# Exercise and Hypertension

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**KIM: *Exercise and Hypertension.*** *Even mild-to-moderate hypertension significantly increases the risk of left ventricular hypertrophy, renal disease, and stroke. Antihypertensive drugs are effective to lower blood pressure and decrease the risk of the target organ damage, but adverse side effects and cost have led to a search for non-pharmacological interventions. The USA Joint National Committee Guidelines on hypertension report strongly recommended lifestyle modification to prevent hypertension as definitive therapy for some and as adjunctive therapy for all hypertensive patients. Lack of physical fitness increases the risk of hypertension and is a strong predictor of cardiovascular mortality independent of blood pressure and other risk factors. Contrarily, physical activity can prevent hypertension and decrease systolic and diastolic blood pressure. The type of exercise should be primarily endurance physical activity (walking, jogging, or bicycling) regular basis supplemented by resistance exercise. The blood pressure is reduced early after the initiation of dynamic exercise training and no further reduction occurs after 3 months but disappears abruptly with detraining. Some antihypertensive drugs such as diuretics and beta blockers can interfere with exercise performance but alpha blockers, calcium channel blockers, and angiotensin converting enzyme inhibitors do not interfere with exercise performance and are well tolerated by active hypertensive individuals. If hypertension is poorly controlled, heavy physical exercise as well as maximal exercise testing should be discouraged or postponed until appropriate drug treatment has been instituted and blood pressure lowered. (J HK Coll Cardiol 2008;16(Suppl):A43-A47)*

*Exercise, hypertension, physical activity*

## 摘要

即使是輕度到中度的高血壓就能夠顯著的增加左心室肥厚、腎臟疾病和中風的危險。抗高血壓藥物可以有效地降低血藥，減少靶器官受損的危險，但其藥物的副作用和費用使得人們尋求非藥物性的干預措施。美國聯合學會就高血壓的指導意見報告中強烈對於所有高血壓患者推薦改變生活方式作爲確定性的治療手段來預防高血壓，而藥物治療作爲輔助治療。缺乏身體良好的適應性不僅是高血壓發病的危險因素，還是心血管性疾病致死的強烈徵兆，且獨立於血壓和其他危險因素。相反，體育活動能夠預防高血壓，並且降低收縮壓和舒張壓。運動的方式應是基礎的耐力性的運動（散步、慢跑或騎自行車），或常規運動輔以抵抗性活動。在起初的運動訓練後血壓在早期便能下降，但在 3 個月後這種下降便不再進一步了，而一旦停止運動血壓下降便會突然消失。有些抗高血壓藥物如利尿劑和 β 受體阻滯劑會影響運動表現，而 α 受體阻滯劑、鈣通道阻滯劑和血管緊張素轉化酶抑制劑則不會干擾運動，它們適用於那些活動期的高血壓患者。如果高血壓控制不佳，不建議參與劇烈運動和極限運動測試，必須在合適藥物治療確立和血壓下降後才考慮運動。

關鍵詞：運動　高血壓　體育活動

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## Introduction

Physically inactive individuals have a 1.5 greater relative risk of developing hypertension than those with high levels of activity. A review of cross-sectional studies in children as well as longitudinal dynamic training studies in young adults below the age of 30 indicate that blood pressure (BP) is inversely related to leisure time physical activity.[1] Adults up to 40 years old who engaged in regular physical activity had a 30% lower risk of developing hypertension than sedentary individuals.[2] Regular physical activity has a protective effect against cardiovascular disease and all cause mortality.[3] Contrarily, physical inactivity is an independent risk factor for hypertension and coronary artery disease, regardless of age, body mass index, and fasting plasma insulin levels.[4]

## Dynamic Exercise and the BP Response

### I. Acute Dynamic (Aerobic) Exercise and the BP Response

BP rises during dynamic exercise and the rate of rise is related intensity and level of training. Systolic BP starts to rise at the beginning of exercise, continues rising in a linear relationship with higher workload, and reaches the peak at the end of the exercise or maximal workload. The exercise induced increase of systolic BP in borderline or definite hypertensive persons is roughly parallel to the changes in normotensive persons. However, the maximal BP at peak exercise in hypertensive subjects is higher than normotensive subjects due to the higher starting BP in both treadmill or bicycle exercise. These differences in BP between normotensive and hypertensive subjects are related to systemic vascular resistance rather than cardiac output. The increase in systolic BP of 50 to 70 mmHg at peak exercise shows no significant difference between treadmill and bicycle exercise whereas change of diastolic BP during exercise is different between those two exercise modes. Diastolic BP does not change or slightly decreases during treadmill exercise, but it tends to slightly increase during bicycle exercise. This is related to greater resistance to the exercising skeletal muscle than running.

An excessive or an exaggerated increase in BP during exercise testing may be a marker of future sustained hypertension.[5] The cause of this abnormal response may be due to a failure to reduce total peripheral resistance adequately during exercise as a result of initial structural vascular change. Several studies showed that an exaggerated response to exercise (systolic BP $\geq$ 210 mmHg in men and $\geq$190 mmHg in women) increased the risk of hypertension 1.5-to fourfold.[6] Subjects with exaggerated exercise blood pressure have a higher mean 24-h BP than subjects with normal exercise BP. An exaggerated exercise BP can be hazardous in the hypertensive subject who wants to continue strenuous exercise, since the repetitive BP peaks triggered by physical activity may impact chronic end-organ damage or cardiovascular events.

### II. Training Effect of Dynamic Exercise on Hypertension

The reports from several meta-analysis studies (including total 155 studies) demonstrate that aerobic exercise training reduces resting systolic and diastolic pressure to 10 mmHg in mild to moderate essential hypertension.[7] Age and gender seem to be not a limiting factor. Endurance training can lower BP also in patients taking antihypertensive drugs and may eliminate or reduce the need for medications.[8] Although the BP reduction from exercise training is small, it may have significant effects to reduce the incidence of stroke and coronary heart diseases. Aerobic exercise can decrease the BP response to stressful conditions, blunt daytime BP peaks, reduce variability, and contribute subsequent target organ damage such as reduction of left ventricular wall mass.[9]

Exercise capacity is 30% reduced in hypertensive subjects compared to age-matched controls. But physical exercise training can increase maximal oxygen consumption and maximal BP. Unlike the resting BP, the maximal BP during exercise is not reduced, but in fact is increased parallel to exercise tolerance and higher fitness levels. In sedentary hypertensive subjects, an increased total peripheral resistance is the most likely mechanism for the rise in BP with exercise. Whereas, the higher maximal BP after training in hypertensive subjects is probably due to an increase in cardiac output and improved ventricular function.[10] High fitness groups shows lower systolic and diastolic pressure and slower

increase rate of the systolic pressure than sedentary group.[11]

## Static Exercise and the BP Response

Acute static exercise increases both systolic and diastolic BP in either normotensive or hypertensive subjects by reflex increases in cardiac output with minimal or no change in vascular resistance.[12] According to the weightlifting subjects study by MacDougall et al,[13] the greatest peak pressure occurred during the double-leg press where the mean value for the group was 320/250 mmHg. Peak pressure with the single-arm curl exercise reached a mean group value of 255/190 mmHg. The magnitude of the BP rise is proportional to the intensity of muscle contraction, the size of muscle mass used in contraction, and the duration of exercise.[14] During heavy weightlifting with a Valsalva maneuver, the BP response is extremely exaggerated but may be dramatically reduced with an open glottis or slow exhalation during exercise. Narloch and Brandstater demonstrated that the mean BP at 100% maximum double-leg press exercise with Valsalva was 311/284 mmHg compared to that of slow exhalation when the mean BP was 198/175 mmHg.[15] So this breathing technique may help to prevent cardiovascular complications in hypertensive patients.

Several preliminary studies showed that supervised static exercise program, particularly circuit training, have acceptable hemodynamic responses and safe clinical limits and can reduce BP in hypertensive patients despite the inherent potential to acutely elevate BP. However, an abrupt elevation of BP induced by weightlifting increases myocardial oxygen demand, which may impact myocardial ischemia. So, heavy resistance training requiring high voluntary effort is generally not recommended in hypertensive patients and even moderate weight training should be delayed until resting BP is under control.

## Prescription of Exercise Training to Patients

All controlled hypertensive patients should participate in exercise training. It can be used with other non-pharmacologic interventions and without medication in uncomplicated mild-to-moderate hypertensive patients. The patients with BP higher than 180/105 and patients with cardiovascular complications such as target organ damage, diabetes, or elderly should start exercise training only after BP is controlled by antihypertensive drugs. Obese patients need aggressive weight reduction combined with a walking program prior to more intense exercise training.

Initially, pre-training assessment is necessary to evaluate exercise risk stratification. The history including family history and physical examination on cardiovascular disease or conditions that might limit exercise capability should be taken. A resting ECG is recommended for all hypertensive patients and echocardiogram in selected patients. Although the American College of Sports Medicine does not recommend exercise test as a screening test to identify high risk subject for developing hypertension as a result of an exaggerated exercise BP response, it can provide information for risk stratification. A graded exercise test is often recommended for adults over the age of 40 who plan to begin an exercise training program and should be performed in moderate to severe hypertensive patients with evidence of left ventricular hypertrophy from an ECG or in diabetic hypertensive patients because of high incidence of silent myocardial infarction.

The BP response to dynamic exercise varies from sport to sport. Walking, running, cycling, or T'ai chi do not cause a sustained increase in BP and possibly are the most suitable endurance exercises for hypertensive patients. Swimming can be an alternative exercise in patients with obesity, exercise induced asthma, or orthopedic problems but showed higher BP levels than running at comparable heart rates with smaller cardiopulmonary effects. Vigorous sprints, rowing, downhill skiing, and mountain sports are unsuitable for hypertensive patients.

Although there are no specific guidelines in exercise management of hypertension regarding intensity and frequency, low-to-moderate intensity endurance exercise training is recommended in general rather than high intensity in lowering BP in hypertensive

patients. Based on a consensus statement by the World Hypertension League, hypertensive patients should exercise at an intensity of 50 to 85% maximal oxygen consumption or 50 to 70% of maximal heart rate for 20 to 60 min, 3 to 5 days per week. The lower intensity requires longer duration.

In most studies, BP is reduced early (3 weeks to 3 months) after the initiation of moderate intensity dynamic exercise in both normotensive and hypertensive subjects, and no further reductions occurs after 3 months.[16] The BP lowering effect of exercise training is evident only as long as a regular endurance exercise training program is maintained[17] and BP rises gradually toward the baseline for 1 to 2 weeks after cessation of exercise. So, the maintenance of regular exercise is necessary and must be encouraged.

## Antihypertensive Drugs for Active Hypertensive Patients

The choice of medication should be individualized and based on hypertension in association with other diseases. There are no absolute contraindications to use any drug classes in active hypertensive patients although certain classes of drugs are preferred, or are better tolerated.

Diuretics are effective to fall BP during exercise by decreasing peripheral resistance and plasma volume.[18] The most trouble but manageable problem with diuretics for active persons is hypokalemia. Exercise with hypokalemia may interrupt skeletal muscle blood flow resulting in rhabdomyolysis and acute renal failure. To ensure against potassium loss, patients taking diuretics such as thiazide should receive potassium supplements. Diuretics and nonselective beta blockers can increase triglycerides and VLDL cholesterol by 10 to 30% and reduce HDL cholesterol by 6 to 25%.

Beta-adrenergic blocking agents especially nonselective beta blocker such as propranolol blunt exercise mediated increases in heart rate and cardiac output and may reduce exercise performance, and is greater with chronic administration than with acute dosing.[19] However, in case of ischemic heart disease, beta blockers can be used without having a negative effect on exercise capacity.[20] In patients with bronchospasm as a component of chronic obstructive lung disease, any beta blockers should be avoided.

Alpha-adrenergic blocking agents doxazosin, prazosin, and terazosin do not suppress cardiac output or exercise capacity and are excellent choices for use in active hypertensive patients. Calcium channel blockers verapamil, diltiazem, and nifedipine reduce systolic and diastolic BP during exercise possibly through reduction in systemic vascular resistance. So, calcium channel blockers are beneficial for patients who are not good candidates for beta blockers.

## Conclusion

Antihypertensive drugs are effective to lower BP and decrease the risk of the target organ damage, but adverse side effects and cost have led to a search for non-pharmacological interventions in mild to moderate hypertension. Dynamic exercise or aerobic training such as walking, running, or bicycling exercise is the choice exercise for hypertensive patients. Low-to-moderate intensity exercise appears to lower systolic and diastolic blood pressure with an average of reduction of 10 mmHg. The blood pressure is reduced early after the initiation of dynamic exercise training and no further reductions occurs after 3 months but disappears abruptly with detraining.

Some antihypertensive drugs such as diuretics and beta blockers can interfere with exercise performance but alpha blockers, calcium channel blockers, and ACE-I do not interfere with exercise performance and are well tolerated by active hypertensive individuals. If hypertension is poorly controlled, heavy physical exercise as well as maximal exercise testing should be discouraged or postponed until appropriate drug treatment has been instituted and blood pressure lowered.

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