Journal of Applied Medical Sciences, vol. 2, no. 2, 2013, 69-78
ISSN: 2241-2328 (print version), 2241-2336 (online)
Scienpress Ltd, 2013

Physical Activity and Well-being: A Review of the Health Benefits of Physical Activity on Health Outcomes

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Abstract

Physical activity is emerging as an important modifiable disease risk factor in developing countries. This notwithstanding, the effects of physical activity on health outcomes remain incompletely understood; however there is ample evidence that physical activity is associated with low body weight and low fat mass. Furthermore, assessment of energy expenditure in free-living subjects is central to complete understanding of the aetiology of obesity, diabetes, hypertension, coronary heart disease, and osteoporosis amongst other lifestyle-related disorders. Recent studies have indicated a clear epidemiological transition in disease profiles in Africans with an increasing prevalence in lifestyle related disorders such as obesity and related co-morbidities. There has also been a clear trend in these lifestyle disorders with the development of urbanization and consequently; adoption of Westernized lifestyles associated with decline in physical activity due primarily to mechanization/automation of occupational and leisure time activities. Furthermore, there is also developing interest in the concept of sedentary behaviour. It is now increasingly accepted that sedentary behaviour is not simply a lack of physical activity but is an independent behaviour (TV/computer use, reading, homework, etc.), which constitutes a potential risk to health irrespective of physical activity level. Current empirical evidence linking physical inactivity and health outcomes is substantial.

Keywords: Physical activity, health

1 Physical Activity and Health

Physical activity has consistently been associated with improved physiological functioning and lower disease risk according to observations drawn from controlled experimental trials and population based epidemiological studies [1]. There is sufficient

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Article Info: *Received :* April 12, 2013. *Revised :* May 7, 2013.
Published online : June 30, 2013

scientific evidence to conclude that physical activity has beneficial effects on adiposity levels in those with a normal body weight, on blood pressure in normotensive youth, on plasma lipid and lipoproteins levels, on non traditional cardiovascular risk factors (inflammatory markers, endothelial function and heart rate variability) and on several components of mental health (self concept, anxiety and depression) [2-5]. The benefits of regular physical activity have been clearly set out across the life course. In particular, for adults, doing 30 min of at least moderate intensity physical activity on at least 5 days a week helps to prevent and manage over 20 chronic conditions including coronary heart disease, stroke, type 2 diabetes, cancer, obesity, mental health problems and musculoskeletal conditions [6]. Furthermore, there is a clear causal relationship between the amount of physical activity people do and all cause mortality [6]. On the other hand, spending large amounts of time being sedentary may increase the risk of some health outcomes, even among people who are active at the recommended levels [7].

Physical inactivity is responsible for 6% of deaths globally - around 3.2 million deaths per year, including 2.6 million in low and middle income countries and 670,000 of these deaths are premature [6]. A recent analysis indicated that reaching the recommended minimum level of physical activity (at least 30 min/day) compared with no activity was found to lead to a reduction in all cause mortality by 19% and this rose to 24% if an hour a day was spent in physical activity [8]. Furthermore, there is a 31% lower risk for all cause mortality in active individuals [4]. This demonstrates a positive dose response - in other words, that the benefits of physical activity increase as the amount and intensity of the activity increases. In adults, the improvements in physical activity are especially pronounced for high risk individuals, for example, those who are obese or have high blood pressure (hypertensive) [4]. Research has also shown that being physically active daily will reduce the chances of mortality associated with cardiovascular disease: 30 min of moderate intensity exercise on most days of the week, equivalent to 4.2 MJ (1000 kcal) a week, was enough to reduce cardiovascular related mortality [9].

Physical activity has beneficial effects on blood glucose levels. Gill and Cooper [10] reviewed 20 longitudinal cohort studies and revealed that regular physical activity substantially reduces the risk of type 2 diabetes. Adjustment for differences in body mass index (BMI) between active and inactive adult groups attenuates the magnitude of risk reduction but even after adjustment, a high level of physical activity was associated with a 20 - 30% reduction in diabetes risk. The data indicated that protection from diabetes can be conferred by a range of activities of moderate or vigorous intensity and that regular light intensity activity may also be sufficient, although the data for this was less consistent. The risk reduction associated with increased physical activity appears to be greatest in those at increased baseline risk of the disease, such as the obese, those with a positive family history and those with impaired glucose regulation [10]. Furthermore, a clinical trial of ≥8 weeks duration on HbA_{1c} (A_{1c}) and body weight in people with type 2 diabetes, demonstrated that post intervention, A_{1c} was significantly lower in those who exercised than controls (7.65 vs. 8.31%, weighted mean difference -0.66%,). In contrast, post intervention body weight did not differ between the exercise and control groups. Meta regression confirmed that the beneficial effect of exercise on A_{1c} was independent of any effect on body weight. Therefore, structured exercise programmes had a statistically and clinically significant beneficial effect on glycemic control and this effect was not primarily mediated by weight loss [11].

The influence of relatively extensive physical exercise on the composition and concentration of lipoproteins was clearly exemplified in a large US study [12] in which overweight men and women were divided into four groups and monitored for eight months, one control group and three exercise groups. Group A exercised (ergometer cycling, jogging) with an energy expenditure that corresponded to 32 km jogging/week at 65 - 80% of maximal oxygen uptake ($VO_{2\ max}$), group B exercised at the same intensity but for a shorter distance (corresponding to an energy expenditure of 19 km jogging/week), while group C underwent the same amount of exercise as group B but at a lower intensity (corresponding to 40 - 55% of $VO_{2\ max}$). After 8 months of exercise, the concentration of high density lipoprotein (HDL) cholesterol increased only in group A (+ 9%), together with several other beneficial lipoprotein changes. Some changes were also noted in groups B and C (primarily an increase in the size of the low density lipoprotein (LDL) and very low density lipoprotein (VLDL)) particles but to a much lower extent [12]. Another cross sectional study was conducted on a representative sample (n = 3110) of 12 - 19 y old American adolescents that measured cardio-respiratory fitness using a sub-maximal treadmill test. The results indicated that unfit girls, defined as the lowest 20% fit, were 1.89 (95% confidence interval: 1.12 - 3.17) times more likely to have hypercholesterolemia and 1.03 (0.74 - 1.43) times more likely to have a low HDL cholesterol compared to moderately and highly fit girls. Unfit boys were 3.68 (2.55 - 5.31) times more likely to have hypercholesterolemia and 1.25 (0.79 - 1.95) times more likely to have a low HDL cholesterol compared to moderately and highly fit boys [13].

Several studies indicate a relationship between physical activity and cardiovascular fitness. Physical activity causes a reduction of around 3 mm Hg for systolic blood pressure (BP) and 2 mm Hg for diastolic BP in hypertensive patients. These reductions are particularly evident for moderate levels of physical activity, including walking [14, 15]. In addition, aerobic based interventions also result in significant reductions (~6% to 11%) in diastolic blood pressure [16]. Regular exercise constitutes strong protection against the increased risk of cardiac infarction in connection with physical exertion and the risk has been estimated to be only 2.5 times greater than at rest for men who exercise regularly (>6 Metabolic equivalent units (MET) at least 4 - 5 days/week) [17]. For women, the risk of suffering a heart attack during and in connection with physical exertion is very small (compared with the risk during a randomly selected hour without physical exertion) and the small risk that has been reported appears to vanish with regular exercise. For both men and women who exercise regularly, the risk of having a heart attack at all (that is at any hour of the day) is less than half of that among untrained individuals [18].

It is known that intense physical exercise in children and adolescents, meaning mechanical loading on the skeleton, results in larger, stronger and more mineral dense bones and that this effect is more pronounced if the exercise is begun early [19]. If the exercise starts at an adult age, only small improvements in bone density are achieved. Nevertheless, it has clearly been shown that the risk of a hip fracture is lower among trained individuals, while evidence is accumulating (albeit less strong) that exercise at an adult age reduces other types of fractures related to osteoporosis [20]. Interestingly, veteran cyclists with many years of training had significantly lower bone density than control persons of the same age and, although very physically fit, they had a higher risk of being affected by brittle bones with increasing age [21]. Among women, intense exercise training such as long distance running can also lead to diminished bone density [22]. There is also evidence that among adolescents, increased leisure time physical activity (i.e. outside structured school programmes) is significantly associated with fewer depressive symptoms (over a two year period) and accelerates learning by increasing cognitive processes (e.g. memory functioning) [23]. In summary, the relationship between physical activity, fitness and health outcomes demonstrates a reciprocal relationship.

2 Physical Activity Guidelines

It is becoming increasingly clear that variations in physical activity and sedentary behaviour are of enormous importance to the current and future health of children and adolescents [2]. This is especially the case since it has been observed that several health outcomes related to physical activity, such as obesity tend to track from childhood into adulthood [24] and therefore adequate participation in physical activity during childhood and adolescence may be critical in the primary prevention of chronic disease [25]. Current interventions are therefore aimed at modifying physical activity and sedentary behaviour which in turn would favourably modify the risk profiles of chronic diseases such as type 2 diabetes, hypertension and cardiovascular disease [5]. There is compelling evidence that an active and fit way of life has many important health benefits and that sedentary habits are associated with an increased risk of numerous chronic diseases and decreased longevity [4, 5, 26]. In addition, strong and consistent evidence based on experimental studies for several health outcomes indicates that participating in as little as 2 to 3 h of moderate to vigorously intense physical activity/week is associated with significant health benefits [27]. Evidence from observational studies also demonstrate dose response relations between physical activity and health [27], with differences in health risk between the least active (or fit) and inactive groups. However, continued debate as to how much, what type, how often, what intensity and how long the physical activity dose should be and how this dose should be quantified and disseminated has led to promulgation of numerous public health and clinical recommendations [1]. Some of the inconsistencies among physical activity recommendations are due to simply inherent uncertainties of biomedical science, augmented by methodological differences in collecting and interpreting data, while some are due to a focus on different health outcomes by different groups [1]. It is clear that moderate intensity exercise of at least 30 min/day as described in the consensus public health recommendations [28] produces significant improvements in work capacity and that exercising at higher intensities has only modest additional effects [1].

The principal recommendation that persons accumulate $\geq$30 min of moderate intensity physical activity/day was largely directed at 40 - 50 million US adults who are sedentary and who account for much of the health burden of chronic disease [28]. Since these persons are unlikely to have the physical capacity to engage in greater quantities of high intensity physical activity and because compelling evidence shows health benefits can be accrued with even moderate amount of regular exercise [1]. The Centres for Disease Control (CDC)/American College of Sports Medicine (ACSM) consensus report recommended a dose of physical activity likely to be achievable by the primary target population and that was supported by a large evidence base as being efficacious for disease risk reduction among most persons [1]. For example in the Harvard Alumni study, that examined physical activity in 16, 936 Harvard alumni showed an inverse relation between all cause mortality and increment of reported physical activity. The risk of death in men with an activity index of 3,500 kcal/week was less than 50% of that associated with <500 kcal/week. Furthermore, the men in the activity index of <2,000 kcal/week had 38% greater risk of death over a 12 y to 16 y follow up period than those in the higher activity index ranges [9]. The CDC/ACSM report also stated that persons meeting the basic recommendations could gain additional benefits by doing more exercise including some at higher intensities. Implicit in the ACSM recommendation is that exercise is similar to other therapeutic agents with a dose response characteristics of which a minimal dose that has proven efficacy and safety is typically prescribed as the initial dose [1]. Recent evidence reaffirms the dose response relationship between physical activity and all cause mortality, since there is typically a risk reduction of around 30% for those achieving the recommended levels of at least moderate intensity physical activity on most days of the week, compared with those who are inactive [29].

A sedentary lifestyle, often adopted during adolescence and continued into adulthood, is a major concern for public health [30-32]. The dramatic increase in the prevalence of overweight and obesity and other lifestyle disorders such as diabetes, cancer, hypertension and cardiovascular diseases over the past decades [4, 33] is related to, and often ascribed to lower levels of physical activity and increase in sedentary behaviour [6, 34, 35]. This has resulted in the development of physical activity guidelines to promote maintenance of appropriate levels of physical activity and sedentary behaviour. Experts advocate promotion of physical activity among children and adolescents for health enhancement and to instil lifelong behavioural patterns that will result in more active and fit adult populations in the future [24, 36]. This rationale rests considerably on two fundamental assumptions: first, that there are inherent acute physical and psychological benefits to physical activity among children and adolescents and, second, that physical activity behaviours between childhood and adulthood are correlated and that physically active children are more likely to grow up to be physically active adults compared with their inactive peers [36]. These active adults will then be healthier by way of a reduced risk to a variety of health conditions [36]. Although the evidence for tracking of physical activity behaviour is tenuous [37], most efforts for physical activity promotion among children and adolescents rely on the assumptions of tracking of physical activity from childhood to adulthood [38]. The United Kingdom Expert Consensus Conference proposed that each child accumulate at least 60 min of at least moderate intensity physical activity each day [5, 39] based on the findings that in general, differences in health outcomes have been observed at around 60 min/day in children and young people, whereas such differences have been observed at a level of approximately 30 min/day in adults. Thus, the best available evidence has been used in determining the level of activity required to benefit health in each specific age group [5, 31].

The 2008 physical activity guidelines for Americans [31] recommend that children and adolescents should accumulate at least 60 min or more of physical activity daily. Most of the 60 or more min a day should be either moderate or vigorous intensity aerobic physical activity and should include vigorous intensity physical activity at least 3 days a week. As part of their 60 or more min of daily physical activity, children and adolescents should include muscle strengthening physical activity on at least 3 days of the week. In addition, children and adolescents should include bone strengthening physical activity on at least 3 days of the week. Similarly, the American Academy of Paediatrics (AAP) has published guidelines for enhancement of physical activity and limitation of sedentary behaviour in paediatric populations [30]. It is recommended that television and video time is limited to a maximum of 2 h/day for the prevention of paediatric overweight and obesity and resultant co-morbidities [30].

In the UK, recent published physical activity guidelines recommend that physical activity should be encouraged from birth, particularly through floor based play and water based activities in safe environments. Children of pre-school age who are capable of walking unaided should be physically active daily for at least 180 min (3 hour), spread throughout the day. All under 5s should minimise the amount of time spent being sedentary (being restrained or sitting) for extended periods (except time spent sleeping). In addition, the 180 min of recommended activity can be of any intensity. This aligns with the types of physical activity most naturally occurring during the early years, including intermittent and sporadic patterns. Moreover, the recommended 180 min of physical activity for pre-school children who can walk can include light intensity activity, active play and more energetic activities, such as running, swimming and skipping. Furthermore, the 180 min of physical activity should be spread throughout the day rather than in one long session. For this age group, the amount of physical activity is more important than the intensity. In addition, this report recommends reduction of sedentary behaviour such as, time spent in infant carriers, car seats, highchairs and TV viewing or other screens based entertainment [5]. Distinct guidelines were also published for children aged 5 - 18 y. It is recommended that this age group should engage in moderate to vigorous intensity physical activity for at least 60 min and up to several hours/day, which is similar to the earlier guidelines [39]. However, the current guidelines also recommend that vigorous intensity activities, including those that strengthen muscle and bone, should be incorporated at least three days a week. Additionally, all children and young people should minimise the amount of time spent being sedentary (sitting) for extended periods. Therefore, the current UK and US physical activity guidelines are consistent in recommending at least 60 min of MVPA daily and limitation of sedentary time for health promotion in children and adolescents.

3 Physical Activity and the Environment

From an evolutionary perspective, humans are designed for a physically active lifestyle, while cultural circumstances permit and reinforce an inactive alternative in industrialised countries [40]. Throughout human evolution history, the lifestyle of humans included physical activity on a regular basis except for the past two or three generations [40]. Consequently, the combined effects of the transition to a sedentary lifestyle and attendant dietary changes have resulted first in an epidemic of coronary heart disease and more recently an epidemic of overweight/obesity in post-industrial societies [40]. Social and environmental changes have accompanied the ongoing rapid urbanisation in a number of countries during recent decades and therefore, understanding the role of urbanisation in the health risk transition is important for health policy development at national and local levels [41]. Urbanisation is recognized as a driver of the globally changing health hazard panorama with specific proximate social, economic, environmental and behavioural health risks developing in the wake of urbanisation [42]. Low participation in health enhancing physical activity may be ascribed to urbanisation, which inevitably affects population health substantially [43]. Urbanisation is a global trend which may be altering habitual physical activity and sedentary behaviour of children, adolescents and adults unfavourably. A reflection of the decline in physical activity levels in Europe was demonstrated in a study by Riddoch et al. [44] where only 2.5% of the 5,595 school children surveyed appear to have met recognized physical activity guidelines for children and adolescents. These disturbing findings reflect an ongoing decline in physical activity across all age groups during the past several decades in Europe [45] based on questionnaire based studies. This decline in physical activity may be explained by the mechanisation of work and daily tasks and thus, not labour intensive, the increased use of motorised transport instead of walking or cycling and increased sedentary behaviour such as inactive leisure pursuits (such as watching television and using a computer) [45]. These trends are beginning to be replicated in the developing world. For example, it is estimated that by 2020 chronic diseases of lifestyle will be almost 50% of the burden of disease in Sub Saharan Africa [46]. Rapid urbanisation with changes in lifestyle, such as physical activity patterns could explain at least partially, the ongoing epidemiological transition in Sub Saharan Africa [46].

4 Conclusion

There is empirical evidence implicating physical inactivity in several lifestyle disorders such as diabetes, obesity and hypertension. Based on this evidence, it is recommended that lifestyle interventions such as promotion of physical activity in populations would result in significant improvements in health outcomes.

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