

## Physical Activity Management and its Role for Health Benefits: Narrative Review

Suliman Mansi<sup>1</sup> & Hasan Mohammed Al Khaldi<sup>2</sup>

### Abstract

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In developed countries, modern conveniences and technology have contributed to increasing physical inactivity among adults. For example, World Health Organization (WHO) reported in 2008, 31% of adults exhibit a sedentary lifestyle, and have a 20-30% increased risk of mortality compared to active people. Therefore, increasing the level of physical activity to help them become more active, and hence reduce the burden of chronic diseases and improve health-related quality of life (HRQL) is considered important. The purpose of this review is to summarize existing evidence for a relationship between increased physical activity and decreased risk of chronic conditions such as type 2 diabetes mellitus, Cancers, Overweight and obesity, and Musculoskeletal disorders. It is based on a narrative review of published research that has reviewed and evaluated the benefits of physical activity on health and well-being in general populations. The review begins with an overview of physical activity concept, and sedentary lifestyle in general. A detailed description of the physical activity recommendations, health benefits of physical activity in general is then reviewed.

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**Keywords:** Physical activity, health benefits, chronic disease, walking, exercise

### 1. Physical activity concept

Daily physical activity is defined as "any bodily movement produced by the skeletal muscle those results in energy expenditure" (Caspersen, Powell et al. 1985). Physical activity can be classified in different ways including intensity, duration, type, frequency and context (Rafferty, Reeves et al. 2002; Haskell, Lee et al. 2007). Intensity refers to how much energy is required by muscle when exercising. For example, moderate-intensity corresponds to around 3 to 5 metabolic equivalents (METs) or 55-69% of Maximal Heart Rate (Haskell, Lee et al. 2007), while vigorous-intensity physical activity corresponds to around 7 to 9 METs (Haskell, Lee et al. 2007). One MET is defined as 1 kcal/kg/hour and is equal to the energy produced per unit surface area of an average person obtained during quiet sitting (Ainsworth, Haskell et al. 2011).

Moderate-intensity and vigorous-intensity physical activity are the most common activities engaged in by the adult population (Rafferty, Reeves et al. 2002). However, these four principles are all modifiable, knowing that independently or combined they are necessary for providing valuable insight for future intervention programmes. In general, these principles may apply for both the diseased and the healthy adult; however, the ways in which they are applied differ, and appropriate adjustments in each of these principles are necessary for most populations (Myers 2008). Therefore, walking is deemed to be one of the most effective forms of physical activity as it is usually carried out in several activity types, including occupational, transportation, leisure time, and household, with little risk of injury (Siegel, Brackbill et al. 1995) helping to promote and maintain health status in the general population.

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<sup>1</sup> PhD, School of Physiotherapy, University of Otago, Dunedin 9054, New Zealand, [sulimanmansi@yahoo.com](mailto:sulimanmansi@yahoo.com), Telephone: 006421515048

<sup>2</sup> PhD, Faculty of Physical Education and Sport Sciences, The Hashemite University, Zarqa 13133, Jordan

## 2. Sedentary lifestyle

Physical inactivity and sedentary lifestyles including TV viewing, computer use, playing video games, and sitting time at work or school, are important risk factors for many chronic diseases. Many studies have demonstrated an association between physical inactivity and increased rates of chronic diseases including hypertension, cardiovascular disease, diabetes, obesity, and metabolic syndrome (Kokkinos, Sheriff et al. 2011; Cooper, Sebire et al. 2012; Edwardson, Gorely et al. 2012; Kushi, Doyle et al. 2012; Matthews, George et al. 2012; Van Der Ploeg, Chey et al. 2012; van Zyl, van der Merwe et al. 2012). The researchers concluded that sedentary lifestyles have become the most important public health challenge in developed countries. The economic burden of physical inactivity has increased to an estimated 1.5-3.0% of total direct health-care costs (Oldridge 2008); for example, the annual cost for direct health-care was £0.9 billion in the UK, \$5.3 billion in Canada, and \$24 billion in USA (Scarborough, Bhatnagar et al. 2011; Kohl, Craig et al. 2012). According to a World Health Organization (WHO) report in 2008, 31% of adults 15 years old and over exhibit a sedentary lifestyle, and have a 20-30% increased risk of mortality compared to active people. Physical inactivity is the fourth leading risk factor for mortality, accounting for 3.2 million deaths globally each year (World Health Organization 2011; Lee, Shiroma et al. 2012).

A survey conducted on US adults, aged 50-70 years, revealed that sedentary lifestyle behaviours such as prolonged television viewing and overall sitting time were positively associated with mortality after controlling for age, sex, education, smoking, diet, race, and moderately vigorous physical activity (Matthews, George et al. 2012). Other studies reported an association between sedentary behaviour, time spent on computer and TV watching, and all causes of mortality (Owen, Healy et al. 2010; Atkin, Adams et al. 2012; Ford 2012; Katzmarzyk and Lee 2012; Stamatakis, Hamer et al. 2012). The priorities of physical activity guidelines are to increase the levels of activity to achieve health benefits across the life span.

## 3. Physical activity recommendation

Physical activity is accepted as improving overall health and quality of life (Warburton, Nicol et al. 2006). Historically, there is painting evidence for physical activity being an important factor in maintaining the health and strength of soldiers in ancient Rome (MacAuley 1994). Since the middle of the last century, the benefit of physical activity leading to improved public health has been identified. In 1972, the American Heart Association (AHA) produced the first formal public health recommendation, titled "Exercise testing and training of apparently healthy individuals: A handbook for physicians" (American Heart Association 1972). This recommendation particularly focused on the beneficial impact of moderate to vigorous exercise on reducing risk for cardiovascular disease. Since the acceptance of these guidelines a number of other countries have also produced physical activity guidelines (Table 1) that have focused on improved health and reduction of risk for health disorders (Tremblay, Warburton et al. 2011; Australian Government 2014). The recommendations in these guidelines have marked similarity and although there are variances in types, frequency and intensity of activity the benefits of such interventions are particularly directed at improving health and reducing risk and reduction of the cost of health care.

In 1978 the American College of Sports Medicine (ACSM) also published the first form of public health recommendation on the amount and intensity of physical activity needed for developing and maintaining cardiorespiratory fitness by accumulating 15-60 minutes of aerobic exercise, 3-5 per week (American College of Sports Medicine 1978). In 1995 the ACSM and the Centres for Disease Control and Prevention (CDC) published an update of a new public health recommendation stating that "All adults should accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week". The recommendation focused on increasing physical activity, encouraging people with a sedentary lifestyle to become active in order get more health benefits. Brisk walking was recommended as one way to accumulate up to 30 minutes of moderate intensity daily physical activity (Pate, Pratt et al. 1995).

**Table 1: Comparison of physical activity recommendations in different countries**

Countries	Children 6-17 years of age	Adults 18-64 years of age	Older adults 65 years of age or older	References
USA	60 or more minutes of physical activity each day	At least 150 min a week or 75 min of vigorous activity each week	For 150 min each week or 75 min of vigorous activity each week	( <a href="#">Department of Health and Human Services 2008</a> )
Canada	At least 60 min of moderate- to vigorous- intensity physical activity daily	At least 150 min of moderate- to vigorous-intensity physical activity per week, in bouts of 10 min or more	At least 150 min of moderate- to vigorous-intensity physical activity per week, in bouts of 10 min or more	( <a href="#">Tremblay, Warburton et al. 2011</a> )
UK	For 60 minutes each day	At least 30 min of at least moderate- intensity physical activity a day, on 5 or more days a week.	In addition to adults, strength and balance activities two days per week	( <a href="#">Fiona Bull, Stuart Biddle et al. 2010</a> )
Australia	At least 60 min of moderate to vigorous intensity physical activity every day	Accumulate 150 to 300 min of moderate intensity physical activity or 75 to 150 min of vigorous intensity physical activity each week	At least 30 min of moderate intensity physical activity on most, preferably all, days.	( <a href="#">Australian Government 2014</a> )
NZ	60 min or more of moderate to vigorous physical activity	30 min of moderate intensity physical activity on most if not all days of the week	30 min of moderate intensity; or for 15 minutes vigorous intensity	( <a href="#">Ministry of Health 2001</a> )

USA: The United States of America, UK: United Kingdom of Great Britain and Northern Ireland, and NZ: New Zealand

In 2007 physical activity recommendations (for adults aged 18-65 years) were updated (Haskell, Lee et al. 2007). The purpose was to clarify the 1995 recommendations for determining the type and amount of physical activity necessary to improve and maintain health outcomes. This update concluded:

- . Adults aged 18-65 years old should accumulate a minimum of 30 minutes of moderate- intensity aerobic physical activity, on five days each week or vigorous-intensity aerobic physical activity for at least 20 minutes on three days per week, or a combination of moderate and vigorous-intensity activity.

- . Moderate-intensity aerobic physical activity or equivalent should be performed for at least 10 minutes or more per bout.

- . To increase or maintain muscular strength and endurance, exercise involving major muscle groups should be performed a minimum of two days per week.

- . Adults who need further health benefits, to help reduce risk of chronic diseases should increase their activities to 300 minutes of moderate-intensity activity per week, or 150 minutes of vigorous-intensity aerobic physical activity (Haskell, Lee et al. 2007).

In older adults, 65 years old and above, and/or adults aged 50-64 years with clinically significant chronic conditions or functional limitation (regular medication needs, or impaired ability to carry out physical activity, respectively), separate recommendations were published by ACSM and AHA to illustrate the amount and types of physical activity that would improve functional health, and reduce the risk of chronic diseases (Nelson, Rejeski et al. 2007; Elsayy and Higgins 2010). The following recommendations were made:

- . Older adults should accumulate at least 30 minutes of moderate-intensity aerobic physical activity five days per week or vigorous-intensity aerobic physical activity for at least 20 minutes on three days per week, or a combination of moderate and vigorous-intensity aerobic physical activity, to promote and maintain health.

#### 4. Physical activity and public health

A number of studies have reported an association between increasing physical activity levels and improvements in the quality of life in the general population (Atalay and Cavlak 2012; Heath, Parra et al. 2012) and workplace setting (Conn, Hafdahl et al. 2009; Harding, Freak-Poli et al. 2013). Participation in physical activity has important benefits for reduced general risk of premature mortality across all groups and both sexes in the general population (Wen, Wai et al. 2011; Gulsvik, Thelle et al. 2012). In addition, evidence from a review of the literature reported that there is a relationship between increased physical activity and decreased risk of chronic conditions (Warburton, Charlesworth et al. 2010). Despite the evidence supporting the benefits of physical activity participation, globally 31% of adults still do not meet the physical activity recommendations (World Health Organisation 2011), causing a serious burden on healthcare expenditures. Those who do not undertake regular physical activity should consider increasing their activity to the recommended level, and while many different forms of activity are capable of meeting this recommendation, walking is considered to be an effective strategy, with little risk of injury in a low activity population (Siegel, Brackbill et al. 1995; Tudor-Locke, Craig et al. 2011). Evidence from a systematic review indicates that participation in sport activities increases psychological and social health benefits in adults (Eime, Young et al. 2013), including improved self-esteem, positive social interactions, and a reduction in levels of depressive symptoms. These authors suggest that team or group sports participation can have more health outcome benefits than individual activities. Promoting physical activity programmes among sedentary employees will likely lead to a reduction in public health concerns with Schröer and colleagues identifying significant improvements in physical activity, fitness, and weight in workplace settings that have incorporated physical activity programmes (Schröer, Haupt et al. 2014). This review also reported that interventions that focused on specific targets were more effective than multi-component intervention strategies.

It is very important to provide long-term physical activity programmes to prevent non communicable diseases (NCD) and reduce the burden of health-care costs. There is evidence for long-term effects of physical activity on the prevention of weight gain, obesity, coronary heart disease (CHD) and type 2 diabetes mellitus in healthy adults (Reiner, Niermann et al. 2013). This review included 15 longitudinal studies with at least 5-year follow up periods in healthy adult populations; four studies focused on weight gain and obesity, six studies focused on CHD, and five focused on type 2 diabetes mellitus. The authors concluded that most of these diseases result from sedentary lifestyles, but there was no evidence for optimal doses of activity to improve health outcomes in the long term (Reiner, Niermann et al. 2013).

The elderly population (60 years and over) has an increased prevalence of chronic diseases, disability, and an increased need for medical intervention compared to other age groups (Etzioni, Liu et al. 2003; McGinnis and Moore 2006). These diseases can impact adversely on their psychological and social health behaviour. Research suggests that physical activity improves mental disorders including anxiety, social dysfunction, and depression in the elderly population (Cassilhas, Tufik et al. 2010; Lapan and Leutar 2012; Mortazavi, Mohammad et al. 2012). A longitudinal study over 11 years conducted in Taiwan, reported that decreases in baseline physical activity over the 11 year period were associated with corresponding rates of decline in cognitive performance (Ku, Stevinson et al. 2012).

Children and adolescents who participate in regular physical activity at school and during leisure time are more likely to require less health interventions in the future. Several studies have demonstrated that high levels of inactivity associated with a sedentary lifestyle place children and adolescents at increasing risk for obesity related-illnesses, cardio-metabolic disease, and type 2 diabetes (Ekelund, Luan et al. 2012; Rohana and Aiba 2012) in later life. In contrast, increasing physical activity levels was found to reduce the risk of many chronic diseases such as obesity related illnesses and cardio-metabolic disease (Sothorn, Loftin et al. 1999; Strong, Malina et al. 2005; Janssen and LeBlanc 2010; Andersen, Riddoch et al. 2011; Friedrich, Schuch et al. 2012; Lavelle, MacKay et al. 2012; Verstraeten, Roberfroid et al. 2012). The majority of those studies recommended that children should accumulate 60 min of moderate to vigorous activity every day to achieve health benefits in the short and long term.

## **5. Physical activity and chronic disease prevention**

### **5.1 Type 2 diabetes**

The effect of physical activity on reducing risk of developing type 2 diabetes has been consistently established by several prospective and controlled trials including either aerobic or resistance exercise programmes (Pan, Li et al. 1997; Tuomilehto, Lindström et al. 2001; Hsia, Wu et al. 2005; Jeon, Lokken et al. 2007; Balducci, Zanuso et al. 2009; Umpierre, Ribeiro et al. 2011).

Most of the studies support moderately intense activity over 5 days helping to improve glucose control, blood lipid levels, insulin resistance, blood pressure, and weight reduction (Laaksonen, Lindstrom et al. 2005; Jeon, Lokken et al. 2007), as well as reducing the risk of all-cause mortality (Balducci, Zanuso et al. 2009; Penn, White et al. 2009; Umpierre, Ribeiro et al. 2011; Yavari, Najafipour et al. 2012) with an estimated 28-58% reduction in the incidence of type 2 diabetes (Knowler, Barrett-Connor et al. 2002; Fernández 2007; Li, Zhang et al. 2008; Penn, White et al. 2009) after follow-up, ranging from 2.8 years to 7 years of active intervention.

### **5.2 Cancers**

Regular physical activity accumulating at least 30 min of moderate-intensity activity a day (Miles 2008; Thompson 2010) has been associated with a reduced risk of colon, prostate and breast cancers (Kruk and Aboul-Enein 2006; Moore, Gierach et al. 2010; Anzuini, Battistella et al. 2011; Loprozi, Cardinal et al. 2012). The authors found a 13-20% estimated reduction in the incidence of cancers as a result of changes in some hormone levels. Long term physical activity that is undertaken from early childhood until later-life has the greatest effect on reduction of cancers risk (Miles 2007). Regular physical activity has also been linked to a reduced risk of cancer-related mortality and improved quality of life following a formal cancer diagnosis (Barbaric, Brooks et al. 2010; Anzuini, Battistella et al. 2011).

### **5.3 Overweight and obesity**

Overweight and obesity are highly prevalent chronic health conditions in the developed world affecting approximately 1.4 billion adults, and more than 40 million children under the age of five in 2010 (World Health Organization 2011). They are associated with 44% of diabetes, 23% of ischemic heart disease, and between 7% and 41% of certain cancers (World Health Organization 2011). Furthermore, the National Health and Nutrition Examination Survey (NHANES) reported that the prevalence of obesity was 35.5% (95% CI, 31.9%-39.2%) for adult men and 35.8% (95% CI, 34.0%-37.7%) for adult women from 1999 to 2010 (Flegal, Carroll et al. 2012). Physical activity is accepted as a key factor in modifying the behaviour of obese individuals (Boreham 2006; Ismail, Keating et al. 2012), and a number of studies have found high levels of physical activity are associated with reduced risk factors for obesity (Boreham 2006; Harrington, Tudor-Locke et al. 2011; Jakicic, Otto et al. 2011; Ismail, Keating et al. 2012; Milanovic, Pantelic et al. 2012). A combination of physical activity (either aerobic or resistance training) and diet have been found to be important short and long term strategies for weight loss in middle aged people 40-64 years (Milanovic, Pantelic et al. 2012). Prospective studies have reported that moderate to vigorous physical activity can reduce obesity and risk of chronic disease in obese individuals (Britton, Lee et al. 2012; Katzmarzyk and Lear 2012), with a decreased risk of metabolic syndrome from 30-40% in general populations (Physical Activity Guidelines Advisory Committee 2009).

### **5.4 Musculoskeletal disorders**

The benefits of physical activity as management and prevention strategies for people suffering from different musculoskeletal disorders (MSDs) are generally well accepted (Proper, Koning et al. 2003). Walking as a form of physical activity has been shown to have a role to play in the management of populations with MSD, including LBP, osteoporosis, hip, and knee osteoarthritis (Talbot, Gaines et al. 2003; Roddy, Zhang et al. 2005; Hurley, O'Donoghue et al. 2009; Hartvigsen, Mors et al. 2010; Ng, Heesch et al. 2010; McDonough, Tully et al. 2013). A study by Hartvigsen. et al (2010) found that Nordic walking for patients with chronic LBP of more than eight week duration was generally effective for reducing pain and improving health related outcomes. Another study reported that a pedometer-based walking intervention was an effective strategy for reducing back pain and improving physical function (McDonough, Tully et al. 2013).

The study examined the feasibility of a pedometer walking programme on reducing chronic low back pain (CLBP) at eight weeks on 57 patients; levels of disability (Oswestry Disability Questionnaire ODO) decreased by -5.5 points (95% CI, -8.8 to -2.2) for the intervention group compared with participants assigned to the control group (-1.0, 95% CI, -7.6 to -5.6) (McDonough, Tully et al. 2013). Furthermore, there is consistent evidence from various literature reviews that walking and physical exercise are beneficial in order to reduce pain and improve health outcomes in the short term for people with LBP (Vuori 2001; Henchoz and Kai-Lik So 2008; Hendrick, Wake et al. 2010). In contrast, some studies show participation in sporting activities that involves twisting, pulling, and intense physical activity may increase the risk of developing LBP (Heneweer, Staes et al. 2011).

People with knee and hip OA may have a fear of worsening disease progression when participating in physical activity. However, many studies have demonstrated that various types of physical activity such as aerobic fitness or resistance and endurance training are effective in the management and treatment of people with knee and hip OA (Hernández-Molina, Reichenbach et al. 2008; Fransen and McConnell 2009; Keysor and Heislein 2010; Pisters, Veenhof et al. 2010; Esser and Bailey 2011; Semanik, Chang et al. 2012). Participation in physical activity of moderate intensity exercise three to five times per week has been shown to decrease pain and disability and improve function and improve quality of life in people with knee and hip OA (Ettinger Jr, Burns et al. 1997; Lundebjerg 2001; Penninx, Messier et al. 2001; Fransen, McConnell et al. 2003; Talbot, Gaines et al. 2003; Roddy, Zhang et al. 2005; Fontaine and Haaz 2007; Li, Zhang et al. 2008; Ng, Heesch et al. 2010). Furthermore, participation in physical activity has also been found to increase or maintain muscle mass, power, and strength in men and women of all ages (Karlsson 2004; Kirk, Washburn et al. 2007; Ferreira, Sherrington et al. 2012), as well as increasing bone density and reducing hip fractures in the general population (Karlsson 2002; Karlsson, Nordqvist et al. 2008; Babatunde, Forsyth et al. 2012) which resulted in better quality of life outcomes and higher levels of performance in quantified daily living activities. Epidemiological studies have shown a reduction of risk hip fracture ranging from 3.6 to 6.4 % (Babatunde, Forsyth et al. 2012), osteoarthritis from 22-80 % (Physical Activity Guidelines Advisory Committee 2009), and falls in older people from 30-50% (Paterson and Warburton 2010) among active people compared with low activity populations.

A summary of systematic reviews highlighted the high frequency of musculoskeletal problems in workplace setting (Hayes, Cockrell et al. 2009; Osborne, Blake et al. 2012). Most systematic reviews have connected workplace physical activity interventions with enhanced management of MSD among employees (Proper, Heymans et al. 2006; Verhagen, Karels et al. 2007; Kuoppala, Lamminpää et al. 2008; Bell and Burnett 2009; Coury, Moreira et al. 2009; Sihawong, Janwantanakul et al. 2011). A systematic review (Sihawong, Janwantanakul et al. 2011) of nine randomized controlled trials (in total 1594 patients) assessed the effectiveness of exercise for prevention of nonspecific neck pain in office workers, reporting strong evidence for various kinds of exercises (muscle strengthening and endurance exercises) in treating workers with neck pain. Moderate evidence supported the use of muscle endurance exercise in reducing pain-related disability. An effective programme should include muscle strengthening and/or endurance exercises performed in 1-3 sets of 5-20 repetitions, 3 to 5 times a week over a period of 15 weeks to 12 months. A critical review by Propper and colleagues that included 26 randomized and non-randomized controlled trials, identified strong evidence for the benefit of worksite physical activity to manage MSD and increase physical activity levels among employees (Proper, Koning et al. 2003). This review used a qualitative method and reported that 23% (6/26) of studies included in the review had a high methodological quality. A further review has also revealed evidence for associations between physical activity during leisure time and musculoskeletal symptoms in worker populations (Hildebrandt, Bongers et al. 2000).

## 6. Conclusions

Physical activity guidelines are established in the USA, and a number of other countries have also produced physical activity guidelines that have focused on improved health and reduction of risk for health disorders (Tremblay, Warburton et al. 2011; Australian Government 2014). National and international guidelines have developed the recommendations on physical activity for health and recommended that every adult accumulate at least 150 minutes of moderate intensity physical activity weekly, or 75 minutes per week of vigorous-intensity aerobic physical activity, or a combination of the two intensities to gain significant health benefits and reduce the cost of health care (World Health Organisation 2011).

Physical activity plays an important role in the prevention or minimization of different chronic diseases including type 2 diabetes (Li, Zhang et al. 2008; Umpierre, Ribeiro et al. 2011), cancers (Anzuini, Battistella et al. 2011; Loprinzi, Cardinal et al. 2012), overweight and obesity (Milanovic, Pantelic et al. 2012), and different musculoskeletal disorders MSDs (Proper, Koning et al. 2003; Hendrick, Wake et al. 2010; McDonough, Tully et al. 2013).

The importance of physical activity is clear for the general population, and it is also important to understand the use of a pedometer based intervention programmes to increase physical activity and improve health-related outcomes among workplace populations. In recent years many studies have demonstrated the benefit of increased physical activity in reducing pain and improving quality of life in workplace populations with MSD; reducing musculoskeletal impairment in the elderly (Benedetti, Berti et al. 2008) and reducing pain for those with low back pain (LBP) (Jones, Stratton et al. 2007; Kuukkanen, Malkia et al. 2007), neck pain, and shoulder pain (Bernaards, Ariens et al. 2007). Moderate physical activity from walking is considered to be an ideal form of physical activity, helping to promote and maintain health status in the general population (Siegel, Brackbill et al. 1995) and workplace setting (Harding, Freak-Poli et al. 2013). It is suitable for all groups, with little risk of injury among low-activity populations.

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