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ORIGINAL

EFFECTS OF AN AQUAGYM TRAINING IN POSTMENOPAUSAL WOMEN

EFECTOS DE UN PROGRAMA DE AQUAGYM EN MUJERES POSMENOPAUSICAS

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ABSTRACT

Changes in body composition in postmenopausal women, such as increases in visceral and abdominal adipose tissue, show metabolic and cardiovascular diseases. Twenty-one postmenopausal women participated in an Aquagym' program during 16 weeks. The variables analyzed included measuring waist circumference (WC), hip circumference (HC), waist-hip ratio (WHR), sagittal abdominal diameter (SAD) and intra-abdominal adipose tissue (IAAT). Statistical treatment was a *t* test used to compare groups, and Goodman's test was used to analyze changes in the qualitative classification of the WHR. Significant reductions ($p \leq 0.05$) were obtained in all variables measured after the exercise intervention. Aquagym program was able to reduce the abdominal and visceral adipose tissue, and to decrease the risk of developing metabolic and cardiovascular diseases, at the same time is is an effective strategy to deal with central obesity.

KEY WORDS: Physical exercise, Adipose tissue, Body composition, Water Activities.

RESUMEN

Los cambios en la composición corporal de mujeres posmenopáusicas, principalmente, el aumento del tejido adiposo visceral y abdominal, son indicadores de enfermedades metabólicas y cardiovasculares. Veintiuna mujeres posmenopáusicas participaron en un programa de 16 semanas de clases de Aquagym. Las variables analizadas fueron la circunferencia de cintura (CCi), la circunferencia de cadera (CCa), el índice cintura-cadera (ICC), el diámetro sagital abdominal (DAS) y el tejido adiposo visceral (TAV). El tratamiento estadístico empleado fue una prueba *t* para comparar entre los grupos y el test de Goodman para analizar las alteraciones en la clasificación cualitativa del ICC. Se han obtenido reducciones significativas ($p \leq 0,05$) para todas las variables medidas después de la intervención de ejercicio. El programa de Aquagym fue capaz de reducir el tejido adiposo visceral y abdominal, además de disminuir el riego para el desarrollo de enfermedades de enfermedades metabólicas y cardiovasculares, constituyendo una estrategia eficaz para tratar la obesidad central.

PALABRAS CLAVES: Ejercicio físico, Tejido adiposo, Composición corporal, Actividades acuáticas.

INTRODUCTION

Hormonal changes after menopause in elderly women cause metabolic and cardiovascular complications. It increases the number of atherosclerotic cardiovascular diseases and modifies the body adipose tissue which increases in internal organs and in the abdominal subcutaneous tissue (Ozbey et al., 2002; Tchernof et al., 2000). Several studies also show that excess abdominal subcutaneous adipose tissue and visceral fat deposit present a clear relationship with the development of chronic diseases related to metabolic anomalies such as type 2 diabetes mellitus, insulin resistance, dyslipidemia and cardiovascular diseases (Bastos et al*.,* 2005*;* Huxley et al., 2010; Hwang et al., 2008; Ohlson et al., 1985; Seidell et al., 1997), due to high levels of inflammatory cytokines (TNF-α, IL-1β, IL-6), together with immune cell activation (Handschin & Spiegelman, 2008; Hotamisligil & Spiegelman, 1994; Hotamisligil et al., 1993).

In the scientific literature there is a great amount of laboratory and anthropometric methods to measure subcutaneous and visceral adipose tissue. Laboratory instruments such as bone densitometry, computerized axial tomography and magnetic resonance are very expensive and they also have risks of ionizing radiation (Hwang et al., 2008). On the other hand, anthropometric indices present great reliability when compared to laboratory methods; in addition, they have easier access to them due to its low cost and because they are not invasive (Hwang et al., 2008). Among these methods, probably the most important are waist circumference (WC), hip circumference (HC), sagittal abdominal diameter (SAD) and waist-hip ratio (WHR), the latter also expressed in qualitative qualifications. In addition, WHR and SAD are found to have a significant relationship with the amount of visceral adipose tissue (VAT), compared to other anthropometric methods, in postmenopausal women posmenopáusicas (Hwang et al., 2008; Snijder et al., 2002; Ozbey et al., 2002; Lean et al., 1995).

Bad nutritional habits and lack of physical exercise are the main reasons of abdominal obesity in the general population (Bastos et al*.,* 2005) and, in particular, in women (Castanheira et al., 2003). Currently, the main non-pharmacological component to deal with obesity and overweight is physical activity (Jones et al., 2009; Hill y Wyatt, 2005). It is also possible to observe that, especially with elderly people, an increase of muscle activity through physical activities is highly related to a longer life expectancy (Handschin & Spiegelman, 2008; Matter & Handschin, 2007; Haffner, 2006).

Due to the fact that physical activity is one of the main ways of controlling body weight, it is important to highlight that the combination of aerobic exercises with strength exercises, also known as circuit training, seems to be more effective and motivating than doing one of the two modalities isolated (Jones et al., 2009). Furthermore, training through circuits is usually performed on dry land, where

impacts are higher than in an aquatic environment. Exercise on dry land may not be the most effective for elderly people or people with obesity or overweight, since, in addition to the intensity used, most of them present limited motility or joint problems that not allow them to perform this kind of exercises (Jones et al., 2009; Takeshima et al., 2002). On the other hand, an aquatic environment seems to better adapt to women motivating needs (Moreno et al*.,* 2009).

For these reasons, Aquagym, which is characterized by circuit training in an aquatic environment, is considered an appealing alternative and one of the most sought activities, as far as women are concerned, due to its low intensity and little joint impact compared to dry land activities; therefore, it is more comfortable and satisfactory (Jones et al., 2009; Lind et al., 2005; Takeshima et al., 2002). Another important aspect of Aquagym is that exercises in water improve several components related to health as strength, flexibility, agility and amount of subcutaneous adipose tissue (Takeshima et al., 2002). As a result, the present study aims to evaluate the impact that Aquagym classes in postmenopausal women without hormone replacement have on abdominal and visceral adipose tissue changes, and on the coronary artery irrigation through anthropometric indices.

MATERIALS AND METHOD

The participants of the following study were selected randomly from a group of 29 individuals. The final study sample was 21 postmenopausal women at the age of 68±7 years old, with 65.95±9.32 kg weight, 158±5 cm height and BMI of 26.25±3.49, with neither osteoarticular injury nor another type of pathology. The procedures used in this project obeyed the rules on research involving human subjects, Resolution nº 196/96, from the National Health Council of 10/10/1996 (BRASIL, 1996) and the Declaration of Helsinki (WMA, 2008). All subjects filled in an informed consent to allow research involving human subjects, where the whole process of the study was completely explained and which contained an authorization form in order to participate in the study. All participants had medical authorization to do physical activity. Postmenopause was identified through the lack of the periods for at least 6 consecutive months. All volunteers were at least 6 months performing no physical exercise at all.

After that an anthropometric evaluation took place with the following measures: weight, height, waist circumference and hip circumference. Height was measured with a stadiometer when barefoot participants were standing on their feet (Sanny, 0.1cm- (Brazil)). Weight was measured with a digital scale (Plenna, with 0.1kg of measurement error, USA). Abdominal circumference was measured in the middle point between the bottom of the last floating rib and the iliac crest. Waist circumference was measured in the maximal gluteal protuberance. All circumference measures were made with the help of a flexible metal tape measure

(Sanny Starett, with 0.1cm of measurement error, Brazil). Participants wore light clothes when their weight was measured. Only one experienced assessor measured everything in pre and post-tests. The WHR was obtained by dividing waist circumference by hip circumference as described by Singh and Young (1995), and this rate classification was obtained through turning points suggested by Heyward et al. (1996). The amount of visceral adipose tissue (VAT) was measured by the following equation: VAT= [(0.370 x sagittal abdominal diameter (cm)) – 485]. It was presented in the study of Ozbeys et al. (2002), where sagittal abdominal diameter was obtained by the body perimeter through hip circumference.

All kinanthropometric procedures took place according to the prescribed by the International Society for the Advancement of kinanthopometry-ISAK (Marfell-Jones et al., 2006).

All participants were informed about the importance of their commitment with this study before and during the experimental period in order to avoid possible withdrawals which may harm the results. The exercise protocol consisted on Aquarobic sessions of 50 minutes, three times a week, always at the same time. The level of the water was established at the level of the xiphoid process and water's temperature was at 30ºC. These sessions were divided into a warm-up (10 minutes), a specific part predominated by aerobics (30 minutes), and elongations (10 minutes) (Martínez Muñez et al*.,* 2009*;* Takeshima et al., 2002).

The sessions' intensity of this study was controlled by the subjective perception of effort (SPE) described by Borg (1970). In order to avoid possible errors during the experimental period, all subjects were familiarized with the evaluation of effort through the SPE before the experimental process started. The intensity suggested was estimated for limits 60 and 75% of the maximum heart rate (HR_{max}) according to the formula of Gellish et al. (2007). Intensity was always measured by the SPE at the last 15 seconds of each session part, and the limit of Borg's scale was established between 12 and15. The exercise protocol lasted 16 weeks (4 months) in order to reduce the influence that neutral adaptation has on the results. At the end of the 16 weeks all participants were measured the same anthropometric measures before the experimental procedure.

The statistical analysis adopted in the present study was the *t* test for paired samples, in order to evaluate pre and post-test anthropometric changes after 16 weeks practicing Aquagym in elderly postmenopausal women. The Goodman test was used to identify the relationship between coronary risk classifications in WHR pre and post-tests. The statistical significance index adopted in the analysis was $p \leq 0.05$. The whole statistical procedure used the program *GraphPad Prisma* 5th version (*GraphPad Software*©, USA).

RESULTS

The evaluation of Waist Circumference showed the significant difference between pre and post-test conditions (p<0.001) (Figure 1).

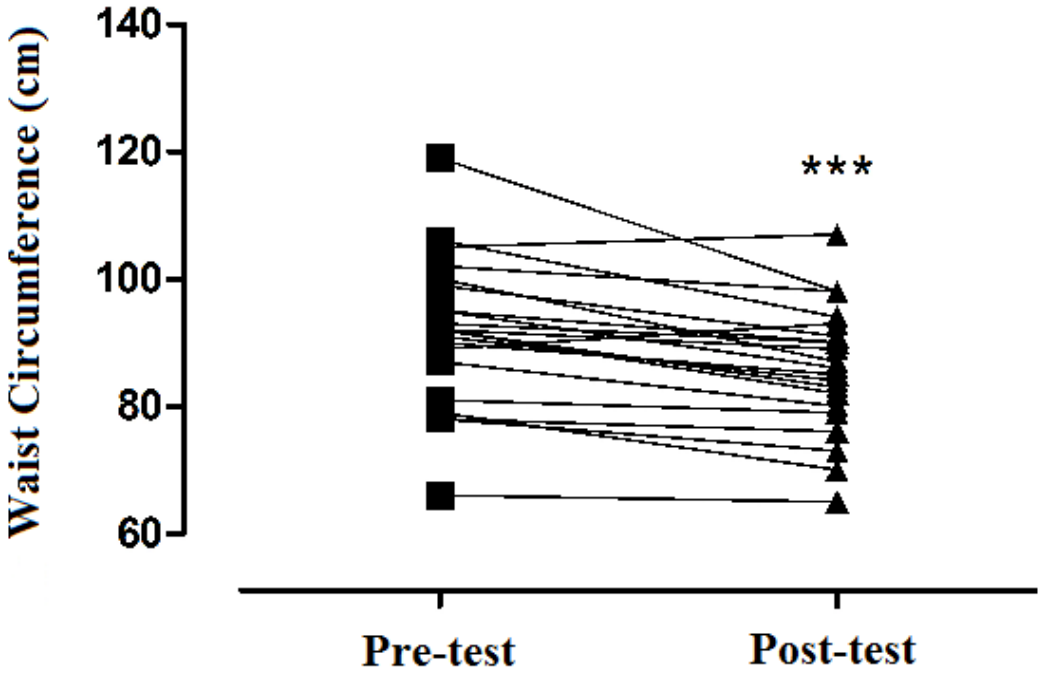

Figure 1: Graphic of the Waist Circumference before and after the Aquarobic 16-week session. *** Significant statistical difference (p<0.001).

The waist circumference showed a significant decrease of the measures at the end of the exercise protocol (p=0.001) (Table 1).

Table 1: Comparison of the anthropometric variables before and after the 16 weeks of Aquatobics.

Variables	Pre-exercise		Post-exercise*		
	Average (±SD)	95% WHR	Average (±SD)	95% WHR	*p*
Waist (cm)	91.9(±11.7)	86.5-97.2	85.7(±9.97)	86.5-97.5	<0.001
Hip (cm)	108(±9.43)	104-112	104(±9.10)	99.6-108	<0.001
WHR	0.84(±0.07)	0.81-0.88	0.82(±0.06)	0.79-0.84	<0.01
SAD (cm)	29.3(±3.72)	27.6-30.9	27.3(±3.18)	25.9-28.7	<0.001
VAT (L)	5.97(±1.37)	5.35-6.60	5.25(±1.18)	4.72-5.79	<0.001

SD (standard deviation); WHR (Waist Hip Rate); SAD (Sagittal Abdominal Diameter); VAT (Visceral Adipose Tissue). * Significant difference compared to pre-exercise data.

It was possible to observe that WHR presented a significant decrease after the 16 weeks of Aquagym (p=0.001) (Figure 2).

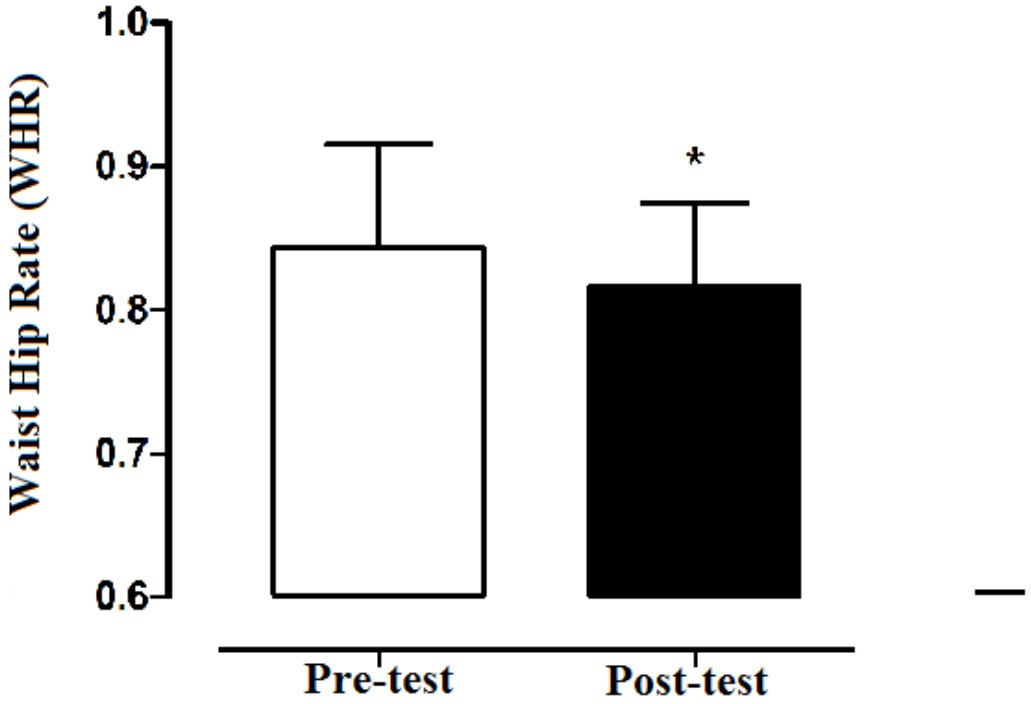

Figure 2: Graphic of the WHR before and after the 16 weeks of Aquagym.
* Significant statistical difference (p=0.001).

However, the coronary risk classification also presented important changes compared to the reference values described by Heyward and Stolarczyk (1996) (table 2) but these differences were not significant after the 16 weeks of Aqyagym (X^2=3.692; *p*=0.055), although there was a significant decrease of the observed frequency of high risk cases from the classification (table 3).

Table 2: Reference values for women waist-hip relationship

Age	Low	Moderate	High	Very High
40-49	<0.73	0.73-0.79	0.80-0.87	>0.87
50-59	< 0.74	0.74-0.81	0.82-0.88	>0.88
60-69	< 0.76	0.76-0.83	0.84-0.90	>0.90

Adapted from Heyward, V.H. & Stolarczyk, L.M. (1996, p.82) Applied Body Composition Assement. Illinois: *Human Kinetics*.

Table 3: Waist-Hip Rate classification (WHR)

	Low *% (f)*	Moderate *% (f)*	High *% (f)*	Total *% (f)*
Pre-test	4.8(1)	38.1(8)	57.1(12)	100(21)
Post-test	14.3(3)	57.1(12)	28.6(6)	100(21)
Δ%	9.5	19.0	- 28.6	

Verification among groups (p=0.156) and WHR classification levels (p=0.106) after Goodman test. Significance level adopted p≤0.05.

In the analysis of visceral adipose tissue we found a significant decrease after the 16 weeks of Aquagym in postmenopausal women without dietary control (*p*<0.001) (Figure 3).

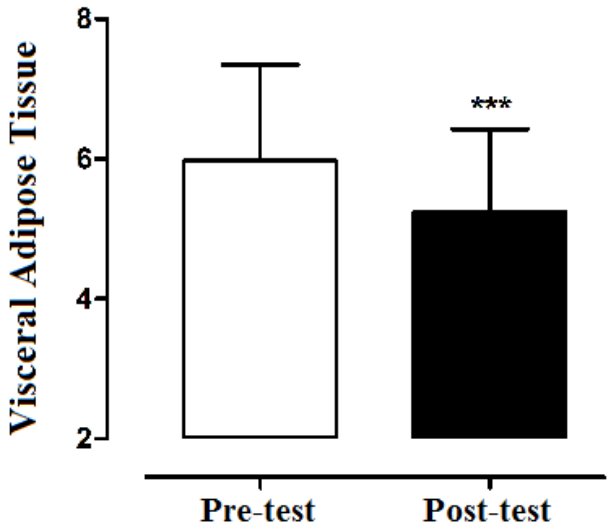

Figure 3: Amount of visceral adipose tissue (VAT) after 16 weeks of Aquagym.
*** Significant difference (p<0.001).

The SAD was evaluated through the waist circumference and presented significant differences at the end of the experimental protocol (p<0.001) (Figure 4).

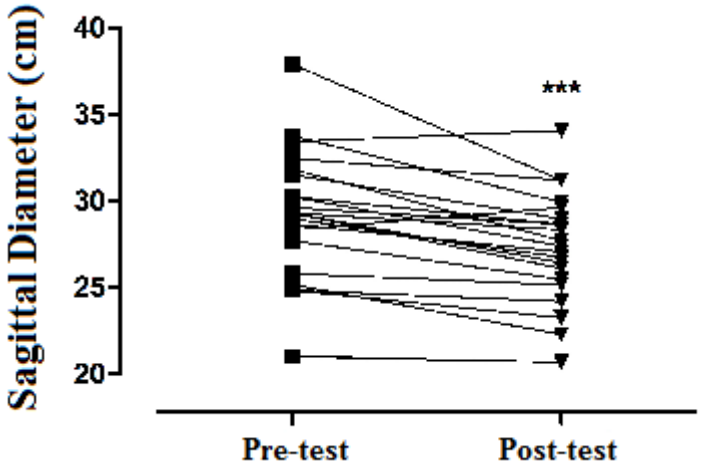

Figure 4: Graphic of the sagittal abdominal diameter (SAD) before and after the Aquagym protocol. *** Significant statistical difference.

DISCUSSION

Menopause is described in literature as the change of ovarian function, which causes great changes in body composition, since it reduces the resting metabolic rate and the muscle mass and it increases the amount of visceral and abdominal adipose tissue. As a result, it increases the risk of metabolic and cardiovascular diseases (Poehlman, 2002; Ozbey et al., 2002). In the present study it is also observed how body composition of all participants was over the normal pattern related to their age probably due to the reduction of ovarian activity.

Several studies highlight the importance of the evaluation of abdominal obesity, since there is a great relationship of excess visceral and abdominal adipose tissue with a large amount of diseases. In this sense, Snijder et al. (2002) and Krause et al. (2007) indicated that anthropometric methods, especially WC and SAD, presented high reliability on predicting visceral and abdominal adipose tissue, with no big differences compared to a computed tomography (*Gold Standard*) (Kamel et al., 2000). As a result, the present study used the WC and SAD anthropometric techniques in order to evaluate abdominal and visceral adipose tissue.

In the present study we obtained higher measures in the anthropometric variables (WC, HC, WHR, SAD and VAT) before the exercise protocol than after it. This probably was caused by the reduction of adipose tissue oxidation and, therefore, a lower lipolytic activity in the viscera and abdominal region, in addition to a low activity of lipoprotein lipase in the thigh of postmenopausal women, which accumulate fat in these specific regions. This is also explained in the review of Pohlman (2002). In the evaluation of body composition in postmenopausal women after 16 weeks of Aqyagym sessions, there was a significant reduction of the WC and the HC. It is possible that the increase of metabolic output influenced by the

adaptation for the exercise has caused such changes, as it happened with the study of Jones et al. (2009).

The WHR and its qualitative classification are considered important indications of future reasons of mortality, with higher precision for cardiovascular diseases (Bigaard et al., 2004). This is due to the fact that cardiovascular and metabolic chronic diseases seem to be related to systematic elevation of inflammatory cytokines (TNF-α, IL-1β, IL-6) released by the inactive muscle and the excess of adipose tissue. However, moderate and regular exercise, similar to the one in this study, is able to reduce systematic inflammation due to the reduction of such inflammatory cytokines (Peake et al., 2010; Handschin & Spiegelman, 2008; Gleeson, 2007; Gleeson et al., 2006). In this sense, the present study shows a reduction of WC and HP which leads to a reduction of the WHR too. Therefore, several changes, although they are not statistically significant, are physiologically important for the classification of this rate, since it shows that our Aquagym protocol seems to be effective to reduce possibilities of developing cardiovascular diseases.

Along this line, Nicklas et al. (2009) in their experiment of 20 weeks of stretching exercises and hiking together with calorie restriction, described an great reduction of visceral adipose tissue in elderly postmenopausal women. Okura et al. (2005) also demonstrated with a group of pre and postmenopausal women that 10 weeks of nutritional control and step classes were enough to reduce visceral adipose tissue. Choi et al. (2012) analyzed the body mass and the WC in 232 women between 40 and 50 years old during 2 years; they found a slight reduction of WC in those who increased their physical activity. Authors suggest that women must be motivated to do more physical activity before and after menopause. Cantarero-Villanueva et al. (2013) evaluated 40 women between 29 and 71 years old with breast cancer. Patients were randomly divided into the aquatic group or the group control. Authors found also a significant reduction of HC in the intervention group compared to the group control.

The results of the present study confirm those found in previous studies, since we also observe a reduction in the visceral adipose tissue. This fact seems to be specifically related to the practice of Aquagym, since one of the characteristics of our method was not to do any kind of dietary control or nutritional orientations or recommendations. Poehlman (2002) and Khan et al. (2010) claimed that in postmenopausal women there is a preference of the body metabolism for carbohydrates and that causes the increase of the activity of malonyl-CoA. This causes a direct inhibition of carnitine palmitoyltransferase I (CPT I) which is the key enzyme for the entrance process of long chain fatty acids and in the oxidation of fatty acids, and causes the biggest accumulation of fat (Khan et al., 2010). At the same time, in our study this process seems to have been reduced due to the

practice of exercises that possibly increased the use of fatty and finally reduced visceral adipose tissue.

This study presents some limitations such as the lack of a group control in order to compare their results.

CONCLUSION

In conclusion, despite the limitations of the method used to evaluate fat and the sample size, this study shows that in elderly postmenopausal women without hormone replacement therapy, aquatic exercises with moderate intensity reduced visceral and abdominal adipose tissue and also the risk of developing metabolic and cardiovascular diseases establishing an efficient strategy to treat abdominal obesity.

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