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Accelerometer-Based Physical Activity Intervention Study in the Workplace: Issues and Challenges

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Abstract

Since the majority of adults spend a considerable amount of their time at work, the workplace has been scrutinised in several studies as a setting for physical activity interventions. Although the overall evidence in support of workplace interventions has been mixed, strong evidence suggests the need for individually tailored behaviour change intervention programmes at the workplace. Challenges related to physical activity assessment tools, study design and advocacy to translate evidence into practice were critically reviewed in this paper. Future studies should continue employing more effective strategies and studying employees over a longer period. This review seeks to serve as a reference for future workplace physical activity promotion programmes.

Keywords: Accelerometer, intervention, workplace, issues and challenges

1. Introduction

The World Health Organisation (2014) ^[1] suggests that at least 30 minutes of moderate-intensity physical activity should be carried out on most days, as it decreases the risk of cardiovascular disease and diabetes. Less than 40% of the world's population are performing a sufficient amount of physical activity despite its widely documented health benefits (World Health Organisation, 2004) ^[2]. This situation is expected to persist as physical activity is continuously decreasing in all life environments such as in the workplace (Brownson, Boehmer, & Luke, 2005; World Health Organisation, 2004, 2014) ^[3, 2, 1]. Physical inactivity is the eleventh leading risk factor for global morbidity, responsible for 2% of disability-adjusted life years, and the fourth leading risk factor for global mortality, responsible for 6% of global deaths (World Health Organisation, 2009) ^[4]. The workplace setting offers an ideal avenue to promote physical activity, overcoming frequently cited obstacles such as a lack of time and providing access to a large intersection of society (Malik, Blake, & Suggs, 2014) ^[5].

Physical inactivity is a major risk factor for chronic diseases, yet an increasing number of individuals are not attaining the recommended physical activity levels essential for good health. Malaysians are no exception; 35% of Malaysians aged 18 years and above are not physically active (Institute for Public Health, 2011) ^[6]. Thus, physical activity promotion intervention is suggested as a public health measure (Cobiac, Vos, & Barendregt, 2009) ^[7].

The main focus of physical activity promotion highlighted by the American College of Sports Medicine (1978) ^[8] was three days of vigorous-intensity physical activity for 20 minutes each week to accrue health advantages. However, after a reassessment of the facts, the 1996 U.S. Surgeon General's Report on Physical Activity recommended that 'at least 30 minutes of moderate intensity physical activity for most days weekly was adequate to produce health advantages (U.S. Department of Health and Human Services, 1996) ^[9]. These recommendations allowed governments, including agencies in areas other than sports and health, to promote physical activity. This broader strategy comprised campaigns and programmes such as the promotion of walking in multiple settings, short transport tours and the promotion of 'active living' or short bouts of incidental physical activity as part of daily activities, such as using the stairs rather than the escalator or elevator.

2. The Workplace as a Setting for Physical Activity Promotion Programmes

The workplace has become an important setting for physical activity and health promotion Programmes (Freak-Poli, Wolfe, & Peeters, 2010) ^[10]; World Health Organisation, 2002, 2014 ^[11, 1]; World Health Organisation & World Economic Forum, 2008) ^[12].

The ability to induce positive behavioural changes in the workplace is crucial as occupations have become more sedentary (Ferro-Luzzi & Martino, 1996; Puig-Ribera, McKenna, Gilson, & Brown, 2008; World Health Organisation, 2000, 2009)^[13, 14, 15, 4]. The workplace setting is gradually becoming the centre of attention for physical activity promotion programmes that aim to decrease the risk factors for chronic diseases, since most adults are employed and spend a considerable amount of time in the workplace (Bort Roig *et al.*, 2012^[16]; Zimring, Joseph, Nicoll, & Tsepas, 2005)^[17]. In addition, the majority of adults spend most of their day in and around buildings (Zimring *et al.*, 2005)^[17]. Workplace physical activity and health promotion programme evaluations have revealed improvements in the leading risk factors for global chronic diseases (World Health Organisation, 2014)^[11]. To raise the physical activity level and to decrease the risk of musculoskeletal problems, workplace physical activity programmes must be implemented (Proper *et al.*, 2003)^[18].

Workplace physical activity and health promotion programmes have considerable potential to improve the health and productivity of employees (Riedel, Lynch, Baase, Hymel, & Peterson, 2001)^[19]. The workplace has been examined in several studies as a setting for physical activity interventions due to its broad reach. Yet the evidence in support of workplace interventions has been varied at best. A review of workplace physical activity promotion programmes showed evidence of decreased absenteeism; inconclusive evidence of a positive effect on employees' job satisfaction, job stress and turnover; and no evidence of an effect on productivity (Proper, Staal, Hildebrandt, Van Der Beek, & Van Mechelen, 2002)^[20]. However, a few randomised controlled trials or methodologically rigorous trials have established more authoritative claims. There is still a need for more well-designed research to determine the effectiveness of workplace physical activity interventions and to identify the most promising types of interventions (Malik *et al.*, 2014)^[5].

An early meta-analysis of workplace physical activity intervention studies found inadequate evidence of an increase in physical activity due to workplace interventions (Dishman, Oldenburg, O'Neal, & Shephard, 1998)^[21]. Moreover, the majority of studies included in this early review were considered to be of poor scientific quality (Dishman *et al.*, 1998)^[21]. In contrast, a more selective review of studies of the highest methodological quality demonstrated strong evidence of upsurges in physical activity as a consequence of workplace interventions, although successful approaches within these interventions were not discussed (Proper, Hildebrandt, Van der Beek, Twisk, & Van Mechelen, 2003)^[18]. Another review of studies revealed somewhat more positive results (Marshall, Owen, & Bauman, 2004)^[23]. A more current meta-analysis by Abraham and Graham-Rowe (2009)^[24] found that workplace physical activity intervention had positive effects on physical activity. Likewise, a systematic review of workplace physical activity intervention studies by Dugdill, Brettle, Hulme, McCluskey and Long (2008)^[25] discovered some evidence that workplace walking interventions positively affected physical activity behaviour. Interventions that allow individuals to engage in physical activity during their working day could also help them overcome the commonly cited barrier to physical activity participation, namely lack of time (Dugdill *et al.*, 2008)^[25]. Such interventions may help individuals develop a healthy habit of exercise, which can be more easily sustained after the end of the programme (Verplanken & Melkevik, 2008)^[26].

Previous physical activity research was mainly atheoretical.

Nevertheless, there has been an increasing focus on the significance of theory in the last decade (Baranowski, Anderson, & Carmack, 1998)^[27]. The most frequently used theories in intervention research fall under the bigger umbrella of social cognitive theory and social learning theory. Even though research on theoretical mediators of physical activity behaviour change is vital to advancing the field, it is seldom performed adequately (Lewis, Marcus, Pate, & Dunn, 2002)^[28]. The Institute of Medicine reported that multidisciplinary collaboration is needed to influence and understand health and behaviour.

Programmes providing onsite fitness facilities or appointments with workplace fitness programmes demonstrated little efficacy and were attended mainly by those who were either already physically active or highly motivated to participate (Marshall *et al.*, 2004)^[23]. Strong evidence supports individually tailored theory-based intervention programmes guided by behaviour change theory, in addition to programmes using environmental prompts to encourage stair use. Even among these more successful interventions, however, physical activity gains were usually short term (Marshall *et al.*, 2004)^[23]. As a whole, more methodologically sound and recent workplace interventions have demonstrated generally positive outcomes, particularly when using individually tailored motivational materials and/or prompts, albeit the generalisability of these favourable effects to less motivated employees and to longer periods has not been ascertained. Future studies could benefit from a longer duration of follow-up, with programmes that are integrated into the regular workplace culture and hence not merely seen as interventions (Marshall *et al.*, 2004)^[23].

3. Challenges related to the study instrument

One of the challenges in creating evidence-based physical activity interventions is measuring physical activity. This is a continuing source of academic discussion and debate worldwide, as the measurement of physical activity is made difficult by the multidisciplinary nature of physical activity behaviour and the multiple related environments in which physical activity can occur.

The field of physical activity has been restricted by relatively imprecise behavioural measures, primarily self-report measures, and by research that is typically cross-sectional in nature. Even though self-reports are quite reliable and demonstrate 'moderate' levels of agreement with objective assessments, self-report assessments may over-report physical activity levels. Furthermore, educational and cultural differences lead to complicated comparisons between and within regions. The validity of such research will be more clearly ascertained when interventions are evaluated by harmonised and objective assessment techniques and tools.

The first commercial use of the accelerometer took place in the 1920s, when accelerometers were used to detect vibrations in bridges and to measure accelerations in aircrafts (Walter, 2007)^[29]. While accelerometers give objective assessments, some drawbacks must be noted. They mainly assess locomotion when attached to the waistband or belt, thus neglecting upper body movement. In addition, they cannot determine whether an individual bringing a load, e.g. walking while carrying a heavy bag, uses up more energy compared with an individual walking without a load. Accelerometers cannot detect the body posture. Hence, they cannot differentiate between standing still and sitting.

Participants might lose or fail to return their accelerometers. For instance, the rate of loss in the Women's Health Survey

(Shiroma, Freedson, Trost, Lee, & I-Min, 2013) ^[30] was 2.1%. While this appears insignificant, 2.1% of the 20,000 who were expected to return their accelerometers translates to 420 units, which come at a considerable cost. In the REGARDS study, researchers reported an 8% loss rate (Howard *et al.*, 2013) ^[31]. Technological development should be embraced, but standardisation in measurement ensures that what is detected as a step today will remain so in the future. Unfortunately, manufacturers' assessment technology is patent protected; this forces competitors to develop alternative approaches, so a solution to the setback is not at hand. There is no authoritative body that demands the standardisation of outputs or supervises quality control. This implies that what is labelled a step by one instrument might not necessarily be labelled as such by another instrument. The measurement of step counts is not the only output concerned; the same issues apply to the objectively monitored time spent in moderate-to-vigorous intensity physical activity (Tudor-Locke, 2010) ^[32].

4. Challenges related to the study design

A randomised trial is best carried out in a double-blind approach, in which neither the participants nor the researchers are aware of the group assignments. However, this approach is impossible in a physical activity intervention study. Only single-blind trials are feasible, in which only the data collection personnel are unaware of the group assignments (Dishman, Washburn, & Heath, 2004) ^[33].

Another difficulty in randomised trials is retaining the number of participants throughout the follow-up period. Given the high rates of attrition in numerous studies, the practicality and feasibility of different types of workplace interventions may also warrant exploration in future studies. This will allow researchers and policymakers to determine whether particular types of interventions are more suitable for certain types of organisations (Malik *et al.*, 2014) ^[5].

Even though some benefits of lifestyle approaches have been ascertained, outcomes are rarely assessed more than one year after baseline, and even fewer studies measure outcomes following a period of no intervention. Typically, maintenance periods involve the continuation of the intervention or a less intensive, scaled-down version of the initial programme. Once researchers and the interventions they offer are no longer prominent, physical activity is likely to decline. Although there has been substantial research on the determinants of physical activity adoption and some interventionists have identified factors that may influence physical activity maintenance (Marcus *et al.*, 2000) ^[34], more research is needed in this area.

There is no shortage of calls for more research on physical activity maintenance and enhanced maintenance interventions, yet there are challenges to performing research in this area. Most studies usually include reduced or modified interventions following the intensive interventions because physical activity generally declines after interventions cease (Marcus *et al.*, 2000) ^[34]. Consequently, we understand little about what happens to physical activity behaviour after all interventions have ceased. Another barrier to physical activity maintenance research is that participants must initially become active before the effect of an intervention on behavioural maintenance can be assessed. Hence, studies with interventions that do not bring about initial behaviour change cannot assess behavioural maintenance, and assessments of participants who do initially improve their physical activity level cannot be causal because randomisation usually happens at the initiation of the intervention. One possible solution to this setback is to re-

randomise initially successful participants to physical activity maintenance interventions. Another potential solution is to recruit and randomise already active participants to maintenance interventions. Additionally, researchers must develop or improve theoretical models to tackle the factors influencing behaviour maintenance instead of presuming that the factors affecting behaviour initiation will also affect behaviour maintenance (Rothman, 2000) ^[35].

Low attrition, high recruitment and compliance will maximise the impact of any programme. Studies with recruitment and compliance rates of 40% to 80% emphasise the need for researchers to recognise and assess creative recruitment strategies to maximise and sustain employees' participation. More proactive and innovative strategies affecting a greater number of employees, specifically those who are physically inactive, are needed. The most promising strategy seems to be the promotion of incidental activity such as increasing stair use or active transport to/from work (Boutelle, Jeffrey, Murray, & Schmitz, 2001; Marshall, Bauman, Patch, Wilson, & Chen, 2002; Marshall, Leslie, Bauman, Marcus, & Owen, 2003; Mutrie *et al.*, 2002; Webster, 2001) ^[36, 37, 38, 39, 40]. Simple strategies such as reducing prolonged sitting time at work and promoting alternatives to 'passive' workplace electronic communication may also be effective in promoting 'incidental' walking in the workplace (Marshall, 2004) ^[41].

Many of the published intervention studies had a narrow focus, often using single (selected) intervention strategies in specific settings with volunteer samples (Shilton, Bauman, Bull, & Sarmiento, 2007) ^[42].

5. Challenges in translating evidence-based physical activity interventions into practice

Although the health benefits of physical activity are supported by strong epidemiological evidence, this evidence has not been translated into initiatives promoting physical activity or into the development and implementation of national physical activity policies and action plans. This incongruity between the commitment and the evidence calls for strategic approaches and the prioritisation of advocacy for physical activity (Shilton, 2006) ^[43].

The impact of physical inactivity on the disease burden is underscored by its high and increasing prevalence; physical inactivity is a major cause of the population attributable risk for non-communicable diseases (Bauman & Miller, 2004) ^[44]. Although a considerable amount of the evidence on the advantages of physical activity was established by 1990, it may take decades to translate this evidence base into public health initiatives. Physical activity promotion is in the preliminary development stage and continues to be a key priority area for health promotion policy initiatives. Furthermore, the promotion of various types of physical activity in different settings, such as cycling and walking, may be linked with other issues such as traffic reduction and cleaner air.

Opportunities for the dissemination of research results on effective physical activity practices have risen in recent years. Specifically, the number of published studies regarding evaluated physical activity programmes in peer-reviewed journals has increased. Publications related to the issue have also been launched, such as the *Journal of Physical Activity and Health*, which publishes review papers and original studies investigating the association between health and physical activity, and the *International Journal of Behavioural Nutrition and Physical Activity*.

It must be noted that some of the evidence supporting physical

activity promotion comes from cross-sectional studies, which do not offer robust evidence of 'effectiveness'. Hence, most of these studies may provide weak evidence from a scientific, 'methodological' point of view. The future evidence base must therefore be composed of research that uses improved study designs.

Despite its significant development, physical activity promotion remains a 'new' field. It continues to be overshadowed by other conventional fields, e.g. tobacco control initiatives, and contemporary fields, e.g. obesity prevention, which have a less significant population burden and less evidence but greater financial support and political interest.

Physical activity is inappropriately resourced compared to its promise to health promotion. This calls for continuing advocacy to encourage policy development and political commitment for physical activity promotion. Physical activity promotion programmes optimally operate within and outside the health area; they require collaboration, joint planning and co-funding between agencies and are time-consuming to create. These concerns are more pronounced in rapidly urbanising and developing countries. Planners and builders of transport systems and built environments are essential prospective partners in dealing with physical inactivity. Policymakers in key settings such as worksites and local government make policy decisions with noteworthy effects on physical activity. The interdisciplinary nature of this area also provides methodological challenges, such as partnerships between researchers, policymakers and practitioners from outside the health area. This might require operating in various approaches and diverse paradigms (Shilton *et al.*, 2007) ^[42].

The criteria for excellent practice in promoting physical activity are as follows:

- a. Discussion with related shareholders throughout the establishment of physical activity action plans and policies
- b. Implementation of a comprehensive physical activity promotion method with multiple strategies, such as individually tailored and environmentally oriented interventions aimed at various population groups, e.g. children, youth, women, elderly, indigenous and disabled
- c. Operation at diverse levels, e.g. local, state, national, individual, community and physical environment
- d. Establishment and adoption of the action plans and policies in numerous settings and agencies through alliances, partnerships and coalitions, e.g. cross-government, non-government and related partners in the private sector
- e. Incorporation of physical activity action plans and policies within and outside the health sector, e.g. in nutrition, health, environment and transport
- f. Established foundation of support and resources to execute the action plans and policies
- g. Establishment of a character for the physical activity programme using a symbol, slogan or branding; identification and development of a spokesperson and communication/advocacy plan
- h. A clear declaration of the time frame for the realisation of the physical activity action plan
- i. Detailed resources and plans for the assessment of endeavours related to physical activity promotion
- j. Establishment or maintenance of physical activity monitoring or surveillance procedures such as appropriate assessments of physical activity levels and associated factors in the population

- k. Declaration of the development or recognition of available national recommendations or guidelines on physical activity (Shilton *et al.*, 2007) ^[42]

One of the drawbacks of the existing evidence base is the limited generalisability of the results to developing countries. Further research is needed to enhance the generalisability of workplace physical activity programmes to all employees and population groups, especially those most at risk. In addition, the extent to which approaches may be translated and sustained across various working contexts, e.g. part-time, blue-collar and rural employees, should be investigated. More evidence of the long-term sustainability of workplace physical activity intervention and data on their cost-effectiveness are needed (Chan, 2009) ^[45]. For instance, the prevalence of metabolic syndrome varies across working contexts, with transportation employees at greatest risk of metabolic syndrome. Workplace physical activity promotion interventions tackling risk factors for metabolic syndrome, which target employees in working contexts with the greatest risk, may be an efficient approach to reach at-risk populations (Davila *et al.*, 2010) ^[46].

Some policy recommendations can be drawn from the existing research. Several policies give incentives for people to be physically inactive, but it is difficult to identify current policies that emphasise physical activity. For example, employees are reimbursed when they travel by motor vehicles but not when they travel by walking or cycling. Medical insurance reimburses the treatment of diseases caused by inactive lifestyles, but most companies do not offer incentives for people to be physically active and prevent those diseases. These and other incentive-related policies need to be revised (Schmid, Pratt, & Witmer, 2006) ^[47].

Advocates for physical activity promotion face two major challenges. The first is to make everyone aware of the dangers of being physically inactive. The second is to convince everyone that they can do something about it. Ignorance and inertia caused by denial or the expectation of a miraculous fix are dangerous. Physical activity professionals should better comprehend the art and science of advocacy and use them more effectively. This may require better expression of the evidence justifications and a strategic method to advocacy (Shilton, 2006) ^[42]. The status of physical activity promotion at the political level should be elevated.

Our understanding of sedentariness or inactivity is limited. The changing workplace, economy, lifestyles and transport systems have brought about increased sitting time and hours of inactivity at home and at work. In this field, we have negligible knowledge of effective health promotion strategies to encourage people to 'move more and sit less'. With the rising preferences for sedentary occupations and recreation, well-funded campaigns are needed to prevent inactivity and promote an active lifestyle.

Analyses of the cost-effectiveness of physical activity interventions, the economic cost of physical inactivity and the cost benefits of engaging in physical activity are crucial drivers of policy decisions. Hence, enhancing knowledge of the costs of physical inactivity is a strong political advocacy knob. In addition, the economic justifications for the funding of physical activity intervention programmes are poorly developed (Pratt, Macera, Sallis, O'Donnell, & Frank, 2004; Sturm, 2005) ^[48, 49].

The majority of national governments do not have a specific and formal national physical activity plan. Physical activity is not included in the current health plans and policies and is not

listed under non-communicable disease or obesity prevention plans. When governments develop such health plans and policies, they may allow non-government parties to concentrate on disease-specific interventions. Policy strategies are often economical, as they may use available resources (Shilton *et al.*, 2007) [42].

Physical activity requires more attention; thus, physical activity advocacy should be the main concern. The low priority given by national governments to physical activity has reduced health promotion efforts for physical activity. Despite the World Health Organisation’s (2014) [1] Global Strategy on Diet, Physical Activity and Health, physical activity has been subsumed under the obesity and nutrition plans.

If our eventual evaluation of effectiveness is raised population physical activity levels, much remains to be done. For instance, research must be conducted on why and in what ways some physical activity promotion programmes are effective. The most important issue is advocacy to ensure that national and global commitments are made to develop physical activity action plans and policies, to mobilise resources and to adopt these plans.

6. Opportunities

Workplace physical activity interventions are associated with fairly small improvements in physical activity. This might be because the participants of these interventions are likely to be already highly active individuals who may not need further improvements in their physical activity levels and who are expected to have a limited increase in step counts (Backholer, Freak-Poli, & Peeters, 2012) [50]. Workplace physical activity programmes have been criticised for recruiting employees who are already physically active (Thomas & Williams, 2006) [51].

Employees who sit for a large proportion of their working day also report longer sitting duration outside work. They do not compensate for their inactive behaviour at work by being more active outside work (Clemes, Patel, Mahon, & Griffiths, 2014) [52].

Hence, for workplace physical activity interventions to have broader health benefits, inactive employees should be targeted. Interventions to promote walking could considerably increase the physical activity levels of the most sedentary individuals. Increasing the population’s physical activity level, specifically among the most sedentary, has therefore become a primary aim of current public health policy (Department of Health, 2004; Physical Activity Task Force, 2003) [53, 54]. Researchers must help develop innovative workplace physical activity promotion programmes.

The studies reviewed by Marshall (2004) [23] corroborate the view that it is difficult to change behaviour in the workplace setting due to the complexity of changing workplace culture. Future studies should incorporate measures that will be of interest to employers. Greater understanding and an assessment of desirable employer-related outcomes-such as decreased job stress, turnover and absenteeism as well as improved job satisfaction and productivity-are needed. How these outcomes are associated with physical activity should also be explored. Multi-strategy interventions that include individually tailored strategies, mass reach strategies (print and electronic media) and social support approaches should be implemented. Management support and incorporation within the organisational structure are crucial as well. A shift in thinking is necessary so that interventions are not perceived as short-term programmes but as part of the workplace culture (Marshall, 2004) [23].

Table 1: Chronology of physical activity promotion (Adapted from Shilton *et al.*, 2007)

Physical activity scientific development	Main physical activity scientific documents and papers	Year	Development of promoting physical activity	Main documents on physical activity promotion
Primary published evidence of health advantages of physical activity	Morris, 1953	1953	Focus on: Exercise Individual’s behaviour Changes in fitness Health education	
American College of Sports Medicine (ACSM) recommendations 1978	ACSM, 1978		Health needs vigorous and aerobic exercise	
Landmark research specifies the health advantages of moderate intensity physical activity	Paffenbarger Blair, 1989	1980s	Focus on: Health promotion models (begun but not well developed for physical activity till later)	Ottawa Charter on health promotion 1986
Progressive research corroborates advantages of moderate intensity physical activity, walking		1990-1995	Conclusive evidence for the health advantages of physical activity	1993 AHA statement raises physical activity as a risk factor
Shift towards identifying community based strategies	1996 US Surgeon General’s Report on Physical Activity and Health	1995-1999	Recognized policy, environmental and individual impacts on physical activity Increasing focus in ecological models of physical activity Emerging collaboration with non-health sectors	Jakarta Declaration on Health Promotion 1997, AHA plan for a strategic approach to physical activity
Emerging research concentrate on the built and physical environments and their association to leisure-time physical activity, active transportation	Active living research Supplement issues of AJHP Supplement issues in AJPH Supplement issues of AJPM	2000-2005	Development of national and international physical activity networks The focus on physical activity has been distracted by obesity	CDC Community Guide published to sum up program effectiveness (2002) Formation of HEPA, PANA/RAFA, and AP-PAN networks Agita Mundo (Move for health) movement joint

				statement of ACS, AHA, and DA on physical activity
First international congress on public health and physical activity		2006	First international congress on public health and physical activity, Atlanta development of the Global Alliance for Physical activity (GAPA)	
<p>Possible upcoming directions in physical activity scientific development</p> <p>Understanding evaluation and impacts of:</p> <ul style="list-style-type: none"> - Physical inactivity (sedentariness) -Variation in socio-demographic -Variation in physical activity between developed and developing nations -Impacts on economy -Environments -Science and art of advocacy -Change in policy -Cultural preferences <p>-Association between physical activity and cognitive function</p> <ul style="list-style-type: none"> -Strategies to equalize physical activity for leisure as well as for transport in swiftly urbanizing, developing world 		The future	<p>Possible upcoming directions in the development of physical activity health promotion</p> <p>Focus on:</p> <ul style="list-style-type: none"> -Development of global networks -Develop and adopt global and regional physical activity plans around the Global Strategy on Diet, Physical Activity and Health (WHO, 2004) -Create inter-sector collaboration, particularly with education, transport and urban planning fields - Programs that tackle diversity and inequity -On-going concern on creating evidence base through researches that affect social and physical environments -Emphasize on intervention focusing policy and advocacy -Advocacy for prioritize physical activity as a national policy -Highlighting physical activity in weight management programs -Interventions to decrease the unfavourable effects on active transportation as car proprietorship rises and reduces walkability in developing nations 	

7. Conclusion

This review is a testament to how far workplace physical activity promotion has advanced. Cross-sectional study designs and inaccurate assessments of physical activity behaviours have restricted knowledge on this topic. Further insight is crucial to developing physical activity intervention programmes that can reach employees across various working contexts, especially those who need it most. Given the recognised benefits of physical activity on health and the increasing emphasis on the workplace as a key setting for the promotion of physical activity, well-designed workplace physical activity intervention studies must be conducted to evaluate the effectiveness of workplace interventions promoting physical activity.

8. References

1. World Health Organization. Physical inactivity: A global public health problem. cited July, 2014. Available from: http://www.who.int/dietphysicalactivity/factsheet_inactivity/e/.
2. World Health Organization. Global strategy on diet, physical activity and health. Switzerland: World Health Organization, 2004.
3. Brownson RC, Boehmer TK, Luke DA. Declining rates of physical activity in the United States: What are the contributors? *Annual Review of Public Health*, 2005; 26: 421-443.
4. World Health Organization. Global health risks: Mortality and burden of disease attributable to selected major risks. Geneva: World Health Organization Press, 2009.
5. Malik SH, Blake H, Suggs LS. A systematic review of

workplace health promotion interventions for increasing physical activity. *British Journal of Health Psychology*. 2014; 19:149-180.

6. Institute for Public Health. The Fourth National Health and Morbidity Survey. Malaysia: Ministry of Health, 2011.
7. Cobiac LJ, Vos T, Barendregt JJ. Cost-effectiveness of interventions to promote physical activity: A modeling study. *Plos Medicine*, 2009; 6:7. e1000110. doi: 10.1371/journal.pmed.1000110
8. American College of Sports Medicine. American College of Sports Medicine position statement on the recommended quantity and quality of exercise for developing and maintaining fitness in healthy adults. *Medicine and Science in Sports*, 1978; 10(3): vii-x.
9. US Department of Health and Human Services. Physical activity and health: A report of the US Surgeon General. Atlanta, Georgia: National Centers for Disease Control, 1996.
10. Freak-Poli R, Wolfe R, Peeters A. Risk of cardiovascular disease and diabetes in a working population with sedentary occupations. *Journal of Occupational and Environmental Medicine*. 2010; 52:1132-1137.
11. World Health Organization. Good practice in occupational health services: A contribution to workplace health. Copenhagen: World Health Organization, 2002.
12. World Health Organization & World Economic Forum (WHO & WEF). Preventing noncommunicable diseases in the workplace through diet and physical activity: WHO/World Economic Forum report of a joint event. Geneva: World Health Organization, 2008.

13. Ferro-Luzzi A, Martino L. Obesity and physical activity. Ciba Foundation symposium discussion 1996; 201(207-221):221-227.
14. Puig-Ribera A, McKenna J, Gilson N, Brown WJ. Change in work day step counts, wellbeing and job performance in Catalan university employees: A randomized controlled trial. *Promotion & Education*, 2008; 5(4):11-16.
15. World Health Organization. Obesity: Preventing and managing the global epidemic. Geneva: World Health Organization, 2000.
16. Bort Roig J, Puig Ribera A, Gilson N, Gonzalez A, Martinez Lemos I, Gine Garriga M, *et al.* A 5-months workplace pedometer-based intervention: Did it change employees' sedentary behaviour 2 months after removal? *Journal of Science and Medicine in Sport*, 15(Supplement1): S197. doi: 10.1016/j.jsams. 2012; 11:483.
17. Zimring C, Joseph A, Nicoll GL, Tsepas S. Influences of building design and site design on physical activity: Research and intervention opportunities. *American Journal of Preventive Medicine*. Supplement2). 2005; 28(2):186-193.
18. Proper KL, Koning M, van der Beek AJ, Hildebrandt, VH Bosscher, R. van Mechelen W. The effectiveness of worksite physical activity programs on physical activity, physical fitness and health. *Clinical Journal of Sports Medicine*. 2003; 13(2):106-117.
19. Riedel JE, Lynch W, Baase C, Hymel P, Peterson KW. The effect of disease prevention and health promotion on workplace productivity: A literature review. *American Journal of Health Promotion*. 2001; 15(3):167-191.
20. Proper KI, Staal BJ, Hildebrandt VH, Van Der Beek AJ, Van Mechelen W, Effectiveness of physical activity programs at worksites with respect to work-related outcomes. *Scandinavian Journal of Work, Environment & Health*. 2002; 28(2):75-84.
21. Dishman RK, Oldenburg B, O'Neal H, Shephard RJ. Worksite physical activity interventions. *American Journal of Preventive Medicine*. 1998; 15:344-361.
22. Proper KI, Hildebrandt VH, Van der Beek AJ, Twisk JW, Van Mechelen W, Effect of individual counseling on physical activity fitness and health: A randomized controlled trial in a workplace setting. *American Journal of Preventive Medicine*. 2003; 24:218-226.
23. Marshall AL, Owen N, Bauman AE, Mediated approaches for influencing physical activity: Update of the evidence on mass media, print, telephone and website delivery of interventions. *Journal of Science and Medicine in Sport*, 7(Suppl). 2004, 74-80.
24. Abraham C, Graham-Rowe E, Are worksite interventions effective in increasing physical activity? A systematic review and meta-analysis. *Health Psychology Review*, 2009, 3. 108-144. doi:10.1080/17437190903151096
25. Dugdill L, Bretle A, Hulme C, McCluskey S, Long AF. Workplace physical activity interventions: A systematic review. *International Journal of Work Health Management*. 2008; 1:20-40. doi: 10.1108/17538350810865578
26. Verplanken B, Melkevik O, Predicting habit: The case of physical exercise. *Psychology of Sport and Exercise*, 2008; 9:15-26. Doi: 10.1016/j.psychsport.2007.01:002
27. Baranowski T, Anderson C, Carmack C, Mediating variable framework in physical activity interventions: how are we doing? How might we do better? [published correction appears in *American Journal of Preventive Medicine*, 17, 98] *American Journal of Preventive Medicine*. 1998; 15:266-297.
28. Lewis BA, Marcus BH, Pate RR, Dunn AL, Psychosocial mediators of physical activity behaviour among adults and children. *American Journal of Preventive Medicine*. (Suppl), 2002; 23:26-35.
29. Walter PL. The history of the accelerometer: 1920s-1996-prologue and epilogue 2006. *Sound and vibration*, January, 2007, 84-92 [Published Online First].
30. Shiroma EJ, Freedson PS, Trost SG, Lee, I-Min. Patterns of accelerometer-assessed sedentary behaviour in older women. *JAMA*, 2562-2563. doi: 10.1001/jama.2013.278896, 2013; (3)10:23.
31. Howard VJ, Rhodes JD, Hutto B, Hearld KR, Colabianchi N, Vena JE, *et al.* Successful use of telephone and mail for obtaining usable accelerometer data from a national cohort: the experience of the Reasons for Geographic and Racial Differences in Stroke (REGARDS) Study. *Circulation*, 2013; 127:AP145.
32. Tudor-Locke C. Steps to better cardiovascular health: How many steps does it take to achieve good health and how confident are we in this number? *Curr Cardio Risk Rep*, 2010; 4:271-276.
33. Dishman RK, Washburn RA, Heath G. Physical activity epidemiology. Human Kinetics Publishers, Champaign, IL, 2004.
34. Marcus BH, Dubbert PM, Forsyth LH, McKenzie TL, Stone EJ, Dunn AL, *et al.* Physical activity behaviour change: Issues in adoption and maintenance. *Health Psychology*, 19(Suppl), 2000, 32-41.
35. Rothman AJ. Toward a theory-based analysis of behavioural maintenance. *Health Psychology*, 19(Suppl), 2000, 64-69.
36. Boutelle KN, Jeffrey RW, Murray DM, Schmitz MKH. Using signs, artwork, and music to promote stair use in a public building. *Am J Public Health*, 2001; 91(12):2004-2006.
37. Marshall AL, Bauman AE, Patch C, Wilson J, Chen J. Can motivational signs prompt increases in incidental physical activity in an Australian health-care facility? *Health Education Res* 2002; 17(6):743-749.
38. Marshall AL, Leslie EL, Bauman AE, Marcus BH, Owen N. Print versus website physical activity programs: A randomized trial. *Am J Prev Med*. 2003; 25(2):88-94.
39. Mutrie N, Carney C, Blamey A, Crawford F, Aitchison T, Whitelaw A. Walk in to work out: A randomized controlled trial of a selfhelp intervention to promote active commuting. *J Epidemiol Community Health*. 2002; 56:407-412.
40. Webster J. Strategy not return on investment, drives health promotion at Applied Materials, Inc. *Am J Health Promot*. 2001; 15(5):373-375.
41. Marshall AL. Challenges and opportunities for promoting physical activity in the workplace. *Journal of Science and Medicine in Sport*. 2004; 7(1)60-66.
42. Shilton T, Bauman A, Bull F, Sarmiento O. Effectiveness and challenges for promoting physical activity globally. In: *Global Perspectives on Health Promotion Effectiveness*, Springer, New York 2007, 87-106.
43. Shilton TR. Advocacy for physical activity - from evidence to influence. *Promotion & Education*, 2006; 13(2):118-126.

44. Bauman AE, Miller Y. The public health potential of health enhancing physical activity (HEPA), in Health enhancing physical activity, Multidisciplinary Perspectives of Physical Education and Sport Science, Eds: Oja P, Borms JM. & Meyer Sport Publishers, Oxford, United Kingdom. 2004, 6:125-149.
45. Chau J. Evidence module: Workplace physical activity and nutrition interventions. Physical Activity Nutrition and Obesity Research Group, University of Sydney. 2009.
46. Davila EP, Florez H, Fleming LE, Lee DJ, LeBlanc WG, Caban-Martinez AJ *et al.* Prevalence of the metabolic syndrome among U.S. workers. *Diabetes Care*, 2010; 33(11):2390-2395.
doi: 10.2337/dc10-0681
47. Schmid TL, Pratt M, Witmer L. A framework for physical activity policy research. *Journal of Physical Activity and Health*. 2006; 3:S20-S29.
48. Pratt M, Macera CA, Sallis JF, O'Donnell M, Frank LD. Economic interventions to promote physical activity: Application of the SLOTH model. *American Journal of Preventive Medicine*. 2004; 273(1):136-145.
49. Sturm R. Economics and physical activity: A research agenda. *American Journal of Preventive Medicine*. 2005; 28(2):141-149.
50. Backholer K, Freak-Poli R, Peeters A. Daily step-count and change in waist circumference during a workplace pedometer program. *Open Journal of Preventive Medicine*. 2012; 2(2):249-256. doi:10.4236/ojpm.2012.22036
51. Thomas L, Williams M. Promoting physical activity in the workplace: Using pedometers to increase daily activity levels. *Health Promot J Aust*. 2006; 17(2):97-102.
52. Clemes SA, Patel R, Mahon C, Griffiths PL. Sitting time and step counts in office workers. *Occupational Medicine*, 2014; 64:188-192.
53. Department of Health. Choosing health: Making healthy choices easier. Stationery Office, London, 2004.
54. Physical Activity Task Force. Let's make Scotland more active: A strategy for physical activity. Scottish Executive, Edinburgh, 2003.