Importance of Frequency, Intensity, Time and Type (FITT) in Physical Activity Assessment for Epidemiological Research

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ABSTRACT

Physical activity is a multi-faceted behaviour comprised of several components: frequency, intensity, time and type (FITT). Despite this understanding, there is currently a lack of knowledge regarding how the individual components of FITT influence chronic diseases. This is partly due to the tendency for researchers to focus on intensity via obtaining accurate measurements of energy expenditure. Although energy expenditure is an important consideration in the assessment of physical activity, it is only one component. Accordingly, future studies examining the association between physical activity and disease risk would benefit from examining all the components of FITT. Considering that all the components of FITT are modifiable, knowing their independent or combined influence on risk may provide valuable insight for future prevention interventions.

Key words: Motor activity; chronic disease; epidemiology

La traduction du résumé se trouve à la fin de l'article.

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Physical activity is defined as any bodily movement produced by the skeletal muscles that results in energy expenditure beyond resting expenditure.¹ Although this definition refers to both voluntary and involuntary movements, the assessment of physical activity is more commonly concerned with voluntary movement of the skeletal muscles. This is a multidimensional and complex behaviour that encompasses four components (FITT): *frequency* (of individual sessions), *intensity* (rate of energy expenditure), *time* (duration of an individual session), and the *type* of activity involved.² Despite the understanding that physical activity is a multi-faceted behaviour, there is currently a lack of knowledge regarding how the individual components of FITT influence chronic diseases. This is partially a result of the tendency for researchers to focus predominantly on factors that are amenable to objective measurements, which in recent physical activity research has translated into a focus on obtaining accurate measurements of energy expenditure.

Energy expenditure is a complex concept that is a result of multiple factors including posture, voluntary and involuntary physical activity, resting metabolic rate, and the thermic effect of feeding (the energy required in the digestion and absorption of food).³ Although energy expenditure is an important consideration in the assessment of physical activity, the methods used to produce accurate measurements cannot distinguish between the individual components of FITT. Considering that these four components are all modifiable, knowing their independent or combined influence on disease risk may provide valuable insight for future prevention programs.

For reasons of practicality, self-administered questionnaires are often the most feasible method of data collection for large population-based studies. The emphasis placed on gathering measurements of energy expenditure is demonstrated by the preference for

researchers to convert all raw data concerning the individual components of FITT into one single measure of metabolic equivalents (METs). This is a widely used physiological concept that expresses the energy cost of physical activity as a multiple of resting metabolic rate.⁴ All activities are assigned a MET value determined by the Compendium of Physical Activities; a reference list developed by Ainsworth et al. (2000),⁵ which is commonly used as the basis for quantifying data from physical activity questionnaires.⁶ However, the Compendium does not take into account individual differences such as percentage body fat, age, sex, environment, etc. In fact, according to the developers of the Compendium, the intent was to provide a classification system that standardized the MET intensities of physical activities reported in surveys, not to prescribe precise energy costs of physical activities conducted by individuals.⁵ In addition to not providing an accurate measure of physical activity, converting all data into a single MET value ignores the individual components of FITT, important considerations in the assessment of physical activity.

The focus placed on energy expenditure can also be seen in the priority researchers place on gathering objective measurement of physical activity via methods that directly measure heat production or loss (direct calorimetry), or those that indirectly measure heat production by measuring oxygen and/or carbon dioxide production in an attempt to validate self-reported measures of physical activity.⁷ Doubly-labeled water is considered the gold standard

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in the measurement of energy expenditure and is commonly used to validate other methods. However, it does not necessarily measure the true exposure of interest. As mentioned above, energy expenditure is a complex and multidimensional exposure comprising several factors; of these factors, physical activity only accounts for 15-30% of an individual's total energy expenditure. Nevertheless, doubly-labeled water measures *total* energy expenditure, and *activity-induced* energy expenditure is calculated based on the understanding that physical activity is the most variable component of energy expenditure. Physical activity-induced energy expenditure is determined by subtracting the resting metabolic rate from the total, and multiplying this value by 0.9. This fraction is based on the assumption that diet-induced energy expenditure is a constant fraction of 10% of a person's total energy expenditure. Alternatively, researchers convert physical activity-induced energy expenditure into a physical activity index by dividing total energy expenditure by one's resting metabolic rate.⁸ Both of these methods are problematic since resting metabolic rate is often based on the individual's body mass (versus being measured directly), while the assumption that diet-induced energy expenditure is a constant fraction of 10% presupposes that the individual consumes an average mixed diet that meets energy requirements.⁸ Clearly, this is not always the case, demonstrating that while the doubly-labeled water method may accurately measure total energy expenditure, it can only provide an estimate of activity-induced energy expenditure. Although there are other objective methods available in the assessment of activity-induced energy expenditure, such as portable metabolic gas systems which are worn while physical activity is being performed, relatively few validation or reliability studies on these devices have been published.⁹ Furthermore, while such devices may be more sensitive to the measurement of activity-induced energy expenditure, they are not able to distinguish between the different components of FITT.

Recent epidemiologic studies have begun to use accelerometry in the measurement of physical activity. Accelerometers are electronic motion sensors designed to respond to acceleration, and are considered the most objective method available in the measurement of frequency, intensity and time.⁷ However, accelerometers are not able to provide information regarding the *type* of physical activity being conducted, specifically with regard to activities that do not involve acceleration, such as weight lifting, climbing stairs, stationary cycling, etc. Furthermore, although accelerometers may provide accurate information regarding frequency, intensity and the amount of time spent in physical activity, it is up to the researchers to ensure that this information is analyzed (versus gathering measurements of the individual components only to combine them into one single measure in an attempt to provide a more accurate estimate of energy expenditure). Understanding the mechanisms behind each component is especially important since recent research suggests that the different components may influence different diseases. Using cancer as an example, physical activity involving abdominal movement may be influential in reducing the risk of developing colon cancer via an influence on gastrointestinal transit time.¹⁰ If this is proven true, different types of physical activity, such as cycling, may prove to provide a greater protective effect than other types of physical activity. As another example, weight-bearing exercises have been shown to be especially effective in pro-

tecting against osteoporosis by augmenting bone mineral during early adult years, and reducing the loss of bone following menopause in women.¹¹ On the other hand, intensity has been suggested to play a more influential role in hormone-induced cancers by decreasing endogenous hormone levels in both men and women.^{12,13}

If it is proven that the individual components of FITT influence different diseases and/or disease sites, this knowledge will allow researchers to develop better interventions to target specific health outcomes, or those at increased risk. Accordingly, it is vital in epidemiologic studies of chronic disease to evaluate physical activity as the multi-facted behaviour that it is. While there is ample research suggesting an association between increased physical activity and decreased risk of developing many chronic diseases, it is necessary to examine all the components of FITT to better understand the mechanisms behind the association.

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RÉSUMÉ

L'activité physique est un comportement multifacette composé de quatre éléments : la fréquence, l'intensité, la durée et le type (FITT). Bien que l'on s'entende sur ce point, on connaît encore trop peu l'influence de chacun de ces éléments sur les maladies chroniques. Cela s'explique en partie par la tendance des chercheurs à mettre l'accent sur l'intensité en voulant obtenir des mesures exactes de la force dépensée. La force dépensée est un important élément à considérer lorsqu'on évalue l'activité physique, mais il y en a d'autres. En conséquence, les futures études qui porteront sur l'association entre l'activité physique et les risques de maladie auraient intérêt à examiner tous les éléments FITT. Comme ils sont tous modifiables, le fait de connaître leur influence, indépendante ou combinée, sur les risques pourrait jeter un précieux éclairage sur les futures interventions de prévention.

Mots clés : activité motrice; maladie chronique; épidémiologie