Effects of a multiprofessional obesity treatment program with aquatic training on biochemical parameters, body composition and physical fitness in adults

Efectos de un programa de tratamiento multiprofesional de la obesidad con entrenamiento acuático sobre parámetros bioquímicos, composición corporal y condición física en adultos

Efeitos de um programa multiprofissional de tratamento da obesidade com treinamento aquático sobre parâmetros bioquímicos, composição corporal e aptidão física em adultos

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ABSTRACT

In the context of the concerning global prevalence of obesity and the critical need for multidisciplinary interventions to drive lifestyle changes among individuals with obesity, this study aims to investigate the effects of a comprehensive multidisciplinary program, including aquatic training, on biochemical parameters, body composition, and physical fitness in severely obese adults. Over a period of 24 weeks, a team of diverse professionals in Physical Education, Nutrition, Psychology, and Medicine collaborated on this research. The study enrolled sixteen participants with severe obesity (BMI > 40 kg/m2). The interventions encompassed aquatic aerobic exercises, accompanied by nutritional and psychological guidance. Significant improvements were observed in the C-Reactive Protein index (mg/L) (p=0.0439), with a notable reduction in body fat percentage (%) after the 24-week treatment program (p=0.0136). Additionally, manual pressure force (kg) displayed a statistically significant increase at 16 weeks (p=0.0006) and 24 weeks (p=0.0014). These compelling findings underscore the remarkable progress in biochemical parameters, body composition, and physical fitness among severely obese adults, underscoring the critical importance of treatment programs targeting dietary and lifestyle changes for public health improvement. By adopting a multidisciplinary approach, this study emphasizes the effectiveness of comprehensive interventions in addressing the complex challenges posed by severe obesity. In summary, this research reinforces the significance of implementing multidisciplinary programs to foster lifestyle modifications and provides valuable insights into tackling severe obesity in adult populations. By highlighting the pivotal role of holistic interventions, this study contributes to the ongoing global efforts to combat the escalating obesity epidemic.

Key words: Obesity, Multiprofessional treatment, Physical exercise.

RESUMEN

Ante el preocupante panorama mundial de la obesidad y la importancia de intervenciones multiprofesionales para el cambio en el estilo de vida de la población con obesidad, este estudio tiene como objetivo analizar los efectos de un programa multiprofesional para el tratamiento de la obesidad mediante entrenamiento acuático en parámetros bioquímicos, composición corporal y aptitud física en adultos con obesidad severa. El estudio fue llevado a cabo por un equipo multiprofesional compuesto por profesionales de Educación Física, Nutrición, Psicología y Medicina, durante un período de 24 semanas. Participaron 16 individuos clasificados con obesidad severa (BMI > 40 kg/m^2). Las intervenciones del programa propuesto en el estudio incluyeron ejercicios aeróbicos acuáticos junto con orientación nutricional y psicológica. Se evidenció una disminución significativa en el índice de Proteína C Reactiva (mg/L) (p=0.0439); en el porcentaje de grasa (%), al final de las 24 semanas del programa de tratamiento (p=0,0136), también se evidencio un aumento estadísticamente significativo de la fuerza de presión manual (kg) con 16 semanas (p=0,0006) e 24 semanas (p=0,0014). Este estudio presentó resultados significativos en la mejora de los parámetros bioquímicos, composición corporal y aptitud física en adultos con obesidad severa, lo que justifica la importancia de los programas de tratamiento que se centran en los cambios en los hábitos alimentarios y el estilo de vida para la salud pública.

Palabras clave: Obesidad, Tratamiento multiprofesional, Ejercicio físico.

RESUMO

Diante ao preocupante cenário mundial sobre a obesidade e a importância de intervenções multiprofissionais para mudança no estilo de vida da população com obesidade. O Objetivo foi analisar os efeitos de um programa multiprofissional para tratamento da obesidade com treinamento aquático, nos parâmetros bioquímicos, composição corporal e da aptidão física de adultos obesidade severa. O estudo foi conduzido por equipe multiprofissional com profissionais de Educação Física, Nutrição, Psicologia e Medicina, durante 24 semanas, com 16 indivíduos classificados com obesidade severa (IMC > 40 kg/m^2). As Intervenções do programa proposto no estudo foram realizadas através treinamento aquático de exercícios aeróbicos associados com a orientação nutricional e psicológica. Foi analisada diminuição significativa no índice de Proteína C Reativa (mg/L) (p=0,0439); no percentual de gordura (%), ao final das 24 semanas do programa de tratamento (p=0,0136), também houve aumento significativo na força de pressão manual (kg) com 16 semanas (p=0,0006) e 24 semanas (p=0,0014). Este estudo apresentou resultados significativos na melhora dos parâmetros bioquímicos, composição corporal e da aptidão física em adultos com obesidade severa, justificando o quanto programas de tratamentos que visam a mudanças nos hábitos alimentares e estilo de vida são de grande importância para a saúde pública.

Palavras chave: Obesidade, Tratamento Multiprofissional, Exercício Físico.

INTRODUCTION

Obesity is a chronic disease with a complex and multifactorial etiology, with a high impact on global public health (Brazilian Association for the Study of Obesity and Metabolic Syndrome [ABESO], 2020). Excess weight, particularly severe obesity, is related to the development of comorbidities such as diabetes, increased cholesterol and triglycerides, blood pressure, cardiorespiratory diseases, arteriosclerosis and cancer, in addition to a condition of chronic inflammation in the body (Borba de Amorim et al., 2008; Zaniboni et al., 2019).

The highest prevalence of severe obesity is in the age group of 25 to 44 years and may be related to several factors, such as stress at work, reduced time for physical activity and meals, high intake of fast food and ultra-processed foods, contributing to the nutritional transition observed in recent years (Poobalan & Aucott, 2016). The prevalence of obesity in Brazil and around the world is worrying, and establishing behaviors related to a healthy lifestyle is a major challenge for health promotion. Studies such as the Diabetes Prevention Program (DPP) and Action for Health in Diabetes (Look AHEAD) demonstrate the effectiveness of multidisciplinary programs in tackling chronic noncommunicable diseases such as diabetes (Look AHEAD Research Group et al., 2006; The Diabetes Prevention Program Research Group, 2005).

A recently published study on individuals with obesity addressed the use of new tools for assessing cardiometabolic risk, using traditional biomarkers and a digital calculator to check the metabolic syndrome score, and demonstrated that the prevalence of metabolic risk is high, and 100% of male participants were classified as at moderate or high risk for cardiovascular disease (Westphal-Nardo et al., 2023).

Therefore, multidisciplinary interventions for lifestyle changes need to be further studied in individuals with severe obesity. According to the Brazilian Obesity Guidelines (ABESO, 2020), nutritional interventions are more successful when combined with increased energy expenditure and behavioral modification. In this case, multidisciplinary obesity treatment programs are necessary for this population, as a way to assist the patient during the intervention with physical exercises or for behavior change (Bim et al., 2021). Aquatic physical exercise produces different physiological reactions than outdoor activities, due to the hydrostatic effect of water on the cardiorespiratory system (Zaniboni et al., 2019). In addition, aquatic training through aerobic exercises is indicated in the case of severe obesity because it reduces the impact on joints, as well as improves muscle strengthening, body composition, flexibility, cardiorespiratory capacity, and health-related quality of life (Takeshima et al., 2002; Zaniboni et al., 2019).

The benefits of aquatic training in people with severe obesity open an area of research to improve the treatment of obesity. Thus, the present study aimed to analyze the effects of a multidisciplinary program for the treatment of obesity with aquatic training, on the biochemical parameters, body composition and physical fitness of severely obese adults.

METHODS

This study is characterized as a pragmatic clinical intervention trial (Patsopoulos, 2011). Those interested in participating in the obesity treatment program were invited through advertisements in the local media (TV, radio, newspaper) and electronic media (website, institutional email, Facebook) and followed the following inclusion criteria:

1) be between 18 and 50 years old;
2) be overweight or obese according to the Body Mass Index (BMI) cutoff points for adults BMI ≥ 30 kg/m² (World Health Organization [WHO], 2011);
3) reside in Maringá or metropolitan region;
4) be available to participate fully in interventions;
5) not having undergone bariatric surgery;
6) not be undergoing other treatment for obesity (therapies, medications, regular physical exercise);
7) sign the Informed Consent Form (TCLE).

Interested individuals who met the inclusion criteria responded to an anamnesis (sociodemographic data) and underwent preliminary assessments (weight, height, waist circumference). Six meetings were held between December 2017 and March 2018 at the Maringá Regional University Hospital (HUM) to recruit participants.

Among those interested in participating in the project, individuals with severe obesity were selected for multidisciplinary obesity treatment. These selected individuals were previously evaluated by a cardiologist who, based on anamnesis, physical examination and complementary tests (echocardiogram, electrocardiogram, and carotid Doppler), certified that the participants were able to continue the proposed training program.

The multidisciplinary obesity treatment program (MOTP) was composed of a multidisciplinary team with professionals from Physical Education, Nutrition, Psychology and Medicine. Three weekly meetings lasting two hours were held, with the first hour dedicated to theoretical interventions (Physical Education, Nutrition and Psychology), and the second hour dedicated to physical activity with aerobic aquatic training lasting 24 weeks.

All study procedures followed the regulations required in Resolution 466/2012 of the National Health Council for research involving human beings. Participants read and signed the Free and Informed Consent Form (FICF), agreeing to voluntarily participate in the research. The research protocol was previously approved by the Permanent Research Ethics Committee of the State University of Maringá (CAAE: 56721016.7.1001.0104, Opinion No. 2,655,268). It was also submitted to and approved by the Brazilian Registry of Clinical Trials (ReBEC), a platform of the Ministry of Health, under the registration.

The evaluations were carried out between May and December 2018 according to the duration of the program, being before the first week (T 1 S), in the eighth (T 8 S), in the sixteenth week (T 16 S) and in the twenty-fourth week (T 24 S).

The effects of MOTP were assessed by biochemical parameters (CRP (mg/L), total cholesterol (mg/dL), HDL cholesterol (mg/dL), VLDL cholesterol (mg/dL) and triglycerides (mg/dL) that were collected and analyzed by qualified professionals in a laboratory accredited for this purpose in the city of Maringá, Paraná, with ISO 9002 certification (International

Organization for Standardization). Blood collections for biochemical analysis were always performed in the morning (7 to 8 am) with participants fasting for at least 8 to 10 hours. Anthropometric variables (weight and height), body composition, body mass (kg), BMI (kg/m2), fat percentage (%) and fat mass (kg) and health-related physical fitness variables, such as flexibility (cm), handgrip strength (kg), static abdominal muscle endurance (sec), dynamic lower limb muscle endurance (n.º) and cardiorespiratory fitness were also assessed. (6-minute walk test - 6MWT).

The researchers involved in the evaluations were all trained and followed standardized procedures for measuring anthropometric variables with appropriate tools, such as height with a wall-mounted stadiometer (Sanny ® , Canastota, NY, USA). The anthropometric assessment followed the WHO recommendations (2011) and used a flexible anthropometric tape (Medical model Starrett-SN-4010, Sanny ®). To assess body composition, the recommendations proposed by Heyward were followed, using an octapolar multifrequency electrical bioimpedance (InBody ® , model 520 Body Composition Analyzers, Seoul, Republic of Korea) (Heyward, 2001).

Considering the variables of health-related physical fitness: Trunk and hamstring flexibility was measured by the sit-and-reach test using the Wells bench (model: BW2002, Sanny®) and a mat (American College of Sports Medicine [ACSM], 2014); Muscle strength, by the handgrip test, which measures maximum isometric strength with a dynamometer model: GRIP D - TKK 5410, Takei® (Caputo et al., 2014); Muscular endurance by the abdominal plank test, designed to measure static muscular endurance of the trunk region, which involves the muscles of the abdominal, lumbar, and pelvic regions. A mat and a stopwatch were used to perform this test (Chase et al., 2014); Dynamic muscular endurance of the lower limbs by the sit-and-stand test, using a chair with a backrest and no arms, with a height of 43 cm and a stopwatch (Rikli & Jones, 2013); Assessment of cardiorespiratory fitness by the 6-minute walk test (6MWT) (American Thoracic Society [ATS], 2002), using 6 small cones, 1 50-meter tape measure, 1 adhesive tape, 1 stopwatch (model: Casio Hs-3 digital), 1 perceived exertion scale, 2 heart rate monitors (Polar model RS800CX), 1 clipboard.

DATA CLASSIFICATION

The biochemical parameters were classified according to the Brazilian Guideline for Dyslipidemia and Atherosclerosis Prevention 2017, which establishes a classification for C-reactive protein into three levels: low risk - less than 1.0 mg/L, moderate risk - from 1.0 to 3.0 mg/L, high risk - greater than 3.0 mg/L and inflammatory or infectious test, acute phase - greater than 6.0 mg/L. Fasting triglycerides were considered to be >150 mg/dL and total cholesterol >190 mg/dL (Faludi et al., 2017).

The cutoff points proposed by the World Health Organization (WHO, 2011) were used to classify the Body Composition Index. The classifications of the components of health-related physical fitness followed the following protocols: flexibility (ACSM, 2014), handgrip muscle strength (National Health and Nutrition Examination Survey [NHANES], 2011), static muscle endurance (Chase et al., 2014), dynamic muscle endurance (Rikli & Jones, 2013), and cardiorespiratory endurance (ATS, 2002).

The statistical analyses were processed using the Statistica Single User statistical package, version 13.2. Since more than 60% of the data presented normality through the Shapiro-Wilk test, it was decided to use parametric statistics, always considering the initial evaluation as a

reference. The variables were presented with mean, minimum, maximum, and standard deviation followed by the Student's t-test for paired data. The significance level adopted in the tests was 5%, that is, comparisons with $p<0.05$ were considered significant.

RESULTS

A total of 358 interested individuals were recruited to complete anamnesis (sociodemographic data) and undergo preliminary assessments (weight, height, waist circumference) performed at the Maringá Regional University Hospital (HUM). Of these interested individuals, 106 did not meet the inclusion criteria for the study. Among the 252 who were interested and met the inclusion criteria, 96 had (BMI > 40 kg/m2), 49 (BMI > 35 kg/m2), 22 (BMI > 30 kg/m2) and 85 (BMI > 25 kg/m2).

For this study, the 30 participants were selected according to the highest BMI, 16 women and 14 men with a mean age of 41.5±6.9 years and classified as severely obese (BMI > 40 kg/m2). All individuals in the study were considered suitable for participation in the treatment program by the cardiologist. At the end of the study, the sample consisted of 16 participants, 37.5% female and 62.5% male. Thus, complete adherence to the multidisciplinary treatment program during the 24 weeks was achieved by 53.33% of the individuals. The flowchart with the procedure for including participants in the study and the final sample can be seen in Figure 1.

Figure 1

Flowchart of procedures for including the sample in the aerobic training program (n=16).

Phase 1 - Assessment of cardiometabolic risk There were 6 meetings
Step 1 – Anamnesis and preliminary assessment n=358 initial participants
Inclusion criteria: 1. Age 18 to 50 years 2. Being overweight or obese 3. Reside in Maringá or metropolitan region 4. Availability to participate fully 5. Not having undergone bariatric surgery 6. Not participating in another obesity treatment 7. Doctor approval 8. Sign the informed consent form
Step 2 – Clinical and laboratory examinations N=252 eligible
Participant characteristics: 1. Did not meet inclusion criteria n = 106 2. Present (BMI > 40 kg/m2) n=96 3. Present (BMI > 35 kg/m2) n=49 4. Present (BMI > 30 kg/m2) n=22 5. Present (BMI > 25 kg/m2) n=85

Phase 2 – Aerobic water training n= 30 participants with the highest degree of obesity were selected n= 16 women n= 14 men
n = 14 participants dropped out during the program n= 1 due to pregnancy n= 4 due to job n= 2 due to family problems n= 4 due to transport n=3 due to schedule
Final sample n= 16 participants n= 6 women n= 10 men They stayed until the end of the program (24 weeks of training)

The anthropometric and body composition variables of the participants can be seen in Table 1. There was a significant decrease in body mass (kg), BMI (kg/m2) and FM (kg) after 8 weeks of participation in the MOTP with aerobic aquatic training. It was observed that the significant decrease ($p<0.05$) of these parameters was present at all times evaluated (8, 16 and 24 weeks). As for the fat percentage (%), a significant difference was observed at the end of the 24 weeks of the T 24 S treatment program ($p=0.0136$).

Table 1

Analysis of the effect of MOTP on anthropometric and body composition variables over the 24 weeks of training n = 16.

Variable	Mean	Minimum	Maximum	SD	*P*
B M (Kg) T 1 S	145,3	110,6	220,5	30	Reference
B M (Kg) T 8 S	141,6	106,6	209,3	28	**0,0035**
B M (Kg) T 16 S	141	112	208,3	27,3	**0,0070**
B M (Kg) T 24 S	140,6	109,2	207,1	27,7	**0,0106**
BMI (Kg/m2) T 1 S	49,5	41,8	77,2	9,4	Reference
BMI (Kg/m2) T 8 S	48,5	41	73,3	8,6	**0,0087**
BMI (Kg/m2) T 16 S	48,1	39,9	72,9	8,7	**0,0089**
BMI (Kg/m2) T 24 S	47,9	39,2	72,5	8,8	**0,0080**
F P (%) T 1 S	50,9	43	58,4	4,1	Reference
F P (%) T 8 S	50,8	44,8	59,1	4	0,7231
F P (%) T 16 S	47,4	5,4	59,4	12,1	0,2513
F P (%) T 24 S	49,8	43,4	58,8	4,8	**0,0136**
F M (kg) T 1 S	74,5	55,5	128,8	19,2	Reference
F M (kg) T 8 S	72,5	57,5	123,8	17,9	**0,0159**
F M (kg) T 16 S	71,3	54,6	123,7	18,3	**0,0019**
F M (kg) T 24 S	70,4	52,4	121,7	18,4	**0,0023**

T 1 W, T 8 W, 16 W, T 24 W: time 1 week, time 8 weeks, time 16 weeks, time 24 weeks. B M (kg): body mass. BMI (kg/m2): body mass index. F P (%): Fat Percentage. F M (kg): Fat Mass. Paired t-test significant considering a significance level of 5%.

For the physical fitness variables, which can be seen in Table 2, there was a statistically significant increase ($p<0.05$) in flexibility (cm) and static abdominal muscle resistance (sec) in the three times evaluated T 8 S ($p=0.0005$), T 16 S ($p=0.0007$), T 24 S ($p=0.0002$). There was also a statistically significant increase in handgrip strength (kg) at 16 weeks T 16 S ($p=0.0006$) and 24 weeks T 24 S ($p=0.0014$), and in dynamic lower limb muscular resistance (n.°) T 16 S ($p=0.0142$), T 24 S ($p=0.0135$), while in static abdominal muscular resistance (sec) there was a significant difference in all program duration times that were evaluated T 8 S ($p=0.0187$), T 16 S ($p=0.0093$), T 24 S ($p=0.0011$).

Table 2

Analysis of the effect of MOTP for variables indicating physical fitness with four different times in the 24-week training period (n=16).

Variable	Mean	Minimum	Maximum	SD	*P*
Flex (cm) T 1 S	9,1	0	19,7	7,5	Reference
Flex (cm) T 8 S	11,8	0	25,9	8,4	**0,0005**
Flex (cm) T 16 S	13	0	27,7	9,3	**0,0007**
Flex (cm) T 24 s	13,4	0	26,5	9,1	**0,0002**
H G S(kg) T 1 S	34,5	19,9	59,2	10,8	Reference
H G S(kg) 8 S	33,3	14	56,7	12,9	0,3904
H G S(kg) 16 S	38,9	20,3	66,8	12,2	**0,0006**
H G S(kg) 24 S	38,9	24,5	68,7	12,1	**0,0014**
S A M R (sec) T 1 S	33	0	72	17,5	Reference
S A M R (sec) T 8 S	39,8	0	70	19,6	**0,0187**
S A M R (sec) T 16 S	42,4	0	88	20,8	**0,0093**
S A M R (sec) T 24 S	48,9	0	82	23,1	**0,0011**
M R D L L (n.) T 1 S	13	9	20	2,8	Reference
M R D L L (n.) T 8 S	13,2	10	16	1,7	0,7443
M R D L L (n.) T16 S	14,8	12	18	1,8	**0,0142**
M R D L L (n.) T 24 S	14,9	12	19	1,8	**0,0135**
6MWT (m) T 1 S	488	240	573	85,5	Reference
6MWT (m) T 8 S	509,9	303	734,2	93,4	0,1633
6MWT (M) T16 S	501,6	281	653	93,4	0,4402
6MWT (M) T 24 S	512,8	280	620	89,9	0,1519

T 1 S, T 8 S, 16 S, T 24 S: time 1 week, time 8 weeks, time 16 weeks, time 24 weeks. Flex (cm): flexibility. H G S (kg): handgrip strength. S A M R (sec): static abdominal muscle endurance. M R D L L (n °): dynamic lower limb muscle endurance. 6MWT (m): six-minute walk test. Paired t-test significant considering a significance level of 5%.

When evaluating laboratory tests (Table 3) at different times of the study, a significant decrease in the C-reactive protein index (mg/L) was evident at the end of the 24 weeks of MOTP (p=0.0439). A reduction in triglycerides was also observed at 16 weeks T 16 S (p=0.0109) and 24 weeks T 24 S (p=0.0331). For total cholesterol, no significant difference was observed throughout the program.

Table 3

Analysis of the effect of MOTP for biochemical indicator variables at four different times, in the 24-week training period n = 16.

Variables	Mean	Minimum	Maximum	SD	*P*
PCR (mg/L) T 1 S	8,1	1,7	11,8	3,1	Reference
PCR (mg/L) T 8 S	7	2,4	10,3	2,7	0,0768
PCR (mg/L) T 16 S	7,1	2	11,1	3,2	0,2101
PCR (mg/L)T 24 S	6,3	1,1	11,6	4	**0,0439**
T C (mg/dL) T 1 S	192,2	81	284	47,1	Reference
T C (mg/dL) T 8 S	185,9	92	225	36,7	0,3793
T C (mg/dL) T 16 S	186,4	86	278	43,9	0,3992
T C (mg/dL) T 24 S	180,1	90	241	36,3	0,2198
T (mg/dL) T 1 S	167,9	69	522	106,1	Reference
T (mg/dL) T 8 S	154,3	61	522	106,9	0,1194
T (mg/dL) T 16 S	126,5	59	322	61,9	**0,0109**
T (mg/dL) T 24 S	130,3	69	302	55,3	**0,0331**

T 1 W, T 8 W, 16 W, T 24 W: time 1 week, time 8 weeks, time 16 weeks, time 24 weeks. CRP (mg/L): C-reactive protein. T C (mg/dL): total cholesterol. T (mg/dL): triglyceride. Paired t-test significant considering a significance level of 5%.

DISCUSSION

Thirty participants with severe obesity of both sexes began the MOTP, with an average age of 41.5±6.9 years (minimum of 30 and maximum of 50 years). Of these, only 16 (53.33%) continued until the end of the MOTP for 24 weeks, 6 women (37.5%) and 10 men (62.5%).

The main benefits of the treatment program proposed in this study, in adults of both sexes with severe obesity, were evidenced by significant improvements in the biochemical profile, in C-reactive protein and in triglycerides. For the body composition variables, improvements were observed in body mass, BMI, fat percentage and fat mass. As for physical fitness, there was a significant improvement in flexibility, handgrip strength, static abdominal muscle resistance and dynamic lower limb muscle resistance.

Thus, MOTP with aerobic aquatic training is an important mechanism to promote improvements in biochemical parameters, body composition and physical fitness in adults with severe obesity. Through data analysis, it was possible to observe that for some variables the evolution process occurred from the eight-week period, followed by the 16- and 24-week periods. Thus, it is demonstrated that the duration of the treatment program interferes with the benefits that are presented with adherence to the program and throughout it.

Intervention studies in populations with severe obesity with aerobic training demonstrated improvements in biochemical parameters (Sartorio et al., 2005; Goodpaster et al., 2010; Marcon et al., 2011; Crowe et al., 2015).

In this study, it was possible to verify that improvements in biochemical parameters may need more time to become significant, occurring after 16 weeks (T 16 W), while body composition and physical fitness variables showed significant improvements after 8 weeks (T 8 W) for most of the variables studied. Thus, it is possible to affirm the benefits of MOTP with a duration of 8 weeks,

but with a longer duration of the program, the better the results were achieved.

Although the improvements in terms of cardiorespiratory fitness in this study were not as significant as those found in other studies (Errickson et al., 2016; Marcon et al., 2011), which focused on moderate and high intensity aerobic work, there was a constant improvement in this variable during all weeks of intervention; despite not working specifically and reaching values similar to those reported for people with obesity after 16 weeks of work (Errickson et al., 2016).

In this sense, it should be noted that people with severe obesity have severely reduced cardiorespiratory fitness, which is a hindering factor (Gallagher et al., 2005; Zavorsky et al., 2007; Marcon et al., 2011), and also have musculoskeletal pain from physical activity (Hu-lens) as a limiting factor, which was reduced by exercise in an aquatic environment. Our findings suggest that low-intensity exercise programs in an aquatic environment, such as the one implemented in the present study, are suitable for people with severe obesity as a way to reduce physical inactivity and mitigate its deleterious effects.

The proposal of performing aquatic aerobic exercise training associated with nutritional and psychological guidance has proven effective in improving the biochemical profile, body composition and physical fitness in adults with severe obesity. This fact was also evidenced in the study conducted by Haynes et al. (2019). According to Swift and collaborators (2014), participation in a training program in the treatment of obesity is important to maintain control of body mass in the long term (Swift et al., 2014).

For Benito and collaborators (2019), training programs are efficient in improving body composition variables in relation to obesity (Benito et al., 2019). Thus, contributing multidisciplinary obesity treatment programs are, therefore, an important alternative for the treatment of obesity and its comorbidities (Christinelli et al., 2022; Pereira et al., 2021; Westphal et al., 2020). Intervention programs that include nutritional guidance, clinical monitoring, physical training and psychological interventions have been identified as more effective (Bim et al., 2021).

According to Swift and collaborators (2014), participation in a physical training program in the treatment of obesity is important to maintain control of body mass in the long term. For Benito and collaborators (2019), physical training programs are efficient in improving body composition and physical fitness variables in relation to obesity (Benito et al., 2019; Swift et al., 2014).

The study in a population with severe obesity showed effects similar to those found in this research, pointing to the reduction of relative and absolute fat mass, as well as other items related to physical fitness, also evidenced in our research (Bim et al., 2021; Castilho, Westphal, Thon, et al., 2021).

The study by Bim (2021) that verified the effects of an obesity treatment program with functional and resistance training on cardiometabolic risk and health-related physical fitness in women with severe obesity and obtained similar results (Bim et al., 2021). After 24 weeks, a significant improvement was observed in all anthropometric parameters, body composition, health-related physical fitness and triglyceride levels.

Curioni & Lourenço (2005) conducted a meta-analysis study indicating that programs that include diet associated with physical exercise produce a reduction in weight loss approximately 20% greater when compared to

programs that use only dietary treatment (Curioni & Lourenço, 2005).

The improvements promoted by multidisciplinary programs usually reach several evaluation parameters. Thus, improvements in cardiovascular risk factors are generally related to increased cardiorespiratory fitness (Castilho, Westphal, Pereira, et al., 2021; Westphal-Nardo et al., 2023).

Based on the findings of the results of the present study, it can be said that they favored the discussion of the benefits of the MOTP model with aquatic aerobic training, which has proven to be effective and applicable. Participants showed significant improvements in their biochemical profile, body composition, and physical fitness, with the possibility of improving their quality of life in accordance with health promotion.

This study has some limitations. The study was conducted in a single university center and of 358 eligible participants, only 30 were eligible according to the inclusion criteria and only 16 completed the intervention, due to the impossibility of attending the sessions three times a week. Applying this study protocol to several health centers may increase the external validity of the results. Another limitation is that, with the exception of activities carried out under our supervision, the amount of exercise that participants performed daily was not measured, which would help to identify the characteristics most associated with a successful intervention.

CONCLUSION

In the present study, MOTP with aerobic aquatic training was effective in improving the biochemical profile, body composition and physical fitness in adults of both sexes with severe obesity. The multidisciplinary intervention methodology used in this study may be an important path in the treatment of severe obesity to help individuals change their lifestyle. Even with other possible forms of treatment (pharmacological and surgical), treatment programs that help build and maintain healthy habits are of great importance for public health.

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