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Evaluation of physical fitness parameters in patients with schizophrenia

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ABSTRACT

The aims of this study were to compare aerobic and anaerobic exercise capacities, pulmonary functions, body composition and fat distribution parameters in patients with schizophrenia and healthy controls and to investigate the associations among these parameters. Sixty (30 male, 30 female) patients with schizophrenia and 60 (30 male, 30 female) healthy controls were included in the study. Maximal aerobic capacity was estimated with the Astrand submaximal exercise protocol, and anaerobic performance was determined with a Wingate test. Body composition was established with a bioelectrical impedance analyzer. Pulmonary function tests, skinfold thickness and body circumference measurements were also carried out. Maximal aerobic capacity, maximal anaerobic power, anaerobic capacity and pulmonary function tests (forced vital capacity and maximal voluntary ventilation) were found to be lower in male and female schizophrenic groups as compared to the controls. Body fat percentage, waist and abdomen circumferences, and waist to hip ratio were found to be higher in female schizophrenic patients than in controls. We suggest that maximal aerobic capacity, maximal anaerobic power, and anaerobic capacity are poor in the schizophrenia patients as compared to healthy controls. Low cardiorespiratory fitness is related to reduced pulmonary function and impaired body composition in schizophrenia patients.

1. Introduction

Physical health problems in patients with schizophrenia are common and contribute to their excess mortality rate, as well as decreasing their quality of life (Von Hausswolff-Juhlin et al., 2009). The greatest cause of death in people with mental illness is from cardiovascular and respiratory diseases (Lawrence et al., 2010). People with schizophrenia have an increased prevalence of being overweight/obese, having type 2 diabetes mellitus, dyslipidemia, metabolic syndrome, cardiovascular, and respiratory diseases (Filik et al., 2006; Monteleone et al., 2009). Much of the increased risk could be explained by lifestyle risk factors among people with schizophrenia. Care plans should prioritize interventions to attenuate lifestyle risk factors in patients with schizophrenia (Vancampfort et al., 2010a). Systematic screening and early intervention of metabolic syndrome in schizophrenia patients would be beneficial in reducing the risk of somatic diseases and early death.

A sedentary lifestyle is one of the modifiable risk factors. Vancampfort et al. (2012d) stated that the functional exercise capacity (6-min walking test) was correlated with the global assessment of functioning ($r = 0.59$, $p < 0.001$). Pajonk et al. (2010) found that following 3 months aerobic exercise training, relative hippocampal volume increased significantly in patients with schizophrenia and healthy subjects, with no change in the non-exercise group of patients. Also, they found that changes in hippocampal volume in the exercise group were correlated with improvements in aerobic fitness measured by change in maximum oxygen consumption. Physical exercise brings about significant improvements in cardiovascular and metabolic parameters and in psychiatric symptomatology (Vancampfort et al., 2010b). A physical exercise program also has social advantages; it helps subjects to cope with stress and improves quality of life in patients with schizophrenia (Vancampfort et al., 2012b). In the treatment programs for schizophrenia, it is also essential for the physicians to understand and evaluate the whole aspect of patients with schizophrenia including physical fitness parameters. Identifying which health and performance related physical fitness components are impaired in patients with schizophrenia will help us in developing physical rehabilitation strategies to prevent or reduce the increased cardio-metabolic risk (Vancampfort et al., 2013).

The aims of this study were to compare aerobic and anaerobic exercise capacities, pulmonary functions, body composition (body fat

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percentage, lean body mass), and anthropometric parameters for body fat distribution in patients with schizophrenia compared to healthy controls and to investigate the associations among these parameters.

2. Methods

2.1. Subjects

The study protocol was approved by the Local Ethical Committee of Clinical Research, and all patients and controls participated voluntarily with written informed consent. The patients were diagnosed with schizophrenia by trained psychiatrists using the Structured Clinical Interview for DSM-IV (SCID) (First et al., 1997). The outpatients who had not used antipsychotic medications regularly (not used medication for at least 3 months) before being referred to psychiatry polyclinic were preselected for the study. The control group who applied to our polyclinic and had not been diagnosed any psychiatric illness were preselected for the study. Inclusion and exclusion criteria were determined and appropriate patients and controls were enrolled in the study. Inclusion criteria included those not actively participating in sports and having no risk associated with exercise. Exclusion criteria included alcohol or drug dependences, major musculoskeletal problems, acute infection, dehydration, metabolic, respiratory, cardiovascular disorders, and other systemic diseases.

There were a total of 120 participants, 60 (30 male, 30 female) patients with schizophrenia and 60 (30 male, 30 female) healthy controls, aged 25–55 were included in the study. Because of their biological differences, the analysis of the data was performed separately in men and women. The patients were matched for age and BMI (Body Mass Index) with controls in both genders.

2.2. Exercise tests

Before the exercise tests, the risk of exercise for the subjects was assessed according to the American College of Sports Medicine criteria, and only appropriate subjects were enrolled for the exercise tests (ACSM, 2009). Aerobic (Astrand test) and anaerobic (Wingate test) exercise tests were performed on different days. The subjects were briefed on the test protocols and instructed to avoid food intake and smoking for 2 h prior to the start of the test, and to avoid beverages or foods containing caffeine or alcohol (Cosar et al., 2008).

2.2.1. Astrand test

The maximum volume of oxygen consumed to produce energy (maximal aerobic capacity or VO_2max) was estimated by the Astrand test protocol. It is a valid submaximal exercise test for estimating VO_2max (Swain et al., 2004). The Astrand test was performed on a computerized cycle ergometer (Monark 839E, Monark Exercise AB, Sweden); the optimal seat height was adjusted for each subject, and heart rate was monitored with a chest belt telemetry system (Polar, Monark Exercise AB, Sweden). The initial workload was selected according to gender and conditioning level (ACSM, 2009). The subjects were asked to perform a 6-min submaximal exercise test by maintaining a pedaling cadence of 50 revolutions/minute and reaching a steady state heart rate (within 6 beats/min) during the 5th and 6th minutes of the test (Mollaoglu et al., 2012). The VO_2max was estimated from the heart rate and workload by the Astrand test using a nomogram and an age-correcting factor (ACSM, 2007). Maximal aerobic capacity (aerobic exercise capacity or cardiorespiratory fitness) was expressed in liters per minute VO_2max (l/min) and milliliters per kilogram of body weight per minute VO_2max (ml/kg/min).

2.2.2. Wingate anaerobic test

Maximal anaerobic power and anaerobic capacity were determined using the Wingate test which is a popular, valid, and reliable anaerobic performance test (Bar-Or, 1987).

The Wingate test was performed once for all participants taking only 30 s for each subject. The Wingate test was performed on a Monark 839E cycle ergometer (Monark Exercise AB, Sweden). The load was calculated using the formula [75 (g) × body weight (kg)] for each subject. Pedal revolutions for every 5-s interval were counted by an electronic counter with resolutions of 1/12 and recorded. The subjects were initially allowed unloaded pedaling for 5 s to reach a maximum cadence. This was immediately followed by the resistance application calculated based on the body weight while they were instructed to maintain maximal pedal speed throughout the 30-s period. The subjects were verbally motivated during the test.

The output for mean power (MP) was calculated for a total of the 30-s period of the Wingate test, while the output for peak power (PP) was calculated based on the highest 5-s period observed during the exercise test (Green, 1995). PP reflects maximal anaerobic power and MP reflects anaerobic capacity. Power outputs (PP and MP) and the fatigue index (FI) were calculated for each participant with the following formulas (Ucok et al., 2009a).

PP = [highest counted 5-s value × distance traveled per pedal revolution (6 m) × applied load (kg)]/6.12

MP = [sum of counted value each 5-s × applied load (kg)]/6.12

FI = [(highest 5-s output − lowest 5-s output)/highest 5-s output] × 100

2.3. Determination of body composition

Body fat and lean body mass of the patients was determined by a bioelectrical impedance analysis (BIA) system (Bodystat 1500, Bodystat Ltd., Douglas, Isle of Man, UK). The basic premise of a BIA procedure is that the volume of fat-free tissue in the body will be proportional to the electrical conductivity of the body (ACSM, 2007). Some cautions were taken before the measurements as follows: (ACSM, 2007; Unutmaz et al., 2012; Uygur et al., 2013). The subjects were instructed to avoid eating or drinking within 4 h, using diuretics within 7 days, and strenuous exercise for 24 h days before test procedure. Also the subjects urinated completely within 30 min before the test and used limited diuretic agents (caffeine and chocolate, etc.). Metal objects were removed from the body and measurements were performed at room temperature. The impedance was measured between the right wrist and right ankle using a tetrapolar electrode system. The subjects lay supine with the arms separated from the body, and with legs not touching each other. Signal electrodes were positioned in the middle of the dorsal surface of the hand and feet proximal to the metacarpophalangeal and metatarsophalangeal joints. Detecting electrodes were more proximally positioned at the ankle and the wrist. An excitation current of 500 μA at 50 kHz was applied to the distal electrodes, and the voltage was detected by the proximal electrodes (Ucok et al., 2011). The data were analyzed using the manufacturer's software, and body fat percentage, total body fat, and lean body mass were determined for each subject.

2.4. Pulmonary function tests

Pulmonary function tests were performed twice with a spirometer (Quark b^2, Cosmed S.r.l., Italy). The tests were carried out at room temperature (Ucok et al., 2004). The tests were explained to the participants prior to each measurement and one or more tests were performed for enhancing their procedures. The procedure required the patient to wear a nose clip and perform a forced expiratory maneuver. Before the mouthpiece was placed into the patient's mouth, the patient was instructed to inhale completely then make a deep and rapid expiration as much as he/she could. Forced expiratory volume in first second (FEV_1), forced vital capacity (FVC), forced expiratory flow at 25–75% of vital capacity (FEF_{25-75}) and peak expiratory flow (PEF) were measured, and FEV_1/FVC ratio was calculated. Maximal voluntary ventilation (MVV) was measured using another spirometry maneuver. The patient expired a maximal volume during 12 s of forced breathing into the spirometer and MVV was calculated for 1 min. Acceptability criteria were applied to all participants (Wanger et al., 2005).

2.5. Anthropometric measurements

Height was measured without shoes using an inflexible steel meter stick while subjects stood with heels, back, and shoulders against a wall, with feet together and head on the Frankfort plane. The body weight measurements were taken while subjects took off their outerwear and shoes with calibrated measurement devices. BMI was calculated as body weight divided by the square of the height (kg/m^2).

Skinfold thickness measurements were taken using a skinfold caliper (Holtain Ltd., UK). Body subcutaneous fat distribution was determined based on the particular skinfold thickness (Ucok et al., 2009a). Skin was picked up between the thumb and index finger, and the caliper was applied about 1 cm from the fingers. The measurements either were taken in rotation through measurement sites, or a period of time was allowed for the skin to regain normal texture and thickness (ACSM, 2007). Triceps, subscapular, abdomen and thigh skinfold thickness measurements were done twice. When the differences between the two measurements were more than 5%, the measurements were repeated.

Circumference measurements were taken with a tape measure while subjects were standing in a straight but relaxed position (Genc et al., 2012). The tape measure was held parallel to the ground and completely surrounded the part of the body being measured, but it did not compress the subcutaneous fat tissue. Duplicate measurements were taken at each site and retests were made if duplicate measurements were not within 7 mm. The sites which reflect central obesity (waist, abdomen, hip and the calculated, waist to hip ratio) were used for circumference measurements (ACSM, 2009).

2.6. Statistical analysis

The data were analyzed using SPSS 18.0 computer program (SPSS Inc., Chicago, IL, USA). The distribution of the group was analyzed with the Kolmogorov Smirnov test. Differences between groups were determined with a t-test and a Mann–Whitney U test. The correlations between the parameters were analyzed with Pearson correlation tests. All parametric results were expressed as mean ± standard deviation for each group. The significance level was determined as $p \leq 0.05$.