REVIEW ARTICLE

Physical Exercise and Health: A Review

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ABSTRACT

Background: *Physical activity results in increased exercise capacity and physical fitness, which may lead to many health benefits. Individuals who are more physically active appear to have lower rates of all-cause mortality, probably due to a decrease in chronic diseases including coronary artery disease (CAD). This may result from an improvement in cardiovascular risk factors in addition to enhanced fibrinolysis, improved endothelial function, decreased sympathetic tone, and other yet undetermined factors.*

Methods: *We reviewed the literature on physical activity and health with particular reference to the benefits derivable by engaging in regular physical activity. The MEDLINE/PUBMED and bibliographic searches for English language studies were used.*

Results: *Physical inactivity is now considered a risk factor for Cardiovascular diseases (CVD). Regular exercise results in an increase in exercise capacity and lower myocardial oxygen demand leading to cardiovascular benefits, including lower mortality rates. Physically active individuals suffer from fewer ailments than do less-active individuals. Physical activity reduces cardiovascular risk through lowering of blood pressure, improved glucose tolerance, reduced obesity, improvement in lipid profile, enhanced fibrinolysis, improved endothelial function and enhanced parasympathetic autonomic tone.*

Conclusion: *Physical exercise has many health benefits and the evidence for this continues to accumulate. Health care professionals should incorporate counselling to patients for physical exercise in their daily clinical practice, while health policy makers and community physicians should see to implementation of this at the community level.*

KEYWORDS*: Physical exercise; Health; Benefits.*

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INTRODUCTION

Non-communicable diseases are currently the leading causes of death worldwide accounting for about 60% of all deaths annually (66% of these in developing countries) and expected to rise to 73% by 2020[1]. Despite the advances in medicine over the past several decades, which have dramatically improved the public health in developed countries, most of the population in developing countries has not benefited equally leading to a disparate burden of illness, disability, and premature death[2]. Regrettably, these countries are ill equipped to handle these diseases and their complications. Control of these diseases at the community level through encouraging physical activity can be a highly cost effective public health intervention[3].

Physical exercise is a form of planned physical activity with the goal of achieving or preserving physical fitness. Exercise training may be a more accurate term, since similar activity may be viewed as exercise by one person and not by others[4]. Physical exercise has been recognized as having health benefits since the time of Hippocrates [5]. Conversely, few studies have shown that physical inactivity doubles health risks and adds a disease burden to society comparable with smoking[6], as well as obesity and hypertension[7]. This article reviews existing literature on the health benefits of physical exercise, and highlights some of its hazards.

The Concept of Physical Activity and Exercise.

The world health organization (WHO) defined physical activity in 1997 as "movements in everyday life, including work, recreation, exercise, and sporting activities" [8]. Physical activity therefore includes ordinary daily activities, physical exercise, as well as sports.

Physical exercise has been defined as an activity for the express purpose of improving fitness or health[9]. Physical exercise may be classified based on mechanical and metabolic aspects of contraction. Mechanical properties relate to whether limb movement occurs and includes isometric contraction (muscle tension without limb movement) and isotonic contraction (limb movement without change in muscle tension). Metabolic properties of physical activity are divided into two: Aerobic and anaerobic. In aerobic exercise, large groups of muscles are used continuously with increased tissue demand for oxygen, which is met through aerobic metabolism with increased cardiac output. This type of exercise (e.g. brisk walking, jogging swimming, etc) can be maintained for a long time. Anaerobic exercise on the other hand can only be maintained for a few minutes (e.g. weight lifting, sprinting), because it is heavy work utilizing few groups of muscle and metabolism is anaerobic[10].

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Health Benefits of Physical Exercise

Evidence supporting the health benefits of physical exercise continues to accumulate at an accelerated rate. In recognition of this, the World Health Organization dedicated the world health day 2002, to promoting physical exercise[11].

All forms of physical activity are beneficial to health, but for maximal health benefits, a minimum duration and intensity is usually prescribed. The American College of Sports Medicine (ACSM) and the Centre for Disease Control (CDC) and Prevention recommends that all adults should accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week[12]. Table I summarises the current recognized health benefits of physical exercise but the list is likely to continue growing.

Better Quality of Life

Physical exercise has been shown to be associated with better quality of life generally. In a large study involving 175,850 adults, regular exercise of $\geq$ 90 minutes/ day was associated with better health related quality of life than physical exercise of less than 20 minutes per day. This demonstrates a positive relationship as well as dose related response[13].

Improvement of Bodily Functions

Exercise has been shown to increase the duration of slow-wave sleep and total sleep time, to decrease sleep onset latency and rapid eye movement (REM) sleep in healthy individuals[14]. Physical exercise enhances some aspects and suppresses other aspects of immunity, but the biological significance of these alterations in the immune system is still a subject of investigation[15]. Physical activity has also been shown to have positive effect on sexual function. In a study by Dahn *et al*, after controlling for age, medical co-morbidity, fatigue and urinary/bowel functioning, greater levels of physical activity were associated with better sexual functioning among men treated for localized prostate cancer[16].

Cardiovascular disease

Many studies have demonstrated that regular exercise and physical activity prevent primary and secondary cardiac events. In one of the most well-known studies, male Harvard alumni without a history of CVD were followed for 16 years[17]. There was a 39% reduction in cardiovascular morbidity and a 24% reduction in cardiovascular mortality in subjects with exercise energy-expenditures of more than 2000 kilocalories per week. In the Nurses' Health Study[18] 73,029 women (aged 40 to 65 years) were followed for 4 years. Physical activity in women was inversely related to the risk for stroke and CAD.

Physical exercise has benefits both in the prevention and treatment of cardiovascular diseases. Exercise improves lipid profile, glucose tolerance, obesity, insulin resistance and elevated blood pressure. However, modification of atherosclerotic risk factors does not fully explain the benefits that have been observed. Other possible mechanisms including effects on thrombosis, endothelial function, and autonomic tone may play an important role. Physical activity reduces the risk of developing coronary heart disease and hypertension by half[19, 20]. Physical activity also reduces the risk of stroke and is beneficial in rehabilitation after stroke[21].

Hypertension

Studies have shown that regular physical exercise prevents the development of hypertension. In the Harvard alumni study[22] there was a 35% increased risk for the development of hypertension in sedentary versus active individuals. This risk was more pronounced in obese subjects. Blair and colleagues[23] in another study found that compared with physically-fit patients, those who were less fit had a relative risk of 1.5 for the development of hypertension. As a result of these studies, the US Preventive Services Task Force believes that there is evidence to recommend regular physical activity for the prevention of hypertension[24].

In addition to preventing hypertension, regular exercise has also been found to lower blood pressure. In mildly hypertensive men, short-term physical activity decreases blood pressure for 8 to 12 hours after exercise, and average blood pressure is lower on exercise than on no exercise days[25]. In severely hypertensive black men, moderate physical activity performed for 16 to 32 weeks results in a decrease in diastolic blood pressure, which is sustained even after reduction in antihypertensive medications. In addition, a significant decrease in left ventricular hypertrophy (LVH) has been reported as early as 16 weeks after the initiation of exercise[26]. Physical exercise reduces established hypertension (average 4.3 mmHg) and aids in the rehabilitation of patients after myocardial infarction[19].

Diabetes mellitus

Physical activity has beneficial effects on both glucose metabolism and insulin sensitivity. These

include increased sensitivity to insulin, decreased production of glucose by the liver, larger numbers of muscle cells that utilize more glucose than adipose tissue, and reduced obesity[27]. In addition physical exercise reduces the risk of development of type 2 diabetes, and in those with the disease, has beneficial effects on the various components of the metabolic syndrome, such as obesity, hypertension, disturbance of lipid and glucose metabolism, and insulin resistance. Lynch *et al*.[28] found that men who participated in moderate physical activity for at least 40 minutes a week were at lower risk for developing NIDDM. This risk reduction was even more pronounced in men at high risk for developing diabetes. Increased physical activity also reduces the risk of atherosclerosis[16].

Glycaemic control can also be improved in type 1 diabetics with regular, well-timed physical activity that has been adjusted according to insulin and nutritional intake of patients. In addition, it has a beneficial effect on the risk factors of coronary heart disease and on life expectancy. Care should however be taken to avoid hypo or hyperglycaemia[16].

Obesity

Obesity is now a global pandemic and poses multiple health risks[29]. Physical exercise has been shown to prevent weight gain in the general population, and is beneficial for weight loss in those with obesity. However, more than the recommended 30 minutes per day is required to achieve this (at least 60 minutes/day required)[30].

Body composition and fat distribution are linked to cardiovascular mortality[31] and are favourably affected by exercise. On average, exercise-training programs reduce body fat by approximately 1.6%[32]. Physically active men and women have a more favourable waist-hip ratio (WHR) (<0.9) than do sedentary individuals. These changes, although significant, are rather small (-0.04) even after 1 year of both diet and exercise[33].

Lipid Profile

There is much variability in the results of exercise/lipid lowering studies, at least in part due to the heterogeneity of the study methods, populations, exercise interventions, and the use of adjunctive interventions such as diet or pharmacological lipid-lowering agents. A meta-analysis of 95 studies[34], most of which were not randomized controlled trials, concluded that exercise leads to a reduction of 6.3% in total cholesterol, 10.1% in low density lipoproteincholesterol (LDL-C) and 13.4% in cholesterol/high-density lipoproteincholesterol (HDL-C), and 5% increase in HDL-C. The greatest changes in lipids were noted in those patients who also lost weight during their exercise program (total cholesterol decreased by 13.2 mg/dl, LDL-C decreased by 11.1 mg/dl). When body weight increased, lipid levels worsened. The mechanisms by which exercise may improve the lipid profile remain uncertain. Exercise-induced lipolytic enzyme activity that promotes the degradation of triglyceride-rich lipoproteins appears to be a factor[35,36].

Although the above studies suggest an improvement in lipid profile with exercise training, the effects are quite modest. These improvements may have a favourable effect on cardiovascular risk.

Thrombosis

Emerging evidence suggests that exercise training favourably affects the fibrinolytic system. This may help to explain the reduction in cardiac events observed in those who are more physically active. Strenuous endurance exercise for 6 months in healthy older patients (aged 60 to 82 years) resulted in a significant improvement in haemostatic parameters, with a reduction in plasma fibrinogen levels of 13%, an increase in mean tissue-plasminogen activator (t-PA) of 39%, an increase in active t-PA of 141%, and a reduction of plasminogenactivator inhibitor-1 (PAI-1) of 58%[37]. In contrast, younger patients (aged 24 to 30 years), whose baseline fibrinolytic variables were lower than the older group, had no significant change in fibrinogen, t-PA, or PAI-1 activity. However, other studies have shown favourable effects of fibrinolytic enzymes after exercise training in younger subjects[38] and in patients after MI[39].

There is also evidence that acute and chronic exercise affects platelet activation. Platelet activation is important in the pathophysiologic mechanisms of unstable coronary syndromes and acute MI. Kestin *et al.*[40] studied the effects of treadmill exercise on platelet activation in sedentary and physically fit individuals. After acute strenuous exercise of similar duration and intensity, platelet activation and hyperreactivity were increased in sedentary subjects but remained unchanged in physically fit subjects. Rauramaa *et al*.[41] demonstrated that regular, moderate-intensity physical activity in middle-aged, overweight, mildly hypertensive men results in decreased platelet aggregation. After the 12-week exercise program, the study subjects demonstrated a 52% reduction in secondary platelet aggregation compared with a 17% decrease for the control group. Thus, it appears that although acute

exercise can lead to increased platelet activity especially in sedentary individuals, regular exercise may abolish or improve this response.

Other diseases

Evidence continues to accumulate on the beneficial effects of physical exercise on many other diseases such as malignancies (e.g. colon and breast cancer), osteoporosis, osteoarthritis, asthma, chronic obstructive airway disease, back pain, [16] mental diseases and possibly many others to come. In general, exercise is associated with decreased anxiety and depression and increased sense of well-being[42]. Psychological benefits have also been found in cardiac patients who are more physically active[43].

Reduction of overall mortality

The observation that physically active individuals suffer from fewer ailments than do less-active individuals dates as far back as the 1500s, when Cogan[4] noted that compared with active individuals, sedentary students were more likely to become ill. Data accumulated over the past 50 years have confirmed the health benefits of exercise. Epidemiologic studies have shown that active individuals are at lower risk for developing many chronic diseases[12]. In addition, all-cause mortality rates are higher in less-active people than in those who are more active[17, 44]. Approximately 12% of deaths per year in the United States are associated with inactivity[45]. The risk for all-cause mortality decreases in inactive individuals who become more physically active[46]. Overall, physical exercise is associated with a more than 40% reduction in age adjusted all cause mortality[47]. In a college alumni study spanning 25 years, Paffenbarger *et al* demonstrated that regular exercise during leisure time protects people against death from any cause[46].

Despite these teeming benefits of physical exercise to health, majority of people don't exercise. In 1995, the U.S. Surgeon General reported that only 15% of Americans older than 18 years of age engaged in regular vigorous activity, while 60% reported no regular or sustained leisure time activity, and 27% reported no leisure time activity at all [48]. Adedeji reported lack of physical activity in 69% of Nigerians studied[49]. Doctors also share the blame, as physician counselling of patients on exercise is low even in developed countries[50].

Table I. Health benefits of Physical Exercise

Physical Health
Better quality of life
Improvement of bodily functions e.g.
Sleep
Improvement of immune function
Improvement of sexual function
Prevention and/or treatment of diseases e.g.
Cardiovascular disease including stroke.
Diabetes mellitus
Obesity.
Back pain
Arthritis
Malignancy
Reduction of overall mortality
Mental health
Improvement of mood in healthy subjects
Reduction of the burden of depression and anxiety
Buffers age related decline in cognitive function
Improvement of mental functions in mentally retarded

Table II. Contraindications to Physical Exercise

Cardiovascular diseases:
Active myocarditis, Cardiomyopathy, Sustained ventricular tachycardia,
Refractory supraventricular tachyarrhythmia, Severe hypertension,
Decompensated heart failure, pathological cardiac dilatation,
Ischaemic heart disease (without permission from a specialized physician),
Dissecting aneurysm, annuloaortic ectasia, aortic root dilation in Marfan's syndrome,
Moderate or severe aortic valve stenosis, Conduction abnormalities,
Congenital long QT syndrome, Pulmonary hypertension
Severe respiratory failure
Thrombo-embolic diseases: Recent embolism, Deep venous thrombosis.
Symptomatic acute infection.
Uncontrolled metabolic disorder: diabetes, thyrotoxicosis, and hypothyroidism.

Exercise Prescription

The CDC and ACSM[6] have recommended that every adult exercise for 30 minutes at moderate intensity levels on most, if not all, days to achieve a weekly energy expenditure of 1400 calories. The AHA[51] recommends a total exercise energy-expenditure of 700 to 2000 calories per week. These statements stem from evidence that regular moderate physical activity provides many health benefits. In addition, these recommendations stress that physical activity can be accomplished in multiple short intervals, which may be more feasible for many individuals, rather than continuous 30-minute exercise sessions. Lower intensity exercise should be performed more frequently

and for longer durations.

Previous recommendations emphasized the performance of moderate-to-high intensity endurance-exercise (60% to 90% of maximum heart rate) for 20 to 60 minutes three or more times a week[6]. These endorsements were based on studies that revealed dose-response improvements in functional capacity with higher levels of training. The newer recommendations are meant to complement and not replace these previous statements, since it appears that moderate intensity physical-activity can also provide many of the same health benefits.

Observational studies have shown that cardiovascular mortality decreases as duration of exercise increases from 15 minutes to 47 minutes per day and when caloric expenditure increases from 500 to 2000 calories per week[17]. However, an important question remains regarding the intensity of physical activity required to incur a mortality benefit. Intensity can be defined in terms of reflecting either the rate of energy expenditure during exercise (expressed in kcal/minute) or the relative percentage of maximum aerobic capacity that is maintained during the exercise or activity (expressed in terms of percentage of maximum heart rate or percentage of maximum VO2 achieved on exercise tests)[6]. Lee *et al.*[52] have reported that only energy expended during vigorous activity (>7 kcal/minute) yielded a mortality benefit among Harvard alumni.

Draw backs of physical exercise.

Physical exercise is not without demerits, although overall, the medical benefits far outweigh the risks of physical exercise[53]. The most lethal complication of physical exercise is sudden death, which is fortunately rare (about 1 in 400,000 to 800,000 exercise hours) [54]. High-risk patients (existing heart disease, age over 45 years, multiple cardiovascular risks) should be reviewed by a physician before embarking on an exercise programme[54]. Other side effects of physical exercise include injuries and worsening of some medical conditions especially if inappropriate exercise is used. Physical exercise is therefore contra indicated in some conditions (Table II)[55].

Apart from these conditions, physical exercise is beneficial to all, young or old, male or female, fat or otherwise[56].

CONCLUSION

The saying of the 18th century Scottish physician Dr William Buchan summarizes every thing: "*Of all the causes which conspire to render the life of man short and miserable, none have greater influence than the want of proper exercise*"[3].

In conclusion, physical exercise has many health benefits and the evidence for this continues to accumulate. Health care professionals should incorporate counseling to patients for physical exercise in their daily clinical practice, while health policy makers and community physicians should see to implementation of this at the community level.

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