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Effect of exercise training in essential arterial hypertension

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ABSTRACT

The objective of this brief review is to give an overview on the current status of exercise training in the prevention and treatment of hypertension. Evidence derived from studies which support the relevance of exercise as a core component of hypertension therapy are presented along with the beneficial effects of exercise training in counteracting the mechanisms sustaining high blood pressure in the context of secondary as well as primary cardiovascular prevention. Practical guides to plan exercise training programs are also provided. Finally, practical open questions in exercise training are advanced.

KEYWORDS

Hypertension, exercise training, cardiovascular disease, primary prevention, secondary prevention.

High blood pressure is a serious public health challenge worldwide. Epidemiologic studies indicate that elevated blood pressure leads to stroke, coronary heart disease, congestive heart failure, and end-stage renal disease[1]. Clinical trials have demonstrated that lowering blood pressure reduces incidence of and death from cardiovascular disease[1,2]. These studies also indicated that even small decreases in arterial blood pressure could substantially reduce the risk for diseases associated with elevated blood pressure[3].

The 2007 ESH-ESC European guidelines[4] on the treatment of arterial hypertension indicate the following "normal" values: ideal: $< 120/< 80$, normal: 120-129/80-84 and high normal: 130-139/85 -89 mmHg. According to these guidelines, arterial hypertension (AH) is defined on the basis of arterial pressure (AP) > 140 mmHg for systolic pressure and 90 mmHg for diastolic pressure.

Antihypertensive treatment can reduce the risk of fatal and non-fatal ictus by 30%-40% and the risk of coronary events by 20%[4]. A reduction in pressure of 4-6 mmHg cuts ictus cases by 35%-40%, ischemic heart disease by 20%-25%, and cardiovascular mortality by 25%[5]. Reduced systolic pressure of 10 mmHg and diastolic pressure of 5 mmHg permits a reduction of 50%-60% in the risk of ictus and of 40%-50% in coronary disease[6].

Along with pharmacological therapy, there is now established evidence and overall consensus in current guidelines on the effectiveness of regular physical activity in the treatment of hypertension, in combination with drug(s) therapy or even alone[7-9].

Physical inactivity is a recognized major risk factor for cardiovascular disease, and persons who are less active and less fit have a 30% to 50% greater risk for high blood pressure. Two cohort studies have demonstrated that regular exercise reduces the incidence of hypertension[10,11]. In addition to preventing hypertension, regular exercise has been found to lower blood pressure in hypertensive subjects. In mildly hypertensive men, short-term physical activity decreased blood pressure for 8 to 12 hours after exercise, and average blood pressure was lower on exercise days than on non exercise days[12]. In hypertensive black men, moderate physical activity performed for 16 to 32 weeks resulted in a decrease in diastolic blood pressure, which was sustained after a reduction in antihypertensive medication[13].

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Randomized controlled trials have shown that exercise training is capable of reducing blood pressure up to 11 and 8 mmHg, for systolic and diastolic pressures, respectively, in approximately 75% of hypertensive individuals of both genders[7,14] with mean reduction of 6.9 and 4.9 mmHg for systolic and diastolic pressure, respectively[15].

In practical terms, this would mean a regression from a "high" to a "normal" blood pressure state for a large part of hypertensive subjects, the majority of which usually fall into the category of mild hypertension. Regular physical activity proved to be effective in improving pharmacological control as the therapeutic dosage can also be reduced[16]. The combined action of training, weight loss, control of hyperglycemia and dyslipidemia can normalize minor forms of arterial hypertension, without the need for drugs. It is important, however, in the presence of other risk factors, to associate an appropriate life-style with physical training, characterised by a low sodium diet and weight loss associating a low calorie diet with low animal fat content in the event of an overweight situation, a limited intake of sugars and alcohol, an increase in fruit and vegetables and the abolition of smoking.

Indeed, physical exercise can cut the 10-year cardiovascular risk by 25%[9] and is now definitely indicated as part of the therapy in hypertensive subjects for better control of AP and of concomitant cardiovascular risk. Thus, the AHA[17] the ACC[18], the Centers for Disease Control and Prevention[19], the ACSM[20], the National Institutes of Health[21], have declared a sedentary lifestyle a major modifiable coronary risk factor. Accordingly, a consensus has been reached that a minimum of 30 up to 60 minutes of moderate intensity physical activity (continuous or intermittent) is required on most (at least 3 to 5 but preferably all) days of the week to reduce the risk of CAD events[20,21].

EXERCISE TRAINING PROGRAM

Aerobic endurance exercise appears to be more effective at lowering blood pressure than other kinds of exercise, including resistance exercise[22]. Any aerobic activity seems to work, including walking, jogging or cycling, although cycling seems to be the most effective[23].

Moderate intensity exercise seems to be the most effective for reducing blood pressure in hypertensive patients[7]. This would be equivalent to ≈1.5 mile per day of brisk walking at an energy cost of 150 kcal per day for an average-sized person. This exercise intensity can be accomplished much easier in middle-age and old hypertensive patients than more vigorous exercise can, results in less musculoskeletal injuries and cardiovascular events, and can be maintained throughout life.

Moderate aerobic exercise training would correspond to a target heart rate of 75% to 85% of HRmax, or to 65% to 75% in older individuals, to be gradually achieved and maintained throughout the training program. When possible, target HR should be determined on the basis of HRmax actually achieved during an ergometric exercise test to exhaustion, rather than on the basis of nomographic tables (e.g., 220 minus age). This would avoid overestimation of the training load with respect to the actual exercise capacity/fitness level, which often is less than predicted on the basis of age-predicted maximum HR. This precaution would contribute to lessen musculoskeletal injuries and, most important, lessen exercise-induced cardiovascular events. A pre-training exercise stress test is, otherwise mandatory in hypertensive patients with co-morbidity, e.g., ischemic heart disease etc. A useful approach to activity prescription is to identify the desirable rating of perceived exertion and instruct individuals to adhere to that intensity. A suggested rating of perceived exertion for most healthy individuals is 12 to 16 ("somewhat hard to hard") on a Borg scale of 6 to 20, an approach that is both effective and acceptable. The physical training process should contemplate an increase in the number and duration of sessions and only later in their intensity. At variance with other CV diseases, resistance and most of all strength exercise are not to be recommended in hypertensive patients, because of the possibility of reaching very high blood pressure values during these kinds of exercise and the much more limited effect on blood pressure reduction. Examples of continuous and intermittent aerobic exercise training programs are illustrated in tables 1 and 2. It is important to outline the need of 5 to 10 minutes of warm-up (i.e., exercising at a low intensity) before and after (cool-down) the training session. Such activities help stretch and warm up muscles and ligaments in preparation for the activity session. The cool-down period also prevents hypotension, which may occur with the sudden cessation of exercise.

Reductions in blood pressure are seen usually within 10 weeks[7] after starting an exercise training program. This result could reinforce motivation in patients. However, it should be remembered that the benefits of exercise training are rapidly lost after quitting regular physical activity. Hence, patients have to be informed on this issue and be continuously encouraged to be physically active. It is important to bear in mind that exercise therapy must be continued all life long, musculoskeletal comorbidities permitting.

MECHANISMS OF EXERCISE-INDUCED DECREASE IN BLOOD PRESSURE

Despite the recognized effectiveness of regular physical activity in reducing blood pressure, the mechanisms responsible for exercise-induced reduction in blood pressure are not completely defined, but it is very likely that several intertwined mechanisms contribute as the etiology of essential hypertension is multifactorial. The ultimate hemodynamic mechanism sustaining

blood pressure decrease with exercise training is a reduction in peripheral vascular resistance[15]. A decrease in sympathetic efferent activity in the vessels surely plays a fundamental role regarding the heart, as does an increase in efferent vagal activity. It has long been recognized that an increase in sympathetic nervous system (SNS) activity is of major importance in the development and maintenance of a hypertensive state[24-27]. Exercise training has been shown to decrease SNS activity and to increase baroreflex sensitivity (an index of reflex vagal control of the heart which carries relevant pathophysiological and prognostic information cit) concomitantly with a decrease in blood pressure in hypertensive patients[15,28,29]. The vascular endothelium is also likely to contribute to exercise-induced decrease in blood pressure. The endothelium shares a functional antagonism with the SNS efferents in maintaining vessel tone[30]. In the normal state, there is a tonic balance between the release of vasodilating factors from the endothelium and vasoconstricting factors from sympathetic nerve terminals to maintain the appropriate vessel tone[31-34]. Endothelium-dependent dilation is impaired in patients with hypertension[35,36]. Emerging evidence suggests that aerobic exercise improves endothelial function and reduces blood pressure in hypertensive patients[37,38] through the release of endothelium-derived relaxing factors such as nitric oxide, which is stimulated mainly by the rise in shear stress occurring during exercise.

Finally, clinical trials have shown that in hypertensive patients aerobic exercise reduces insulin resistance and insulin levels[7,13,39], which are enhanced in hypertensive patients[40,41] through complex interactions with endothelial function and SNS activity[42-46]. It does appear that impairment in SNS activity, endothelial function and insulin secretion/activity interact with one another in the development and maintenance of hypertension and that regular aerobic exercise is capable of counteracting each of these factors, thus resulting in a reduction of blood pressure.

Table 2. Example of an aerobic physical activity program

Frequency	3-5 (better if all) days/week
Intensity	55-85% HRmax
Duration	3-60 min
Modality	
Lower limbs	Walking Running Cycling
Upper limbs	Arms ergometer
Combined (upper and lower limbs)	Rowing (rowing machine) Swimming Calisthenics, dancing etc.

UNSOLVED PROBLEMS

The main practical problem is the adherence to all life long regular physical activity programs, which is an essential element for success in achieving and maintaining the benefit of exercise on blood pressure, as well as other cardiovascular risk factors and health.

The flexibility of accumulating the adequate dose of physical activity in short, repeated, sessions throughout the day might improve motivation and adherence to regular exercise programs. Another important factor, especially at the beginning of exercise programs, is to start at lower intensities than the predicted and then to progress gradually to the recommended exercise prescription, with assessment of success and reinforcement provided regularly. Short-term successes may increase the patient's self-efficacy for being physically active. At present, periodic follow-up visits with encouragement and reinforcement by physician appear mandatory to achieve this goal.

CONCLUSIONS

The findings summarized in this brief review make evident that aerobic exercise is of paramount importance as a strategy for prevention and treatment hypertension and its complications.

Table 1. Classification of physical activity intensity

	Aerobic endurance activity				
	Relative intensity	**Absolute intensity (METs)**			
Intensity	**Maximum HR (%)**	**Young (20-39)**	**Middle-aged (40-64 yr)**	**Old (65-79 yr)**	**Very old (> 80)**
Very light	< 30	< 3	< 2.5	< 2.0	< 1.25
Light	30-49	3-4.7	2.5-4.4	2.0-3.5	1.26-2.2
Moderate	50-69	4.8-7.1	4.5-5.9	3.6-4.7	2.3-2.95
Hard	70-89	7.2-10.1	6.0-8.4	4.8-6.7	3.0-4.25
Very hard	≥ 90	≥ 10.2	≥ 8.5	≥ 6.8	≥ 4.25

METs (metabolic equivalents, 1 MET = resting energy expenditure). Adapted from: American College of Sports Medicine Position Stand: the recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. Med Sci Sports Exerc. 1998;30:975-91.

It is now the time to consider physical activity as a *therapy*, and physicians should be trained to being capable of prescribing the appropriate dose of exercise, in terms of type, intensity and frequency, as if it were the dosage of a drug.

Public health policies are mandatory to identify ways to enhance exercise prescription by physicians and adherence to training programs by patients.

Further studies are clearly needed to better define the mechanisms involved in the blood pressure-lowering effect of exercise as well as to best define the more appropriate dose of exercise on an individual basis.

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