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Short- and long-term effects of a head-out aquatic exercise programme on body composition, anthropometrics and cardiovascular response of middle-aged women

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Abstract

Background: The assessment of chronic responses represents a major trend of research in the aquatic environment. Aquatic programmes have gained in popularity due to perceived health benefits. **Research question:** The aim of this study was to assess chronic adaptations in middle-aged women participants in a head-out aquatic exercise programme. **Type of study:** experimental, prospective. **Methods:** Twenty-three middle-aged female subjects participated in a head-out aquatic exercise programme (26 weeks, two sessions per week, 40 minutes per session). Data was collected before starting the programme (pre-test), at the 13th week (post-test 1) and at the 26th week (post-test 2). Body composition was assessed measuring several body skinfolds. Anthropometrical data included measurements of weight, body mass index and several anatomical perimeters. Cardiovascular measures included the resting heart rate, systolic, diastolic and mean blood pressures. **Results:** Subjects improved their body composition by decreasing their fat mass. While most anatomical perimeters significantly decreased, weight and the body mass index remained unchanged. The systolic and mean blood pressures decreased while the resting heart rate and the diastolic blood pressure remained stable. The main improvements occurred in the first 13 weeks of the programme, since most variables did not show significant variation from that point forward. **Conclusions:** It can be concluded that: (i) a head-out aquatic exercise programme over 26 weeks promotes a significant improvement in body composition, anthropometrics and cardiovascular response of middle-aged women (ii) major adaptations occur in the first 13 weeks of the programme. **Keywords:** head-out aquatic exercises, anthropometrics, cardiovascular, body composition, middle-aged women

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Introduction

Research into head-out aquatic exercise has focused on acute or chronic responses. Chronic responses represent the accumulation of several acute adaptations that are reached during each aquatic session and demonstrate the outcome of a head-out aquatic exercise programme.

In the last two years, head-out aquatic exercise programmes have gained in popularity, due to perceived health benefits. Some evidence suggests that such programmes have become a major component in weight reduction[1], balance improvement in the elderly[2], performance enhancement in elite athletes[3] or physical fitness enhancement in healthy subjects[4]. To promote these cumulative effects of acute responses over time, the use of appropriate means and methods of work during the sessions (i.e. mode or type of exercise, frequency of participation, duration of each exercise bout, and intensity of the exercise bout) needs to be assured[5]. In addition, there are some indicators, such as anthropometrics, body composition and cardiovascular response that can be measured on a regular basis to assess chronic adaptations[5].

Physical activities such as head-out aquatic exercises can change body composition. The effect on body composition has been shown to be quite similar in both the terrestrial and aquatic environments[1]. Significant decreases in body fat were observed in women participating in several weeks of head-out aquatic sessions[6,7,8]. Adaptations to several anthropometric measures should also be expected. Weight, body mass index and anatomical perimeters show a tendency to change with aquatic training[7,8]. Cardiovascular assessment is also a key concern in head-out aquatic exercises, since they may contribute to the prevention of several pathologies, such as, coronary artery disease, hypertension, stroke, obesity or diabetes. Evidence indicates a tendency for both resting heart rate [9,10] and blood pressure[7] to decrease after participation in head-out aquatic exercise programmes.

Despite the utility of such findings, most of the relevant studies have primarily focused on obese or elderly women. Generally, head-out aquatic classes comprise mixed subjects differing in gender, chronological age and physical fitness. However, many of the target populations participating in head-out aquatic exercise programmes are middle aged healthy women. Despite this, to the best of the authors' knowledge there remains a lack of research regarding the effect of an intervention programme on this population.

Therefore the aim of this study was to assess the chronic adaptations (body composition, anthropometric, and cardiovascular variables) of middle-aged women participating in a head-out aquatic exercise programme over a 26 week period. It was hypothesised that there would be a significant improvement in body composition, anthropometrics and physiological response throughout the intervention programme.

Methods

Subjects

Twenty-three middle-aged women (47.6 ± 10.1 years-old; 160.4 ± 1.7 cm of body height) participated in the head-out aquatic exercise programme. None of the subjects were involved in other fitness programmes during the research. Subjects were asked to maintain their daily routines. They reported no previous history of orthopaedic or musculoskeletal injuries in the previous six months. All procedures were in accordance with the Helsinki Declaration concerning research on humans. The Institutional Review Board of the Polytechnic Institute of Bragança approved the study design. The women were informed of the experimental risks and signed an informed consent document before the investigation.

Head-out aquatic exercises training programme

The head-out aquatic exercise programme consisted of 26 weeks of training and followed the main Aquatic Exercise Association's guidelines[11]. The programme included two sessions per week, each of 40 minutes' duration. All sessions were conducted in a shallow water swimming pool, where subjects were immersed to the xiphoid process. Musical cadence ranged between approximately 125-150 bpm and exercises were cued to be performed at water tempo. In some sessions, rubber bands, buoyancy and drag equipment were used. Sessions were structured so as to conform with the technical literature[12] starting with a warm-up (5 minutes), followed by cardio-respiratory conditioning (20 minutes), muscle strength conditioning (10 minutes) and stretches and/or cool down (5 minutes). Subjects participated in 80.1 ± 10.1 % of the sessions.

Data collection

Data was collected before starting the programme (pre-test), at the 13th week (post-test 1) and at the 26th week (post-test 2). For body composition assessment, a skinfold calliper (Harpenden, RossCraft, Canada) was used to measure the triceps, subscapular, abdominal, and germinal skinfolds with the subjects in the specific anatomical position. The sum of the triceps and the subscapular skinfolds was also considered. Anthropometrical data included the measurement of the weight in the upright position with a digital scale (SECA, 884, Germany). Body mass index (BMI) was computed as $BMI=weight/height^2$. The chest, waist, hip, lower leg and brachial perimeters were measured with a flexible anthropometrical tape (RossCraft, Canada). Cardiovascular measures included the resting heart rate (HRr), systolic blood pressure (SBP) and diastolic blood pressure (DBP) (M4-I, Omron, Netherlands) with the subjects in a seated position. Mean blood pressure was calculated as $MBP=DBP+[0.333x(SBP-DBP)]$[13].

Statistical procedures

All assumptions to conduct the ANOVA (normality, independence and homoscedasticity) were checked. Since the assumptions failed, non-parametric procedures were adopted. For descriptive analysis, mean and one standard deviation were computed as central tendency and dispersion measures, respectively. Box plots, including quartiles, were also performed. The non-parametric Friedman test was used to compare each variable throughout the exercise programme. Whenever a significant difference was verified, Pairwise Wilcoxon Rank Sum Tests were used to identify differences between each evaluation. The level of statistical significance was set at $P \leq 0.05$.

Results

Figure 1 presents the adaptations on body composition throughout the three periods of evaluation. The exercise programme promoted significant decreases in all assessed variables: (i) the triceps skinfold ($\chi^2(2) = 9.566$; $p < 0.01$) decreased between the pre-test and post-test 1 ($p < 0.001$) and post-test 2 ($p < 0.01$); (ii) the subscapular skinfold ($\chi^2(2) = 10.541$; $p < 0.01$) decreased between the pre-test and post-test 1 ($p < 0.01$) and post-test 2 ($p < 0.01$); (iii) the abdominal skinfold ($\chi^2(2) = 13.390$; $p < 0.01$) decreased between the pre-test and post-test 1 ($p < 0.01$) and post-test 2 ($p < 0.01$); (iv) the germinal skinfold ($\chi^2(2) = 6.100$; $p = 0.05$) decreased between the pre-test and post-test 1 ($p = 0.01$) and post-test 2 ($p = 0.04$) and; (v) the sum of triceps and subscapular skinfolds ($\chi^2(2) = 18.396$; $p < 0.001$) decreased between the pre-test and post-test 1 ($p < 0.001$) and post-test 2 ($p < 0.001$).

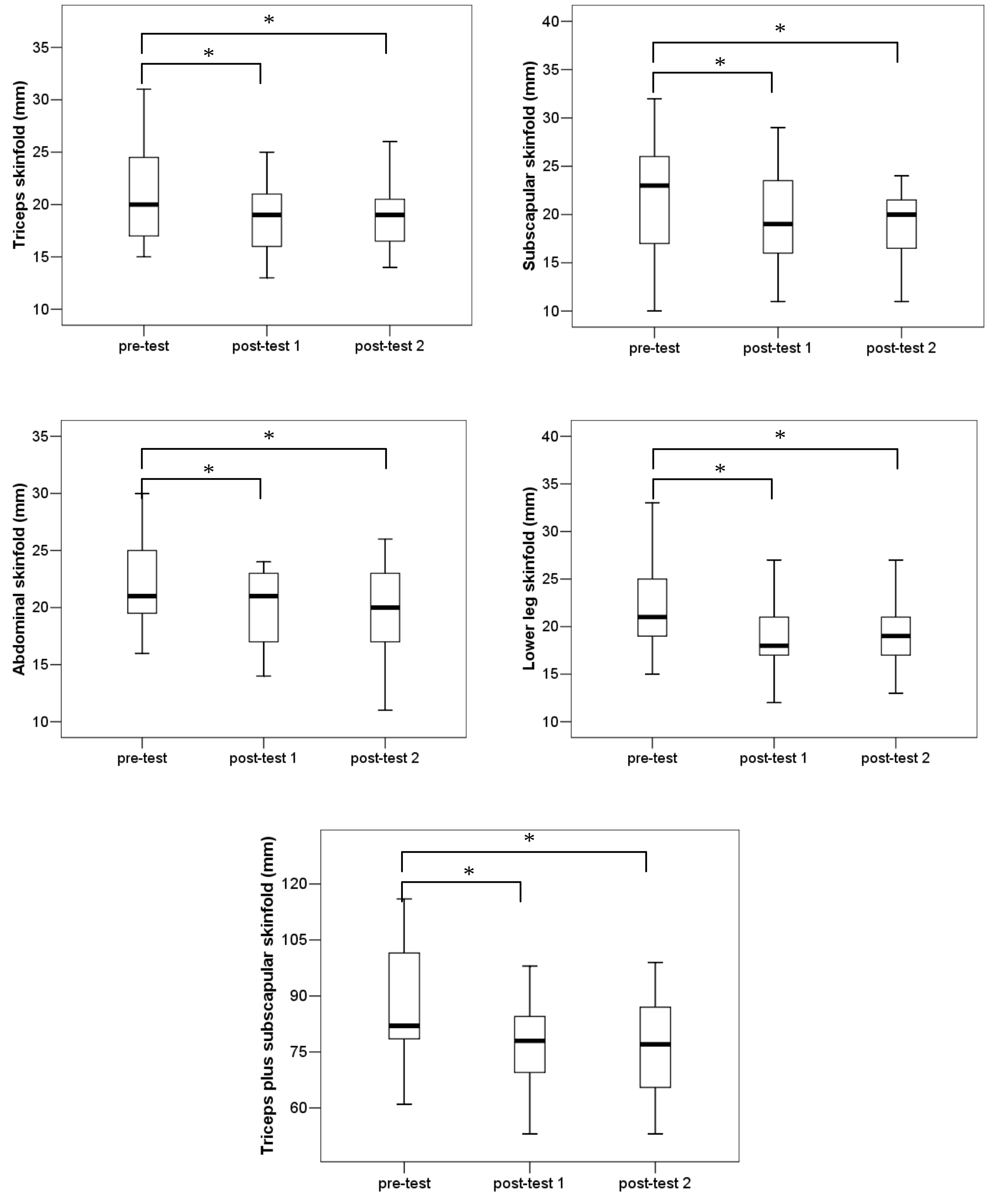

Figure 1: Quartiles of the body composition adaptations throughout the programme

* indicates P ≤ 0.05.

Figure 2 presents the adaptations in anthropometric variables throughout the three periods of evaluation. Significant differences were verified in: (i) the arm perimeter ($\chi^2(2) = 7.811$; $p = 0.02$) with a significant decrease between the pre-test to post-test 1 ($p = 0.03$) and post-test 2 ($p = 0.01$); (ii) the waist perimeter ($\chi^2(2) = 7.634$; $p = 0.02$) with a significant decrease between the pre-test and post-test 1 ($p = 0.05$); (iii) the hip perimeter ($\chi^2(2) = 15.367$; $p < 0.001$) and (iv) the lower leg perimeter ($\chi^2(2) = 24.641$; $p < 0.001$) with a significant decrease between all periods of evaluation. Both weight and BMI remained unchanged during the intervention programme.

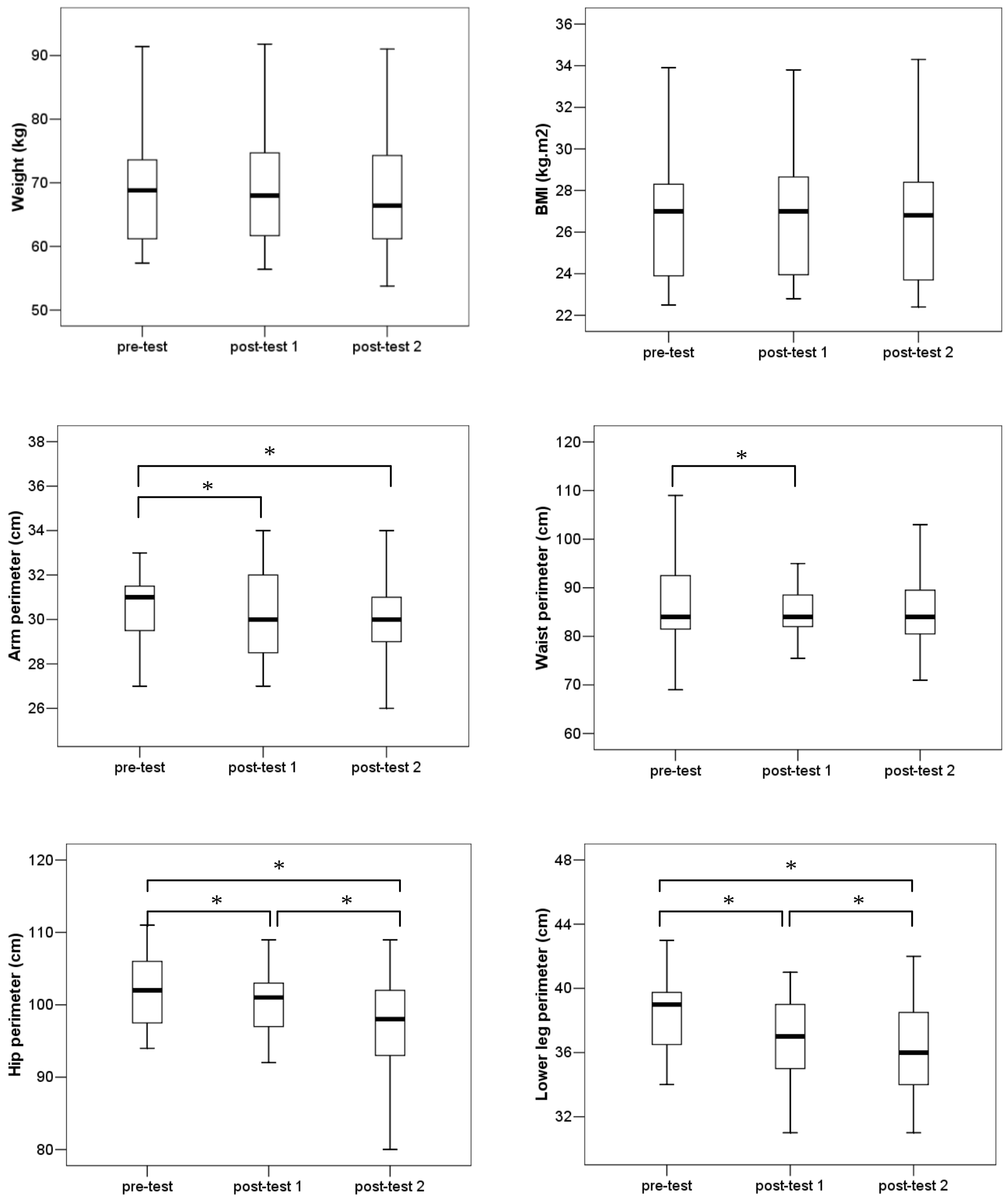

Figure 2: Quartiles of the anthropometric adaptations throughout the programme

* indicates P ≤ 0.05.

Figure 3 presents the adaptations in cardiovascular response throughout the three periods of evaluation. Both SBP and MBP presented significant changes during the intervention programme: (i) the SBP ($\chi^2(2)$ = 8.000; p = 0.02) decreased between the pre-test and post-test 1 (p = 0.01) and post-test 2 (p < 0.01) and; (ii) the MBP ($\chi^2(2)$ = 12.568; p < 0.01) decreased between the pre-test and post-test 2 (p = 0.04) and between the post-test 1 and post-test 2 (p = 0.01). Both HRr and DBP remained unchanged during the intervention programme.

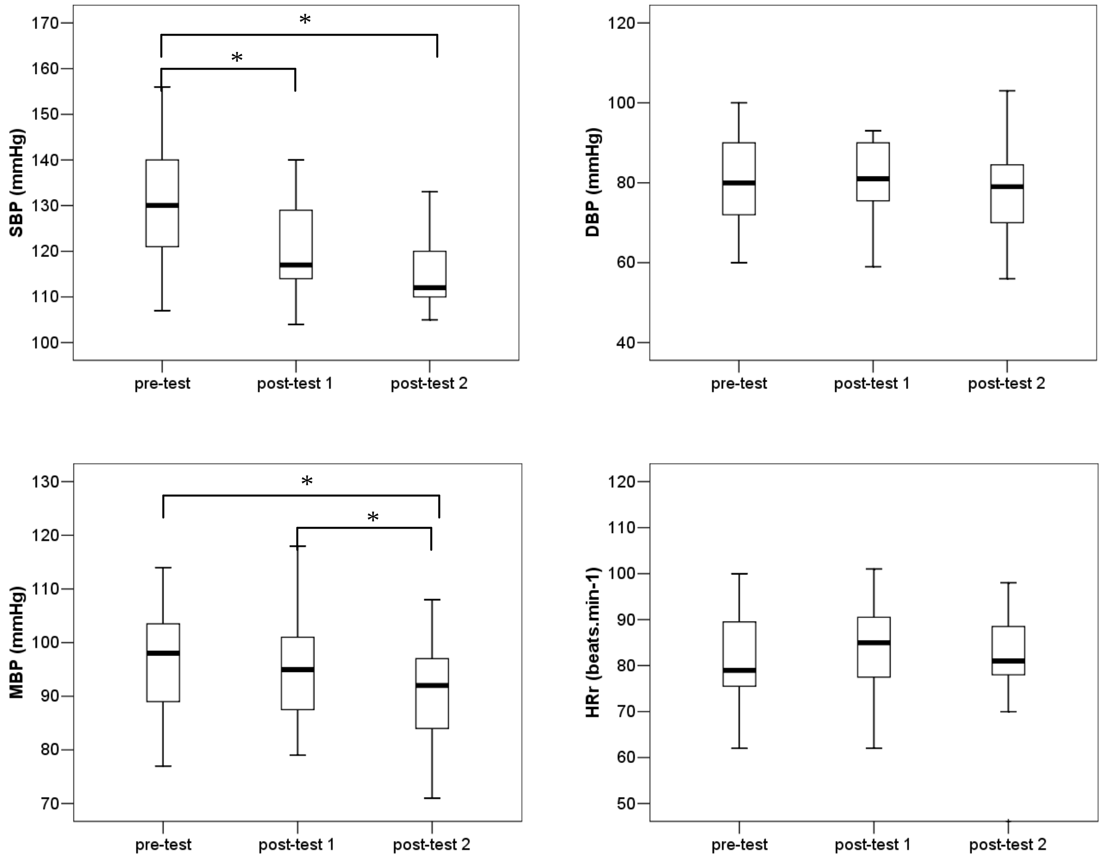

Figure 3: Quartiles of the cardiovascular adaptations throughout the programme

* indicates P ≤ 0.05.

Discussion

The aim of this study was to assess the chronic adaptations (body composition, anthropometrics, and cardiovascular variables) occurring in middle-aged women participants during a head-out aquatic exercise programme. Although there were significant improvements in most assessed variables, major adaptations occurred in the first 13 weeks of the intervention programme.

With regard to health parameters, the effect is fairly similar when land and water aerobic exercises are compared[1]. For those uncomfortable with exercising at higher intensities in the terrestrial environment, head-out aquatic exercise programmes appear to represent a reliable alternative since: (i) the effect of the force of gravity is less; (ii) the energy cost increases; (iii) there is less discomfort while exercising and; (iv) it is easy to establish interpersonal relationships. For all these reasons, the last couple of years have seen head-out aquatic exercises become one of the most important physical activities within the healthcare primary prevention system (i.e. the fitness context) and in the healthcare tertiary prevention system (i.e., therapy and rehabilitation context)[5].

The current 26-week head-out aquatic exercise programme was shown to be effective in improving the body composition of middle-aged women. All the assessed skinfolds presented a significant decrease over the period. As previously suggested, exercise programmes in an aquatic environment promote favourable adaptations regarding subjects' body composition[14]. For land-based movements, air viscosity presents a constant resistance in all anatomical reference planes.

In the aquatic environment, a greater effort is necessary to move the body due to the higher density and viscosity of this fluid (water)[15]. Subjects immersed in water face an increased drag force, expending higher metabolic power and energy[5]. This represents an additional caloric cost to produce the movement outcome leading to a reduction in body fat. Consistent decreases in body fat have been established after several weeks of head-out aquatic exercise programmes[6,7,16,17].

The change in body composition probably affected the anthropometric adaptations. Anatomical perimeters significantly decreased throughout the 26 weeks of the intervention programme. Since the measurement of the anatomical perimeters is partly dependent on the amount of fat mass surrounding the anatomical area, the decrease in skinfolds may have implied a reduction of perimeters throughout the programme. Several aquatic programmes have been shown to be effective in promoting significant decreases in the waist-circumference of post-menopausal[7] and obese[8] women. Such programmes also appear to induce novel adaptations in male anthropometrics. Twenty-four weeks of an aquatic programme promoted a significant increase in the upper arm circumference of healthy men[18]. These anatomical adaptations seem therefore to be dependent on several factors (e.g. gender, fitness status, programme design) and further studies are required to provide more detail on this issue.

Although both weight and BMI decreased slightly during the study period, no statistical differences were observed. This non-significant change in the weight and BMI can be explained by simultaneous adaptations that were not assessed throughout the intervention programme. Despite the main decrease in fat mass that led to reduced weight, it seems likely that these women gained in lean body mass, mainly muscle. There is consensus in the literature that head-out aquatic exercise programmes promote significant improvements in the muscle strength of untrained women[3,7,19,20,21]. Indeed, at least one study showed that a water exercise programme of 12 weeks promoted significant improvement in neuromuscular performance (e.g. upper and lower body strength) of elderly women, while the weight remained unchanged[10]. Muscle mass was not considered in the present investigation. Nevertheless, it should be included in future research. Similarly, the understanding of the co-variation between physical activity and food intake should also be considered. It has been suggested that interventions in eating routines are simultaneously required together with physical activity to obtain more pronounced and healthy adaptations[22].

Wilmore and Costill[13] suggest that resting blood pressure decreases after endurance training. In the present study mean blood pressure (MBP) significantly decreased after the aquatic programme. The decrease was mainly due to a significant reduction in systolic blood pressure (SBP) along with a slight decrease in diastolic blood pressure (DBP). Some inconsistent findings are reported in the literature on this topic. On the one hand, following an aquatic programme, the MBP of elderly woman remained unchanged[9,10]. On the other hand, a 24-week programme of resistance aquatic training decreased the DBP of post-menopausal women[7]. Earlier observations have already suggested the suitability of these exercise programmes for subjects with high blood pressure[23].

Training also appears to increase parasympathetic activity while decreasing heart sympathetic activity[5]. The HRr can be expected to decrease by one beat per minute in each week of training for healthy but sedentary subjects[13]. In the present study, the HRr remained almost constant. The subjects included in this study may well not be considered “sedentary” people in that they reported involvement with some exercise routines before this participation. Probably due to their previous fitness levels, they were unable to significantly decrease their HRr. Nevertheless, meaningful HRr decreases have already been reported for elderly women after several weeks of head-out aquatic programmes[9,10].

Most body composition, anthropometric and cardiovascular adaptations occurred in the first 13 weeks of the programme. This suggests that up to 13 weeks one can expect adaptations for healthy middle-aged women. However, for a correct training periodisation it is also necessary to have an idea of the minimum period necessary for adaptations to occur. Two papers have demonstrated that aquatic programmes no longer than six weeks' duration were insufficient to change body composition[24,25]. On the other hand, an 11-week[16] and 13-week[1] programme was shown to be effective in reducing body-fat by 6% and 3.7% respectively. In this sense, head-out aquatic exercise instructors should be aware that the major adaptations induced by their programmes are most likely occur over a period of between 8 and 12 weeks. The training load of their head-aquatic exercise sessions should be cyclically adjusted to induce further adaptations in practitioners.

Study limitations

The following can be considered as limitations with regard to this study: (i) the absence of a control group to serve as comparison; (ii) there are reports in the literature of other physical fitness variables that are also of interest in this kind of research but were not consider and; (iii) in the near future, this kind of research could be implemented in subjects with special conditions and/or diseases to gain a deeper insight of the aquatic exercises' effect on their health.

Conclusions

In conclusion, a head-out aquatic exercise programme of 26 weeks promotes significant anthropometric improvements, improvements in body composition, and the cardiovascular response of healthy middle-aged women. Such improvements mainly occurred in the first 13 weeks of the programme. As a practical implication, instructors should design and conduct head-out aquatic exercise programmes according to the Aquatic Exercise Association's guidelines for at least 13- to 26 weeks to promote significant adaptations in the physical fitness of middle-aged women.

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