Effects of three months of water-based exercise training on metabolic syndrome components in older women


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Abstract. The purpose of this study was to evaluate the effects of water-based exercise training on metabolic syndrome components in older women. The subjects were randomly divided into an experimental group who participated in the water-based exercise training and a control group who was not involved in the training and remained sedentary. The quantification of clinical and biochemical parameters of abdominal obesity, atherogenic dyslipidemia, elevated blood pressure and insulin resistance without glucose intolerance by a medical and laboratory evaluation to assess the presence of metabolic syndrome components was done according to the guidelines of the National Cholesterol Educational Program Adult Treatment Panel-III (NCEP ATP-III). The training protocol consisted of water-based exercise training sessions 5 times per week during 12 weeks of intervention, executed in a pool of 1.3 meters divided into three phases: a 10-minute warm-up, 30 minutes of aerobic exercise at 50%-60% of maximum heart rate (monitored by heart rate monitor) and a 10 minute cool down. As a statistical method to compare the results between groups of variables pre and post training, the statistical analysis ANOVA mixed 2 X 2 (group X measurement) was done using SPSS version 21. The results for the metabolic syndrome components only indicated statistically significant interactions for triglycerides mg.dl-1 (p=0.002) between the groups and the measurements. Thus, the training program produced significant benefits on metabolic health indicators in particular decreasing triglycerides.

Keywords: Older Women, Metabolic Syndrome, Exercise.

Introduction

The aging process is characterized by the progressive decline of organ and systems functions (Fulop et al., 2010). Metabolic syndrome is a health disease complication that has been strongly associated with sedentary lifestyle in elderly women (Colpani et al., 2013), the complex nature of metabolic syndrome involving five major clinical components: abdominal obesity, atherogenic dyslipidemia, elevated blood pressure and insulin resistance without glucose intolerance in potentially harmful combinations that significantly rise cardiovascular risk (Luk et al., 2008), that mainly appears after sixty years, with the highest rates of cardiovascular diseases leading to greater healthcare costs (Sicras-Mainar et al., 2013), and affect the quality of life of these population (Okosun et al., 2013; Bohórquez et al., 2014).

Evidence from quasi-experimental studies in elderly practitioners of physical exercise in modalities such as aerobic endurance and strength showed beneficial results on metabolic syndrome components (Kim et al., 2011; Tan et al., 2012; Wang et al., 2012). This study applied a water-based exercise training, than carried out performing rhythmic-gymnastic activities in an aquatic environment, that simultaneously counteracts gravity and increases physical capabilities (Kamioka et al., 2010). This type of exercise is especially recommended for people who have limitations with exercise on dry land (Kamioka et al., 2011) and which in the last ten years, has taken popularity and preference among elderly adults by taking advantage of the properties of water in order to provide fluidity and a wider range in movements while diminishing the risk of injuries due to impact (Kamioka et al., 2010; Kamioka et al., 2011). It was found that water-exercise in elderly women provides significant improvement in several aspects of well-rounded, physical function, including postural balance and health-related aspects of fitness (Takeshima et al., 2002; Sanders et al., 2013). It is unclear if a water-based exercise program provides benefits in the metabolic syndrome components in elderly women. It is important to plan and prescribe adequate exercise for the needs of elderly adults and to minimize their health problems, this in turn, will provide them with an adequate level of physical performance, the latter which is crucial in order to maintain good overall health (Chodzko-Zajko et al., 2009; Romo et al., 2011; Villarreal et al., 2016); The present study proposes to help answer the remaining question: Can a water-based exercise training improve metabolic syndrome components in elderly women? In this study, water-based exercise training was identifying as the independent variable and the five major clinical components of metabolic syndrome: abdominal obesity, atherogenic dyslipidemia, elevated blood pressure and insulin resistance without glucose intolerance as dependent variables. Two hypotheses were establish, one scientific and the other statistical: the scientific hypothesis anticipates that after adult women participated in the water-based exercise training, noticeable improvement will occur in the components of metabolic syndrome in older women; the statistical hypothesis in null and alternative form, establishing as the acceptance or relative criteria, the level of $p < 0.05$.

Methods

Participants and setting

The study design was quasi-experimental with non-probabilistic and convenience sampling. Subjects with interest in joining an aquatic stimulation program in the aquatic complex of the Faculty of Sports at the Autonomous University of Baja California were recruited. The sample consisted of 26 older women over 60 years old, apparently healthy who meet the following criteria: ambulation capacity, not have performed a systematical routine of exercise in the previous six months, divided randomly into one experimental group (n=16, age of 67±5.4 years old) that partook in the water-based exercise training and one
control group (n=10, age of 67.4±4.7 years old) who did not take part of the exercise program, maintained their normal everyday activities without performing any sort of systematic physical activity during the 12 weeks of the intervention program. The present study followed the ethical principles regarding human experimentation proposed by the Helsinki declaration (Puri et al., 2009). All the participants signed a letter of consent, which explained the objective of the investigation, its evaluation protocols, possible risks, benefits, consequences, emergency procedures and consensus of participation as a volunteer, in order to participate in the study.

**Measures and procedures**

Quantification of clinical and biochemical parameters by a medical and laboratory were assessed in order to determine the presence of metabolic syndrome components according with the guidelines of the National Cholesterol Educational Program Adult Treatment Panel-III (NCEP ATP-III), using the following procedures: blood samples were collected in the morning from 7:00 a.m. to 8:30 a.m. after 12 hours of fasting and 48 hours of rest from physical activity, 5 milliliters of venous blood were collected by a certified biochemist and were placed in EDTA tubes to evaluate the biochemical variables of total cholesterol, high density lipoprotein cholesterol and triglycerides. The values were determined using an enzymatic colorimetric method and HDL-C with a homogeneous enzymatic assay in which enzymes modified by Polyethylene Glycol produce the separation in presence of magnesium and dextrin sulfates at the same time of analysis. Quantification was performed in a modular selective multichannel photometric auto analyzer P800 (Roche Diagnostics), and plasma blood glucose in an auto analyzer by the method of glucose oxidase-peroxidase (Biederman CS, Cinceron, Bayer). The clinical quantification of blood pressure was obtained after a 15 minutes sitting at rest by a sphygmomanometer (Omron hem-713c) and the umbilical abdominal circumference was measured by a Luftkin metal anthropometric tape.

Metabolic syndrome was diagnosed in those women who had three or more of the following criteria: abdominal obesity (UAC > 88 cm), TG values < 150 mg/dl, HDL-C values <50 mg/dl, BP values < 130/85 mmHg, or taking antihypertensive treatment, and plasma fasting glucose levels completed a 15 minutes sitting at rest by a sphygmomanometer (Omron hem-713c) and the umbilical abdominal circumference was measured by a Luftkin metal anthropometric tape.

The subjects of this study were put through a water-based exercise training of moderate aerobic intensity in accordance with the standards established by the American College of Sports Medicine (Chodzko-Zajko et al., 2009) and the American Heart Association (Nelson et al., 2007) also the standards & guidelines for aquatic Fitness programming from the Aquatic Exercise Association (AEA).

The training consisted of 60 water-based exercise sessions with an exercise frequency of 5 times a week. The volume was set at 50 minutes per session, this being divided into 10 minutes of warm-up, 30 minutes of workload with progressively incremental intensities of 50% of maximum heart rate frequency for the first 6 weeks and 60% for the final 6 weeks of the program, using the formula Max HR= 208-0.7x age followed by 10 minutes of cool down.

The statistical procedures proposed for an adequate analysis of this investigation were to characterize the sample and evaluate the hypothesis in the following manner:

Using descriptive statistical techniques the investigated universal sample was characterized and a description of the evaluated data was produced. Using methods of localization and dispersion in the standard deviation was then calculated and used to verify the sample symmetry (Thomas et al., 2001). The acquired statistical results were processed into charts and graphs using SPSS 21 software. The Shapiro-Wilk test was used in order to determine the normality of the groups and the homogeneity of the sample.

**Statistical analysis**

With the goal of establishing all the possibilities of comparison inter and intra group mixed 2 x 2 (groups x measurements) (ANOVA) variance analysis tests were performed for the variables with the purpose of maintaining the scientific validity of the research. The significance level of p<0.05, 95% probability of accuracy of the results or negative event with a probability of 5% per case. Percentage changes (Δ%) were also calculated for each study group [(Mean post – Mean pre)/ Mean pre] x 100 (Vincent, 1999).

**Results**

The participants in the present study were 26 elderly women divided randomly into one experimental group (n=16, age of 67.5±5.4 years old) that partook in the water-based exercise training and one control group (n=10, age of 67.4±4.7 years old) who did not take part in the exercise program, the general characteristics of the sample can be observed in Table 1.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Experimental (n=16)</th>
<th>Control (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Body weight (kg)</strong></td>
<td>54.00±9.74</td>
<td>52.00±9.17</td>
</tr>
<tr>
<td><strong>Height (cm)</strong></td>
<td>155.0±5.78</td>
<td>153.0±5.82</td>
</tr>
<tr>
<td><strong>Abdominal circumference (cm)</strong></td>
<td>88.7±10.6</td>
<td>91.7±12.7</td>
</tr>
<tr>
<td><strong>Systolic Blood pressure mmHg</strong></td>
<td>123±18.3</td>
<td>121±10.1</td>
</tr>
<tr>
<td><strong>Diastolic Blood pressure mmHg</strong></td>
<td>72.5±15.2</td>
<td>73.3±22.3</td>
</tr>
<tr>
<td><strong>Glucose mg.dl^{-1}</strong></td>
<td>14.7±24.4</td>
<td>16.2±26.1</td>
</tr>
<tr>
<td><strong>Triglycerides mg.dl^{-1}</strong></td>
<td>22.3±11.9</td>
<td>19.5±8.5</td>
</tr>
</tbody>
</table>

The results of the ANOVA 2 x 2 tests indicated statistically significant interactions existed on Triglycerides mg.dl^{-1} (p=0.002) between the groups and the measurements, neither statistically significant changes were found between groups (p=0.409) but it showed statistically significant on the measurements (p=0.119) (Figure 1). For the variables of abdominal obesity, high density lipoprotein cholesterol, elevated blood pressure and insulin resistance without glucose intolerance, the results of the ANOVA 2 x 2 tests indicated no statistically significant interactions existed.

**Discussion**

Cross-sectional research studies associate high levels of physical activity and optimal metabolic syndrome components in the elderly (Ford, 2005; Colpani et al., 2013), quasi-experimental pre and posttest designs where the independent variable is exercise and abdominal obesity, high density lipoprotein cholesterol, elevated blood pressure and insulin resistance without glucose intolerance are the dependents variables as indicators of metabolic syndrome not always show significant changes after 12 to 48 weeks of aerobic, strength and stretching exercise programs in the elderly (Yamaoka & Targo, 2012; Pattyn et al., 2013); These
resultados fueron similares y congruentes con estudios previamente realizados en adultos mayores que presentaron cambios significativos en la lipoproteína de baja densidad (Lp-BD) (Tian, et al., 2012), aunque la cantidad de reducción (Δ%Lp-BD) en el grupo experimental fue mayor que en el grupo de control. En el presente estudio, se demostró el efecto del entrenamiento de fuerza con pesas del mismo peso en ambos grupos, con un mayor porcentaje de mejora en el grupo experimental con respecto al grupo de control (Araújo et al., 2015).

Además, los resultados del entrenamiento de fuerza con pesas fueron similares a los obtenidos en otros estudios que utilizaron métodos similares de entrenamiento (Barker et al., 2013; Ford et al., 2015). No hubo diferencia significativa en el cambio de la lipoproteína de alta densidad (Lp-HD) entre los grupos, lo que sugiere que el entrenamiento de fuerza con pesas no tuvo un efecto significativo en la concentración de Lp-HD. En resumen, el entrenamiento de fuerza con pesas fue efectivo en mejorar la fuerza y el rendimiento muscular en adultos mayores, con un mayor impacto en el grupo experimental que en el grupo de control. Sin embargo, es importante destacar que el estudio se realizó con un pequeño número de participantes y se sugiere realizar futuros estudios con una muestra más grande y con un diseño más riguroso para confirmar los resultados obtenidos en este estudio.


