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Review

Position statement on physical activity and exercise intensity terminology ☆

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Abstract

The terminology used for monitoring and promoting physical activity and exercise among health and fitness professionals varies considerably. There is a large array of descriptor terms reported in the literature and used in day-to-day practice and this inconsistency can be confusing for clients and practitioners alike. The variation in terminology also makes it difficult to track changes in activity patterns over time and across studies. There are also a range of objective and relative intensity cut-offs used to describe the same intensity descriptors. This position statement addresses the question of standardisation of physical activity and exercise intensity terminology and makes recommendations that should assist those undertaking research and prescribing physical activity/exercise as well as those clients who are receiving professional guidance.

Keywords: Exercise intensity; Exercise prescription; Physical activity patterns; METs; Energy expenditure

Contents

1. Introduction

Health and fitness professionals play important roles in helping to monitor and promote physical activity. Consequently the use of standard terminology related to physical activity and exercise among these professionals is important to ensure consistency of care and for collecting reliable data for research purposes.

Standard definitions of physical activity and exercise intensity are relevant to health and fitness professionals working in a variety of roles. This includes researchers working on the surveillance of physical activity and tracking trends

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over time, clinicians measuring health outcomes with activity prescription, and practitioners planning and guiding safe and effective exercise sessions.

There are also specific challenges and risks associated with exercise prescription such as when the exercise intensity exceeds an individual's physical capacity, or when a high relative intensity is prescribed in the absence of prior conditioning. These situations often need to be considered when working with people who have limited physical capacities, chronic illness or are engaged in rehabilitation programs.

This position statement addresses the question of standardisation of physical activity and exercise intensity terminology and makes recommendations that should assist those researching and prescribing activity as well as those clients receiving professional guidance. This, in turn, will assist the reliability of data collection on activity patterns and trends, and help in successful exercise prescription.

2. Categories of exercise and physical activity intensity

All physical activities result in energy expenditure ranging from the low levels of sedentary activities such as quiet sitting [generally referred to as 1 metabolic equivalent or 1 MET which is equal to 3.5 mL O_2/kg/min] to the extreme levels of high-intensity exercise for conditioned athletes [from 9 to over 20 METs]. Essentially, there is a continuum of rates of energy expenditure across the many forms of movement, occupational and leisure-time activities. For convenience, analytical and exercise prescription purposes these are often grouped into intensity categories, although the descriptor terms and metabolic cut-offs used in the literature vary considerably. Furthermore, the exercise intensity can be expressed as either an absolute measure, for example, heart rate or METs, or as a relative measure such as a percentage of maximal heart rate [$\%HR_{max}$ where HR_{max}, when unknown, is usually estimated as 220 − age].[1] These variations can lead to problems in measuring and comparing activity patterns, and tracking them over time. Such inconsistencies can also introduce elements of confusion among health and fitness professionals and their clients that may lead to inappropriate and potentially unsafe exercise routines.

This position statement proposes the use of the following five categories to reflect clusters of activities that place similar relative physiological stress [within category] on the exercising individual. The descriptors and cut-offs were

Table 1
Categories of exercise intensity and the subjective and objective measures [both absolute and relative] accompanying each category. The relative intensity measures such as % HR_{max}, %HRR [heart rate reserve = HR_{max} − resting HR] and $\%VO_{2max}$ [maximal oxygen uptake] will not always correspond to the same RPE among individuals nor will the ability of clients to exercise for a specific duration at each intensity since this varies depending on training status and other personal characteristics. Subjective measures are from Borg's RPE scales where C = category scale [6–20] and C-R = category-ratio scale [0–10] [7].

Intensity category	Objective measures	Subjective measures	Descriptive measures
SEDENTARY	< 1.6 METs < 40% HR_{max} < 20% HRR < 20% VO_{2max}	RPE (C): < 8 RPE (C-R): < 1	• activities that usually involve sitting or lying and that have little additional movement and a low energy requirement
LIGHT	1.6 < 3 METs 40 < 55% HR_{max} 20 < 40% HRR 20 < 40% VO_{2max}	RPE (C): 8-10 RPE (C-R): 1-2	• an aerobic activity that does not cause a noticeable change in breathing rate • an intensity that can be sustained for at least 60 minutes
MODERATE	3 < 6 METs 55 < 70% HR_{max} 40 < 60% HRR 40 < 60% VO_{2max}	RPE (C): 11-13 RPE (C-R): 3-4	• an aerobic activity that is able to be conducted whilst maintaining a conversation uninterupted • an intensity that may last between 30 and 60 minutes
VIGOROUS	6 < 9 METs 70 < 90% HR_{max} 60 < 85% HRR 60 < 85% VO_{2max}	RPE (C): 14-16 RPE (C-R): 5-6	• an aerobic activity in which a conversation generally cannot be maintained uninterupted • an intensity that may last up to about 30 minutes
HIGH	≥ 9 METs ≥ 90% HR_{max} ≥ 85% HRR ≥ 85% VO_{2max}	RPE (C): ≥ 17 RPE (C-R): ≥ 7	• an intensity that generally cannot be sustained for longer than about 10 minutes

chosen based on a combination of those most informative and easy to remember, and commonly used in the relevant literature [for both researchers and the general public]. The categories are 'sedentary', 'light', 'moderate', 'vigorous' and 'high' intensity activities as outlined in Table 1. These categories are ranked according to the energy demands and, therefore, represent the gradient in metabolic and neurohumoral responses during activity. These 'stress' responses are not linear as the intensity of exercise increases. Many physiological responses, or disturbances in homeostasis, show an accelerating pattern as intensity increases. Small increases in exercise intensity can lead to relatively large increases in the physiological and metabolic demands of the body. Typical stress responses that display an exponential increase with linear increases in exercise intensity include blood lactate levels,[2] pulmonary ventilation and respiratory rate,[3] stress hormones such as adrenaline and noradrenaline,[4] the redistribution of blood flow away from some non-active tissues,[5] and neuromuscular traffic.[6] These patterns of relative change are similar in all healthy people and are also reflected in the perceptual-cognitive sensation of exertion or physical effort. Furthermore, since there is a common relative intensity versus physiological stress relationship, it has formed the basis of various 'perceived exertion' scales such as the most popular Borg RPE scale.[7,8] The general relationship between activity intensity and the physiological or metabolic stress is illustrated in Fig. 1.

A range of category descriptors [or terminologies] for the progressively increasing activity intensities can be found in the literature. In a recent single issue of a leading journal, for example, 'sedentary' intensity was called 'very light' intensity, 'light' intensity was referred to as 'low' and 'resting' intensity, whereas 'vigorous'/'high' were also 'hard'/'very hard', 'intense' and 'strenuous'.[9,10,11] Others refer to 'very light' and 'light' activity as 'very weak' or 'weak' and to vigorous activity as 'heavy' whereas 'high' intensity has been called the 'strongest' intensity activity.[8]

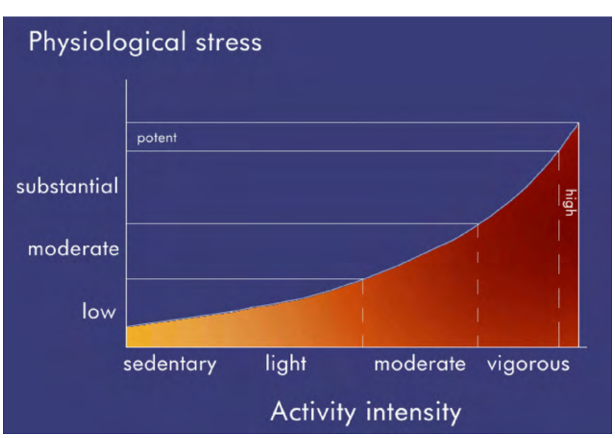

Fig. 1. The relationship between physical activity intensity and the physiological stress on the body. Activity intensity is categorised as sedentary, light, moderate, vigorous or high. These are aligned to physiological or metabolic parameters that indicate the relative stress at these intensities is best described as low [for sedentary and light intensities], moderate, substantial and potent, respectively.

To add further confusion the American College of Sports Medicine [ACSM] has published variations to their guidelines for exercise prescription in recent years. In their two most recent editions – the 7th and 8th editions of *ACSM's Guidelines for Exercise Testing and Prescription*,[1,12] – they list categories of intensity together with % HR_{max} cut-offs. Considerable variation exists between these publications and the 6th edition.[13] The hard [vigorous] activity cut-offs are 70–89% in the 6th edition and 77–93% in the recent editions of their guidelines. Moderate intensity is 55–69% and 64–76% HR_{max} in the 6th versus 7th and 8th publications, while very light is <35% and <50% HR_{max}, respectively. Many of the category cut-offs are different again from those recommended by the US-Surgeon General, although the category descriptors are all the same.[14]

Metabolic equivalents [METs], are multiples of resting metabolic levels. They are often used to quantify physical activities and set limitations, for example for those patients undergoing rehabilitation. A major difficulty with these objective boundaries for each category is the fact that individuals vary widely in their functional capacity. The relative intensity for specific activities,[15] for example 'leisurely walking' at 4.8 km h^{-1} [3.3 METs] or cycling at 20 km h^{-1} [8.0 METs], may differ considerably across the population and may be above the maximal capability of some individuals. This is especially true for different age groups and with variations in fitness. The MET values in Table 1, therefore, are most appropriate for the majority of healthy adults up to about 30 years. Objective cut-off measures for older adults or those with co-morbidities should be adjusted to accommodate the general decline in cardiorespiratory fitness that occurs with ageing. Aerobic fitness decreases by an average of about 8–10% per decade beyond 30 years.[16] Because of these limitations, the ordinal categories and their *relative* physiological/metabolic anchor points [cut-offs] are recommended when (1) describing patterns of behaviours or the time allocated to various groups of activities, and (2) prescribing exercise and other physical activities within zones that minimise risk of adverse events and optimise physiological adaptations for individuals. Exercise-related health benefits are generally proportional to the relative overload within individuals rather than for specific absolute metabolic workloads. However, absolute MET measures may be useful for estimating energy expenditure, particularly for lower-intensity activities that most people perform for long periods, in population-based surveys where questionnaire responses are converted to energy expenditure estimates, and when prescribing specific activities that may be done [or avoided] as part of a rehabilitation program.

Each of the five categories is listed below with additional detail about the typical activity types and patterns of adult behaviour included within their metabolic boundaries. A range of physical activities and their corresponding relative and absolute MET values are also illustrated in Fig. 2.

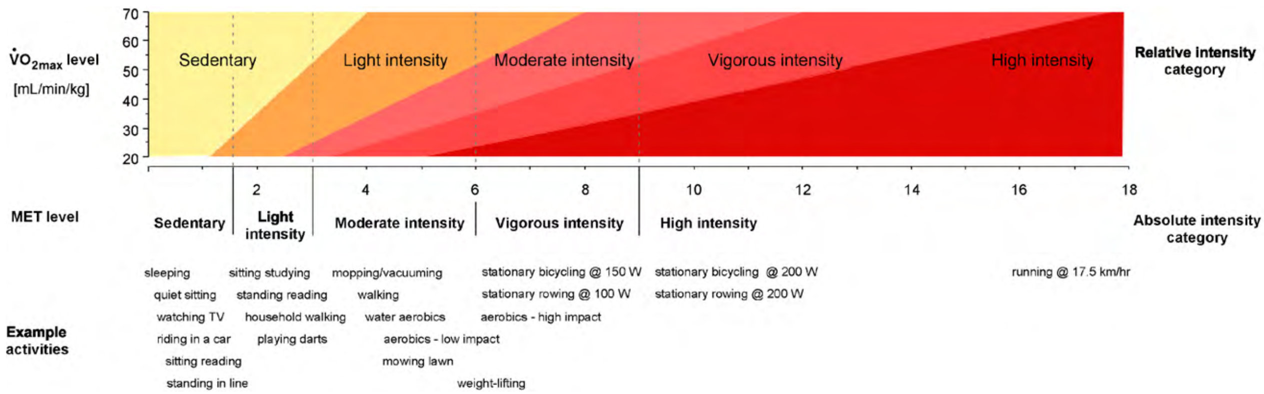

Fig. 2. The five categories of physical activity intensities are illustrated using both a relative intensity method across the top section [based on % VO_{2max} at the proposed cut-off levels] and the absolute MET values at the bottom. Also shown are example activities within each category using absolute MET cut-offs. The graph highlights the inconsistencies between the relative and absolute intensity ratings that may present when an absolute MET value is used to prescribe exercise. The relative intensity that this induces may vary considerably depending on the aerobic fitness level of the individual. For example, high-impact aerobics has an absolute MET level of 7 METs or a vigorous-intensity level using the absolute intensity scale. For people with an aerobic fitness score less than about 30 mL/kg/min this is a high-intensity activity while it may also be a moderate or even light-intensity activity for people with high aerobic capacities. Data have been used from two main sources [15,30].

3. Sedentary activity

Sedentary time is a relatively subjective term since the cut-off in intensity between sedentary and light activity levels has rarely been quantified. In general terms sedentary is derived from the Latin 'sedere' meaning 'sitting' so it usually incorporates almost all sitting-based activity. Pate and colleagues regard sedentary activities as having a metabolic equivalent level <1.6 METs.[17] There have been many studies to show that long-term sedentary behaviours are associated with a variety of health risks.[18,19] There are also recent studies that illustrate the two extremes of the activity spectrum may operate in different ways to alter risk factors and can therefore operate independently.[18,19,20] Research has shown convincingly that people who regularly perform moderate–vigorous physical activity exhibit numerous health benefits.[14,20] Consequently, despite reaching levels of moderate physical activity, some people who at other times undertake significant periods of sedentary activity may be blunting these [otherwise] positive benefits[21,22] or be overweight.[23]

Using questionnaires and recall methods to quantify the time spent in various categories of activity intensity is difficult. Trying to dissect out 'sedentary' activities from 'light' activities is equally problematic [even more so if the category 'very light' intensity is used]. Activities such as watching TV or riding in a car [1.0 MET], standing quietly in line [1.2 METs], or sitting reading [1.3 METs] are considered sedentary under the definition outlined in Table 1. However, sitting studying [1.8 METs], standing reading [1.8 METs], fishing [2.5 METs] or playing a musical instrument [2–4 METs] would not be sedentary.[15] Many people would consider sitting playing with children, fishing from a boat or standing reading to be sedentary activities, or would at least vary in their interpretation of these as sedentary behaviours. The most popular physical activity questionnaire in Australia – the Active Australia Survey [AAS] – asks subjects to identify the time spent walking, doing other moderate-intensity activities or undertaking vigorous activity.[24] If respondents reported doing none of these activities in their leisure time they are usually classified as insufficiently active rather than sedentary. More recently, surveys are beginning to ask specifically about time spent doing sedentary activities such as time spent sitting, reading, riding/travelling in [non-active] transport or in 'other' sedentary activities over the past week.[25,26] Hence the resolution of the AAS to specifically detect activities that would generally be classified as sedentary [<1.6 METs] is poor and many activities that involve sitting, for example at work, may be missed completely. The International Physical Activity Questionnaire [IPAQ] helps to overcome this problem by including a question on sitting activities.[26]

The most recent Australian national and state-based physical activity surveys indicate that between about 15 and 18% of the adult population report they are completely sedentary.[25,27,28] This level may be declining over the last 20–30 years of surveys from the highs of about 27% in the 1980s.[29] When gardening and occupational activities are included the proportion who are still completely sedentary drops to about 8–10% of the population.[25]

4. Light-intensity activity

Light-intensity activities include domestic or occupational tasks such as washing dishes, hanging washing, ironing, cooking, eating, working at a computer desk or performing other office duties.[15,30] Operationally, light-intensity activities are those where the metabolic equivalent is between 1.6 < 3.0 METs or the relative intensity is 40 < 55% HR_{max}.

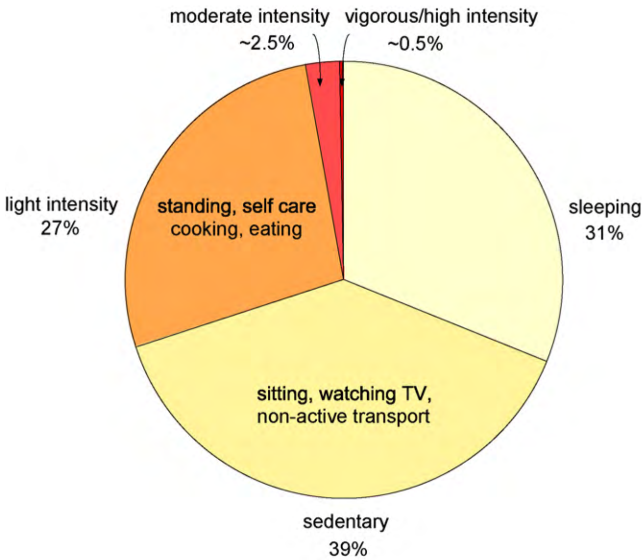

Fig. 3. The typical adult pattern of daily activities [percentage of a 24-h day] when categorised in terms of intensity level assessed using accelerometer counts. About 31% [7.5 h] is sleep, 39% [9.4 h] is spent in sedentary activities [sitting], 27% [6.5 h] in light activities and only about 3% of the 24-h day [43 min] is spent in moderate–high intensity activities. Data are indicative values only from several studies [9,21,22].

These activities have been shown to be the major determinant of variability in total daily energy expenditure[31] because they consume, on average, about 6–7 of the waking hours as illustrated in Fig. 3.[22] Other studies have also revealed associations between energy expended in non-exercise activities such as light-intensity household, garden and occupational tasks, and obesity risk,[32] and with other risk factors such as glucose control.[21] Physical activity surveys using questionnaires such as the AAS and IPAQ have not had the resolution to filter out and quantify light-intensity activities from the other intensity categories.

5. Moderate-intensity activity

Moderate-intensity activities range from 3 < 6 METs or have a relative intensity of 55 < 70% HR_{max}. The AAS describes moderate-intensity activity as either 'walking' [for a duration of 10 min or greater] or 'other activities' such as 'for example, gentle swimming, social tennis, golf'.[24] The IPAQ is the same but includes the following examples 'carrying light loads, bicycling at a regular pace, or doubles tennis'.[26] Subjects wearing accelerometers showed that only a small fraction of the total day in developed countries [approximately 2.5% or about 30 min] is spent undertaking moderate physical activities [Fig. 3].[9,22] Questionnaire responses for Australian subjects indicated the average level of self-report moderate activity was about twice this, or between about 60 and 80 min.[25,27,33] However, correlation coefficients relating minutes per day from physical activity questionnaires with minutes per day from directly measured accelerometer counts have been found to be relatively weak—modest for moderate-intensity activity and poor for vigorous-intensity movement.[9] The total moderate activity levels contribute only a small fraction of daily energy expenditure for most Australian adults and there is a skewed distribution across the population.

Despite these limitations, moderate physical activity is the category referred to in health promotion messages in numerous countries around the world. Physical activity guidelines such as those proposed by the US-Surgeon General, the joint guidelines by ACSM and the American Heart Association, and in the Active Australia campaign consistently recommend that adults achieve a minimum of 30 min of moderate activity on most, if not all days of the week for health benefits.[34] The reason for the focus on moderate activity is related to the effort-versus-benefit relationship. People who lead relatively inactive lives and [like a growing proportion of the population] have low occupational activity demands, achieving 30 min of moderate activity per day has been shown to result in health benefits.[14] The physiological stress of moderate activity, over the long term, results in biological adaptations that are favourable towards lowering major risk factors for chronic illness and the odds of premature death. Fig. 2 highlights several example activities in the moderate-intensity category.

Unfortunately, the larger national surveys in Australia showed that in 2000, more than half [54%] of Australians aged 18–75 years did not undertake moderate physical activity at the levels recommended to achieve health benefits.[35] This rose from 49% in 1997.[36] Data from the 1995, 2001 and 2004–2005 Australian National Health Surveys, together with many more-recent state-based surveys show these physical activity patterns have remained relatively unchanged over the past 15 years.[25,27,28,35]

6. Vigorous-intensity activity

Most people in developed countries perform very little vigorous-intensity activity on a typical day.[9,22] Perhaps this is due to the reason that, using absolute measures, it requires between 6 and 9 times the resting levels of metabolism [6–9 METs] and involves considerable homeostatic disruption in the physiological systems. Vigorous-intensity activity is defined in the AAS as physical activity which 'made you breathe harder or puff and pant—for example, jogging, cycling, aerobics, competitive tennis'; it has a relative intensity equivalent of 70 < 90% HR_{max}.[24] The IPAQ question is the same with slightly modified examples that include 'heavy lifting, aerobics, or fast bicycling'.[26] In fact, other than the occasional lifting or climbing activity, it is rare [although not unfeasible] for an occupation in a contemporary developed society to require any vigorous activity at all. Studies in the USA using accelerometers have shown the total time per day spent on vigorous activity is only a few minutes, and this is usually in very short intervals.[9]

The health benefits of regularly performing vigorous activity are irrefutable.[20] Numerous reports have identified additional health benefits for those undertaking vigorous activity relative to those performing light-moderate activity in a range of cross-sectional and prospective cohorts studies.[18,37–39] These results have been instrumental in shaping physical activity guidelines for health benefits. In the most recent update of the joint ACSM and AHA guidelines for those under 65 years, recommendation is made for doing vigorously intense cardiorespiratory activity 20 min a day, 3 days a week as an alternative to moderate-level intensity activity.[34] Questionnaire responses from repeat physical activity surveys in Australia show the median level of vigorous activity is consistently zero mins.[25] If vigorous or high-intensity activity is undertaken the relative stress and health benefits of performing these activities are recognised by weighting the time spent by two. These minutes are then added to the minutes of moderate physical activity to determine who achieves the threshold [for monitoring purposes of population risk] of 150 min of activity per week.[24] However, since vigorous-intensity activity presents substantial physiological stress to the body it should only be prescribed after a period of conditioning.

7. High-intensity activity

High-intensity activity has a relative intensity level of at least 90% HR_{max}. Using absolute measures, high-intensity activities are those requiring at least 9 METs. This rate of energy expenditure occurs very rarely in daily life. The Australian population averages for maximal oxygen uptake for age-and gender-specific groups,[16] show this level of metabolism is above the maximal capacity of an estimated 35% of adults aged 18–29 year, 45% for 30–39, and over 50% of the rest of the population, clearly supporting the use of relative intensity measures. Notwithstanding this limitation, high-intensity activities are still important within conditioning programs for young and conditioned athletes.

8. Summary

Researchers investigating patterns of physical activity behaviour, how people spend their time, the role of activity in energy balance, and how these variables trend over time and across regions need to standardise the way information is collected and analysed. Furthermore, there is also a need for greater consistency in terminology and intensity cut-offs for health professionals and their clients. This statement proposes five intensity categories and specific objective physiological and metabolic guidelines be used to help in these efforts. While technologies have improved our ability to quantify physical activities in either relative or absolute terms these methods are yet to be trialled in large population studies. This means we still depend on questionnaire-based data for tracking activity patterns over time. Questionnaires should, where possible, be designed to capture information on each of the intensity categories listed in Table 1 to improve the resolution of physical activity data. On an individual basis the new technologies are becoming more important tools in exercise prescription. Nevertheless, there is still the need to link the physiological/metabolic stress of activities to standardised, simple-to-use intensity categories such as those proposed.

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