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Diet and exercise effects on aerobic fitness and body composition in seriously mentally ill adults

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Abstract
Low exercise capacity and high obesity levels are the main characteristics of people with serious mental illness (SMI). We conducted a pilot study on the effects of a 3-month exercise and dietary intervention on the aerobic capacity and body composition of obese adults with SMI taking Olanzapine, a second generation antipsychotic medication known to induce weight increments. Fifty adults with SMI (15 males and 35 females) followed a 3-month weight loss intervention programme based on exercise and diet. Pre- and post-intervention, a submaximal $\dot{V}O_2$ exercise test was performed in order to assess $\dot{V}O_{2max}$ anthropometric and body composition measurements were also performed. All participants were obese (body mass index (BMI): 33.61 ± 0.91 kg/m^2). Pre- and post-intervention, a submaximal $\dot{V}O_2$ exercise test on the treadmill was performed in order to assess $\dot{V}O_{2max}$ anthropometric and body composition measurements were also performed. Significant reductions in body weight, BMI, body fat and waist circumference were found from pre to post ($p < 0.01$). $\dot{V}O_{2max}$ was significantly improved in both genders (males: pre: 30.63 ± 2.06 vs. post: 33.19 ± 1.77 ml·kg^{-1} min^{-1}, females: pre: 25.93 ± 1.01 vs. post: 29.51 ± 1.06 ml·kg^{-1} min^{-1}, $p < 0.01$). A significant correlation was found between the change in $\dot{V}O_{2max}$ and the change in body weight and BMI ($p < 0.05$). Multiple regression analysis revealed that the relative change in $\dot{V}O_{2max}$ explained approximately 26% of the variance in the changes for both BMI ($p = 0.07$) and body weight ($p = 0.06$). A treatment of exercise and diet improves the aerobic capacity and body composition of obese adults with SMI, despite the use of Olanzapine.

Keywords: *Exercise, nutrition, obesity, mentally ill adults*

Introduction

People with serious mental illnesses (SMIs) such as schizophrenia, depression and bipolar disease are characterised by high levels of obesity (Allison et al., 1999) and almost twice the normal risk of dying from cardiovascular and metabolic disease (Brown, 1997; Joukamaa et al., 2001; Richardson et al., 2005; Ross et al., 2000). In this population, the challenge of treating obesity is even greater than healthy individuals, as obesity is attributed not only to poor exercise and nutrition habits but also to the treatment with second-generation atypical antipsychotic medications such as Olanzapine and Clonzapine that are associated with both weight gain and the metabolic syndrome (Allison et al., 1999; Keck & McElroy, 2003; McEvoy et al., 2005; Richardson et al., 2005). A number of studies have shown that unhealthy lifestyle practices such as poor nutrition (i.e. lack of regular meals and overeating) (Daumit et al., 2005; Dickerson et al., 2006) and low physical activity (Brown, Birtwhisle, Roe, & Thompson, 1999; Chacón, Mora, Gervás-Ríos, & Gilaberte, 2011; Davidson et al., 2001; Jerome et al., 2012; Newcomer, 2005; Richarson et al., 2005; Scheen & De Hert, 2005; Scheen & De Hert, 2007) appear to play an important role in the obesity development of adults with SMI, similarly to healthy obese individuals (Allison & Casey, 2001; Brown et al., 1999; McCreadie, 2003). However, the exact contribution that low physical activity has on the obesity epidemic in this population, independent of the effects of medication, is not clear. Furthermore, limited data exist on the aerobic capacity of this population, a parameter that exhibits a strong

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inverse association with the obesity indexes in healthy individuals (Telford, 2007).

In healthy obese individuals, exercise and dietary interventions lead to improvements in body weight, body composition and obesity-related comorbidities (Meckling & Sherfey, 2007; Okay, Jackson, Marcinkiewicz, & Papino, 2009). Furthermore, improvements in aerobic capacity ($\dot{V}O_{2max}$) are strongly associated with improvements in obesity indexes (Hamer & Donovan, 2010). In people with SMI, the high obesity rates and the metabolic risk profile appear to be effectively managed with a weight control programme comprised of diet and exercise despite the use of atypical antipsychotic medications. Specifically, improvements in anthropometric, metabolic, cardiovascular and psychological parameters have been observed (Blouin et al., 2009; Daumit et al., 2013; Poulin et al., 2007; Richarsdon et al., 2005; Skouroliakou, Giannopoulou, Kostara, & Hannon, 2009; Smith et al., 2007; Van Citters et al., 2010). Moreover, an important evidence exists on the important role that exercise participation by itself plays in the quality of life and health as well as the obesity epidemic in people with SMI (Richardson et al., 2005). However, no studies have investigated the effect of diet and exercise on the aerobic capacity of obese adults with SMI, possibly due to the difficulty of performing a $\dot{V}O_{2max}$ test in this clinical population. To our knowledge, only one pilot study in a small sample of adults with SMI (N = 6) has investigated the effects of exercise and dietary intervention on the estimated aerobic fitness by the Rockport exercise test, but with no oxygen consumption measurements performed during exercise (Blouin et al., 2009). This study reported improvements in estimated aerobic fitness that were related to changes in body composition and metabolic health following 12 weeks of training (Blouin et al., 2009). More research is needed to investigate the effects of exercise and diet on the aerobic capacity ($\dot{V}O_{2max}$) of adults with SMI, as low aerobic fitness is an independent risk factor for obesity, metabolic and cardiovascular health.

Accordingly, the purpose of this pilot study was to investigate the effect of a three-month exercise and dietary intervention on the aerobic capacity and body composition in obese adults with SMI taking Olanzapine, a second-generation antipsychotic medication that contributes to obesity. Moreover, we sought to examine whether the possible changes in aerobic capacity are related to improvements in body composition in this population. We hypothesised that the exercise and dietary intervention will improve both the aerobic capacity and the body composition of obese adults with SMI.

Methods

Subjects

Sixty-seven participants volunteered for the study. They were recommended to participate in the study from the clinical psychologists in the Iaso Hospital in Athens, Greece, from private psychiatry offices located in Athens and from advertisements in the local newspapers. Of this total number of participants, 55 participants participated in the study. Twelve participants were excluded from the study as they were either found incompetent to participate in the study by our psychiatrist. During the course of the study, five participants dropped out of the study due to inability to continue with the exercise and diet intervention for the full course of the study due to difficulties with the dietary and exercise programme as inability to cook and eat as instructed, inability to go out and exercise on a regular basis, anxiety and depression. Fifty participants completed the study (15 males and 35 females). Prior to participation in the study, all the participants were diagnosed with mood or psychotic disorders by their referring psychiatrist using the Diagnostic and Statistical Manual of Mental Disorders fourth edition. All the adults with SMI were found competent by a psychiatrist to participate in the research study and to follow the weight loss intervention at the enrolment visit. All the participants were taking Olanzapine for an average time period of 6.9 ± 1.63 years at a stable mean dosage of 8.96 ± 0.2 mg/day. The participants were required to be between 18 and 55 years of age and to be free of any other chronic diseases or musculoskeletal problems. None of the participants was enrolled in a regular exercise programme prior to participation in the study.

We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during this research study. Institutional review board approval for the study was obtained by the ethical committee of the Iaso Hospital, Athens, Greece. Prior to enrolment in the study, all participants signed an informed consent form for participation in the study and possible side effects were fully explained to them.

Experimental protocol

The overall intervention period lasted for three months, during the years 2010–2012. In particular, it consisted of four phases: (1) an evaluation session, (2) the pre-intervention testing, (3) a 3-month dietary and exercise intervention period and (4) the post-intervention testing.

During the evaluation phase, at visit 1, each subject participated in a complete screening session in order to collect information and assess the subject's health profile, lifestyle and eating habits, physical activity, food preferences, food likes and dislikes. Pre-intervention testing was performed including anthropometric measurements of body weight, height and waist circumferences. Body weight was measured without shoes on a standing scale that was calibrated to 0.1 kg. Body height was measured without shoes on a wall-mounted stadiometer. Body mass index (BMI) was calculated according to the equation: BMI = body weight (kg)/[height]^2(cm). Waist circumference was measured at the narrowest part of the participants' waist. In addition, measurement of body composition (body fat and fat-free mass) was performed on each patient with the use of the BodPod (Life Measurement Inc, CA, USA) according to the manufacturers' instructions. Participants also completed a 10–15 minutes familiarisation on the treadmill.

At visit 2, a submaximal exercise test was used to determine the $\dot{V}O_{2max}$ of our participants. The submaximal $\dot{V}O_2$ measurements allowed us to estimate the $\dot{V}O_{2max}$ of our participants based on the linear relationship between $\dot{V}O_2$ and heart rate that can estimate $\dot{V}O_{2max}$ by measuring the heart rate response to a known levels of submaximal work. $\dot{V}O_{2max}$ can be derived by the equation: Estimated $\dot{V}O_{2max}$ = (predicted maximal heart rate − Intercept)/slope (Astrand & Rhyming, 1954).

We had set a goal to measure $\dot{V}O_2$ only at submaximal level due to the nature of some of the adults with SMI that are characterised by major psychological problems and serious medication side effects such as difficulty to concentrate while walking on the treadmill, agitation, anxiety, headaches, sleepiness, etc. A modified Balke exercise protocol was used, in which each participant performed a submaximal incremental exercise test on a treadmill with an incline increment of 2% per minute. Resting values were measured during a five-minute period preceding the exercise bout. The initial workload was set at an individualised speed with 0% incline. The criteria for termination of the exercise test were: (1) the attainment of 85% of age-predicted heart rate maximum, (2) rate of perceived exertion (RPE) over nine and (3) the inability to continue the exercise. In order to ensure that all the participants would fulfil the aforementioned criteria, we included a familiarisation session on the treadmill in the first visit of the subjects. Throughout the exercise protocol, oxygen consumption (Cosmed Fitmate, Italy) was measured breath by breath (Lee, Bassett, Thompson, & Fitzhugh, 2011; Nieman et al., 2007). Prior to the exercise test, calibration of the metabolic cart was performed according to the manufacturer's instructions. Heart rate was recorded continuously using a cardio-telemeter during the entire test (Polar S-810, Finland). All of our tests included in the results were valid estimation of fitness.

Fasting blood samples were taken from a subgroup (N = 13, 4 males and 9 females) to detect changes in blood glucose, cholesterol, low- and high-density lipoproteins. The rest of the participants did not accept to have their blood tested due to fear and/or stress of giving blood. Subjects had to abstain from participation in vigorous physical activity for the last 24 hours prior to giving blood. Fasting blood samples were obtained by fingerstick technology using Cholestech LDX analyzers (Cholestech, Hayward, CA) commonly used in clinical programmes (Bard, Kaminsky, Whaley, & Zajakowski, 1997).

In the three-month intervention period, subjects visited the laboratory every 15 days during which dietary and exercise counselling and behavioural interventions were taken place with the scope of assisting the participants's adherence to a healthy life plan. Sessions consisted of one-to-one counselling, primarily on nutrition issues and teaching of basic nutritional principles.

The nutrition plan was designed by a registered dietician in order to meet the individual needs of each participant. In particular, the food plan was a reduced energy diet designed to promote weight loss at a rate of 0.5–1 kg/wk. The dietary intervention was based on the principles of the Mediterranean diet as it was characterised by a moderate consumption of carbohydrates (55% of total energy per day) and high-fibre content, 15% protein and a fat intake of ~28–30% of total energy per day. The Harris–Benedict equation multiplied by an activity factor of 1.3–1.5 according to the activity level of the participant was used to estimate energy requirements. In order to assess the adherence to the diet plan, participants were asked to record their food intake in diaries that were collected by the dieticians at each session. Participants were instructed to complete daily food diaries including both weekdays and weekends.

The exercise regimen consisted of a daily moderate intensity (60–70% of age-predicted heart rate maximum), home-based aerobic exercise sessions in the form of walking or cycling that lasted from 30 to 45 minutes. Participants were asked to walk or cycle outside their house on a daily basis. In order to assist them with goal setting and achieving the recommended guidelines of the exercise programme, the participants were asked to set a functional goal they wanted to achieve (e.g. to be able to walk around the block for a minimum of 30 minutes), and they were encouraged to find company such as a family, or friend to help them exercise. At the beginning of the programme, the participants were instructed to walk for 25–30 minutes, 3–4 times per week at the lowest prescribed intensity and in the next 3–4 weeks to progressively increase to 45 minutes and seven days per week. Heart rate monitors (Polar S-810, Finland) were provided to the participants, and they were asked to keep a daily exercise log.

At the completion of the intervention at three months, participants were asked to visit the laboratory and to have all the tests performed at the pre-intervention phase repeated (anthropometric tests and submaximal exercise test).

Statistical analysis

Statistical analysis was performed with SPSS for Windows, version 11 (SPSS, Inc). Data are reported as means ± SE. Statistical significance was assessed with a two-way analysis of variance (ANOVA) for repeated measurements. An independent *t*-test and analyses of covariance (ANCOVA) to control for regression to the mean (RTM) were used to compare the mean absolute and percent changes in body weight, fat mass, fat-free mass and waist circumference between the two genders in the adults with SMI. Pearson correlation was employed to identify significant correlations. In the variables at which significant correlations were found, a multiple regression analysis was run. The threshold for significance in all tests was set at $\alpha = 0.05$.

Results

All participants were obese (BMI: 33.61 ± 0.91 kg/m^2) with a low aerobic capacity ($\dot{V}O_{2max}$: 27.33 ± 0.98 ml·kg^{-1} min^{-1}). At pre-intervention period, a significant difference was observed between genders in $\dot{V}O_{2max}$, anthropometric variables and body composition (Table I). Specifically, males had significantly higher $\dot{V}O_{2max}$ (mL·kg^{-1} min^{-1}), body weight, percentage of fat-free mass and waist circumference compared to the females ($p < 0.05$, Table I). Age did not appear to affect the aforementioned parameters ($p > 0.05$). No significant differences were found at baseline between the subgroup of participants that gave blood for analysis and the rest of the participants that did not (data not shown).

A significant reduction was found in body weight (Table I, $p < 0.01$) and body fat from pre- to post-intervention (Table I, $p < 0.01$), with no differences observed between genders ($p > 0.01$). Waist circumference was also significantly reduced from pre to post ($p < 0.01$), with no difference between genders ($p = 0.25$). $\dot{V}O_{2max}$ was significantly improved after the three-month intervention programme (Table II, Figure 1, $p < 0.05$), with no difference between genders ($p = 0.35$) and no effect of age ($p > 0.05$). Plasma cholesterol levels were significantly reduced after the intervention in both genders ($p < 0.01$). No changes were observed in any of the other haematological parameters, such as blood glucose, low- and high-density lipoproteins ($p > 0.05$) (data not shown).

Significant correlations were found at baseline between $\dot{V}O_{2max}$ and all anthropometric variables ($p < 0.05$). Specifically, $\dot{V}O_{2max}$ was significantly correlated with the body weight ($r = -0.30$, $p < 0.05$), BMI ($r = -0.52$, $p < 0.01$), body fat percentage ($r = -0.63$, $p < 0.01$), fat mass ($r = -0.54$, $p < 0.01$) and waist circumference ($r = -0.46$, $p < 0.01$).

At baseline, various multiple regression models were run with independent variables the age and $\dot{V}O_{2max}$ and dependent variables the body weight, percentage body fat, BMI and waist circumference. Multiple regression analysis revealed that $\dot{V}O_{2max}$ was a statistically significant predictor of most anthropometric and body composition parameters, explaining 33% of the variance in body weight ($p = 0.01$), 63% of the variance in percent body fat ($p < 0.001$), 53% of the variance in BMI ($p < 0.001$) and 47% of the variance in waist circumference ($p < 0.001$).

The relative changes in $\dot{V}O_{2max}$ from pre to post were significantly correlated with the relative changes in body weight ($r = 0.28$, $p = 0.05$) and in BMI ($r = 0.28$, $p = 0.05$, Figure 2). No significant correlation

Table I. Baseline characteristics of males and females with SMI

	Males ($N = 15$)	Females ($N = 35$)	p Value
Age (years)	37.13 ± 3.19	39.68 ± 2.10	0.51
Stature (cm)	174 ± 0.02	160 ± 0.00	0.001*
Body weight (kg)	105.60 ± 5.39	85.77 ± 2.83	0.001*
Body mass index (kg/m^2)	34.50 ± 1.28	33.24 ± 1.18	0.53
Waist circumference (cm)	111.80 ± 3.29	100.11 ± 2.41	0.00*
Fat free mass (%)	65.34 ± 2.36	45.88 ± 0.92	0.001*
$\dot{V}O_{2max}$ (L·min^{-1})	3159.98 ± 176.5	2169.74 ± 76.1	0.00*
$\dot{V}O_{2max}$ (mL kg^{-1} min^{-1})	30.63 ± 2.06	25.93 ± 1.01	0.03*

Note: Values are means ± SE.
*Significant difference between genders.

Table II. Changes in anthropometric characteristics and $\dot{V}O_{2max}$ of all adults with SMI before and after the intervention programme

	Pre	Post	p Value
Body weight (kg)	91.72 ± 2.84	86.85 ± 2.70	0.001
Body mass index (kg/m^2)	33.61 ± 0.91	31.82 ± 0.85	0.001
Waist circumference (cm)	103.62 ± 2.09	99.40 ± 2.06	0.001
Body fat (%)	43.09 ± 1.07	39.81 ± 1.12	0.001
Fat-free mass (%)	56.94 ± 1.01	60.10 ± 1.06	0.001
$\dot{V}O_{2max}$ (L·min^{-1})	2466.82 ± 98.4	2622.91 ± 96.8	0.001
$\dot{V}O_{2max}$ (mL kg^{-1} min^{-1})	27.33 ± 0.98	30.62 ± 0.94	0.001

Note: Values are means ± SE.

was observed between the change from pre to post in $\dot{V}O_{2max}$ and any other anthropometric variables.

Various multiple regression models were run with independent variables the age and the relative changes in $\dot{V}O_{2max}$ and dependent variables the relative change in body weight or BMI. Multiple regression analysis revealed that relative change in $\dot{V}O_{2max}$ tended to be a statistically significant predictor of the variance in the relative change in body weight (p = 0.07) and BMI (p = 0.06), explaining 26% of the variance in the change in body weight and BMI.

Discussion

Low aerobic capacity has been established as an independent risk factor for the development of obesity and its related co-morbidities in healthy obese individuals (Hamilton, Hamilton, & Zderic, 2007). In adults with SMI, the use of second-generation medications such as Olanzapine and Clozapine provide additional challenges in the obesity epidemic and treatment due to their direct effect on body fat accumulation (Allison et al., 1999; Keck & McElroy, 2003; McEvoy et al., 2005). However, no studies have investigated the role of low aerobic capacity on the obesity development in this population. The present study assessed the aerobic capacity of obese adults with SMI and further investigated the effects of an exercise and diet programme on the aerobic capacity and body composition of this population. Our results demonstrate that obese adults with SMI have very low aerobic capacity similar to the levels observed in healthy obese individuals, which is inversely associated with the

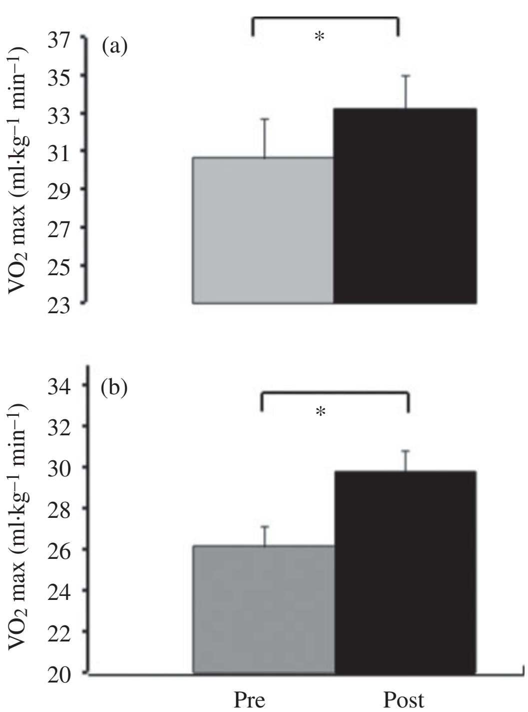

Figure 1. Changes in $\dot{V}O_{2max}$ for (a) males (N = 15) and (b) females (N = 35) with SMI after the exercise and dietary intervention.

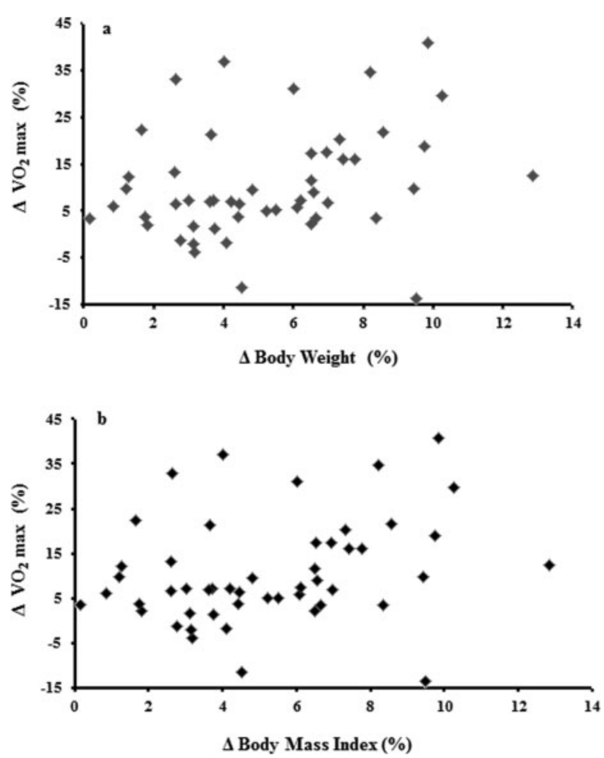

Figure 2. Correlations between the change (Δ) in $\dot{V}O_{2max}$ and (a) Δ in body weight and (b) Δ in body mass index after the exercise and dietary intervention.

indexes of obesity. Furthermore, we have shown that a personalised programme based on exercise and diet can effectively improve the $\dot{V}O_{2max}$ of obese adults with SMI despite the use of antipsychotic medications.

A growing number of research studies show the important role that exercise participation plays in people with SMI not only in their psychological health and quality of life but also in their overall health and risk of obesity and its co-morbidities (Richardson et al., 2005). However, a paucity of research exists on the aerobic capacity of adults with SMI and its role on obesity development. A possible reason is the difficulty of performing a maximal oxygen consumption test on a high percentage of these patients due to psychological problems and medication side effects such as lack of concentration, agitation, sleepiness, headaches, and so on. In the present study, we examined the aerobic capacity of obese adults with SMI using a submaximal exercise test, an essential clinical tool for assessment of aerobic capacity in populations that are at high risk of complications during maximal exercise. Moreover, the submaximal test was purposefully used, as we have previously observed from our practice in the hospital that a number of adults with SMI have a difficulty to push themselves to exhaustion and their actual $\dot{V}O_{2max}$ due to serious psychological problems such as anxiety, agitation, depression and lack of concentration. We found that the aerobic capacity of our participants was poor, averaging at 27 $ml \cdot kg^{-1} min^{-1}$. Our results are in agreement with the recent study by Strassnig, Brar, and Ganguli (2011) in adults with schizophrenia and the study by Jerome et al. (2012) in adults with mental illness, as well as studies in healthy obese individuals with no mental diseases (Kempen, Saris, & Westerterp, 1995; Okura, Nakata, Lee, Ohkawara, & Tanaka, 2005). The aerobic capacity of our participants was inversely associated with all measures of obesity indexes, such as body weight, body fat, and waist circumference, with the strongest correlation found between $\dot{V}O_{2max}$ and body fat percentage ($r = -0.63$). These findings are in accordance with the results of Strassnig et al. (2011) as well as findings of studies in healthy obese individuals, where increased aerobic capacity is associated with reduced obesity indexes such as body fat and waist circumference (Ross et al., 2000). Furthermore, we found that $\dot{V}O_{2max}$ was a significant predictor of the obesity indexes, explaining from 30% to 60% of their variance; possibly demonstrating that apart from medications and diet, fitness level is also an important parameter in the obesity development in SMIs.

We found significant improvements in aerobic capacity after only three months of exercise and diet intervention in our obese adults with SMI taking Olanzapine, a medication known to contribute to obesity. Specifically, $\dot{V}O_{2max}$ was increased by ~11% from pre- to post-intervention. Only one pilot study in a small population sample (N = 6) has shown significant increases in aerobic fitness in adults with SMI after a 12-week intervention programme of exercise and nutrition (Blouin et al., 2009). However, in the study by Blouin et al. (2009), the researchers did not measure oxygen consumption during exercise in the patients, but estimated the aerobic fitness of their participants by using an adapted Rockport test (Kline et al., 1987). The improvement observed in $\dot{V}O_{2max}$ in our participants was a clinically important predictor of the improvements observed in body weight and BMI, explaining 26% of their change, suggesting the primary role that regular exercise plays in the obesity treatment in this population of obese adults with SMI. Finally, our results are in agreement with exercise and nutrition studies in obese healthy individuals, where similar but slightly greater improvements (~15%) in fitness level are found (Kempen et al., 1995), possibly showing that obese adults with SMI can respond similarly to exercise and diet treatments despite the use of antipsychotic medications. However, due to the lack of research studies investigating the relationship between improvements in aerobic capacity and potential beneficial changes in body weight and body composition as well as health indexes in this specific population more research is needed to establish such a phenomenon.

The nutrition and exercise programme resulted in significant reductions in body weight and BMI (~5%), fat mass (~13%) and waist circumference (~4%) in our adults with SMI. Our results are in agreement with the findings of Blouin et al. (2009) that observed significant decrements in body weight (3%), and BMI (~3%) after a 12-week exercise and nutrition programme, in adults treated with antipsychotics. Our results are also in accordance with diet studies conducted on adults with SMI. Previous work in our laboratory has found similar improvements in all anthropometric variables (6% in body weight and 13% in fat mass) in SMI patients taking Olanzapine after a 12-week nutritional programme with exercise counselling (Poulin et al., 2007; Skouroliakou et al., 2009) have also found a significant reduction in body weight (~4%), BMI (~5%) and waist circumference (~5%) in a study that assessed the effect of 18-month weight control programme including exercise counselling in the prevention of weight gain in adults with schizophrenia and mood disorders. Finally, we did observe a significant reduction in total cholesterol (18%) after the intervention programme but we did not find any other differences in the rest of the haematological parameters. In Poulin's (2007) study, researchers saw a significant decrease in the total cholesterol (12%) and significant improvement in HDL cholesterol, LDL cholesterol, triglycerides and fasting glucose in 59 SMI patients. We must note, however, that the small sample size (N = 13) of our study might have affected our results and not allowed us to detect any other meaningful changes. Certainly, greater sampler sizes are needed to establish the effect of exercise and diet interventions on the haematological health profile of obese adults with SMI.

In the present study, 10% of the participants dropped out of the study during the course of the study. This finding is in accordance with previous findings in people with SMIs (Roberts & Bailey, 2011). In a recent review paper by Hutzler and Korsensky (2010), the lack of motivational parameters such as low levels of self-efficacy, persistence and self-motivation has been shown to disturb exercise compliance. Our findings once more present the need for inclusion of behaviour modification programmes and careful and regular monitoring of the participants during their involvement in diet and exercise programmes, in order to ensure proper attendance and successful treatment. The pilot findings of this study need to be translated into clinical practice with caution and no generalisations should be made at this point, as the small sample size of the study as well the lack of a control group, may have allowed for the problem of the RTM to take place, and part of the change that we have demonstrated to be attributed to RTM. However, ANCOVA was run where *t*-tests were run, in order to deal with RTM, and no differences were observed in our reported findings.

In conclusion, a personalised home-based exercise and diet programme improve the fitness level and body composition of obese adults with SMI despite the use of antipsychotic medications. This improvement in exercise capacity appears to be a clinically important predictor of the improvements seen in obesity indexes and emphasises the need for the promotion of exercise programmes for people with SMI. Hence, it appears that exercise when combined with proper nutrition may have a crucial role in the development and treatment of obesity in adults with SMI as in healthy obese individuals. More studies should target their interventions to structured exercise and not just diet or medications in order to achieve optimal results in obesity management in this clinical population.

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