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EFFECTS OF AQUATIC INTERVAL AEROBIC TRAINING ON FUNCTIONAL FITNESS AND CARDIOVASCULAR HEALTH OF MIDDLE-AGED ADULTS: A PILOT STUDY

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Abstract

Bachground: Aquatic training can improve the health of adults and seniors. However, it still lacks elucidation about the controlled and periodized prescription.

Goal: To verify the effect of 12 weeks of structured and monitored aerobic interval training on functional and cardiovascular outcomes in middle-aged adults.

Methods: A pilot study, with 12 weeks of intervention, 3 weekly sessions of 50 minutes duration. Participants of both sexes, between 30 and 80 years old, were recruited. Was collected the 30-s arm curl test, 30-s chair stand test, 8-foot Up and Go test (8UG) and 6-minute walk (6MWT), blood pressure (BP), heart rate rest (HRR) and quality of life (WHOQOL-8). Training was prescribed with 4 mesocycles of 3 weeks each, with linear progression in volume (duration), density (relation stimulus: recuperation) and intensity (rating perceived effort).

Results: Participated od this study thirteen middle-aged adults (58.54±4.67 years old) with 56.50 ± 17.29% adherence to training. After 12 weeks, was found improvement in the 30-s arm curl test (Δ%: 19.13), 8UG (Δ%: 6.9), diastolic BP (Δ%: 11.5) and HRR (Δ%: 12.2).

Conclusion: The practice of 12 weeks of aerobic interval training were able to improve upper limb strength, functional cardiorespiratory fitness and generate cardiovascular changes in middle-aged adults.

Keywords: Aquatic exercise, Middle aged, Physical fitness, Blood pressure, Exercise.

Resumen

Antecedentes: El entrenamiento acuático puede mejorar la salud de adultos y personas mayores. Sin embargo, todavía falta dilucidación sobre la prescripción controlada y periodizada.

Objetivo: verificar el efecto de 12 semanas de entrenamiento interválico aeróbico estructurado y monitorizado sobre los resultados funcionales y cardiovasculares en adultos de mediana edad.

Métodos: Un studio piloto, con 12 semanas de intervención, 3 sesiones semanales de 50 minutos de duración. Se reclutaron participantes de ambos sexos, entre 30 y 80 años. Se recogieron las pruebas de flexión de brazos de 30 s, prueba de reposo en silla de 30 s, prueba de 8 pies Up and Go (8UG) y caminata de 6 minutos (6MWT), presión arterial (PA), frecuencia cardíaca en reposo (FCR) y calidad. de vida (WHOQOL-8). El entrenamiento se prescribió con 4 mesociclos de 3 semanas cada uno, con progresión lineal en volumen (duración), densidad (relación estímulo: recuperación) e intensidad (calificación del esfuerzo percibido).

Resultados: Participaron de este estudio trece adultos de mediana edad (58,54±4,67 años) con 56,50±17,29% de adherencia al entrenamiento. Después de 12 semanas, se encontró mejoría en la prueba de curl de brazos de 30 s (Δ%: 19,13), 8UG (Δ%: 6,9), PA diastólica (Δ%: 11,5) y HRR (Δ%: 12,2).

Conclusión: La práctica de 12 semanas de entrenamiento interválico aeróbico logró mejorar la fuerza de los miembros superiores, la aptitud cardiorrespiratoria funcional y generar cambios cardiovasculares en adultos de mediana edad.

Palabras clave: Ejercicio acuático, Edad media, Aptitud física, Presión arterial, Ejercicio.

Resumo

Introdução: O treinamento aquático pode melhorar a saúde de adultos e idosos. Contudo, ainda faltam esclarecimentos sobre a prescrição controlada e periodizada.

Objetivo: Verificar o efeito de 12 semanas de treinamento aeróbico intervalado estruturado e monitorado sobre os resultados funcionais e cardiovasculares em adultos de meia-idade.

Métodos: Um estudo piloto, com 12 semanas de intervenção, 3 sessões semanais de 50 minutos de duração. Foram recrutados participantes de ambos os sexos, com idade entre 30 e 80 anos. Foram coletados os testes de flexão de cotovelo, sentar e levantar, 8-foot Up and Go test (8UG) e caminhada de 6 minutos (TC6), pressão arterial (PA), frequência cardíaca de repouso (FCR) e qualidade de vida. O treinamento foi prescrito com 4 mesociclos de 3 semanas cada, com progressão linear em volume (duração), densidade (relação estímulo:recuperação) e intensidade (classificação deesforço percebido)

Resultados: Participaram deste estudo treze adultos de meia idade (58,54±4,67 anos) com 56,50±17,29% de aderência o ao treinamento. Após 12 semanas, foi encontrada melhora significativa no teste de flexão de cotovelo em 30 segundos (Δ%: 19,13), 8UG (Δ%: 6,9), PA diastólica (Δ%: 11,5) e FCR (Δ%: 12,2).

Conclusão: A prática de 12 semanas de treinamento aeróbio intervalado foi capaz de melhorar a força de membros superiores, a aptidão cardiorrespiratória funcional e gerar alterações cardiovasculares em adultos de meia-idade.

Palavras-chave: Exercício aquático, Meia idade, Aptidão física, Pressão arterial, Exercício.

Introduction

For successful aging, promoting physical exercise during middle age is important (Szychowska & Drygas, 2022). The physical behavior adopted during this period may reflect on the behavior during the next phase of life. This was observed in the study of Chen et al. (2022), who followed men and women for 20 years and reported that physically active middle-aged individuals tend to remain in the practice of physical activity during old age.

However, several barriers can compromise a healthy lifestyle (Herazo-Beltrán et al., 2017), as well, as preferences need to be taken into account (Amireault et al., 2019). In this perspective, different possibilities are offered, among them, aquatic activities in upright position have gained popularity, due to their thermal and mechanical properties, which allow mitigating articulation overload and providing beneficial changes in the cardiac, respiratory, renal and hormonal systems (Carregaro & Toledo, 2008; Pendergast et al., 2015), in addition to being recommended for individuals with different clinical conditions (Bailly et al., 2022; Faíl et al., 2022).

Several meta-analyses have demonstrated the positive impacts of the aquatic training on adults and elderly people with and without pre-established chronic diseases, generating improvements in muscle strength (Prado et al., 2022), functional capacity (Waller et al., 2016), and aerobic capacity and flexibility (Saquetto et al., 2022), in addition to significant reductions in the lipid and glycemic profile (Delevatti et al., 2015), with improvements in the worsening of cardiometabolic diseases in aging (Leonel et al., 2023; Reichert et al., 2018), making the aquatic environment an important alternative for carrying out physical training.

Aquatic exercise programs in upright position have been popular and sought after by middle-aged and elderly audiences for decades, however, these programs are sometimes just a set of exercises performed in water, with or without music, in shallow or deep water which involves any type of physical exercise performed immersed, without suitable structuring and control of training variables (Moreira et al., 2019; Neiva et al., 2018; Silva et al., 2019; Waller et al., 2016). Althought there are increasing advances in scientific studies in this área, there is still a lack in the prescription, monitoring of internal and external load in periodization models that modulate volume and intensity, in a pragmatic perspective. It is necessary a movement of transfer the important scientific findings of aquatic exercise area for reality of gyms aquatic, being important studies performed in a “real world”, which consider the practical challenges in several income situations, as lack of equipment to evaluate participants and for monitoring the intensity prescription during the classes. Given this, the present work aims to verify the effect of 12 weeks of structured and monitored aerobic interval training on functional and cardiovascular outcomes in middle-aged adults.

Methods

Study design

This is a pilot study, with the aim of verifying the effect of an aerobic training program in an aquatic environment in upright position.

Participants

Participants in the extension program of aquatic activities in an upright position, linked to the Universidade Federal de Santa Catarina (UFSC) enrolled in the 2022.1 semester, were invited to participate in this work. As eligibility criteria, participants had to be between 30 and 80 years of age, of both sexes and have medical authorization to practice physical exercise and not have musculoskeletal limitations that could aggravate any physical condition or compromise the proper performance of the exercises. All participants signed the free and informed consent form and the study was approved by the Research Ethics Committee for Human Beings (5.510.243) and registered in the Brazilian Registry of Clinical Trials (RBR-2txw8zy).

Intervention

Given the scenario in which the participants of this study found themselves, coming from a post-pandemic period and after long detraining (more than 3 months), 3 familiarization sessions with the aquatic environment were carried out prior to the training program, with the aim of understanding the technique performing the exercises and using the Borg Perceived Exertion Scale (6 to 20). The training was carried out for 12 weeks, with three weekly sessions, on non-consecutive days (Monday, Wednesday and Friday). All sessions were taught and supervised by physical education professionals or by a student specifically selected for the training program.

Each training session lasted 50 minutes, divided into a warm-up period (5-10 minutes), followed by the main part (30 to 36 minutes) and ended with relaxation and/or stretching (5 minutes). The main part consisted of interval aerobic exercise in the upright position, through hydrogymnastics and/or walking/running in a deep pool. The training intensity was prescribed according to the Subjective Perceived Exertion (RPE) from 6 to 20 (Borg, 1982).

Regardless of the modality (hydrogymnastics and jogging) the training program was structured with 4 mesocycles of 3 weeks each. The first two mesocycles consisted of 1 minute of execution at higher intensity and 1:30 minutes at a lower intensity (1:1.5), with a total duration of 30 minutes. From the third mesocycle onwards, there was an increase in training density and volume, with a total duration of the session lasting 36 minutes and with a stimulus:recovery ratio of 1 minute each (1:1). In the last mesocycle, the training intensity was also increased. In the jogging, the movement technique remained the same, details in Table 1.

Table 1. Periodization characteristics of interval aerobic training in jogging.

Mesocycle	Week	Training sessions	Duration (main part)
1	1-3	12 x (1min 30s RPE 11 and 1 min RPE 13)	30 min
2	4-6	12 x (1min 30s RPE 11 and 1 min RPE 15)	30 min
3	7-9	18 x (1 min RPE 11 and 1min RPE 15)	36 min
4	10-12	18 x (1 min RPE 13 and 1min RPE 15)	36 min

Note: min= minutes; RPE: Rating of perceived effort; s= seconds.

In the sessions in which the hydrogymnastics modality was prescribed, 6 exercises were performed in the following order: stationary running, posterior elevation, frontal kick, hip adduction and abduction, frontal sliding and posterior running. Each exercise was performed at stimulus and recovery intensity to move on to the next exercise. The execution of the 6 exercises was counted as a block, more details prescription (Table 2).

Table 2. Periodization characteristics of interval aerobic training in hydrogymnastics.

Series block	Exercise	Execution time	RPE
		Mesocycle I (Week 1-3)	
2x	Stationary running	1 min 30s	11 (light)
		1 min	13 (somewhat hard)

	Posterior elevation	1 min 30s	11 (light)
		1 min	13 (somewhat hard)
	Frontal Kick	1 min 30s	11 (light)
		1 min	13 (somewhat hard)
	Hip adduction and abduction	1 min 30s	11 (light)
		1 min	13 (somewhat hard)
	Frontal sliding	1 min 30s	11 (light)
		1 min	13 (somewhat hard)
	Posterior running	1 min 30s	11 (light)
		1 min	13 (somewhat hard)
Mesocycle II (Week 4-6)			
2x	Stationary running	1 min 30s	11 (light)
		1 min	15 (hard/heavy)
	Posterior elevation	1 min 30s	11 (light)
		1 min	15 (hard/heavy)
	Frontal Kick	1 min 30s	11 (light)
		1 min	15 (hard/heavy)
	Hip adduction and abduction	1 min 30s	11 (light)
		1 min	15 (hard/heavy)
	Frontal sliding	1 min 30s	11 (light)
		1 min	15 (hard/heavy)
	Posterior running	1 min 30s	11 (light)
		1 min	15 (hard/heavy)
Mesocycle III (Week 7-9)			
3x	Stationary running	1 min	11 (light)
		1 min	15 (hard/heavy)
	Posterior elevation	1 min	11 (light)
		1 min	15 (hard/heavy)
	Frontal Kick	1 min	11 (light)
		1 min	15 (hard/heavy)
	Hip adduction and abduction	1 min	11 (light)
		1 min	15 (hard/heavy)
	Frontal sliding	1 min	11 (light)
		1 min	15 (hard/heavy)
	Posterior running	1 min	11 (light)
		1 min	15 (hard/heavy)
Mesocycle IV (Week 10-12)			
3x	Stationary running	1 min	13 (somewhat hard)
		1 min	15 (hard/heavy)
	Posterior elevation	1 min	13 (somewhat hard)
		1 min	15 (hard/heavy)
	Frontal Kick	1 min	13 (somewhat hard)
		1 min	15 (hard/heavy)
	Hip adduction and abduction	1 min	13 (somewhat hard)
		1 min	15 (hard/heavy)
	Frontal sliding	1 min	13 (somewhat hard)
		1 min	15 (hard/heavy)
	Posterior running	1 min	13 (somewhat hard)
		1 min	15 (hard/heavy)

Note: min= minutes; RPE: Rating of perceived effort Borg Scale 6-20; s= seconds; x: series.

Sample characterization measures

To characterize the participants, an initial anamnesis with sociodemographic information, health conditions and physical activity practice was applied. The collects of anthropometric characteristics followed the procedures reported by Lohman et al. (1988). Body mass and height were collected using a digital scale with a precision of 100 grams (Marte®, modelo PP 180), and a stadiometer with a precision of 1 millimeter (AlturaExata®), respectively. The ratio between total body mass and height squared was used to calculate the Body Mass Index (BMI) represented by kg/m². In addition, the waist-to-height ratio was also calculated using the ratio between waist circumference (cm) and height (cm).

Outcome measures

Functional fitness, quality of life, capillary blood glucose, blood pressure and resting heart rate were evaluated before and after 12 weeks of training. Training control parameters were also collected through internal and external load.

As primary result, functional fitness was assessed using the Rikli and Jones battery of tests (Rikli & Jones, 2013). In summary, the resistance and strength of the dominant upper limb was evaluated through a 30-s arm curl (4 kg for men and 2 kg for women), the resistance and strength of the lower limbs was performed through the 30-s chair stand, functional mobility was assessed using the 8-foot Up and Go test (8UG), and cardiorespiratory endurance through the 6-minute walk test (6MWT). For the evaluations, the participants were instructed to wear suitable clothes and received instructions on how to perform each test. Once familiarized, the evaluation was performed following the sequence mentioned above.

To assess the quality of life, the instrument was used WHOQOL-8 (Fleck et al., 2000). This instrument is self-administered, cross-culture translated and validated into Portuguese, consisting of 8 questions. Its score varies between zero and 32 points, with questions about the global quality of life and general perception of health, in addition to questions related to the physical, psychological, social relationships and environment domains.

In the collection of capillary blood glucose, a digital puncture procedure was performed with a clinical glucometer (Accu-CheckPerforma, Roche, Portugal), with the aid of disposable lancets (Accu-Check Safe-T-Pro Uno, Roche, Portugal) and a drop of capillary blood, which made it possible to assess the concentration of blood glucose at the moment. Resting systolic (SBP) and diastolic (DBP) blood pressure were measured using automatic equipment (OMRON, model HEM-7113, Brazil) after the participants remained at rest, sitting in a calm environment, for 10 minutes. Resting heart rate was measured after 10 minutes of rest, using a portable heart rate meter (Polar®, S810i) positioned on the wrist of the participants.

Training load measures were collected at the end of the first and last session of the training program. Internal load (IL) was collected using the modified Borg CR10 scale (Foster et al., 2017) in order to evaluate the intensity individually. For this evaluation, each participant had to answer, individually, the following question: "How was your training today?". The answer was given through the descriptor in the table, linked to a numerical value from zero to 10 (zero corresponding to no effort and 10 to maximum exertion). The internal training load was calculated by multiplying the RPE score by the total duration of the session expressed in minutes (including warm-up, cool-down and rest between efforts) expressed in arbitrary units (AU) (Nakamura et al., 2010). The external load (EL) was given by the number of repetitions performed in the last exercise (Posterior running) of the last session of the training block, in hydrogynastics and in jogging, the distance covered in the pool. These repetitions were counted by the students themselves, who at the end of the series, individually, passed on the information to the coaches.

Statistical analysis

The sample was characterized with variables of age, sex, BMI, Waist-to-Height Ratio and health status with presence of systemic arterial hypertension and dyslipidemia. Continuous variables were expressed as mean and standard deviation and categorical variables as absolute and relative frequency.

For the analysis of the study outcomes, the Shapiro-Wilk test was applied to assess the normality of the data. Once normality was identified, the paired Student's t test was applied for pre- and post-intervention comparisons. The effect size was calculated using the Cohens'd (Cohen, 1988) and classified as: 0.20 > d < 0.50 – small; 0.50 > d <0.80, mean and; d ≥ 0.80 – large. The significance level adopted was 0.05. All these analyzes were performed using SPSS, version 21.0 (IBM Corp., Armonk, NY, EUA).

Results

Started the training program 21 participants of both sexes, however, after some withdrawals due to personal reasons, only 13 participants completed the intervention. Of these participants, 5 reported using some medication, such as diuretics, beta-blockers and angiotensin-converting enzyme (ACE) inhibitors.

Thirty-five training sessions were planned, in which participants completed 19.61±6.18 sessions. Adherence to the training program was 56.50±17.29%, however, it is worth mentioning that 4 participants achieved adherence equal to or greater than 70%. No adverse effects to training were reported, although some participants complained of pain and/or musculoskeletal limitation, which disappeared during training. In Table 3 are the sociodemographic and health characteristics of the participants.

Table 3. Characteristics of the participants (n=13).

Variables	$\bar{X}$ (±sd)
Age (years)	58.54±4.67
BMI (kg/m²)	28.46±4.44
Waist-to-Height Ratio	0.55±0.06
	n (%)
Sex (female)	10 (76.9%)
Presence of systemic arterial hypertension	5 (38.5%)
Presence of dyslipidemia	5 (38.5%)

Note: BMI= body mass index; $\bar{X}$ = average; sd= standard deviation; n= absolute frequency; %= relative frequency.

After a period of 12 weeks of aerobic training in the aquatic environment, there was a significant improvement in the 30-s arm curl and 6MWT scores, as well as a significant reduction in DBP and heart rate resting (HRR) of the participants. Table 4 describes all functional fitness, quality of life and cardiometabolic measures.

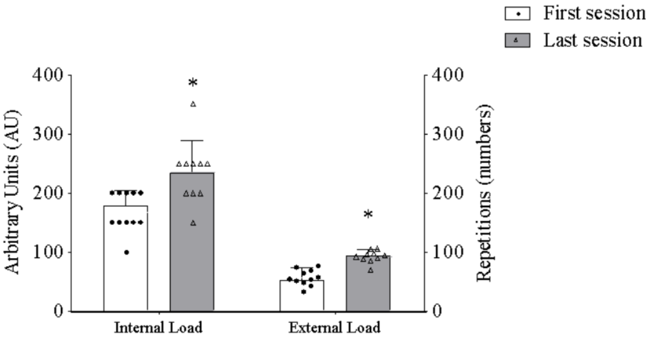
Table 4. Effects of aquatic training in upright position before and after 12 weeks of intervention (n=13).

Variables	Before $\bar{X}$ (±sd)	After $\bar{X}$ (±sd)	*Cohen's d*	p value
30-s chair stand (reps)	14.81±3.21	16.81±3.25	0.61	0.073
30-s arm curl (reps)	16.46±4.33	19.61±4.50	0.71	0.007*
8UG (s)	6.02±1.32	5.69±8.15	0.05	0.213
6MWT (meters)	563.07±90.36	601.90±66.18	0.49	0.016*
WHOQOL-8 (points)	29.14±2.90	31.00±2.28	0.71	0.095
Capillary blood glucose (mg/dl)	111.10±16.15	103.10±7.66	0.63	0.190
SBP (mmHg)	118.60±12.35	114.21±9.39	0.40	0.261
DBP (mmHg)	78.86±9.44	70.25±9.98	0.88	0.001*
HRR (bpm)	79.38±9.48	69.69±11.42	0.92	0.006*

Note: 8UG= 8-foot Up and Go test; 6MWT= 6-minute walk test; bpm=beats per minute; DBP= diastolic blood pressure; HRR= heart hate resting; reps=repetitions; s=seconds; SBP= systolic blood pressure; $\bar{X}$ = average; sd= standard deviation; *= p<0.05

In Figure 1 are expressed the means and standard deviation in group and individual values of the internal and external training load. Both types of loads showed a significant increase after 12 weeks of aquatic training (IL = First session: 177.78±26.35 AU; last session: 233.33±55.90 AU; p=0.030/ EL =First session: 51.10±22.27 repetitions; last session: 93.30±10.33 repetitions; p<0.001).

Figure 1. Participants averages and individual values of internal and external load of the first and last training session.



Note: Internal training load represented by the left y-axis in arbitrary measures; External training load is represented by the right y-axis in number of repetitions of the posterior running exercise; *= p<0.05 pre vs post.

Discussion

The aim of the present polit study was to verify the effect of 12 weeks of structured and monitored aerobic interval training on functional and cardiovascular outcomes in middle-aged adults. As main findings, despite the low dose of exercise, there was an improvement in the muscular resistance of the upper limbs and cardiorespiratory conditioning, as well as a reduction in the participants' DBP and HRR.

Although adherence to the training program was approximately 56%, it is worth highlighting that these improvements in different functional and cardiovascular outcomes have great clinical relevance, given the natural decline of organic functions in the continuous aging process (Valenzuela et al., 2019). The reduction of physical capacity, for example, leads to the impossibility of performing activities of daily living (Gomes et al., 2020), increased blood pressure exposes individuals to the risk of cardiovascular events (Kokkinos, 2014), while increased HRR is associated with heart failure in the general population (Böhm, Bewarder, et al., 2020).

In this scenario, interventions that promote the improvement of different body functions are important and necessary (Valenzuela et al., 2019). In our study, we observed an improvement of 19.13% in the performance of the 30-s arm curl, which demonstrates the influence of the training in gaining strength and muscular endurance of the upper limbs. This result is of great clinical relevance, since in our study the upper limbs only accompanied the movement, and no specific training was prescribed for gains in this muscle group. In addition, in the land environment, it is necessary to prescribe specific training in order to have significant improvements in the upper limbs (Wu et al., 2023). This positive effect found in our study is related to the increase in resistance created by the water in upper limb movements, together with an increase in intensity, which contributed to generate positive neuromuscular adaptations, improving the strength and functional capacity of the participants.

In studies that prescribed interval aerobic training in an aquatic environment, where the upper limbs accompanied the movements, they also obtained relevant improvements in the strength and resistance of the upper limbs, with gains of 15.5% (Farinha et al., 2021) and 42.44% (Reichert et al., 2016). The difference in values found in these studies compared to ours may be related to training prescription and intervention time. In the study by Farinha et al. (2021) the authors used the predicted HR as a parameter to control the intensity, however, properties such as water temperature and immersion depth reduce the HR values and this may have underestimated the actual intensity performed by the participants (Graef & Kruel, 2006). In the study by Reichert et al. (2016), we understand that the training time provided the expressive magnitude of gains for the resistance of the upper limbs. The observed gains are important, as the function of the upper limbs is crucial for realization out activities such as carrying groceries and performing household chores. Therefore, the maintenance or improvement of its function contributes positively to the individual's ability to perform activities of daily living (Dunsky et al., 2011).

Although no significant change was observed, an average effect size was observed in the result of the 30-s chair stand test, with an average increase of 2 repetitions in a group with already satisfactory baseline values. This increase in repetitions becomes relevant considering that in aging the increase of 2 repetitions corroborates in improvement for activities in daily life, in addition, this increase is found with specific strength training on land (Lemos et al., 2020). We can infer that the aerobic aquatic training performed contributes to the maintenance of lower limb strength and resistance in middle-aged adults. In the same sense, in the functional mobility test (8UG) there was no significant change, however, the participants had values below those evidenced with aerobic training in an aquatic environment (Delevatti et al., 2018; Reichert et al., 2016).

Regarding the 6MWT, we observed an increase of 6.9% in the distance covered by the participants in our study, indicating greater displacement speed for the same time. In this context, the importance of the observed results is emphasized, since the distance covered after training is in accordance with the values considered clinically relevant in clinical populations (Bohannon & Crouch, 2017).In addition, based on the assumption of increased speed in the execution of the test, we can infer that the proposed training model provided a protective functional gain, since the reduction in walking speed is associated with an increased risk of cardiovascular diseases and premature mortality (Veronese et al., 2018).

Our findings for the walk test differ from some findings in the literature. Reichert et al. (2016), for example, after 28 weeks, they observed gains of 11.96%, however, the sample of this study was composed of elderly people, who generally present greater amplitude for improvement. Also in this study, it is worth mentioning that the weekly frequency was two sessions per week, representing 20 sessions more than in our study, however, even with a more expressive improvement, our participants ended the intervention with 18 m more in distance covered.

In the study by Kargarfard et al. (2018), participants with multiple sclerosis underwent 8 weeks of training in the aquatic environment and experienced gains of 11.52% in the distance covered in the walk test. This clinical condition of the participants in the study by Kargarfard et al. (2018) may be the main factor for the difference between our findings. This is because, in this study, the participants started the training program by walking 451 m and ended the intervention with 503 m. However, the pre-training value in our study was 563 m, which is greater than the post-training values by Kargarfard et al. (2018). Therefore, we can infer that the functional condition of the participants before the training program may have been determinant for the greater gains observed by Kargarfard et al. (2018).

As well as functional fitness, training in an aquatic environment can positively influence cardiovascular aspects, given the significant reduction in DBP (11.5%) accompanied by a non-significant reduction in SBP (3.7%) observed in our study. Although relevant, it is worth mentioning that these results differ from those reported by Delevatti et al. (2016), which observed a significant reduction only in SBP (4.6%), without significant reduction in DBP (2.3%). Our findings, especially in DBP, confirm the findings of an important meta-analysis (Reichert et al., 2018) who found a reduction in both SBP (-10.58 mmHg) and DBP (-4.40 mmHg). Discussing more specifically, our findings obtained lower reductions than this study in SBP (-4.39 mmHg) and higher in DBP (-8.61 mmHg).

Despite the particularities of the prescription of training in the study by Delevatti et al. (2016), the baseline DBP reported by these authors was lower than that recorded in our study. Interestingly, the opposite was observed for SBP, which was higher in the study Delevatti et al. (2016). In this scenario, according to Wilder's principle (Messerli et al., 2015), the possibility of greater reductions was observed in those whose basal blood pressure values were higher, which corroborates the scientific literature, as it has been reported that pre-training values are determinant in the BP response to physical exercise (Sardeli et al., 2020).

Overall, the reduction in all studies was beneficial to participants' cardiovascular function. Jeffers et al. (2015) reported that small reductions in blood pressure reduce the risk and mortality from cardiovascular events. Clinically, a decrease of 2 mmHg in DBP can reduce the risk of stroke by 15% (Cook et al., 1995), as well as, a 5 mmHg reduction in SBP can reduce the risk of cardiovascular events by 10% (Canoy et al., 2022). In this perspective, we observed reductions of 8.6 mmHg and 4.4 mmHg in DBP and SBP, respectively, which leads us to believe that the practice of training applied in our study seems to have good clinical relevance.

This positive impact on the cardiovascular health of the participants can also be seen in the reduction in HRR, which corroborates the findings of Delevatti et al. (2016). Even with findings in the same direction, the magnitudes of change differ, possibly due to differences in drug use and baseline HR values. However, regardless of the magnitude, the reduction in HRR is extremely important for the clinical context, indicating, among other alterations, a possible sympathetic suppression (Fu & Levine, 2013).

High HRR values have been associated with poor physical fitness, disease development and mortality, and although the ideal HRR may vary from individual to individual, average values that exceed 70 bpm are considered to be of concern (Böhm, Schumacher, et al., 2020; Olshansky et al., 2022). In our findings, there was a decrease of 10 bpm, going from 80 bpm to 70 bpm and, in this context, they seem to reinforce even more the possible cardiovascular clinical benefit that 12 weeks of aerobic training in an aquatic environment provided to the participants.

Although no significant changes were observed, it is noteworthy that a medium effect size was observed in the quality of life and capillary blood glucose results. The improvements in these parameters need to be highlighted, as they corroborate several studies in the literature. The systematic review of Delevatti et al.(2015), for example, describes that glycemia and lipid profile can improve with the practice of aquatic training in the upright position, as well as, in the meta-analysis of Faíl et al. (2022) aquatic training has been reported to be effective in improving health and physical fitness in healthy adults and adults with chronic diseases.

The control of the internal and external load carried out in this work contributes to infer that these increases are consistent with the proposed training progression that we proposed, with a significant increase of 23.29% in the internal load and 45% in the external load, which denotes that the training prescribed, performed and perceived by the participants progressed over the 12 weeks. The control, the correct application and distribution of loads in the training prescription is necessary to generate physiological changes and improvements in the performance and health of practitioners (Impellizzeri et al., 2019). With the records of internal and external load, we can infer that the beneficial effects found are associated with the capacity of the training to generate adaptations and changes in the body of the participants.

In this sense, our study presents benefits provided by the applied training, however, some limitations were observed and need to be reported. As this is a pilot study linked to a community-oriented project, it was not possible to previously determine a sample size and the period of the day that the training was applied may have hindered the presence and participation of more volunteers. In addition, due to the small number of participants, it was not possible to design an intervention that included a control group, making certain comparisons difficult. The use of medication by some participants may have influenced cardiovascular measurements. Structural and temperature problems in the pool, corroborated the low adherence to the training program, and due to logistical issues of scheduling pools and the problems reported above, they made it difficult to practice the jogging modality. Randomized clinical studies should be encouraged, as this type of study offers the possibility of controlling other variables that may influence the outcome variable.

Conclussion

The pilot study of twelve weeks of aerobic interval training showed improvements in upper limb strength, functional cardiorespiratory fitness and generate cardiovascular changes in middle-aged adults.

Clinical relevance

- Aerobic aquatic training with intensity and volume progression improves upper limb strength and walking distance.
- Twelve weeks of aquatic aerobic exercise with intensity and volume modulation reduce diastolic blood pressure and heart rate resting.

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