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Reliability and clinical correlates of the Astrand–Rhyming sub-maximal exercise test in patients with schizophrenia or schizoaffective disorder

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ABSTRACT

Cardiovascular fitness is reduced in people with schizophrenia and is related to an increased morbidity and mortality. There is mounting interest in the accurate measurement of cardiovascular fitness in schizophrenia, yet existing measures used in the general population have not been tested on validity and reliability in this high-risk group. Therefore, we examined the reproducibility and feasibility of the Astrand–Rhyming sub-maximal exercise test in patients with schizophrenia or schizoaffective disorder. Secondary aims were to assess minimal detectable changes, practice effects and the presence of clinical symptoms that are associated with cardio-respiratory fitness (expressed as estimated oxygen uptake). From 47 patients with schizophrenia or schizoaffective disorder two trials of the Astrand–Rhyming test, administered within three days, were analysed. The intraclass correlation coefficient for the estimated oxygen uptake between the two tests was 0.92 (95% confidence interval: 0.85–0.95). The minimal detectable change was 6.5 ml O_2/min/kg. No practice effect could be detected. A backward regression analysis demonstrated that illness duration, negative symptoms and level of physical activity explained 63.0% of the variance in estimated oxygen uptake. The current study demonstrates that the Astrand–Rhyming test can be recommended for evaluating the aerobic fitness in patients with schizophrenia or schizoaffective disorder.

1. Introduction

In persons with schizophrenia or schizoaffective disorder, an impaired aerobic fitness is a major modifiable risk factor for cardiovascular disease and overall morbidity and mortality (Strassnig et al., 2011; Scheewe et al., 2012; Vancampfort et al., 2013a). For this reason, an impaired aerobic fitness is an important indicator for physical activity interventions within the multidisciplinary treatment of patients with schizophrenia (Stubbs et al., 2014; Uwakwe et al., 2014; Vancampfort et al., 2009, 2010). Given that physical activity might be beneficial in the prevention of cardiovascular diseases, support for aerobic exercise programmes in the multidisciplinary treatment of schizophrenia and schizoaffective disorder is growing (Scheewe et al., 2012, 2013; Strassnig et al., 2012; Vancampfort et al., 2012a, b).

Until recently, the promotion of aerobic fitness in patients with schizophrenia or schizoaffective disorder has received limited attention, in part due to lack of appropriate measures (De Hert et al., 2011; Vancampfort et al., 2011a). Laboratory-based incremental exercise testing protocols, that use breath-by-breath gas analysis and measure the maximum level of oxygen consumption (VO_2max) are considered the 'gold standard' measurement of aerobic fitness (Vanhees et al., 2005). However, these test protocols are time-consuming, costly and need highly sophisticated equipment (Vanhees et al., 2005), which is often not available or practical in mental health care settings. Moreover, the maximal nature of the test may be influenced by the motivation of participants (Strassnig et al., 2011; Vancampfort et al., 2013b). Submaximal exercise tests that use measures of heart rate (HR) to estimate $V0_2$max are considered to be a reliable and valid measure of aerobic fitness (Lambrick et al., 2009). Importantly, for high-risk populations, submaximal tests are safer, better tolerated and

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consequently ideal for monitoring levels of aerobic fitness (Vanhees et al., 2005). A further benefit of submaximal testing is that it can allow greater numbers of patients to be longitudinally monitored at minimum costs. To date, there is no sub-maximal test which has been validated to assess the aerobic fitness of patients with schizophrenia.

One test which could be considered is the Astrand–Rhyming test (Astrand, 1960). The test utilises a six minute, single stage, submaximal cycle ergometer protocol and is considered suitable for testing the general population (American College of Sports Medicine, 2013). Using this test, research (Nilsson et al., 2012; Ozbulut et al., 2013) has identified that patients with schizophrenia have a significantly lower aerobic fitness compared with age- and gender matched healthy controls. In order to validate these findings, help capture and reduce the burden of cardiovascular disease in individuals with schizophrenia, and further provide clinical practice a validated submaximal test of aerobic fitness, it is important that the psychometric properties of the Astrand–Rhyming test are considered. Therefore, the aims of this study follow a series of iterative steps: (a) to investigate the test–retest reliability of the Astrand–Rhyming test in patients with schizophrenia or schizoaffective disorder, (b) to determine limits for the smallest difference in VO_2max that indicated a clinically meaningful change, (c) to explore whether there was a practice effect with repeated testing, (d) to assess clinical and demographic characteristics that might interfere with the test performance, and (e) to describe the feasibility of the test in patients with schizophrenia or schizoaffective disorder.

2. Methods

2.1. Participants

Over a 5-month period, inpatients with a DSM-V diagnosis of schizophrenia or schizoaffective disorder (American Psychiatric Association, 2013) admitted to the UPC KU Leuven in Belgium were invited to participate. Patients were excluded if they had a current co-morbid DSM-V diagnosis of substance abuse (American Psychiatric Association, 2013). The somatic exclusion criteria included evidence of significant cardiovascular, neuromuscular and endocrine disorders which, according to the American College of Sports Medicine (2013), might prevent safe participation in the study. All participants received a physical examination and baseline electrocardiogram before testing. Participants taking beta-blocking agents were excluded due to the potential influence on heart rate (HR) response. The study procedure was approved by the Scientific and Ethical Committee of the UPC KU Leuven, Campus Kortenberg, Belgium in accordance with the principles of the Declaration of Helsinki. All participants gave their informed written consent. There was no compensation for participation in the study.

2.2. Sample size analysis

An a-priori sample size calculation was conducted. With a minimal acceptable intraclass correlation coefficient (ICC) of 0.80 and the hypothesis based on previous research (Vancampfort et al., 2011b; Vancampfort et al., 2012c) that present findings would be consistent with a minimum ICC of 0.90, a minimum sample size of 46 patients was required to attain a level of significance (α) of 0.05 and power of 0.8 (β=0.2) (Donner and Eliasziw, 1987; Walter et al., 1998). Considering previous reliability studies in patients with schizophrenia (Vancampfort et al., 2011b, 2012c), it was anticipated that approximately 15% of patients would be excluded a-priori, approximately 15% would decline participation for motivational reasons and approximately 15% would dropout from the testing for motivational or other reasons. Therefore, a sample size around 75–80 participants was pre-specified to allow for these potential factors.

2.3. Study design

A test–retest design was used to test the reproducibility of the Astrand–Rhyming test (Astrand, 1960). Two tests were undertaken with the second test being repeated within three days by the same trained mental health physical therapist.

2.4. Astrand–Rhyming test

The Astrand–Rhyming protocol (Astrand, 1960) is a single-stage cycle ergometer test designed to elicit a steady-state heart rate over a 6-min period. The initial workload is selected from the Astrand test loading wattage table, pedalling speed remains constant (60 revolutions per minute) and HR is recorded at every minute interval. The workload is set during the first 2 min and maintained throughout the test. In the case that HR fails to achieve the target zone, the load is adjusted accordingly. HR and loading wattage are noted at the end of each minute, with a target goal of obtaining two consecutive HR values over 120 beats per minute (bpm), within 5 bpm of each other, during the fifth and sixth minute of work. The protocol was to be interrupted if threatening symptoms appeared or when the HR reached 85% of age-predicted (220-age) maximum HR. Oxygen uptake (VO_2) was estimated using the Astrand–Rhyming gender-sensitive nomogram (Astrand, 1960; American College of Sports Medicine, 2013). Results were then normalised to age.

2.5. Testing procedures

The testing procedures were performed according to the American College of Sports Medicine guidelines (2013) in an indoor gym room with a minimum of external stimuli (e.g. no other participants present during the test). The therapist used a standardised instruction and language for each test and did not provide any verbal encouragement. Patients were requested to refrain from eating, drinking coffee or smoking during a two-hour period prior to the tests. At testing days medication was taken at the same hour of the day. Patients performed the retest at the same hour in standardised conditions. Blood pressure (BP) was before, during and after the test recorded with an Omron M6 (HEM-7001-E). HR was monitored continuously during testing by Polar HR monitors (Polar Heart Rate Monitor, Polar Oy, Kempele, Finland).

2.6. Psychosis evaluation tool for common use by caregivers (PECC)

The PECC was used to assess schizophrenia symptoms (De Hert et al., 1998). The assessment was made prior to the first Astrand test by an independent mental health nurse. The assessor was blinded to all the other assessments and was provided with training on how to administer the PECC. The semi-structured PECC-interview evaluates 20 symptom items on a 7-point scale. Symptoms are grouped in 5 factors: positive, negative, depressive, cognitive and excitatory symptoms. The scores for each factor range from 4 to 28. Also extrapyramidal side-effects of antipsychotic medication (EPS) were evaluated with the PECC-instrument. Scores range from 4 to 16. Higher scores indicate more severe side-effects. Validation results demonstrate that the PECC can be used for the evaluation of these symptoms and side-effects in schizophrenia or schizoaffective disorder (De Hert et al., 2002).

2.7. Physical activity participation

The International Physical Activity Questionnaire (IPAQ) (Craig et al., 2003) was used to assess the level of physical activity. The IPAQ asks participants to recall activities for each of the last seven preceding days in morning, afternoon, and evening time periods. On the basis of what activities participants self-reported, the interviewer (blinded physical therapist) also clarified the perceived intensity of that specific activity. A continuous indicator was calculated as a sum of weekly metabolic equivalent (MET)-minutes per week of physical activity. The MET energy expenditure was estimated by weighting the reported minutes per week by a MET energy expenditure estimate for each type of activity (low, moderate and vigorous intensity physical activity). The weighted MET-minutes per week were calculated as duration × frequency per week × MET-intensity, which were then summed to produce a weighted estimate of the total physical activity from all reported activities per week as per the IPAQ scoring protocol. Previous research indicated that the IPAQ can be considered as a reliable surveillance tool to assess levels of physical activity in patients with schizophrenia (Faulkner et al., 2006).

2.8. Medication use

Antipsychotic medication was recorded for each patient and converted into a daily equivalent dosage of chlorpromazine according to consensus by Gardner et al. (2010). Data on the use of medication was obtained from patients' medical records.

2.9. Other clinical variables

Body weight was measured by the (blinded) research nurse in light clothing to the nearest 0.1 kg using a SECA beam balance scale, and height to the nearest 0.1 cm using a wall-mounted stadiometer. Illness duration and data on physical co-morbidity were obtained from patients' medical records. Metabolic syndrome was assessed using the International Diabetes Federation criteria (Alberti et al., 2006).