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Original Article

Adherence to an adapted physical activity program in sedentary adults

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ABSTRACT

Background/Objective. Physical exercise plays a key role in the prevention and prognosis of chronic diseases. Despite this evidence, a low percentage of patients regularly perform physical activity. A better understanding of the variables associated with poor adherence may help to develop some strategies to encourage people to participate in exercise interventions. This study investigated the factors influencing adherence to an Adapted Physical Activity (APA) program in subjects suffering from Acute Coronary Syndrome (ACS) clinically stable, Type 2 diabetes, or metabolic syndrome. Secondary end point was to test the efficacy of the exercise training on fitness parameters (VO_2, Speed and Time) by 1 km test. Methods. The program was planned in two phases. Phase 1: individual and supervised training free program for 4 weeks; Phase 2: paid training supervised program involved small groups of 4-6 participants for 8 weeks. Results. 117 patients (50-64 years, 49 men and 68 women) started the APA program, but only 32 patients (17 men and 15 women) completed phase 2. As collected during telephone interviews, the main factors that influenced adherence including health status, work commitments or family problems. Regarding the physical efficacy, an improvement of the three fitness parameters was observed in the 32 patients who completed the 12 weeks of the APA program. Conclusions. The identification of factors that can influence adherence to exercise programs is the first step in planning and improving health interventions. These parameters have an important public health interest.
Keywords: Chronic diseases; Fitness; Health; Physical exercise; Prevention.

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INTRODUCTION

Physical inactivity is a leading risk factor for non-communicable disease and specifically for cardiovascular disease including obesity, type 2 diabetes, coronary heart diseases, and hypertension (Arem et at 2015; Hupin et al 2015; Nasi et al 2019; Physical Activity Guidelines Advisor Committee 2008; Fletcher GF 2015). The benefit of regular physical activity affects both individually directly and indirectly the community (Poorolajal J 2020; Mazzuca et al 2017; Mattioli et al 2020 a). The increased health risks associated with physical inactivity may also generate a heavier economic burden. Although studies vary with respect to the data and methodologies used, the economic burden of physical inactivity on health care costs has been shown to be substantial (Sambamoorthi et al 2015). Physical inactivity is significant in reducing the autonomy of the people and in the onset and/or exacerbations of many chronic diseases, resulting in fallout cost for both social and health care. It is estimated that, globally, insufficient physical activity causes 3.2 million deaths per years and that only in 2010, caused 69.3 million DALYs, or 2.8% of total (GBD Risk Factors Collaborators 2013; World Health Organization 2010).

The Improvement of individual adherence to exercise programs is a key element to gain in health benefits on the population levels.

We propose an Adapted Physical Activity (APA) program to change sedentary behaviour in subjects suffering from Acute Coronary Syndrome (ACS) clinically stable, Type 2 diabetes, or metabolic syndrome. The present study investigated the efficacy of the exercise training on some fitness parameters, and the adherence of patients to the different phases of the program.

METHODS

Selection of patients

Patients with clinically stable coronary artery disease (CAD), type 2 diabetes, and hypertension were included in the study. They were referred by physicians (cardiologists and endocrinologist from the Regional Health Service). All participants were sedentary and they had not been previously engaged in a regular physical exercise program. All procedures performed in the study were in accordance with the Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study. The institutional review board of our University approved the project.

The Project has been activated with a collaboration agreement between the Ministry of Health and the Emilia Romagna Region and it was approved by Resolution of the Emilia Romagna Regional Council n° 2054 of 20 December 2010.

Clinically stable CAD was defined by the absence of residual ischemia and electrical instability and left ventricular function at rest with FE ≥ 40 %.

Type-2 diabetes patients included subjects with Diabetes Mellitus (DM) diagnosed by not more than 5 years, fasting blood glucose below 250mg/dl, not insulin therapy and Body Mass Index (BMI) between 27 and 40. (International Diabetes Federation 2006).

Exclusion criteria were respiratory diseases, systemic conditions which do not allow a physical activity even if moderate, history of Central Nervous System (CNS) events (e.g. hemiparesis, myelopathy, cerebral ataxia), diabetic foot, proliferative retinopathy (allowed up to mild and moderate kidney disease (eGFR < 60 ml \ min),

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osteoarticular particularly debilitating, postural hypotension defined as a decrease in Blood Pressure (BP) moving from a supine position to orthostatic ≥20 mmHg for systolic or ≥10 mmHg diastolic. Physician specialists in sports medicine (PSSM), in collaboration with an expert specialist in physical exercise, performed the specialist check by strength test and the maximal exercise test. After the evaluation, PSSM certificated eligible subjects that can participate in the study. Participants who were taking medication were included, provided they were willing to maintain their current level of drug therapy.

A control group of 30 patients was included. They monitored 5 vital parameters (heart rate, blood pressure, oxygen saturation, respiratory rate and temperature) before and after physical activity using a non-invasive device Butterflife® (VST srl, Italy).

Incremental test

Based on the physical capacity subject were assigned to one of 3 types of protocols: 1) Balke protocol, modified, 2) Protocol to the American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR 2004), and 3) protocol to the bicycle ergometer.

During the Balke protocol, the subjects had to walk for two minutes to fixed speed and a slope 0%. During the test period, the gradient was increased by 2 % per minute until the participant subjectively reported a 9 (very hard) on the Borg rating of perceived exertion (RPE) scale (RPE peak = 10). The test was terminated earlier if adverse signs and symptoms arise. The protocol of AACVPR 2004 recommended for those with a reduced functional capacity, less than 12 metabolic equivalents (MET). On the treadmill, the speed and incline increments were expected every 30 seconds. The bicycle ergometer test was carried out by three minutes without load, free cadence followed by increments of 10 watts each minute, until exhaustion muscle.

The test monitored continuously by using a 12-lead electrocardiogram (ECG) every minute, was conducted until muscle exhaustion or discontinued whenever the following signs and unwanted symptoms occurred: angina, sub-segment elevation ST segment ≥2mm, hypotension (decrease in systolic blood pressure of 10mmHg after initial physiological increase), over-ventricular tachyarrhythmia or ventricular.

Blood pressure and stress perceived intensity were measured every two minutes, according to Borg Category Ratio (CR) 10 scale. (Borg 1982).

ECG evaluation and the BP continued for at least three minutes after discontinuation of the trial, with indications of the values of heart rate (HR) and BP every minute of injury time.

The determination of the exercise capacity of each subject was calculated using the basis of the duration of the test, the speed and incline level of the carpet or the load of bicycle at which the test was discontinued.

The maximum load has been reached thus expressed in MET, applying validated formulas, available for both the Balke protocol and for the AACVPR2004 protocol.

Strength test

Indirect evaluation of muscle strength was performed using estimation of 1 Repetition Maximum (RM) as follows: according to the load that each subject was able to lift for a number of repetitions between 5 and 8 for every mode of operation; subsequently applying the equation of Brizycky the theoretical maximum load was estimated as a function of the number of repetitions performed. (Armstrong et al 2006).

The participants will be instructed and allowed to practice correct lifting and breathing techniques for each exercise before the test and will complete ten repetitions of the exercise at a low to moderate load.

The upper limbs have been tested to the "Chest Press", the trunk at "Low Row" and the limbs below the "Leg Press".

The post-ACS subjects performed monoarticular movement to avoid an excessive increase of blood pressure.

Study design

Phase 1

At the initial stage, APA program was conducted at the gym of Sports Medicine Center under specialist supervision at least twice a week. The participation to APA program was free. The sessions of training were individual and personalized structured and supervised by an exercise specialist.

APA program provided training combined (aerobic + strength) based on the recommendations contained in the current international guidelines. (U.S. Department of Health and Human Services 2008). The expected duration of phase 1 was of 4 weeks.

Each training session lasted 90 minutes and consisted of 5 minutes' warm-up, 60 minutes of conditioning, and 25 minutes of cool-down, balance exercise and stretching. The conditioning component consisted of approximately 40 minutes of aerobic training (0-10- on Borg's RPE scale), followed by 20 minutes of resistance exercise.

The resistance exercise involved three different exercises, predominantly multi-joint exercises for the upper and lower extremities at intensity 3 sets of 10 repetitions (30% of 1 Revolution per minute (RPM)), with 1-2 minutes of rest among the exercise. The progressively increased workload is conducted by an increase of 10% of 1RPM until 80% of 1RPM (during all study) or repetitions (20*2sets) about every 2 weeks.

The resistance-training program included: leg press, chest press and low row. Patients with knee and back problem performed seated exercise.

The mode of aerobic exercise varies depending on the participant's choice but included two activities (treadmill, bike or recline); however, weight-bearing exercise such as walking was encouraged. The intensity of activity was 55-60% of maximal heart rate (220-age) and increased of 5-10% until 80% (during all study) about every 2 weeks. The heart rate was monitored at the end of each aerobic activity.

Phase 2

Subjects are admitted to phase 2 if they have the ability to self-control and understanding the training session by monitoring of some indicators of exercise intensity, like the intensity of Borg's RPE(Rate of Perceived Exertion) and heart rate (%HRR). The subjects continued the program outside the Sports Medicine Center, in a gym certificated by Regional Health Service (Regional resolution n.1154 of 1 august 2011). Patients had to pay a fee to participate in the program. Training sessions were organized for small groups of patients (4-6 participants) at scheduled times. The recommended frequency was at least twice per week. The physical exercise was structured and supervised always by an exercise specialist. The frequency and type of physical exercise were comparable to phase 1, but the exercise specialist modified training intensity taking into account the physical fitness of each subject.

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Follow-up

All patients were contacted by telephone 3 months after the end of phase 1 or following their abandonment during phase 1. Through a structured interview to all participants, the frequency of training, in case of continuity, or the causes of abandonment were investigated. The factors of drop out were classified into the following categories: health status, work commitments, family reason, lack of time, laziness, motivation, gym, distance, economic.

Physical fitness-1km

Walking tests have been used to assess exercise capacity and to investigate outcomes in many rehabilitation programs. The walking test (1km) allows estimating the VO_{2max} in subjects with a previous acute cardiovascular event, in secondary prevention. (Molino-Lova R et al 2012; Chiaranda G et al 2012; 2014) Participants began the test walking on the level at 2 km/h, with subsequent increases of 0.2 km/h every 30 s up to a walking speed corresponding to a perceived exertion of 3-4 on the Borg CR10 scale. This value corresponds to moderate intensity: VO_{2max} ($ml*kg^{-1}*m^{-1}$), HR ($beat*min^{-1}$),Speed (kg/h) and time (min*sec).

The measured VO_{2max} was obtained by using the formula by Hansen and Wasserman (2005).

Statistical analysis

The analysis was performed using Package for Social Study version 22 (SPSS v22). Descriptive statistics were used to explain the abandoned during the study. Unless otherwise stated, data were presented as mean and standard deviation (SD) and percentage (%) for categorical data.

A paired T-test was performed to analyse the effect of APA program on the value of 1km (VO_2, HR, Speed and time) in the group of participants who concluded the study. A p-value < .05 will be considered statistically significant.

RESULTS

The flow chart of the study plan is shown in Figure 1.

Of the initial 160 patients invited to participate to the study (aged between 50-74 years, 81 women and 79 men) by a specialist physician (cardiologists, endocrinologists), 133 subjects accepted to adhere to APA program and 27 patients declined. Among the main reasons, which prevented their participation, they reported health status, laziness and lack of time (Figure 2A).

Patients population included 30 individuals suffering from CAD, 20 individuals with type-2 diabetes, 2 were obese and 81 individuals were affected by multi-pathological status including stable CAD and metabolic syndrome.

Based on the results of both strength test and maximal exercise test, 16 subjects were declared not eligible for the study by PSSM.

After the selection, 117 patients (age between 50-64 years, 49 men and 68 women) were included in the study and started the structured and supervised APA program in the gym of sports medicine centre twice a week for 4 weeks. 88 patients completed the training program (16 individuals suffered from coronary artery disease, 10 individuals from type-2 diabetes, 1 individual was obese and 58 of multi-pathological status). 29

patients have abandoned the study before the 4 weeks. The drop out was mainly associated with the health status, laziness and work commitments (Figure 2B).

Among the 88 patients, only 55 began the Phase 2 program in a gym certificated by Regional Health Service. The adherence was 62.5%. 33 patients did not take part in the Phase 2 program mainly because of health status, family reasons and work commitments (Figure 2C). Only 32 patients completed the 8 weeks program of Phase 2. Twenty-three patients dropped out mainly due to health status, work commitments and lack of time (Figure 2D).

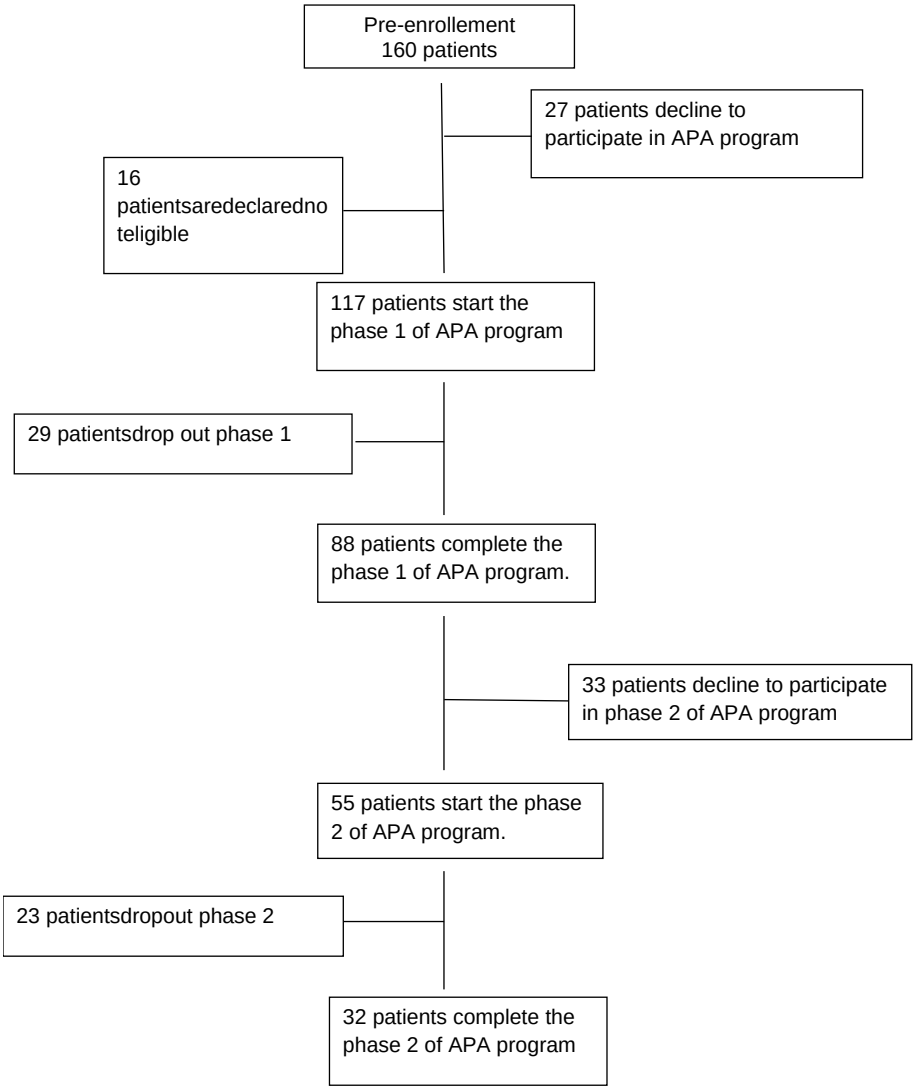

Figure 1. Flow chart of the study design. Adapted Physical Activity Programis based on two phases. Phase 1: individual and supervised training free program conducted at the gym of Sports Medicine Center for 4 weeks; Phase 2: paid training supervised program conducted in a gym certificated by Regional Health Service involved small group of subjects for 8 weeks.

The control group of 30 patients using a non-invasive device for monitoring heart rate and blood pressure has only one drop out due to symptoms of peripheral arterial disease.

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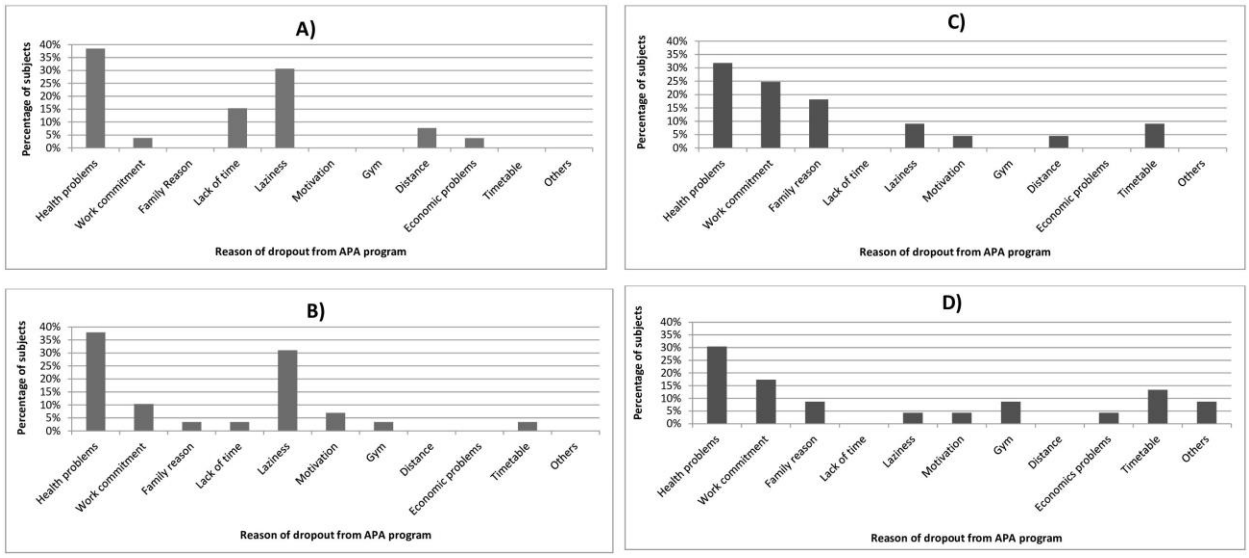

Figure 2. Factors that influenced the drop out of the Adapted Physical Activity (APA) program. A: Patients (n:27) declined to participate in the APA program; B: Patients (29) dropped out the phase 1; C: subject (33) did not take part to pe 2; D: subject (23) dropped out the phase 2.

Taking into account the starting number of patients who adhered to the APA program (n:117), the percentage of patients who completed the study was only 27.35% (32 individuals, 15 females and 17 males). On the contrary, the number of patients that concluded the follow-up period in the control group was higher (96.6%) suggesting strong support of technology to maintain activity. A total of 85 patients abandoned the study during the different phases of the program. Table 1 shows data relating to the abandonment of the patients from the APA program. The number of females was greater than that of males at each step.

Table 1. Number of patients who abandon the different steps of the APA Program.

	Steps of the Adapted Physical Activity Program		
	T1	T2	T3
All (n°)	29	33	23
Male (n°)	12	9	11
Female (n°)	17	24	12

T1: Patients who abandon during the 4 weeks of phase 1; T2: Patients who did not take part to phase 2; T3: Patients who abandon during the 8 weeks of phase 2.

Table 2 shows the results regarding physical fitness parameters measured – at baseline and at the end of phase 2 – in the 32 patients who completed the program.

Table 2: Physical fitness parameters (mean ± SD) measured – at baseline and at the end of phase 2 – in the 32 patients who completed the APA program by 1 km Test.

Physical fitness parameters	**Baseline**	**End of phase 2**	**p value**
VO_2 ($ml*kg^{-1}*m^{-1}$)	49 ± 17	61 ± 24	.01
Speed (km/h)	4 ± 1	5 ± 1	.02
Time(min:sec)	13:26 ± 3:16	11:30 ± 2:17	.02

Overall, data show an improvement for all the parameters at the end of APA program. In particularly the duration of the submaximal treadmill test decreasing by approximately 1 min and 54 seconds ($p = .02$) compared to baseline, and estimated VO_{2max} increasing by 12 ml/kg/min ($p = .01$) compared to baseline.

DISCUSSION

Physical inactivity is associated with an increased risk for multiple causes of mortality, chronic morbidity and disability, and is an important global public health concern. (hypertension (Arem et at 2015; Hupin et al 2015; Nasi et al 2019) Regular physical exercise can prevent or change the prognosis of chronic disease, including hypertension, diabetes, metabolic syndrome (Mattioli et al 2019, Nasi et al 2019). Despite such evidence the number of individuals who regularly attend exercise programs is relatively low. Adherence to a regular exercise program is affected by the complex interaction of health, psychological, social, economic and demographic factors. A number of different variables can interact to create a barrier to adequate exercise (Burgess et al 2017). A better understanding of the variables associated with low adherence may help in the development and planning of exercise intervention involving a specific group of people such as the elderly, obese or individual suffering from metabolic syndrome or heart diseases.

The present study found that the main reason for the drop out was health status in all four steps of the study. Our finding is in line with previous studies indicating that poor health status (chronic health condition, illness perception, the severity of diagnosis) is an important barrier to adhere to physical exercise program (Jefferis et al 2014; Siegmund et al 2017; Foreschi et al 2018). Each exercise program for patients with chronic pathologies should be personalized considering health status and delivered by qualified personnel. The specialists in physical exercise have to motivate patients to start and continue an adapted exercise program by explaining to each participant the safety of new training movements and the characteristics of the proposed exercises. Misconceptions about physical exercise can be a significant barrier to attendance and highlight the importance of participant's education by healthcare staff (Armstrong et al 2006) Education has been shown to improve motivation to adhere to a healthy lifestyle in acute coronary syndrome patients (Mattioli et al 2020 b; Eshah 2013).

Laziness is a factor that influenced participation in the program or caused abandonment during the 4 weeks of the supervised individual APA program in the gym of Sports Medicine Centers. An important aim among healthcare professionals is to encourage patients to make a healthy lifestyle choice, such as engaging in exercise. The motivation for exercise is an important concept in the examination of the physical activity program. Burges et al. (2017) highlighted that behavioural treatment strategy (e.g.: goal setting, motivational interviewing) improve adherence to lifestyle intervention programs in adults with obesity. Patient's effective judgments, defined as the overall pleasure/displeasure and enjoyment expected from a given activity, plays an important role in behaviour change. A behavioural approach can also help to address the barriers to behaviour change in the initial phases of lifestyle intervention and to develop individualized treatment plans Beauchamp et al 2015).

Self- monitoring of health parameters through ButterfLife has a strong influence on adherence as shown by results obtained in the control group. These results are in agreement with previous observation (Jacobsen et al 2020).

During phase 2 of the study, participants reported as a factor for abandoning of the program, in addition to health status, work commitment and family reason. In phase 2, the training session was organized in a small group of 4-6 participants, at scheduled times in certificated gyms. These findings indicate the need to improve

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the planning of sports activities, including the timetable and session-schedule, to prevent the exercise program disrupts daily activities, overlaps with family commitments or interferes with work performance.

As expected, gender was an important factor of compliance to physical program in our study population. A larger number of females started the program, but the percentage of females who completed the program was lower than that of males. Moreover, a large number of females did not participate in phase 2 of the study when physical activity was planned outside the Sports Medicine Center. This finding is in agreement with previous literature (Sciomer et al 2019; McArthur et al 2014; Mattioli et al 2019; Diemberger et al 2017)). The lower adherence of women to exercise program than men might reflect the situation that women devote more of their time to their multiple responsibilities including work, home care and family (Oosenburg et al 2016; Sciomer et al 2019). On the other hand, men may enjoy physical activity more than women, and men usually have higher self-efficacy for physical activity thus perceiving fewer barriers or less influenced by barriers (Oosenburg et al 2016; McArthur et al 2014) . Therefore, particular attention should be addressed to identify the factors that can influence women and help them find ways to overcome their barriers to regular exercise.

The overall results regarding abandonment from the program indicate that a large number of patients did not participate in phase 2 of the study based on paid training supervised program for a small group at scheduled times. The main reasons for low adherence were health status, work commitments or family problems. Factors related to economic situations, subjectivity (laziness and motivation) or logistical factors (gym, distance) did not influence the participation of patients in the program. This highlights the need to develop a combination of individually tailored strategies, implemented within a multi-disciplinary setting, based on training programs correctly adapted to the health status of the patients, alongside the planning of the sports activity in terms of timetable and schedule to overcome the barriers linked to the individual daily life.

Another objective of our pilot study was to evaluate the efficacy of the APA program on aerobic fitness. Improvement of all three physical health parameters evaluated was observed in the 32 patients who completed the 12 weeks of APA program. This finding is in line with previous studies. Kang et al. (2016) showed a large-scale amelioration in physical function and muscular strength of patients with metabolic syndrome were trained for 12 weeks. In a group of overweight and/or obese individuals, after 12 months of moderate regular exercise, Gondim et al (2015) observed a better distance of the aerobic capacity test, beneficial effects on the low-grade inflammatory state, decreasing leptin, and IL. Regular training confers beneficial effects on the heart as well as the entire body. This occurs partly because exercise training improves skeletal muscle work capacity and reduces resistance, thus increases conductance in the peripheral circulation. Extrinsic modulation of the heart alters and improves the intrinsic pump capacity of the heart (Kemi et al 2010).

Limitation of the study

The APA program was designed for only 12 weeks and then the duration may have been insufficient to elicit significant adaptation to the measured parameters. Only 32 patients have completed the program, so the limited number precluded the possibility to check the influence of some variables (e.g.: age, gender) on the evaluated fitness parameters.

CONCLUSIONS

Our study has an important public health interest. APA-program improved physical fitness parameters in sedentary patients who completed the 12 weeks exercise program. The benefits of physical activity should be explained to patients at risk. Patients who know that changing lifestyles has a positive impact on their

health can be motivated to participate in exercise programs. The identification of factors that can influence adherence to exercise training is the first step that can help health professionals and political authorities to develop prevention interventions.

AUTHOR CONTRIBUTIONS

P.M.L and F.T. conceived of the idea at the basis of the article. F.M, A.V.M. and P.M.L developed the different part of the manuscript. L.N.V., M.N. and L.B. collected data sample. S.T., A.V.M. and PLM performed the final supervision. All authors contributed to and approved the final manuscript.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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