PM R 7 (2015) 141-148

www.pmrjournal.org

Original Research—CME

Effects of an Aquatic-Based Exercise Program to Improve Cardiometabolic Profile, Quality of Life, and Physical Activity Levels in Men With Type 2 Diabetes Mellitus

Lucia Cugusi, PhD, Christian Cadeddu, MD, PhD, Silvio Nocco, MD, PhD, Fabio Orrù, MD, Stefano Bandino, MD, Martino Deidda, MD, Alessandra Caria, MSc, Pier Paolo Bassareo, MD, PhD, Alessandra Piras, MD, PhD, Sergio Cabras, MD, Giuseppe Mercuro, MD

Abstract

Background: The role of structured exercise in improving cardiometabolic profile and quality of life in patients with type 2 diabetes mellitus (2DM) has been widely demonstrated. Little is known about the effects of an aquatic-based exercise program in patients with 2DM.
Objective: To evaluate the effects of a supervised aquatic-based exercise program on cardiometabolic profile, quality of life, and physical activity levels in patients with 2DM.
Design and Setting: Observational study, community pre-post aquatic-based exercise program, primary care intervention.
Patients: Eighteen men diagnosed with 2DM (52.2 ± 9.3 years).
Methods: and Main Outcome Measurements: Cardiometabolic profile, quality of life, and physical activity levels were assessed before and after 12 weeks of an aquatic-based exercise program.
Results: The results show a significant improvement of cardiometabolic assessments (maximum oxygen consumption: 24.1 versus 21.1 mL/kg/min, $P < .05$; blood pressure: 125.4/77 versus 130.7/82.5 mm Hg, $P < .05$; fasting blood glucose: 119.6 versus 132.5 mg/dL, $P < .05$; body mass index: 29.9 versus 31.1 kg/m^2, $P < .005$; low-density lipoprotein cholesterol: 95.2 versus 104.9 mg/dL, $P < .05$; and diastolic function: E/E′ 9.1 versus 10.1, $P < .005$) and an increase in quality of life and physical activity levels (Medical Outcome Study 36-item Short Form Health Survey mental component summary: 72.3 versus 67, $P < .05$; Problems Area About Diabetes: 20.1 versus 33.2, $P < .005$) and energy expenditure in general physical activity (physical activity: 3888.7 versus 1239.5 kcal/wk, $P < .05$).
Conclusions: These findings demonstrate that an aquatic-based exercise program produces benefits for the cardiovascular system and metabolic profile and appears to be safe and effective in improving quality of life and increasing physical activity levels in patients with 2DM.

Introduction

Diabetes mellitus is a metabolic disorder characterized by hyperglycemia resulting from defects in insulin production, insulin resistance, or both [1]. Type 2 diabetes (2DM) is associated with being overweight, obesity, and a sedentary lifestyle [2]. Its prevalence is increasing in industrialized countries, parallel to the increasing prevalence of obesity and physical inactivity.

Structured exercise training alone or in combination with diet or treatment with subcutaneous insulin or oral hypoglycemic drugs are the foundations of 2DM therapy [3]. Several studies, particularly in the past 10 years, have highlighted the potential benefits of maintaining an active lifestyle, both in healthy persons and in persons with cardiovascular risk factors. This approach is effective especially in reducing the incidence of 2DM or other metabolic disorders such as insulin resistance and impaired glucose tolerance that can evolve to 2DM and represent risk factors for the development of cardiovascular diseases (CVDs) [2,4]. The effects of exercise training on glucose control, cardiovascular profile, and physiologic parameters have also been extensively studied in patients with 2DM [3]. These studies reported

http://dx.doi.org/10.1016/j.pmrj.2014.09.004

that both aerobic and resistance training improve insulin action, blood glucose control, and fat oxidation and storage in muscle. However, it has been demonstrated that resistance exercise enhances skeletal muscle mass [3]. For this reason, it would be desirable to incorporate this type of physical exercise in adapted training programs for persons diagnosed with 2DM. With this knowledge and with the increasingly strong belief that exercise is the treatment of choice for 2DM, it is easy to explain why various studies in this area have used combined aerobic and resistance exercise [3], as well as the growing amount of research that analyzes the effects of other types of alternative exercise programs such as yoga [5], tai chi [6], and aquatic training [7-9].

Aquatic immersion has profound biological effects, extending across essentially all homeostatic systems, and these therapies are beneficial in the management of patients with musculoskeletal problems, cardiovascular diseases, rheumatic disease, and other conditions [7,10]. Aquatic exercise should be indicated in patients with 2DM, who are often obese [11]; in fact, it appears to offer the safest and most protective environment for overweight persons because of the buoyancy effects of immersion, which reduce the risk of joint injury [7]. The training performed in water may minimize some of the risks of exercise such as joint tendon injuries or trauma in sedentary patients with 2DM who are unaccustomed to exercise and wish to initiate a training program [12,13].

This study is based on these considerations with the aim of determining if the benefits pertaining to glucose control, cardiovascular profile, and quality of life (QOL) obtained by conventional training are similar to those brought about by aquatic training, in order to include it as training of choice, especially for those patients with 2DM who are more exposed to the risk of joint injury during exercise.

Materials and Methods

Study Population

Eighteen men affected by 2DM (ages 52.2 $\pm$ 9.3 years), selected from a population of persons under the care of the Diabetic Center of our University-Hospital, were enrolled. They had been diagnosed with 2DM for fewer than 10 years and were being treated with oral hypoglycemic drugs. They underwent no changes in hypoglycemic treatment, diet, or other health-relevant lifestyle measures during the study period. The subjects did not participate in additional exercises on land, and no subjects dropped out during the 12 weeks of training.

The study included the following inclusion criteria: between the ages of 40 and 65 years, echocardiographic left ventricular ejection fraction (LVEF) $\geq$55% and absence of echocardiographic wall motion abnormalities, and normal hepatic and renal function (bilirubin $\leq$1.5 mg/dL and creatinine $\leq$2.0 mg/dL).

Exclusion criteria were moderate to severe heart valve disease, atrial fibrillation, or severe arrhythmias. Subjects were also excluded if they had illnesses that could seriously reduce their life expectancy or their ability to participate in the study.

Written informed consent was obtained from all participants before screening, consistent with the Declaration of Helsinki for Human Research of 1964 (last modified in 2000).

Supervised Aquatic-Based Exercise Program

All enrolled patients carried out a supervised aquatic-based exercise program (SAEP) for 12 weeks. The SAEP consisted of 50-minute sessions in a heated pool (31°C-32°C), 3 times a week for 12 weeks [3,9]. Each session consisted of a warm-up phase, a central phase, and a cool-down phase with stretching exercises. The patients trained as a group following a moderate to vigorous exercise intensity, that is, 50% to 75% of maximum oxygen consumption (VO_2 max) [14], calculated on the basis of the results of cardiopulmonary exercise test performed at baseline. The SAEP is focused both on increasing aerobic capacity through the use of swimming techniques and muscle group strengthening through the use of circuit training both with and without aquatic exercise equipment. During the program all the subjects were monitored continuously while exercising in the water with use of Polar FT2 heart rate monitors (Polar Electro Inc, Lake Success, NY). At the beginning and at the end of each training session, blood glucose levels were recorded through the FreeStyle Freedom Lite [15] (supplied with test strips from Abbott Diabetes Care Inc, Abbott Park, IL), and minimum and maximum blood pressure values were measured.

Cardiometabolic Profile

Conventional and Tissue Doppler Echocardiography

Echocardiographic images were recorded using a commercially available system (Toshiba Artida; Toshiba Corp, Tochigi, Japan). LVEF was obtained from the apical 4- and 2-chamber views according to Simpson's rule and was considered abnormal when <55%. Longitudinal function was assessed using tissue Doppler spectral analysis of mitral annulus, placing the sample volume at the septal and lateral wall corner from the apical 4-chamber view. Peak velocities in systole (S'), and early (E') and late (A') diastole were measured. The mitral inflow peak velocity E/E' ratio was calculated to evaluate left ventricular filling pressure.

Speckle Tracking Echocardiography

Global longitudinal strain (ε) and strain rate measurements were obtained as an average from the 2- and