

Standing up to diabetes: sedentary behavior matters

Stuart JH Biddle^{*1,2}, Melanie Davies^{1,3}, Kamlesh Khunti^{1,3} & Thomas Yates^{1,3}

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The importance of physical activity as a powerful therapeutic agent in the treatment and prevention of Type 2 diabetes has been recognized for many years. However, once-accepted dogmas around the definition and utility of physical activity have been challenged in recent years by the emergence of a new separate paradigm: sedentary behavior. This may appear to be just the simple inverse of physical activity but this is not the case. Sedentary behavior refers to “any waking behavior characterized by an energy expenditure ≤ 1.5 METs while in a sitting or reclining posture” [1]. Typical examples include TV viewing, computer use, sitting in meetings and car travel. Conversely, any standing behavior can be thought of as nonsedentary. Thus it is possible to meet the national recommended levels of physical activity (30 min per day for adults), and therefore be classified as ‘active’, whilst at the same time indulging in high levels of sedentary behavior – the two behaviors may coexist; indeed it is thought that where these behaviors do coexist, being physically active may not fully ameliorate the deleterious impact of high levels of sedentary behavior.

The behavioral epidemiology framework, proposed by Sallis and Owen, specifies that in the early stages of researching a new topic, such as sedentary behavior,

we need to establish that we can measure the behavior of interest and the behavior leads to meaningful health outcomes [2]. Once these have been at least partially satisfied, we need to identify the correlates of sedentary behavior and test how to reduce sedentary behavior through interventions. In this editorial, we will highlight the links between sedentary behavior and poor health and comment on current evidence concerning interventions to change sedentary behavior.

Sedentary behavior: does it matter for health?

Jeremy Morris’ seminal work in physical activity epidemiology in the 1950s suggested that sedentary (sitting) occupations incurred a high health risk relative to active jobs [3]. More recently, data show that higher levels of sitting are associated with various negative health outcomes, often independent of the amount of moderate to vigorous physical activity (MVPA; operationally defined as the equivalent of at least brisk walking or activity 3 METs or more). For example, in a review of prospective studies, Proper *et al.* concluded that there was moderate evidence for a positive relationship between sitting time and the risk for Type 2 diabetes and strong evidence for associations with all-cause and



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¹The NIHR Leicester–Loughborough Diet, Lifestyle & Physical Activity Biomedical Research Unit, UK

²School of Sport, Exercise & Health Sciences, Loughborough University, Leicester, LE11 3TU, UK

³University of Leicester, University Hospitals of Leicester NHS Trust, Leicester General Hospital, Leicester, LE5 4PW, UK

*Author for correspondence: s.j.h.biddle@lboro.ac.uk

cardiovascular disease mortality [4]. Similarly, Edwardson *et al.*, using meta-analytic methods, reported that those in the highest sedentary group had a 73% increased risk of metabolic syndrome compared with those in the lowest sedentary group [5]. This remained unchanged when accounting for physical activity, thus suggesting that sedentary behavior is an independent risk factor. However, it is also important to recognize a note of caution when evaluating the above epidemiological data, as sedentary behavior, mainly in the form of TV viewing, clusters with other deleterious lifestyle practices, such as a poor diet [6], which could act to overestimate the independent effect of sedentary behavior. The majority of the evidence to date has focused on establishing the link between total sedentary time and health. However, emerging evidence is suggestive that the nature of sedentary behavior may also be important. In particular, it might be informative to know whether periods of sitting are prolonged or whether they take place in a more sporadic form, independent of the total time in sedentary behavior. To this end, Healy and colleagues found that objectively assessed breaks in sedentary time were beneficially associated with waist circumference, BMI, triglycerides and 2-h plasma glucose, independent of total sedentary time and MVPA [7]. Until we have further intervention evidence, it appears sensible to be recommending reductions in total sitting time and increases in the number of breaks from sitting along with traditional messages around moderate-to-vigorous physical activity.

Can we change sedentary behavior?

We have made the case for intervention research to establish whether sedentary behavior is linked to poor health outcomes. In addition, interventions are required to see whether it is possible to reduce the time people spent sitting. While there are many ideas of how to do this, such as standing desks, there are very few interventions with adults that have been designed primarily with the goal of reducing sedentary behavior. This is surprising as the evidence concerning young people is more voluminous and interventions have been conducted for many years. Several recent systematic reviews suggest that interventions to reduce sitting time (usually in the form of TV or screen time) in children and adolescence have been successful, albeit showing small effect sizes and few clear moderators to guide translational efforts [8,9]. In a review of

adult studies purporting to analyze interventions for reducing sitting in the workplace, Chau and colleagues located six studies; however, all were designed to increase physical activity, with sedentary behavior as a secondary outcome [10]. This may have accounted for the lack of intervention effectiveness as far as sitting was concerned.

A recent feasibility trial on Australian adults aged 60 years and over used a 45-min face-to-face meeting to assist participants in reducing their sitting time and to increase their breaks in sitting [11]. Various strategies were offered, including goal setting and self-monitoring. The intervention was successful with a reduction in sedentary time of 3.2% and an increase in the number of breaks from daily sedentary time. Time spent in light and moderate-to-vigorous physical activity increased. Participants reduced their sedentary time mainly between 10.00 and 21.00 h, and increased their breaks in sedentary time after 19.00 h. Other trials are ongoing to test whether sedentary behavior reduction is possible in groups at risk of Type 2 diabetes [12].

Until further intervention evidence is available, possible strategies will involve a mixture of individual (goal setting, self-monitoring and prompts), social (targeted social support) and environmental actions (e.g., modified office design such as standing desks, waste bins away from desks, walking meetings and public prompts). Participant engagement is likely to be important to ascertain what strategies are feasible and acceptable.

Looking to the future

Public health professionals have long accepted the beneficial role that physical activity can play in disease management, including diabetes. However, the emerging role of sedentary behavior as a risk factor in its own right, and independent of MVPA, means that greater attention now needs to be paid to this cluster of behaviors. Recognition is needed that drivers of sedentary behavior range from the individual and psychological, through to social and environmental influences. Indeed, the latter may be particularly strong and create ingrained 'habits' that may prove tough to break. An initial step, therefore, is to publicize the importance of reducing sedentary behavior and, to this end, we welcome UK guidelines for physical activity that now include sedentary behavior [101].

Future actions required include changes to office design to allow for more productive time while standing, technology-driven

self-monitoring of sitting time and prompts to encourage less sitting, more standing and greater habitual movement.

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