Physical Activity and Risk of Cardiovascular Disease Among Older Adults


1 Department of Radiology, Mackay Memorial Hospital, 2 Department of Nursing, School of Nursing, National Yang-Ming University, 3 Department of Cardiology Medicine, Mackey Memory Hospital, 4 Department of Rehabilitation Medicine, Mackay Memorial Hospital, 5 Department of Physical Therapy, Mackay Memory Hospital, Taipei, Taiwan

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SUMMARY

Cardiovascular disease (CVD) represents a leading cause of mortality and morbidity especially among the elderly people, and therefore the need of effective preventive strategies is imperative. Despite limited data among the elderly people, the majority of published studies have demonstrated that physically active elderly people have lower rates of CVD. In this article, we provide an overview of the epidemiology studies that investigate this association and analyze the relevant underlying biological mechanisms. We also discuss the types and amounts of physical activity recommended for the primary prevention of CVD in older adults.

1. Introduction

Coronary artery disease (CAD) and stroke are two major manifestations of cardiovascular disease (CVD), which are the most important causes of mortality and morbidity worldwide. CAD and stroke involve overlapping atherosclerotic mechanisms and share the same risk factors. According to World Health Organization estimates, CAD and stroke are the two leading causes of death worldwide, accounting for over 20% of all death, and the leading causes of overall disease burden.

Studies have demonstrated that the reduction of cardiovascular risk factors may contribute to reducing the morbidity and the mortality of CVD and reducing the burden of CVD. Physical activity, a promising modifier of the risk factors of CVD, has been extensively investigated. Physical activity is defined as any bodily movement produced by the contraction of skeletal muscles, which results in energy consumption beyond resting expenditure. Physical activity can be described as an activity performed during exercise and recreation at leisure, physical activity-associated work, transportation, and housework.

Exercise is defined as planned, structured, and repetitive physical activity that aims to improve or maintain physical fitness. Physical activity is usually measured by objective or subjective assessment, which may yield a semi-quantitative or quantitative estimate of the energy consumption associated with the performance of physical activity.

The aim of this review is to address the relationship of exercise and physical activity to the risk of CVD and its possible mechanism of benefit, and discuss the types and amount of physical activity recommended for the primary prevention of CVD in older adults.

2. Pathophysiological mechanisms

Although many epidemiological studies have shown that regular exercise or physical activity can reduce the risk of CVD, details on the mechanism remain largely unknown. The protective effect of physical activity on cardiovascular risk might be explained by the deceleration of the atherosclerotic process, including amelioration of endothelial dysfunction, and decreased systemic inflammation and thrombosis that accompanies physical activity. In addition, the favorable effect of physical activity may be mediated by controlling various known risk factors, such as hypertension, diabetes, and obesity. Fig. 1 summarizes the potential mechanisms by which physical activity helps in reducing the risk of CVD.
2.1. Endothelial function

Endothelial dysfunction (ED), mainly characterized by a reduction of nitric oxide (NO) bioavailability, is the initial event in the development of atherosclerosis. Physical activity or exercise training can change the velocity and increase the shear stress on the vascular endothelial cells, which promotes endothelial nitric oxide synthase expression and reduces nitric oxide scavenging, thus enhancing the nitric oxide mediated vasodilation and vasomotor function.

2.2. Thrombosis

Thrombosis and vessel clotting are important factors in the end-stage progression of atherosclerosis. Moreover, thrombosis plays a significant role in the pathogenesis of acute myocardial infarction, unstable angina, ischemic stroke, and sudden cardiac death. Physical activity can play an antithrombotic role through reducing blood coagulation and enhancing fibrinolytic activity. Physical activity is associated with a reduction in several haemostatic markers, including fibrinogen, blood viscosity, plasminogen activator inhibitor-1, and blood coagulation factors.

2.3. Systemic inflammation

Chronic systemic inflammation, as evidenced by the increased concentration of proinflammatory markers such as C-reactive protein (CRP), and interleukin-6 (IL-6), has been postulated to be associated with cardiovascular risk. Many cross-sectional studies have documented an inverse relationship between levels of chronic exercise and systemic levels of inflammatory markers. Studies have shown that exercise training can reduce plasma levels of CRP, IL-6, and other inflammatory cytokines.

2.4. Lipid parameters

The atherogenic lipid profile, consisting of high levels of triglyceride, low levels of high-density lipoprotein (HDL)-cholesterol, and high levels of low-density lipoprotein (LDL)-cholesterol, in particular small and dense LDL particles, have been shown to predict cardiovascular and related events. The evidence of the beneficial lipid changes due to chronic physical activity is strongest for HDL and triglyceride. A meta-analysis of 52 exercise training trials demonstrated an average increase in HDL levels of 4.6% and a decrease in triglyceride levels by 3.7%. Although recent data indicated no change in serum LDL concentrations with regular exercise, there is evidence of increased mean LDL particle size with exercise and therefore a decrease in cardiovascular risk.

2.5. Diabetes

It is now well accepted that diabetes is a major independent risk factor for CVD. Physical activity might reduce the incidence of diabetes by reducing insulin resistance and glucose intolerance. Observational epidemiological studies indicated that physical activity was associated with a decreased risk of type 2 diabetes. Several trials demonstrated that exercise training or physical activity intervention could greatly reduce the risk of developing diabetes. A meta-analysis summarized the data from 14 studies of physical activity interventions lasting 8 weeks or more and found

Fig. 1. Potential mechanisms of physical activity that help in reducing the risk of cardiovascular disease.
that postintervention levels of glycosylated hemoglobin A1c were significantly lower in the physical activity groups than those in the control groups (7.65% vs. 8.31%, respectively)\textsuperscript{21}. The Diabetes Prevention Program Research Group Study demonstrated strong evidence that physical activity and diet control can have an effect on preventing the onset of type II diabetes in individuals at high risk for this disease\textsuperscript{22}.

2.6. Hypertension

Physical activity can reduce blood pressure and the incidence of hypertension by decreasing vascular resistance and suppressing the activity of the sympathetic nervous system and the renin-angiotensin system. Folsom et al studied the association between leisure-time physical activity and hypertension in 41,837 women in the age group of 55–69 years. They found the incidence of hypertension was reduced by 10% and 30%, respectively, in participants with moderate and higher levels of physical activity, compared to those with low levels of physical activity\textsuperscript{23}. A meta-analysis of 44 randomized trials studied the effect of exercise training on resting blood pressure. The average reduction in systolic and diastolic blood pressure was 3.4 mmHg and 2.4 mmHg, respectively\textsuperscript{24}.

2.7. Obesity

Physical activity can enhance energy expenditure to achieve a negative energy balance and improved weight control. Those persons undertaking moderate-level physical activity for 150–200 minutes/week (equivalent to 1200–2000 kcal/week) are capable of maintaining an ideal body weight. If weight loss is required, the moderate-level physical activity should exceed 250 minutes/week. There is a dose-dependent relationship between the amount of physical activity and the weight loss effect, which means the greater the weekly accumulation of physical activity, the greater the weight loss\textsuperscript{25,26}.

3. Clinical outcomes

3.1. Physical activity and the risk of CAD

Over the past few decades, many epidemiologic studies performed with several different and large populations have found a clear protective effect of physical activity on CAD. A systematic review summarized the findings from 30 prospective cohort studies on the association between physical activity and the risk of CAD. The expert panel concluded that compared with the least active participants, the most active men and women had risk reductions of 30–35% for incident CAD\textsuperscript{27}. When interpreting the inverse relationships between physical activity and the risk of CAD, one must consider the possibility that unmeasured or unknown third factors may influence the selection of study participants and account for the association, and the possibility that an imperfect measurement of the level of physical activity or disease status could influence the results. However, the overall findings from these studies, which were conducted in many countries throughout the world, showed consistent inverse associations between physical activity and the risk of CAD. In addition, many plausible biological mechanisms might account for this association. Most of these observational studies were of a prospective longitudinal nature, and the follow-up duration was adequate, which might prevent and dilute any potential bias. Although, the protective role of physical activity on the risk of CAD is well established, the exact shape of the dose-response curve between physical activity and the risk of CAD is uncertain. A recent meta-analysis of data from 33 studies found that compared to those reporting no physical activity, individuals who engaged in the equivalent of 150 minutes/week of moderate-intensity physical activity had a 14% lower CAD risk, and those engaged in the equivalent of 300 minutes/week of moderate-intensity physical activity had a 20% lower CAD risk\textsuperscript{28}. In summary, there is substantial evidence to indicate that physically active individuals have a lower risk of CAD, and it is also clear that increasing amounts physical activity are associated with additional risk reduction.

3.2. Physical activity and the risk of stroke

Plausible biological pathways support the benefits of physical activity in reducing the risk of stroke, both ischemic and hemorrhagic. The potential effects on the risk of ischemic stroke disease may be mediated through mechanisms that decelerate atherosclerotic progression, and the potential effects on the risk of hemorrhagic stroke disease may be mediated through reduced blood pressure and other related risk factors. However, the findings from prospective studies on the association between physical activity and the risk of stroke are inconsistent, with some studies reporting U-shaped associations or no association\textsuperscript{29,30}. The inconsistency might be due to the differences in study design, population, and the definition and measurement of physical activity between studies. A meta-analysis by Lee et al examined 23 studies and reported that compared with sedentary individuals, the risk of stroke was significantly reduced, between 20% and 27%, in individuals with a moderate or high level of physical activity\textsuperscript{31}. Further evidence in support of a beneficial effect of physical activity on stroke risk can be found in a meta-analysis of 13 cohort studies that investigated the effects of physical activity on stroke risk and the related outcome. The meta-analysis found that a high level of physical activity was associated with a 19% reduction in the risk of stroke-related outcome and a moderate level of physical activity with an 11% reduction, compared with a lower level of physical activity\textsuperscript{12}.

Taking into consideration recent epidemiological data that favor an association between physical activity and the risk of CAD, the beneficial effects of exercise on stroke risk reduction seem likely. However, definitive controlled trials are justified to establish the intensity and frequency of the physical activity required to achieve cardiovascular benefits.

3.3. Physical activity and the risk of CVD among older adults

The evidence on the relationship between physical activity and the risk of CAD as a whole has been derived from studies targeting the middle-aged and elderly combined. Studies that have investigated physical activity exclusively in the elderly remain fairly sparse, with hardly any data available for individuals aged 80 years and older. Among 2678 elderly men aged 71–93 years studied for four years in the Honolulu Heart Program, those who walked 1.5 miles/day had a predicted 50% reduction in the risk of CAD compared to those who walked fewer than 0.25 mile/day\textsuperscript{33}. In the 10-year Zutphen Elderly Study, men aged 64–84 years who walked or cycled at least three times per week for 20 minutes experienced a 31% reduction in CAD mortality compared to their less active counterparts\textsuperscript{34}. The Northern Manhattan Stroke study, including 1047 participants (mean age, 69.9 years), found that physical activity was significantly protective against ischemic stroke\textsuperscript{35}. Thus, these data suggest that higher levels of physical activity are related to lower rates of CVD among people older than age 60 years.

3.4. Physical activity recommendations for older adults

There is strong scientific evidence that regular physical activity reduces the risk of CVD and other chronic illnesses in older adults. The current recommendations from the American Heart
Association and the American College of Sports Medicine for older adults is as follows: physical activity should be primarily aerobic, supplemented by strengthening activity, flexibility, and balance exercise. The intensity of physical activity should be moderate or vigorous intensity. The so-called moderate-intensity aerobic physical activity involved a moderate level of an effort relative to an individual’s aerobic fitness. On a 10-point scale, where sitting is 0 points and all-out effort is 10 points, moderate-intensity activity is 5 points or 6 points and produces noticeable increases in heart rate and breathing. On the same scale, vigorous-intensity activity is 7 points or 8 points and produces large increases in both heart rate and breathing. The duration of physical activity should consist of a minimum 30 minutes on most, preferably on all days of the week. Frail elders and those restricted because of disease activity can also gain health benefits when moving from an “inactive” status to performing “some activities.” Physical activity should be tailored to meet an individual’s needs and ability, which is especially for frail and older adults. Training programs must emphasize safety, and a priority strategy should be implemented to increase daily activities and to develop a more active lifestyle. Such an activity should integrate daily walking or other activities as they become tolerated. Thus, except where such advice is contraindicated, older adults should be encouraged to be physically active.

4. Conclusion

CVD is an important cause of death and disability worldwide. The outcome of a patient with a treated CVD will never be as good as that of someone in whom a CVD was prevented. Many clinical trials have proved that physical activity or exercise training can improve traditional cardiovascular risk factors by slowing down the process of atherosclerosis. The results of most epidemiological studies are consistent: regardless of gender and age, regular and appropriate physical activity can prevent the occurrence of CVD. Given the breadth and strength of the evidences, physical activity should be one of the highest priorities for preventing the risk of CVD in older adults. Effective interventions to promote physical activity in older adults may have great impact on cardiovascular health. Future studies on older populations, especially those older than 80 years old, to develop information on the minimal and optimal amounts of physical activity are needed. Additional studies are also needed to investigate the effect of different domains of physical activity, such as work, leisure, or domestic activity.

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