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Variations in Energy Expenditure Throughout Life: A survey review

Variações no Gasto de Energia ao Longo da Vida: Uma revisão de pesquisa

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RESUMO

Diversos estudos têm investigado sobre as alterações que ocorrem no gasto energético ao longo da vida. De facto, da infância à velhice o ser humano passa por uma serie de transformações nos seus hábitos de vida, que provocam alterações de ordem física e fisiológica no organismo, o que pode influenciar o gasto energético dos indivíduos. Esta breve revisão teve como objetivo sintetizar os fatores determinantes para a alteração do gasto energético ao longo da vida particularmente durante a atividade física. Concluiu-se que o processo de senescência e os determinantes genéticos são fundamentais para a variabilidade do gasto energético ao longo da vida.

Palavras-chave: Fisiologia, Atividade física, Crianças, Adultos, Idosos

ABSTRACT

Several studies have investigated the changes that occur in energy expenditure throughout life. In fact, from childhood to old age, human beings go through a series of changes in their life habits, which cause physical and physiological changes in the body, which can influence the energy expenditure of individuals. This brief review aimed to synthesize the determining factors for the change in energy expenditure throughout life, particularly during physical activity. It was concluded that the senescence process and genetic determinants are fundamental for the variability of energy expenditure throughout life.

Keywords: Physiology, Physical activity, Children, Adults, Elderly

INTRODUCTION

In all of physiologic aspects, there are a tendency towards the incessant research for balance, and therefore, with regard to energy expenditure, it could not be otherwise (Wilmore & Costill, 2001). Advancing age from childhood to old age is accompanied by a trend towards a decline in average daily energy expenditure at the expense of less physical activity (Mendonça & Anjos, 2004). This fact is essentially due to changes in behavioral and social factors (e.g., increased workload in the progression of studies or professional career, and retirement period)(Bouchard et al., 2012). Allied to the aforementioned factors, there are others percussors that can contribute to a sedentary lifestyle, such as technological development and the reduction of outdoor spaces in urban centers, which results in a decrease in leisure opportunities to practice physical exercise, enhancing sedentary habits and the appearance of chronic non-communicable diseases (e.g., watching TV, playing video games using computers) (Buckworth & Nigg, 2004; da Silva et al., 2020; González-Gross & Meléndez, 2013; Oehlschlaeger et al., 2004). In fact, the structural changes incited by society minimizes physical effort physical effort, which is particularly problematic when combined with the innate tendency of the human being to save energy and reduce physical efforts to a minimum (Thivel et al., 2018). Despite the known negative health effects of physical inactivity, an increased morbidity and mortality of cardiovascular and metabolic organ has been widely reported in developed countries. (Cheval et al., 2018; Lee et al., 2016). For these reasons, there is an urgent need to promote healthy and active habits and lifestyles that can prevail from childhood to old age (Back et al., 2022; Branquinho et al., 2022; Palomäki et al., 2018; Rovio et al., 2018) and that may result in increased levels of physical activity in different populations (Azevedo et al., 2014; Foster et al., 2007; Guthold et al., 2018; Haase et al., 2004). However, the proportion of lifetime is a multifactorial phenomenon on the domain of physical activity promotion (i.e., training, leisure, work, locomotion, activities of daily living) (Kasser & Lytle, 2013; Roychowdhury, 2020). Furthermore, there are different parameters that must be taken into account in each age group, given that throughout life the human body undergoes a series of morphological and physiological transformations at all levels of the organism, which influences the energy expenditure spent in activities (Geist, 2013). Indeed, the ageing process and the consequent loss of autonomy in performing daily tasks presupposes morpho-functional changes that substantially alter energy balance and expenditure (Back et al., 2022). Thus, this survey review aims to synthesize the determining factors for the change in energy expenditure throughout life particularly during physical activity.

MATERIAL AND METHODS

2.1. Literature Search Strategy

To carry out this review, the available literature was investigated by searching the Web of Science, PubMed and SPORTDiscus electronic databases. Articles published in 2022 or earlier were considered. The search strategy consisted of search words that combined one of the two primary keywords ("physical activity" and "energy expenditure"), with a second keyword ("child's", "adults" and "elderly" using an Boolean operator. The inclusion criteria for these articles were: (1) relevant data on energy expenditure during lifetime. Studies were excluded if: (1) they did not include data relevant to this study according to the inclusion criteria; and (2) were conference abstracts. To assess the quality of the studies, a validated protocol was used (Sarmento et al., 2018). The articles and books were screened based on the evaluation of the title and abstract. All articles or books that did not focus on the investigation were excluded. In total, 148 articles were considered relevant for this review. All articles were read in detail and evaluated for relevance and quality by two senior researchers with experience and relevant publications in the field. All articles that did not meet the criteria were excluded. After this procedure, 54 articles remained for analysis (Figure 1).

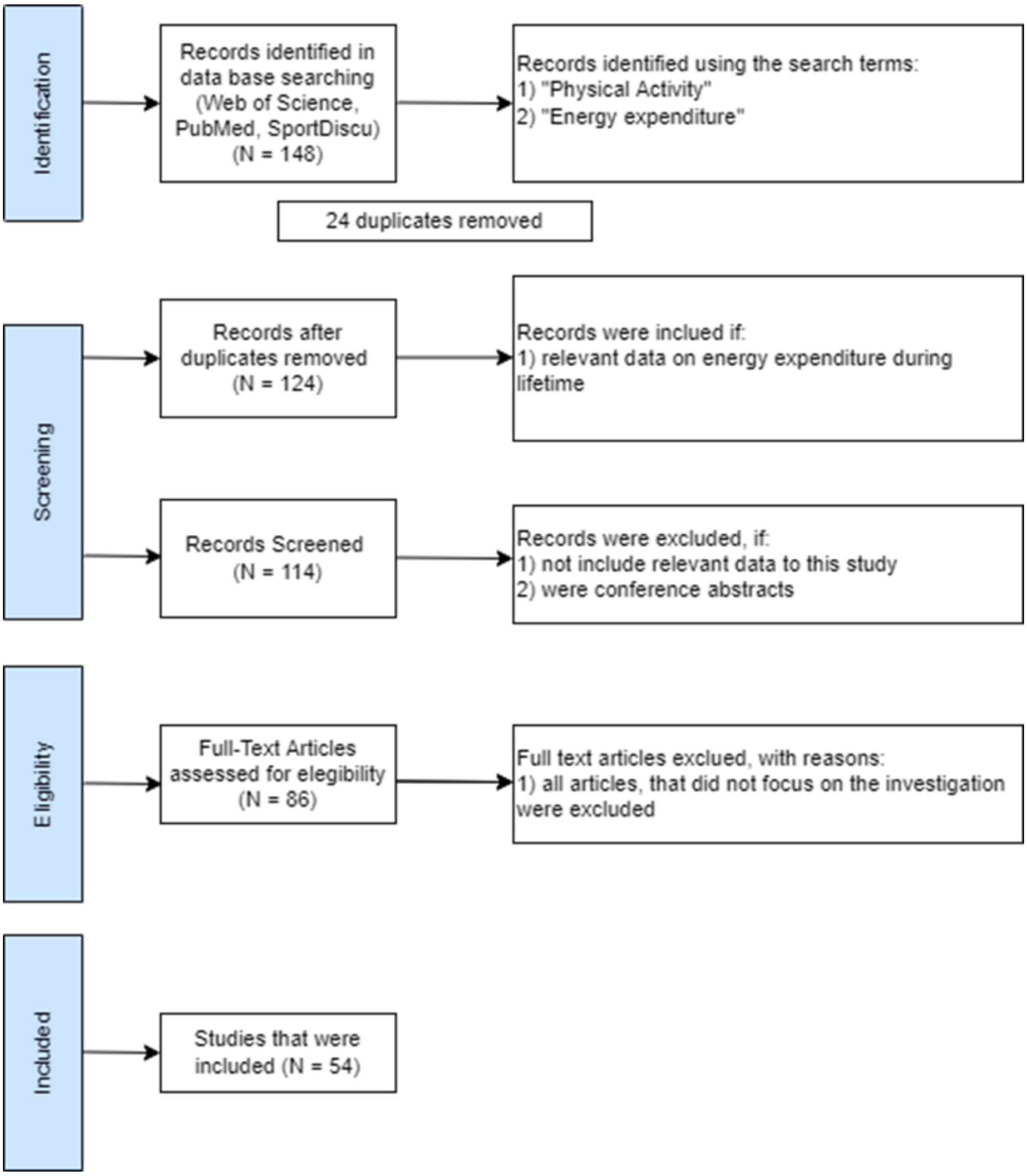

Figure 1 – Flow diagram adapted from PRISMA 2009 (Banno et al., 2018)

THE ROLE OF PHYSICAL ACTIVITY IN ENERGY EXPENDITURE

Physical activity was previously defined (Caspersen et al., 1985) as any bodily movement produced by skeletal muscles that results in energy expenditure above the resting level, assuming itself as a determining factor in health and motor performance skills (Branquinho et al., 2022; Forte et al., 2022; Silva et al., 2022; Sortwell et al., 2022). The energy expenditure induced by physical activity is fundamentally determined by the type of movement, body size, and spatio-temporal environmental constraints, with more energy required to move a large body compared to a small body, which is why obese people generally move less than in people. Previous evidence suggests that energy expended can be divided into 3 components (Pan et al., 2021; Rennie et al., 2005; Salbe et al., 2002): i) basal metabolic rate or basal metabolism which is characterized as the minimum amount of energy required by the body to perform physiological functions and which represents approximately 50 to 70% of the total energy expended per day; ii) thermic effect of food that is directly related to the digestion, absorption, transport, metabolism and storage of food ingested daily and which represents approximately 10% of the total energy expended per day; iii) energy expended through physical activity (i.e. spontaneous and/or voluntary) which represents approximately 20 to 40% of the energy expended daily. In this sense, the proportion of each of the components varies according to the regularity and intensity of physical activity, leaving the body to balance the energy expenditure by alternating between the three components (i.e., basal metabolism, thermic effect and energy expenditure during physical activity (Hill, 2006; Hill et al., 2012).

OTHER FACTORS THAT INFLUENCE ENERGY EXPENDITURE

In early life, energy requirements are essentially determined by growth and energy used to maintain biological systems (i.e., human body) (de Bruin et al., 1998). It is important that physically active children and adolescents consume enough energy and nutrients to meet their needs for growth, tissue maintenance and higher motor performance with a cognitive and physical demands increases with repercussions in the energy expenditure (Miles, 2007). The participation of children and adolescents in exercise and sports activities is important for the growth and development process, which must be periodically evaluated (Juzwiak et al., 2000; McCarron et al., 2010; Sharma et al., 2014). A physically active child's energy needs a less daily food intake, leading to growth rate, age, and physical activity (Behm et al., 2008; Boreham et al., 2004; Steen, 1996). However, the total daily energy expenditure increases by about 15% until adulthood, and this change is directly related to the increase in the individual's body size (Donahoo et al., 2004).

The variability in energy expenditure between children and adults was investigated, and the evidence suggests that children need more energy compared to others age groups, and methodological characteristics of the activities such as intensity, duration (volume), frequency, and density may be determinant (Bar-Or, 2000; Dollman et al., 2005). In addition, the energy cost of walking and running, if calculated per kg of mass, is higher in children than in adults. In the youngster children (i.e., early childhood), the greater the relative energy cost with variations up to 30 % per kg when compared to adolescents and adults (Davies, 1980). This higher energy expenditure is essentially linked to the lack of coordination between the agonist and antagonist muscle groups, which increases the energy requirements during childhood (Damiano et al., 2000; Frost et al., 1997). On the other hand, physical inactivity during adolescence is a prominent potential source of energy imbalance, causing variations in energy reserves, especially when energetic depletion exceeds the energy expenditure. Consequently, this mechanisms can lead to weight gain and consequently obesity in the medium to long term (González-Gross & Meléndez, 2013; Kumanyika et al., 2008). There are also other biological, behavioral, endocrine, metabolic and genetic factors that can affect energy expenditure and balance (Berthoud, 2004; Schneider, 2004; Spiegelman & Flier, 2001). Thus, it is essential that the practice of physical activity is stimulated by parents and pairs. In this regard, previous evidence suggests that fathers influence their children at a genetic and behavioral level. However, in a different way between father and mother, given that the father's BMI is related to body fat while the mother's lifestyle seems to be associated with children's physical activity (Kontogianni et al., 2010). Particularly during adulthood, there is a need to increase physical activity levels, as well as to carry out greater planning and control of the energy intake, to avoid deficits that can result in serious pathologies. In adults, the variation in total energy expenditure is only 7% in terms of physical activity levels (Pontzer et al., 2016).

Finally, in the elderly, there is also a reduction in the level of regular physical activity practice, leading to a decrease in lean body mass, bone density and balance. Indeed, it is the extreme importance to promote the practice of physical activity for the prevention of physical and mental diseases, as well as to provide a better quality of life. The energy needs for all daily activity shows a negative age-related evolution, with a more recurrence in men. Chronic diseases and disabilities increase with age, affecting more than 60% of people over 75 year and limiting activities in about half of them. Recent evidence indicates that sedentary behaviors represent a large part of their daily life in elderly people, with an average of 9.4 hours of inactivity and reduced activity (Smith et al., 2015). Even more, in elderly people aged 90 years and over, the energy expenditure of men undergoes significant changes while that of women does not. These changes seem to be related by the senescence process such as the decrease in lean mass, both in men and in women, however the basal metabolic rate only shows significant changes in men (Cooper et al., 2013).

CONCLUSIONS AND SUGGESTIONS FOR FUTERE RESEARCH

Current survey review emphasizes the variation of the energy expenditure and balance throughout life, demonstrating that the physical activity levels, the senescence process and genetic determinants plays a key role in the energy expenditure variability. In future research, a meta-analysis between energy expenditure, sedentary behavior and physical activity levels throughout life should be added to determine the effective dose-response for the prescription of physical exercise in each age group.

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