

Inactivity Physiology- Standing up for Making Sitting Less Sedentary at Work

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Abstract

Emergent research suggests that prolonged sitting throughout the day over long periods of time in adults is significantly associated with chronic diseases such as diabetes, heart disease, hypertension and some cancer forms. Singaporean youths and adults respectively, are not sufficiently active during schooling and at work. This pervasive exposure to prolonged sitting in youth and adulthood (e.g. more than four hours daily) expose large segments of the population to health risks and increased all-cause mortality. Some researchers describe 'prolonged sitting' as the new 'smoking' disease, because of it could be a serious threat to optimal physical and metabolic health. Interventions to fragment sitting time involve the use of standing desks or treadmill workstations but these have produced mixed results since prolonged standing could give rise to other health ailments that are associated with too much standing while expensive desk treadmills would be impractical and are beyond the reach for most people. Moreover, it is inconceivable that these could be used in work group discussions. The use of a seat cycle, to sit and cycle at the same time is an innovative approach at intervening where it makes sense, where its use is not intrusive and could be 'assimilated' into the work culture. The use of the seat cycle even challenges the notion and definition that prolonged sitting is sedentary. This case study briefly describes the key concepts and ingredients of an on-going pilot 3-month intervention study that examines the feasibility and utility of making sitting less sedentary at the National Institute of Education in Singapore. Results emanating from the study would provide empirical data for product innovation and development, strong opportunities for interdisciplinary collaborations among product engineers, sensor scientists, medical practitioners and health-promotion advocates at worksites.

Introduction

Despite the best efforts among health-promoting organizations world-wide and nationally to adopt a physically more active and healthy lifestyles among youths and adults, large proportions of the population remain entrenched in sedentary lifestyles. Efforts to get the physical inactive youths and adults to adopt more active lifestyles have met with marginal success. Moreover, emergent data show that among sedentary male adults, those who sat for more than 4 hours daily were more susceptible to lifestyle chronic diseases than those who sat for less than 4 hours daily [1]. Another Japanese study on 483 adults, aged 30-64, showed that among sedentary participants (less than or equal to 1.5 METs), those who were most sedentary had 2.27 times the risk for metabolic syndrome (MS) compared those who rated sedentary but were in the lowest segment for physical inactivity [2]. The accepted wisdom that intervening in the most physically inactive segments of the population are likely to bring about the most benefits is the prevailing motivation for the intervention study.

Prevalence of physical inactivity among youths and adults

Our studies suggest that young people are physically inactive for most parts of the day [3,4] and they do not meet national and international guidelines for daily minimum levels of accumulated physical activity for healthy living despite sustained efforts at inculcating physically active lifestyles among the school-going population. National Health Survey results on adults aged between 18 and 69 suggest that nearly up to 33% of Singaporeans are classified as obese based on the BMI-cut offs for Asians. It appears that more adult Singaporeans are exercising regularly, from national press reports, yet the leading causes of premature deaths from heart disease, stroke and certain cancer forms have remained relatively unchanged over the last decade. Additionally, sedentary lifestyles among youths and adults are linked to increased risk of type II diabetes.

Type II diabetes

Diabetes mellitus (DM) is a global health problem currently affecting

over 3 percent of the world's population. Its prevalence in Europe and the US is expected to double before 2025 according to the WHO. Some large scale studies show that metabolic syndrome (an eventual condition that is linked to DM) is negatively associated with less time spent sitting [1,2] The prevalence of DM in Singapore is between 7 percent and 15 percent depending on ethnic group. Moreover, it is estimated that 3-15 percent of healthcare costs are spent in the treatment of DM and its complications. In a study on the metabolic health of 233 Singaporean adolescents, sedentary youths were more than twice more likely to have insulin resistance [4]. In recent years, Singapore led the world in terms of the rate of increase in DM and the disease remains a major threat to human health and currently one of the most extensive burdens to the health care system in Singapore. Carefully monitoring the prevalence of the disease in adults and even among youths, and intervening to ameliorate and delay the onset of DM is a worthwhile national pursuit as the future physical, metabolic and social health of Singapore is in the balance.

Inactivity physiology and associated interventions

Research in this emerging field of study has shown even among adults who meet exercise guidelines of 30-60 minutes for most days of the week, yet remain sedentary for the rest of the non-exercise time

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are also susceptible to the risk of all-cause mortality [5,6]. Published data among schoolchildren in Singapore show that even when a year-long physical activity intervention during school increased step-count within school by up to 15%, this did not alter total accumulated step count [7]. This, in essence, meant that it was extremely difficult to alter sedentary behaviours with exercise interventions. Human exposure to sedentary lifestyle at school, work and play is likely to be entrenched even more. Recommendations to fragment sedentary sitting include taking the stairs, walking to different workstations rather than emailing, having standing meetings, doing workstation five-minute stretching exercises every 60-90 minutes, working and sitting behind a desk, to name a few. However, these have not been very successful at changing sedentary behaviors, on a sustained and continued basis beyond the intervention period. A behavioral medicine expert on the psychology of sedentary behavior [8] professes that physical inactivity and physical activity are different constructs that require different thinking and approaches. To use an analogy, activity and inactivity in the physical sense are not opposite sides of the same 'coin' but rather coins of different denominations- that interventions to increase physical activity and to concomitantly reduce sedentary behaviours have to be handled with 'kids' gloves' but different 'gloves' are required. Indeed, Biddle [8] explains that operationally, sedentary behaviours should involve activities that involve 'sitting' or 'lying down', at work or at leisure where seated computer work, seated screen time, watching television, reading or chatting on the phone are common examples of activities engaged in while 'sitting' or 'lying down'. In terms of estimated energy expenditure for an average-sized adult, the activity cost is usually less than 1.5 METs (described as the energy cost for light or sedentary activities). In the light of the present pilot intervention study, seated cycling accumulated daily over time, and if used pervasively at work and at home, may challenge the present notion that sedentary behaviors involve activities done sitting.

The conceptual reframing of sitting as a legitimate health promoting activity would have implications for different subject populations with differing needs. In an educational context, the ability to manage daily stressors is key to the mental well-being of children. A recent study has shown that young children that participate in higher levels of daytime physical activity are better equipped to cope with acute stressors compared to their less active counterparts due to differences in neuroendocrine regulation [9]. With the amount of time spent sitting within classrooms [10], a seat cycle would provide regular opportunities for children to increase their baseline physical activity levels thereby addressing their mental and physical needs.

In light of the dangers of prolonged sitting, more working adults have started adopting standing desks at their homes and workplaces to reduce the risks associated with sitting. This undertaking is potentially fraught with its own set of hazards. Prolonged standing has been linked with increased musculoskeletal pain, the progression of carotid atherosclerosis due to the increased load on the circulatory systems, as well as reduced infant birth weight [11-13]. Interventions to break up continuous sitting time with light-intensity activities, such as walking, have shown to be beneficial in regulating glucose metabolism and reducing cardiovascular risk without the risk of prolonged standing [14]. However, multiple activity breaks during the day may not be feasible in certain workplaces due to operational or cultural imperatives. This gives further relevance to a novel intervention that could potentially increase an individual's energy expenditure while sitting. Recent evidence suggests that such a minimal reduction in overall sedentary time has the potential to significantly reduce all-cause mortality amongst older adults [15].

In sum, emerging evidence is suggesting a shift from the emphasis on the traditionally prescribed, single bout of daily exercise, towards a reduction of overall sedentary time to reduce health risk. Interventions into the wide spectrum of activities described as non-exercise activity thermogenesis (NEAT)-type behaviours, which constitute a significant portion of daily energy expenditure for healthy and diseased populations. In terms of an active preventive and intervention programme for the treatment of obesity, increasing energy expenditure and fat oxidation during NEAT offers strong potential for success but this needs to be studied and explained. This represents a rich and fertile area for present and future research.

Current Pilot Intervention

Institutional ethical clearance was sought and granted for the study. The pilot study involved a cross-over design over an intervention period of 4 weeks (only weekdays at work between 0900 hrs and 1700 hrs). The group is monitored using validated measured mood, concentration and sleep scales, over the periods when using the seat cycle and when not. A parallel study involves the use of a portable expired air analyzer to measure the oxygen consumption at rest whilst seated passively and during cycling on the seat at a self-selected pedal-rate. Case study and group comparisons will be described following the analysis of the data.

Conclusions

New and novel ways of intervening at fragmenting sedentary periods at work and at play would be necessary to prevent large segments of the population from falling 'prey' to the 'sitting disease'. Some have likened 'sitting' to the 'new smoking', since sitting too much, over the long term can kill. No research intervention has apparently intervened in the manner that is used in the pilot study, where multi-factorial and holistic potential outcomes are alluded to. Therefore there is a need for more novel approaches by way of intervention to make sitting time less sedentary throughout the day that is sustainable, minimally intrusive and time-saving. Research into increasing accumulated energy expenditure with NEAT-type behaviors on a daily and continued basis is not only 'neat' but 'cool'.

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