility and limited lateral flexion, along with lordosis of the lumbar spine, are associated with the development of low back pain (422,423), and Hafeti et al. showed that a program of stretching exercise reduced low back pain and improved ROM (405). Participation in stretch training improves arterial remodeling and vascular endothelial function and can reduce arterial stiffness, heart rate, and diastolic blood pressure (424–427). Stretch training has also been associated with favorable acute effects on several cardiovascular disease-related biomarkers, such as improved cardiac autonomic function and mucosal immune function (428–433). Although there is a paucity of studies examining the link between flexibility and all-cause mortality, a recent prospective study found an inverse relationship between flexibility and all-cause mortality in middle-aged men and women (434).

Assessments. There is a diverse array of instruments to directly and indirectly measure flexibility, including goniometers and digital levels (435–437), and functional tests such as the Schober and modified Schober Tests for measuring lumbar flexibility (438), the back scratch test (224), sit and reach (439–441), straight leg raise (442), and weight-bearing lunge test (443). Goniometers and digital levels have been evaluated as having high intrarater reliability (444,445), but they may not have consistently strong inter-rater (445) or between instrument reliability. Other assessments may not always measure what people expect. For example, the sit and reach test is commonly used to measure lower back and hamstrings flexibility (441,70,446–448); however, studies show mixed validity for different aspects of flexibility being measured, and factors like scapular abduction, arm and spine length differences, compensation strategies, and individual differences in discomfort perception can influence the results (449–451).

APPLICATION OF THE UPDATED MODEL OF PHYSICAL FITNESS

The expert panel proposed an updated model of PF that differs from the original model of the past decades in several ways. First, there was an effort to compile and present the components of PF in a clear and organized manner. The updated model of PF includes CRF, muscular fitness, body composition, neuromotor fitness, and flexibility as the major components, with muscular fitness, body composition, and neuromotor fitness further divided into subcomponents (Fig. 1). Muscular strength, muscular endurance, and muscular power were integrated into one PF component entitled muscular fitness, standardizing the categorization of this component and the related subcomponents. Second, the components of skill-related fitness were gathered into one category in a manner that is consistent with the other PF components and renamed neuromotor fitness. Third, the dichotomization of health-related and skill-related fitness has been eliminated because all components provide health and fitness benefits that are applicable to all adults. Moreover, consistency has been built into the updated model of PF as all components and subcomponents were clearly defined and met rigorous inclusion criteria (i.e., health benefits, can be changed by training, related to the ability to perform PA, measurable in practice), ensuring that there was sufficient scientific evidence to support their recognition as distinct aspects of PF. Finally, PF is conceptualized in a highly innovative way that emphasizes both interconnectedness and individualization as core tenets of the updated model PF as described below.

The interconnectedness among the components of PF was a consistent theme that emerged throughout this project (Fig. 2). The updated model moves beyond the traditional approach where the components are viewed in isolation to a model where PF is shown to be more complex with overlapping and interrelated attributes that may be responsive to a variety of exercise modalities.

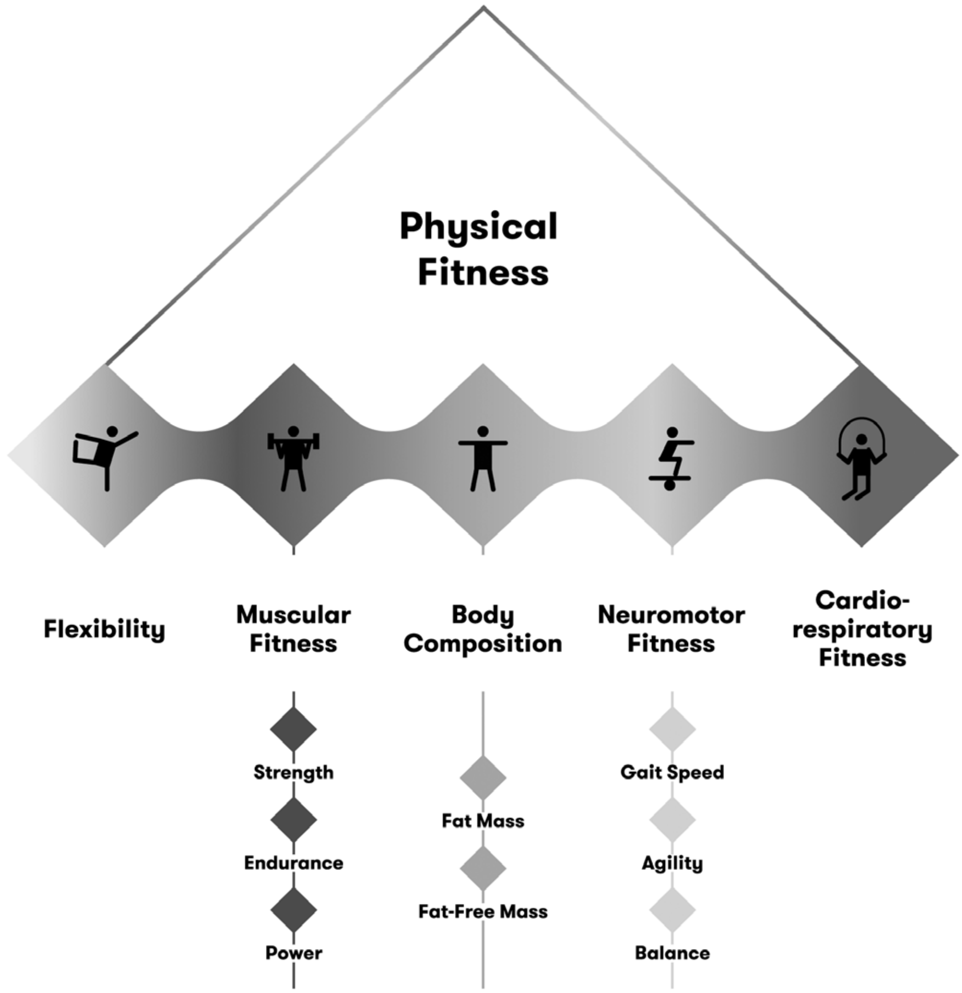

FIGURE 1—Updated model of physical fitness.

This is an important revision that deserves emphasis and consideration in practice. While it is beyond the scope of this paper to outline all interrelationships, presented are some examples that emphasize the interconnectedness of fitness components. FFM, and its component of skeletal muscle mass, was included as a dimension of body composition. However, skeletal muscle hypertrophy is induced by resistance exercise and is one of the mechanisms whereby muscular fitness is improved. Additionally, there is evidence for small magnitude improvements in skeletal muscle hypertrophy with extensive stretch training to improve flexibility (416,452). Resistance exercise can result in improvements in both CRF and flexibility (398,453). Aerobic exercise training can improve balance (304,454) and gait speed (455,456) and attenuates age-related reductions in skeletal muscle strength (457). Multicomponent exercise programs (e.g., tai chi, Pilates, yoga, and dance), which include a combination of exercise modalities within a single program, improve balance and physical function, muscular strength, body composition, flexibility, agility, reaction time, and gait speed in younger and older adults, including those experiencing frailty (160,320,323,326–328,330–335,458). However, the common practice of combining exercises to improve fitness can make it difficult to identify the independent effects of the exercises involved, as the benefits can be synergistic or additive.

The concept of individualization emerged as an important consideration in this consensus statement. Rather than considering the components of PF and their related subcomponents as a static list of variables that apply to everyone in the same manner and to the same degree, they should be considered dynamic in that each can be highlighted or de-emphasized in the exercise prescription depending on the characteristics (e.g., health status, level of fitness, and disability) and priorities of the individual. For an older adult, it may be more important to participate in exercise to improve muscular fitness, neuromotor fitness, and body composition (FFM) because reducing risks of falling is a priority. Conversely, a younger adult might prioritize exercises to improve CRF and lower extremity strength to prepare, for example, for a community 5K road race. Further, an individual may have variable levels of fitness across the components, such that

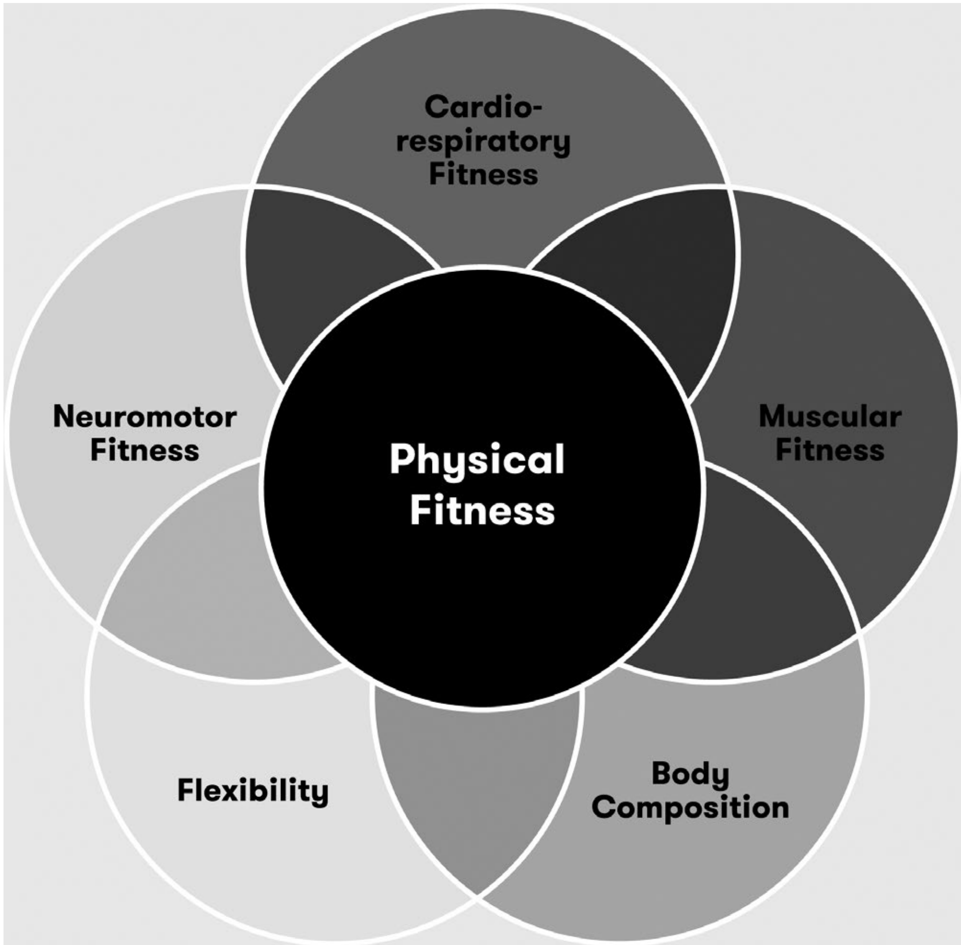

FIGURE 2——The interconnectedness among the components of physical fitness.

they may have high fitness in one component and poor fitness in another, indicating the need for specific focus in weaker areas. Additionally, owing to genetic, health conditions, and other individual factors, not everyone is able to achieve the highest normative levels of fitness. While optimizing all components of fitness is ideal for a given individual, in practice, behavioral and psychological factors need to be considered for effective exercise programs to improve PF (459–461).

CONCLUSIONS

This consensus statement presents an updated model of PF, reflecting advances in science and recognizing the complexity of PF. It can be applied in practice directly to the individual as a tool to organize exercise program design and can continue to serve as a blueprint for PA guidelines (462). The updated model of PF is supported by scientific evidence and each component of PF included in the model meets four criteria (i.e., can be changed by exercise, impacts the ability to perform exercise and PA; contributes to health; can be feasibly assessed in practice). Importantly, the updated model standardizes the definitions of PF and its components, and it leaves room to add new components and subcomponents over time as additional evidence or assessment technologies come to light.

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