Sedentary behaviour: redefining its meaning and links to chronic disease

Sedentary behaviour, characterized by excess sitting, is a growing public health problem across the whole population, from the young and healthy to elderly and infirm. This article gives an overview of sedentary behaviour as a chronic disease risk factor in its own right and discusses possible solutions.

Among most non-communicable chronic diseases that account for the large majority of disease burden in the developed world, there is one common denominator: physical inactivity. Large amounts of research evidence accumulated over the last 50 years or so suggest that lifestyles incorporating regular moderate to vigorous physical activity can prevent or treat no fewer than 30 chronic conditions including coronary heart disease, stroke, some types of cancer, type 2 diabetes, depression, anxiety, erectile dysfunction, hypertension, arthritis, asthma… and the list could go on. Currently, 39 official clinical sets of guidelines for prevention or treatment of chronic disease in the UK include advice to increase the patient's physical activity (Weiler et al, 2011).

Despite the extensively demonstrated importance of physical activity for health, there is presently limited corresponding action by public health and clinical practice to use this powerful medicine. In addition to physical activity, considerable attention has been diverted to the study of sedentary behaviour over the last decade, i.e. to those behaviours that are characterized by sitting, such as watching TV, using a computer or driving. Such activities occupy most of an adult's day in developed economies, as modern lifestyles are characterized by ubiquitous opportunities to be sedentary (i.e. to sit) during work, commuting and domestic life.

There is an ongoing trend for reductions in manual and increases in non-manual occupations and, for example, it is estimated that in England the percentage of occupations classified as manual decreased from 46% in 1991–2 to 40% in 2004 (Stamatakis et al, 2007). Fifty-six per cent of working English men and 50% of women reported that they spend more than 5 hours a day sitting while at work (Joint Health Surveys Unit, 2009). These amounts of sitting are in addition to, on average, 6 hours of TV watching and other leisure time sedentary pursuits a day (Joint Health Surveys Unit, 2009) as well as sitting time during motorised commuting. In a nutshell, technological advances and the structure of modern life have made sitting a seemingly unavoidable habit for most of us. Low levels of daily movement are not only relevant to the general healthy population, but also to clinical patient groups and the elderly. The marked sedentariness of hospitalized patients is well documented, and data have also demonstrated that the elderly spend the majority of their day sitting (Davis and Fox, 2007; Harris et al, 2009).

Consistent evidence over the last few years suggests that sitting is an independent entity and not simply the opposite of physical activity. An example illustrating the possible independence of these two concepts (sedentary behaviour compared with lack of physical activity) is an adult who routinely walks briskly for 30–40 minutes a day during the week and plays sports for 2 hours every weekend but spends the rest of his/her day sitting in front of a computer, sitting during meetings, driving and watching TV or DVDs in the evenings. While such a pattern is relatively common among those who do some moderate to vigorous physical activity (approximately 70% of UK adults) (Joint Health Surveys Unit, 2009) it would be difficult for a health professional to answer the questions: 'Is this an active or inactive patient?' or 'Does this patient undertake enough physical activity for prevention of major chronic disease and/or maintenance of adequate physical functional health?' Such a patient comfortably meets the current physical activity public health recommendations (the equivalent of 150 minutes of moderate intensity or 75 minutes of vigorous physical activity a week) (O'Donovan et al, 2010) but at the same time spends the large majority of the day sitting, the posture that defines a sedentary individual.

This article gives an overview of sedentary behaviour as a chronic disease risk factor in its own right and discusses possible solutions. The focus of this overview will be cardiovascular disease and metabolic risk since cardiometabolic conditions account for the majority of the chronic disease burden in the westernized world.

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Historical context of physical activity, sedentary behaviour and health

Ancient Greeks placed great emphasis on exercise as a means of physical, spiritual and mental improvement. The Greek physician and teacher Hippocrates (c. 460–370 BC), who defined many of modern medicine's principles, was a great advocate of balanced physically active lifestyles. Another ancient Greek physician, Galen (Aelius Galenus, c. 200–129 BC), recognized the benefits of moderate intensity exercise for physical and mental health but objected to the physical strains associated with vigorous exercise which he considered harmful. Following the complete disregard of human 'body culture' during the Christian church-dominated Dark Ages, Galen's views that vigorous exercise is harmful persisted throughout the 19th century. It was not until 1912 that the idea that exercise is not harmful started to emerge, and this idea was eventually confirmed in 1951 following a major review of the literature (MacAuley, 1994).

The origins of modern physical activity research lie in the seminal studies led by Jerry Morris published in the 1950s (Morris et al, 1953). Following strenuous resistance by the medical establishment rejecting the concept that exercise could possibly protect against heart disease (MacAuley, 1994), Morris' ideas that physical activity is an integral part of the body's defence eventually gained general acceptance over the following 40 years. Ironically, Morris' studies were about sedentary behaviour as the comparisons in coronary heart disease rates were made between the active ticket conductors and the sedentary bus drivers. Nevertheless, the focus of physical activity research and health promotion until the end of last century remained on moderate to vigorous intensity activities (such as brisk walking, aerobic classes, running, cycling and competitive sports).

Defining sedentary behaviour

In terms of intensity, human movement can be characterized by metabolic equivalents (METs), defined as the metabolic rate (and therefore the rate of energy consumption) during a specific physical activity with reference to the metabolic rate at rest, and is generally categorised as sedentary (<1.5 MET), light (1.5–3 MET), moderate (3–6 MET) and vigorous (>6 MET) (Ainsworth et al, 2000). A large body of evidence has established that regular moderate to vigorous physical activity is associated with decreased risk of many chronic conditions, including coronary heart disease, diabetes, certain types of cancer and obesity (Warburton et al, 2006). While the root of the term 'sedentary' is the Latin 'sedere' (sit), terms like 'sedentary behaviour' and 'inactivity' have been used widely to describe a lack of health-enhancing moderate to vigorous physical activity. Such a use of the word sedentary does not differentiate between light intensity activity and actual sedentary time, as characterized by activities that involving mostly sitting, such as motorised transportation, watching TV or using a computer (Pate et al, 2008).

The term 'non-exercise activity thermogenesis' was first introduced approximately a decade ago and referred to energy expenditure through habitual and unstructured daily physical activity of mainly light intensity, e.g. moving about and fidgeting (Levine et al, 1999). Initially it was proposed that substantial body weight control benefits could be achieved by substituting sedentary time with non-exercise activity thermogenesis, even in the absence of moderate to vigorous physical activity (Levine et al, 2006).

More recent investigations expanded on this idea by specifically examining the links between sedentary behaviour and health with studies showing that, even among individuals who meet the moderate to vigorous physical activity guidelines, important, detrimental associations of sedentary time exist with all-cause and cardiovascular mortality (Dunstan et al, 2010; Stamatakis et al, 2011), waist circumference and body mass index (Stamatakis et al, 2009), glucose (Healy et al, 20007), blood pressure (Jakes et al, 2003), lipids, and the metabolic syndrome (Chang et al, 2008). The adverse consequences of sedentary behaviour are not limited to adults and it has been suggested that it threatens children's physical (Ekelund et al, 2006; Rey-López et al, 2008) and mental health (Hamer et al, 2009), independently of moderate to vigorous physical activity. The emergence of such evidence suggests that sedentary behaviour should be treated as an independent risk factor for cardiometabolic disease that is not simply the opposite of moderate to vigorous physical activity.

Possible mechanisms

The proposed independent benefit of non-exercise activity thermogenesis on weight control involves low but almost constant expenditure of energy through low-intensity physical activity during waking times (Levine et al, 1999, 2006). The mechanisms accounting for the detrimental health effects of excess sitting remain largely unknown, although one proposed mechanism is the dramatic decrease in activity of the lipoprotein lipase enzyme (by some 80–90%) during sitting compared to standing or ambulating (Hamilton et al, 2007). Reduced lipoprotein lipase activity is causally linked to coronary heart disease, mainly through impairment of local lipid metabolism in the capillaries (Hamilton et al, 2007). It has been suggested that moderate to vigorous physical activity does not have marked effects on lipoprotein lipase activity compared to light activities such as standing (Hamilton et al, 2007), which provides a mechanism whereby sitting could plausibly increase cardiovascular disease risk, independently of moderate to vigorous physical activity.

Moderate to vigorous physical activity is thought to benefit the cardiovascular system through different

mechanisms, including anti-inflammatory benefits, several improvements in endothelial function and lipid profile, and blood pressure lowering (Hamer and Stamatakis, 2009).

Possible solutions

There may be considerable health hazards associated with lifestyles and occupations that involve prolonged periods of sitting and these risks may be over and above a lack of moderate to vigorous physical activity. Since modern life offers plenty of opportunities to be sedentary, it is important to identify feasible interventions to mitigate any such sedentary-related health hazards. Such an intervention could involve taking breaks from sitting (Healy et al, 2008). Breaking up sedentary time regularly is associated with lower adiposity, improved postprandial glucose control and reduced triglyceride levels (Healy et al, 2008).

In addition to the known benefits of moderate to vigorous physical activity, even light intensity activities are beneficially and independently associated with such biomarkers. Preliminary laboratory studies suggest that intermittent (2 minutes every 20 minutes) bouts of light intensity activity (slow walking) during long periods of TV watching are beneficially associated with reduced glucose levels and that the acute improvements associated with light intensity activity are comparable to those resulting from moderate intensity activity, such as walking at 6 km/hr. Such interventions may also be feasible in the hospital setting. For example, in a study of hospitalized type 2 diabetic patients, brief advice about 'taking a walk instead of staying seated' led to a 50% increase in objectively measured activity and a further 50% increase if the advice was coupled with the use of a pedometer (Pezzino et al, 2010).

KEY POINTS

- Historically, public health and clinical advice has focused on moderate to vigorous intensity physical activity, e.g. walking briskly, running, cycling, sports.
- Sedentary behaviour (characterized by activities involving sitting, e.g. TV watching, driving or sitting in a car, working in a computer) is not simply the opposite of physical activity.
- Modern lifestyles entail few opportunities to be physically active and an abundance of opportunities to be sedentary.
- The majority of the western population spend most of their waking hours in sedentary activity, sitting down. There is also marked sedentariness in hospitalized patients, clinical groups and the elderly.
- Prolonged sitting is associated with cardiometabolic risk factors and heart disease, and this association may be independent of participation in physical activity.
- Subtle lifestyle changes that incorporate taking active breaks from sitting may alleviate some of the detrimental effects and present a promising public health intervention.
- It is imperative to find cost-effective approaches to make movement the easy option for both healthy individuals and patients.

If a causal link between sitting or total sedentary time and cardiovascular disease is established, clinical and public health recommendations should explicitly address sitting in addition to physical activity. Since only a minority of adults in western populations participate regularly in sport and exercise activities (Stamatakis and Chaudhury, 2008), it may be possible to reduce the risk of non-exercise participators by restricting sitting time and increasing non-exercise activity (e.g. standing and ambulating) throughout the day. There is no conclusive evidence comparing the feasibility or long-term effectiveness of interventions designed to increase formal exercise *vs* decreasing sitting behaviour during the day. However, the latter approach may be more promising in terms of long-term adherence as it will involve more subtle lifestyle changes and fewer of the commonly cited barriers for joining a sporting or lifestyle exercise programme (Allender et al, 2006). This approach is also much more feasible in clinical settings where patients are too ill to undertake any form of structured exercise, but may benefit from reducing their sitting time.

Conclusions

Modern lifestyles entail few opportunities to be physically active and an abundance of opportunities to be sedentary. Evidence to date suggests that both low levels of physical activity and sedentary behaviour are detrimental to health in their own right. It is therefore imperative for modern medicine, public health and health policy to find ways to both promote physical activity and discourage sedentary behaviour. This will not only involve action aimed at individual patients, but alteration of the physical environment in each and every domain of life. **BJHM**

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