RBCDH Revista Brasileira de CINEANTROPOMETRIA e Desempenho Humano

DOI: http://dx.doi.org/10.5007/1980-0037.2015v17n2p145

original article

# The effects of water walking on the anthropometrics and metabolic aspects in young obese

## *Efeitos da caminhada aquática sobre aspectos antropométricos e metabólicos em jovens obesos*

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**Abstract** – Water-based exercise has been recommended for obese individuals due to reduced joint load. The aim of this study was to determine the effects of twelve weeks of water walking (WW) with or without nutritional guidance on anthropometric and metabolic variables in young obese individuals. Seventy-three young obese individuals of both genders (10 – 16 years) were randomly assigned in one of the three groups: Water walking and nutritional guidance group (WWN; n=23), Water walking group (WW; n=22) and Control group (CG; n=28). Body mass, height and waist circumference were assessed. Body Mass Index z score (BMI-z) was calculated, also analyzing total blood cholesterol levels (TC) and its fractions, high density cholesterol (HDL-C), low density cholesterol (LDL-C), triglycerides (TG) and fasting glucose before and after the training program. A two-way repeated-measures analysis of variance (ANOVA) was applied to compare groups and *post hoc* Tukey`s test was used for multiple-comparison in case of significant differences. Analysis of covariance was applied when differences were detected in the pretest. The significant level was set at p<0.05. The distance per exercise session increased from 377 to 829 meters from beginning to the end of the training period. The lipid profile and fasting glucose did not change after training (p>0.05). Reduction in total cholesterol in the walking group with nutritional guidance was observed (p<0.05). Water walking training can be considered as alternative to improve the physical fitness, being particularly effective for cholesterol reduction when combined with nutritional guidance.

**Key words**: Blood glucose; Body mass index; Food and nutrition education; Lipoproteins; Water walking.

**Resumo** – *Exercícios aquáticos são recomendados para pessoas obesas devido a redução do impacto articular. O objetivo deste estudo foi verificar o efeito de um programa de doze semanas de caminhada/corrida aquática em suspensão (CAS), com ou sem orientação nutricional (ON), nas variáveis antropométricas e metabólicas em crianças e adolescentes obesos. Participaram 73 indivíduos de ambos os sexos, faixa etária de 10 a 16 anos, divididos aleatoriamente em três grupos: Grupo CAS e ON (WWN; n=23), Grupo CAS (WW; n=22) e Grupo controle (Controle; n=28). Mensuraram-se massa corporal, estatura e Circunferência Abdominal (CA). Calculou-se o Índice de Massa Corporal escore z (IMC-z) e analisaram-se as concentrações sanguíneas de Colesterol total (CT) e suas frações HDL- colesterol (HDL--C), LDL (LDL-C), triglicerídeos (TG) e a glicemia em jejum antes e após o treinamento. Os grupos foram comparados por uma série de análises de variância (ANOVA) e o teste post hoc de Tukey foi utilizado para localizar as diferenças encontradas. Utilizou-se análise de covariância quando dados iniciais diferiram. Considerou-se nível de significância de p<0.05. Os resultados mostraram que a distância percorrida por sessão variou de 377 metros iniciais para 829 metros ao final do treinamento. As variáveis do perfil lipídico e glicemia em jejum não se alteraram (p>0,05). Observou-se redução no colesterol total (CT) no WWN (p<0,05), após o treinamento. Concluiu-se, neste estudo, que o treinamento de caminhada/corrida aquática pode ser considerado alternativa para a melhora da aptidão física e aliado a orientação nutricional, mostrou-se eficaz para redução do colesterol.*

**Palavras-chave**: *Caminhada aquática; Educação alimentar e nutricional; Glicemia; Índice de massa corporal; Lipoproteína.*

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Received: 13 April 2014
Accepted: 22 January 2015

## INTRODUCTION

Obesity has increased alarmingly in all social groups and age groups in the world population[1], which is determined by genetic, metabolic, socio-cultural, economic, psychological and environmental factors. Urban areas are most affected due to changes in lifestyle especially with regard to eating habits and reducing the usual level of physical activity[2-4]. As a result, the practice of physical exercise has been recommended for reducing body mass and cardiovascular risk factors in all age groups, including in obese children and adolescents[5,6].

Due to the physical properties of water, water activities, especially fluctuation, may be alternative exercises suitable for obese individuals, as they reduce the impact on joints responsible for supporting body weight. Among modalities, deep water walking or running (DWW) stand out, which is a simulation of the running held on land without the contact of the feet to the bottom of the pool, and can be performed with or without the use of float equipment [7]. In addition, the resistive effect of the fluid (drag effect) is higher in aquatic exercises due to the fluid viscosity. Thus, DWW, in addition to reducing joint stress, provides high energy expenditure to overcome the resistance imposed by water[7].

Regarding nutritional aspects, the better capacity to select foods can lead to better energy balance[5,8,9]. Thus, nutritional guidance programs can assist in the identification and selection of better quality foods. Therefore, aquatic exercise combined with nutritional guidance can positively contribute to the treatment of obesity[8]. However, no known studies have combined nutritional counseling with walking/water running exercises in children and adolescents to assess possible changes in anthropometric variables, lipid profile and blood glucose.

This study aimed to verify the effect of a twelve-week walking or water running program in suspension with or without nutritional guidance on anthropometric and metabolic variables in young obese individuals.

## METHODOLOGICAL PROCEDURES

Participants were recruited from the disclosure of the project in newspapers, radio and television in Curitiba. After presentation of the study objectives, participants signed a free and informed consent form according to the Ethics Research Committee of the Health Sector - UFPR, resolution 466/12 of the National Health Council on research involving humans (CAAE - 3183.0.000.091-08.CEP / SD).

### Participants

Overall, 80 volunteers were evaluated, 07 did not meet the criteria established for obesity classification. Thus, the study included 73 obese children and adolescents selected by non probabilistic and convenience sampling process, of both sexes, aged 10-16 years randomly divided into three groups:

Exercise and nutritional guidance group (WWN; n = 23; 11.74 ± 2.2 years; 14 boys and 9 girls), Exercise group (WW n = 22; 12.05 ± 1.6 years; 13 boys and 9 girls), Control group (CG, n = 18; 12.4 ± 1.6 years; 10 boys and 8 girls). There were no differences between groups for age ($p > 0.05$). To characterize the participants into children and adolescents, the age group classification proposed by the Center for Disease Control and Prevention (CDC, 2000) was used. The statistical power analysis was carried out "post hoc" and demonstrated that with a total of 63 subjects distributed into three groups, the statistical power calculated was 0.79 for an alpha value of 0.05, beta value of 0.95, and effect size of 0.20 (G Power 3.1.9.2).

A schematic model of the selection process is shown in Figure 1.

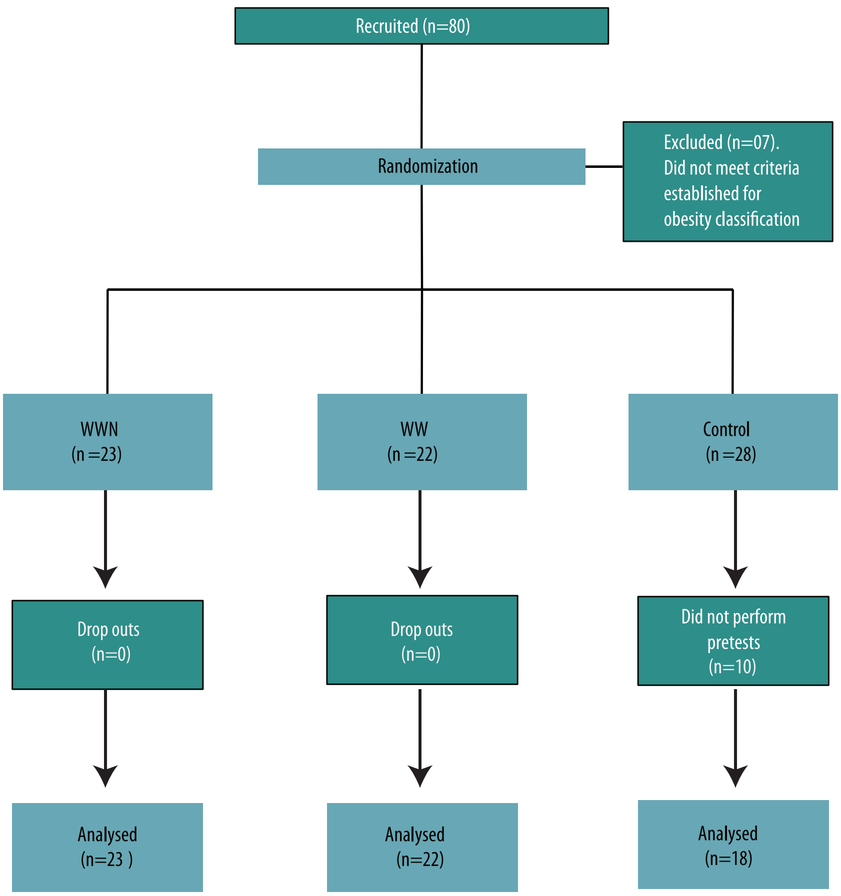


**Figure 1.** Selection and distribution of experimental and control groups, follow-up and final composition of groups.

Volunteers were initially selected based on body mass index (BMI), ranked above 95$^{th}$ percentile for age and sex[10]. Subsequently, subjects underwent clinical evaluation in order to detect possible contraindications for the practice of aquatic exercises, individuals who could not use medications to hyperinsulinemia, anorexigenic drugs or others who might interfere with weight control.

Body mass, height and waist circumference were assessed and BMI and BMI Z-score were calculated before and after 12 weeks of exercise. Measurements were performed by the same evaluators and the mean value of three measurements was considered. To obtain body height (cm), a wall stadiometer model WCS was used (accuracy of 0.1 cm). Body weight (kg) was measured on a mechanical platform scale (precision of 0.1 kg)[11]. For BMI, subjects were classified according to the criteria defined by the Centers for Disease Control and Prevention [10] according to sex, age and ethnicity, with the 95$^{th}$ percentile as cutoff point for obesity. To determine the waist circumference (WC), an anthropometric tape measure (accuracy of 0.1 cm) was used, considering values above or equal to the 75$^{th}$ percentile as threshold or increased, according to age, sex and ethnicity[12].

Blood tests (pre and post-training) were collected in the laboratory of clinical analysis of the Red Cross Hospital (Curitiba- Parana - Brazil) in the morning. Fasting glucose, total cholesterol (TC), HDL-C, LDL-C and triglycerides (TG) concentrations were analyzed.

## Exercise program

Participants of aquatic walking in suspension groups (WWN and WW) used a float vest and performed 3 familiarization sessions. The activities were conducted for 12 weeks, three weekly sessions, one hour per session, 25-meter pool, with a depth of 1.45 meters and water temperature of 27,5º C - 28,5º C.

To determine training heart rate (HRtrain), maximum stress test specific for swimming pool was performed[16]. For resting heart rate (HRrest), the individual remained for five minutes in a sitting position inside the pool with the aid of the acquatube. Then, HRtrain (40% to 60%) reserve heart rate (HRres) were calculated[13].

Sessions were composed of five minutes of warm-up exercises, 45 minute of walk and 10 minutes of recovery. Training heart rate was individually monitored (Polar® model F1).The exercise intensity was increased every four weeks and ranged from 40% to 60% of the reserve HR. The mean distance (meters) traveled per session was controlled in order to ensure that the load principle has been met and if subjects adapted to the exercise program.

The exercise and nutritional counseling group (WWN) and a responsible participated on twelve lectures on nutrition education, carried out practical activities with the use of the food pyramid, reading and understanding of food labels.

## Statistical analysis

The Shapiro-Wilk test was used to verify the normality of data. After confirming normal distribution, parametric tests were used (analysis of variance). Variables that did not show normal values were transformed into log base 10 and retested. To analyze the initial parametric data (pre-training), one-way anova was used. For variables that differed between groups before the beginning of the study, an analysis of covariance (ANCOVA) was used, with initial data as covariates to compare the post-test values excluding initial differences. A comparison of variables between groups before (pre) and after (post) 12 weeks of intervention was performed using a set of analysis of variance for repeated measures. When differences were found, the post hoc Tukey test was used to verify where they took place. Statistical tests had significance level of $p < 0.05$ and were applied using the Statistica software version 7.0 (StatSoft, USA).

## RESULTS

The aim of this study was to evaluate and compare the effects of water walking in suspension program and nutritional guidance with the effects of water walking in suspension program on anthropometric and laboratory parameters of obese children and adolescents.

The mean HR ranged from 128 beats per minute (bpm) in the initial weeks to 142 bpm in the final weeks, which corresponded to training heart rate of 40-60% the reserve HR. The evolution of the distance traveled by participants during the walking program / running program is shown in Figure 2. When considering the mean distances at the end of each training cycle consisting of four weeks, distances were 490 ± 68.24 meters (4$^{th}$ week) 678 ± 63.52 meters (8$^{th}$ week) and 829 ± 93.06 meters (12$^{th}$ week). The means were statistically different between 12$^{th}$, 8$^{th}$ and 4$^{th}$ weeks (F 92.59, $p < 0.001$).

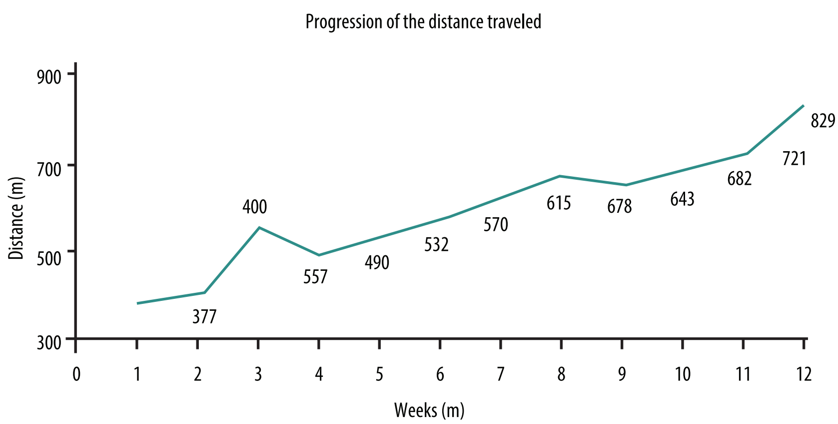


**Figure 2.** Progression of the distance traveled over the 12 weeks of water walking / running in suspension program.

The initial distribution of participants' conditions who showed alterations in relation to metabolic variables was (69%) for TC (52%) for LDL-C (56%) for HDL (45%) for TG and (12%) for blood glucose. The mean initial values of total cholesterol did not differ among groups, but there were differences in pretest values for HDL-C, LDL-C, triglycerides and fasting blood glucose. Figure 3 shows the results of pre and post-intervention laboratory variables. The results showed reduction in total cholesterol (TC) in WWN group after intervention with differences for WW and CG groups (F, 2.58; 7.238; $p = 0.001$). The other variables of the lipid profile, HDL-C, LDL-C and triglycerides did not differ among groups at posttest ($p > 0.05$).

Blood glucose levels of exercise and control groups are shown in Figure 4. No changes were found in this variable for the groups assessed after training ($p > 0.05$).

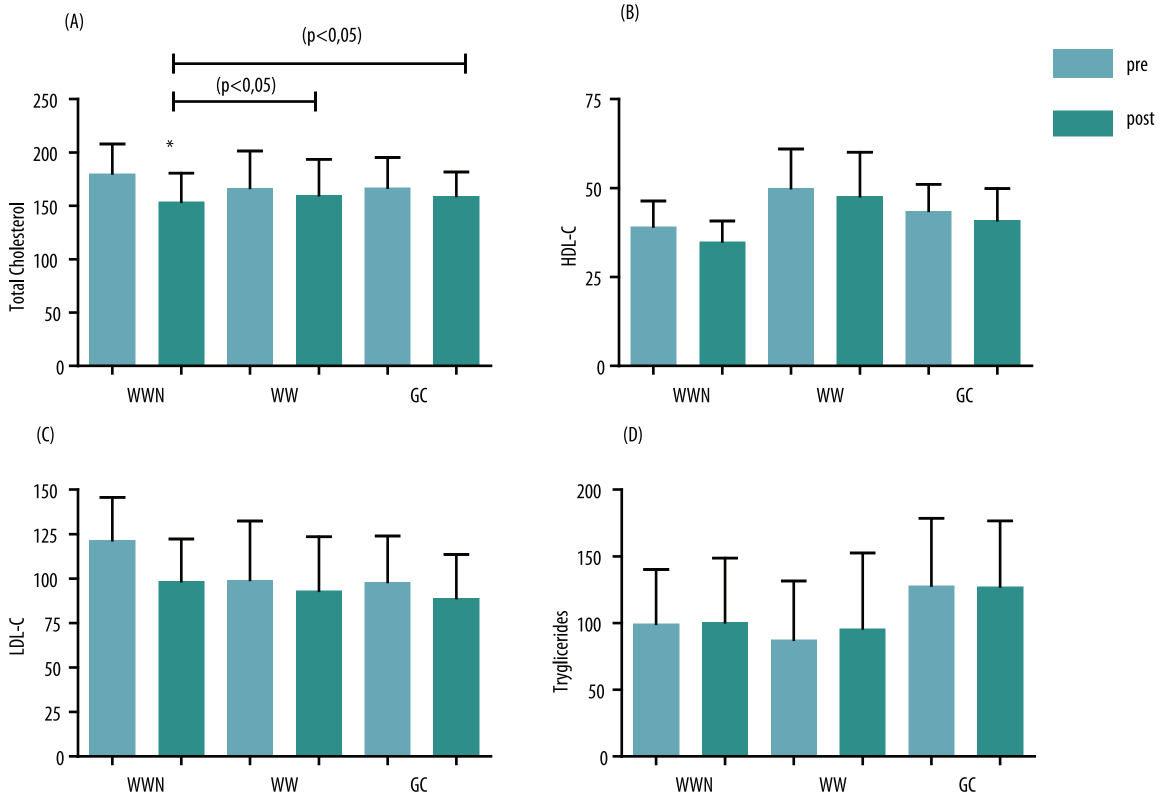


**Figure 3.** Mean values (± standard deviation) for total cholesterol (A), HDL-C (B), LDL-C (C) and triglycerides (D), pre and post-intervention for exercise and nutritional guidance (WWN), exercise (WW) and control groups (CG) pre- and post-intervention. * Differences between pre and posttest (p <0.05).

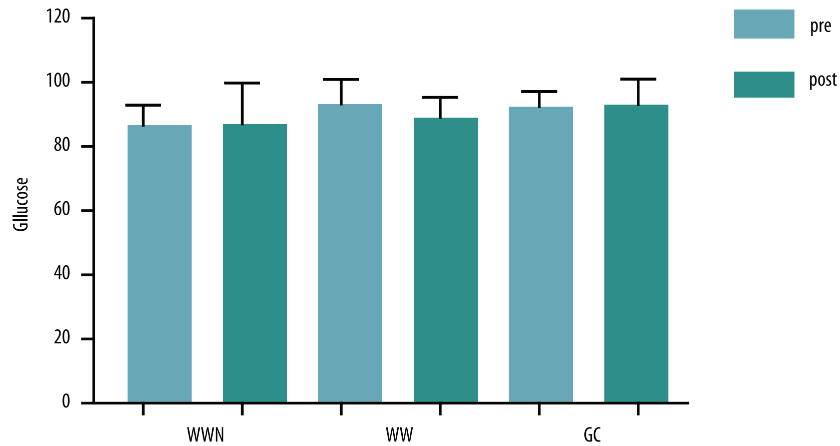


**Figure 4.** Mean fasting blood glucose values (± standard deviation) for exercise and nutritional counseling (WWN), exercise (WW) and control groups (CG) pre- and post-intervention. * Differences between pre and posttest (p <0.05).

Regarding the anthropometric variables, groups did not differ in baseline (p> 0.05). Figure 5 shows the means and standard deviations of initial anthropometric variables and after 12 weeks of intervention.

Adolescents from WWN group showed no significant changes for weight, height, WC and BMI z-score (p> 0.05) after intervention. WW group showed no statistical differences for variables, weight, BMI z-score and WC; however, there was a significant difference for height (p <0.001). The same occurred with participants from the CG group, in which only height was different and significant (p <0.001). There were differences between groups, in which obese adolescents from WW and CG groups significantly increased height compared to WWN group (p <0.02).

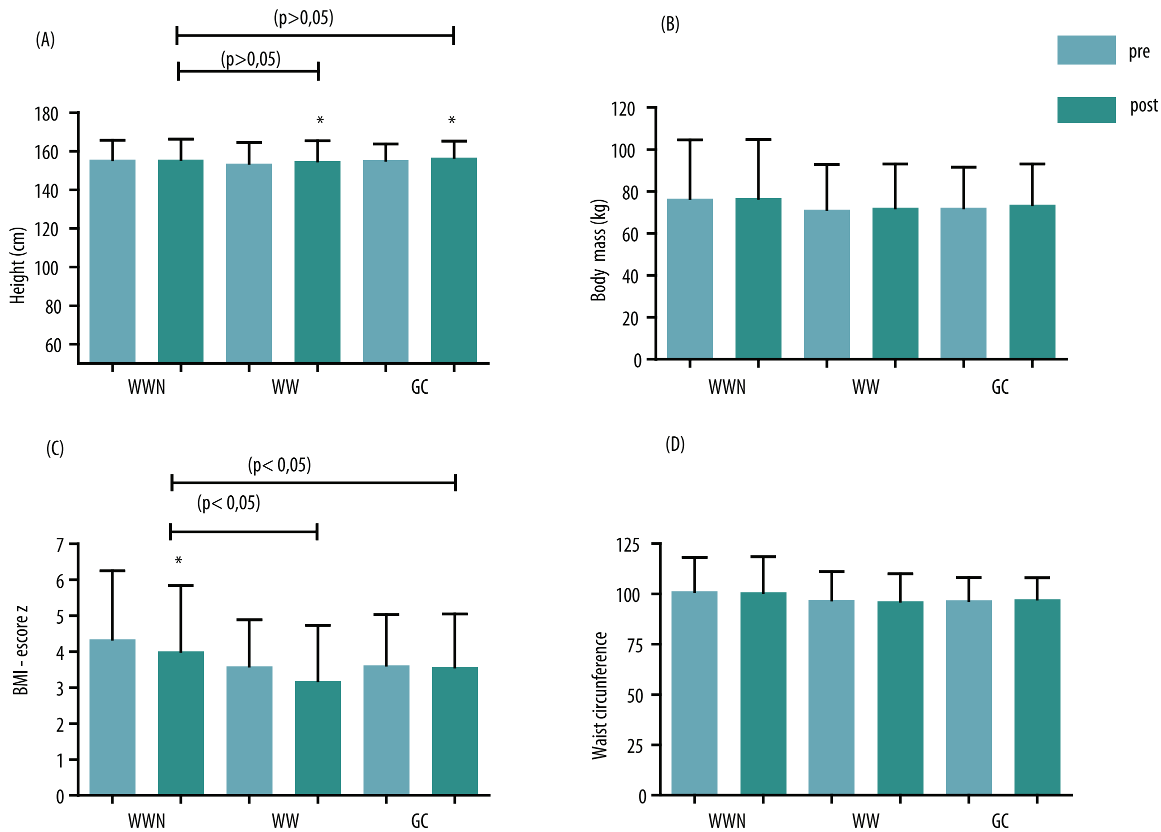


**Figure 5.** Mean values (± standard deviation) for anthropometric variables, height (A), muscle mass (B), BMI z score (C) and waist circumference (D) for exercise and nutritional counseling (WWN) exercise (WW) and control groups (CG) pre- and post-intervention. * Differences between pre and posttest ($p < 0.05$).

## DISCUSSION

The main finding of this study was that the group participating in the aquatic walking program and nutritional counseling reduced total cholesterol and these changes were not observed in the group that participated only in the exercise program and the control group.

It could be observed through the HR response and mean distance traveled in the water walking / running throughout the program that there was adaptation to exercise and that the progressive load principle was met. It is noteworthy that in this study, children and adolescents performed 3 exercise adaptation sessions before the training itself, thus increased distance traveled can be attributed to improved physical fitness and not to the possible learning effect.

Analyzing the initial results, high rate of changes in TC, LDL-C, HDL-C and TG concentrations was observed, which corroborate findings from other studies that indicated that overweight and obesity in children and adolescents are determinants of changes in the metabolic profile and the development of cardiovascular complications, persisting into adulthood[14-16].

In this study, there was a significant reduction in total cholesterol in the WWN group, and this reduction was not observed in WW and CG groups. Previous studies have shown that cholesterol (Total and LDL-C) showed little or no change in response to physical exercise programs, when they were the only form of intervention[8,15-19]. For major changes in cholesterol levels to occur, it is also necessary that there is a change in diet[5]. This may explain the reduction in TC only in the WWN group, since nutritional guidance can result in a better food selection.

Studies have shown an increase in HDL-C after physical training programs [5,6]. However, other studies found no increase in HDL-C after exercise[17,19-21] and this was also not observed in two groups of this study. These controversial results may be due to differences among exercise programs in relation to the session duration, intensity and intervention period[8,22]. Studies that found an increase in HDL-C showed greater length of time of each session[6,8]. Another variable that can interfere with lipid and lipoprotein concentrations is the stage of maturational development. Among girls, for example, there is an increase in HDL concentration during adolescence, and menarche is possibly important for the development of this phenomenon

TG levels after 12 weeks of water walking / running showed no reduction in both groups (WWN and WW) and CG. Similarly to the present study, other studies in children and adolescents found no changes in TG levels[5,17,19]. In a study that showed a reduction in TG concentration, the longer duration of exercise sessions appeared to have been decisive[6].

Park et. al.[23] found a reduction in blood glucose after 12 weeks of intervention, other studies, however, found no changes[17,20]. In the present study, the fasting blood glucose values did not change in the experimental groups. This absence of change may be due to that fact that most participants (78%) have shown initial glucose concentration values within desirable values.

Regarding the anthropometric parameters, after twelve weeks, children from the WW and the control groups showed an increase in height due to the growth process. In the WWN group, such changes were not observed, which may reflect differences in the stage of maturational development of individuals from this group compared to the WW and CG groups.

Intervention studies with land-based activities in obese adolescents have found reduced body mass and WC in boys[24] and girls[25]. However, no changes in these variables after training were found. The BMI-z score has been considered an important parameter for the evaluation of the exercise metabolic response in children and adolescents, especially in reductions equal to or greater than 0.5 BMI-z score [26]. In the present study, although the WWN group showed improved metabolic response (reduction in TC concentrations), these reductions were independent from reductions in the BMI-z score. As previously mentioned, the exercise program with nutritional guidance can result in better food selection. However, the total caloric value possibly remained unchanged, which was verified by the absence of changes in BMI and BMI-z score.

Another factor that may have contributed to the absence of changes in anthropometric parameters refers to the energy expenditure of walking in suspension. Although this program benefits for obese due to the absence of joint impact, it can result in lower energy expenditure, because the individual does not need to support and carry the body weight, in spite of the resistance to body displacement provided by water[7,27]. When the immersion occurs at the level of the umbilicus for example, the reduction of the apparent weight is around 50%[27]. Thus, future studies using aquatic walking in shallower pools (foot in contact with the ground) are required to combine the effect of fluctuation with the drag force and verify the effects on anthropometric variables in obese individuals.

One of the limitations of this study was the fact that it did not apply a food survey to compare food intake before and after intervention in the experimental groups, especially in the nutritional counseling group. In addition, the evaluation of the stage of maturational development could allow better assessment of the effect of exercise on the lipid profile.

## CONCLUSIONS

This study showed that the deep water walking / running in suspension program together with nutritional guidance was effective to reduce total cholesterol.

The other lipid profile parameters remained unchanged. Thus, other studies with longer exercise sessions and longer intervention periods should be carried out.

The participation of a larger number of children and adolescents with changes in fasting blood glucose might provide better understanding of the effects of this exercise program to control blood glucose concentrations.

The exercise program alone or associated with nutritional guidance did not change the anthropometric parameters. Changes in height only in the exercise and control groups may be related to pubertal development.

In addition, aquatic walking was an attractive alternative of exercises for this population and provided improved physical fitness.

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