The Effects of a Group-based Intervention through Physical Activities and Diet in Young Patients with Serious Psychiatric Disorders: An Exploratory Study

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Research Article

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Abstract

Background and objectives: The present study aims to investigate the effect of the 4-F (Fit, Fun, Feel and Food) group-based program on physical, clinical and biological outcomes in young patients suffering from serious psychiatric disorders.

Methods: To prevent weight gain and improve mental and physical health in young patients, we investigated in a naturalistic design, the effect of a group-based intervention through an exploratory study.

Results: We observed that out of the 61 outpatients initially included in the program, 71% were overweight or obese. The 24 patients who completed the full program showed no significant decrease in weight or body composition. Our main findings were the significant improvement in muscular endurance as well as coordination from T0 ($M=13.65$, $SD=\pm 1.93$) compared to T1 ($M=12.49$, $SD=\pm 1.81$), ($t(20) = 3.072$ $p = <0.05$) and the increase in the general mental well-being of these patients from baseline to the end of the program. According to the type of psychopathology, ($F(3,10) = 4.25$, $p < .05$), we also noticed a slight modification in eating behaviour with a tendency to decrease in the TFEQ hunger's level.

Conclusion: Despite the limitations, the findings of this exploratory study demonstrated that this program is feasible and resulted in better physical conditions with enhanced mental well-being in young patients suffering from psychiatric disorders, sedentary behaviour and unhealthy lifestyles. Further research is warranted in controlled and larger population samples to further our understanding of the effect of such interventions.

Background

People with moderate to severe mental illnesses have higher somatic comorbidities and premature mortality than the general population [1, 2]. Factors such as individual vulnerability, unhealthy lifestyle, poor diet, lack of exercise and sedentary behaviour [3, 4], in addition to the use of new atypical antipsychotics as first line therapy [5, 6], might result in rapid weight gain [7]. Recent studies in the field have reported that weight gain is only the beginning of a series of comorbid illnesses, such as metabolic disturbances, metabolic syndrome (MetS) and premature cardiovascular complications [8, 9]. The short-term consequence is poor treatment adherence [10], while medium- to long-term consequences are physical or mental discomforts with impaired quality of life and decreased life expectancy compared to the general population [11].

New evidence suggests that balanced dietary habits, physical activity (PA) and other lifestyle adaptations can modulate brain function and promote changes in adaptive neural plasticity [12]. In an incidence study (NEMESIS), it was observed that patients with mental illness engaging in regular PA were more likely to recover from their illness compared to their counterparts who did not exercise [13], plus the patients had enhanced mental capacity [14] and cognitive function [15]. There is biological plausibility that exercise may have anti-inflammatory effects [16], and PA allows an improvement in functional

ability, cardiorespiratory fitness, as well as overall physical health [17]. In addition, lifestyle modifications and behavioural interventions were demonstrated to be effective after 18 months, in reducing weight in a large-scale study of obese individuals with serious mental illness [18]. Furthermore, weight loss can be achieved by the combination of a suitable exercise program associated with healthy eating behaviour and not only dietary restriction [19, 20]. Moreover, in a group context, PA programs were delivered and/or supervised by a qualified professional throughout the duration of the intervention. The use of a qualified professional appeared to be associated with significantly lower dropout rates, higher-intensity physical activity, and better adherence to care and group cohesion [21].

Psychiatric disorders usually begin during adolescence and early adulthood [6]. The neurobiological aetiology of the positive impact of PA on psychiatric symptoms of schizophrenia remains unclear [22]. However, the prevalence of excess body fat may be as much as four times higher in this population than in the general population [23]. This is especially so in patients with first-episode psychosis, as reported in an early intervention study, in which providing information about diet and exercise might not be enough to prevent weight gain; thus, the need to implement effective lifestyle and life skill interventions as routine care is crucial from the beginning of treatment in youths with serious mental disease [24]. Similarly, a randomised control study observed better weight management in the intervention group (behavioural interventions, nutrition, and exercise) within the first 3 months following the introduction of atypical antipsychotics in drug-naïve first-episode psychotic patients. These results were confirmed in a 14-week aerobic interval training program with 25 male subjects following their first episode of psychosis. The authors observed the effectiveness of aerobic training in reducing weight and waist circumference by improving maximal oxygen uptake (38% increase in VO_2 max and a diminished resting heart rate by 9 bpm) [25].

Furthermore, a number of clinical studies have investigated PA program-induced disorders and suggested that exercise can relieve both depressive and anxiety disorders. An association between depression and sedentary behaviour, as well as lack of PA, has previously been reported [26]. Based on 23 randomised controlled trials comparing physical exercise to different conditions (usual care, waiting lists or no interventions), this meta-analysis showed that exercise had a moderate to large and significant effect on depressive symptoms compared to usual care and the control group, but the effect was not significant compared to psychological treatment and medication [27]. In a 12-week moderate-intensity exercise intervention, a positive effect was demonstrated with a reduction in symptoms and severity of anxiety, as well as an increase in overall wellbeing. Cardiorespiratory fitness improved over a relatively short period in 15 patients suffering from obsessive compulsive disorder [28]. These results were in line with a randomised controlled trial that reported a harmful effect of PA and a sedentary lifestyle in increasing the risk of developing anxiety with cognitive and psychosocial changes in 39 young adults with anxiety aged 18-35 years in a 2-week program (1 week sedentary and 1 week PA with pedometer) [29].

Moreover, a controlled study revealed a strong correlation between the domains of quality of life, level of vitality, and mental health ($r = 0.77$). The prevalence ratio showed that physical activity is a contributing factor against anxiety and depression in the elderly [30].

Finally, a group-based program should improve mid- to long-term compliance to healthy habits, resulting in better adherence to appropriate psychotropic treatment, plus better quality of life, prevention of weight gain, as well as the metabolic and cardiovascular consequences [31].

It is challenging in clinical psychiatric practice to focus on improved physical and mental health conditions; however, we believe that it is crucial to investigate the effects of a multidisciplinary group-based program aimed at improving physical, nutritional and mental well-being among young patients suffering from psychiatric disorders. The 4-F program was set up in June 2017 in the psychiatric department (PD) of HUG (University Hospitals of Geneva), centred on physical activity, healthy food education, and improved body perception and emotion regulation) [20, 32] to prevent weight gain and improve mental as well as physical health in young patients aged 18 to 35 years old with moderate to severe psychiatric disorders. On this basis, we investigated, in a naturalistic design, the effect of a group-based intervention on an exploratory design.

Material And Methods

Aim of the study

The aim of this exploratory study was to investigate the effect of an innovative 4-F program (Fit, Fun, Feel and Food) on physical, clinical and biological outcomes in a cohort of 24 young outpatients with moderate to severe psychiatric disorders, over time. This study was conducted over 3 evaluation periods: two during the program (at baseline and after 8 weeks) and one follow-up (phone call) 12 weeks after the inclusion day (Fig. 1). Clinical and anthropometric evaluations are part of routine practice; blood tests and an ECG were performed under the usual conditions.

Participant selection

From August 2018 to October 2020, we recruited outpatients of both sexes, aged between 18 and 35 years, in an ambulatory mental health centre in Geneva, who had moderate to severe psychiatric disorders (MINI International Neuropsychiatric Interview; [33] treated or untreated by psychotropic drugs. The patients included in the study also had a predisposition to weight gain and medical ability to participate in an exercise programme, and agreed to signed an informed consent form. The exclusion criteria for the study comprised individuals with severe personality or addictive disorders, acute somatic disorders, or severe suicidal risk, and those who did not speak French.

Data collection and procedures

The monitoring was centred and conducted in a naturalistic and systematic way by qualified professionals, including senior psychiatrists, psychologists, adapted PA coaches, dieticians and registered nurses, in collaboration with the personal physicians of these patients.

Outcome parameters

A specific study procedure was set up in addition to the usual 4-F program procedure [32]. In addition to the interview and the series of evaluations used in routine program inclusion, additional psychometric evaluations (such as the MINI International Neuropsychiatric Interview) and the follow-up telephone interview, MADRS (Montgomery Asberg Depression Rating Scale Self-assessment), [34], HAM-A (Hamilton Anxiety Rating Scale, [35], psychotic disorders (PANSS: The Positive and Negative Syndrome Scale) [36], well-being (WEMWBS (The Warwick-Edinburgh Mental Wellbeing Scales); [37] food behaviour evaluation (TFEQ: The Three-Factor Eating Questionnaire) [38]. Blood samples were collected in the morning and assayed using standard laboratory settings at baseline and at T1 for fasting blood glucose and lipid levels.

The vital signs, height, weight (using balance-beam scale), BMI (weight in kg/height in metres squared), umbilical perimeter, VO2 max (an index of maximum capacity of an individual's body to transport and use oxygen during incremental aerobic exercise), body composition (biceps, triceps, subscapularis, supra-iliac), were recorded at baseline and at T1 using body stat impedance metre. An ECG was obtained for all patients in the study upon inclusion.

To assess the patient's activity and lifestyle habit maintenance, we performed a follow-up telephone interview 1 month after the end of the study (T2), evaluating the patient's physical activity, body weight and clinical condition (CGI: The clinical global impression scale) [39].

As part of the 4-F program, the patients participated in 2 sessions of moderate exercise intervention of 60 minutes each, per week. One of the sessions (Fit) consisted of 15 minutes of progressive articular and muscular warm-up, 30 minutes of moderate-intensity aerobic exercises in the form of circuit training with a short resting interval and 15 minutes of relaxation through stretching exercises. The other session (Fun) consisted of 5 minutes of articular warm-up followed by 20 minutes of specific and progressive intensity exercises related to the sport. The participants followed with 30 minutes of a chosen sport at moderate to sustained intensity, and finished with 5 minutes of relaxation through stretching. The patients were assessed with a Eurofit physical fitness test battery [40] to evaluate cardiorespiratory endurance, coordination, suppleness and balance (e.g., Shuttle run test for cardiorespiratory endurance or plate strike test for limb speed).

A therapeutic session (Feel) with interdisciplinary co-facilitators (psychologist and dietitian) proposed a therapeutic space for talking; participants shared their experiences with weight gain, their body perception, and exchange about their therapeutic program (difficulties, concerns, successes, strategies, etc.). The facilitators had the dual objective of motivational interviewing and listening, plus nutrition on the one hand and psychological support (through self-esteem and support, for example) on the other hand. This management improved follow-up, better adherence to appropriate psychotropic treatment, enhanced quality of life, aided the prevention of weight gain, as well as its metabolic and cardiovascular consequences.

The dietician and the psychologist organised bimonthly sessions (Food) to share educational counselling about nutritional knowledge and behavioural goals according to well-defined topics. The bimonthly sessions helped the participants share their experiences with eating habits, weight gain, and healthy lifestyle.

Data analysis

The descriptive analysis of the data is expressed as the mean ($\pm$ SD), percentage or number of patients. Paired t-tests for the difference between T0 and T1 (8 weeks after the beginning of the program) were used to evaluate the evolution of anthropometric (fat mass per kg, fat-free mass per kg, abdominal circumference, weight, BMI, waist circumference, blood pressure, waist-to-hip ratio and hip circumference), psychometric (WEMWBS, MADRS, PANSS) and nutritional outcomes (TEFQ).

In addition, a general linear model of covariance (ANCOVA) was first performed to examine between-group differences in anthropometric, psychometric and nutritional outcomes across the 3 groups of patients (patients with anxiety and depression disorders, with psychotic disorders and others). The ANCOVA allowed controlling for differences in sex.

Global statistical significance was set at $p \leq 0.05$. Statistical and demographic analyses were performed with the Statistical Package for Social Sciences (SPSS) software Version 25.0. (Armonk, NY: IBM Corp).

Human participant protection

The study was carried out in accordance with the protocol and with principles enunciated in the current version of the Declaration of Helsinki, and the guidelines were approved by the local ethics committee of Geneva (CCER, N°2018-00010).

Results

Descriptive analyses (Table 1)

From August 2018 to October 2020, sixty-one patients were included in the 4-F program with a mean age of 26.9 years ($\pm$ 6.1, 60% men). Among these patients, 73% were overweight or obese (26% and 47%, respectively), with 39.3% MetS prevalence, 57.4% suffered from anxiety and mood disorders, and 26.2% suffered from psychotic disorders. Most (88.6%) of the patients had at least one psychotropic treatment, and 44.3% were on an antipsychotic treatment (Table 1).

Due to the COVID-19 outbreak, lockdown periods and usual dropout rate (20 to 50% in outpatients [21, 41], almost 50% of patients failed to complete the study protocol, while 24 patients dutifully followed the 8-week training program. We decided to investigate the feasibility of the 4-F program with an exploratory study to analyse its effect over time, only on this sample of the population.

Of the 61 outpatients enrolled, 24 completed the 4-F program (mean participation = 33.3%), and 11 completed at least 50% of the training sessions (mean participation = 57.4%). The reasons for dropping out were lack of motivation and attrition (N = 8), COVID outbreak and national quarantine period (N = 8), worsening psychiatric state and hospitalisation (N = 8), and only a few patients did not start the program (N = 6). For patients included before the COVID outbreak (January 2020) and consequent lockdown measures, we decided to adapt the 4-F program via online videoconference format [42].

The sociodemographic and clinical characteristics of this cohort of patients (N=24) are shown in Table 2 and Table 3.

These 24 patients had a mean age of 25.7 years (± 7.5 ; 66.7% men). Among these patients, 93.8% were single, 56.3% were Swiss or European, 43.8% lived alone and 79.2% were overweight or obese (25% and 54.2%, respectively), with 37.5% MetS prevalence, 62.5% suffered from anxiety and mood disorders and 33.3% from psychotic disorders. Most of the patients had at least one psychotropic treatment (87.5%) and 54.2% were on an antipsychotic treatment (Table 2).

Univariate analysis of variance

Differences between men and women:

Concerning the anthropometric outcomes, univariate tests indicated a significant difference between men and women at baseline and T1. A univariate analysis of variance ANCOVA was performed to identify a difference in the above variables over time, while controlling for sex. No significant difference was observed from baseline to T1 for the fat-free mass (kg) (F (1.17) = .818, $p = .66$), waist circumference (WC) (F (1.19) = .885, $p = .18$) or waist-to-hip ratio (F (1.19) = 2.48, $p = .11$).

Physical and anthropometric results

Concerning PA, at postintervention, patients improved muscular endurance and coordination (speed of limb movement) from T0 (M=13.65, SD= ± 1.93) to T1 (M=12.49, SD= ± 1.81) ($t(20) = 3.072$ $p = <0.05$). No significant differences were observed for the two other subscales of the EUROFIT test: flexibility ($t(20) = -1.026$, $p = .53$) or whole body balance ($t(20) = .497$, $p = .93$) (Table 3).

At the postintervention point, there was no difference in weight, BMI or body composition compared to baseline. In particular, at T1, we observed no change in fat mass and fat-free mass (lean mass) compared to baseline ($t(26) = -.228$, $p = .821$); ($t(25) = -.646$, $p = .524$).

Food behaviour results

Concerning the evolution of eating behaviour outcomes over time, we observed a slight change in the TFEQ hunger score from baseline ($M=7.38$, $SD= \pm 3.9$) to post-intervention at T1 ($M= 5.3$, $SD= \pm 3.2$), ($t(12) = 2.057$, $p=.06$). No significant difference was observed for the two other subscales of the questionnaire, such as dietary restriction ($t(15) = -.064$, $p= .95$) and disinhibition ($t(15) = 4.404$, $p= .18$) (Table 3).

Biological results

Concerning the evolution of biological outcomes over time, we did not observe a significant change in biological outcomes such as triglycerides ($t(20) = -.899$, $p = .38$), total cholesterol (Tot-Cs) ($t(20) = -.849$, $p = .41$), LDL cholesterol (LDL-Cs) ($t(18) = -.1074$, $p = .30$), HDL cholesterol (HDL-Cs) ($t(20) = .986$, $p = .34$), or among HDL cholesterol ($F(1,17) = .818$, $p = .79$), fasting blood glucose ($t(20) = .291$, $p = .78$), serum leptin level ($t(7) = -.525$, $p = .61$) and serum ghrelin ($t(7) = -.020$, $p = .98$) (Table 3).

Psychometric outcomes

Concerning the patients suffering from anxiety or mood disorders, we observed that the scores of the MADRS questionnaire slightly decreased after 8 weeks, from baseline T0 ($M = 1.75$, $SD = \pm .89$) to T1 ($M = 1.30$, $SD= \pm .81$), ($t(2) = 3.272$, $p = .081$). Significant difference was observed for the general well-being (WEMWBS) ($t(13) = -1.008$, $p=.05$) from T0 ($M=44.23$, $SD= \pm 7.8$) to T1 ($M = 47.41$, $SD= \pm 6.7$) where patients with anxiety, depression and psychotic disorders increased their general well-being from T0 ($M = 47.75$, $SD = \pm 5.12$; $M = 41.80$, $SD = \pm 9.98$) to T1 ($M = 52.00$, $SD = \pm 5.10$; $M = 50.60$, $SD = \pm 3.78$) ($t(3) = -4.12$, $p = .026$; $t(4) = -2.91$, $p = .044$).

Differences according to diagnosis

A one-way ANCOVA was performed to determine the difference between the psychopathology (anxiety-depression, psychosis and others) on the psychometric, nutritional and anthropometric variables using the pretest as a covariate. There was a significant effect of the program on mental well-being according to the type of psychopathology ($F(3,10) = 4.25$, $p < .05$). In particular, the patients with anxiety-mood disorder symptoms increased their general mental well-being (WEMWBS) from T0 ($M = 47.75$, $SD = \pm 5.12$) to T1 ($M = 52.00$, $SD = \pm 5.010$), ($t(3) = -4.123$, $p = .03$). Concerning patients with psychosis, no significant difference was found for the total score of the PANSS ($t(4) = -1.51$, $p = .205$) and a tendency of a decrease in abdominal circumference at T1 ($M = 108.50$, $SD = \pm 15.46$), ($t(7) = 2.11$, $p = .072$) compared to T0 ($M = 110.75$, $SD = \pm 14.73$). No difference in abdominal circumference (AC) was observed at T1 among patients suffering from mood disorders ($t(7) = -1.340$, $p = .222$) or patients with anxiety disorders ($t(4) = 1.00$, $p = .374$).

A tendency of a decrease in plasma leptin levels among patients with psychosis from baseline ($M = 9.56$, $SD = \pm 9.68$) to the end of the program ($M = 12.11$, $SD = \pm 10.51$), ($t(2) = -3.32$, $p = .080$) was observed, as well as a slight change (not significant) in glucose from T0 ($M = 5.24$, $SD = \pm .400$) to T1 ($M = 4.90$, $SD = \pm .707$), ($t(6) = 2.16$, $p = .074$). No significant differences in plasma leptin levels and glucose blood levels were observed among the patients with anxiety-depression symptoms ($t(7) = 2.11$, $p = .072$) (Table 3).

Finally, we did not observe a difference over time in CGI Gravity or in CGI Improvement from baseline T0 ($M = 4.07$, $SD = \pm 1.07$) compared to T1 ($M = 4.00$ ($SD = 1.36$) and to T2, 4 weeks after the end of the program ($M = 2.92$, $SD = \pm 1.75$), $p = 0.86$, and $p = 0.36$, respectively (Table 4).

Discussion

Testing the effect of this 4-F program in a real-world intervention, we conducted an exploratory study among 24 outpatients suffering from moderate to severe psychiatric disorders who completed the eight-week intervention. Our main findings were the significant improvement in muscular endurance, as well as coordination, and the increase in the general mental well-being of these patients from baseline to T1, while the depression scores slightly decreased following the 8-week program. Meanwhile, we observed no significant decrease in weight, BMI or body composition. However, we noticed that only the subgroup of patients suffering from psychosis had a slight decrease in abdominal circumference (AC). Finally, we observed a slight change in eating behaviour with a tendency of a decrease in the TFEQ hunger scores over time.

Indeed, we found that patients who completed the 8-week program improved muscular endurance and their coordination with no change in flexibility or whole-body balance. Compared to a previous report in 2012 [43], the Eurofit test battery was used to evaluate physical fitness parameters in patients with schizophrenia or schizoaffective disorder. Both patient groups had impaired limb movement speed, strength and abdominal muscular endurance compared to the healthy controls. This demonstrates that patients with psychiatric illnesses have poor physical performance exacerbated by unhealthy lifestyle habits, feeding and sedentary behaviour; in addition, an increasing duration of illness could be a strong correlate for the performance on several Eurofit test items. Possible reasons for the association of worse physical fitness with a longer duration of illness include the cumulative long-term effect of poor health behaviours such as physical inactivity in patients often suffering from psychomotor slowing. Moreover, the Eurofit test can be recommended for evaluating the physical fitness of inpatients with bipolar disorder. These authors reported that significant correlations with Eurofit test items were found with age, illness duration, body mass index, smoking behaviour, mean daily lithium dosage, plus depressive and lifetime hypomanic symptoms [44].

In the 4-F program, we deliberately chose a good exercise dosage, an 8-week group-based intervention following OMS and the American College of Sports Medicine (ACSM) recommendations [45, 46], using 2 sessions per week of 60 minutes each, sessions with progressive, moderate-intensity aerobic exercises and sessions with ball team sports. Indeed, we observed in the recent literature that these exercise groups

varied in duration from 2 to 52 weeks [29, 47], with a mean of 12 weeks, in session duration of 10 to 90 minutes with a mean of 60 minutes [48, 49], frequency of 1 to 4 times/week; [48, 50], the quality and the intensity of physical exercise, performed at a low (yoga or similar), moderate, [51] and moderate to vigorous intensity (aerobic training) (Rahman, 2018) [52]. We found that despite some discrepancies in methodological design, these interventions had a real impact on the physical and mental health of patients suffering from serious psychiatric disorders. We are convinced that the high dropout rates and lack of motivation are obstacles to increasing the retention of patients, and it is crucial to manage their motivation tapering with behavioural and motivational counselling [53].

We also observed an improvement in the general mental well-being of our patients from baseline to postintervention and a slight positive change in depression scores in the 8-week program, while we note no difference in positive or negative scores on the PANSS. In line with a previous work, with 12 weeks of moderate to intense aerobic PA duration, the authors observed enhanced cardiorespiratory fitness, wellbeing and decreased psychiatric symptoms [54]. In a longer 12-week randomised controlled study with PA intervention on first-episode psychotic patients, the authors reported a decrease in positive symptoms on PANSS and psychopathology in general, while exercise was helpful against the negative score increase observed in the control group [55].

This is consistent with a randomised control study reporting better weight management in the intervention group (behavioural interventions, nutrition, and exercise) for drug-naïve first-episode psychotic patients in the first three months following the introduction of atypical antipsychotic drugs compared to control condition groups [56].

Not surprisingly, we found that among our final sample, 79.2% were overweight or obese, and the prevalence of MetS was 37.5%. In the general population, these constellation risk factors have been associated with the development of cardiovascular disease [57]. This result is consistent with the results of a previous meta-analysis [58] which found that almost one in three unselected patients with schizophrenia met the criteria for MetS as well as in a study among bipolar and unipolar depressed patients [59] who demonstrated a higher MetS prevalence and BMI (BD = 46.9% vs. MDD = 35.1%, vs. general population = 22.1%) than the general population. A recent meta-analysis showed that the prevalence of MetS was 31.8% in 18-year-old subjects with depression [60]. In contrast with a previous work, we conducted in 2009, where we found that in a cohort of 153 psychotic patients, 46.4% were overweight or obese, while only 19% of them had MetS [19]. These results indicate that before inciting individuals with psychiatric disorders and who are overweight to increase their level of PA, it is essential to quantify their physical health and low PA level, plus help them establish realistic and gradually attainable objectives in terms of the frequency, intensity and duration of the exercises [61]. The American College of Sports Medicine (ACSM) defined the beneficial exercise dosage, using the frequency, intensity, time and type of exercise as determinants of dosage [45].

Interestingly, we observed no significant decrease in weight, BMI, WC or body composition. This could be due to the short duration of the program, lower participation rate and characteristics of the population

studied (most of them were overweight or obese with several diagnoses).

In contrast, in an 18-month controlled study, the active group with a weight control program that included an educational activity significantly reduced their bodyweight and WC [62]. Playing in team sports requires anticipation and speed to understand the actions of team members [22]. Consistent with a 12-week randomised controlled study of PA intervention in psychotic patients, the authors reported no change in BMI [53]. In addition to a previous report [25] in a patient within a first episode of psychosis who followed a 14-week aerobic interval training program, improved metabolic outcomes and cardiorespiratory fitness, the clinical statute remained moderately to severely symptomatic and functionally impaired after the intervention. Meanwhile, we observed that the depression scores slightly decreased in the 8-week program. A large number of clinical studies have investigated PA programs in mood disorders and suggested that exercise can relieve both depressive and anxiety disorders [62].

However, in this exploratory study, we noticed that only the subgroup of patients suffering from psychosis had a slight decrease in abdominal circumference (AC) after 8 weeks of the program. These results were confirmed in a fourteen-week aerobic interval training (AIT) program with 25 individuals after their first psychotic episode. The authors observed the effectiveness of aerobic training in reducing weight and waist circumference by improving maximal oxygen uptake (Abdel-Baki et al., 2013) [25]. In an AIT 14-week study, greater WC reduction and weight loss were reported, while it took 12 to 18 months and 3 to 6 months, respectively, in a previous study to obtain the same magnitude of reduction in WC and weight [63].

This suggests that AIT might induce faster WC reduction than traditional exercise training in a psychiatric population, as demonstrated in the general population [54]; however, we should take into account psychiatric population characteristics such as amotivation or psychomotor slowing to implement a progressive intensity dosage.

We did not observe an improvement in the patient's VO_2 max at the end of the program, while in a 14-week aerobic interval training (AIT), the authors reported a significant increase in VO_2 max [25]. This result was confirmed in metabolic syndrome patients; VO_2 max increased more after AIT vs. moderate continuous training after 16 weeks and was associated with the removal of more risk factors that constitute metabolic syndrome [54]. In a 4-week randomised, single-blinded controlled clinical trial in 57 patients with depression plus add-on aerobic exercise or no activity, the authors reported that VO_2 max and O₂ pulse parameters increased over time only in the exercise group and remained unchanged in the control group [64].

In this 8-week intervention, there was no significant improvement in laboratory parameters (lipid profile or fasting glucose) over time, as in a previous controlled study in an exercise and dietetic program conducted in young patients with first-episode psychosis [24]. Since the onset of the disease represents a critical period to prevent side effects and metabolic morbidities, it is crucial to implement effective lifestyle habits and acquire life skills through multidisciplinary trainings and include them in their routine

care (as quickly as possible from the onset of the disease) from the initiation of treatment in young patients with serious mental diseases [24]. This result must consider that most of the patients had at least one psychotropic treatment (87.5%; 54.2% benefited from an antipsychotic treatment), which differs from prior reports that observed blood lipid or glucose dysregulations when patients were under atypical AP [65].

Interestingly, we observed a slight decrease in the TFEQ hunger score from baseline to postintervention at T1, in line with previous works that reported that the TFEQ disinhibition and hunger scores increased according to body mass index [19]. PA may represent a valuable factor and predictor to help change the physiological imbalances caused by several psychiatric disorders and unhealthy lifestyles (such as eating attitudes) [66]. Moreover, there is evidence that exercise could influence the drive to eat through the modulation of appetite [67].

Finally, we observed that the effects of the 4-F program's clinical global impression (gravity and improvement) did not differ 4 weeks postintervention. In line with improvements in the Calgary Depression Scale (CDS) in both the yoga and aerobic exercise groups at 3 months of intervention, it remained stable at the 18-month follow-up in both intervention groups [68].

Limitations

The outcome of this exploratory study is that we demonstrated the feasibility and effectiveness of the 4-F program in young patients with moderate to severe psychiatric disorders in assessing 8-week adapted PA levels and improvement in muscular endurance, as well as coordination and the increase in the general mental well-being. However, there are some limitations to this exploratory study. The first limitation was its nonrandomised controlled nature and lack of an active control group. Nevertheless, we evaluated the effect of a specific 8-week program on mental and physical outcomes in outpatients with a 4-week follow-up period. Second, longitudinal analyses were performed in a relatively small sample size of participants, which suggests that our results and conclusion should be viewed as preliminary. Our dropout rate reached the upper limit of the range reported by previous findings (20 to 50% in outpatients), [41], caused by multiple factors such as the lack of motivation and attrition induced by mental disease itself, the outpatient inclusion, the COVID-19 outbreak with the quarantine periods, the lack of encouragement and priority given to physical activity by psychiatrist and other barriers to engage in exercise program such as psychological difficulties regarding ongoing motivation and the organisation of daily routines [69]. Lastly, the response to physical activity was highly individualized, making it difficult to satisfy everyone. However, creative ways and optimised motivation are needed to monitor and enhance adhesion and compliance of this population [70].

Third, the patients' clinical backgrounds were heterogeneous, and we chose to investigate the effect of a program group including patients with different psychiatric disorders. Nevertheless, these results suggest that an innovative program is feasible and can be effective with improving muscular endurance, as well as coordination and increasing wellbeing over time. Second, we conducted this exploratory study from

the perspective of pragmatic and real-world settings to be more inclusive (diagnosis), to initiate exercise, to improve physical health and good lifestyle habits and to prevent weight gain and metabolic dysfunctions.

Conclusion

Despite the limitations, the findings showed that this 8-week group-based program is feasible and led to an increase in muscular endurance and coordination, which could be good predictors for improving physical and mental health in patients often suffering from psychomotor slowing. This exploratory study will help us to improve upon the procedures to facilitate a better involvement and retention of the patients for the program (motivation to avoid a high rate of drop-out) and focus on both physical and mental health outcomes of a multidisciplinary intervention. In addition, it suggests initiation of subsequent longitudinal follow-up research in a larger and controlled cohort of patients to enhance our understanding of the effect of such interventions; which have already been demonstrated to improve quality of life, limit morbidity and mortality of seriously mentally ill patients.

Declarations

Availability of data and materials

The anonymized data and the research protocol that support the findings of this study are available on request from the corresponding author, OS. The data are not publicly available due to their containing information that could compromise the privacy of research participants.

Consent for publications

Not applicable

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Role of the sponsor

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Competing interests

The authors declare that the research was conducted in the absence of any commercial or financial partnership that could be considered as a potential conflict of interest.

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The coauthors have nothing to disclose.

Authors' Contributions

OS developed the search question and strategies, supervised advancement of the project and to the main part of manuscript redaction. GZ participated in development of the search question strategies and participated to redaction of the manuscript. CC supervised advancement of the project, contributed to data analysis and performed statistical analysis. AC helped in the coordination collection and extraction of the data, and revised the manuscript. The authors accepted the present manuscript.

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Ethics approval and consent to participate

This human prospective study have been approved by the appropriate ethics committee, the Swiss Ethics Committee on Research Involving Humans of Geneva (No. 2018–00010) and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. All included patients were informed Participants were informed about the general purpose of the study to examine effects of a therapeutic program on clinical and biological variables and signed informed consent (protocol available).

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Tables

Due to technical limitations, tables are only available as a download in the Supplemental Files section.

Figures

Pretest: Pre-screening and consenting procedures if inclusion-exclusion criteria met + completing evaluations
 Posttest: Completing clinical, psychometric and nutritional evaluations

Figure 1

Experimental design of the exploratory study

Supplementary Files

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