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Physical Activity as Preventive Medicine

In today's world of pressures and tension, there is a growing conviction that the prevention of disease and the maintenance of health must be allotted a far more important place than has been the case in the past. A life free from disease is a most desirable goal. Increasing numbers of adults are now acting on the realization that they have not kept themselves in optimal physiological and psychological condition and are seeking health enhancement by reorienting their lifestyles. Against this background, it is important to ask the question, "Is the recent increase in physical fitness activity and concern with cardiac rehabilitation through exercise based upon concrete scientific evidence?"

Most of us are aware that coronary heart disease is the single most frequent cause of adult death and disability in Canada and the United States. Canadian census statistics in 1971 revealed that for the age group 35 to 70 years, diseases of the cardiovascular system accounted for 25,700 deaths out of a total of 58,000, or 44.3 percent.¹⁴ Also, Canadian morbidity statistics in the same year indicated that diseases of the cardiovascular system were the principal cause of hospitalization. Inevitably, this results in high costs for rehabilitation and compensation. On the assumption that regular physical exercise may offer promising long-range benefits that could alleviate these costs, much research has been conducted to examine the role of physical activity as a preventive measure for cardiovascular diseases. Although the existence of a direct link between cardiovascular diseases and physical inactivity has not been conclusively demonstrated, it is clear that exercise is beneficial for controlling certain high risk factors associated with the development of the symptoms of arteriosclerosis.

A risk factor for arteriosclerosis is an attribute which occurs more commonly among persons with the disease, although causality is not necessarily implied. High blood pressure, elevated cholesterol level, and a history of cigarette smoking are well established risk factors.

Other factors that have been identified through epidemiological studies are age, sex, diabetes mellitus, obesity, family history of coronary heart disease, certain personality and behavioral traits, gout, hardness of drinking water, and physical activity status. The greater the number of risk factors in a given individual the more likely he/she will develop some manifestation of arteriosclerosis.

This paper reviews physical activity as it relates to the prevention of cardiovascular disease and examines many of the risk factors for arteriosclerosis associated with a sedentary life-style.

Physical Inactivity and Cardiovascular Disease

The relationship of physical activity to the development of coronary heart disease (CHD) has been studied largely by classifying the physical activity associated with occupation. The classic study of Morris *et al.* in 1953 was the first to report a statistically significant relationship between physical activity and CHD.¹⁷ Bus conductors were compared with bus drivers in London, England. The conductors spent much of their working day walking and climbing stairs, whereas the drivers were seated for most of their working day. The more active conductors had only 70 percent of the incidence of CHD compared to the less active drivers (CHD incidence of the conductors/CHD incidence of the drivers x 100). It might be noted that in this study, no attempt was made to assess the psychic stress of driving.

Subsequent studies compared the incidence of CHD in postal workers, industrial employees, railroad switchmen, clerks, longshoremen, civil servants, and farmers. The results of these studies are illustrated in *Figure 1*. The CHD incidence rate of the less active group has been set at 1.00 so that the CHD incidence rate of the more active group can be observed. *Figure 1* indicates that the more active groups have lower rates of CHD. Only one study involving civil servants in Los Angeles has found a greater incidence of CHD for moderately active compared with less active individuals.⁹ Since off-the-job physical activities were not assessed, such activities may have compensated in part for sedentary occupational status.

A study of 8,500 adults living in communal settlements in Israel controlled many of the factors that were not regulated in other research projects. In this investigation, subjects were ethnically homogeneous and demonstrated similar environmental conditions such as diet, cultural activity, and recreation. The finding revealed that the sedentary group had three times the CHD incidence and mortality rate compared with the active group.¹

Evidence obtained from post-mortem pathological examinations of 3,800 persons where CHD was not suspected suggests the same conclusion. Individuals with "active" jobs as compared with individuals with "light" jobs had a much lower frequency of fibrotic

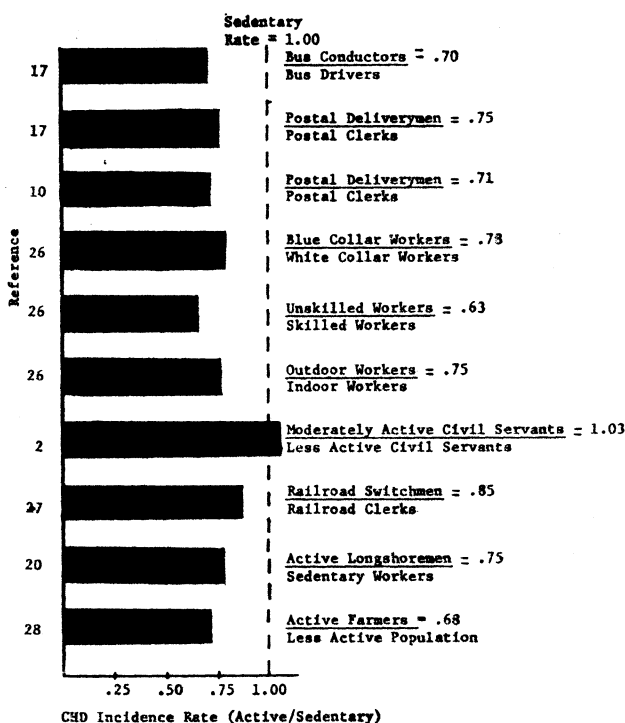


Figure 1: *Incidence of Coronary Heart Disease in Active vs Sedentary Groups*

patches, scars, healed infarcts, and coronary occlusions — all indicators for the development of atherosclerosis.¹⁸ We may therefore conclude that atherosclerosis affects the blood vessels before any overt symptoms are evident. A large segment of the adult population may possess early atherosclerotic lesions that remain undetected until clinical symptoms develop.

Much of the data presented suggests a possible beneficial association between physical activity and CHD. However, the duration and intensity of physical activity necessary to promote positive cardiovascular health is still unknown, although several studies have examined this question.

One such investigation assessed the physical activity of men both on-and off-the-job, and classified the participants into three levels of overall physical activities ("light," "intermediate," or "heavy"). Men characterized as engaging in "light" physical activity had a higher prevalence of myocardial infarction than men in either of the more active groups. Men in the "heavy" physical activities classification had as high a risk for angina as those with "light" physical activities.²⁵ Similar results have been observed among farmers.²⁸ Farmers working more than seven hours per day or less than one hour per

day had CHD incidence rates comparable to that of sedentary populations.⁶ Again, when the amount of time that civil servants spent in walking to work was used to assess the duration of exercise, the same trend was observed. Of those civil servants who did not walk to work, 6.33 percent were found to have abnormal "ischemic" resting electrocardiograms.²² As the length of time spent walking to work increased, there was a progressive reduction in the percentage of abnormalities as measured by the electrocardiogram. Results of this kind strongly support the preventive benefits of physical activity.

Several studies have examined the energy expenditure of various occupations and made group comparisons of the CHD incidence based upon the intensity of the work. Physically active longshoremen who expended 925 more calories per work day than workers with sedentary jobs had 75 percent of the incidence of CHD deaths after a 16-year follow-up period.²⁰ In this study, the effects of physical activity remained significant even after other risk factors were accounted for. However, an examination of a group of peasants in Finland indicated a high rate of CHD despite the presence of heavy occupational work.¹² Hence, we may tentatively conclude from the preceding studies that intensity and duration of physical activity need only be moderate in order to act as a preventive measure against cardiovascular disease.

Finally, it should be pointed out that physical activity may act as a rehabilitative measure by producing positive benefits for the cardiac patient through a guided exercise program of controlled duration, frequency, and intensity. Physical rehabilitation results in a given workload being performed while sustaining a lower heart rate and a slightly lower blood pressure. At the same time, stroke volume increases. These changes imply increased efficiency of the heart muscle. In the peripheral circulatory system, training increases certain enzyme levels within the muscle cell which improves oxygen extraction. Such a physical training program results in a more rapid return to employment for the cardiac patient. Coupled with increased mobility to pursue leisure activities, this has improved the sense of security and self-image of the cardiac patient.

Hypertension

Hypertension, or high blood pressure, is a very common disease in North America and is a widely accepted risk factor leading to arteriosclerosis. Life insurance data has established that mortality is directly related to the level of both the systolic and diastolic blood pressures. Optimal blood pressure for an adult may even be below the traditional 120/80 mm Hg so widely quoted by physicians, since some increases in mortality are evident with elevations of only 10 to 20 mm Hg.¹⁹ When an arbitrary value such as 150/90 mm Hg is used to define

hypertension, about 15 percent of males in their thirties and 20 percent of males in their fifties would be classified as hypertensive.¹¹

Although potent drugs are available to lower blood pressure, patients are sometimes unwilling to continue treatment, due to occasional side reactions caused by the drugs. On the other hand, exercise can be beneficial in the treatment of elevated blood pressure. "Borderline" hypertensive and normotensive men have reduced their systolic and diastolic blood pressures at rest and during submaximal work following a six month conditioning program.³ The evidence also suggests that hypertension occurs less frequently and at later ages in more active persons.¹² Excessive body fat is another factor that is associated with hypertension. Regular exercise can assist in the maintenance of desirable weight and thus contribute as a preventive measure.

Obesity

Obesity is a major health hazard since obese individuals frequently have a higher mortality rate for many diseases, including arteriosclerosis. One epidemiological study using the criteria of fast heart rate, diminished vital capacity, and obesity as sedentary traits, revealed that the risk of death was five times greater for those subjects with the traits than for subjects without the three traits.¹¹

Genetic predisposition, glandular imbalance, and psychological factors may contribute to the tendency for individuals to gain excessive weight. However, for most individuals, the primary causes are overeating and sedentary living habits. Some researchers claim that lack of exercise is the most common cause of overweight. Films of the activity habits of children have supported this claim,¹³ showing that obese children spent less time in active play than nonobese children. When the caloric intakes of the two groups were compared, there was no significant difference in caloric consumption. Hence, the authors maintain that prescription of exercise is important in the medical treatment of obesity.

Exercise can assist in preventing obesity in two ways. First, exercise helps to burn up excess calories. For example, a glass of beer with a caloric equivalent of 110 kilocalories would require 88 minutes of reclining, 22 minutes of walking or 6 minutes of running to burn up. Since most occupations in today's world have very low energy requirements, restricted food intake is necessary if weight is going to be controlled by diet alone.

Second, exercise contributes to the control of the appetite. Laboratory tests using rats have shown that moderate exercise, compared with no exercise, actually decreases the food intake of the exercising group.¹⁶ Similar results have been observed in man. Work classified as "light" and "medium" resulted in a decrease in caloric intake.¹⁶

Also, many adult physical fitness programs based on some regimen of walk-jog-run have found that regular exercise produced a decrease in body weight with a reduction of excess fat and an increase in lean body weight. Hence in moderate exercise, some mechanism causes the appetite to be depressed so that less food is desired.

Hyperlipemia

Hyperlipemia is an elevation of the fat content in the blood. Cholesterol and triglycerides are the major lipids that are altered to cause this change. Epidemiologic studies have shown that the incidence of CHD increases with the level of serum cholesterol. There does not appear to be a critical level of serum cholesterol for the development of CHD, rather, the risk increases in proportion to the serum concentration from the lowest to highest values. Serum triglycerides are also higher in patients with CHD.

Chronically active populations often have lower serum cholesterol levels than sedentary populations. It is difficult to prove that the low cholesterol levels in these populations is due to an increase in physical activity: probably nutritional and environmental factors are also involved. However, recent studies on middle-aged businessmen have shown that the most physically fit subjects had about 20 mg percent lower serum cholesterol levels than those subjects of average and low fitness.^{7, 8} Also, numerous physical fitness programs have demonstrated that physical activity will reduce the serum cholesterol concentration whenever there is a corresponding decrease in the percentage of body fat. Significant reduction in serum triglyceride levels also results from exercise programs that are high in energy expenditures.

There is direct evidence to show that physical activity reduces serum cholesterol in studies using cholesterol labelled with radioactive carbon. When radioactive cholesterol is injected into the bloodstream of man, it can be followed throughout the body. Exercise increases the degradation of portions of the cholesterol molecule and the radioactive carbon from the cholesterol molecule is now found as carbon dioxide in the expired air samples.¹⁵

Exercise and Psychological Factors

Stress research in North America has centred primarily on heart disease. Occupational stresses such as work overload, insecurity, lack of participation in decisions governing the individual's job, being trapped between people who want different things, have been linked to cardiovascular diseases. These stresses create nervous tension. For many years it has been contended that physical activity promotes relaxation. Only recently has scientific evidence supported such a claim. In 1968, deVries used electromyographic techniques to pro-

vide objective measurements of nervous tension.⁴ An exercise group compared to a control group had lower levels of muscular tension. In a follow-up study on subjects with anxiety-tension problems, it was observed that moderate exercise produced a significantly greater reduction in the resting neuromuscular tension level than did meprobamate, one of the most frequently prescribed tranquilizer drugs.⁵ Hence, it can be concluded that exercise of moderate duration and intensity may bring about a significant tranquilizing effect.

Exercise and Aging

There is ample evidence to show that age influences exercise performance, however, research has yet to produce evidence that exercise influences longevity. Although irrefutable evidence is lacking, some positive statements can be made regarding exercise and aging.

Functional deterioration which is usually associated with increasing age may be delayed in individuals who are chronically active. For example, physical training may counteract the decline in maximal aerobic power that is normally associated with aging. This variable is currently accepted as the best single indicator reflecting the condition of the cardiovascular system. In a longitudinal study of 56 subjects re-tested after twelve years in which one group was physically inactive, the group that had been inactive decreased 31 percent in maximal oxygen uptake, whereas the active group declined only 10 percent.⁹ In a similar study²³, two groups of athletes were compared after ten years. The athletes who remained active had 20-25 percent higher maximum oxygen uptake values than the group who had lived a sedentary life-style. Hence, what has been considered to be the aging process may in fact be an increasing sedentary life-style that normally accommodates age.

The changes in function of various organs in the human body that we associate with aging are very similar to the changes that can be produced in young men by keeping them inactive. Evidence of "deconditioning" was observed in five healthy male subjects who rested in bed for 20 days.²⁴ Maximal oxygen uptake, stroke volume, and physical working capacity on a bicycle ergometer decreased significantly. Inactivity also resulted in a decrease in circulating blood volume, and a reduction in the contractile strength of the body musculature. Hence if we do not use our bodies, functional deterioration results.

Summary

Physically active individuals differ from sedentary persons in many aspects. The active subjects usually have lower blood pressure and heart rate levels both at rest and during submaximal exercise compared with sedentary subjects. Physically active persons usually ex-

hibit fewer cardiac arrhythmias and have a higher functional work capacity. There are marked differences in the peripheral and central circulatory adaptations to physical stress in the two groups.

Physical activity as a preventive measure is accepted as a prudent regimen. Even though physical activity has not been proven to decrease either the rate of development of atherosclerosis or prevent its complications, it is the opinion of this writer that physical activity is beneficial for healthy subjects and certain cardiovascular impaired patients because of improved efficiency of the human organism from both a physiological and psychological viewpoint. Physiologically, physical activity prepares the organism to withstand the stress of illness. Psychologically, physical activity exerts favourable effects on the quality of life. It may not add "years to your life" but it can add "life to your years."

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