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Research paper

Effects of a personalized nine weeks intermittent exercise working program on left ventricle filling function in middle-aged women with mild diastolic dysfunction

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ABSTRACT

Background: Beneficial effects of physical training in aged women with diastolic dysfunction (DD) remain controversial.
Objective: To investigate the effects of a short-term intermittent work exercise program (IWEP) among older women with and without grade I DD.
Study design: Longitudinal prospective study.
Study participants: Eighty community-dwelling women ranged in age from 52 to 78 (mean age: 65.5 ± 6.0 years), identified as being free of any cardiopulmonary disease, assigned to two groups according to their baseline mitral E-A ratio (> 0.8 vs. grade I DD).
Measurements: Before and after the IWEP, an incremental cycle exercise test to obtain first ventilatory threshold (VT_1), maximal tolerated power (MTP) and peak oxygen uptake (VO_{2peak}) and a 6-minute walk test (6MWT) and a Doppler echocardiographic examination were performed. Effects of the IWEP were computed trough intra- and inter-group comparisons.
Results: By chance 40 women were assigned to each group. The IWEP resulted in a significant increase of MTP, VO_{2peak}, and VT_1, with respectively, +17.4, +19.1 and +22.2% in group 1 and, +19.3, +8.2% and +27.8% in DD group. The distance walked at the 6MWT was improved in both groups. Endurance and maximal cardiorespiratory parameters were similar in both groups before and after the IWEP. For women with an E-A ratio ≤ 0.8, IWEP was associated with a slight but significant increase of mitral E wave, mitral E-A ratio and mitral E-Ea ratio.
Conclusion: The IWEP enhanced endurance and maximal cardiorespiratory capacities in both groups and slightly but significantly improved the transmitral inflow.

1. Introduction

The current optimism created by the ever-increasing life expectancy and the expectation of many individuals that they will live longer and healthier, should, however be balanced by the simple fact that human aging is inextricably linked with an ever-increasing incidence of chronic comorbid conditions such as hypertension, diabetes, heart failure, obesity and osteoporosis [1]. Within this population the prevalence of physical inactivity tends also to be very high and it is widely known that this is a predisposing factor for all the major age-related comorbidities [2]. However, convincing are the evidence that older individuals who

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engage in regular endurance exercise are able to limit these health-related risk, with a possible concomitant improvement in quality of life (QoL) and survival [3–5]. Recent public health guidelines advocate that regular physical activity is essential for healthy aging [6].

For many authors [7–10], over time continuing progression of myocardial diastolic dysfunction (DD) (i.e. alteration of diastolic filling functions of the left ventricle) represents a direct risk factor for hypertension, atrial fibrillation, heart failure but also altered quality of life and increased mortality. Assessed by echocardiography and pulsed Doppler, the DD is defined as a decelerating time (DT) of the early left ventricle diastolic filling wave (i.e. E wave) and a compensatory increase in the velocity of the late left ventricle diastolic filling wave (i.e. A wave), while the global LV ejection fraction (EF) is usually preserved. As a consequence, the E-A ratio is measured < 1 and refers to a "slow relaxation" mitral inflow pattern [11]. Nagueh et al. have provided a simple recommendation for grading LV DD by using pulsed Doppler at the mitral valve and at the mitral annulus [12]. In mild (grade I) DD, the mitral E/A ratio is < 0.8, and the deceleration time (DT) of the E wave is > 200 msec. In moderate (grade II) diastolic dysfunction, the mitral E/A ratio is 0.8–1.5 and DT is 160–200 msec. In severe (grade III) diastolic dysfunction, the mitral E/A ratio is ≥ 2 and DT < 160 msec [13].

In previous reports, we showed that an intermittent work exercise programme (IWEP) significantly improved cardiac, respiratory and endurance parameters [14,15]. By contrast, the beneficial effects of aerobic endurance training on the DD are poorly investigated and hotly debated [16–19]. Hereinafter, we report the results of a prospective longitudinal study conducted to evaluate the efficiency of a 9-week 18-session IWEP in two groups of middle-aged women selected according to their LV diastolic function (normal vs. grade I DD).

2. Material and methods

2.1. Population study, inclusion and non-inclusion criteria

The analytic sample consisted of 80 healthy women ranged in age from 52 to 78 years (mean age 65.5 ± 6.0 years). They were part of a cohort composed of 160 volunteers recruited in the department of geriatrics medicine of the university hospitals of Strasbourg (France). Design, sampling methods, inclusion and non-inclusion criteria have previously been described elsewhere [14]. Briefly, men and women constituting this cohort were initially recruited following a call for research study subject recruitment. The aim of the research project was to investigate the short-term effect of an intermittent work exercise programme (IWEP) among older healthy volunteers on maximal cardiorespiratory functions [15]. All the volunteer thus recruited first completed a personal interview as well as a complete physical examination including an electrocardiogram (ECG) to determine any health-related issues that would limit their ability to exercise or contra-indicate their enrolment in the cohort. Thus, a complete review their current and past health condition including past injuries or surgeries and current fitness level was conducted. The physical examination recorded the body weight, resting pulse rate and blood pressure. In addition to all physical system exploration, a particular attention was given to lower extremities for oedema and the presence of arterial pulses along with tests of neurological functions. All conditions that contra-indicated exercise or predisposed participants to injury such as uncontrolled hypertension, any significant heart valve or symptomatic cardiac and/or pulmonary diseases, severe autonomic neuropathy, severe peripheral neuropathy and/or any history of foot lesions or orthopaedic limitations such as joint or musculotendinous disorders were reviewed; if at least one was present then the concerned volunteer was not included. In addition people with known LVEF below 50% were not included. During the personal interview, the volunteers also received instructions about the study protocol.

On the base of the systematic Doppler echocardiography assessment (see §2.4.3. for further details) performed in every volunteers before definitive inclusion, 12 subjects have been secondarily excluded due to medical condition, LVEF below 50% or significant heart valve disease. Out of the 160 volunteers (mean age: 65.9 ± 6.9 years) finally enrolled, 80 healthy women were considered in the present study (mean age: 65.5 ± 6.0 years). The 80 remaining volunteers were men. Indeed, although diastolic function is on average reduced up to 50% at the age of 80 years [20], this process does not affect all the aging population homogenously and women are more often affected compared to men [21,22]. Thus we have preferentially considered women in order to work on the population the most affected by this process and to be sure to obtain a sufficient number of volunteers with DD as well.

According to pre-IWEP Doppler echography assessment, two groups were constituted according to the E-A ratio measured on the mitral valve site [12]. The first group (group 1) included women with normal diastolic function (i.e. E-A ratio > 0.8 and normal E wave DT); the second group (group 2) women with grade I DD. The characteristics of this analytic sample at baseline are detailed in Table 1, and by chance 40 individuals composed each group. In addition to personal medical history, tobacco and alcohol consumptions, all treatments taken were collected in enrolled volunteers. In Table 1, only the most significant data are detailed.

All along the 9-week IWEP programme, for each participant a medical follow-up and assessment was organized in order to collect any exercise-related injuries or other adverse effects.

The investigation was carried out in accordance with the rules concerning good clinical practice and the study protocol approved by the institutional review board of the university hospitals of Strasbourg (France).

Table 1
Characteristics of the analytic sample at baseline.

Characteristics	Group 1 (E/A > 0.8)	Group 2 (E/A ≤ 0.8)
	$n = 40$	$n = 40$
Age (years)	64.4 ± 6.1	66.5 ± 5.8
Body mass index (kg/m^2)	25.8 ± 4.5	26.3 ± 6.0
Systolic blood pressure (mmHg)	123 ± 18	125 ± 14
Diastolic blood pressure (mmHg)	72 ± 11	78 ± 8*
Heart rate (beats/min)	73 ± 13	82 ± 14*
Medical history, %		
Hypertension	32.5	42.5
Hypercholesterolemia	20	37.5*
Breast cancer	10	15
Diabetes	7.5	2.5
Treatments, %		
Hormonal replacement therapy	25	2.5*
Beta-blocker	17.5	7.5
Statin	12.5	20
Angiotensin II receptor blockers	10	15
Angiotensin-converting enzyme inhibitors	7.5	10
Aspirin	5	5
Physical activities, %		
Walking	52.5	40
Gymnastics	27.5	15
Biking	22.5	10
Sedentarity	15	12.5
Swimming	5	20*
Gardening	5	10

* Comparison between group 1 and 2: $P < 0.05$.