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ACUTE DEEP WATER RUNNING RESPONSE AND LINEAR LOAD INSPIRATORY EXERCISE IN OVERWEIGHT/OBESE AND SLIM ADULTS: RANDOMIZED STUDY

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Abstract: **Introduction**: Obesity causes several clinical manifestations, whether orthopedic, respiratory and cardiovascular, so aquatic and respiratory exercise are therapeutic options. **Goal**: To compare the acute effect of the use of linear inspiratory booster in subjects submitted to deep water running (DWR). **Methods**: Prospective, randomized study, single session of continuous exercise, DWR and respiratory exercise (PowerBreathe Classic, 50% Maximal Inspiratory Pressure - IMR), water temperature 32 to 36°C, in adults of both sexes, thin and overweight/obese. The subjects were divided into two DWR and DWR+TMI. Body mass index (BMI), ankle-brachial index (ABI) and cardiorespiratory measures were evaluated. Data will be analyzed by normality test, dependent and independent t test, Wilcoxon and MannWhitney ($p<0.05$). **Results**: Eleven volunteers were evaluated, 8 (72.7%) were female Age: 27.00±9.56 years, BMI: 25.21±7.47 kg/m2, lean mass: 49.07±17.36 kg, Body fat: 20.79±11.84 kg, ABI: 1.01±0.02 mmHg. The DWR group had a 9 bpm increase in heart rate after exercise. **Conclusion:** DWR associated with IMT does not promote acute cardiorespiratory changes in young adults.
Keywords: Hydrotherapy. Breathing Exercise. Obesity.

REPORT SUMMARY

The project aimed to investigate the acute cardiovascular and respiratory response of deep water running associated with linear load inspiratory exercise in overweight/obese and lean adults. Data collection was carried out at the UNISAGRADO physiotherapy clinic, from October 2020 to August 2021. Due to the restrictions imposed by the authorities during the COVID-19 pandemic, there was a delay in data collection and a reduction in the number of participants of the research due to the unavailability of the laboratory, as well as the fear of participating in the study, given that they must travel to the clinic, exposing themselves to the risk of contamination. The data were submitted to statistical analysis, which allowed the presentation of the results that supported the discussion and final considerations. Participated in the survey. Eleven volunteers were evaluated, 8 (72.7%) were female Age: 27.00±9.56 years, BMI: 25.21±7.47 kg/m2, lean mass: 49.07±17.36 kg, Body fat: 20.79±11.84 kg, ABI: 1.01±0.02 mmHg. The DWR group showed a 9 bpm increase in heart rate after exercise. In addition, complementary bibliographic surveys were carried out on Deep Water Running, breathing exercises, hydrotherapy and obesity. Subsequently, the work was completed with the preparation of the monograph to be made available at the UNISAGRADO Library, as well as the oral presentation for the Scientific Initiation Forum and the abstract for insertion in the Annals of the Event.

INTRODUCTION AND LITERATURE REVIEW

Obesity is considered a chronic disease of multifactorial and complex etiology, characterized by the increase in body fat stores. Its prevalence is increasing on the world stage and is related to the increase in morbi-mortalality and low level of physical Atividade. (ABESO, 2016; HASLAM; JAMES, 2005; YANOVSKI; YAHOVSKI, 2002).

The cardiorespiratory changes identified in Obesity involve changes in compliance and pulmonary resistance, which limits the maximum ventilatory capacity, generating a rapid and low-amplitude breathing pattern and causing an increase in the work of breathing. The myocardium also undergoes morphological changes such as increased left ventricular diameter, ventricular mass, eccentric hypertrophy, in addition to the presence of fatty infiltrate, promoting changes in diastolic and systolic functions, increased cardiac output and oxygen consumption. (SOUZA et al., 2014).

The association between obesity and sedentary lifestyle promotes functional and metabolic limitations, causing great damage to health, and increases the risk for the development of other chronic non-communicable diseases, such as diabetes mellitus, cardiovascular diseases, chronic respiratory diseases, dyslipidemia and obstructive sleep apnea syndrome. sleep. (HASLAM; JAMES, 2005; MANCINI; ALOE; TAVARES, 2000).

The Guidelines for coping with Obesity in Supplementary Health (2017) identify assistance for subjects using the body mass index (BMI) as a reference, and, regardless of body composition, reinforcement and change in lifestyle/habits of life are essential.

The change to a healthy lifestyle and habit involves physical exercise, which is an efficient strategy to minimize the impact of excess body weight on functional capacity (muscular strength, motor coordination, etc.), respiratory capacity (respiratory muscle strength, volumes and capacities) and cardiovascular (reduction in blood pressure, heart rate and arterial thickness, etc.), being considered a key component for promoting physical health. (YUMUK et al., 2015; CHODZKO-ZAJKO et al., 2009; MATSUDO; MATSUDO, 2007; WAY et al., 2019).

Several exercise modalities can be used in Obesity (NIEMIRO; ALGOTAR, 2019), so for this study, the focus will be on aquatic and respiratory exercise.

The simple fact of immersing in water, depending on the level, provides a reduction in respiratory parameters (forced expiratory volume in the first second - FEV1 and maximum inspiratory pressure - PImax) and cardiovascular parameters (bradycardia, hypotension, etc.). (ANDRADE et al., 2014; BECKER et al., 2009; SANDI; SILVA, 2018; WILCOCK; CRONIN; HING, 2006).

However, many therapeutic strategies can be employed, regardless of immersion. In this case, deep water aquatic exercise, Deep Water Running (DWR), can be highlighted, which is an effective form of cardiovascular conditioning for injured athletes, obese patients, cardiac patients, the elderly and individuals who need aerobic exercises without impact on the lower limb joints. It is an exercise that can be performed with or without displacement, done with the individual in a vertical position with a float vest, making it impossible to touch the feet on the bottom of the pool. (KANITZ et al., 2014).

In this type of exercise that requires vertical displacement, it promotes an increase in cadence resulting in an increase in angular velocity and, subsequently, in oxygen consumption and heart rate. It is also a physical activity with the same intensity as continuous exercise, but the degree of fatigue after interval training is considerably less. (ALBERTON et al., 2009; HIGGINGS et al., 2016). Water temperature, hydrostatic pressure, seriousness and fluctuation directly affect muscle recruitment, running kinematics and method learning and skill. (KILLGORE, 2012). The method provides adequate stimulus for cardiovascular training. It promotes an increase in cardiac output and systolic volume, generating an increase in blood volume, largely compensating the cardiac deceleration reflex at rest. The DWR favors sedentary individuals more than athletes, establishing relief of muscle pain, reduction of musculoskeletal injuries and reduction of vertebral load. (REILLY; DOWZER; CABLE, 2003). After training there is improvement in peripheral muscular endurance, muscular and respiratory strength. (KANITZ et al., 2015).

DWR shows a decrease in maximal physiological responses when compared to treadmill running. (NAKANISHI et al., 1999). Under maximum conditions, the DWR has a reduced rate of maximum oxygen uptake, ventilation, heart rate, rate of perceived exertion and respiratory exchange ratio when compared to the maximum conditions of a treadmill run. (BROMAN et al., 2006).

The benefits of exercise in the aquatic environment are vast. Subjects (n=29) with diabetes and the elderly performed aerobic exercise, 3x/week for 12 weeks, on land and in water (36°C). There were changes in blood glucose concentration, insulin resistance, plasma concentrations of nitric oxide with improvement in flow-mediated arterial dilation and reduction in arterial thickness, but only in water there was an increase in the microvascular reactivity index. (SUNTRALUCK; TANAKA; SUKSOM, 2017).

In 35 elderly (60 to 75 years old) who underwent DWR training continuously and at intervals, 28 weeks, 2x/week, it was possible to verify that the continuous form promotes improvement in functional fitness, however, diastolic blood pressure (DBP) remained high during all training. (REICHERT et al., 2016).

After understanding the effects of aquatic exercise, specifically DWR, on the cardiorespiratory system, what would be the cardiorespiratory repercussions of supplementing this type of exercise with respiratory exercise in obese individuals?

Subjects with obesity are predisposed to develop respiratory muscle fatigue during exercise. (CHLIF et al., 2007). Aerobic exercise improves muscle strength, inspiratory performance and decreases the perception of dyspnea in obesity. (CHLIF; CHAOUACHI; AHMAIDI, 2017). In addition, Nepomuceno Jr, Gómez and Gomes Neto (2016) in a systematic review on the use of inspiratory muscle training by the Powerbreathe concluded that this equipment is useful as a supporting respiratory therapy.

Respiratory muscle training is a training method capable of improving the functionality of the respiratory muscles, which was initially created to minimize and reduce the strength and resistance of the respiratory muscles, reducing the effect of the disease and its adverse effects, such as dyspnea, hypercapnia, and reduced tolerance to physical exertion in adult patients with chronic respiratory disorders, obesity, heart and osteoarticular diseases. It is currently widely used routinely applied to healthy adults, in the context of sports performance and health promotion. (GÖHL et al., 2016; SIQUEIRA et al., 2018).

Respiratory muscles can be exercised for those who wish to increase muscle strength and ventilatory capacity. Training tends to increase maximal inspiratory pressure (PImax) by decreasing fatigue. (COLMAN; BERALDO, 2010).

Obese subjects undergoing inspiratory muscle training (30% MIP) for 12 weeks showed an increase in MIP (-86.86 to -106.43 cmH2O) and in maximal voluntary ventilation, without changing diaphragmatic mobility. (TENÓRIO et al., 2013).

Furthermore, the European Guidelines for the control of obesity in adults (YUMUK et al., 2015) reinforce the responsibility to recognize obesity as a disease and offer assistance to the individual with obesity with appropriate prevention and treatment.

Separately, it is possible to verify that subjects with obesity benefit from the aforementioned interventions, now, what will be the acute cardiorespiratory response when submitting the subject with obesity to respiratory exercise when performing aquatic exercise in deep water?

Therefore, it is important to understand the mechanisms and responses when submitting the subject with obesity to respiratory and aquatic exercise, in order to contribute to scientific progress. In this context, the primary objective of this study was to investigate the influence of inspiratory muscle exercise combined with deep water aquatic exercise (DWR) in thin and overweight/obese adult individuals, however, with the limitations already presented, this study was limited to comparing the effect of the use of linear inspiratory booster in subjects submitted to DWR.

MATERIALS AND METHODS

This study is characterized clinical, prospective, 2 arms, randomized with adults of both sexes aged 18 to 50 years, BMI between 18.5 to 30 kg/m² (WHO, 2019), ability to adapt and perform the exercise in aquatic environment.

This study was carried out at the Laboratory of Research in Physiotherapy and the aquatic intervention program, Therapeutic Swimming Pools, and Laboratory of Cardiorespiratory Physiotherapy, both located at the Unisagrado Physiotherapy Clinic, Bauru-SP, Brazil.

Individuals with dermal infection and inflammation, fistula or open wounds, mycosis, varicose ulcers, limb amputation, urinary tract infection, conjunctivitis, otitis, tympanic perforation, fecal and urinary incontinence, severe heart and respiratory diseases, unstable coronary artery diseases, angina and heart failure confirmed by medical diagnosis, cardiac pacemaker, pregnant woman, hospitalization in the last 3 months, regular physical exercise more than three times a week, sensitivity to chlorine, epilepsy, hydrophobia, inability to perform and maintain aquatic and respiratory exercise.

After the initial assessment, the subjects performed the subsequent examinations and intervention. At the same time, the therapeutic pool and the apparatus for performing the breathing exercise were presented. The groups that performed the breathing exercise (IMT) used the PowerBreathe®, Classic, High resistance, red equipment (PowerBreathe®, United Kingdom), at 50% of the Maximum Inspiratory Pressure (PImax). The subjects handled and tested the equipment to understand its operation, a stage characterized as adaptive.

In the second moment, body mass (kg) was measured using a digital anthropometric scale (BALMAK®, BKH, 200F, Brazil), with a precision of 0.1 kg, calibrated for each measurement (GUEDES; GUEDES, 1998), with the patient barefoot and with minimal clothing. Height (m) was measured by a stadiometer, with an accuracy of 0.5 cm. Having this information, the body mass index (BMI) (kg/m2) will be obtained. (CRONK; ROCHE, 1982; KEYS et al., 1972). From this, subjects are classified according to nutritional status (WHO, 2019).

To measure the abdominal circumference, the anthropometric tape of inextensible cellulose (Singer®) was used, wrapping the abdomen between the iliac spines and the last ribs, with the individual in a standing position. (CHAN et al., 2003). This measure allows the stratification of cardiovascular risk, with values of up to 88 cm for women and 102 cm for men being expected. (III NCEP, 2002).

The amount of lean mass and total body fat was measured by the BIODYNAMICS TIM body composition monitor (model 310. version 8.01 international). (FAPESP PROCESS, 2017/18473-3). The subjects were instructed to: remain at rest for 5 to 10 minutes in the supine position before the test, keep fasting for four hours before the test, not drink alcoholic and caffeinated beverages in the 24 hours prior to the test, not perform intense physical activity and emptying the bladder at least 30 minutes before the assessment. In seconduida, they were positioned in dorsal decubitus, with arms and legs abducted, on the non-energy-conducting mobile. Two

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electrodes placed on the right foot, the distal electrode (black) at the base of the middle finger and the proximal electrode (red) above the ankle joint line, between the lateral and medial malleolus. And two electrodes placed on the right hand, the distal one at the base of the middle finger and above the wrist joint line, coinciding with the styloid process. Guided to remain barefoot, without socks and metal adornments attached to the body. (COMODO et al., 2009; GUEDES; GUEDES, 1998). Excess body fat was considered when the percentage of fat mass (%MG) was greater than 15%. (LOHMAN; ROCHE; MARTORELL, 1988).

A heart rate monitor (POLAR® - A300, Finland) was used for cardiovascular assessment, a pressure device (Omron 110, Omron®, Brazil) was used for BP measurement, and the recommendations of the VII Brazilian Hypertension Guideline were used to apply the technique. (2016). In the MS with the highest SBP, it was possible to calculate the pulse pressure (PP) (mmHg) defined by the difference between systolic and diastolic pressures, which shows a significant risk factor for the development of heart disease. Normality for PP is approximately 40 mmHg. (BLACHER et al., 2000; HOMAN; CICHOWSKI, 2018).

The ankle-brachial index (ABI) is calculated taking into account the relationship between the highest arterial pressures of the ankle and arm. (KAWAMURA, 2008), measuring the systolic pressures of the brachial artery (PSAB) and the posterior tibial artery (PSTP) bilaterally. This index allows classifying the degree of arterial obstruction, as follows: absent (>0.9), mild (0.71-0.90), moderate (0.41-0.70) and severe (0.00-0, 40). Figure 6 brings some considerations about the ITB. (BRAZILIAN ARTERIAL HYPERTENSION GUIDELINES, 2016; KAWAMURA, 2008; NEWMAN et al., 1993; NEWMAN, 2000).

The level of dyspnea and lower limb fatigue referred to rest, immediately after and 15 minutes after the intervention, was evaluated using the modified Borg scale (0-10), observed in Annex B, which was printed on paper and presented to the patient. subject to verbally and visually relate his symptoms to the scale presented. (BORG, 1982).

The indirect measurement of inspiratory and expiratory muscle strength, respectively, MIP and MEP, was performed using a manovacuometer. (BLACK; HYAT, 1969; NEDER et al., 1999).

Peripheral oxygen saturation was measured using a table oximeter (Morya, M1000, Brazil).

In continuation, spirometry was performed, SPIDA 5 (Micromedical, England), which measures the air entering and leaving the lungs, performed during slow breathing or during forced expiratory maneuvers. Spirometry is a test that helps in prevention and allows the diagnosis and quantification of ventilatory disorders. (MILLER et al., 2005; PEREIRA et al., 2002; I BRAZILIAN CONSENSUS ON SPIROMETRY, 1996).

After the evaluations, two envelopes were made available to the research participants, each containing the option for the formation of the groups, being them training with the use of the inspiratory resistor (DWR and IMT) or not (DWR). Figure 1 exemplifies the selection and intervention process.

After the evaluation and the drawing, the subjects were invited to enter the pool. The aquatic environment can cause bradycardia and, consequently, the differentiation of the exercise prescription in relation to the land is necessary. This change depends on the depth, temperature and body position adopted during the exercise (GRAEF; KRUEL, 2006). To determine the exercise intensity in the aquatic environment, it was necessary to calculate the maximum heart rate (HRmax), using the following equation (KARVONEN; KENTALA; MUSTALA, 1957).

Maximum heart rate = 220 – Age

Sequentially, from this result, the subjects, before starting the aquatic exercise, remained, at rest for five minutes, immersed with water level up to the manubrium of the sternum, in an orthostatic position. After this period, the HR was measured (Polar A300 frequency meter). This procedure allowed the identification of the HR delta (ΔHR) to calculate the HRmax in the water, for which the mathematical equation was used (GRAEF; KRUEL, 2006):

FCmax água = FCmax - ΔFC

The exercise was performed in the Unisagrado swimming pool, in deep water – 1.60 cm, water temperature between 32 and 35°C, a single session, lasting 45 minutes. The first five minutes were intended for the warm-up consisting of an independent walk (anterior, lateral and posterior) in the middle part of the pool (depth 1.20 cm).

The subjects were equipped with a Deep Runner pelvic vest and traditional shin guard (Floty®, Brazil) and moved to the deepest level of the pool (1.60 m). They had two minutes to familiarize themselves with the environment and perform the technique (learning period), then rest for 3 minutes so that, finally, 30 minutes of uninterrupted DWR could be performed, that is, continuous aquatic exercise, with an intensity of 50% HRmax Finally, 5 minutes of cool-down (deceleration of movements to gradually reduce HR) were added after the exercise.

In case of clinical complications through the process of evaluation and physical therapy intervention, the researchers kept in touch with the medical service that, if necessary, would be immediately called, by reference or summons, to attend to any cases of manifestation of adverse effects that were not effectively reversed by researchers and/or local professionals.

Data normality and homogeneity were verified using the Shapiro-Wilk and Levene tests, respectively. For the Variables with normal distribution, the two-way ANOVA test with mixed design seconded by Bonferroni's post hoc was used. For Variables with non-normal distribution, the Wilcoxon test was applied, used to compare the differences between the initial and final moments, and the Mann-Whitney test to compare the differences between the groups. The significance level was considered to be 5%. The software used was SPSS 20.

All subjects received verbal feedback about their physical condition after the final assessment.

RESULTS

Eleven volunteers took part in this study, three men (27.3%) and eight women (72.7%), six (54.5%) were white, three (27.3%) were Asian and two (18.2%) participants were of other races, five (45.5%) practiced physical activity. Regarding marital status, seven (81.8%) were single, one (9.1%) was married or in a stable relationship and one (9.1%) was divorced. About (90.9%) of the volunteers had no pre-existing pathologies and one (9.1%) reported being a smoker.

Graph 1 shows the distribution of the volunteers' professional activities.

Table 1 depicts the anthropometric measurements, body composition and initial sociodemographic data of the participants.

Table 2 presents the baseline cardiorespiratory variables of the volunteers.

Table 3 presents pre- and post-intervention respiratory data for the general sample technique.

There was no difference in respiratory variables before and after the intervention in the general sample.

Table 4 presents pre- and post-intervention

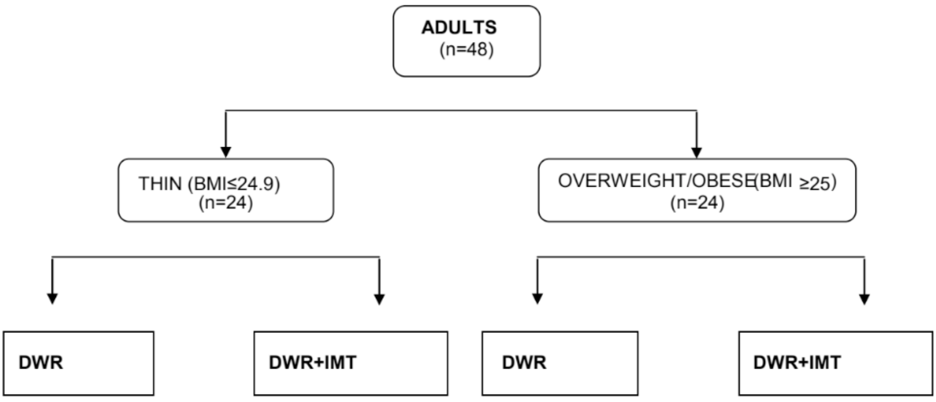
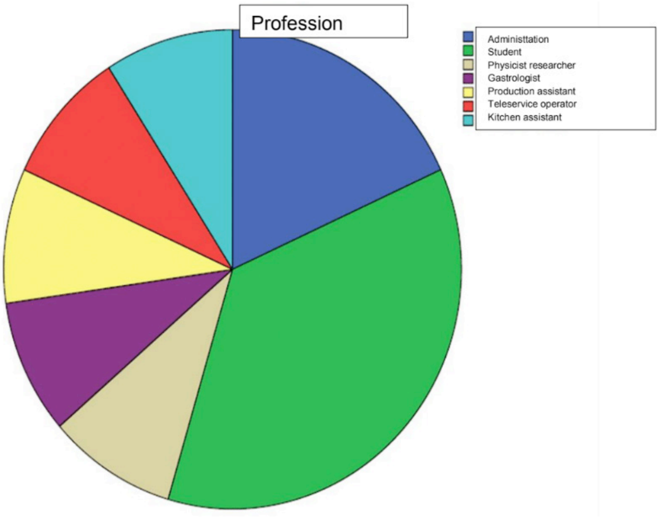


Figure 1 - Flowchart for selection and intervention of subjects.

Caption: BMI: body mass index; DWR: deep water running; IMT: inspiratory muscle training.

Prepared by the authors.



Graph 1 – Distribution of professions.

Source: Prepared by the authors (SPSS).

Variables	Valores
Age (years)	27,00±9,56
Height (m)	1,64±0,05
(kg)	69,86±9,68
IMC (Kg/m²)	25,21±7,47
Body fat (%)	30,09±6,20
Body fat (kg)	20,79±11,84
Lean mass (kg)	49,07±17,36
Metabolic rate	1491,0±528,01
Body weight (%)	49,70±5,22
Lean weight (%)	71,70±4,16

Caption: BMI: body mass index.

Table 1 - Anthropometric, body composition and sociodemographic data of the volunteers

Source: Prepared by the authors.

Variables	Valores
PAS (mmHg)	119,18±15,11
PAD (mmHg)	69,72±9,82
FC (bpm)	79,09±17,34
SpO_2 (%)	98,00±0,66
Borg (dyspnea)	0,09±0,31
ITB (mmHg)	1,04±0,07
PImax (cmH_2O)	79,72±31,02
PEmax (cmH_2O)	71,18±21,43
CVF (l)	3,20±0,95
VEF_1 (l)	2,66±1,06
VEF_1/CVF	82,45±19,31
PFE (l/min)	272,90±127,63
FEF (l/second)	3,00±1,40
FCtreino (bpm)	107,99±4,84

Caption: SBP: systolic blood pressure; DBP: diastolic blood pressure; HR: heart rate; SpO2: peripheral oxygen saturation; MIP: maximum inspiratory pressure; PEmax: maximum expiratory pressure; FVC: forced vital capacity; PEF: peak expiratory flow; FEF: forced expiratory flow; FEV1: forced expiratory volume in the first second.

Table 2 – Basal respiratory and cardiovascular variables of volunteers

Source: Prepared by the authors.

Variables	Before	After	P value
SpO_2 (%)	98,00±0,66	97,72±0,82	0,180
Borg (dyspnea)	0,09±0,31	1,18±2,78	0,059
PImax (cmH_2O)	79,72±31,02	80,09±30,73	0,721
PEmax (cmH_2O)	71,18±21,43	69,09±17,93	0,443
CVF (l)	3,20±0,95	3,24±0,92	0,289
VEF_1 (l)	2,66±1,06	2,73±1,06	0,371
VEF_1/CVF	82,45±19,31	83,81±20,42	0,674
PFE (l/min)	272,90±127,63	268,09±156,27	0,834
FEF (l/sec)	3,00±1,40	3,12±1,37	0,517

Caption: SBP: systolic blood pressure; DBP: diastolic blood pressure; HR: heart rate; SpO2: peripheral oxygen saturation; MIP: maximum inspiratory pressure; PEmax: maximum expiratory pressure; FVC: forced vital capacity; PEF: peak expiratory flow; FEF: forced expiratory flow; FEV1: forced expiratory volume in one second; FEV1/FVC: ratio between forced expiratory volume in one second and forced vital capacity

Table 3 – Comparison of Respiratory Variables Before and After the Intervention

Source: Prepared by the authors.

cardiovascular data for the general sample technique.

It can be seen that there was an increase of 9.09 bpm after the intervention in the general sample.

As for the division of groups for DWR, seven volunteers (63.6%) were allocated to the DWR group and four (36.4%) to the DWR+IMT group.

In Table 5 it is possible to identify the anthropometric, body composition and baseline sociodemographic characteristics according to the groups.

There were no statistically significant differences between the variables studied between the groups.

Table 6 represents the division of groups and their respective pre- and post-intervention data for the technique.

HR increased by 10 bpm after intervention in the DWR group (p=0.022).

There were no complications during the collection and intervention procedure.

DISCUSSION

The current main objective of this study was to compare the effect of the use of linear inspiratory support in subjects submitted to DWR.

The studied sample comprised young adults with body mass classification between normal and overweight, but with an increase in body fat percentage.

According to previous studies, DWR is a great therapeutic activity working on cardiovascular conditioning in young adults who are overweight, due to reduced joint overload and low risk of musculoskeletal injury. (KANITZ et al., 2014, SADEJA et al., 2019).

In the same way that the DWR, in isolation, promotes benefits, the use of linear respiratory incentive preserves respiratory muscle strength by decreasing dyspnea, increasing exercise tolerance and preventing pulmonary complications, according to Souza et al. (2014).

However, when submitting young adults to DWR and associating the implementation of inspiratory effort, it was not possible to notice acute cardiorespiratory changes.

On the other hand, in this sample, the DWR led to an increase in heart rate, a fact that was not observed in the DWR+IMT group.

DWR is used as an adjunct to training and conditioning. Maximum heart rate and oxygen consumption values in deep water runs have been consistently lower than those found during land running (KILLGORE, 2012).

The understanding of the HR behavior when performing the exercise in deep water and on the ground is already elucidated. The relationship between ratings of perceived exertion and heart rate achieved during tests of submaximal running on a treadmill and during deep water running was investigated in 12 male subjects. Heart rate and perceived exertion scores analyzed. While the heart rate slope for the classification of the regression equations of perceived exertion remained similar, the mean heart rate was 17 beats per minute lower in the deep water running condition than during treadmill running (HAMER; SLOCOMBE 1997). Furthermore, both stroke volume and cardiac output increase during immersion in water: an increase in blood volume largely compensates for the resting cardiac deceleration reflex. At submaximal exercise intensities, blood lactate responses to exercise during deep water running are elevated compared to treadmill running at a given oxygen consumption (VO2). While VO2, minute ventilation and heart rate decrease under maximal water exercise conditions, deep water running can be justified as an adequate stimulus for cardiovascular training. Aerobic performance

Variables	Before	After	P value
PAS (mmHg)	119,18±15,11	121,18±13,10	0,491
PAD (mmHg)	69,72±9,82	69,09±9,40	0,792
FC (bpm)	79,09±17,34	88,18±17,01	0,009*
ITB (mmHg)	1,04±0,07	1,01±0,02	0,445

Caption: SBP: systolic blood pressure; DBP: diastolic blood pressure; HR: heart rate; ABI: ankle brachial index. *: comparison between before and after ($p<0.05$).

Table 4 – Comparison of cardiovascular variables before and after the intervention

Source: Prepared by the authors.

	DWR (n=7)	DWR+IMT (n=4)
Age (year)	24,00 (19,26-39,89)	21,00 (16,62-28,38)
IMC (kg/m²)	23,40 (17,48-34,00)	24,15 (16,34-32,25)
Body fat (%)	30,20 (24,68-37,39)	28,95 (19,97-36,87)
Body fat (kg)	15,30(7,34- 35,05)	19,70 (13,35-26,79)
Lean mass (kg)	41,30(29,67-66,21)	54,55 (27,67-74,42)
Tax Metabolic	1254,00 (901,36-2013,20)	1658,00 (842,32-2262,17)
Body weight (%)	48,90 (44,01-55,55)	49,80 (43,85-55,29)
Body water	28,90 (21,70-46,15)	36,90 (20,80-49,79)
Lean weight (%)	72,80 (68,93-76,60)	68,75 (63,47-76,22)
Bioresistance	619,00 (528,72-710,69)	595,50 (395,18-875,31)

Caption: BMI: body mass index.

Table 5 - Anthropometric, body composition and baseline sociodemographic characteristics according to groups

Source: Prepared by the authors

	DWR (n=7)		DWR+IMT (n=4)	
	Initial	Final	Initial	Final
PAS (mmHg)	117,42±18,16	120,85±16,47	122,25±9,03	121,75±5,37
PAD (mmHg)	70,00±9,14	70,57±7,54	6,20±12,41	66,50±12,92
ITB (mmHg)	1,03±0,04	1,01±0,03	1,07±0,01	1,01±0,01
FC (bpm)	84,42±19,50	94,42±17,22*	69,75±7,67	77,25±10,99
SpO2 (%)	98,14±0,69	98,00±0,81	97,75±,050	97,25±0,50
Borg (dyspnea)	0,14±0,37	0,43±0,53	0,00±,0,00	2,50±4,35
PIMAX (cmH2O)	72,14±30,53	74,42±29,52	93,00±31,21	90,00±34,64
PEMAX (cmH2O)	71,00±18,82	69,14±14,25	71,50±26,14	69,00±25,79
CVF (l)	2,90±0,66	2,95±0,64	3,72±1,26	3,74±1,23
VEF1 (l)	2,38±0,91	2,41±0,91	3,15±1,25	3,30±1,21
VEF1/CVF	81,57±23,77	81,85±25,47	84,00±10,73	87,25±8,22
PFE (l/min)	289,00±144,57	258,14±159,42	244,75±104,09	285,50±173,01
FEF (l/sec)	2,81±1,37	2,86±1,27	3,34±1,59	3,57±1,60

Caption: * Intra-group comparison ($p<0.05$); BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure; HR: heart rate; SpO2: peripheral oxygen saturation; MIP: maximum inspiratory pressure; PEmax: maximum expiratory pressure; FVC: forced vital capacity; PEF: peak expiratory flow; FEF: forced expiratory flow; FEV1: forced expiratory volume in one second; FEV1/FVC: ratio between forced expiratory volume in one second and forced vital capacity.

Table 6 - Comparison between groups before and after the intervention

Source: Prepared by the authors.

is maintained with deep water running for up to 6 weeks in trained endurance athletes; sedentary individuals benefit more than athletes in improving maximal oxygen uptake (REILLY; DOWZER, 2003). Water immersion (WI) alone results in decreases in respiratory and cardiovascular parameters in young subjects immersed in water up to the neck. These decreases become more pronounced with exercise, so maximal oxygen consumption and HR are lower during DWR compared to floor running. Although differences in acute metabolic responses have been observed in several studies, the studies investigate the long-term repercussions, different from the current proposal (CHU; RHODES, 2001). Seventeen runners, adapted (n = 10) or non-adapted (n = 7) to running in deep water were submitted to experimentation. Runners adapted to deep water running experienced a smaller reduction in maximal oxygen consumption (VO2max) in deep water running compared to treadmill running than runners not adapted to deep water running.

Maximum oxygen consumption, maximum heart rate, maximum ventilation, VO2max at ventilatory threshold, heart rate at ventilatory threshold, and ventilation at ventilatory threshold were significantly higher during the treadmill than in deep water running. Thus, it is possible to know that the adaptation to running in deep water reduces the difference in VO2max between the two modalities, possibly due to an increase in muscle recruitment. The results of this study support previous findings of the expected physiological response (AZEVEDO et al., 2010).

Rictchie and Hopkins (1991) explain cardiovascular phenomena for deep water running by the cooling reflex or the increased venous return caused by immersion in water.

Notably, IMT does change cardiac modulation, however these findings involve different populations from the current study and, generally, prolonged training programs. Cutrim et al. (2019) proposed training at 30% PIMAX in 22 patients with chronic obstructive pulmonary disease. The intervention improved cardiac autonomic modulation with increased vagal modulation. IMT performed at low intensities can chronically promote increased parasympathetic modulation and/or reduced cardiac sympathetic modulation in patients with diabetes, hypertension, chronic heart failure and gastroesophageal reflux, when evaluated by spectral analysis of HRV (ABREU et al., 2017). Inspiratory muscle training (50% PIMAX) improves physical performance and cardiac autonomic modulation in elderly women (RODRIGUES et al., 2018). On the other hand, DeLucia, Asis and Bailey (2018) proposed daily IMR (75% PIMAX) and found a reduction in blood pressure and vascular resistance in healthy men and women, however, they found no change in HR.

Above all, in a systematic review and meta-analysis, Cipriano et al. (2019) point out the benefits of IMT on the cardiovascular system and conclude that IMT is an effective treatment for inspiratory muscle weakness in various populations and can be considered a complementary treatment to improve the cardiovascular system, especially HR and diastolic blood pressure.

It seems that IMT has a protective effect on cardiac responses in young adults undergoing DWR, however, the explanation for the maintenance of HR after exercise needs further investigation.

Some limitations were observed during the research due to restrictions imposed by the authorities during the COVID-19 pandemic, there was a delay in data collection and a reduction in the number of research participants due to the unavailability of the laboratory, as well as the fear of participating in the study. given that they must travel to the clinic, exposing themselves to the risk of contamination.

FINAL CONSIDERATIONS

DWR associated with IMT does not promote acute cardiorespiratory changes in young adults.

More studies with different protocols are needed to assess the effect of IMT in young adults.

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ANEXO A –

CENTRO UNIVERSITÁRIO
SAGRADO CORAÇÃO
UNISAGRADO

Plataforma Brasil

OPINION CONSTITUTED FROM THE CEP

RESEARCH PROJECT DATA

Research Title: Acute response to deep water running and linear load inspiratory exercise in overweight/obese and lean adults: a randomized trial

Researcher: Bruno Martinelli
Thematic Area:
Version: 2
CAAE: 14758719.8.0000.5502
Proposing Institution: University of the Sacred Heart - Bauru - SP
Main Sponsor: Universidade do Sagrado Coração - Bauru - SP

OPINION DATA

Opinion Number: 3,574,747

Project presentation:

rediated documents were presented in order to allow an adequate analysis of the research project

Research Purpose:

to investigate the influence of inspiratory muscle exercise combined with deep water aquatic exercise (DWR) in lean and overweight/obese adults.

Assessment of Risks and Benefits:

The risks are reported in the text, including, in your own words, tiredness, dyspnea, headache and clouding. however, to avoid these possible symptoms, the subjects will be seated, monitored by the devices and accompanied by the researchers. To reverse these symptoms, just rest and breathing control. These symptoms are transient and resolve in a few minutes, as reported. However, considering the proposed physical burden, it would be convenient for researchers to establish a protocol of care referred to cases in which such symptoms and signs do not re-emerge as expected. eventually, they get worse due to some intrinsic condition of the participant that it is not possible to predict with previous exams.

Address: Dean of Research and Graduate Studies
Neighborhood: Rua Irma Arminda No. 10-50 CEP: 17.011-160
State: SP Municipality: BAURU
Phone: (14)2107-7340 E-mail: comitedeeticadehumanos@usc.br

International Journal of Health Science ISSN 2764-0159 DOI 10.22533/at.ed.1592622213106

Continuation of the Opinion: 3,574,747

The benefits are specific to the area under study and very relevant.

Comments and Considerations on the Research:

The study is well designed and its proper application will allow the achievement of the intended results in the objectives.

Considerations on the Mandatory Submission Terms:

The ICF is well written and sufficiently detailed so that the potential participant can make a decision. The text uses very accessible terms, which facilitates the understanding of what is expected of the participant.

Recommendations:

the requested recommendations were met by the authors.

Conclusions or Pending and List of Inadequacies:

the study can be conducted

Final Considerations at the discretion of the CEP:

This opinion was prepared based on the documents listed below:

Document Type	File	Post	Author	Situation
Project Basic Information	PB_INFORMAÇÕES_BASIC_DO_PROJETO 1357651.pdf	26/06/2019 15:21:58		Accepted
Detailed Project / Investigator Brochure	DWRproject26jun19.pdf	26/06/2019 15:19:59	Bruno Martinelli	Accepted
ICF / Terms of Assent / Justification of Absence	TERMOCLE26jun19.pdf	26/06/2019 15:17:58	Bruno Martinelli	Accepted
cover sheet	SIGNED Facesheet.pdf	23/05/2019 16:55:28	Bruno Martinelli	Accepted
Budget	BUDGET.pdf	15/05/2019 17:41:19	Bruno Martinelli	Accepted
Timeline	SCHEDULE.pdf	15/05/2019 17:41:03	Bruno Martinelli	Accepted

Opinion Status:
Approved

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International Journal of Health Science ISSN 2764-0159 DOI 10.22533/at.ed.1592622213106

ANEXO B - QUESTIONÁRIO DE ATIVIDADE FÍSICA - IPAQ ADULTOS (MATSUDO ET AL., 2001)

Attachment
International Physical Activity Questionnaire - IPAQ
Long form, usual/normal week, adapted by Benedetti et.al. (12)

The questions are related to the time you spend doing physical activity in a normal/usual week.

To answer the questions remember that:

- Vigorous physical activities are those that require a lot of physical effort and make you breathe much harder than normal.
- Moderate physical activities are those that require some physical effort and make you breathe a little harder than normal.
- Light physical activities are those in which physical exertion is normal, causing breathing to be normal.

OF QUESTIONS 1B to 4C THE TABLE BELOW MUST BE AVAILABLE FOR COMPLETION

Day of the week	Day of the week
Time hours/min morning afternoon night	time hours/min
2nd Wednesday	morning afternoon night
tuesday	friday
wednesday	Saturday

DOMAIN 1-PHYSICAL ACTIVITY AT WORK: This domain includes the activities you do in your paid or volunteer work, and college or school activities (intellectual work) Not including housework, gardening and housekeeping or taking care of from your family. These will be included in Domain 3.

1st Do you currently have a paid occupation or do you volunteer outside your home?

(Yes ( ) No - If you answer no, go to Domain 2: Transport

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The next questions relate to all the physical activity you do in a normal/usual week, as part of your paid or volunteer work. Do not include transportation to work. Think only of those activities that last at least 10 continuous minutes within your work:

1b. How many days and how long (hours and minutes) during a typical week do you do VIGOROUS activities such as: heavy construction work, lifting and transporting heavy objects, chopping wood, sawing wood, cutting grass, painting a house, digging ditches or holes, climbing stairs as part of your paid or volunteer work, for at least 10 CONTINUOUS MINUTES?

____hours.____min.____days per week ( ) None. Go to question 1c.

1c. How many days and how long (hours and minutes) during a typical week do you do MODERATE activities, such as: lifting and carrying small objects washing clothes with your hands, cleaning windows, sweeping or mopping the floor, carrying children on your lap, as part of the your paid or voluntary work, for at least 10 CONTINUOUS MINUTES?

____hours___min.___ days a week ( ) None. Go to question 1d.

1d. How many days and how much time (hours and minutes) during a typical week do you WALK, IN YOUR PAID OR VOLUNTEER WORK FOR AT LEAST 10 CONTINUOUS MINUTES? Please do not include walking as a means of transport to and from work or the place where you are volunteering.

___hours___ min. ___days per week ( ) None. Go to Domain 2 Transport

DOMAIN 2-PHYSICAL ACTIVITY AS A MEANS OF TRANSPORT

These questions are about the normal way you move from place to place, including your seniors group, church, supermarket, work, movie theater, shops, and others.

2nd How many days and how long (hours to minutes) during a typical week do you RIDE BY BUS AND CAR/MOTOR?
__hours ___min. ___ days per week ( ) None. Go to question 2b.

Now just think about walking or cycling to get from one place to another in a typical week.

2b. How many days and how long (hours and minutes) during a typical week do you RIDE A BIKE to get from one place to another for at least 10 continuous minutes? (Does not include cycling for leisure or exercise)
____hours ____min.____days per week ( ) None. Go to question 2d

2c. How many days and how long (hours and minutes) during a normal week do you WALK to go from one place to another, such as: going to the elderly group, church, supermarket, doctor, bank, visiting a friend, neighbor and relatives for at least 10 continuous minutes? (DO NOT INCLUDE Leisure Walks or Physical Exercise)

____hours____min _____days a week ( ) None. Go to Domain 3

DOMAIN 3- PHYSICAL ACTIVITY AT HOME OR APARTMENT: WORK, HOUSEHOLD TASKS AND CARING FOR THE FAMILY

This part includes the physical activities you do in a normal/usual week in and around your house or apartment. For example: housework, taking care of the garden, taking care of the yard, house maintenance work and to take care of your farmia. Again, think only of those physical activities lasting at least 10 continuous minutes.

3a. How many days and what time (hours and minutes) during a typical week do you do VIGOROUS PHYSICAL ACTIVITIES AROUND YOUR HOUSE OR APARTMENT (BACKYARD OR GARDEN) such as: hoeing, chopping wood, sawing wood, painting the house, lifting and transporting objects heavy cutting grass for at least 10 CONTINUOUS MINUTES?

____hours ____min ____days a week ( ) None Go to question 3b

3D How many days and how long (hours and minutes) during a typical week do you do MODERATE activities around your house or apartment (garden or backyard) such as: lifting and carrying small objects, cleaning the garage, gardening in general, for at least 10 continuous minutes?

___hours, ___min. ____days a week ( ) None. Go to question 3c

3c. How many days and how much time (hours and minutes) during a typical week do you do MODERATE activities INSIDE your house or apartment such as: carrying light weights, cleaning windows and/or windows, washing clothes by hand, cleaning the bathroom and the floor, for example at least 10 continuous minutes?

___hours ____min.____ days per week () None. Go to Domain 4.

DOMAIN 4- PHYSICAL RECREATION, SPORT, EXERCISE AND LEISURE ACTIVITIES

This domain refers to the physical activities you do in a normal/usual week solely for recreation, sport, exercise or leisure. Again, just think about the physical activities you do for at least 10 minutes straight. Please do not include activities that you have already mentioned.

4a Not counting any walks you mentioned earlier, how many days and how long (hours and minutes) during a typical week, you CAMI. NHA (physical exercise) in your spare time for AT LEAST 10 CONTINUOUS MINUTES
____hours. ___min.___ days per week () None. Go to question 4c.

4b. How many days and how much time (hours and minutes) during a normal week do you do VIGOROUS activities in your free time such as: running, fast swimming, weight training, canoeing, rowing, in short, sports in general for at least 10 continuous minutes?

____hours ___min. ____days a week ( ) None. Go to question 4d.

4c. How many days and how long (hours and minutes) during a typical week do you do MODERATE activities in your free time such as: cycling at a moderate pace. play recreational volleyball, do water aerobics, gymnastics for seniors, dance for at least 10 continuous minutes?

____hours ,___min____days a week ( ) Nerhum. Go to Domain 5.

DOMAIN 5-TIME SPENT SITTING

These last questions are about the time you spend sitting in different places, for example: at home, in the elderly group, in the doctor's office and others. This includes sitting time while resting, watching television, doing crafts, visiting friends and relatives, reading, making phone calls, and eating meals. Do not include time spent sitting during transport by bus, car, train and subway
5th How much time, in total, do you spend sitting during A typical weekday?

ONE DAY___hours___minutes.

Day of the week One day	time hours/min Morning afternoon night

5b. How much time, in total, do you spend sitting during A typical weekend DAY?
____ONE DAY _____hours _____minutes

end of week One day	time hours/min Morning afternoon night

Matsudo S, Araujo T, Marsudo V, Andrade D, Andrade E, Oliveira LC, et al. International Physical Activity Questionnaire (IPAQ): Validity and reproducibility study in Brazil. Brazilian Magazine about Physical Activity and Health. 2001;6(2):5-18

APPENDIX A - FREE AND INFORMED CONSENT FORM

Project title: Acute response to deep water running and linear load inspiratory exercise in overweight/obese and lean adults: a randomized trial.

Researcher name: Profº Dr. Bruno Martinelli.

Address: Street: Maria José, 11-75. Bauru/SP. Tel: 21077056 / (014)991340994.

Research place: Clínica de Fisioterapia da Universidade do Sagrado Coração. Street: Irmã Arminda, 10-50, Zip code: 17011-160, Jd Brasil, Bauru/SP.

Research goal: To investigate the influence of inspiratory muscle exercise combined with deep water aquatic exercise (DWR) in lean and overweight/obese adults.

What will be done: Through this we clarify that the subjects will be evaluated through non-invasive devices (which do not puncture or injure the body) obtaining information about the Weight and Height of the body, heartbeat, blood pressure in the vessels, amount of air in the lungs, amount of oxygen in the blood, amount of difficulty breathing both before starting the exercise and after exercising in the pool, and the strength of the muscles that help to fill the lung with air will also be evaluated. Devices to assess the amount of air and the strength of the breathing muscles are small and will be placed in the individual's mouth and asked to breathe into them, sometimes fast and hard and other times slowly. Another device is a bag that will wrap around the arm to measure blood pressure. A device, similar to a clothespin, will be attached to one of the fingers of the hand, which will measure the oxygen in the blood. A chest strap will be placed to measure your heart rate. There will be a lottery to determine who will do the exercise in the pool along with another device that forces breathing. This device is small and will be connected to the mouth throughout the exercise and the nose will be closed by means of a nose clip. All subjects who will participate in this study will be evaluated and will be aware of their respiratory and cardiovascular health status. It will only be an exercise session, for that, the subjects will have to wear a bathing suit and will have to walk alone in the pool and do the exercise at the bottom of the pool, simulated running, with equipment that allows the body to float in the water. This study will contribute to the field of physiotherapy by understanding the responses that will occur in thin and fat subjects who do breathing exercise together with exercise in water. In addition, the subject who participates in this research will have information about their physical and respiratory condition.

Safety and expenses: To ensure the safety of the participants involved in the study, the procedures used will be in accordance with ethical standards (Resolution 466/2012), guaranteeing confidentiality and privacy. In addition, there will be no financial expenses resulting from the participation of the subjects in the study, neither by the participants nor by the researchers.

These procedures cause small risks during the assessment and intervention of the subject participating in the study. If there is any intercurrence, the researchers will be responsible for reversing such acute symptoms resulting from the evaluation and intervention. The main discomforts that can occur are: tiredness, shortness of breath, headache and dizziness, but to avoid these possible symptoms, the subjects will be seated, monitored by the devices and accompanied by the researchers. To reverse these symptoms, just rest and breathing control. These symptoms are fleeting and remedied in a few minutes.

Participation: there is no obligation to participate in this study, and your withdrawal can occur at any time and will not entail any commitment to other treatments performed or to be performed.

Therefore, we, the researchers, request your consent to participate in this research, in accordance with the conditions mentioned in this document. If more information is needed, it is suggested to contact the researchers or those responsible for the study (see contact information at the beginning of this document), who will provide clarification.

I certify that I have read and read this consent form and that I understand its content. My signature shows that I have freely agreed to participate in this study.

Yours sincerely,

Advisor:

____

Bruno Martinelli

____

Researcher

I agree with the proposal presented.

____

Signature of the subject participating in the research

Bauru, ______, _______________20__.

APPENDIX B - DYSPNEA SCALE - MODIFIED BORG

0	None
0,5	very very light
1	Very light
2	Light
3	Moderate
4	Little intense
5	Intense
6	
7	Very intense
8	
9	Very very intense
10	Maximum