The sedentary patient

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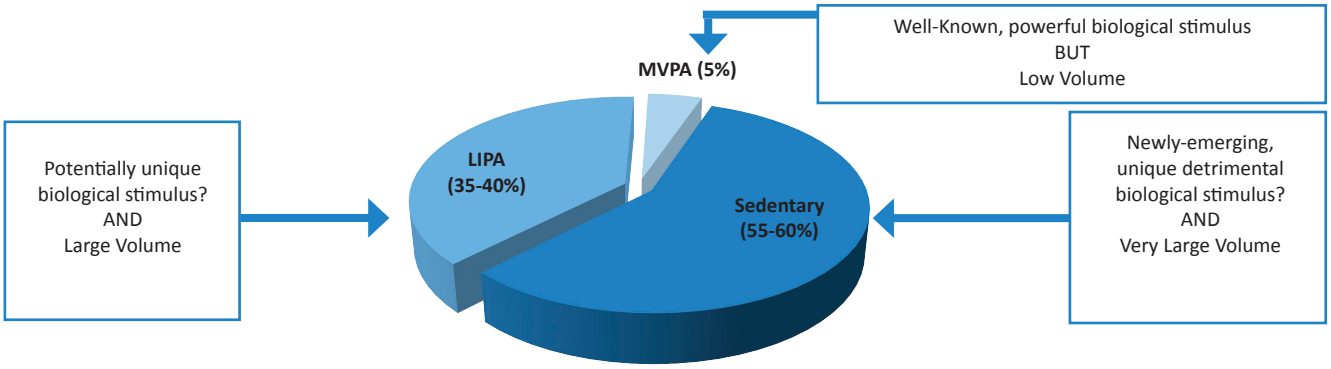
Introduction

The importance of regular physical activity for health and longevity is evident, even with traditional risk factors and genetic factors accounted for. Public health guidelines subsequently promote 150 minutes of weekly exercise of at least moderate intensity. More recently, prolonged sitting has been recognised as, regardless of regular exercise, an independent deleterious behaviour associated with increased risk for type-2 diabetes, the metabolic syndrome, non-fatal and fatal cardiovascular disease, all-cause mortality as well as ovarian, colon and endometrial cancers (1;2). In a recent meta-analysis, Chau and co-workers reported an increased risk of 5% for every 1-hour increase in sitting time >7 hours/day of total sitting after taking exercise into account, with an overall weighted population attributable fraction (number of deaths attributed to daily sitting time) of 5.9% (3). This is comparable to recent World Health Organization estimates for other major risk factors such as physical inactivity (5.5%) and obesity (4.8%) (4).

Historically, being sedentary has often been considered equivalent to a lack of sufficient amount of exercise, hence conceptualised as reflecting the lower end of the physical activity continuum. In the light of the recent research, it is suggested that regular exercise and sedentary behaviours should rather be seen as two distinct behaviours, each with partly independent importance for health and disease risk (5). Prolonged sitting is a behaviour related to bodily movement, or in this case absence of movement, but distinct from physical activity. It is defined as any waking behaviour characterised by energy expenditure ≤ 1.5 metabolic equivalents (METs, where 1 MET is considered as the resting metabolic rate) in a sitting or reclining posture, with absence of muscular contractions within the large skeletal muscle groups of the body (5). Sedentary behaviours are ever-present in today's society, but seldom reflected upon by the individual. They typically occur in the context of workplace sitting, television viewing, computer and video game use, and car travel. Recent data from population-based samples indicate that in general 55-70% of the waking hours is spent sitting (6).

Sedentary behaviours primarily limits the activity embedded into much of daily life; this activity is mainly performed on a low intensity level not intended to constitute exercise, and is hence referred to as non-exercise physical activity. Conversely, sedentary behaviours are poorly correlated with time spent in exercise. One reason for this is that the proportion of time spent doing intentional exercise usually consists of only a fraction of the day, leaving much time for daily activity or sitting. Figure 1 describes the daily movement pattern captured by an objective motion sensor. It shows the potential effects and volume of sitting, low-intensity daily activity and moderate-to-vigorous physical activity (exercise). The powerful biological effect of exercise is well-known; however, the daily volume is low, and a large proportion of the adult population lack daily exercise. On the other hand, the emerging evidence of the hazard of prolonged sitting and the importance of low intensity daily activity is a central issue. Along with the revolution in technology and restructuring of society in recent decades, there has been a shift in the balance between time spent in daily activity and time spent sitting, in favour of the latter. The result of this is an "unnaturally" high amount of sitting time in the general population. As the human genetic structure has probably changed little in the past 30,000 years, and is therefore not selected for a sedentary lifestyle, it is hardly surprising that the contemporary lifestyle has generated health consequences

Figure 1 Time spent in sitting, low-intensity physical activity of daily life, and moderate-to-vigorous activity (exercise) in a cohort of adult Australian men and women, illustrating the three main intensity components of the daily movement pattern, their interrelationship, and their potential health impact (adapted from (12)).



for the humans of the modern 21th century. Epidemiological studies have also implied that in today's society it is not only possible, but very common, to exercise regularly yet be highly sedentary during the day, referred to being an "active couch potato" (7). A common example may be an office desk worker who sits most of the day, but exercises in the evening. A reverse example is a childminder who is constant moving around caring and supervising the children, but without regular exercise habits in leisure-time. Hence, the importance of non-exercise daily activity as the main substitute for prolonged sitting during the day is subsequently augmented. Recent research has reported independent importance of non-exercise activity for metabolic health, cardiovascular disease and mortality (8-10). For example, after 12.5 years follow-up in 60-year-old Swedish men and women, a generally active daily life, regardless of regular exercise habits, reduced the risk of a first-time CVD event by 27% and that of all-cause mortality of 30%, in comparison to low daily activity (11).

Secondary prevention and hospital care

Most research has until now been conducted in healthy subjects. However, the importance of reducing sedentary behaviours in clinical populations and hospital patients might be even more significant, as these more frequently tend to be highly sedentary, physical inactive and overweight or obese (13;14). Previous studies in adults at high risk for and patients with newly diagnosed type-2 diabetes, have reported strong, adverse associations between time spent sedentary and cardiometabolic risk, even after adjustment for exercise (14, 15). In a small sample of men with manifest type-2 diabetes, introduction of short repeated bouts of low intensity walking, compared to a day of prolonged sitting, reduced postprandial glucose and insulin responses (16). Moreover, low leisure-time physical activity has been associated with an increase use of hospital care (17). Men with the lowest leisure time activity level had on average 36% more hospital days, and women 23%, than their more active counterparts.

Potential mechanisms

A potential mechanism to explain the observed hazardousness of prolonged sitting and benefits of a daily active life is energy expenditure. Prolonged bouts of sitting results in low energy expenditure close to the basal metabolic rate, while standing up and engaging in daily activity multiplies it. Hence, variation between sitting and standing/ambulating plays a significant role for the general population in the maintenance of energy balance and in regulating body fat storage. Comparisons of different daily movement patterns have shown that the daily energy expended in activity for standing or ambulatory workers might be double the energy expended in seated workers (18). The importance of daily activity for long-term energy balance has also been shown on a greater scale in middle-aged adults in the U.S, where the authors concluded that jobs requiring higher energy expenditure had decreased in U.S. private industry over the last five decades, resulting in an average decrease of 130 kcal in daily occupation-related EE (19). Subsequent energy balance modelling showed that this EE reduction could account for a significant proportion of the increase in mean body weight in the U.S. during recent decades. Another potential mechanism is linked to the lack of muscular contraction during sitting. This leads to reduced glucose uptake and undermines the endocrine function of the skeletal muscle, which may cause malfunction of several organs and tissues of the body. However, activation of the skeletal muscle per se, and not necessarily the intensity of the activity, will ensure sustained endocrine function and blood glucose regulation. Other proposed mechanisms are linked to vascular function. Even short periods of sitting (30 to 60 minutes) have been shown to induce different adverse haemodynamic responses within the blood vessels, causing elevation of oxidative stress and endothe-

lial dysfunction; both of which promote atherosclerosis (underlying cause of cardiovascular diseases) (20). Moreover, a recent published paper also linked reduced sitting time with telomere lengthening (21). A telomere is the region at the end of a chromosome, protecting the end of the chromosome from deterioration, and seen as a marker of biological ageing.

Breaks in prolonged sitting

The distribution of the time spent in sitting seems to be as relevant as the total time. A higher number of breaks in sedentary time (a transition from sedentary to an active state) have been, independently of total sedentary time and exercise, significantly associated metabolic health (22). In addition, recent experimental trials have showed that compared to uninterrupted sitting for 5 hours, when the prolonged sitting was broken up with low-intensity walks, irrespectively of walking intensity, postprandial glucose and insulin levels were lower and beneficial changes were induced in the expression of a number of genes linked to factors including glucose homeostasis, inflammation, and metabolic risk (23;24).

What should we communicate?

Evidence now exists which implies the importance of reducing sitting time in the prevention and treatment of several common public health diseases, both in healthy subjects as well as in clinical populations. Hence, as with considering different components of our diet (e.g. carbohydrates, fat, and protein) as unique nutrients with different importance for bodily function, the three different aspects of our daily movement pattern (sitting, low-intensity daily activity and exercise) should be independently considered in research and health promotion. Although it may seem that sitting or moving is a voluntary choice, there are many different factors that influence whether, when, and how we sit for extended periods during the day. For example, sitting is often non-discretionally incorporated in different tasks, mainly as occupational sitting by the desk. Social norms, such as sitting versus standing during meetings, are another influencing factor, and the possibility of walking during the busy day is limited by the need for quick transport between different activities. Hence, to reverse the negative trend and to decrease sitting time in the society, the responsibility lies not only in the hands of the individual but also in for example clinical practice to address and highlight an unhealthy sedentary behaviour, decision-makers and employers to design the neighbourhood and occupational setting into promoting and enabling regular daily activity (walkability, active transport and alternative work station arrangements), and the social context to accept that sitting is not the normal state.

For future health, a generally active daily life, interruptions with low-intense activity breaks while seated for prolonged periods as well as regular exercise should be recommended.

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