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Comparing cardiorespiratory fitness, body composition, and muscular endurance of patients with schizophrenia and schizoaffective disorders with a population-based sample

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Abstract

Background There is an entrenched reverse link between cardiorespiratory fitness (CRF) and earlier deaths. The purpose of our study was to provide a report of CRF elements in a sample of hospitalized patients with schizophrenia and to compare them with a population-based sample.

Methods This study was performed on 60 subjects (30 in the schizophrenic and schizoaffective group and 30 in the control group). CRF factors such as body mass index (BMI), and body fat, push-up test, curl-up test, VO2 peak, and sit-and-reach test, were compared across two groups. The Positive and Negative Syndrome Scale (PANSS) and the World Health Organization Disability Assessment Schedule (WHODAS 2.0) were assessed in the case group.

Results The body fat percentage, abdominal circumference, and BMI are more in schizophrenic patients. Also, flexibility, muscle endurance, and maximum aerobic capacity are significantly lower in schizophrenic and schizoaffective patients comparing healthy subjects ($P < .001$). Moreover, we found that with the increasing severity of the disease, the CRF of the patients became worse ($P < .001$).

Conclusion Patients with schizophrenia and schizoaffective disorders should be evaluated for cardiorespiratory and other factors of CRF. Exercise prescription treatment can be helpful to improve social functioning and decrease the impact of cardiovascular disease in patients with schizophrenia.

Keywords Schizophrenia, Cardiorespiratory fitness, Anthropometry

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Introduction

Schizophrenia is a debilitating mental disease and has a significant public health burden. It affects up to 1% of the population [1]. Death rates in schizophrenic cases are double times more than all other individuals [2]. Also, on average, they live 15 years less [3].

The higher prevalence of cardiovascular diseases and metabolic syndrome rationalizes this issue [4]. Moreover, it can be related to other comorbid diseases accompanying schizophrenia disease [5]. Genetic factors, environmental and antipsychotic, and lower physical activity treatments give a higher risk for metabolic syndrome in these patients [6, 7].

At the beginning of psychotic illnesses, when symptoms start showing up, the prevalence of obesity and metabolic disease is not much different comparing the normal population [8]. After taking medication for years, the metabolic syndrome increases fivefold [9], and body weight increases by up to 15 kg [10, 11]. Besides weight gain, many cases treated with antipsychotic medication would have insulin resistance [12, 13]. Insulin resistance induces the development of cardiovascular disease by numerous metabolic pathways and mal-interruption [14].

So, the level of CRF among patients with schizophrenia is a serious risk factor regarding its relationship to morbidity and mortality. The goal and focus of this study were cardiovascular health levels and percentages of fat, bone, water, and muscle in a sample of warded cases with schizophrenia and to assess them with a population-based sample.

Methods

Subjects

In our cross-sectional survey, 60 participants were engaged from Taleghani Educational and Research Hospital in Tehran, Iran.

Cases that achieved the *Diagnostic and Statistical Manual of Mental Disorders* according to DSM-5 (American Psychiatric Association, 2013) criteria for schizophrenia spectrum disorder (schizophrenia, schizoaffective disorder, and schizophreniform disorder) were chosen. These patients were aged 20–60 years old and also had the cooperation ability to participate in research. Patients who were pregnant, or had a chronic physical illness such as diabetes, musculoskeletal problems, cardiac, respiratory, and blood pressure problems, diagnosis of mild mental retardation or dementia, and physical or motor conditions, were removed. The facts and details needed for the study were explained to cases by psychiatry and sports medicine residents. If they wished to participate, written informed consent was taken. Our research was confirmed and accepted by the Ethics Committee of Shahid Beheshti University of Medical Sciences.

We had two groups of participants: 30 individuals in the case group and 30 individuals in the control group. The case group was selected among patients with schizophrenics or schizoaffective disorder. The control group was selected among people aged between 20 and 60, who did not have any mental disorder or major musculoskeletal problem, and for other reasons, they referred to the sports medicine department.

Procedures

At first, case group was asked to fill out the Positive and Negative Syndrome Scale (PANSS) and the World Health Organization Disability Assessment Schedule (WHODAS 2.0). Positive and negative symptoms in the schizophrenic group were appraised by PANSS. The Positive and Negative Syndrome Scale (PANSS) has an extensive application in schizophrenia studies, and its benefits for the evaluation of antipsychotic therapeutics efficacy have been shown. In the same way, the burden of illness was valued by WHODAS 2.0. The WHODAS 2.0 is a practical evaluation means to contribute an average measuring health and disability across populations.

We measured variables of CRF and percentages of fat, bone, water, and muscle in both samples. Candidates did body composition analysis by bioelectrical impedance device. Bioelectrical impedance analysis allows the measurement of body composition including fat percentage, lean body mass, minerals, and body water.

A professional body composition analyzer was performed by GAIA 359 PLUS Jawon Medical device. Patients were asked to eat breakfast and then eat nothing for at least 2 h before performing body analysis. Exercise and alcohol consumption were not allowed for 48 h before test day. Implanted cardiac devices like pacemakers or implantable cardiac defibrillators, metal implants, and pregnancy are contraindications of bioelectrical impedance tests. None of our participants mentioned contraindications. The main elements of anthropometry: height, weight, and BMI were documented before starting the exercise test.

To assess the maximum oxygen that the body can use throughout the exercise and CRF, an exercise test was executed. The test was done by utilization of the Bruce protocol. The Bruce procedure test is one of most commonly implemented exercise treadmill protocols. Bruce's exercise test protocol was performed on an electric-powered treadmill. The 12-lead ECG was being supervised while tested by a trained physician. The cardiac rate and rhythms, ST-segment changes, T-wave changes, premature ventricular contractions, or any arrhythmia were monitored. The first Bruce stage is initiated at 1.7 mph at a 10% grade which equals five METs. Respectively, stages were as follows: stage 2 is 2.5 mph at a 12% grade, stage

3 is 3.4 mph at a 14% grade, stage 4: 16% incline at 4.22 mph, and stage 5: 18% incline at 5 mph. Each stage takes 3 min.

The earliest stage of this procedure is about five METs, and it increases by about three METS between stages. Other variables monitored during Bruce's exercise testing involve heart rate, blood pressure, perceived exertion, and clinical signs/symptoms. Heart rate, electrocardiogram, and rating of perceived exertion (RPE) were monitored continuously and documented through the latest 5–10 s at every stage.

Bruce is a maximal test (versus a submaximal test). Participants were inspired to do as well as they are able on the treadmill. RPE was rated with the Borg scale. RPE is a subjective way of assessing activity intensity level, recognized as increasing heart rate, respiration, and overall physical performance. Cases reported a subjective rating for each test concerning the test intensity. Scoring is clarified on a 6 to 20 scales: 6 means very very light, and 20 means very very hard. An exercise test was terminated on RPE (rating of perceived exertion) more than 18 which equalizes to approximately achieving 85% maximal heart rate for age prediction. Each of these symptoms, angina, dyspnea, claudication, ataxia, dizziness, cyanosis, or pallor, was an indication to stop the test. Also, marked *ST-segment* changes, ventricular arrhythmia, second- or third-degree atrioventricular block, decreasing systolic blood pressure of more than 10 mm Hg, SpO2 ≤ 0%, or participant's request to stop were considered as a point for test termination. VO2 Max shows the s maximum capacity of oxygen that a participant consumes through the maximal test.

None of our exercise tests was terminated due to cardiac causes like chest pain. VO_{2max} values were calculated from exercise duration, highest stage finished, and final MET achieved. Another criterion for ending the exercise test was when the patient reached maximum heart rate according to age (maximal heart rate = 220—age).

After a rest period of 30 min, both groups did a flexibility test, push-ups test, and curl-up test. The push-up test is used for estimating the endurance of upper body muscles. Push-ups test for males was executed with men starting in the standard position (fingers pointing forward and under the shoulder, spine neuter, head up, and toes as the momentum point) and women in the modified position (lower legs in touch with floor covering with ankles plantar-flexed and using the knees as the momentum point). This should be performed as much repeating as one can do to reach fatigue. Acceptably done push-ups were counted in 1 min. Curl-up is another test for evaluating abdominal muscle strength and endurance. For test doing, cases lay supine, knees bent, and feet on the ground, bringing their head up and their chin towards their chest. This test like the push-up test should be performed as much repeating as one can do to reach fatigue. The number of correct repeated movements was enumerated in 1 min, which is the score.

Sit-and-reach test is regarded for assessing flexibility. This test challenges the tightness of the lumbar and biceps femoris, semimembranosus, and semitendinosus muscles. For performing this test, the participant sat on the base lower extremities extended out, and feet are positioned touching the box. Then, hands stretched forward along the sit-and-reach box as much as he can. Then the number on the box, that is in line with the fingers, is recorded.

Data analysis

Details were studied in the two groups with a sample size of 30. Comparison of the expression of stratified variables was performed through the chi-square test (Pearson's χ^2-test). Relations between variables in the presence of a normal distribution *t*-test were utilized and not the presence of normal distribution Mann-Whitney test was used. All data are reported as mean values ± SE. Statistical significance was supported with a *p*-value less than 0.01.

Results

The present study was performed on 60 individuals (30 in the patient group and 30 in the healthy control). Of 60 cases, no one refused to join. Out of 60 individuals who participated, 41 were male, (68.3%), and 19 were females (31.7%). The average age of people was 35.8 and was aged between 20 and 48 years. The mean and standard deviation of age in patients and healthy individuals' statistical difference was not static a difference ($P > 0.05$.). During the study, there was no case loss.

The average period of cases of the disease was 7.86 years. The average greater extent of the disease was equal to 101.1 based on the PANSS questionnaire. The average score for the negative symptoms sub-scale was equal to 29.46, and it was obtained as 25.86, 18.66, 12.23, and 14.86 for disorganization, positive symptoms, excitement, and depression (anxiety) sub-scales, respectively. Disability is measured based on WHODAS 2.0. The questionnaire was significantly higher in cases with schizophrenia or schizoaffective disorder compared to the other group (mean ± SD: 19.22 ± 12.4 vs. 10.5 3± 5.97) (*P*-value = 0.035).

Comparison of the cases with healthy subjects revealed significant differences in some physical aspects including weight (78.13 vs. 71.3 kg), BMI (26.99 vs. 24.53 kg/m^2), waist circumference (111.93 vs. 97.16 cm), and body fat percentage (35.12 vs. 31.9%). Height was not found to be statistically different (Table 1).

Table 1 Comparison between cases and control characteristics

Variable		Average	Standard deviation	*p*-value
Height (cm)	Cases	170.46	9	0.877
	Control	170.13	7.5	
Weight (kg)	Cases	78.13	12.02	0.021
	Control	71.3	10.3	
BMI	Cases	26.92	4.12	0.012
	Control	24.53	2.38	
Abdominal circumference (cm)	Cases	111.93	18.77	0.002
	Control	97.16	15.52	
Fat percent	Cases	35.12	6.6	0.034
	Control	31.2	4.73	

Table 2 Comparison of push-up and sit-up and flexibility test of case and control group

	Group	Average	Standard deviation	*p*-value
Maximum number of full push-up moves in 1 min	Case	26.33	5.61	0.007
	Control	31.86	8.25	
Maximum number of full sit-up moves in 1 min	Case	33.96	7.03	0.008
	Control	38.7	6.4	
Flexibility	Case	−2.26	7.39	0.009
	Control	2.3	6.18	

The maximum number of full push-ups moves in 1 min (26.33 vs. 31.86), maximum number of full curl-up moves in 1 min (33.96 vs. 38.7), and flexibility (−2.26 vs. 2.3) was remarkably lower in the patients' group compared to the control group (Table 2).

Vo2 peak was significantly lower in the patients' group compared to the healthy group (mean ± SD: 23.16 ± 4.85 vs. 25.56 ± 3.7) (*P*-value = 0.035). The severity of the disease had a direct and significant association with the abdominal circumference, BMI, body fat percentage, and duration of the disease. It had an inverse and significant correlation with the push-up, curl-up, and VO2 tests, as shown in Table 3.

Discussion

The principal and key outcomes of the research project were that schizophrenic patients have lower CRF and poorer muscle endurance and flexibility test results comparing a sample of the healthy population. This study emphasizes on health-associated CRF details rendering to the subdivision of the American College of Sports Medicine (ACSM): percentages of fat, bone, water, and muscle, muscular strength, muscular endurance, CRF, and flexibility [15]. Recently, evidence has been published indicating the prominence status of exercise capacity about prediction among individuals [16]. Exercise tests help physicians contribute data on exercise capacity and cardiovascular burden pitfalls and give clues and guide therapeutic choices.

We found that vo2max, flexibility, push-up, and curl-up numbers had decreased in schizophrenic cases than in the controls. Also, body fat and BMI were significantly higher in schizophrenic patients than in the controls. Firth J. stated that a decrease in muscle strength is accompanied by a decrease in performance and memory [17]. Scheewe T. W. and colleagues in a paper published in 2019 presented that worse CRF was cohered with the greater extent of negative symptoms in patients with schizophrenia. According to this paper, these patients have low CRF, which has been known as an important predictor of CVDs [18]. Our results also showed that whatever patients' disease scores were more, CRF was more deteriorated.

Table 3 Correlation between CRF and severity variables in patients with schizophrenia or schizophrenia

	Waist circumference	BMI	Body fat	Disease duration	Push-up test	Curl-up test	Flexibility	VO2	Disease severity
BMI	0.856**								
Body fat	0.654**	0.730**							
Disease duration	0.412*	0.431*	0.367*						
Push-up test	−0.905**	−0.855**	−0.634**	−0.464**					
Curl-up test	−0.863**	−0.877**	−0.820**	−0.396*	0.868**				
Flexibility	−0.678**	−0.854**	−0.756**	−0.267	0.699**	0.834**			
VO2	−0.841**	−0.882**	−0.724**	−0.325	0.765**	0.881**	0.809**		
Disease severity	0.376*	0.411*	0.399*	0.816**	−0.377*	−0.411*	0.217	−0.372*	
Disability	0.409*	0.481**	0.360	0.781**	−0.448*	−0.423*	0.238	−0.364*	0.953**

**p*-value<0.05

***p*-value<0.001

VO2max is a standard indicator of the assessment of CRF and physical capacity [15]. Gretchen-Doorly et al. (2012) specified that CRF is decreased in schizophrenia patients [19]. Nilsson stated that the respiratory quotient was higher on submaximal exercise and lower physical capacity. Schizophrenic patients consumed more oxygen uptake even at submaximal exercises. Thus, it can limit exercise capacity and exercise and is related to weight gain.

Ozbulut et al. (2013) compared aerobic and anaerobic exercise capacity, respiratory parameters, percentages of fat, bone, water, and muscle, and lipid profiles between patients with schizophrenia and fit controls. They concluded that maximum aerobic capacity, maximum anaerobic power, anaerobic capacity test, and respiratory performance were lower in patients with schizophrenia than normal group. Body fat percentage, abdomen circumference, and waist-to-hip ratio were higher in women with schizophrenia than in the control group. These results are in accord with our study results [20]. In our study, CRF andVO2 peak were established to notably deteriorate in patients with schizophrenia than the healthy subjects, and their body fat and BMI were higher and which was linked with the greater extent of the disease.

Stressing et al. pointed out an obvious diminishment in physical health of obese (BMI more than 30) patients with schizophrenia in comparison with healthy subjects [21]. In the study of Vancomfort to study the relationship between obesity and aerobic functional exercise capacity in people with schizophrenia in schizophrenic patients, the percentage of maximal oxygen uptake in individuals with schizophrenia with metabolic disorders was lower than in patients without metabolic syndrome [22]. Methods of Vancamfort were different from our study, but the results obtained are similar to the results of our study.

Meanwhile, our study provides data comparing schizophrenic patients with a healthy population, and some limitations can be mentioned. First, schizophrenic patients may not cooperate properly, so the accuracy of exercise tests can be lower. Larger sample size helps to make this error inconspicuous. In this study, all patients received a type of antipsychotic medication during hospitalization, but the type of medication and the duration of treatment before hospitalization were not investigated. Additional research is required to judge and appraise medication as a mediating and influential factor.

Conclusion

The results recommend that the existing rate of obesity in patients with schizophrenia is considerably upper in comparison with other individuals. Also, these patients have reduced vo2 peak. With the increasing severity of the disease, Patients' conditions also get worse. Deteriorated cardiovascular health and reduced aerobic function are defective and bug cycles.

It has been stated that schizophrenic patients are sedentary [23]. Making an additional point, lesser partaking in physical activities in these cases accompanies the existence of negative symptoms and side effects of therapeutics [24]. Regarding the fact that these people have low aerobic capacity, schizophrenic patients benefit from prescribing exercise.

As attested by the outcomes of the present study and other studies that indicate a high prevalence of obesity, disability, and reduction of the peak of VO2 exists in cases with schizophrenia and schizoaffective, we suggest that exercise can be prescribed to schizophrenic patients, including aerobic exercise program and also strength and flexibility exercise.

Abbreviations

CRF	Cardiorespiratory fitness
BMI	Body mass index
PANSS	Positive and Negative Syndrome Scale
WHODAS 2.0	World Health Organization Disability Assessment Schedule
RPE	Rating of perceived exertion

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Authors' contributions
Conceptualization, AK, MH, and AHAY. Writing — review and editing, MH, SA, and HD. Writing — original draft, SA and HD.

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Availability of data and materials
The data of this study is available to the corresponding author and provided if needed.

Declarations

Ethics approval and consent to participate
Ethics approval code is IR.SBMU.MSP.REC.1397.558. in Shahid Beheshti University of Medical Science. Consent has been taken from all the participants to participate in the study.

Consent for publication
All participants and authors of the study consent to the publication of this study.

Competing interests
The authors declare that they have no competing interests.

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