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AQUATIC EXERCISES FOR WOMEN: PHYSIOLOGICAL INTENSITY PRESCRIPTION AND HEALTH-RELATED BENEFITS

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Abstract
Background: Physical exercise has a fundamental role in promoting health, and the characteristics of the aquatic environment favor its practice for achieving health-related benefits across all age groups. Nevertheless, it is crucial to understand the physiological alterations induced by immersion and their implications for regulating exercise intensity.
Goals: This article provides a perspective on the possibilities of intensity monitoring in water aerobics, considering the physiological shifts resulting from immersion. Additionally, a practical framework is proposed for aquatic instructors to tailor exercise intensity, thereby optimizing health outcomes among adult and older women.
Results: Evidence supporting intensity control through heart rate and ratings of perceived exertion is presented, contextualizing the health benefits derived from water-based exercise programs prescribed by these parameters for women.
Conclusions: Based on such aspects, the authors recommend using heart rate and/or rating of perceived exertion as parameters for intensity monitoring during water aerobics since both allow the training load to be individualized and easy to implement in groups of adults and older women.
Keywords: aquatic environment, water-based exercise, heart rate, rating of perceived exertion.

Resumen: Ejercicio acuático para mujeres: prescripción por intensidades fisiológicas y beneficios para la salud.
Antecedentes: La actividad física juega un papel fundamental en la promoción de la salud, y las características del medio acuático favorecen su práctica para obtener beneficios relacionados con la salud en individuos de todas las edades. Sin embargo, es crucial comprender las alteraciones fisiológicas inducidas por la inmersión y sus implicaciones para el control de la intensidad del ejercicio.
Objetivos: Este artículo ofrece una perspectiva sobre las posibilidades de monitorear la intensidad en la hidrogimnasia, teniendo en cuenta las alteraciones fisiológicas resultantes de la inmersión. Además, se propone una estructura práctica para que los instructores de actividades acuáticas adapten la intensidad del ejercicio, optimizando así los resultados de salud en mujeres adultas y mayores.
Resultados: Se presentan evidencias que respaldan el control de la intensidad a través de la frecuencia cardíaca y el índice de esfuerzo percibido, contextualizando los beneficios para la salud derivados de programas de hidrogimnasia prescritos según estos parámetros para mujeres.
Conclusiones: Basados en estos aspectos, los autores recomiendan la utilización de la frecuencia cardíaca y/o la percepción subjetiva de esfuerzo como parámetros para monitorear la intensidad durante la hidrogimnasia, ya que ambos permiten personalizar la carga de entrenamiento y son de fácil implementación en sesiones en grupos de adultos y mujeres mayores.
Palabras clave: ambiente acuático, aeróbic acuático, frecuencia cardíaca, índice de esfuerzo percibido.

Resumo: Exercício Aquático para mulheres: prescrição por intensidades fisiológicas e benefícios relacionados a saúde
Introdução: O exercício físico tem um papel fundamental na promoção da saúde, e as características do meio aquático favorecem sua prática para o alcance de benefícios relacionados à saúde em indivíduos de todas idades. No entanto, é crucial compreender as alterações fisiológicas induzidas pela imersão e suas implicações para o controle da intensidade do exercício.
Objetivos: este artigo traz uma perspectiva sobre as possibilidades de monitoramento da intensidade na hidroginástica, considerando as alterações fisiológicas decorrentes da imersão. Além disso, uma estrutura prática é proposta para os instrutores de atividades aquáticas adaptarem a intensidade do exercício, otimizando assim os desfechos de saúde entre mulheres adultas e idosas.
Resultados: São apresentadas evidências que dão suporte para o controle da intensidade por meio da frequência cardíaca e do índice de esforço percebido, contextualizando os benefícios à saúde derivados de programas de hidroginástica prescritos por esses parâmetros para mulheres.
Conclusões: Baseados nesses aspectos, os autores recomendam a utilização da frequência cardíaca e/ou percepção subjetiva de esforço como parâmetros para monitoramento da intensidade durante a hidroginástica, visto que ambos permitem que a carga de treinamento seja individualizada e são de fácil implementação em sessões em grupos de adultos e mulheres idosas.
Palavras-chaves: ambiente aquático, hidroginástica, frequência cardíaca, índice de esforço percebido.

Introduction

Physical exercise promotes health, reduces the risk of major non-communicable diseases development, and can be a non-pharmacological therapy in selected diseases. The definition of the optimal type and dose of exercise is essential for reaching these benefits (Garber et al., 2011; Pedersen & Saltin, 2015). In this scenario, healthcare professionals have widely indicated aquatic exercises for individuals of all ages and different physical fitness and health statuses. ACSM's guidelines, for example, recommend this type of exercise for endurance training of older individuals, considering it is advantageous for this population (ACSM, Chodzko-Zajko et al., 2009). Among their characteristics are the low impact exercises (Alberton et al., 2015; Alberton et al., 2021b), high neuromuscular demand (Alberton et al., 2011; Alberton et al., 2014b), and the possibility of reaching high physiological intensities (Andrade et al., 2020c; Schaun et al., 2018) due to the water's physical characteristics.

Several studies have investigated water aerobics and its health-related benefits in the current literature. We highlight that most of them developed water-based programs for women, who are the primary practitioners of aquatic exercises (Andrade et al., 2020c; Costa et al., 2018a; Costa et al., 2018b; Häfele et al., 2022; Pinto et al., 2015; Reichert et al., 2020; Takeshima et al., 2002). Nevertheless, it is well-established that water immersion causes physiological alterations, which have important implications in the intensity monitoring during water-based exercises (Pendergast et al., 2015). Accordingly, the correct intensity prescription, considering the physiological alterations from the aquatic environment and the population at hand, is a crucial factor for the success of the exercise program.

Hence, this article provides a perspective on the possibilities of intensity control during water aerobics for women, considering the physiological changes from immersion. In addition, the aim is to propose a practical framework for aquatic instructors to prescribe tailored intensity and obtain health-related benefits in adult and older women.

Intensity prescription during water aerobics

Water aerobics is a modality composed of several exercises, such as running, kicking, jumping, rocking, sliding, and scissors, usually performed stationary. Tailoring exercise by varying frequency, duration, and, most importantly, intensity is crucial to maximizing health-related benefits. Intensity control is achieved by using both objective or subjective parameters of intensity control; however, their choice should take into consideration the mode of exercise (e.g., water versus land-based exercises) and the population (e.g., healthy versus individuals with cardiovascular disorders).

For adequate intensity control in the aquatic environment, we should consider that immersion exposes the individuals to profound physiological stresses, leading to several acute cardiovascular and renal adjustments. During immersion, the hydrostatic pressure action results in a translocation of blood from the dependent limbs to the chest and increased plasma volume due to transcapillary autotransfusion of fluid from the cells (Arborelius et al., 1972; Watenpaugh et al., 2000). Moreover, water's high heat conductivity can significantly influence human function in the aquatic environment (McArdle et al., 1976; Srámek et al., 2000). These mechanisms augment intrathoracic blood volume, which increases cardiac end-diastolic volume, stroke volume, and cardiac output due to increased end-diastolic cardiac fiber length, and reduces the heart rate and total peripheral resistance (Pendergast et al., 2015). In addition, the increased venous return and atrial stretch lead to the attenuated secretion of anti-natriuretic hormones and vasopressin, which results in diuresis and natriuresis (Pendergast et al., 2015).

Therefore, intensity monitoring during water-based exercises must consider all these physiological alterations, and the prescription cannot be based on the same parameters used for land aerobic training because training loads may be overestimated. Hence, we will present the characteristics of the main types of physiological intensity prescription during water aerobics: heart rate (HR) and rating of perceived exertion (RPE) for adult and older women.

Intensity controlled by HR

The HR is recommended as a feasible physiological parameter to prescribe the training intensity during water aerobics (Alberton et al., 2014a). HR during water-based exercises is directly related to oxygen consumption (VO_2), not only when expressed in absolute values but also when expressed in percentages of maximal values obtained in aquatic graded maximal tests in women (David et al., 2017; Andrade et al., 2020b). Nevertheless, lower HR and VO_2 values during maximal and anaerobic threshold intensities are reported in women during graded maximal tests employing water-based exercises compared to a land treadmill (Alberton et al., 2013a; Alberton et al., 2014a). The aquatic HR may also be affected by the water temperature. For example, HR during different aquatic exercises was shown to be significantly greater in water at 36°C compared to water at 28°C (Hall et al., 1998; Bergamin et al., 2015), but no significant difference was observed between temperatures of 31 and 27°C (Yázigi et al., 2013). Therefore, for a precise prescription, the intensity control by HR needs to use values measured in the aquatic environment considering the water temperature and exercise characteristics, such as body position and water depth (Alberton & Kruel, 2009).

Therefore, a graded maximal test is necessary for obtaining the maximal HR (HR_{max}) in the aquatic environment. Protocols with water-based exercises (usually stationary running) were proposed in previous studies performed in women. Intensity increases of 15 $b.min^{-1}$ every 2 min (Alberton et al., 2013a; Andrade et al., 2020a; Kruel et al., 2013) or 10 $b.min^{-1}$ every 1 min (Alberton et al., 2014a) are recommended, with the initial cadence adjusted for the assessed population (young women: 80-85 $b.min^{-1}$; older women: 70 $b.min^{-1}$). The resulting HR_{max} may be used as a reference, and the target intensity may be calculated according to the program's purpose.

On the other hand, it is known that a pre-selected percentage of training based on HR_{max} (regardless of the environment) does not accurately represent the metabolic stress and may result in different training zones for different individuals (Wolpern et al., 2015). Therefore, determining the anaerobic threshold may be a more precise and tailored alternative for intensity monitoring, which has also been employed in water aerobics studies for young and older women (Costa et al., 2018a; Pinto et al., 2015; Reichert et al., 2020). In practical terms, studies have shown that during the aquatic graded maximal tests aforementioned is possible to determine the anaerobic threshold in young and older women by using the HR deflection point (Alberton et al., 2013b; Andrade et al., 2020a; Kruel et al., 2013), which is a non-invasive and easy procedure (Conconi et al., 1982). Based on this parameter, percentage values below, at, or above the anaerobic threshold may be calculated according to progression and target training zones.

Although aquatic instructors may have difficulties applying this type of prescription in large groups when an apart physical fitness evaluation is not a routine, it is indispensable for personalized training (individual or small groups). Notwithstanding, alternative procedures for training prescription are recommended for conditions in which individuals are not allowed to perform a graded maximal test or physician supervision is needed.

Intensity controlled by RPE

Subjective parameters are possibilities of intensity control widely recommended for endurance training in adult and older individuals (ACSM, Chodzko-Zajko et al., 2009; Garber et al., 2011). RPE may be applied for monitoring intensity during water-based exercises because it is a low-cost and straightforward tool, easily adapted for use in the aquatic environment. Among different scales, Borg's RPE 6-20 is the most investigated during water aerobics in adult and older women (Alberton et al., 2016; Andrade et al., 2020b; David et al., 2017).

Recent studies performed with young and older women showed that RPE during water-based exercises is directly related to the percentages of maximal VO_2 and HR obtained in aquatic graded maximal tests (Alberton et al., 2016; Andrade et al., 2020b; David et al., 2017). In addition, RPE at maximal and anaerobic threshold intensities seems to be similar between aquatic graded maximal tests (employing water-based exercises) and a land treadmill protocol in young women (Alberton et al., 2013a; Alberton et al., 2014a). Table 1 presents RPE values (6-20) corresponding to different training zones determined for the water-based stationary running exercise in young (Alberton et al., 2016) and older women (Andrade et al., 2020b).

Moreover, the knowledge of the RPE corresponding to the anaerobic threshold in the aquatic environment may help aquatic instructors more accurately prescribe intensity considering the metabolic stress. RPE value corresponding to ≈16 (between hard and very hard) was observed at the anaerobic threshold for the water-based stationary running in young (Alberton et al., 2013a; Alberton et al., 2016) and older women (Andrade et al., 2020a). Therefore, RPE may be used to individualize training loads during water aerobics based on these reference data. We may use it for individuals of any age and health condition since it has been widely used during water aerobics in realistic conditions or scientific and controlled settings, resulting in health-related benefits (Andrade et al., 2020c, Costa et al., 2018b).

This type of intensity control requires only a banner with identical reproduction of the selected scale, positioned in a visible place, and a suitable familiarization procedure (Borg, 1990). Furthermore, RPE is recommended for particular populations on medications whose cardiovascular responses may be affected during the exercise (Mitchell et al., 2019). However, time and effort are necessary to provide enough instructions about its use and appropriate familiarization so that this subjective method may be considered valid and accurate for reaching the target intensity.

Health-related benefits in women

The reduced joint impact and lower cardiovascular responses give the aquatic environment interesting characteristics for women, especially climacteric and older women. Once during these periods, there is a greater propensity for developing cardiovascular diseases and weight gain, which, as a consequence, can lead to an increase in joint and muscle damage. The benefits of water aerobics training for women in different age groups are well elucidated, demonstrating, for example, reductions in resting blood pressure values (Reichert et al., 2018), improvement in the lipid profile (Costa et al., 2018b), and glycemic (Delevatti et al., 2016), as well as improvements in physical fitness components, such as muscle strength, balance, and cardiorespiratory capacity (Costa et al., 2018a; Häfele et al., 2022).

Older women, particularly climacteric women who are going through a series of hormonal changes, can benefit from water aerobics training and the acute physiological effects of immersion. A reduction in female sex hormones, such as estrogen and progesterone, can negatively affect a women's health. Estrogen, for example, has an essential cardioprotective role, and its reduction can lead to sympathetic hyperactivity, increased release of vasoconstrictor hormones, and, consequently, an increase in the activity of the renin-angiotensin system. These changes can lead to cardiometabolic complications. The scientific literature is already quite clear on the role of exercise in improving women's health during menopause (Zanesco & Zaros, 2009). Exercise in an aquatic environment can have additional beneficial effects, as immersion leads to physiological adjustments due to hydrostatic pressure and greater thermoconductivity. Among these adjustments, we have a lower sympathetic activation and several hormonal changes, for example, a reduction in vasoconstrictor hormones. As a result, the renin-angiotensin system is suppressed (Coruzzi et al., 1984; Gabrielsen et al., 2002). These effects of immersion are contrary to those observed by the estrogen production reduction, which can enhance the effects of exercise when performed in this environment.

In addition, these physiological changes, especially after menopause, can lead to greater chances of developing metabolic diseases, such as obesity, dyslipidemia, diabetes, among others. Therefore, aquatic exercise also has an additional benefit, as the physiological adjustments arising from immersion also lead to an increased release of atrial natriuretic peptide (Shiraishi et al., 2002). This response contributes to the increase in the oxidative capacity of lipids, especially in the breakdown of triglycerides, which may help treat dyslipidemia and obesity (Akahoshi et al., 2001).

Future directions in this research area are randomized clinical trial designs in which aquatic aerobic training is used as the central intervention (not combined with resistance exercises or multicomponent exercises) compared to traditional control groups in different populations. Water aerobics interventions prescribed by one of the main types of physiological intensity (HR or RPE) on health outcomes with high methodological quality and low risk of bias are still scarce in the literature. Comparative studies could also be developed as a sequence to compare different intensity prescription models during water aerobics on health outcomes (HR versus RPE; $\%HR_{max}$ versus HR deflection point).

Table 1. Rating of perceived exertion (RPE) values corresponding to different percentages of maximal oxygen consumption ($\%VO_{2max}$) during water-based stationary running exercise.

$\%VO_{2max}$	RPE (Borg's 6-20 Scale)	
	Young women	Older women
50-59%	13	10
60-69%	15	11
70-79%	16-17	13-14
80-89%	18	17
90-99%	19	17-18

*Note: Adapted from Alberton et al. (2016) and Andrade et al. (2020b) for young and older women, respectively.

Final Considerations

The present opinion article recommends using HR and RPE as parameters for intensity monitoring during water aerobics because both allow the training load to be individualized and easy to implement in groups of adults and older women. Both HR and RPE have high relationships with VO_2 and have been used in studies that verified positive gains in physical fitness and health-related outcomes. The physiological changes during immersion should be considered regardless of the intensity control choice. Reference values for HR or RPE suitable for the aquatic environment should be adopted, considering their positive and negative points, as shown in Figure 1. In addition, we showed that aquatic training promotes remarkable health-related benefits for women of all ages, especially in climacteric and older ones. Among such benefits, we highlight the acute physiological adjustments from water immersion and the chronic metabolic improvements arising from water aerobics training.

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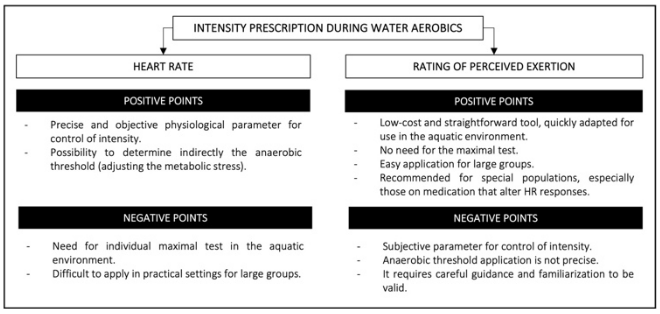
Figure 1. Intensity prescription during water aerobics: summary of positives and negatives points.



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