

## Sitting Made in Time to be Less Sedentary at Work (SMILES@Work)

Michael Chia\*

Professor of Paediatric Exercise Physiology, National Institute of Education, Nanyang Technological University, Singapore

### Activity and Inactivity- A Different Kind of Difference

Physical (in) activity can be described in the context of work, home, transport or leisure time. However, physical activity and inactivity are different constructs and therefore require different treatments [1]. Indeed, activity and inactivity are not opposite sides of the same coin but are coins of different denominations and have to be handled with not just 'kid's gloves' but with 'different gloves' [2]. The causes of physical inactivity are multifaceted, complex and difficult to eradicate since the many lifestyle conveniences are anchored on physical inactivity. It appears that physical inactivity will worsen as technological gadgets make physical exertion unnecessary.

Physical inactivity is a characteristic of sedentary behaviour which can be described as a continuum that encapsulate activity confined to bed-rest to not meeting current physical activity guidelines recommended by national or international health promoting organizations. In energy expenditure terms, this is usually described as activity engagement that is less than 1.5 METs (metabolic equivalent; where 1 MET is equal to an oxygen consumption of 3.5 ml/kg/min, while sitting quietly) [3]. It appears that even among healthy people who are already described as habitually sedentary, they have not reached the ultimate situation of physical inactivity which is prolonged bed-rest, while engaged in activities requiring minimal physical exertion.

During prolonged sitting, the energy expenditure of the large skeletal muscles of lower limbs, back and trunk, which are responsible for keeping the body in an upright posture, become greatly suppressed. This has a negative impact on the activity of skeletal enzymes, such as lipoprotein lipase that help to regulate plasma triglyceride and cholesterol [4].

An understanding of physical (in)activity among different population cohorts- pupils and students in schools, youths and adults at work, homemakers and caregivers, the retired elderly, the unemployed, disabled people and people living with disease- is paramount and is a pre-requisite for addressing the issue in a holistic and multifaceted manner. It is encouraging that in recent times, there has been a plethora of research addressing the many issues of physical inactivity, a noticeable shift in emphasis from getting people to meet minimum physical activity guidelines (e.g. adult-based guidelines stipulate engaging in at least 150 minutes of moderate intensity exercise per week) to encouraging people to be less physically inactive throughout the day, to increase non-exercise activity thermogenesis (NEAT) [5] and to reduce occupational sitting. This research momentum needs to be sustained.

### Modern Lifestyles Equal Less Energy Expended all Day

In many developed countries, the rapid advances in technology and computerization have resulted in many changes to how people function at work, at home, during transit from place to place and how they choose to spend their leisure. The Baker IDI Heart and Diabetes Institute [6] reported that there are on the average day (7 am to 11 pm), an average Australian adult had 15.5 hrs of sitting opportunities. Chia [7] cited Health Promotion Board Singapore Survey data on adolescent Singaporean youth in 2002, where subjects spent a mean of 15 hrs daily engaged in physical inactivity, presumably sitting while engaged with schooling, homework, watching TV and transport.

Other survey data showed that Singaporean youths aged between 15 and 35 years spent a daily average of 5.5 hrs engaged in social media, presumably while sitting, and this is a marked increase from an daily average of 4.8 hrs recorded in 2011 [8]. Comparison survey data across 12 different countries (among them, South Korean, Japan, Hong Kong and Taiwan) that involved 13 000 youths aged eight to 24 years showed that Singaporean youths were among the busiest in Asia, where over a 24 hour period, they cramped 42 hours worth of activities by multi-tasking, especially in sedentary activities that involved the media [9]. Some data show that desk-bound workers spend more than 6 hours per day sitting [10] and that the energy expended was less than 300 kcal per day [11]. These rapid changes in lifestyle have resulted in less energy expended across all four domains. Clearly and collectively, less energy is expended during NEAT.

Few would argue that many useful accomplishments are achieved during physical inactivity at school, during safe transport, at work and at home, and during leisure. Advances in digital and media technology has enabled multi-tasking (working on the computer, completing homework, reading and writing, taking phone calls, watching television, listening to music, on-line shopping, chatting with friends online, etc), presumably while sitting, among large segments of youth and adults to accomplish many things at the same time. Nonetheless, these useful and important accomplishments of inactivity must be weighed against the detrimental costs of prolonged physical inactivity.

### Prevalence, Exposure, Costs of Inactivity and Potential Savings from Reducing Inactivity

Physical activity insufficiency is now considered as a global public health problem. Estimates from the World Health Organization (WHO) in 2008 show that 28% of male persons and 34% of female persons aged 15 years and above were insufficiently active and at least 3.2 million annual deaths were the result of physical inactivity [12]. Globally, inactivity accounts for 10-16% of each of breast cancer, colon cancers and diabetes and about 22% of heart disease. It also accounts for higher death rates among adults of any age [12].

Some researchers estimate that the annual healthcare costs attributed to physical inactivity in the USA, Canada, Switzerland and the UK range from 1.5% to 3% of total healthcare costs [13]. European data show that that physical inactivity cost Norway, Switzerland and Finland, respectively €980, €564 and €1200 per person per year [14].

An Australian study showed substantial economic benefits of reducing physical inactivity, where a 10% reduction in inactivity

\*Corresponding author: Michael Chia, Professor of Paediatric Exercise Physiology, National Institute of Education, Nanyang Technological University, Singapore, Tel: 65-67903081; E-mail: [michael.chia@nie.edu.sg](mailto:michael.chia@nie.edu.sg)

Received February 11, 2014; Accepted March 10, 2014; Published March 13, 2014

Citation: Chia M (2014) Sitting Made in Time to be Less Sedentary at Work (SMILES@Work). *J Obes Wt Loss Ther* S4: 004. doi:10.4172/2165-7904.S4-004

Copyright: © 2014 Chia M. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

prevalence of 70% among Australian adults would result in 6000 less disease cases and 2000 fewer deaths; gains of 114000 working days; and 180000 days of home-based production. Importantly, this will confer savings of \$96 million in annual healthcare costs [15].

There is a need for more country-specific research, especially among Asian countries since the region has one of the highest rates of diabetes and other hypokinetic diseases, especially among the emerging economies. Such research needs to elucidate and enunciate the economic costs of inactivity and the benefits to be gained in reducing a feasible percentage of population-cohort specific levels of physical inactivity. The cost of physical inactivity could be expressed in terms of reductions in annual healthcare costs and loss of working days due to illness.

This is important in galvanizing policy makers, schools, workplace employers and community agencies to engineer innovative practices that are sustainable in the near and medium term in addressing behaviours that are entrenched in physical inactivity.

### **Prolonged Sitting is the New Smoking and is Linked to Major Diseases**

In recent times, the deleterious effects of prolonged occupational sitting at the workplace have come to the fore. In a meta-analysis of 18 studies that included nearly 800,000 subjects, Wilmot et al. [16] reported that the greatest sedentary time compared with the lowest was associated with increased relative risk for diabetes, cardiovascular disease and all-cause mortality. Importantly, the cited study revealed that the association between sedentary time and diabetes was stronger than for all-cause mortality. Animal [4] and human [17] studies show that immobility significantly leads to peripheral insulin resistance, which is a characteristic of diabetes and impaired glucose tolerance.

A longitudinal study by the American Cancer Society that tracked 123,216 healthy subjects (53,440 men and 69,776 women) from 1993 to 2006 and analyzed subjects' sitting time and physical activity showed differential risks for heart disease and all-cause mortality of prolonged sitting for men and women. Results showed that women who sat for more than 6 hours daily outside of work were 37 percent more likely to die during the 13-year period of study than those who sat for less than 3 hours a day outside of work. Male subjects who sat for more than 6 hours a day outside of work were 18 percent more likely to die than those who sat for less than 3 hours a day outside of work. Importantly for both sexes, these probabilities remained after adjusting for leisure-time physical activity. Also, the sitting-cardiovascular mortality link was stronger than the sitting-cancer mortality link. Researchers explained that prolonged sitting have negative metabolic consequences on biomarkers of cardiovascular and other chronic disease [18].

Some research liken the health risks that are associated with sitting for prolonged stretches of time to be equivalent or greater than the health risks that are associated with smoking [19]. Researchers in the cited study quantified the relative risks of watching television, presumably while sitting with that for smoking- for every hour of television that people watched, their life span were shortened by 22 minutes while smokers shortened their lifespan by 11 minutes for smoking 1 cigarette.

### **Wait a Minute, not all Studies are Unequivocal**

While evidence that prove an association between prolonged sitting and cardio-metabolic risk and all cause mortality in different populations in the USA, Canada and Australia appear compelling, not all research findings are unequivocal.

Maher et al. [20] conducted a cross-sectional analysis of 4618 adults from the National Health and Nutrition Examination Survey in the USA from 2003 to 2006, using accelerometry to quantify moderate to vigorous physical activity and sedentary time in minutes. Associations between sedentary time and cardio-metabolic biomarkers were examined using linear regression. The authors report that total physical activity was most favourably associated with 9 out of 11 biomarkers (standardized beta value: 0.08-0.30) while sedentary time was associated with only 1 biomarker (standardized beta value: 0.12). The authors concluded that there is no association between sedentary behavior and cardio-metric biomarkers, once total physical activity was taken into account during data analysis.

As research attention into physical inactivity mounts and methodologies to assess inactivity become more precise, reliable and valid, greater clarity about the associations between prolonged sitting, cardio-metric risks and all-cause mortality will come to fore. A novel motion sensor which can differentiate between times spent sitting, standing, lying down and stepping offers a promising approach in the study of sedentary behaviour.

### **Smart Innovations at Interrupting Prolonged Sitting at Work**

Interventions at getting segments of the population to be more physically active on a regular basis at work in order to improve the health of workers and to reduce healthcare costs due to heart disease, hypertension, type II diabetes and some cancers are common. However, the effectiveness of such interventions at the workplace is equivocal because of problems of adherence and continuance [21].

Increased awareness about the deleterious effects on health and mortality as a result of prolonged sitting at work has galvanized researchers to investigate potential benefits to health in terms of breaking up or interrupting or reducing occupational sitting. Occupations most at risk of prolonged sitting include those working in offices, transportation and highly mechanized trades. It is not uncommon for people employed at call centres, software companies, print and other media, transportation services (taxi, bus, lorry and train) or factory workers, to spend nearly all the hours at work sitting, confined behind a desk or a computer, behind the steering wheel or stationed sitting at assembly lines, except for limited breaks for meals. Even then, the meals are oftentimes consumed while sitting.

In many developed economies, a majority of working adults work in office-like setting, where prolonged occupation sitting is the norm. These workplaces represent an opportune place for interventions to reduce prolonged sitting. The author presents five of his favourite SMART (specific, measureable, attainable, realistic and timely) picks of innovations at reducing prolonged sitting at the workplace.

### **Good Stuff: Interrupting Long Periods of Sitting**

Rutten et al. [22] explain that for behavioural interventions to work, they should be simple, easy to perform and easily available. In the marketing of the intervention programme, the authors postulate that for the change programme to be widespread, it must satisfy three key conditions- (i) law of the few (ii) the stickiness factor and (iii) the power of context. The authors operationalize the three conditions by introducing a recognizable brand name for the behaviour change programme called STUFF or Stand Up for Fitness. STUFF involves fragmenting long periods of sitting by having standing breaks (e.g. standing for 5 minutes for every 30 minutes of sitting). STUFF is simple, easy to perform and is available to anybody and everyone. The authors

has piloted STUFF with health sciences students at a university in the UK and hope that its introduction will facilitate more research into the social, psychological and health benefits of reducing sitting time.

### **NIE Smiles (Sitting made in Time to be Less Sedentary)**

Chia and Suppiah [2] describe a pilot study that involved group of volunteer staff (mixed sex) working at the National Institute of Education (NIE) who had office- and desk-bound job descriptions. Using a cross-over and 'random sample-split half' design (4-week intervention-2-week wash out and vice versa), the researchers introduced a commercially available seat cycle to half the sample of volunteers to replace the normal office chair and modified the work station that involved raising the computer screen to the eye-level of the subject whilst seated on the seat cycle (intervention phase). Following the wash-out period, the sample reverted to the normal desk-chair set up. The modified workstation set up allowed the subject to cycle at a self-selected pedal cadence against a minimal resistance, to work on the computer or read, at the same time. The 4-week non-intervention phase involved the normal chair and normal work station arrangement. The measurements taken in the research included anthropometry, resting heart rate and blood pressure, cycle time, alertness scale taken every hour at the office, lower back and disability scales, and sleep quality taken at the start and end of each phase of the research. A summary of yet to be published data showed that there were significant improvements for sleep quality, lower back pain, resting blood pressure and daytime alertness for cycling up to 30% of the time spent in the office (Chia, Chen and Suppiah, in personal communication).

An associated sub-study showed that the self-selected pedal cadence while reading elicited up to 2.4 times the measured resting oxygen consumption of the subjects who participated in the study (Chia, Chen & Suppiah, in personal communication). The fact that cycling at a self-selected pedal pace against a minimal resistance while reading or working on the computer elicits MET values greater than 2, challenges the general acceptance that desk-bound office work is sedentary. In the literature, MET values of activities of less than 1.5 are usually considered as sedentary [3], though researchers have described activities that elicit a response of less than 2 MET values as sedentary [23].

### **Treadmill Desks: A one-year Prospective Study**

Koepp et al. [24] studied the impact of replacing traditional office desks with treadmill desks on daily physical activity and sedentary time (zero activity) in a mixed group of male and female office employees (10 lean; 15 overweight; 11 obese) with sedentary jobs over a one-year period. Objective measures of daily physical activity using accelerometers, work performance (employee self-rating and supervisor rating), and body composition (air-displacement plethysmography) and blood parameters were monitored at baseline, at six months and twelve months of the intervention. Daily physical activity of those who had access to the treadmill desks increased significantly by 33% at the 6-month mark, and by 25% at the 12-month mark, from the baseline accelerometer count. Zero activity time also decreased significantly by 8.9% and 4.1%, respectively from baseline values at the 6-month and 12-month marks. Resting systolic blood pressure and blood HDL also showed significant positive improvements from baseline values at the 12-month mark. The increase in daily physical activity and a reduction in sedentary time from the use of the treadmill desks did not result in any work performance decrement. Significant weight loss was detected in those with obesity.

### **Take-a-Stand Project, 2011: Reducing Occupational Sitting Time and Improving Worker Health**

Pronk et al. [25] describe a 7-week workplace project that involved 34 employees (Intervention group, N=24; Control group, N=10) in the USA with sedentary jobs. The study involved the intervention group using a sit-stand device for 4 weeks with the control group using the normal desk-chair workstation. Experience-sampling methods were used to collect sitting behaviour data for 1 week at baseline, during the 4-week intervention period and for another 2 weeks after the intervention period. Additionally, survey responses on self-reported health risk factors, mood states and other office behaviours were obtained. The following key results of the study are instructive- (i) Sitting time at work declined in the intervention work by 66 minutes per day but regressed to baseline values after the removal of the sit-stand device. Sitting time in the comparison group (without the sit-stand device) increased significantly throughout the monitored period (it was 38 minutes more per day compared to baseline values; (ii) upper back and neck pain decreased in the intervention group when the sit-stand device was in use but the improvement was negated when the device was removed; (iii) no significant change was detected in both groups for lower back pain, time spent in face-to-face interactions with co-workers or time spent in physical activity breaks; and (iv) self-reported mood state improved during the intervention period but regressed to baseline values while self-esteem improved slightly during the intervention period but fell to below baseline values after the sit-stand device was removed. At the end of week 7, employees in the intervention group reported the on benefits of using the sit-stand workstation: 87% felt more comfortable, 87% felt energized, 75% felt healthier, 71% felt more focused, 66% felt more productive, 62% felt happier and 33% felt less stressed. While the authors acknowledged certain limitations of the study such as a biased sample in that participants were aerobically fit, healthy and health-conscious, they also pointed out strengths of the study in that the design of the study was able to document that the positive changes were due to the sit-stand workstation set up and that the Take-a-Stand project was able to reduce sitting time at work and also improve the health of workers.

### **A Pilot Study of Increasing Non-purposeful Movement Breaks at Work as a Means of Reducing Prolonged Sitting**

Cooley and Pedersen [26] describe the feasibility of using a passive approach to increase non-purposeful movement breaks as a means of reducing prolonged periods of sitting at a Tasmanian workplace. 46 (33 female and 13 male) employees were given passive prompts on their computer screens every 45 minutes reminding them to stand and engage in non-purposeful activity throughout the workday over a period of 13 weeks (passive condition). After 13 weeks the prompt was disabled and participants were free to engage the software as they wished (active condition). In the cited study, the passive condition followed the active condition. Key findings reported by the authors included the following (i) there was a high degree of worker acceptance for the e-health intervention- passive condition (computer software prompt to engage in non-purposeful movement breaks); and (ii) that the passive prompt improved the odds of desk-bound subjects complying with non-purposeful movement breaks on the hour, seven times per day, nearly five times more compared to the active condition (where they had to voluntarily engage the software on their own). The authors concluded that a 13-week e-health intervention programme was not sufficient to alter post-intervention worker behaviour to engage

in non-purposeful movement breaks and the sustainability of such an approach needs to be studied further.

## Strength and Limitation

The narrative review proposes that research into physical inactivity represents the 'next frontier' of research that can potentially have significant impact on the physical and metabolic health of working adults. Given that prolonged occupational sitting can be likened to the 'new smoking' in terms of threats to lifespan and longevity, and can increase healthcare costs, a variety of novel and promising interventions at reducing sitting time at the office is highlighted. The narrative review does not provide a meta-analysis of successful workplace intervention programmes and is also not a comprehensive literature review on physical inactivity and interventions to disrupt prolonged sitting at work. Moreover prolonged sitting outside of work also contributes to inimical effects on health.

## Conclusion

An emergent body of knowledge suggests that prolonged sitting is inimical to good health and longevity even for people who meet physical activity or exercise guidelines. Indeed prolonged sitting with extended periods of screen time, either on the computer or with television viewing have been associated with eye strain, high energy density snacking behavior, high blood fats, obesity, insulin resistance and some cancer forms. Long periods of physical inactivity among human subjects are associated with significant decreases in activity or various enzymes that help to regulate metabolism.

Despite this knowledge, physical inactivity continues to be entrenched in the lifestyles of young people and adults in the context of school, work, home, transport and community activities. Substantial benefits- physical, economic and social can be accrued in reducing prolonged sitting at the workplace- and several innovative initiatives are highlighted.

Human beings are created for movement and it appears that it is 'cruel and unusual punishment' to have people sit and remain immobile for long periods of time. Some research show that substituting prolonged sitting with standing all day may also create other health issues like blood pooling in the lower limbs, general fatigue and lower back pain. It therefore appears that interrupting prolonged sitting throughout the day with standing and moving around for a few minutes, many times over, throughout the day could be a promising intervention, which is deserving of greater research attention. If indeed this is found to be beneficial to health over the longer term, the challenge would be to entrench this new workplace behaviour and imbue this movement behavior in schools and offices, at home and in community amenities. How does this new thinking sit with you? Stand up and move around a bit, if you agree. Spread the good word, and repeat the 'sit-stand-and-move-around' action, for your own good.

## References

- Biddle S (2011) Fit to sit? Is there a psychology of sedentary behavior? *Sport and Exercise Psychology Review* 7: 5-10.
- Chia M, Suppiah H (2013) Inactivity physiology- standing up for making sitting less sedentary at work. *Journal of Obesity and Weight Loss Therapy* 3: 171.
- Ainsworth BE, Haskell WL, Herrmann SD, Meckes N, Bassett DR Jr, et al. (2011) 2011 Compendium of Physical Activities: a second update of codes and MET values. *Med Sci Sports Exerc* 43: 1575-1581.
- Bey L, Hamilton MT (2003) Suppression of skeletal muscle lipoprotein lipase activity during physical inactivity: a molecular reason to maintain daily low-intensity activity. *J Physiol* 551: 673-682.
- Levine JA (2003) Non-exercise activity thermogenesis. *Proc Nutr Soc* 62: 667-679.
- Baker IDI Heart and Diabetes Institute.
- Chia M (2012) Still and Heavy - Obesity and Physical Inactivity Among Singaporean Youths- Consequences and Challenges for the 21st Century. *Journal of Obesity and Weight Loss Therapy* 2: e107.
- Sim F (2013) Singapore youths spending more time online.
- <http://news.asiaone.com/News/Education/Story/A1Story20090325-130910.html>
- Thorp AA, Dunstan DW, Clark B (2009) Stand up Australia: sedentary behaviour in workers, report for Medibank Private Limited, Melbourne, Australia.
- Levine J, Melanson EL, Westerterp KR, Hill JO (2001) Measurement of the components of nonexercise activity thermogenesis. *Am J Physiol Endocrinol Metab* 281: E670-675.
- World Health Organisation (2008).
- Oldridge NB (2008) Economic burden of physical inactivity: healthcare costs associated with cardiovascular disease. *Eur J Cardiovasc Prev Rehabil* 15:130-139.
- <http://www.sharetheroad.ca/what-is-the-economic-cost-of-inactivity--p128282>
- Cadilhac DA, Cumming TB, Sheppards L, Pearce DC, Carters R, et al. (2011) The economic benefits of reducing physical inactivity: an Australian example. *Int J Behav Nutr Phys Act* 8: 99.
- Wilmot EG, Edwardson CL, Achana FA, Davies MJ, Gorely T, et al. (2012) Sedentary time in adults and the association with diabetes, cardiovascular disease and death: systematic review and meta-analysis. *Diabetologia* 55: 2895-2905.
- Hamburg NM, McMackin CJ, Huang AL, Sherene A, Shenouda ME, et al. (2007) Physical inactivity rapidly induces insulin resistance and microvascular dysfunction in healthy volunteers. *Arterioscler Thromb Vasc Biology* 27: 2650-2656.
- <http://www.nbcnews.com/id/38385104/ns/health-fitness/>
- Veerman JL, Healy GN, Cobiac LJ, Vos T, Winkler EA, et al. (2012) Television viewing time and reduced life expectancy: a life table analysis. *Br J Sports Med* 46: 927-930.
- Maher C, Olds T, Mire E, Katzmarzyk PT (2014) Reconsidering the sedentary behaviour paradigm. *PLoS One* 9: e86403.
- Conn VS, Hafdahl AR, Cooper PS, Brown LM, Lusk SL (2009) Meta-analysis of workplace physical activity interventions. *Am J Prev Med* 37: 330-339.
- Rutten GM, Savelberg HH, Biddle SJ, Kremers SP (2013) Interrupting long periods of sitting: good STUFF. *Int J Behav Nutr Phys Act* 10: 1.
- Church TS, Thomas DM, Tudor-Locke C, Katzmarzyk PT, Earnest CP, et al. (2011) Trends over 5 decades in U.S. occupation-related physical activity and their associations with obesity. *PLoS One* 6: e19657.
- Koepp GA, Manohar CU, McCrady-Spitzer SK, Ben-Ner A, Hamann DJ, et al. (2013) Treadmill desks: A 1-year prospective trial. *Obesity (Silver Spring)* 21: 705-711.
- Pronk NP, Katz AS, Lowry M, Payfer JR (2012) Reducing occupational sitting time and improving worker health: the Take-a-Stand Project, 2011. *Prev Chronic Dis* 9: E154.
- Cooley D, Pedersen S (2013) A pilot study of increasing nonpurposeful movement breaks at work as a means of reducing prolonged sitting. *J Environ Public Health* 2013: 128376.

This article was originally published in a special issue, **Influence of Diet and Nutrition on Obesity** handled by Editor(s). Dr. Reza Hakkak, University of Arkansas for Medical Sciences, USA