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Research Article

Accumulated brisk walking reduces arterial stiffness in overweight adults: Evidence from a randomized control trial

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Abstract

Arterial stiffness is a major contributor to the development of atherosclerosis and consequently cardiovascular disease. This study aimed to examine whether 6 months of accumulated (3 × 10 minutes, 5 days/week) brisk walking was sufficient to reduce arterial stiffness in sedentary, overweight individuals. Seventy-seven individuals (19 men, 58 women; age, 30-55 years) were randomly allocated to one of three groups; two groups completed 30 minutes of accumulated walking with either monthly or weekly telephone support; the third group (control) performed stretching exercises. The walking groups were combined and telephone support included as a covariate. Anthropometry, blood pressure (BP), blood lipids, pulse wave velocity (PWV), and NO_x (surrogate marker for nitric oxide) were measured at baseline, post-intervention and 4 months post-intervention. No changes were observed for anthropometry, BP, or lipids. However, at the end of the intervention, there was a decrease in PWV ($P < .001$) accompanied by an increase in NO_x ($P < .001$), with changes maintained 4 months post-intervention. A strong negative correlation between PWV and NO_x was also observed ($P < .001$; $r = -0.65$). A lifestyle approach to meeting current physical activity guidelines results in favorable alterations in arterial function in overweight individuals. J Am Soc Hypertens 2014;8(2):117–126. © 2014 American Society of Hypertension. All rights reserved.

Keywords: Pulse wave velocity; nitric oxide; exercise; moderate activity.

Introduction

In 2007, the American College of Sports Medicine suggested that healthy adults should complete at least 30 minutes of moderate intensity aerobic activity on 5 days/week, accumulated in bouts lasting 10 minutes or more.[1] In 2008, the (American) Department of Health and Human Services modified these guidelines, stating that healthy adults should attain at least 150 minutes of aerobic activity per week in bouts of not less than 10 minutes, spread throughout the week.[2]

Despite the health benefits of regular exercise, 57.3% of the adult population in Northern Ireland (NI) are currently not meeting physical activity recommendations.[3] Inactivity is estimated to cost the NI Health Service approximately £0.62 billion per year, with at least 2000 deaths per year in NI attributed to a sedentary lifestyle.[4] Although there are many contributing factors to cardiovascular disease (CVD), inactivity has been shown to be one of the major risk factor[5–7] It has been estimated that 9% of all coronary heart disease cases could be avoided if sedentary individuals became moderately active.[8]

Walking has been described as a ''near perfect exercise''[9] and has been cited as the most popular physical activity within the European Union.[10] The Health Survey for England 2008 stated that both men and women spend more hours per week walking than on any other activity outside of work.[11] Although adherence to many exercise programs is often less than 50%, walking programs tend to achieve higher levels of adherence than other forms of exercise.[12–14] For most middle-aged and/or overweight individuals, brisk

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walking at a pace of 5 km/hour (3 miles/hour) meets the requirements for moderate intensity physical activity in sedentary adults.[15,16]

Arterial stiffness is a major contributor to the development of atherosclerosis and consequently CVD.[17,18] It results in an increased after-load on the left ventricle, which can subsequently cause cardiac hypertrophy, elevated systolic pressure, reduced diastolic function, and decreased coronary perfusion.[19] When arterial stiffness is measured via pulse wave velocity (PWV),[20] it has been shown to be a strong independent predictor of cardiovascular morbidity.[21] PWV increases progressively with age, with a 2.5-fold increase between 20 and 91 years.[22] In typical middle-aged adults, normal PWV values are approximately 8 m/s in the iliac artery, 7 m/s in the brachial artery, 5 m/s in the abdominal aorta and carotid, and 4 m/s in the ascending aorta.[23] These values increase proportionally, depending on the extent and number of other CVD risk factors present.[24]

It is hypothesized that regular exercise improves arterial stiffness by altering vascular shear stress, causing increased production of the vasodilator, nitric oxide (NO).[25] The increase in hemodynamic shear stress and endothelial stretching generated through regular exercise increases endothelial nitric oxide synthase (eNOS) activity,[26,27] which enhances long-term biosynthesis of endothelial NO thereby reducing arterial stiffness. An increased release of NO in response to increased shear stress not only dilates the underlying smooth muscle of the arteries, but also maintains the concentration of NO within the vascular endothelium, despite an increase in blood flow.[28]

To date, no published work has examined the effects that brisk walking may have on arterial stiffness in overweight individuals. Therefore this study investigated whether 6 months of regular accumulated brisk walking, in line with current physical activity guidelines, was sufficient to reduce arterial stiffness in sedentary, overweight individuals, even without weight loss, and if the changes could be sustained for 4 months beyond the intervention period.

Methods

Ethical approval was obtained from the institution's Research Ethics Committee, and the study was carried out in accordance with the Declaration of Helsinki (2008). Informed consent was obtained from participants prior to the onset of the intervention. Overweight (body mass index [BMI] $\geq$25 kg/m^2), sedentary (<2.5 hours moderate activity per week during previous 6 months), apparently healthy, non-smoking individuals, aged 30-55 years, were recruited from within the institution and surrounding area. Previous activity levels were assessed via 7-day recall questionnaire,[29] with individuals also being asked if their behaviors or occupations had changed within the last 6 months. A total of 102 individuals were assessed for eligibility; however, 12 did not meet the criteria and 13 withdrew prior to the study onset. This study was a randomized parallel group design. Participants were randomly allocated, by a third party, into one of three groups; a walking group with monthly telephone contact, a walking group with weekly telephone contact, and a control group. The walking groups were required to incorporate three 10-minute bouts of brisk walking into their daily routine on 5 days per week. Brisk walking was described to participants as a walk that left them slightly out of breath but still able to maintain a conversation. Participants were contacted by telephone during the intervention either monthly or weekly to provide support and encouragement. The control group were given light stretching exercises to complete twice daily on 5 days per week and were contacted on a monthly basis to control for effects of the telephone contact given to the walking groups. Telephone contact did not affect the results presented within this paper and therefore will not be discussed further. As both walking groups completed the same volume and intensity of walking, they have been amalgamated into a single group for subsequent analysis and ease of presentation. The telephone contact has been included as a covariate for statistical analyses.

Anthropometric Measures

Height was measured using a freestanding stadiometer (Holtain Ltd, Crymych, UK) to the nearest 0.1 cm, and digital scales (model TBF-410,Tanita Corp, Toyko, Japan) measured body mass to the nearest 0.1 kg. Participants wore light clothing with no shoes. BMI was calculated (kg/m^2). Body fat mass (kg) and percentage body fat was assessed via bioelectrical impedance (model TBF-410, Tanita Corp, Toyko, Japan).[30] Waist circumference was measured at the narrowest part of the waist,[31] and hip circumference was measured at the maximum buttock circumference over light clothing to the nearest 0.1 cm. Participants stood with legs parallel and shoulder-width apart. Waist-hip ratio was calculated (waist/hip). All measurements were carried out by the same researcher (TMK).

Dietary Assessment

During the study period, participants were requested not to alter their usual dietary pattern. Diets were monitored using food diaries (2 weekdays and 2 weekend days) at week one, mid-intervention (3 months), end of intervention, and 4-months post-intervention. Energy intake was analyzed using the weighed intake software program WISP for WINDOWS (version 3.0, Tinuviel Software, Warrington, Cheshire, UK). Under-reporting was calculated using the Institute of Medicine Equations.[32]

Average Daily Activity Levels

As an indication of adherence to the intervention, all participants were requested to wear a tri-axial accelerometer (RT3) (Stayhealthy, Monrovia, CA, USA) on the same