THE CONTEMPORARY MODEL OF THE PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOR IN THE CONCEPTS OF BEHAVIORAL EPIDEMIOLOGY AS THE BASIS FOR OBESITY RESEARCH AND THE CHOICE OF METHODS AND TOOLS FOR MEASURING BEHAVIOR AND HUMAN MOVEMENT OF CHILDREN AND YOUTH

Discussion paper

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Keywords: behavioral epidemiology, obesity, physical activity, movement behavior, human movement, exercise, physical fitness, health related fitness, sedentary behavior, MET, REE, Associated Activity Intensity Thresholds for Children and Adolescents, Tools for the assessment of individual physical activity

Abstract:

Aim. Presentation of the assumptions of the new definition of physical activity and their consequences for the interpretation of the essence and the measurement of its category and components.

Material and methods. Unobtrusive research, content analysis, narrative review

Results. Based on the review of the positions of American methodologists of behavioral epidemiology on the definition of physical activity attention was drawn to its new approach, alternative to that created in the 1980s. The detailed analysis of the model of the structure of physical activity, built on the assumptions of the new definition, allowed to indicate its innovativeness and consequences for: interpretation of its essence (as behaviour) and for the quantitative or qualitative measurement of the components of the structures of the new model: behaviour, human movement, exercise, physical fitness, fitness in terms of health (health related fitness, H-RF).

Conclusions.

1. The new concept of the definition of physical activity deserves wider popularization outside the American continent because it is the result of the experience and broad scientific discussion of outstanding representatives of behavioral epidemiology, the leading American scientific trend, creating methodological foundations for research on obesity and other civilization diseases, health training and physical education.

2. Regardless of the existing barriers (most often mental) in the adoption of new concepts by supporters of the concept of physical activity, in the sense of movement or physical fitness, and despite the well-established positions of traditional-
1. Introduction to the research problem: the traditional concept of physical activity in terms of its terminology and American kinesiology and behavioral epidemiology

The importance of physical / physical activity in the scientific works and in everyday use is used and defined variously. According to Oxford Collocation Dictionary for Students of English, there are 48 synonymous terms for the term “physical activity”, and in the available thesauruses of the English language, several hundred shades of meaning are given to such a proximity. The review of the scientific literature shows that steps aimed at refining the concept led to the emphasis in numerous definitions of two basic aspects of human physical activity.

In the first case, the definition relates the meaning of physical activity to the effect of any work performed by skeletal muscles that leads to energy expenditure above the resting metabolic rate (BMR) [3]. The authorship of such a simplified approach to physical activity is attributed to C. J. Caspersen et al.[3], which was articulated in the paper Physical activity and physical fitness: definitions and distinctions for health-related research: “(...) physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure”. This physiological and biomechanical approach to the interpretation of the meaning of “physical activity” is most often found in publications in the natural sciences. It also appeared in the official bulletin of the US Department of Health and Human Services [4].

A similar meaning of the *definiendum* of physical activity can be found in the position of the newly established association Sedentary Behavior Research Network (SBRN) [5] According to it, the caesura between the energy expenditure at rest (EE) and the sedentary behavior (SB), / physical activity (PA) was set at the level of the metabolic equivalent index, 1.5 MET [6].

However, it cannot be based only on the above-mentioned meaning of the definition of human physical activity in action / men in action. It is worth noting that although C. Caspersen et al. [3] did not strictly define the value of energy expenditure in active action, it was similarly indicated by C. Bouchard and R.J. Shephard [7] and Malina et al. [8] that muscle work should be combined with a task that a person performs for a purpose. It led to the distinction of two main categories of the defined concept: leisure activity and occupational activity [9] and a number of their varieties and categories [10].

Among the many concepts of use of physical activity definitions, which arose from the paradigm of linking its essence with the behavioral context, the proposal by R.M. Malina and P. Katzmarzyk [11] defining the essence of the concept of physical activity in relation to the (also ambiguous) term: physical fitness.

“Physical activity is a behavior involving movement of the body through space. It has several dimensions. Physical activity is viewed most often in terms of energy expenditure and the stresses and strains associated with weight-bearing and ground-reaction forces. It also has a major performance component viewed primarily in specific movement skills and measures of physical fitness. Context refers to the settings and types of physical activities (sport, play, education, work, “exercise,” etc.) and is strongly influenced by culture.[11:295.]”

In turn, physical fitness should be related to a specific state of the physiological adaptation and instrumental skills caused, among others, by through the use of various forms of physical activity:

“Physical fitness is a state or a condition that permits the individual to carry out his or her daily activities without undue fatigue and with sufficient reserve to enjoy active leisure pursuits” [11:295].

The study by RM Malina and P. Katzmarzyk [11] presents the methods of measuring both defined concepts used at the turn of the 20th / 21st century.

In the past the essence of physical fitness as the “state of motor skills” was related to the motor potential (condition and energy abilities) [12] and currently, according to the American concept of Health Related Fit-
ness (H = RF), it is associated with health indicators [13]. In the United States this issue was dealt with by the Institute of Medicine (IOM) [14,15].

This taxonomy of concepts (physical activity versus fitness) and their various measurements is justified for several reasons.

Firstly, for semantic and logical reasons. According to the assumptions of the Aristotelian classical definition ("definientia fit per genus proximum et differentiam specificam"), the definiens of the defined word (definiendum) is different in both defined words.

According to RM. Malina and P. Katzmarzyk [11]: “physical activity” (definiendum) = it/meaning (copula) + “behaviour” (definiens): “Physical activity is a behaviour involving movement of the body through space”. “physical fitness” (definiendum) = it/meaning(copula) + “state” (“definiens”): “Physical fitness is a state or a condition that permits the individual to carry out his or her daily activities (...)”.

Secondly, most studies showed no statistical significance of the correlation between such defined activity and physical fitness [11]. Such a case is explained by A.E. Bauman et al [16:6], as: “etiological variables in behavioural sciences are probabilistic factors that significantly increase the probability of the emergence of specific results but do not guarantee them”.

Thirdly, although physical activity is not a “correlate” of physical fitness, it can be an important “determinant” of physical activity (and vice versa) [17:19]. According to the views expressed by well-known researchers of physical activity C. Bouchard, RM Malina, L. Peruse [17] JF Sallis, J.J. Prohaska, WC; Taylor [18], SJBH Biddle and N Mutrie [19], G.J Walki JA. Schaben [20], CD.Heizler et al. [21], GJ Norman et al. [22], Malina and Katzmarzyk [11]: the concept of the determinants, as J. Buckworth and RK Dishman [23:191]; (...) is not used to suggest a cause-and-effect relationship but refers to established repetitive relationships that are only potentially causal”. In this approach, the term “determinants” will be used in this paper.

Fourthly, since the middle of the last century [24] it has been shown in countless studies that both physical fitness (especially now in terms of the Health Related Fitness [H-RF] convention) and “physical activity” are important determinants of broadly defined health by the WHO. The subject of interest, in this relation, was and still is above all the physiological basis of physical activity. It has been the interest in the field of medical science.

In the area of the research interests we can see the second, very important stream of research on physical activity which refers to the behavioral, emotional and motivational context (broadly understood pedagogical aspects) of the use of physical activity which should be associated with the aspect of “behavior”. In this case, the essence of physical activity and the research undertaken on it is closely related to the function of mental processes that underlie physiological processes, and consequently, motor activities for a specific purpose. The aspect of “behavior” of the phenomenon of physical activity then becomes the reverse of its physiological state (biological basis), which is its obverse. The research in this area formally belongs to the social sciences, however they are indirectly related to the potential of the biological basis as indicated by the definition of the broad sense of physical activity. The relationship between the behavioral context and the physiological basis of physical activity is evidenced by the fact that you must first want to be and be able to be physically active, then be physically active in environmental conditions conducive to being active to the best of your potential abilities. Only then, an important physiological determinant of health and muscle performance will be able to reveal its potential biological capabilities.

However, in scientific studies the pedagogical trend of the behavioral aspect (behavior) remains somewhat overshadowed by the medical and physiological approaches to the meaning of physical activity. This is probably due to the specificity of health behaviors and difficulties in defining their essence and determinants [25].

This issue will be discussed in more detail in the presentation of the differences between the new and the older definition of physical activity created in the field of the newly established field of medicine: behavioural epidemiology, pointing to its usefulness in solving the important problem of the obesity epidemic in the United States using the methodology inspired by its assumptions, which were presented in Measures Registry User Guide: Individual Physical Activity [26] developed by the National Collaborative on Childhood Obesity Research (NCCOR).

NCCOR is a partnership of the four leading funders of childhood obesity research: The Centers for Disease Control and Prevention (CDC), the National Institutes of Health (NIH), the Robert Wood Johnson Foundation (RWJF), and the U.S. Department of Agriculture (USDA). These four leaders joined forces in 2008 to continually assess the needs in childhood obesity research, develop joint projects to address gaps and make strategic advancements, and work together to generate fresh and synergistic ideas to reduce childhood obesity.

2. A new approach to physical activity in the definition of behavioral epidemiology and its impact on the proposal to solve the obesity epidemic in the USA

Just like the sociologist [88] in the motto, so are the authors of the NCCOR guide: [27], (the medical scientists), point out that a key point of reference and a priority in research methodology and in the practical implications of the effective use of physical activity in the elimination
of obesity is not only an accurate assessment of physical activity and sedentary behaviour in all their aspects but also in making decisions about the most appropriate instrument it is first important to fully consider the distinctions between movement and behaviour.

In the older version of the definition of physical activity [27], created in behavioural epidemiology in the 1980s, the difference between physical activity, behaviour and movement was not considered. "Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure." [3: 126]. In this approach, it was assumed that the word physical activity may be synonymous with human movement and the work performed by him, the effect of which is energy expenditure. "The energy expenditure can be measured in kilocalories" (...) "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 precedents" [3: 126-127]. Of course, the concept was innovative for the eighties of the last century.

Due to the energy expenditure the physical activity was divided based on the identifiable portions of daily life during which the physical activity occurs, such as a) while sleeping, b) at work, and c) at leisure) The possibility of creating its further divisions was also included. For example, leisure-time physical activity can be further subdivided into categories such as sports, conditioning exercises, household tasks (for example, yardwork, cleaning, and home repair). Another taxonomy of physical activity was also considered. The 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.

The exercise and physical fitness were not included in physical activity. The term "exercise" has been used interchangeably with "physical activity"[28]. According to Carpense et al. [3]:"Exercise, however, is not synonymous with physical activity: it is a subcategory of physical activity. 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."[3: 128]:

In turn, it was assumed that: physical fitness is a set of attributes that are either health- or skill-related. [ ] In this way, the American approach to physical fitness was referred to by President’s Council on Physical Fitness and Sports [29], in the early 1970s, in which 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". In this case, 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. The degree to which people have these attributes can be measured with specific tests [ 3:128 ].

Referring to an interesting review of the taxonomy of physical fitness research from the last decades of the 20th century, physical activity was divided into two groups according to the purpose of its formation (Fig. 1): one related to health and the other related to skills that pertain more to athletic ability. The health-related components

![Physical fitness taxonomy](source: Caspersen et al. [63: 28])

**Fig 1. Physical fitness taxonomy according to Caspersen et all [3]**
of physical fitness are (a) cardiorespiratory endurance, (b) muscular endurance, (c) muscular strength, (d) body composition, and (e) flexibility. The five health-related components of the physical fitness are more important to public health than are the components related to athletic ability. Therefore, in the practical recommendations of behavioral epidemiology, the issue of shaping health related fitness (H-RF) was the main focus. A crucial element of this definition Caspersen et al. [3] is that exercise be intended to improve or maintain components of physical fitness rather than to achieve or maintain an established level.

Although the definition of Caspersen et al. [3] was established nearly half a century ago, it is still popular and accepted in the scientific community. The review of publications on Google shows that until 2019 it was cited in scientific publications 9,490 times [30]. In addition, with the minor modifications, its narrow, simple, but also transparent and clear assumptions became the basis for the justification of the creation of social policy in the world (e.g. Australian Government Department of Health [31]; World Health Organization [32]; UK Chief Medical Officers [33], US Department of Health and Human Services 34, 35]). The definition is found in the classic university academic textbooks [36-39]. Although, apart from one case [30], there was no attempt to undermine the basic concept of its essence as an important determinant of health, it is still difficult to associate the concept of measurement methodology from half a century ago, with the new paradigms of research on the phenomenon and the resulting dispositions for practice.


Note that in the new approach the physical activity is a complex and multidimensional behavior that does not stand in isolation from other related constructs, including sedentary behavior, energy expenditure, and physical fitness [40] and not as suggested by Caspersen et al. [3] "(...) any bodily movement produced by skeletal muscles that results in energy expenditure. Such an interpretation can be considered a result of the scientific consensus of the American behavioural epidemiology and kinesiology community achieved in the course of discussions, at the turn of the century, in the medical periodicals and during symposia and conferences organized on the methods of measuring physical activity, human movement and sedentary behaviour [13, 17, 18, 32, 40-44].

According to the new approach to the physical activity it was assumed that its essence is behaviour that activates human physical movement in the desired direction which results in physiological adaptation processes and changes in somatic structure, which constitute health related fitness level (H-RF) or fitness for performance, e.g., in sports (Motor Motor-Performance Physical Fitness) [11, 13, 15, 26, 40].

A very simple scheme of motor activity presented in fig. 2, which is very similar to the one already developed much earlier in the Polish psychological theory by J. Tomaszewski [45], has become the basis for the construction of a new definition of physical activity, in which – as stated by its creators American epidemiologists KK. Pettee Gabriel, JR. Morrow Jr., AL Woolsey 40:12: "is more clearly defined as the behavior that involves human movement, resulting in physiological attributes including increased energy expenditure and improved physical fitness.

To a large extent, it is a continuation and modification of the Canadian proposal to a structure of the human movement by Shephard and Bouchard [46] and the later American one – LaMonte and Ainsworth [41]. The motor behaviour model of Pettee Gabriel et al. [40] (followed by NCOOR [26]) differs from the above-mentioned con-
cepts of the of human movement structure distinguishing the structural elements of the model more widely than in its predecessors granting them autonomy and clear operationalization and directional subordination of their role to specific goals. The consequence of this is the proposed new definition of physical activity.

The key point of research in behavioural epidemiology is that the accurate assessment of physical activity is a priority in all facets of research, but in making decisions about the most appropriate instrument, it is first important to fully consider the distinctions between movement and behavior.

Below are summarized related important distinctions with the new definition. For this purpose, the model of the discussed structure of physical activity was used. A distinctive feature of the interpretation of the essence of the physical activity of American epidemiologists is the ability to draw problems. This method makes it possible to limit their ranges to the necessary minimum, which greatly facilitates the formal analysis of smaller parts. A visualization of Peetee Gabriel definition [40] is a drawn diagram. It is presented in Fig. 3 and 4.

Firstly, the definition of human movement is as in academic research. This concept includes study of how human beings move around, perform and exercise, especially in sport. For youth, the movement captured in this behavioural definition can be categorized as either structured or unstructured. Activities are also operationally characterized according to their frequency (i.e., number of movements per day), duration (i.e., recorded minutes of actual movement), intensity (i.e., associated effort to perform the movement), and type (i.e., nature of movement as being, for example, aerobic or bone-strengthening related activities). The combination of frequency, duration, and intensity is often referred to as the dose or volume of physical activity and reflects the total amount of movement performed within a specific time period.

Secondly, as evidenced by the new definition of behavioural epidemiology, physical activity is a complex and multidimensional behavior that does not stand in isolation from other related constructs, including sedentary behavior, energy expenditure, and physical fitness” [40:12]. The behavior is ascribed to the expression behaviour similar to psychology. For example, according
The Contemporary Model of the Physical Activity

As the example, accordingly to Oxford Dictionary of Psychology this name is called any observable overt movement of the organism generally taken to include verbal behavior as well as physical movements”. In a different dictionary meaning “Behaviours are physical events that occur in the body and are controlled by the brain” [48].

In the research undertaken [49] by twenty-four UK experts from the social and behavioural sciences and / or population health research, carried out for the scope – specialists in the field of theories of behaviour and behaviour change of potential relevance to the public health interventions across four scientific disciplines: psychology, sociology, anthropology and economics – “behaviour was defined as: “anything a person does in response to internal or external events. Actions may be overt (motor or verbal) and directly measurable or, covert (activities not viewable but involving voluntary muscles) and indirectly measurable; behaviours are physical events that occur in the body and are controlled by the brain”[49: 327].

As previously noted, a critical element in the new definition is the labelling of physical activity as a behaviour [11,26,40]. With this basic framework, we can begin to operationalize the components and expand on the main constructs of human movement. This captures the volitional nature of physical activity and the various physiologic, psychosocial, and environmental factors that influence it. Therefore, in this new conception of physical activity, a better understanding of the context and settings where physical activity behaviour occurs (e.g., home, work) as well as the purpose (e.g., recreation, occupation) is needed. Although categories can vary, four broad domains that effectively capture behaviours for both adults and youth include: (1) leisure-time physical activity (i.e., recreation, play), (2) work- or school-related physical activity, (3) home or domestic physical activity, and (4) transportation physical activity (commuting from place to place).

Previous frameworks have not illustrated the direct relationship between the behaviour and the physical and physiological results of that behaviour [40]. In the new definition the behaviour of human movement can be conceptualized as active (i.e. physical activity) and sedentary behaviour (Figure 3, 4). Sedentary behaviour was not addressed in previous conceptual frameworks. As can be seen from the data presented in Figure 3 both active and sedentary behaviour can be influenced by upstream factors, including physiological, psychological, social, and environmental correlates and sedentary behaviour can be influenced by upstream factors, including physiological, psychological, social, and environmental correlates.

Sedentary behaviour and physical inactivity are two different and distinct concepts that have been and are still confused in the literature [50]. According to the Sedentary Behaviour Research Network (SBRN) [51], sedentary behaviour is any waking behaviour characterized, multiples of resting energy expenditure while in a sitting or reclining posture. In contrast, the term “inactive” must be used to describe those who are performing insufficient amounts of moderate to vigorous physical activity (i.e., not meeting specified physical activity guidelines). Physical activity and sedentary behaviour can be seen as a continuum on the human movement spectrum[52]. In addition, being sedentary is not necessarily associated with being inactive – an active individual can meet physical activity guidelines while spending the vast majority of the day sitting [53]. Evidence suggests that different types of sedentary behaviours have different impacts on health and wellbeing [54]. For instance, some sedentary behaviours can have potential health-enhancing effects (rest and relaxation can be an essential need). In addi-
sion, research suggests that the consequences of sedentary behaviours on health depend greatly on their pattern (i.e., how they are accumulated throughout the day). For example, the same total amount of sedentary time would be associated with fewer negative health outcomes if it is accumulated with regular interruptions than if it is continuous [55]. Understanding the sedentary behavior setting – the physical and social context where it occurs – is of particular importance to the study of its consequences on health [56].

It is worth noting that the model of physical activity as human behaviour and movement [fig 4-5] did not take into account its important subcategory, which are exercise. It can be found in the detailed characteristics of the model presented in Fig. 5 and in the interpretation of the assumptions of the new concept of physical activity in the article: Framework for Physical Activity as a Complex and Multidimensional Behavior [40].

In the old concept of physical activity, Caspersen et al. [3]: “Exercise, however, is not synonymous with physical activity: it is a subcategory of physical activity”, but the meaningful importance was attached to them “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”.

In the same way, the vocabulary of terms used in the research on physical activity emphasizes the significant exercise language, which in the publication: Physical Activity, Inactivity, and Sedentary Behaviors: Definitions and Implications in Occupational Health [57].

The practical significance of distinguishing exercises in the model of human motor behaviour was emphasized even more in the website of the European Commission [58] which publishes the theoretical foundations of health promotion and prevention of civilization diseases, combining their semantic meaning with the phrase training “Exercise (also referred to as exercise training) is a subcategory of physical activity that is planned, structured, repetitive and purposive, with the goal to improve or maintain one or more components of physical fitness, performance and health.

Similarly, in the NCCOR guide [26], the term exercise “(…)is viewed as a subcategory of leisure-time physical activity that is more structured (e.g., steady state running) and performed with a well-defined purpose in mind (e.g., improving or maintaining physical fitness)”. [26: 11]

However, it is stated that the distinctions between physical activity and exercise are more relevant, for adults, but participation in sports or structured activity programs or lessons by youth can be considered analogous to. It can also be added that the importance of exercise as a subcategory of human behavior and movement is revealed in the case of determining energy expenditure as a result of movement intensity. The new definition focuses on the contribution to energy expenditure and its impact on the adaptation process in terms of physiological functions and somatic structure of the human.

Moreover, the new definition of physical activity stipulates, that movement needs to be of sufficient magnitude to increase energy expenditure. Energy expenditure is typically expressed in the units of kilojoules (kJ) or kilocalories (kcal), but it is also frequently expressed as multiples of resting energy expenditure known as Metabolic Equivalent Tasks (METs) [3, 26, 50-58] Resting energy expenditure is often estimated because it is challenging to measure, and the value of 3.5 ml/kg/min has been widely adopted as the oxygen consumption of a person at rest. Using standard conversions and additional assumptions, resting energy expenditure (i.e., 1 MET) has been equated to an energy cost of 1 kcal/kg/hour [3].

On this basis, the physiological cost of hundreds of different behaviours and motor activities was determined. The most famous are the periodically published studies of the results of research in this area entitled the Compendium of Physical Activities [59, 60, 61]. This helped standardize the results to routinely calculate physical activity levels using the established ranges: sedentary behaviour (i.e., 1.0-1.5 METs) [62, 63] and light-intensity (1.6-2.9 METs) [64], moderate-intensity (3-5.9 METs), and vigorous-intensity (≥6 METs) activities [65].

Assessing physical activity is challenging for all populations but it is particularly difficult in children and adolescents. Children have unique behavioural patterns of physical activity, unique perceptions and cognitions related to physical activity, and distinct physiological and maturational responses and adaptations to physical activity. Most foundational work on assessing physical activity and energy expenditure has been derived in adults and the simple assumption has been that these also hold in youth. However, it is clear that children are not just “little adults.” [66] – so special considerations are needed to evaluate and study individual physical activity behaviour in this segment of the population.

Distinction with assessing physical activity and sedentary behaviour in youth is that standard physiologic adaptations and relationships do not always hold when applied to youth. Perhaps the most critical distinction is the difference in metabolic cost of physical activity as a result of aging or growth. The amount of activity performed based on absolute intensity (e.g., use of MET values) assumes a standardized resting state of 3.5 ml/kg/min, a value established based on adult values of resting energy expenditure. Resting energy expenditure is primarily determined by body composition and more particularly by muscle mass, but other important predictors include age, sex, and body fat. These factors lead
to error when using the standardized value of 3.5 ml/kg/min in adults but more significant errors (and systematic bias) when applied in youth populations.[26, 67-72]. The error is introduced due to known differences in resting energy expenditure for youth. Failure to consider this difference leads to systematic over-estimation of children’s physical activity intensity and a misclassification of performed activities [73]. Error is further compounded due to additional variability associated with differences in lean body mass in children classified as normal weight and children classified as overweight or obese [26:52-56].

Children undergo systematic changes in body composition as a result of growth and maturation and these changes are particularly relevant when considering the use of MET values in youth. In general, both boys and girls (though more so in girls) experience gains in fat mass during preadolescent ages, but patterns change after puberty. The variability in body composition during development has important implications for activity intensity classifications based on METs and requires that cut points be adjusted for differences in resting energy expenditure that occur during growth.

By definition, METs assume resting energy expenditure as being 3.5 ml/kg/min (based on adult values and therefore often referred to as adult-METs), and multiples of this value (e.g., 3 METs) are used to distinguish light intensity from moderate-intensity activity. The systematic change in resting energy expenditure during growth in youth implies that moderate activity might be better characterized by 4.0 METs and not 3.0 if resting energy expenditure is higher than 3.5 ml/kg/min (e.g., 4.2 to 6.0 ml/kg/min as seen in previous research). Adjusted MET values for sedentary, light, and moderate-to-vigorous intensity are directly affected by changes in resting energy expenditure and result in MET values that are higher in younger ages but decrease as youth get older, reaching adult values at about the age of 18 years. 26:

The authors of the NCOOR guide [26] presented it (Table 1) their own proposition of corrected values of Resting Energy Expenditure (REE) and in sedentary behaviour and in total Moderate-to-Vigorous Physical Activity (MVPA) for children and adolescents aged 8-19 years.

In another US academic centre, a Youth Compendium of Physical Activities (Youth Compendium) was developed to estimate the energy costs of physical activities using data on youth only [74]. This Youth Compendium of Physical Activities presents MET values for 196 activities across four age-groups: 6–9, 10–12, 13–15, and 16–18 yr. The new Youth Compendium can be used to standardize the scoring and interpretation of youth physical activity data in research and public health surveillance applications.

This is not the first proposal to relativize the physical activity intensity thresholds with the use of MET indicators. As shown earlier, there is an awareness of the lack of grounds for using the methodology for determining the resting metabolic rate (RMR) and estimating the energy expenditure in MET units on this basis. Adult values met, however, do not apply to children [75, 76]. As shown before, children have a higher basal metabolic rate (BMR) per unit of body weight than adults, which decreases gradually as children grow and mature. Therefore, it cannot be used to estimate the physiological cost of the forms of exercise for children included in the previously mentioned Adult Compendium [59-65] which included the development of 21 main categories of activities and 821 specific activities. To

### Table 1: Extrapolated Resting Energy Expenditure (REE) and Associated Activity Intensity Thresholds for Children and Adolescents [26:56]

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| **GIRLS** |     |           |      |
| 8 yr   | 1.8 | 2.7       | 5.4  |
| 9 yr   | 1.7 | 2.6       | 5.1  |
| 10 yr  | 1.6 | 2.4       | 4.9  |
| 11 yr  | 1.5 | 2.3       | 4.6  |
| 12 yr  | 1.4 | 2.2       | 4.3  |
| 13 yr  | 1.4 | 2.0       | 4.1  |
| 14 yr  | 1.3 | 1.9       | 3.8  |
| 15 yr  | 1.2 | 1.8       | 3.5  |
| 16 yr  | 1.1 | 1.7       | 3.3  |
| 17 yr  | 1.0 | 1.6       | 3.1  |
| 18 yr  | 1.0 | 1.5       | 3.0  |
| 19+yr  | 1.0 | 1.5       | 3.0  |

solve these problems, Ridley and colleagues [77] developed a compendium of youth energy expenditure in 2008 (Ridley Compendium), which provided MET values for 244 activities, 38% of which were met-based in children. However, Ridley Compendium had several limitations. To address these limitations, the Centers for Disease Control and Prevention, the National Cancer Institute, and the National Collaborative for Childhood Obesity Research convened by the Centers for Disease Control and Prevention on April 19-20, 2012. The panel of experts agreed that an updated, expanded and accessible online compendium (now known as the Youth Compendium of Physical Activity, now known as the Youth Compendium) [74].

The Youth Compendium of Physical Activity has been based entirely on empirical measurements of energy expenditure in children. This Compendium for Youth consists of MET values MET data from age and for 196 specific actions classified in the 16 main categories for the four age groups: 6-9, 10-12, 13-15 and 16-18 years. The methods used in formulating this Compendium for Young People have sought to respond to the unique developmental challenges associated with determining the energy costs associated with physical activity in children. The Youth Compendium was published on the National Collaborative for Childhood Obesity Research website at www.nccor.org/nccor-tools/youthcompendium. A significant part of it was published in the article: Youth compendium of physical activity: activity codes and metabolic.[77].

The reservations contained in that Compendium for Youth are no different from those recognised by the Ridley Compendium [77] and the Compendium for Adults [59-65]. In all cases, MET values are average and therefore do not reflect the individual variability associated with body composition, fitness, effort, mechanical performance or the environmental conditions under which the activity is performed. Some activities in this Youth Compendium can be performed at different intensity and are therefore inherently more variable than recommended activities such as walking and running at a fixed speed. Met and values will be more accurate at group level than at individual level. Where an individual assessment is desirable, users should be aware that energy expenditure may be affected by a number of factors that are not taken into account average MET values shown here. Users should be also aware that these values are estimates and are not recommended to be used to accurately estimate the energy balance.

The authors of the NCOOR guide raised other objections to the relativization of the intensity of physical activity [26:55-56].

"The Youth Compendium of Physical Activity provides the energy cost using different metrics of the MET values (with both unadjusted and adjusted values for youth resting energy expenditure). Therefore, the above thresholds are appropriate only for energy cost when expressed in adult-METs (using 3.5 ml/kg/min). For example, according to the corrected thresholds, a reported activity for a boy age 10 years that is estimated at a value of 4.4 adult-METs values would be interpreted as a light intensity activity (because it is <5.1 METs as shown in Table 3) and not as being moderate as it would be if based on the traditional and unadjusted cut points (i.e., 3.0 METs). Alternatively, crude data obtained from activity monitors also calibrated against adult-MET values and the output activity intensity would need similar adjustments”. The conclusion is that presented in Table 1, the adjusted values for boys and girls ages 8 to 19+ years can be used to overcome misclassification and inappropriate assumption of the 1 MET value for resting energy expenditure when assessing activity levels in youth.

The assessment of physical activity and the estimation of energy costs in children has many applications in clinical practice, public health and applied studies. In order to assess compliance with physical activity guidelines and to test the effectiveness of programmes and interventions, a correct methodology is needed. In epidemiological studies and clinical practice, self-description questionnaires, direct observation and monitoring devices are common tools for assessing physical activity [79-80]. In these approaches, reported or observed physical activity data are converted to energy expenditure using pre-defined MET.

Research is often hindered by the challenge of employing a valid, reliable measure that also adequately satisfies the research question or design [79, 81-84] The doubly labelled water method (DLW) remains the gold standard for assessing total energy expenditure; however, it is not often used for research studies as it is expensive, has high subject burden, is time-intensive, and cannot capture qualitative data [85-86].

For a review and a critical assessment of the most commonly used methods, see the review: A Practical Guide to Measuring Physical Activity [87] On the other hand, the NCOOR [26] study assessed their application values. The most frequently used techniques used in research on physical activity include survey research (Report-based measures according to NCOOR [26]), classified as observational techniques in social sciences [88]. Of these, the most popular are seven well-verified and commonly used self-assessment questionnaires: Modifiable Activity Questionnaire (MAQ) [89] Previous Week Modifiable Activity Questionnaire (PWMAQ [90]. Recent Physical Activity Questionnaire (RPAQ) [91]. International Physical Activity Questionnaires (IPAQ) [92.93]. Previous Day Physical Activity
Recall (PDPAR) [94], and 7-day Physical Activity Recall (PAR) [95,96].

In research on physical activity, the unobtrusive research method is used, modelled on research on social behavior that does not affect it. It focuses on the content analysis of Self-Report Activity Diaries / Logs. Self-report diaries require participants to record PA in real time which provides the most detailed data [97-98] and can overcome some limitations of questionnaires (i.e., less susceptible to recall errors, social desirability bias, measurement bias) [98-99].

The Direct Observation method can be considered interesting, but rarely used in population studies. It is known, in this case, an independent observer monitors and records PA [100,101]. This method of assessment is often used when activity is restricted to a delineated space (e.g., a classroom) [101-103]. It is also a popular method for young children as they have difficulty recalling their PA [102, 104]. This flexible method is valuable in gathering contextual information. Disadvantages include high cost of time and energy [105], potential reactivity [106-108], difficulty obtaining ethical approval [108], and the lack of objective measures of energy expenditure [108].

In recent decades, apparatus techniques for measuring indicators of physical activity, mainly one of its components - exercise intensity - have become very popular, called Monitor-based measures [26, 87]. This name includes various measures that directly or indirectly evaluate movement. Technical progress, especially in the field of computer science, enables the creation of constantly new and more perfect measuring equipment. Not only due to patent, competence and marketing protection, but above all the scope of the objective and this study, the detailed characteristics of Monitor-based measures, which are used to study the most important component of behavior, will not be taken into account. Besides, they can be found in numerous scientific studies.

Accelerometers measure acceleration (counts) in real time and detect movement in up to three orthogonal planes (anteroposterior, mediolateral, and vertical) [105,109]. These counts are then translated into a metric of interest, which can be biological (e.g. energy expenditure) or PA patterns (e.g. stationary) [109, 110]. Devices can be worn in numerous places on the body, including waist, hip, and thigh. American research shows that due to the possibility of using investigators accelerometer data to compute physical activity volume, rate, and time spent in different intensities of exercise, and of using of using broader characterizations such as achievement of public health guidelines and classification by physical activity levels, the following triaxial accelerometers were most useful: active Pal [111], Tritrac [112], Tracmor D [113], Actigraph [114].

However, accelerometers are expensive [84] and require technical expertise, specialized hardware, software, and individual programming [84]. Accelerometers also lack a standard protocol for managing or reducing data [108] can induce a reactivity bias [105], and do not provide any contextual information. Additionally, some accelerometers are unable to differentiate body position (i.e., sitting, lying, standing) or walking intensity [108]. Notably, the relationship between accelerometer activity counts and energy expenditure depends on the count cut-point applied to the data; choosing different cut-points can differentially influence measurements of physical activity intensity.

Pedometers measure number of steps taken with a horizontal, spring-suspended lever arm which is deflected when the subject’s hip accelerates vertically with a force beyond a chosen threshold. Pedometers correlate strongly with uniaxial accelerometers, and directly observed duration of activities [105,115-117]. Their simplicity, relatively low cost, and ability to pick up short durations of PA (often missed by self-report measures) make these devices popular.

Disadvantages of pedometers include inability to record PA involving horizontal motion occurring during periods of inactivity, leisure activity, or solely upper body movements [118-119]. Pedometer brands differ in the set vertical acceleration threshold needed to register a step, which necessarily yield varying PA sensitivity and thus different outputs [120]. Pedometers do not record intensity, frequency, or duration of PA, [121-122], have significantly less data storage capacity than accelerometers [122], and can also induce reactivity in subjects [106, 115, 123]. Are bestsuited to categorize subjects’ PA levels (i.e., highly active, somewhat active, sedentary) as opposed to the exact amount of PA. These devices tend to show discrepancies particularly at very high and low intensities [81, 122, 124-125].

Heart rate [63] monitoring is a physiological indicator of PA and energy expenditure [64], providing real-time data on the frequency, duration, and intensity of PA in an unobtrusive (e.g., they can be worn as watches or on the chest), low-effort way for periods up to one month [124-126]. These devices tend to show discrepancies particularly at very high and low intensities [81,124-127]. Discrepancies are due to HR and energy expenditure not sharing a linear relationship at rest and low-intensity. Age, body composition, muscle mass, gender, and fitness level also affect this linear relationship or reduce its accuracy[121].

In recent years, the armband technology has been developed and validated using the doubly labeled water method (DLW) [128] to overcome the limitations that are typical of other devices. There are several versions of
the wristbands (e.g., SenseWear, HealthWear, bodybugg) [129]. In this case, for measuring energy expenditure and monitoring metabolism. In PA, motion and heat sensors are used (e.g., heat fluxes, galvanic skin response, skin temperature, body temperature). This dual measurement strategy (i.e., body temperature and movement) is more sensitive in assessing the energy expenditure associated with complex and non-walking activities such as heavy weight walking [130-131]. Consequently, the bands proved to be excellent devices for daily activities (or activities of low or moderate activity), but were not ideal for higher-intensity exercise [132].

The doubly-labelled water technique, indirect calorimetry, and various direct observation measures that involve direct coding of behaviour (e.g., time, intensity, type, location), form the Criterion measures group according to NCOOR. The double labelled water method (DLW) remains the gold standard for assessing total energy expenditure. However, it is not often used for research studies as it is expensive, has high subject burden, is time-intensive, and cannot capture qualitative data [8–9].

Currently, the use of modern monitors in observations is very often considered the basis of “scientificity” in the study of physical activity. Studies in which are used monitors are called (controversially!) objective [133] Research with application “Report-based measures” (e.g., Questionnaires, diaries, logs) is classified as subjective. Large discrepancies in prevalence rates and levels of physical activity have been observed when objective and subjective measures are compared [134,135]. According to the information contained in the NCOOR guide [26:9], it is important not to assume that one category is better than the other. Monitor-based (e.g., activity monitors) measures are certainly more objective than report-based measures (e.g., diaries), but the key distinction is that they capture amounts of movement as opposed to a person’s perception or recall of physical activity experiences. An unfit individual may perceive a certain activity as vigorous in intensity while a fit person may perceive the same activity as being light intensity. This example describes physical activity intensity expressed in relative terms (i.e., accounting for one’s individual level of fitness) and highlights the need to differentiate between relative and absolute intensity of the physical activity performed. Report-based measures capture relative intensity (i.e., individual perception of intensity) while monitor-based measures capture the absolute intensity and volume of activity without considering perceived or actual effort. It is true that report-based measures contain a considerable degree of subjectivity that can contribute toward sources of error and bias, but different sources of measurement error also plague monitor-based measures [26:9].

3. A brief conclusion on the American concept of defining and methods of researching physical activity may encourage discussion, as it results from the subtitle of the report: discussion paper

The issue of physical activity is a frequent topic of the Polish and European authors’ publications shared not only in Human Kinetics. Relating the issues discussed in them to the works inspired by the theoretical and application concepts of the representatives of the American behavioral epidemiology, one can have a feeling of strong attachment of European researchers to the tradition and respect for history without a greater willingness to change established dogmas. The Dutch founders of Eurofit after analyzing American concepts of the essence and measuring physical fitness, drew attention to the overtaking of European theories of motor skills by the American ones and following them in practice other ways. The new core curriculum, implemented in Poland, based on the assumptions of Health Related Fitness, proves that American solutions should be the focus of the interest. One may doubt whether or not when creating one it was fully aware of its relationship with the concept of physical activity developed in the USA from the inspiration and needs of behavioral epidemiology.

Guided by the wisdom of Ludwig Boltzmann’s sentence, according to which there is nothing more practical than a good theory, in this report, attention was drawn to the new model physical activity. The detailed analysis of the model of the structure of physical activity, built on the assumptions of the new definition, allowed to indicate its innovativeness and consequences for: interpretation of its essence (as behaviour) and for the quantitative or qualitative measurement of the components of the structures of the new model: behaviour, human movement, exercise, physical fitness, fitness in terms of health (health related fitness, H-RF). Undoubtedly, it is worth paying attention to it when undertaking research on the issues of physical activity, because it is the result of the experience and broad scientific discussion of outstanding representatives of behavioral epidemiology, the leading American scientific trend, creating methodological foundations for research on obesity and other civilization diseases, health training and physical education.

Regardless of the existing barriers (most often mental) in the adoption of new concepts by supporters of the concept of physical activity, in the sense of movement or physical fitness, and despite the well-established positions of traditionalists regarding changes in the methods of promoting physical activity and participation in the broadly understood physical culture, the logical nature of the theoretical foundations and pedagogical pragmatism, supported
by research results, suggests that in the matter of adopting a new concept of human movement and methods of studying motor behavior, one should strive to challenge the regularities found by Dutch researchers, with regard to the acceptance of American physical fitness tests in the past: In Europe, the development of fitness tests followed the Americans, with a delay of 20 years. [1].

**General conclusions and recommendations**

1. According to the new definition, *physical activity is a complex and multidimensional behavior that does not stand in isolation from other related constructs, including sedentary behavior, energy expenditure, and physical fitness*. In such an approach, the essence of physical activity differs from the commonly accepted definition of Caspersen et al. in which physical activity was “Any bodily movement produced by skeletal muscles that result in caloric expenditure that physical activity”.

In a new framework, *physical activity* represents a class of actions (such as cleaning house or playing soccer). *Behavior* is a specific action embedded in the activity, such as standing in the goalie box or wiping the windows with a paper towel. Human movement is about changing the position of the body in relation to the selected frame of reference. Such a change takes place over time. Can be captured by devices such as accelerometers. A critical element in the new definition is the labeling of physical activity as a behavior. In the new definition, physical activity is clearly defined, as “the behavior that involves human movement, resulting in physiological attributes including increased energy expenditure and improved physical fitness”. This captures the volitional nature of physical activity and the various physiologic, psychosocial, and environmental factors that influence it. Within the behavior of physical activity, 4 main domains or types of activity have been identified. These activity domains include leisure-time physical activity; work- or school-related activity; household, domestic, or self-care activities; and activity for transport from place to place.

The behavior of human movement can be conceptualized as active (ie, physical activity) and *sedentary behavior* (SB). Both active and sedentary behavior can be influenced by upstream factors, including physiologic, psychological, social, and environmental correlates. Sedentary behavior was not addressed in previous conceptual frameworks. SB has emerged as a new field of focus in physical activity and public health research.

Research and public health guidelines have distinguished physical activity and sedentary behavior as independent behavioural constructs and they also may have independent effects on health, although this is less established in youth. No universally agreed-upon consensus has yet been achieved on defining sedentary behavior for both children and adults, though concerted efforts have been made for adults. Researchers in the Sedentary Behavior Research Network have come to agreement that sedentary behavior should be defined as “any waking behavior characterized by an energy expenditure ≤1.5 adult-METs while in a sitting or reclining posture.” The threshold of 1.5 adult-METs has been generally considered a cutpoint for identifying sedentary behavior in adults. (MET is used to express energy costs during physical activity as multiples of resting metabolic rate (RMR)). According to the Convention, in adults, an oxygen uptake of 3.5 ml is considered to be 1 MET • kg$^{-1} \cdot \text{min}^{-1}$ or 1 kcal • Kg$^{-1} \cdot \text{min}^{-1}$. Adult values met, however, do not apply to children. Children have a higher basal metabolic rate (BMR) per unit of body weight than adults, which decreases gradually as children grow and mature. Gender-specific developmental changes in organ mass, metabolic rate, muscle mass and obesity affect BMR in different ways and are responsible for the decline of BMR. The use of standard MET equivalence for adults would undercut children’s BMR. Also, young children compared to teenagers or adults have a disproportionately higher energy expenditure per unit of body weight per physical activity. The energy cost of performing submaximal activities increases with age when expressed in kilocalories per minute, but decreases with age when expressed in relation to body weight (kcal • kg$^{-1} \cdot \text{min}^{-1}$). However, different assumptions must be considered for children.

In addition to the developmental changes in body size and composition discussed above, children become more skilled and productive in performing certain activities. As a consequence, the energy costs associated with physical activity are not constant throughout childhood. In order to solve the signaled problem, several variants of the relativization of energy expenditure in the performance of activities due to the developmental age of children have been developed (including: *Ridley Compendium*, *Youth Compendium of Physical Activity* (Youth Compendium)). In the own publication presented table Extrapolated Resting Energy Expenditure (REE) and Associated Activity Intensity Thresholds for Children and Adolescents Using Adult-MET Values (Welk et al).

**The human movement** captured in this behavioural definition can be categorized as either structured (i.e., repetitive, organized activity, often led by an adult and performed in physical education class) or unstructured (i.e., play, unsupervised, activity performed during recess or school breaks). This new definition helps to distinguish physical activity from non-volitional forms of movement (e.g., fidgeting) and focuses attention more on larger contributions to energy expenditure. Otherwise definition the of physical activity stipulates that movement needs to be of sufficient magnitude to increase energy expenditure.
Energy expenditure is typically expressed in units of kilojoules (kJ) or kilocalories (kcal), but it is also frequently which has already been pointed out - expressed as multiples of resting energy expenditure known as Metabolic Equivalent Tasks (METs). Resting energy expenditure is often estimated because it is challenging to measure, and the value of 3.5 ml/kg/min has been widely adopted as the oxygen consumption of a person at rest. Using standard conversions and additional assumptions, resting energy expenditure (i.e., 1 MET) has been equated to an energy cost of 1 kcal/kg/hour. Other procedures yield different estimates (as mentioned earlier).

Levels of physical activity are routinely calculated using established ranges (Rest is 1.0 to 1.4, Light physical activity [LPA] is 1.5 to 2.9, Moderate physical activity [MPA] is 3.0 to 5.9, Vigorous physical activity [VPA] is 6.0+). Most physical activity research has used a combined indicator that captures both moderate physical activity and vigorous physical activity (MVPA). However, research has increasingly emphasized the importance of understanding the allocation of time spent in different intensity classifications, as they each contribute directly to overall energy expenditure and health. Considerable attention has been given to time spent in sedentary behavior because it has been shown to be independent of time spent in MVPA. By default, the time spent in LPA also has implications because it falls between these two intensities. More time spent in LPA can be beneficial if it corresponds with less time in sedentary behavior. However, time spent in LPA does not provide benefits that come from participation in MVPA.

According to the adopted structure of the new model of physical activity, the term “exercise” is viewed as a subcategory of leisure-time physical activity that is more structured (e.g., steady state running) and performed with a well-defined purpose in mind (e.g., improving or maintaining physical fitness). Starting of Caspersen et al., that’s how the term is understood.

In the past, the term activity “exercise” has been used interchangeably with “physical activity”, and, in fact, both have a number of common elements. Both physical activity and exercise involve bodily movement produced by skeletal muscles that expends energy, continuously from low to high, and are positively correlated with physical fitness as the intensity, duration, and frequency of movements increase. As Caspersen et all stated, 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 term exercises can be so associated with human movement in health training.

The new definition of physical activity specifically references its contributions to improving dimensions of physical fitness. It is important here that, in contrast with physical activity, which is related to the behavior and is related to the movements that people perform, physical fitness is a set of attributes that people have or achieve. Their role is differently defined. In the US definition for half a century, it is assumed that, physical fitness it is: “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”. In the old one and the new concept of the definition of physical activity, the attributes of physical fitness fall into two groups: one related to health and the other related to skills that pertain more to athletic ability. The degree to which people have these attributes can be measured with specific tests. The important thing is that, is that participation in physical activity may not necessarily lead to predictable or measurable improvements in physical fitness.

2. Physical activity (PA) is a multi-dimensional construct and thus, there is no measure that can assess all facets of PA. Thus, investigators should approach PA measure selection with a clear concept of the type of data they intend to collect. For many studies, combining multiple PA assessments is recommended however, it is possible multiple measures may not be necessary if an investigator is only interested in one facet of PA. Given that further research is needed to validate individual PA measures for different populations, it is difficult to determine an optimal PA assessment. Thus, investigators when selecting a PA measure need to pay close attention to each assessment’s strengths and limitations. Physical activity is a complex construct, often qualitatively classified into the main categories based on function (occupation, recreation, sport, locomotion and self-care) or quantitatively based on exercise intensity (sedentary, light, moderate and energetic). Knowing the level of intensity of physical activity in young people’s participation can help researchers and practitioners understand patterns of physical activity and recommend and encourage optimal health activities.

3. Indicators of physical fitness (including body fatness) have generally shown stronger links with health indicators than with physical activity. However, this is due in part to the less precise methods available to assess physical activity. Physical activity directly improves fitness (and body composition) and consensus suggests that it improves health independently of both fitness and fatness. These findings clearly justify the emphasis on physical activity for advancing public health research focused on obesity and health. Accurate estimates of physical activity are essential for advancing research on the health benefits of physical fitness.
activity; for understanding patterns and correlates that influence physical activity behaviour; and for evaluating interventions designed to promote physical activity, improve health, or reduce obesity.

Considerable attention has been given to improving physical activity assessment methods but progress has been hampered by limitations in the way that physical activity measures are used, scored, and interpreted. Many options are available for assessing physical activity, so it is important to appreciate and consider the relative advantages and disadvantages of the various measurement approaches. Decisions typically depend on the type of study or project being conducted as well as on the degree of precision needed for the assessment. However, consideration must also be given to the inherent challenges in collecting, processing, scoring, and interpreting physical activity data.

4. The physical fitness is a multi-dimensional construct and thus, there is no measure that can assess all facets of PA. Physical activity is the main component of daily energy expenditure and is the most variable among young people. Understanding its relationship with growth and development is of great importance for the health and well-being of children. Specific expertise may be needed to appropriately process and interpret data (particularly when using electronic monitoring devices). The various decisions and challenges involved can make it extremely difficult for researchers and practitioners to select, find, and use physical activity assessments effectively. Obtaining accurate assessments of physical activity is challenging in all populations but the issues are even further complicated when studying youth due to a variety of age and maturation effects.

The variability in body composition during development has important implications for activity intensity classifications based on METs and requires that cutpoints be adjusted for differences in resting energy expenditure that occur during growth. The MET was not intended to capture these differences, but interestingly, it has become a popular energy expenditure metric when establishing cut points or converting activity behaviors into estimates of energy expenditure or classifications of intensity. The simplicity of METs and relative ease for comparison across different subgroups of the population might well justify its use. However, researchers and practitioners are now more aware of the limitations of this metric and how it might affect activity classification and measurement of physical activity in general.

References:

Antropomotoryka


Journal of Kinesiology and Exercise Sciences


