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Healthy aging with sport: A case-report of an 81 years-old Italian man

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Abstract

Age-related decreases in endurance performance are well known. However, several researches have been carried out on octogenarian athletes, who achieved high performance in some endurance sports. This case report aimed to discuss exercise capacity, body composition and the cardiovascular and common risk factors of an 81-year-old man with a high level of physical activity. The man had a body mass index of 25.59 kg/m^2 with a high percentage of skeletal muscle mass (79%). Maximal oxygen uptake was 39.5 mL/min/Kg and oxygen pulse was 18.7 mL/beat showing an excellent exercise capacity. Heart and pulmonary functions were optimal for his age. Bioelectrical phase angle was higher than the average values for his age and gender. Physical activity carried out continuously is confirmed a predictor of healthy state in elderly age, however it is mandatory that master athletes carry out periodic checks of their state of health and monitor vital parameters during intense training.

Keywords: Aging; Cardiovascular risk; Endurance training; Master athlete; Monitoring.

Introduction

Physical activity is a fundamental part of healthy lifestyle, together with healthy diet and good sleep quality [1,2]. Performing regular physical activity help to prevent chronic disease and increase longevity and good life quality [3-5]. In response to population ageing, several conceptual models such as active ageing, successful ageing, or healthy aging have been proposed to address the idea of aging well. A model has recently been proposed that includes a personalized diet and physical activity tailored to the subject [4]. The decrease in VO_2 that accompanies aging appears to accelerate from 65 to 85 years. Therefore, if the decline in the VO_2max curve is greater in these older ages, the oxygen delivery and utilization systems of many of the less fit elderly are known to fall below the minimum needed to maintain independent living.

Age-related alterations in bioimpedance variables during aging reflect changes in body composition and muscular function occurring during aging process [6,7]. A rapid decrease in the bioelectrical Phase Angle (PA) in men and women from 65 to 90 years old has been demonstrated [8]. Cumulative findings from research on training effect in the elderly support the notion that a substantial amount of physical deterioration previously attributed to aging can be prevented, delayed and, in some cases reversed [9]. However, there are still many controversial issues. Physical activity has a positive effect on chronic diseases, but there is no certain information that intense training has the same effect. Strength training is a potent tool to improve maximal strength and Rate of Force Development (RFD), however, individuals' response to training may be highly variable [10]. Furthermore, biological factors influence single person's predisposition to physical performance [11]. Age-related decreases in endurance performance have been described on running, swimming and triathlon [12]. Endurance performance shows a progressive reduction after the age of 70 years. A high level of physical performance and a healthy lifestyle are fundamental to prevent several diseases during the aging process and to reduce "in-flammaging" [13]. Physical abilities are a strong and independent predictor of mortality and ensure a lower predisposition to depression, sarcopenia, cardiovascular, metabolic and respiratory diseases [2,14-16]. Most of the studies in literature focus on pathophysiological changes in master athletes. Tangchaisuriya P and coworkers [17] evaluated the physiologic adaptation to High-intensity interval training combined with blood flow restriction [17]. They found that this combination may be more effective in enhancing performance and physiological functions in Master Road cyclists [17]. Similarly, Del Vecchio and coworkers found that including strength and sprint exercises in training can increase total lower limb lean mass and sprint performance in endurance-trained masters road cyclists [18].

We present this case report to support the hypothesis that a constant physical activity could lead to a significant improvement in body composition parameters, an increase in vital functions and a progressive improvement in health conditions in Master athletes

Methods

A male triathlon was analysed (81 years old, 163 cm, and 68 kg). An accurate pathological and sporting anamnesis was made and several tests were performed. Subject completed the SF-36 questionnaire [19]. Questionnaire consists of eight scales (physical activity, physical role functioning, health in general, bodily pain, vitality, emotional role functioning, mental health, social role functioning), each of which consists in an evaluation based on a single question on the change in health conditions. Questions and subscales of the SF-36 are organized in such a way that the higher the score, the better is the health for the specific subject.

Respiratory function test and cardiopulmonary exercise test

Subject performed a respiratory function test (forced flow-volume curve) and a maximal cardiopulmonary exercise test.

The forced flow-volume curve was performed to measure forced vital capacity and Forced Expiratory Volume in one second (FEV1). In accordance with the guidelines of the American Thoracic Society/European Respiratory Society subjects repeated the maneuver at least three times and the two largest values had to be within 0.15 L of each other.

The maximal exercise test was performed on a cycloergometer until subjective exertion, exertional chest pain, or other untoward findings (i.e. ST-segment depression). Exercise was considered adequate if was limited by dyspnea o muscular fatigue and by the attainment of at least 2 of 3 following criteria: Heart Rate (HR) value within ±10 beats per minute of predicted age-related maximum, HR ≥85% of predicted age-related maximum, and maximal Respiratory Exchange Ratio (RER) ≥1.10. A 25 watt/min ramp protocol was used. A standard 12-lead electrocardiogram was continuously recorded. Gas-exchange measurements were performed using a metabolic cart (Quark b2, Cosmed, Rome, Italy). Oxygen consumption (VO_2) and Carbon Dioxide Output (CO_2) were acquired breath by breath and average for 15 second intervals. VO_2 peak was defined as the highest level of VO_2 achieved during the test. Blood pressure was recorded at rest and every minute during the test. He was asked to rate his "shortness of breath" and "leg discomfort" every minute using the 0-10 Borg's category-ratio scale (RPE).

Blood sample test

Subsequently, blood samples were collected to analysed haemoglobin, glucose, total cholesterol, High Density Lipoproteins (HDL), Low Density Lipoprotein (LDL) and triglycerides.

Assessment of physical-motor skills

The assessment of physical-motor skills was carried out with three different tests: chair stand test, for the assessment of strength and endurance of lower limbs; sit and reach, as a measurement of the flexibility of the rear kinetic chain; finally, back scratch test for the evaluation of the mobility of the shoulder girdle [20].

The Fullerton test comprises 6 trials that enable an indirect assessment of the upper and lower body strength, aerobic endurance, motor coordination, and balance. Prior to commencing the test, the examined person should be instructed to perform the tasks as good as possible. Appropriate safety should be secured by proper positioning of the devices used during the testing procedure. Before the tests are started, a five- to ten-minute warm-up should be conducted as well as general stretching exercises performed. Prior to the commencement of and after the termination of the trials, arterial blood pressure and heart rate should be measured [20].

Bioelectrical impedance

Impedance measurements (resistance, R; reactance, Xc) were obtained using a single-frequency analyzer (BIA 101, Akern, Italy) with an operating frequency of 50 kHz at 800 μA. The whole procedure complied with international criteria (NIH, 1996), and participant avoided eating or drinking (for 4 h), intensive exercise or alcohol intake (for 12 h) before the test. Standard whole-body tetrapolar measurements were taken according to conventional procedures established in the literature [21,22].

Anthropometric measurements

Finally, several anthropometric measurements were collected: body height, body mass, waist circumference, hip circumference, thigh circumferences, calf circumferences, wrist circumferences, arm circumference in relax condition, arm circumference in a contracted position, thoracic circumference, thoracic maximum circumference, thoracic minimum circumference; triceps skinfold, biceps skinfold, subscapular skinfold, suprailiac skinfold, supraspinal skinfold, calf skinfold (medial and lateral); humeral diameter and femoral diameter. Height was measured to the nearest 0.1 cm using an anthropometer (Raven Equipment Ltd, Great Donmow, UK). Body mass was measured to the nearest 0.1 kg using calibrated electronic scales (Seca, Basel, Switzerland). Circumference measurements were determined using a metric tape; waist and hip circumferences were assessed to calculate the Waist Hip Ratio (WHR), an index related to numerous cardiovascular and metabolic diseases [23]. Skinfolds measurements were made using a skinfold caliper (Lange, Beta Technology Inc., USA); diameters measurements were made using a curved branch compass (Leo Temin, Firenze, Italy). Body composition indices: Body Mass Index (BMI), Fat Mass percentage (%FM), Lean Body Mass percentage (%LBM), Total Upper Arm Area (TUA), Upper Arm Fat Area (UFA), Upper Arm Muscle Area (UMA), Total Calf Area (TCA), Muscle Calf Area (CMA), Fat Calf Area (CFA), and morphological parameters (somatotype) were calculated from anthropometric measurements. The BMI was calculated as the ratio between weight and height (expressed in meters) and then squared; the %FM was calculated using the Siri formula [24]. In addition, the somatotype was calculated [25].

Ethical: The study was approved by Bioethical Committee of "Alma Mater" University of Bologna on October 26, 2016. Informed consent was obtained from the subject involved in the study.

Results

The man had a long story of training in different sports. He began to practice boxing when he was 16 years-old; then he played tennis and practiced swimming until 1996, when he began to practice triathlon. He also decided to participate to the Ironman competition; he ranked third in Lanzarote 2002 and ninth in Fredericia (Denmark). He was twice long distances Italian champion, once Olympics Italian champion, twice vice World champion. He always trained by himself according to his sporting experience. His best time in an Ironman competition was 12 hours and 25 minutes. In his career he also had several incidents like injuries and fractures that forced him to cease his trainings but after every accident he returned training. He had an optimal health, without limitations in personal care and in physical, social or personal activity. Additionally, he had not physical pain and psychological distress.

The man is now 81 years old. He had a body max index of 25.59 kg/m^2 and he had a lean body mass of 79%, corresponding to 53.72 kg. Bio-humoral parameters are shown in Table 1.

Doppler echocardiography was normal, the ejection fraction was 67%. Spirometry was normal, Forced Expiratory Volume in one second (FEV1) was 3.41 L and his ratio between FEV1 and Forced Vital Capacity (FVC) was 0.94. Test was interrupted for muscular fatigue (RPE 9/10) at 206 watts. The VO_2 peak was 39.5 mL/min/Kg corresponding to 2.65 L/min and 11 Metabolic Equivalent (METS). At maximum effort,

Table 1: Demographic description of the case.

General	
Age, year	81
Height, cm	163
Weight, kg	68
BMI, kg/m^2	25.59
Fat mass, %	21
Lean body mass, %	79
Fat mass, kg	14.28
Lean boby mass, kg	53.72
Total upper arm area, cm^3	482
Upper arm fat area, cm^3	346.05
Upper arm muscle area, cm^3	136.75
Total calf area, cm^3	961
Muscle area of the calf, cm^3	156.27
Fat area of the calf, cm^3	805.35
Endomorphic value	4.5
Mesomorphic value	3
Ectomorphic value	0.5

Circumferences	
Waist, cm	87.2
Hip, cm	91.5
Calf, cm	35
Wrist, cm	17.5
Relaxed arm, cm	24.8
Waist-to-hip ratio	0.95
Width	
Humerus, cm	6.5
Femor, cm	9.6
Skinfolds	
Biceps, mm	4
Triceps, mm	16
Subscapolar, mm	13
Suprialiac, mm	16
Supraspinal, mm	11
Lateral calf, mm	8
Medial calf, mm	6

the HR was 142 beats/min (101% of the afore-mentioned), ventilation was 85.6 L/min (94% of the afore-mentioned) and ventilatory reserve was 27,4% that was classified as normal. The oxygen pulse at peak was 18.7 mL/beats (184% of his hypothetical value). The anaerobic threshold was normal at 57% of VO_2 peak (VO_2= 1513). Ventilatory Efficiency was normal (VE/VCO_2) 27.9.

He did 24 repetitions in the chair stand test (data are above average >15 within his age range). He did the sit and reach test with a score of 32.2 cm (Test Scores are 28 to 34 = Above average) and in the back scratch flexibility test he got a score of 1.5 cm (data are above the average of -9.5 to -2.0 within his age range).

General information and measured features are reported in Table 1.

Discussion

This case report demonstrates that lifelong physical activity led to a significant improvement in body composition parameters and was a useful tool for maintaining good vital functions.

Despite his age, the subject showed good physical abilities. The subject had good vital functions and had an optimal perception of his mental and physical health state, so he represents a positive example of a healthy aging. Recently, a meta-analysis conducted on more than 250,000 subjects showed a pooled estimate mean Phase Angle of 5.3 (95% CI: 4.5-6.0) for elderly above 80 years old [8]. Since that Phase Angle is considered as an important predictor of health status [8], the value measured in this study, above average for its age and gender, reflects the beneficial effects of a correct lifestyle and sports practice.

However, we must differentiate between physical activity and intense training. While the effects of physical activity on chronic disease prevention, sarcopenia and frailty are well known, little is known about the effects of intense training [25], several evidence underline how intense training acts at the cardiovascular level by inducing ventricular and vascular remodelling. It is conceivable that these effects are different in junior athletes than in master athletes. The question is: when enough is enough?.

Master athletes have a high CV risk determined by age and exposure to risk factors throughout their life. Among endurance-trained masters athletes, clinically relevant aortic dilatation, defined by a diameter at the aortic root or ascending aorta ≥40 mm, is common [26]. Whether this phenotype represents adaptive vascular remodelling, akin to the 'athlete's heart', vs. a manifestation of overuse pathology is uncertain [26]. The risk of developing coronary artery plaque has been underlined by Merghani and coworkers [27]. They found that male masters endurance athletes are more likely to have a CAC score >300 Agatston units or coronary plaques compared with sedentary males with a similar risk profile. The significance of these observations is uncertain, but the predominantly calcific morphology of the plaques in athletes indicates potentially different pathophysiological mechanisms for plaque formation in athletic versus sedentary men. Coronary plaques are more abundant in athletes, whereas their stable nature could mitigate the risk of plaque rupture and acute myocardial infarction [27]. The need for accurate monitoring of cardiovascular parameters during training has also recently emerged. Monitoring is an essential part of well-being and of performing physical activity and sport in safety, mainly in older subjects [28]. In this case the subject had a 50% lower all-cause mortality risk compared to untrained octogenarians. His METS values placed him in the lower mortality risk category. In fact, for every 1-MET level increase in exercise capacity above 5 METS the mortality risk was 12% lower. Another indicator of mortality risk was the WHR and the health risk increases as WHR increase and for people aged older than 60 years-old the cut-off values were ≥1.03, so he had a lower mortality risk (0.95). Furthermore, he had an optimal concentration of LDL cholesterol and a desirable value of total cholesterol, normal values of triglycerides and haemoglobin. The lipid pattern suggests a low risk of developing cardiovascular diseases [16,27,29,30]. Regarding his aerobic exercise capacity his data pointed out a large cardiorespiratory reserve if we considered a VO_2max of 17.5 mL/kg/min the threshold for frailty. The VO_2max is primarily attributable to a high cardiac output that is heart rate x stroke volume. The reduction in maximal heart rate is one of the principal causes of decline in aerobic capacity with age. The high maximal heart rate in this man contributed to his high VO_2 peak. In addition, the high O_2 pulse at peak effort is comparable with that reported for 70 years master athletes [29,31]. Moreover, ventilatory efficiency reflects a good integrated function of the cardiorespiratory and skeletal muscle systems and a good match of ventilation and perfusion in pulmonary ventilation.

The volume of weekly physical activity for an active 81 years-old man was high, two times higher than recommendations for moderate and vigorous physical activity. The subject VO_2max was also 18 ml/kg/min higher than the average of 21 published studies about octogenarians and VO_2max in which the average was 21±4 ml/kg/min. The man's aerobic power was comparable to healthy non endurance-trained men 20 years-old younger (75th percentile), 40 years-old (50th percentile) and 60 years-old younger

(20th percentile) [31]. The improvement in performance observed among master athletes over the past few decades was more marked for the older age groups and the octogenarians endurance performance was exceptional. Previous studies showed that in the Ironman triathlon males older than 44 years old improved their performance in the three disciplines (3.8 km swimming, 180 km cycling and 42 km running) and in the total time necessary to complete the race. His maximal ventilation was higher than his untrained peers and it was comparable to young (25 years-old) and master-level (45-65 years-old) endurance trained men [32].

Conclusion

This case highlights how intense training can keep the muscular and cardiovascular systems efficient. However, it should be specified that the subject has carried out intense activity throughout his life and this has led to a slowdown in the muscular and cardiovascular changes of ageing. Difficult to transfer these results to the general population. However, our observations suggest that some changes are modifiable. From a cardiovascular point of view, the subject shows good cardiac and respiratory efficiency. The risk of developing CV events is lower than suggested for age-matched individuals. All of this suggests promoting sporting activity and physical activity in young people and encouraging them to continue throughout their lives.

This case suggests that an active lifestyle may help to maintain the proper operation of different physiological systems at 80 years old, which has direct benefits for overall health and reduces the risk of disability. Physical activity carried out continuously is confirmed a predictor of health state in elderly age. The man of this study was a demonstration of physical activity importance during all the life to have a healthy aging. However, we do not know whether starting intense physical activity in old age can give an advantage with respect to cardiovascular risk. There is a need for extensive studies on the effects of training initiated at different ages. We can conclude that the suspension of sport is not indicated in trained elderly subjects in the presence of adequate parameters of cardiovascular and respiratory performance. Moreover, adequate stratification of arrhythmic risk in master athletes is required.

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