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■ Review Article

Physical Inactivity, Sedentary Behavior and Chronic Diseases

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New research into physical activity suggests that it is no longer sufficient just to meet minimum levels recommended by health guidelines in order to reduce cardiovascular risk. Both physical inactivity and sedentary behavior have their own health hazards and need to be addressed separately, in order to explore their different deleterious mechanisms. The aim of this review was to define and to characterize both concepts, and their relationship with major non-communicable chronic diseases. A PubMed database search was undertaken, using the following key words: physical activity, physical inactivity, sedentarism, sedentary behavior, and non-communicable chronic disease. This literature review provides an updated view on physical inactivity and sedentary behavior, and reevaluates their prevalence and association with major non-communicable chronic disease.

Keywords: Exercise; Sedentary Lifestyle; Chronic Disease; Public Health

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INTRODUCTION

The terms 'physical activity,' 'exercise,' 'physical inactivity,' 'sedentarism,' and 'sedentary behavior' have been defined and interpreted differently throughout history.

Caspersen et al.[1] defined 'physical activity' as any bodily movement produced by skeletal muscle that requires energy expenditure, and 'exercise,' as a subset of physical activity. Exercise involves a planned, structured, and repeated behavior aimed to maintain or improve components of physical fitness. These definitions remain in popular use.[2]

One method to estimate the intensity of physical activity more accurately is by applying the metabolic equivalent method (MET). One measure of MET corresponds to the level of energy expenditure while resting quietly. Thus, physical activity may be classified as of light-intensity (<3 METs), moderate-intensity (3–6 METs) and vigorous-intensity (>6 METs) physical activity.[3]

Currently, a variety of recommendations exists to meet the minimum requirement for physical activity. Most of these recommendations indicate that individuals need to engage in moderate or vigorous intensity physical activity for a certain amount of time per week. At least 30 minutes of moderate-intensity physical activity, five days per week, or 20 minutes of more intense physical activities, 3 days per week, is recommended, for example.[4,5] The World Health Organization[2] recommends that adults aged between 18 and 64 years should accumulate at least 150 minutes of moderate-intensity aerobic physical activity throughout the week, or undertake at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week, or perform a combination of both forms of physical activity.

The use of the terms 'physical inactivity,' 'sedentarism' and 'sedentary behavior' has been controversial and some authors have suggested that it is essential to refine their definitions.[6,7]

One of the first attempts to address the emergence of a health crisis from a physical-inactivity perspective was Booth et al.,[8] who introduced an evolutionary explanation related to thrifty genes for an unhealthy sedentary population. Hamilton et al.[9] reiterated that sedentary behavior involves all activities with low levels of metabolic energy expenditure. They highlighted 'too much sitting' as an important sedentary behavior leading to differing health hazards on metabolism, in relation to the lack of exercise.[9,10] Ten years after Booth's article, a call for scientists to explore the consequences of sedentary behavior, as an independent metabolic risk factor, was still being made.[10,11]

An accurate classification of subjects, according to their total daily activities, is essential. This can be illustrated by objectively measuring physical activity. Pate et al.[7] compared accelerometer data from two subjects with different patterns of physical activity. First, they evaluated subject A, who did not meet the recommended levels of physical activity, but was engaged in low-intensity physical activity for 75% of his day, with 25% of his daily activity defined as sedentary behavior (≤1.5 METs). Secondly, they evaluated subject B, who met the recommended levels of physical activity, but spent 70% of the day in sedentary behaviors. The authors concluded that subject A had a higher energy expenditure level than subject B (26.3 METs and 23.6 METs, respectively) despite the latter being normally considered as 'active' by most studies.[7]

The development of sedentarism as a research field has been complex, since two working definitions currently exist, namely one definition used by those studying the effects of accumulating sedentary behaviors (mainly reported within biology and health literature); and another definition used by those who define 'sedentary behavior' as not engaging in minimum levels of physical activity (mainly reported within sports and exercise literature).

Aware of inconsistencies in the terminology, the Sedentary Behavior Research Network (SBRN) proposed, in 2012, a definition of sedentary behavior as any waking behavior with an energy expenditure of ≤1.5 METs, while in a sitting or reclining posture. The term 'physical inactivity' was described as performing insufficient amounts of physical activity, that is, not meeting specified physical activity guidelines.[12] Despite some dissenting views,[13] an increasing number of researchers agree with the SBRN definition.[14-16]

THE PROBLEM OF NON-COMMUNICABLE CHRONIC DISEASES

A chronic disease is slow in its progression and long-lasting.[17] The incidence of chronic disease has increased dramatically in the last century, and are considered to be an underestimated epidemic.[8,18,19] It is well known that obesity rates have risen dramatically over the last few years. In 2008, 34.3% of men and women over 20 years of age had a body mass index (BMI) of ≥25 kg/m^2, globally.[20] It is estimated that, from 1980 to 2013, the prevalence of overweight and obese men and women has increased from 28.8% to 36.9%, and from 29.8% to 38%, respectively. Similarly, it was estimated in 1998 that the worldwide prevalence of diabetes in adults had been 4.0% in 1995, and that this was expected to rise by 5.4% by the year 2025.[21]

Finally, in 1999, 34% of all worldwide deaths in women and 28% in men were related to cardiovascular disease (CVD).[22] More recent data shows that one-third of worldwide deaths are due to CVD and this figure is expected to increase.[23]

THE PROBLEM OF PHYSICAL INACTIVITY

In 2011, a study estimated that 1 in 5 people are insufficiently physically active. The sample recruited almost 300,000 individuals older than 15 years, from 76 different countries.[24] Booth et al.[8] suggested that the battle against chronic disease is inefficient due to an underestimation of the reality of the problem, and the emphasis is directed toward treatment strategies instead of preventative strategies.

Individuals engaging in light, moderate or vigorous physical activity had significantly lower risk for CVD mortality, regardless of their metabolic risk factors.[25] Conversely, physical inactivity resulted in a gain of abdominal and visceral fat.[26] In addition, physical inactivity has been associated with a higher risk of type 2 diabetes, regardless of age, sex,

ethnicity, or BMI.[27] In fact, the two major risk factors associated with type 2 diabetes are obesity and physical inactivity.[5] Evidence shows that the prevalence of diabetes is higher in obese, overweight and physically inactive individuals, and physical inactivity is independently related to an increased risk of each of these diseases.[28,29]

In Canada, physical inactivity represents 3.7% of the overall health care costs.[30] In China, more than 15% of both medical and non-medical costs are attributable to physical inactivity, per year.[31]

The effects of small changes in physical inactivity habits are remarkable. In Australia, the benefits of reducing physical inactivity by 10% represent a cost saving of 0.19% of total annual health expenditure.[32] In people aged ≥70 years, low-intensity physical activity at least once a week is associated with a reduced risk for type 2 diabetes, compared with those physically inactive.[33]

Clearly physical inactivity is a determinant for health. However, recent evidence supports the fact that both physical inactivity and sedentary behavior contribute to the global burden of chronic disease, as discussed below.

THE PROBLEM OF SEDENTARY BEHAVIOR

Several studies have explored the relationship between diverse sedentary behaviors and CVD. For example, Warren et al.[34] found that men who reported being in a car for more than 10 hours per week had an 82% greater risk of CVD mortality compared to men who reported fewer than 4 hours per week. Also, it has been reported that one additional hour of sedentary activity increases the risk of being overweight (13%) and developing high abdominal fat (26%).[35]

The effects of different leisure-time sedentary behaviors on obesity have also been studied. In a Canadian population study, the prevalence of obesity was significantly higher in people who watched television for more than 21 hours per week, and lower in people who watched television for fewer than 5 hours per week (from 25% to 14% in men and from 24% to 11% in women), regardless of leisure-time and physical activity.[36] An increase of 2 hours per day in watching television was related to a 14% higher risk of developing type 2 diabetes. Moreover, an increment of 2 hours per day in time spent seated at work was associated with a 7% increase in developing diabetes.[37]

Recently, the National Heart, Lung and Blood Institute, the National Institute on Aging, and the Office of Disease Prevention of the National Institutes of Health, assembled a panel of expert scientists to discuss relevant issues in the field of sedentary behavior and to identify research priorities. Discussion meetings were summarized into four areas; epidemiology, physiology, intervention strategies, and research strategies about sedentary behavior.[38-42] This demonstrates a growing institutional scientific recognition of this topic.

CONCLUSION

Current trends in the study of physical activity and inactivity merit close attention. There is growing evidence to suggest that there is a potential risk threshold for health, related to the degree of activity or inactivity. On the one hand, there is an optimal amount of time spent in physical activities to promote favorable health effects, while on the other hand, there is an optimal amount of time spent in sedentary behavior, beyond which developing chronic disease is more likely. The clear message is that to be physically active is not enough, but one also needs to avoid too much time spent in sedentary behaviors.

A more complete physiological understanding of the implications for health of the physical activity continuum is urgently needed. Both physical inactivity and sedentary behavior contribute to the burden of chronic disease. It has been proposed that future investigation designs should attempt to include examples of both sedentary conditions and physically inactive conditions, in order to establish a global perspective about the specific contribution of each one to chronic disease.[42]

To achieve this goal, methods should include both subjective and objective measurement tools. Objective measurements, such as accelerometers, provide more accurate information about patterns of physical activity, thereby reducing measurement error. However, objective measurements cannot account for the specific domain of sedentary behavior, such as watching television, playing video games, or being seated at work.[39] Therefore, a global assessment needs to incorporate self-report data from subjects in addition to objective measurements.

Future research needs a new approach to focus on the appropriate use of these assessment methods to gain a better understanding of the impact of sedentary behavior and physical inactivity for global population health. This is necessary because sedentary behavior and physical inactivity represent two different conditions with unique and differing underlying biological mechanisms. Once this new approach is applied, more effective intervention strategies can be proposed.

The primary interest of research studies has been centered on the positive health benefits of exercise as a gold standard medicine. Better understanding of the detrimental effects of both physical inactivity and sedentary behaviors can also assist in promoting positive health outcomes.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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