Archives of Gerontology and Geriatrics 53 (2011) 350–353

Contents lists available at ScienceDirect

Archives of Gerontology and Geriatrics

journal homepage: www.elsevier.com/locate/archger

A moderate intensity exercise program did not increase the oxidative stress in older adults

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ARTICLE INFO

Article history:
Received 19 August 2010
Received in revised form 1 December 2010
Accepted 2 December 2010
Available online 13 January 2011

Keywords:
Oxidative stress
Exercise
Lipoprotein
Carbonylation
Nitration

ABSTRACT

Oxidative damage to lipoproteins, in particular low density lipoprotein (LDL), is known to play a role in a number of diseases associated with aging such as cardiovascular disease (CVD) and dementia. Exercise can alter the balance of oxidative and anti-oxidative species within the human body and may cause oxidative damage to lipoproteins. The purpose of this study was to assess the effect of a moderate intensity exercise program on markers of oxidative stress in older age adults. Parameters of lipoprotein protein and lipid oxidation, and lipoprotein nitration were assessed in aged individuals who undertook a program of moderate physical activity for a period of 8 weeks. There were no significant changes in LDL protein oxidation or nitration which could be attributed to 8 weeks of walking exercise, however, LDL nitration was increased following acute steady state exercise (pre-: 0.34 ± 0.1 vs. post-: 0.44 ± 0.07 μm/mg LDL; $p = 0.04$). Walking at moderate intensity caused a significant weight decrease in the exercise group, but did not have any significant effect on VO_2max. Exercise at this intensity was not harmful and did not increase risk factors for diseases associated with oxidative stress in the participants of the study.

1. Introduction

Oxidative damage to lipoproteins, in particular LDL, is known to play a role in a number of diseases associated with aging such as CVD, rheumatoid arthritis (RA), diabetes and dementia, for review see (Cutler, 2005). Oxidized LDL is involved in the development of atherosclerosis (Fogelman et al., 1980) and is known to contribute to a state termed oxidative stress, which can arise when the balance of reactive species and antioxidant species becomes altered (Finkel and Holbrook, 2000). Oxidative damage to LDL has also been identified as an increased cardiovascular risk factor in RA, when compared to osteo-arthritis (OA) (Aldred et al., 2002) and LDL protein nitration is also elevated in both RA and OA patients with CVD compared with disease matched patients that had no evidence of CVD (Griffiths et al., 2006). Although increased systemic reactive oxygen and nitrogen species (RONS) have been shown to play a role in chronic disease conditions, RONS are naturally occurring by-products of normal cellular oxidation processes and act as transient signaling molecules in the Ras GDP/GTP cycle and MAP kinase cascades (Accorsi et al., 2001). Exercise can alter the balance of oxidative and anti-oxidative species within the human body and recent research has identified a clear role for RONS in normal and adaptive physiological processes in exercise and aging (Jackson, 1999). For example exercise training has been shown to increase antioxidant enzymes such as superoxide dismutase (SOD) and glutathione peroxidase (GPX) (Elosua et al., 2003) and regular physical activity has been shown to be beneficial in reducing oxidative stress.

Current guidelines from the American College of Sports Medicine for physical activity in older age are 30 min of moderate exercise 5 days a week. However these guidelines are rarely met, with studies reporting on average only 30% of adults actually achieve recommended daily physical activity levels (Jones et al., 1998), with some studies suggesting that undertaking moderate exercise 3 times a week is more achievable and may give similar health benefits (Tully et al., 2007). Despite the known risks which are associated with lipoprotein oxidation and cardiovascular pathology, few studies have specifically assessed how exercise may alter circulating lipoprotein oxidation in older age. Historically controversy existed which was associated with exercise induced production of radical species. Although it is acknowledged that the exercising muscle will produce radical species (Bailey et al., 2004), the fate of these species remains unknown. One study (Barnard and Inkeles, 1999) found reduced oxidizability of LDL isolated from postmenopausal subjects following daily walking exercise suggesting that exercise may protect against LDL oxidation. However the message arising from current literature in regard to exercise and its effect upon the oxidative status of lipoproteins is lacking and often confusing. Research into exercise in aged subjects is very limited.

This study assessed parameters of lipoprotein protein and lipid oxidation, and lipoprotein nitration in aged individuals who

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doi:10.1016/j.archger.2010.12.002

Table 1
Subject information by randomized group, mean ± S.D.

Parameters/groups	Control		Exercise	
	Males	Females	Males	Females
Age, years	68 ± 2.4	67.4 ± 1.5	67.5 ± 2	68.7 ± 2.3
Height, cm	178.8 ± 4.5	161.4 ± 5.1	171.8 ± 7.6	156.3 ± 4
Weight, test 1, kg	83.1 ± 4.9	64.5 ± 12.6	79.5 ± 8.1	69.8 ± 4.4
Weight, test 2, kg	82.5 ± 5	64.7 ± 11.5	78.6 ± 8.2	68.9 ± 4.5
VO_2max, test 1, ml/kg/min	33.6 ± 1.3	24.7 ± 4.8	34.5 ± 4.7	26 ± 3.7
VO_2max, test 2, ml/kg/min	33.1 ± 2	25.3 ± 2.5	35.3 ± 3.7	26.8 ± 4.3

undertook a program of moderate physical activity for a period of 8 weeks, in order to identify changes due to physical activity which may impact upon diseases associated with aging.

2. Subjects and methods

2.1. Subjects

The study recruited 21 individuals (12 males and 9 females) aged between 65 and 75 years from the Bellevue Medical practice, Edgbaston, Birmingham, UK. All participants were classified healthy by the medical practice and were not prescribed any medication at the time of the study. Participants gave informed consent and ethical approval for the study was obtained from the Coventry research ethics committee. Research and development permission was given to use general-practice surgeries by the south Birmingham PCT and Heart of Birmingham PCT. Table 1 shows the subject information for each group. All participants were asked to abstain from alcohol, caffeine, and food for at least 12 h before testing.

2.2. Exercise testing

All volunteers came into the Human performance laboratory in the School of Sport and Exercise Sciences, University of Birmingham to undertake testing. All participants were made aware of the exercise procedure, were weighed and familiarized with the mouthpiece used. Volunteers performed a graded submaximal test to estimate their maximal aerobic capacity. VO_2, VCO_2, total expired air volume, and temperature of expired air were all recorded. All gas analyzers (Servomex, UK) were calibrated using known gas volumes before the start of our gas analysis.

During a second visit, the volunteers exercised for 30 min at an intensity eliciting 50% of their maximal performance (Wmax). This intensity was chosen as it was considered an appropriate and sustainable moderate intensity exercise that the volunteers would be able to continue once the study was completed. Food was provided for the evening meal prior to this test in order to control dietary influences upon lipoproteins. Subjects could choose from 3 meals which were balanced for nutrient intake. The male and female volunteers were then randomized into either the exercise or control group. The subjects in the control group were asked to continue their normal activity in the following 8 weeks and the volunteers of the exercise group attended a 30-min walking session three times a week for the following 8 weeks. All training sessions were supervised and subjects used a polar heart rate monitor (Polar, Finland) to ensure that the target heart rate to achieve 50% Wmax was met. After completion of the 8-week period, all volunteers came back to the laboratory to perform the graded sub maximal and 30 min test again and to allow post 8 weeks blood samples to be taken. Fig. 1 shows a schematic representation of the study.

2.3. Measures

A 7 day self reported physical activity questionnaire was obtained in week 1, week 6 and week 12 to deduce energy expenditure during the study. This physical activity questionnaire was a modification of the methods of Bouchard et al. (1983), and Richardson et al. (2001). This questionnaire collected information on the type and duration of various types of physical activities completed each day. Participants were asked to maintain their normal diet throughout the study and were asked to complete a 7-day, daily food record of their nutrient intake at the beginning of the study (week 1), at the mid-point of the study (week 6), and after the study (week 12). Instructions and visual guides were provided to allow participants to estimate portion sizes of all foods and drinks consumed (Young and Nestle, 1995).

An intravenous Teflon catheter (Quickcath, Baxter) was introduced into an antecubital vein and connected to a posiflow adaptor (BD Biosciences). The catheter was kept patent with regular flushing using isotonic saline 0.9% NaCl. Blood was drawn immediately before and directly after exercise. At each draw, blood (6 ml) was collected into an iced tube containing ethylene diaminetetra-acetic acid (EDTA K3E 15%, 0.054 ml BD Vacutainer, Meylan Cedex), which was centrifuged (3000 rpm at

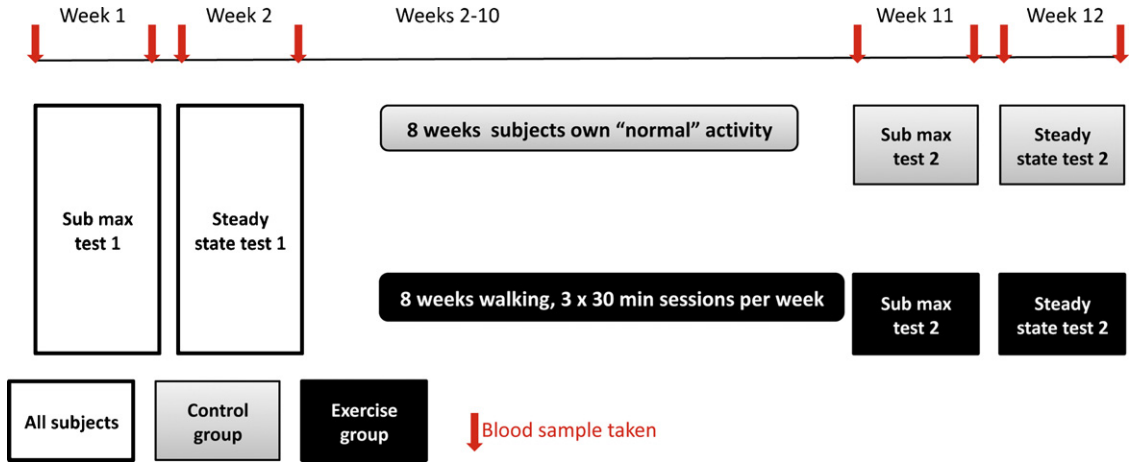

Fig. 1. A schematic representation of the design of the study.