

# The hazards of sedentary behaviour

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We have been aware of the potential hazards of excess sitting since the 1950s when Jeremy Morris published his landmark study in the *Lancet*, demonstrating that London bus drivers had more than double the risk of a myocardial infarct compared to the more active bus conductors.<sup>1</sup> In the following decades a great amount of research investigated the benefits of moderate-to-vigorous intensity physical activity, overlooking the important distinction between sedentary (sitting) and light-intensity physical activity (standing, slow walking). As you will realise, sitting too much is simply not the same as exercising too little.

## Defining sedentary behaviour

Sedentary behaviour is defined as any waking sitting or lying behaviour with low energy expenditure (<1.5 metabolic equivalent units), not just the absence of exercise.<sup>2</sup> Sedentary behaviours are an important facet of human behaviour with the average adult spending between half and three-quarters of their waking hours sedentary – unsurprising given how ubiquitous the opportunities are: watching television, sitting in the car, using the computer etc.<sup>3,4</sup>

The amount of time spent sedentary is closely associated with health risk, diabetes in particular, regardless of the amount of exercise performed. A recent meta-analysis, which included 18 cross-sectional and prospective observational studies with almost 800 000 participants from across the world, demonstrated that excess sedentary time was significantly associated with diabetes, cardiovascular disease, cardiovascular mortality and all-cause mortality.<sup>5</sup> The most robust association was between sedentary time and diabetes.<sup>5</sup> This association existed independent of physical activity, which is an important conclusion because it suggests that the deleterious effects of higher levels of sedentary behaviour are not mediated through lower amounts of moderate-to-vigorous intensity physical activity. Even if an individual meets the physical activity guidelines, their health may still be compromised if they sit for long periods of time throughout the day.

## The relationship between sedentary behaviour and diabetes

Why does such a strong relationship exist between sedentary time and diabetes? There are a number of potential behavioural and physiological mechanisms which may underpin the observed association.

### Behavioural aspects

Sedentary time, television viewing in particular, is associated with increased dietary intake and people who sit more may snack on unhealthy food and drinks, and compensate by down regulating healthy aspects of their diet.<sup>6</sup> This is supported by the finding that television viewing disrupts the ability to respond to normal hunger and satiety cues, leading to a short-term increase in food

intake.<sup>7,8</sup> In addition, sedentary individuals may work in more stressful desk jobs or have predispositions to other behaviours and experiences which compromise health. These variables are almost impossible to measure in epidemiological studies and exist as potentially significant confounders. Furthermore, there is the possibility of reverse causation: greater sitting or television viewing may be the result of poor health, rather than its cause.

### Physiological aspects

However, animal and human studies suggest that it is the sitting posture, rather than associated behaviours, which has the negative influence on health. Sitting has a direct impact on skeletal muscle, the largest insulin-sensitive organ in the body. In animal models, immobility rapidly results in dramatic reductions in muscle triglyceride uptake with raised plasma triglyceride and the development of peripheral insulin resistance.<sup>9,10</sup> Lipoprotein lipase regulation has been identified as a potential pathway through which sedentary behaviour results in some of the negative metabolic consequences, with a demonstrable reduction in postural muscle lipoprotein lipase activity in rats within 6 hours of immobilisation.<sup>9</sup> Interestingly, exercise has little impact on lipoprotein lipase activity, highlighting the importance of postural muscle contraction.<sup>9</sup> More recent studies of skeletal gene expression have identified that light physical activity, compared with sedentary activity, is associated with anti-inflammatory pathways, and lipid and carbohydrate metabolism; this has led to the proposal that sedentary time may result in reduced fatty acid transport in skeletal muscle with the subsequent accumulation of intracellular fatty acids and less GLUT4 glucose transporter translocation, leading to reduced insulin induced glucose uptake.<sup>11,12</sup>

More recently in human studies, just one day of sitting was associated with a significant reduction in postprandial glucose and insulin.<sup>13</sup> Furthermore, there is a specific genotype which is particularly susceptible to the adverse effects of sedentary behaviour. When those with a specific T-allele of the *TCF7L2* gene (the most significant type 2 diabetes susceptibility gene) are exposed to bed rest conditions, they fail to increase their insulin secretion to overcome the insulin resistance induced by muscular inactivity.<sup>14</sup> Therefore, not only is there the lipoprotein lipase metabolic pathway through which inactivity acts, but there is also a potential gene–environment interplay which determines who is most susceptible to developing diabetes when exposed to excess sedentary time.

Intervention studies are now underway and the initial results are fascinating. In overweight and obese adults, when periods of prolonged sitting were interrupted every 20 minutes with 2-minute bouts of light-intensity physical activity there was a 24% reduction in postprandial glucose and a 23% reduction in insulin, compared with uninterrupted sitting.<sup>15</sup> Light-intensity activity has also been shown to have a similar impact on

postprandial glucose in people with type 1 diabetes.<sup>16</sup> Reductions in postprandial glucose are similar for both light and moderate activity conditions, suggesting that substituting sitting with standing and moving around a little has the potential to impact on glycaemic control.<sup>15</sup> The rapid and significant deleterious impact of sedentary behaviour on insulin resistance and glycaemia helps explain the strong and consistent associations between sedentary time and diabetes in large epidemiological studies. Substituting sitting with light physical activity could have a beneficial role in the prevention and management of diabetes. Large randomised controlled trials are required to investigate this further.

### Clinical implications

These recent developments in the field of sedentary behaviour research have implications for clinical practice. Meeting the recommended 30 minutes of exercise per day is important for health, but attention must also be given to the level of activity performed in the remaining 23.5 hours in the day. We now know that going to the gym at the end of the day is not enough to undo the harm of hours and hours of time spent sitting at a desk. Individuals need to have a heightened awareness of the time they spend sitting so that they can consider ways in which they may reduce or break up sitting time. Solutions to reducing sitting need to be personalised but options might include standing desks, standing or walking during coffee and/or lunch breaks, standing when on the telephone etc. Limiting sedentary time, especially after meals, can reduce the postprandial glucose excursion. This is an important message to communicate to those with and at risk of diabetes. It is also a useful message for those with comorbidities which limit exercise (e.g. those with arthritis). At present there are no specific recommendations about how much time we should spend sedentary. The development of clear and specific public health recommendations will require randomised controlled intervention trials to assess the magnitude of effect from reducing sedentary time.

### Summary

In conclusion, excess sedentary time is associated with diabetes, independent of the amount of moderate-to-vigorous physical activity undertaken. Substituting

sedentary time with light physical activity has a beneficial impact on postprandial glycaemia, and may have a significant role in diabetes prevention and management. Despite this, little is known about how best to change sedentary behaviour in adults. There is an urgent need to investigate further the impact of reducing sedentary time on metabolic health.

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### Declaration of interests

There are no conflicts of interest declared.

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