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Physical Activity, Exercise, and Physical Fitness: Definitions and Distinctions for Health-Related Research

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Synopsis

"Physical activity," "exercise," and "physical fitness" are terms that describe different concepts. However, they are often confused with one another, and the terms are sometimes used interchangeably. This paper proposes definitions to distinguish them.

Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure. The energy expenditure can be measured in kilocalories. Physical activity in daily life can be categorized into occupational, sports, conditioning, household, or other activities. Exercise is a subset of physical activity that is planned, structured, and repetitive and has as a final or an intermediate objective the improvement or maintenance of physical fitness. Physical fitness is a set of attributes that are either health- or skill-related. The degree to which people have these attributes can be measured with specific tests.

These definitions are offered as an interpretational framework for comparing studies that relate physical activity, exercise, and physical fitness to health.

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THE EPIDEMIOLOGIC STUDY of any concept or event requires that the item under investigation be defined and measured. The common and professional uses of the terms "physical activity," "exercise," and "physical fitness" reveal a need for clarification. This paper, therefore, defines physical activity, exercise, and physical fitness, with the hope that each definition will provide a framework in which studies can be interpreted and compared. Ideally, standardized terminology will promote greater understanding of the relation between physical activity, exercise, physical fitness, and health.

Physical Activity

Several elements of physical activity have been identified (see box page 127). Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure. The amount of energy required to accomplish an activity can be measured in kilojoules (kJ) or kilocalories (kcal); 4.184 kJ is essentially equivalent to 1 kcal (*1*). Technically, the kJ is preferred because it is a measure of energy expenditure; however, historically the kcal, a measure of heat, has

been employed more often. We have chosen to follow historical precedent.

Expressed as a rate (kcal per unit time), the amount of energy expended by each person is a continuous variable, ranging from low to high. The total amount of caloric expenditure associated with physical activity is determined by the amount of muscle mass producing bodily movements and the intensity, duration, and frequency of muscular contractions (*2*).

Everyone performs physical activity in order to sustain life; however, the amount is largely subject to personal choice and may vary considerably from person to person as well as for a given person over time. The most common units of time used to refer to kcals spent in physical activity are the week (*3*) and the day (*2*). Physical activity during monthly, seasonal, or yearly periods may also be examined to establish the stability of physical activity for longer time periods.

Elements of physical activity and exercise

PHYSICAL ACTIVITY	EXERCISE
1. Bodily movement via skeletal muscles	1. Bodily movement via skeletal muscles
2. Results in energy expenditure	2. Results in energy expenditure
3. Energy expenditure (kilocalories) varies continuously from low to high	3. Energy expenditure (kilocalories) varies continuously from low to high
4. Positively correlated with physical fitness	4. Very positively correlated with physical fitness
	5. Planned, structured, and repetitive bodily movement
	6. An objective is to improve or maintain physical fitness component(s)

Categories of physical activity. Physical activity can be categorized in a variety of ways. A commonly used approach is to segment physical activity on the basis of the identifiable portions of daily life during which the activity occurs. The simplest categorization identifies the physical activity that occurs while sleeping, at work, and at leisure (*4*). A simple formula can be used to express the caloric contribution of each category to the total energy expenditure due to physical activity:

$$\text{kcal}_{\text{sleep}} + \text{kcal}_{\text{occupation}} + \text{kcal}_{\text{leisure}} = \text{kcal}_{\text{total daily physical activity}}$$

The caloric contribution of each category to the total energy expenditure due to physical activity is above basal metabolic rate and does not include the effect of diet-induced thermogenesis (which is the energy expenditure above the metabolic rate in the resting state) (*5*). The energy expenditure due to physical activity during sleep would, of course, be small.

Leisure-time physical activity can be further subdivided into categories such as sports, conditioning exercises, household tasks (for example, yardwork, cleaning, and home repair) (*6*), and other activities. Substituting in the formula these subcategories for the leisure category previously used, the formula becomes:

$$\text{kcal}_{\text{sleep}} + \text{kcal}_{\text{occupation}} + \text{kcal}_{\text{conditioning}} + \text{kcal}_{\text{household}} + \text{kcal}_{\text{other}} = \text{kcal}_{\text{total daily physical activity}}$$

Physical activity is complex behavior, however, and may be meaningfully partitioned into other categories mutually exclusive of each other but not necessarily of those mentioned previously. Examples might be to divide all physical activities into those that are of light, moderate, or heavy intensity; those that are willful or compulsory; or those that are weekday or weekend activities. All of these are acceptable ways of subdividing physical activity. The only requirement is that the subdivisions be mutually exclusive and that they sum to the total caloric expenditure due to physical activity.

There are undoubtedly many methods of categorizing daily physical activity. Each system would allow measurement not only of total calories expended but also of the calories expended in a variety of subcategories, any one of which may relate to a specific aspect of health. Distinction between an evenly accumulated total caloric expenditure (that is, equivalent contribution from several categories) and an unevenly accumulated total expenditure (that is, major contribution from one category) is possible. In this manner, individuals and groups can be described by the absolute energy expenditure for a specific category, by the relative contribution of that category to total energy expenditure, or both. To the extent that each of the categories has different determinants (*7*) and different health effects, these categorical distinctions have both epidemiologic utility and public health implications in terms of promotion and intervention strategies (*8*).

Few studies of physical activity allow estimates for each of the categories or for the total. Discus-

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Figure 1. Probability that physical activity performed during selected categories is exercise

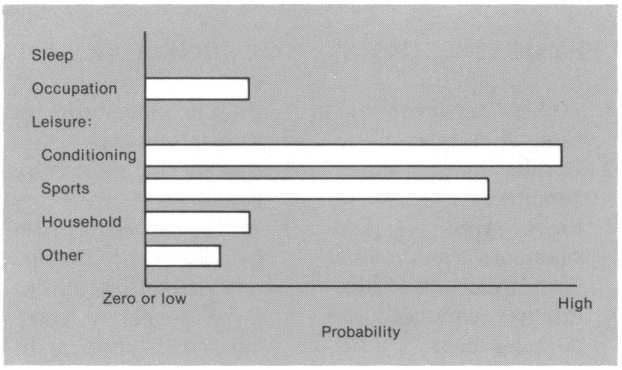
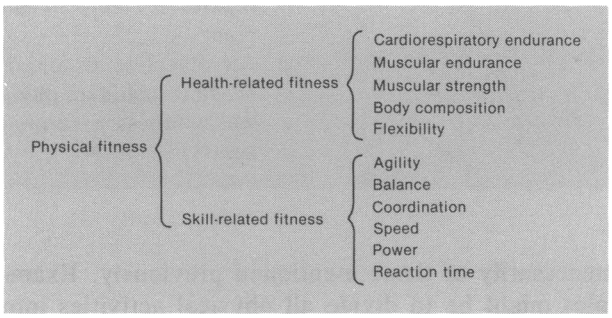


Figure 2. Components of physical fitness



sion and comparison of studies of physical activity will be facilitated if the data in the studies are discussed in terms of specific identifiable categories.

Exercise

The term "exercise" has been used interchangeably with "physical activity" (*9*), and, in fact, both have a number of common elements (see box p. 127). For example, both physical activity and exercise involve any bodily movement produced by skeletal muscles that expends energy, are measured by kilocalories ranging continuously from low to high, and are positively correlated with physical fitness as the intensity, duration, and frequency of movements increase. Exercise, however, is not synonymous with physical activity: it is a subcategory of physical activity. Exercise is physical activity that is planned, structured, repetitive, and purposive in the sense that improvement or maintenance of one or more components of physical fitness is an objective. The formula relating physical activity and exercise is:

$$\text{kcal}_{\text{exercise}} + \text{kcal}_{\text{nonexercise}} = \text{kcal}_{\text{total daily physical activity}}$$

Exercise, then, is a subset of physical activity and may constitute all or part of each category of daily activity except sleep. However, it is more likely to be an important part of some categories of physical activity than of others (fig. 1). For example, virtually all conditioning and many sports activities are performed to improve or maintain components of physical fitness. In such instances they are planned, structured, and, more often than not, repetitive. Activities such as occupational, household, and many daily tasks are typically performed in the most efficient manner possible. These physical activities are done with little regard to physical fitness and are often structured with conservation of energy expenditure as a goal. However, a worker may plan and structure the performance of some work tasks in a less efficient manner to develop muscular strength or to "burn up" calories. Similarly, a person may plan and structure the performance of household or other tasks in a labor-producing rather than a labor-saving manner. Tasks regularly performed in this manner are considered exercise.

Physical Fitness

In contrast with physical activity, which is related to the movements that people perform, physical fitness is a set of attributes that people have or achieve. Being physically fit has been defined as "the ability to carry out daily tasks with vigor and alertness, without undue fatigue and with ample energy to enjoy leisure-time pursuits and to meet unforeseen emergencies" (*10*). Although the definition may be conceptually sound, things such as vigor, alertness, fatigue, and enjoyment are not easily measured. On the other hand, a number of measurable components do contribute to physical fitness (fig. 2). The most frequently cited components fall into two groups: one related to health and the other related to skills that pertain more to athletic ability (*11*).

The health-related components of physical fitness are (*a*) cardiorespiratory endurance, (*b*) muscular endurance, (*c*) muscular strength, (*d*) body composition, and (*e*) flexibility. These components are defined in the glossary (p. 129). Just as the amount of physical activity ranges from low to high, so does the level of physical fitness. Moreover, the levels of the five health-related components need not vary in concert; for example, a person may be strong but lack flexibility. The five health-related components of physical fitness are more important to public health than are the components related to athletic ability; therefore, we limit our discussion to these.

Operational definitions and methods of measuring components of physical fitness vary with the interests and needs of investigators and evaluators (*12–14*). The table below lists procedures commonly employed to evaluate health-related physical fitness components for laboratory, epidemiologic, and self-assessment techniques. Although the comparability of these measures has not been addressed formally, the cost, precision, and accuracy of the measures are generally assumed to decline as one moves from laboratory measures to self-assessment. Within these three levels of evaluation, one may choose to employ a different measure of greater or lesser precision or accuracy, depending on the specific objectives of the investigation and cost constraints.

Discussion

The definitions of physical activity and physical fitness we have proposed contain useful parallels.

Health-related physical fitness measures

Fitness component	Evaluation procedures: Laboratory	Epidemiologic	Self-assessment
Cardiorespiratory	Maximum oxygen uptake on treadmill (*16*) or cycle ergometer (*15*).	Canadian Home Fitness Test (*17*), cycle ergometer (*18*).	Canadian Home Fitness Test (*17*), 12-minute run (*19*).
Body composition	Underwater weighing, potassium-40 (*20*).	Skinfold (*209*, body mass index (*21*).	Skinfold pinch test (*22*).
Muscular strength	Cable tensiometer (*23*).	Handgrip dynamometer (*24,25*).	Upper-lower trunk lift, hanging leg lift (*26*).
Muscular endurance	Isokinetic tests (*24*).	...	Pull-ups, flexed arm hang, situps (*26*).
Flexibility	Leighton flexometer (*27*).	Sit-and-reach flexometer (*26*).	Sit-and-reach test (*13*).

Glossary of Terms

Agility—A skill-related component of physical fitness that relates to the ability to rapidly change the position of the entire body in space with speed and accuracy.[1]

Balance—A skill-related component of physical fitness that relates to the maintenance of equilibrium while stationary or moving.[1]

Body composition—A health-related component of physical fitness that relates to the relative amounts of muscle, fat, bone, and other vital parts of the body.[1]

Cardiorespiratory endurance—A health-related component of physical fitness that relates to the ability of the circulatory and respiratory systems to supply fuel during sustained physical activity and to eliminate fatigue products after supplying fuel.[1]

Coordination—A skill-related component of physical fitness that relates to the ability to use the senses, such as sight and hearing, together with body parts in performing motor tasks smoothly and accurately.[1]

Exercise—Planned, structured, and repetitive bodily movement done to improve or maintain one or more components of physical fitness.

Flexibility—A health-related component of physical fitness that relates to the range of motion available at a joint.[1]

Muscular endurance—A health-related component of physical fitness that relates to the ability of muscle groups to exert external force for many repetitions or successive exertions.[1]

Muscular strength—A health-related component of physical fitness that relates to the amount of external force that a muscle can exert.[1]

Physical activity—Any bodily movement produced by skeletal muscles that results in energy expenditure.

Physical fitness—A set of attributes that people have or achieve that relates to the ability to perform physical activity.

Power—A skill-related component of physical fitness that relates to the rate at which one can perform work.

Reaction time—A skill-related component of physical fitness that relates to the time elapsed between stimulation and the beginning of the reaction to it.[1]

Speed—A skill-related component of physical fitness that relates to the ability to perform a movement within a short period of time.[1]

[1]From Corbin, Charles B., et al., Concepts in physical education with laboratories and experiments, 4th ed. © 1970, 1974, 1978, 1980 Wm. C. Brown Publishers, Dubuque, IA. All Rights Reserved. Adapted by special permission.

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Both physical activity and physical fitness vary among members of the population from low to high. No member has no activity just as no person has no fitness—all are active or fit to greater or lesser degrees. When it is necessary to categorize members of the population into those who achieve certain levels and those who do not, operational definitions can be used.

In contrast, the definition of exercise we have proposed is considerably more restrictive and focused than those in common use. A crucial element of this definition is that exercise be intended to *improve* or maintain components of physical fitness rather than to *achieve* or maintain an established level. Therefore, it is not necessary to determine the specific achievements necessary to become "physically fit," which will vary, at least, by age and sex. The proposed definition of exercise is not encumbered by questions concerning whether all of the five components of fitness are achieved, nor does it require the determination of whether the desired level of fitness has, or even could be, achieved by the activity under consideration. In contrast, the definition of exercise we propose requires only that the activity be intended to improve or maintain some component of fitness. The improvement or maintenance of fitness may be an intermediate objective, and the participant does not need to be continuously aware of it. The proposed definition applies at all levels of physical fitness and does not require predetermined levels of achievement. Activities to improve or maintain the flexibility of a person with arthritis may require and achieve less joint flexion than activities of the gymnast, yet still satisfy this definition of exercise.

We have not addressed the underlying motivation to perform; to do so would compound the concept being defined with the reason for doing. One hoped-for advantage of carefully defining exercise as we propose is that investigators will be encouraged to describe the activity under study with more care. More careful descriptions and considerations of the components of daily living will facilitate cross-study comparisons. Discussion of activities that are not "exercise" may require more descriptive words but should produce a clearer understanding of how the categories of physical activity relate to physical or mental health.

Physical activity is a complex behavior. The major purpose of this paper has been to encourage more careful descriptions of the categories of physical activity that are being studied and discussed. This would facilitate comparison of reports in the scientific literature and hasten progress in this important area of study. In addition, we think it is likely that the different subcategories of physical activity have different determinants, may relate to very specific aspects of physical fitness and health, and may require different intervention and promotion strategies.

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Assessment of Physical Activity in Epidemiologic Research: Problems and Prospects

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Synopsis

More than 30 different methods have been used to assess physical activity. These methods can be grouped into seven major categories: calorimetry, job classification, survey procedures, physiological markers, behavioral observation, mechanical and electronic monitors, and dietary measures. No single instrument fulfills the criteria of being valid, reliable, and practical while not affecting behavior. The instruments that are very precise tend to be impractical on a population basis. Surveys are the most practical approach in large-scale studies, although little is known about their reliability and validity. Studies employing objective monitoring through heart rate, movement sensors, and doubly labeled water procedures appear promising, but are still experimental and costly. Despite the difficulty of measurement, relatively strong association has been found between physical activity and health, suggesting that, with improvements in assessment techniques, even stronger associations should be seen.

A CRITICAL FACTOR FOR EPIDEMIOLOGIC RESEARCH is the accurate assessment of the variables under study. For the cardiovascular risk factors of smoking, serum cholesterol, and blood pressure, there are standardized techniques for assessment of the factors that provide consistency of measurement and definition across studies. However, with research on physical activity this has not been the case.

This review considers seven major categories of physical activity assessment procedures that have been used in various settings (table 1) and evaluates their potential for use in epidemiologic studies with respect to four important criteria:

- To be valid, the instrument must measure what it is intended to measure.
- To be reliable, the instrument must consistently give the same results under the same circumstances. If the instrument is reliable and valid, it is also accurate.
- To be practical, the instrument must have acceptable costs to both the investigator and the participant.

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