

## Original article

## Impact of a community-based exercise programme on physical fitness in middle-aged and older patients with type 2 diabetes

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## ABSTRACT

**Objectives:** Physical fitness is related to all-cause mortality, quality of life and risk of falls in patients with type 2 diabetes. This study aimed to analyse the impact of a long-term community-based combined exercise program (aerobic + resistance + agility/balance + flexibility) developed with minimum and low-cost material resources on physical fitness in middle-aged and older patients with type 2 diabetes.

**Methods:** This was a non-experimental pre-post evaluation study. Participants (N = 43; 62.92 ± 5.92 years old) were engaged in a community-based supervised exercise programme (consisting of combined aerobic, resistance, agility/balance and flexibility exercises; three sessions per week; 70 min per session) of 9 months' duration. Aerobic fitness (6-Minute Walk Test), muscle strength (30-Second Chair Stand Test), agility/balance (Timed Up and Go Test) and flexibility (Chair Sit and Reach Test) were assessed before (baseline) and after the exercise intervention.

**Results:** Significant improvements in the performance of the 6-Minute Walk Test ( $\Delta = 8.20\%$ ,  $p < 0.001$ ), 30-Second Chair Stand Test ( $\Delta = 28.84\%$ ,  $p < 0.001$ ), Timed Up and Go Test ( $\Delta = 14.31\%$ ,  $p < 0.001$ ), and Chair Sit and Reach Test ( $\Delta = 102.90\%$ ,  $p < 0.001$ ) were identified between baseline and end-exercise intervention time points.

**Conclusions:** A long-term community-based combined exercise programme, developed with low-cost exercise strategies, produced significant benefits in physical fitness in middle-aged and older patients with type 2 diabetes. This supervised group exercise programme significantly improved aerobic fitness, muscle strength, agility/balance and flexibility, assessed with field tests in community settings.

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## Impacto de un programa de ejercicios basado en la comunidad sobre la aptitud física en pacientes de mediana edad y ancianos con diabetes tipo 2

## RESUMEN

## Palabras clave:

Actividad motora

Ejercicio

Diabetes mellitus tipo 2

Aptitud física

Investigación participativa basada en la comunidad

**Objetivos:** La aptitud física se relaciona con la mortalidad por todas las causas, la calidad de vida y el riesgo de caídas en pacientes con diabetes tipo 2. Este estudio tuvo como objetivo analizar el impacto de un programa de ejercicio combinado (aeróbico + resistido + agilidad/equilibrio + flexibilidad), a largo plazo, basado en la comunidad y desarrollado con el mínimo de recursos materiales y de bajo coste, sobre la aptitud física de pacientes de mediana edad y mayores con diabetes tipo 2.

**Métodos:** Fue un estudio de evaluación pre-post no experimental. Los/las participantes (N = 43; 62,92 ± 5,92 años) fueron implicados/as en un programa de ejercicio supervisado basado en la comunidad (compuesto por una combinación de ejercicios aeróbicos, resistidos, agilidad/equilibrio y de flexibilidad), de tres sesiones por semana (70 min por sesión) durante 9 meses. La condición física aeróbica (6-Minute Walk Test), la fuerza muscular (30-Second Chair Stand Test), la agilidad/equilibrio (Timed Up and Go Test) y la flexibilidad (Chair Sit and Reach Test) se evaluaron antes (línea basal) y después de la intervención de ejercicio.

**Resultados:** Entre el inicio y el final del programa de ejercicio se observaron mejoras significativas en el desempeño del 6-Minute Walk Test ( $\Delta = 8,20\%$ ,  $p < 0,001$ ), el 30-Second Chair Stand Test ( $\Delta = 28,84\%$ ,  $p < 0,001$ ), el Timed Up and Go Test ( $\Delta = 14,31\%$ ,  $p < 0,001$ ) y el Chair Sit and Reach Test ( $\Delta = 102,90\%$ ,  $p < 0,001$ ).

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*Conclusiones:* Un programa de ejercicio combinado a largo plazo, basado en la comunidad y desarrollado mediante estrategias de ejercicio de bajo coste, logró beneficios significativos en la aptitud física en pacientes de mediana edad y mayores con diabetes tipo 2. Este programa de ejercicio en grupo supervisado mejoró significativamente la capacidad aeróbica, la fuerza muscular, la agilidad/equilibrio y la flexibilidad, evaluadas con pruebas de campo en un contexto comunitario.

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## Introduction

Physical fitness has been traditionally defined as the ability to perform the daily life tasks effectively and without fatigue, and includes a variety of components, such as aerobic fitness, muscle strength, flexibility, agility and balance.<sup>1</sup> One of the most important aspects of physical fitness is its relationship with health, and in this context it can be understood as a demonstration of skills that are associated with a lower risk of prematurely developing hypokinetic diseases.<sup>2</sup>

Type 2 diabetes is associated with low levels of physical fitness, and people with this chronic disease have lower exercise tolerance than people without diabetes.<sup>3</sup> High levels of physical inactivity, overweight and obesity, poor glycaemic control, history of cardiovascular disease, insulin resistance, endothelial dysfunction, impaired myocardial perfusion, changes in mitochondrial functions, and medication with influence on cardiovascular response to exercise, appear to be at the basis of these differences.<sup>4</sup> Physical fitness, in particular aerobic fitness, is a strong predictor of cardiovascular events, and is inversely related to cardiovascular mortality and mortality from all causes in people with type 2 diabetes.<sup>5</sup> Physical fitness is also associated with quality of life in this population<sup>6</sup> and with the risk of falls,<sup>7</sup> particularly in elderly with type 2 diabetes.

The effects of regular exercise programs developed according to exercise recommendations for people with type 2 diabetes (aerobic, resistance and flexibility exercise)<sup>8</sup> on the main components of physical fitness appear to be well established.<sup>9–11</sup> However, the great majority of studies have developed exercise programs with expensive equipment such as ergometers for aerobic exercise (treadmills, stationary bikes, rowing machines, steppers and ellipticals) and resistance machines for resistance exercise. The assessment of the different components of physical fitness was also performed in these expensive equipment. The access to this type of material resources represents an elevated economic cost in a population with high health expenditures, and not always is available to the majority of people with type 2 diabetes, especially in a community context, as in health care institutions, elderly institutions, city infrastructures and small clubs and associations.<sup>12</sup>

This study aimed to analyze the impact of a long-term community-based combined exercise program (aerobic + resistance + agility/balance + flexibility) developed with high applicability exercise strategies and with minimum and low-cost material resources on aerobic fitness, muscle strength, agility/balance and flexibility in middle-aged and older patients with type 2 diabetes.

## Methods

### Study design

This was a non-experimental pre-post evaluation study, conducted in the city of Covilhã, Portugal, in 2013. Participants were engaged in a 9-months supervised exercise program. Aerobic fitness, muscle strength, agility/balance and flexibility were assessed

before (baseline) and after the exercise program, through physical fitness field tests. Habitual physical activity was also evaluated.

### Participants

Sixty volunteers with type 2 diabetes (30 women and 30 men) were randomly selected (using a computer software) among the patients followed in a local hospital diabetology consultation who applied to participate in a long-term regular exercise program according to the following inclusion criteria: aged 55 to 75 years; diagnosis of type 2 diabetes for at least one year; glycated hemoglobin less than 10%; pharmacological regimen stabilized for at least three months; major complications of diabetes screened and controlled (diabetic retinopathy, diabetic nephropathy, diabetic foot and major cardiovascular risk factors); without limitations in gait or balance; independent living in the community; without participation in supervised exercise programs in the last 6 months; non-smokers in the last 6 months; and dietary pattern stabilized for at least 6 months.

Before study engagement all patients underwent a detailed medical evaluation to screen for relative or absolute contraindications to vigorous intensity exercise, including a maximal treadmill stress test.<sup>13,14</sup>

Study protocol has been approved by the local hospital ethics committee in accordance with the Declaration of Helsinki. All individuals were informed of the benefits and risks of the investigation prior to signing an institutionally approved informed consent document to participate in the study.

Participants received the indication to maintain their routines of daily living (lifestyle-related physical activity, dietary pattern and pharmacological plan), and continue with diabetology consultations at the local hospital along the study duration.

During the study the following exclusion criteria were applied (fig. 1): dropout of the exercise program (N=7); adherence to the program < 65% (N=6); participation in other supervised exercise sessions (N=0); changes in dietary pattern (N=1); accident, illness or surgery with hospitalization (N=2); pathology with limitation in the performance of program activities (N=1). Final sample characteristics are presented in table 1.

### Procedures

Aerobic fitness was assessed through the performance in the 6-Minute Walk Test (6MWT)<sup>15</sup> –the participant is encouraged to walk as far as possible in 6 minutes in a closed circuit. Muscle strength (lower limbs) was assessed through the performance in 30-Second Chair Stand Test (30SCST)<sup>16</sup> –from the seated position, the participant is encouraged to complete as many full stands as possible within 30 seconds. Agility/balance was assessed through the performance in Timed Up and Go Test (TUGT)<sup>17</sup> –from the seated position, the participant is encouraged to rise from the chair, walk three meters, turn around, walk back to the chair, and sit down, in the shortest time possible. Flexibility (lower limbs and lumbar spine) was assessed through the performance in Chair Sit and Reach Test (CSRT)<sup>18</sup> –seated on a chair, with the preferred leg

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