Journal of Science and Medicine in Sport xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Journal of Science and Medicine in Sport

journal homepage: www.elsevier.com/locate/jsams

Original research

Quality of life and sleep quality are similarly improved after aquatic or dry-land aerobic training in patients with type 2 diabetes: A randomized clinical trial

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ARTICLE INFO

Article history:
Received 22 March 2017
Received in revised form 2 July 2017
Accepted 29 August 2017
Available online xxx

Keywords:
Aerobic exercise
Training programs
Mental health
Depressive symptoms
Diabetes

ABSTRACT

Objectives: To compare the effects of two aerobic training models in water and on dry-land on quality of life, depressive symptoms and sleep quality in patients with type 2 diabetes.
Design: Randomized clinical trial.
Methods: Thirty-five patients with type 2 diabetes were randomly assigned to aquatic aerobic training group (n = 17) or dry-land aerobic training group (n = 18). Exercise training length was of 12 weeks, performed in three weekly sessions (45 min/session), with intensity progressing from 85% to 100% of heart rate of anaerobic threshold during interventions. All outcomes were evaluated at baseline and 12 weeks later.
Results: In per protocol analysis, physical and psychological domains of quality of life improved in both groups ($p < 0.05$) without between-group differences. Overall quality of life and sleep quality improved in both groups ($p < 0.05$), without between-group differences in per protocol and intention to treat analysis. No changes on depressive symptoms were observed in both groups at follow-up.
Conclusions: Aerobic training in an aquatic environment provides similar effects to aerobic training in a dry-land environment on quality of life, depressive symptoms and sleep quality in patients with type 2 diabetes.

Clinical trial reg. no. NCT01956357, clinicaltrials.gov.

1. Introduction

Type 2 diabetes (T2DM) is a chronic disease, marked by its impact on physical health, such as at critical changes on metabolic, functional and cardiovascular impairments.[1,2] In addition, or as consequence of the impact on physical health, people with T2DM also presents impairments on mental health outcomes, such as sleep quality and depressive symptoms.[3,4] All together, these alterations lead patients to an expressive worsening in the quality of life (QoL). In fact, when compared to the non-diabetic population, these individuals present a worse QoL in several domains, including, but not limited to physical, psychological and social.[5]

High levels of physical activity (PA) and involvement in structured exercise training programs are associated with better QoL in patients with T2DM.[6] In addition, specific characteristics such as weekly volume[7] and exercise supervision[8] seems to moderate the effects of training on patients QoL.

Although different modalities of structured exercise programs are indicated on diabetes management, aerobic training has been the traditionally recommended and prescribed form, providing clear acute and chronic benefits for patients with T2DM[9,10]

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http://dx.doi.org/10.1016/j.jsams.2017.08.024
1440-2440/

although similar benefits can be obtained with resistance or combined exercise training.[11]

Previous studies with aerobic training have found that the most beneficial exercise programs are those with high volume,[12] intensity[13] and that make progression of the training variables.[14] However, these studies are performed in dry-land environment, which may expose patients to moderate to high impact forces on their musculoskeletal system, especially in running.[15] Importantly, as patients with diabetes are prone to chronic complications, including peripheral neuropathy that increases risk of foot lesions, it is important to find alternatives for the adequate dosage of exercise training.

Exercise alternatives for patients with T2DM include aquatic exercises, in which the physical properties of water can provide low impact forces on the lower limb joints, probably making it safer as regards joint damage.[16] These characteristics are especially relevant in the case of diabetes, due to its frequent association with obesity,[17] lower strength and functional capacity.[2] Thus, the aquatic environment favors exercise training due its lesser risks of injuries and ulceration caused by the impact being directly absorbed by the foot in contact with the ground. Moreover, the aquatic environment allows the achievement of training with open kinetic chain, without impact on the musculoskeletal system, such as deep-water running.[18] Although some studies have been showed similar metabolic, cardiorespiratory and functional effects after training in different environments (aquatic or dry-land) in patients with T2DM,[10] mental health outcomes and QoL have not been evaluated after training in these two environments yet. Considering this caveats, the aim of this study was to compare the effects of two aerobic training models (aquatic vs. dry-land training) on QoL, depression symptoms and sleep quality in patients with T2DM. Our hypothesis is that aerobic training will present positive and similar effects in all evaluated outcomes in the two environments (aquatic and dry-land).

2. Methods

Patients with T2DM were recruited through advertisements in local newspapers. Inclusion criteria were: T2DM, not engaged in regular exercise (defined as not exercising more than 20 min on 3 or more days a week), 30 years old or more, and having had an electrocardiogram (ECG) stress test performed recently (6 months preceding the study). Exclusion criteria were severe autonomic neuropathy, severe nonproliferative and proliferative diabetic retinopathy, decompensated heart failure, limb amputations, chronic renal failure (MDRD-GFR <30 ml/min),[19] or any muscle or joint impairment which prevented individuals from engaging in physical exercise.

All participants provided written consent prior to participation. This study was approved by the Research Ethic Committee of the Universidade Federal do Rio Grande do Sul (protocol number 108997) and was registered in Clinical trials (number NCT01956357).

Eligible patients were randomized to either an aquatic aerobic training (AT) or dry-land aerobic training (DLT) by picking an envelope with predefined group numbers, using a 1:1 ratio and stratified according to gender. The randomization procedure was performed after baseline evaluations.

Participants underwent a 12-week training program with three weekly sessions. Training intensity was prescribed according to the corresponding anaerobic threshold heart rate (HR_{AT}), determined by heart rate deflection point,[20] which was determined by progressive exercise tests conducted in the water or on dry-land for the AT and DLT groups, respectively. The incremental test in the water was a mode-especific deep-water running test based on the study of Kanitz et al.,[21] and the incremental test on land was performed in treadmill, according Delevatti et al.[9,10] The modalities adopted were walking and/or running in deep water (AT), and walking and/or running on athletic track (DLT). Participants trained wearing heart rate (HR) monitors (RSX 300, Polar, Kajaani, Finland) during exercise to control training intensity. Each 45-min session was divided into a warm-up period (5 min), followed by the main training program (35 min) and a cool down period (5 min). Both groups underwent interval-training programs, with the following periodization: weeks 1–3, 7 sets (3 min 85–90% HR_{AT} with 2 min <85% HR_{AT}); weeks 4–6, 7 sets (4 min 85–90% HR_{AT} with 1 min <85% HR_{AT}); weeks 7–9, 7 sets (4 min 90–95% HR_{AT} with 1 min <85% HR_{AT}); weeks 10–12, 7 sets (4 min 95–100% HR_{AT} with 1 min <85% HR_{AT}). Both groups had identical periodization, differing only with regard to the training environment.

At the first week of assessments, participants realized clinical evaluations including body composition tests. Initially, height, body mass, waist circumference, and the sum of eight skinfolds (Σ SF) were calculated. The equations proposed by Petroski[22] were used to estimate the body density of men and women, while body fat percentages were estimated using the Siri formula.[23] Following the clinical assessments, QoL, depressive symptoms and sleep quality were evaluated.

In the second week, participants were familiarized with the training programs that they subsequently underwent, with the training environment, and with the equipment used during experimental sessions. In the third week of pre-training evaluation, a graded exercise test was performed. This test was conducted on a previously calibrated treadmill (Inbramed, Porto Alegre, Brazil) with initial velocity of 3 km h^{-1} for 3 min, fixed inclination (1%), and increments of 1 km h^{-1} every 2 min, until exhaustion. Heart rate was monitored every 10 s (Polar, Kajaani, Finland) and the rate of perceived exertion (Borg Scale) was measured in the final 20 s of each stage.

Quality of life was considered the primary outcome, being assessed using the portuguese version of the World Health Organization QoL-Bref (WHOQOL-BREF).[24] The WHOQOL-BREF is a self-assessment, 26-item, short version of the WHOQOL-100 instrument. The results are presented in four domains (physical, psychological, social relationships, and environment) with scores ranging from 0 to 100 (0 indicates the worst QoL and 100 better QoL).[24]

Secondary outcomes were depressive symptoms and sleep quality. Depressive symptoms were evaluated using the Beck Depression Inventory (BDI).[25] The BDI is a 21-item, self-assessment instrument that is widely used in research and clinical practice. BDI scores range from 0 to 63, with 0–9 indicating minimal depression, 10–18 mild depression, 19–29 moderate depression, and 30–63 severe depression.

Sleep quality was evaluated by Pittsburgh Sleep Quality Index (PSQI).[26] PSQI is an instrument that assesses subjective sleep quality and related disorders. PSQI comprises seven domains divided in 10 questions, of which questions 1–4 are open and 5–10 are semi-open. PSQI scoring scale ranges from zero to 21 and scores greater than 5 indicate poor sleep quality. Each domain has a set weight between zero and three and global score is given by the sum of the scores in the seven domains.

All outcomes were evaluated at baseline and at the end of the interventions. All analyses were performed by blinded evaluators. Post-training evaluation was conducted 72 h after the last exercise session.

Descriptive data from characterization of participants and training adherence are presented as mean and standard deviation or median and interquartile range (P25–P75) for continuous variables and as raw numbers (*n*) for categorical variables. Baseline

Please cite this article in press as: S. Delevatti R, et al. Quality of life and sleep quality are similarly improved after aquatic or dry-land aerobic training in patients with type 2 diabetes: A randomized clinical trial. *J Sci Med Sport* (2017), http://dx.doi.org/10.1016/j.jsams.2017.08.024