Original article

The effect of exercise on physical and mental health for adults with schizophrenia: A review of clinical aerobic exercise

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Abstract

Background: The importance of aerobic exercise for people with mental illness has been discussed. Among many studies that explore the effectiveness of aerobic exercises, some researchers found positive results while others showed negative results. The purpose of this study was to review randomized controlled trials focusing on the physical and mental health benefits of aerobic exercise interventions for individuals with schizophrenia.

Methods: Using multiple research engines, the study collected research articles published between January 1990 and December 2018. Based on inclusion and exclusion criteria, six studies were selected. Typically, the collected studies used exercise interventions that lasted between 10 to 16 weeks, 2 to 4 days a week, for 30 to 40 minutes per day.

Results: The studies showed that aerobic exercise is beneficial for individuals with schizophrenia in that it improves their physical and mental health functions. The review found that exercise improved levels of physical and psychological changes (16 of the 26 measurements yielded moderate or large effect size). However, because of insufficient information in each study (e.g., the rationale for intensity of exercise, conditions of participants, and low engagement), it is unclear why some studies found a more significant improvement than others.

Conclusions: This review showed that aerobic exercise are basic, easily implemented, effective and low-cost forms of exercise, which can lead to a modest increase in levels of physical and psychological changes in a variety of settings. However, a few studies showed no noticeable changes in the symptoms of mental health, so the study results should be interpreted carefully. *Ethiop. J. Health Dev.*2020; 34(1):35-43]

Key words: Aerobic, walking, physical exercise, schizophrenia, mental illness, exercise training manual

Background

For over three decades, the World Health Organization (WHO) and the International Federation of Sports Medicine (FIMS) have acknowledged a relationship between a lack of aerobic exercise and the risk of physical diseases. Accordingly, medical and public health authorities encourage people to carry out aerobic exercise regularly for health benefits. People who receive mental health treatment (medication and therapy) are also recommended aerobic exercise. Aerobic exercise refers to the bodily movement of skeletal muscles without heavy physical activity, including walking and cycling, that increases energy expenditure. The effects of aerobic exercise on the human body are critical to improve body, immune, and brain functions (1).

Adults with schizophrenia have a higher prevalence of cardiovascular disease, metabolic syndrome, diabetes, hepatitis, and respiratory illness; the underlying illness results in higher levels of mortality and morbidity than the general population, even when receiving proper medical treatment and nutritional supplements (2). Life expectancy for individuals with mental illness is 11 to 18 years shorter than the general population (3). One study shows that the obesity rate of individuals with schizophrenia is over 40% – a rate more than four times greater than those with no mental illness (4). There is mounting evidence that adults with schizophrenia are more likely to have lifestyle risk factors for cardiovascular disease and obesity than the general population because of tobacco and substance abuse. The costs of tobacco and substance abuse contribute to statistically lower levels of socioeconomic status(5).

In addition to higher rates of health-threatening behaviors (e.g., cigarette smoking, alcohol consumption, poor exercise habits, and high-cholesterol diets), individuals with schizophrenia struggle with unique challenges (6). Health-threatening behaviors, which affect physical well-being and increase the risk of illness, are particularly problematic when attempting to develop a physically active lifestyle.

Antipsychotic medications used in the treatment of schizophrenia are associated with physical complications and side effects that influence mood, motivation, diet, and appetite (2,7). Of notable relevance, using antipsychotic medication – particularly first-generation neuroleptics – often contributes to weight gain and low energy levels. Due to the debilitating symptoms of their disease, individuals with schizophrenia generally continue to use antipsychotic medications, despite what are often serious adverse health effects. In conjunction with the primary features of schizophrenia, the side effects of antipsychotic medications can lead to poor diet and a lack of physical exercise, both of which can contribute to the development and continuation of obesity and cardiovascular disease (5).

The increased incidence of chronic health conditions is particularly problematic in individuals with schizophrenia due to the fact that medical professionals

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may be less likely to recognize and treat physical conditions in these individuals (5,8). Professionals not specializing in mental health may be uncomfortable dealing with psychiatric issues and neglect physical symptoms, assuming that most or all symptoms of people with schizophrenia are "psychological" and not rooted in a physiological disease process. The social stigma of schizophrenia is another barrier to individuals seeking physical treatment and, due to impaired cognitive function, individuals with schizophrenia are often less likely to effectively communicate their physical needs and to receive treatment (9). Finally, many individuals with schizophrenia have experienced difficulty in obtaining health insurance, often resorting to alternative health services in place of conventional medical care. Based on various studies, we can conclude that people with schizophrenia have not adequately benefited from medical care or preventive health services, and that their physical issues are serious.

In a review process combining 35 randomized controlled trials (RCTs), researchers indicated that aerobic interventions for the general population are more effective in managing obesity and reducing both weight and body mass index (BMI) when compared to progressive resistance exercise training (10). In addition to gym-based exercise programs, several investigations have focused on walking as an intervention and established its efficacy for the reduction of cardiovascular and metabolic risk factors (11).

Although typical physical exercise is effective in reducing cardiovascular disease and obesity in the general population, little is known about the effectiveness of exercise in people with schizophrenia – a population less likely to be engaged in regular physical activities, and less likely to be adequately engaged with available health care services. As interest about health conditions and physical exercise increases, a question arises as to whether typical physical exercise produces physical and mental health benefits for those with schizophrenia. The aim of this paper is to provide a review of recent findings regarding the effectiveness of physical exercise, supervised by fitness professionals, among individuals with schizophrenia. We have limited the scope of this review to physical exercise studies applying RCTs that maximize the generalizability of study findings.

Methods

Search strategy: The authors independently searched databases for articles on physical exercises published between January 1990 and December 2018. In addition, the following journals were searched: *Archives of Physical Medicine and Rehabilitation*, *Clinical Rehabilitation*, *Disability and Rehabilitation*, *Medicine and Rehabilitation* and *Psychiatric Services*. The authors investigated articles using the following key words: "physical exercises", "walking", "aerobic", "psychiatric disorders", "mental illness" and "schizophrenia".

Study selection criteria: After collecting articles and abstracts, the inclusion criteria of articles were that they: (a) conducted RCTs; (b) focused on individuals with schizophrenia aged over 18 years; (c) were based on an aerobic exercise program meeting the American College of Sports Medicine's (ACSM) definition of exercise (e.g., standard-accepted, regular, and purposeful exercise that involves major muscle groups and is continuous and rhythmic in nature); (d) measured participants' physical or psychological changes; and (e) were full-text articles published in English. After reviewing the collected articles independently, the authors held meetings to compare results and reach a consensus. Exclusion criteria were: (a) not standard-accepted aerobic exercises, such as yoga, tai-chi, or stretching; (b) used mixed exercises, such as aerobics exercise with dietary modification or resistance training; (c) only one-day or one-time training; (d) people with co-occurring disorders, including physical disability. If it was unclear whether the study met the inclusion and exclusion criteria, emails were sent to the authors of the articles to collect clear information (e.g., study method, intervention, participant, and result).

Through the data collection process, an initial search was completed of the list of journals, which found 77 citations and abstracts written in English that discussed aerobic exercises for people with schizophrenia (see Figure 1). In the first review, eight duplicate articles were removed and 63 studies that contained any of the exclusion criteria were also excluded. Finally, the 6 articles were reviewed and analyzed. One further study, whose authors did not provide enough information to calculate effect size, was excluded from the analysis. Therefore, six studies were selected for final analysis to explore how aerobic exercises are effective for adults with schizophrenia.

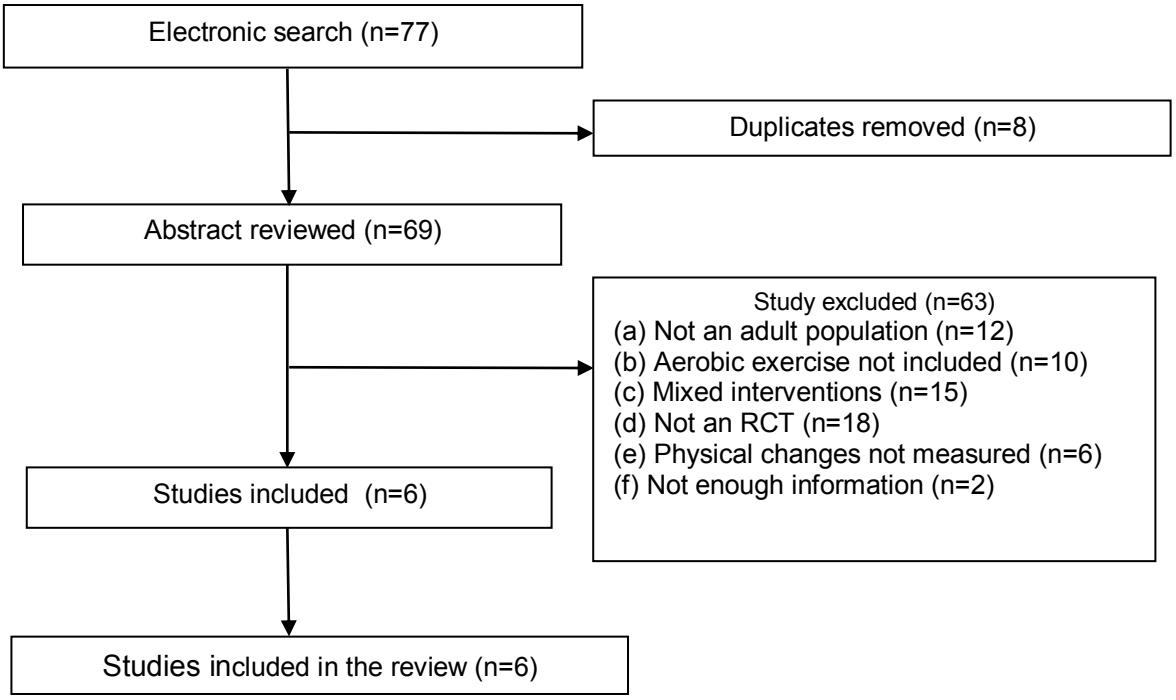

Figure 1: **Flow chart showing different phases of the search process**

Effect size extraction and calculation: The collected studies employed within-subjects design, in which the participants were assessed at test, while engaging in other traditional physical activities. Although we expected to use a meta-analysis program to summarize measures of treatment effects, we could not find similar instruments for the meta-analysis. Therefore, this study applied a method to calculate effect size using Microsoft Excel.

Results

Current physical activity guidelines indicate aerobic exercise for the reduction of cardiovascular and metabolic disease in the general population. Although many studies have explored the effectiveness of aerobic interventions in the general population, four recent research articles focus on adults with schizophrenia and utilize a two-group RCT design.

The first article, by Acil *et al.* (2008), evaluates the effectiveness of aerobic exercise interventions consisting of sessions lasting 40 minutes per day, three days a week, for a period of 10 weeks (13). The exercise group (n = 15) performed a 10-minute limber-up, a 25-minute aerobic period, and a 5-minute cool down.

In order to assess exercise effectiveness, the following measures were used in all trials: Scale for the Assessment of Negative Symptoms (SANS), Scale for the Assessment of Positive Symptoms (SAPS), and World Health Organization Quality of Life (WHOQOL). Although no standardized exercise process was provided in the study, a notable finding is the significant reductions in both SANS and SAPS inventories; specifically, there were reduced numbers of illusions, hallucinations, and anhedonia. Increases in the quality of life, as indexed by WHOQOL, were also found in the intervention group ($p < .05$). We found that three of four tests yielded moderate or large effect size(ESs) (see Table 1).

Table 1: **Baseline and final measures of the collected studies**

Author (year)	Measures	Exercise group		Control group		Effect size (95% CI)
		M (SD)	N	M (SD)	N	
Acil *et al.*, 2008	SANS	15.2 (12.2)	15	35.1 (18.9)	15	1.2** (-7.0 ~ 4.5)
	SAPS	11.2 (8.0)	15	15.5 (11.3)	15	0.4 (-3.9 ~ 3.1)
	Mental WHOQOL	15.7 (2.4)	15	13.6 (3.8)	15	0.7* (-0.5 ~ 1.8)
	Cultural WHOQOL	15.3 (2.5)	15	13.9 (1.8)	15	0.6* (-1.4 ~ .1)
Marzolini *et al.*, 2009	6MWD	563.7 (35)	7	484.2 (47)	6	1.8**(-20.4~24.0)
	MHI	65.5 (9)	7	58.1 (5.5)	6	0.9** (-3.2 ~ 5.0)
	1RM	51.2 (1.1)	7	49.2 (1.5)	6	1.4** (0.7 ~ 2.2)
	Body mass	82.8 (3.5)	7	81.5 (5.5)	6	0.3 (-2.2 ~ 2.7)
	BMI	27.6 (1.1)	7	29.3 (2.2)	6	0.9** (-1.9 ~ 0.0)
	Waist circumference	101.9 (2.6)	7	101.0 (5.2)	6	0.2 (-2.0 ~ 2.4)
	Hip circumference	106.1 (1.9)	7	105.7 (2.8)	6	0.2 (-1.1 ~ 1.4)
	Waist-to-hip ratio	0.96 (0.02)	7	0.95 (0.02)	6	0.5* (0.45 ~ 0.48)
	Resting systolic blood pressure	110 (4.0)	7	118 (12.5)	6	0.8* (-5.7 ~ 4.0)
Pajonk *et al.*, 2010	STM index	9.4 (3.2)	8	9.9 (5.4)	8	-0.1 (-2.3 ~2.1)
	LTM index	13.4 (3.0)	8	11.6 (8.4)	8	0.3 (-2.8 ~ 3.4)
	Corsi span	5.4 (0.7)	8	4.6 (1.1)	8	0.8* (0.4 ~ 1.3)
Wang *et al.*, 2018	Positive symptom	14.38(4.57)	28	15.36 (6.57)	23	0.2 (-1.7 ~ 1.4)
	Negative symptom	15.33 (5.61)	28	22.55 (9.87)	23	0.9** (-3.1 ~ 1.2)
	General psychopathology	29.82 (8.19)	28	34.36 (15.76)	23	0.4* (-3.7 ~ 3.0)
	Total PANSS	58.50 (16.87)	28	71.26 (30.17)	23	0.5* (-7.1 ~ 6.0)
Beebe *et al.*, 2011	Minutes walked	116.9 (117.3)	48	78.8 (106.4)	49	0.3 (-22.0 ~ 22.6)
	Persistence in weeks	9.1 (6.5)	48	7.5 (6.2)	49	0.3 (-1.0 ~ 1.5)
	Percent attendance	27.3 (32.8)	48	22.9 (32.6)	49	0.1 (-6.4 ~ 6.6)
Methapatara & Srisurapanont, 2011	Body weight	-0.3 (4.0)	32	0.8 (3.1)	32	0.5* (-1.3 ~ 0.3)
	BMI	0.3 (1.3)	32	0.5 (1.6)	32	0.6* (-0.9 ~ -0.2)
	Waist circumference	-3.4 (4.4)	32	0.9 (5.2)	32	0.9** (-2.1 ~ 0.3)

SANS = Scale for the Assessment of Negative Symptoms; SAPS = Scale for the Assessment of Positive Symptoms; WHOQOL = World Health Organization Quality of Life; 6MWD = 6-minute walk distance(meters); MHI = Mental Health Inventory; 1RM = one-repetition maximum strength; BMI = Body mass index; STM = short-term memory; LTM = long-term memory; PANSS = Positive and Negative Syndrome Scale
* .3~.6 (Moderate effect size), ** >.7 (Large effect size)

The second article, conducted by Marzolini *et al.* (2009), examined the effectiveness of aerobic and resistance training among 13 adults with schizophrenia (*Mean age* = 45 years) (14). The intervention group (n = 7) participated in two aerobic sessions per week, for 60 minutes per day, for an average of 12 weeks, under supervision at a local recreation center. Additionally, mental health clinicians provided an individualized, home-visit exercise session once per week. The control group (n = 6) received usual care without any intervention. Functional exercise capacity (6-minute walk distance: 6MWD), Mental Health Inventory (MHI), muscular strength via a one-repetition maximum (1RM), body mass, and body mass index (BMI) were measured at baseline and at 12 weeks after the baseline (see Table 1). At the follow-up assessment, the intervention group demonstrated an average increase of 27.7 meters in 6MWD, while the control group showed an average decrease of 28.3 meters (ESs = 1.81); however, neither of these findings reached statistical significance ($p > .05$). The intervention group showed significant improvement in the 1RM ($p < .01$), while no differences were observed in the control group. Additionally, there was a significant increase in MHI scores in the intervention group ($p < .05$) but not for the control group ($p > .05$). We found that most tests yielded moderate or large ESs, in that six of nine tests were significantly different from usual care (see Table 1). The levels of participant attendance in the intervention group were consistently maintained – it is likely that this was the result of cooperative implementation of the intervention by a multidisciplinary team that included a registered nurse, a social worker, and a cardiac rehabilitation exercise specialist. Beyond utilization of a team-based approach to treatment, the authors emphasized that structured, manual-based, and supervised exercises were necessary to improve treatment adherence and maximize positive outcomes (14).

The third article, by Pajonk *et al.* (2010), evaluated the effectiveness of aerobic exercise for 12 weeks, three times per week, with sessions lasting 30 minutes per day (15). The intervention group (n = 8) participated in

aerobic fitness sessions with supervision. The program consisted of cycling at a heart rate corresponding to a blood lactate concentration of about 1.5 to 2 mmol/L. The control group (n = 8) played tabletop football three times per week, for 30 minutes per day. The following measures were used: short-term memory (STM) index, long-term memory (LTM) index, and Corsi Direct Block Span (CDBS). With a manual based exercise training , a notable finding is the significant improvement in both STM ($p < .01$) and CDBS ($p < .05$). The aerobic group with schizophrenia had a 34% increase in the STM score, while the control group had a 17% lower score after exercise. Likewise, CDBS was improved in the exercise group compared to the control group. This study found that one test yielded moderate ES (15).

The fourth article, by Wang *et al.* (2018), evaluated the effectiveness of an aerobic exercise intervention for 12 weeks, three times per week, with sessions lasting 40 minutes per day (5 minutes of walking for a warm-up, 30 minutes of aerobic, 5 minutes to cool down) (16). The intervention group (n = 28) participated in aerobic sessions with one-to-one supervision. The stretching and toning control group (n = 23) consisted of a 30-minute program of 14 exercise routines, including a 3-minute warm-up, 25 minutes of exercises (flexibility, toning and balance exercises designed to use all major muscle groups of the upper and lower extremities), and a 2-minute cool-down exercise. A Mandarin Chinese version of the Positive and Negative Syndrome Scale (MC-PANSS) was measured at baseline, at the end of the intervention, and at the 3-month follow-up point. With the manual based exercise training, a notable finding is the significant improvement in negative symptoms ($p < .01$). The aerobic group with schizophrenia had a 30% decrease in the negative symptoms score, while the control group had a 7% higher score at the 3-month follow-up. This study found that most tests yielded moderate or large ESs, in that three of four tests were significantly different from the control group (16).

In addition to gym-based exercise programs, several investigations have focused on walking as an intervention and established its efficacy for the reduction of cardiovascular and metabolic risk factors (11). This study reviewed several investigations that have focused on walking as an exercise intervention. Two studies investigating the effects of walking on health outcomes for individuals with schizophrenia using two-group RCT designs were identified in this review. Beebe and colleagues (2011) investigated the effect of a 16-week walking program (four days a week, for 30 minutes a day) combining exercise guidance and motivational interviews for adults with schizophrenia (17). The intervention group (n = 48) received the walk, address, learn about exercise, and cue exercise (WALC-S) program. Participants in this program discussed the benefits of and barriers to walking, warming up, and exercises; they also planned specific times to walk in order to facilitate adherence. The control group (n = 49) attended an education program that focused on medication adherence, smoking cessation, therapeutic use of humor, and progressive muscle relaxation techniques. Walking group attendance, persistence (as measured by consecutive weeks of attendance), and compliance were used as dependent measures. After completing 16 weeks of exercise, attendance and persistence in the walking group were higher than in the control group. Increases in minutes walked were found to be greater in the intervention group than in the control group (116.89 minutes vs. 78.83 minutes). This study found significant improvement in the exercise group, though the effect size was small (see Table 1).

Similar to the previous study, Methapatara & Srisurapanont (2011) examined the effects of a 12-week walking program, combined with motivational interviews, with 64 adults who had schizophrenia (*Mean age* = 40 years) (8). The intervention group (n = 32) participated in five 1-hour sessions, which included: (a) daily walking (predominantly unsupervised) with a target of 3,000 steps in 30 minutes and motivationally contextualized within the SMART (specific, measurable, acceptable, realistic, and timed) goal framework; (b) motivational interviews focusing on obesity and body weight; (c) group education on exercise, warming up, and cooling down; (d) supervised group walking practice with pedometers; (e) feedback on program/progress. The control group (n = 32) received continued usual care without any intervention or supervision. Body weight, BMI, waist circumference, and mini-mental state examination (MMSE) assessments were conducted at baseline and at 12 weeks. The intervention group showed an average decrease in body weight (-2.21 kg, $p < .05$), BMI (-.077 kg/m^2, $p < .05$), and waist circumference (-4.24 cm, $p < .01$) compared to the control group. This study found that all tests yielded moderate or large ESs; all three tests were significantly different from usual care (see Table 1). The researchers attributed the positive findings to pedometer walking and motivational interviewing; the intervention seemed to influence participants' cognition and behavior around exercise, resulting in increased engagement in physical activities.

Table 2: **Review – Model, duration, frequency, supervision, and protocol**

Type	Author (year)	Model of aerobic exercise	Duration and frequency	Supervision	Treatment protocol
Aerobic	Acil *et al.*, 2008	10-minute limber-up, 25-minute aerobic, 5-minute cool down	10 weeks, 3 days a week, 40 minutes a day	Yes	Yes
	Marzolini *et al.*, 2009	10-minute warm-up, 20-minute resistance training, 60-minute aerobic, 5-minute cool down	12 weeks, 2 days a week, 95 minutes/day, plus individualized, home-visit exercise session 1 day a week	Yes	No
	Pajonk *et al.*, 2010	Aerobic exercise consisted of cycling at a heart rate corresponding to a blood lactate concentration of about 1.5 to 2 mmol/L	12 weeks, 3 times per week, 30 minutes a day	Yes	Yes
	Wang *et al.*, 2018	5-minute walking (warm-up), 30-minute aerobic, 5-minute cool down	12 weeks, 3 times per week, 40 minutes a day	Yes	No
Walking	Beebe *et al.*, 2011	Walk, address, learn about exercise, and cue exercise, plus motivational interviewing	Walking program: 16 weeks, 4 days a week, 30 minutes a day	Yes	Yes
	Methapatara & Srisurapanont, 2011	3,000 steps in 30 minutes with SMART goal, plus motivational interviewing	12 weeks	Yes	Yes

Discussion

In the studies focusing on the general population, researchers indicated that aerobic interventions are more effective in managing obesity and reducing both weight and BMI (10). In the gym-based exercise programs, several investigations have focused on walking as an intervention and established its efficacy for the reduction of cardiovascular and metabolic risk factors. Although walking interventions have physical and psychological benefits, walking regularly and steadily is important to maximize the effectiveness of the exercise (11).

Additionally, walking is low impact and relies upon pre-existing, well-practiced motor programs for which the human body is highly adapted, thus minimizing the risk of acute or chronic injury in those unaccustomed to sustained physical activity. For sedentary individuals, walking provides a relatively low-intensity, low-risk activity with which to begin building an aerobic base prior to the transition to higher intensity exercise. Finally, for individuals with schizophrenia, walking may be of particular interest for two reasons. First, it can be performed in social settings and in the community, thus providing opportunities for the enhancement of social and community engagement. Second, walking does not necessitate the level of organization, memory, or motivation often required by complex, periodized exercise programs, and thus may constitute an ideal starting point for individuals with compromised mental functioning.

In this review, six RCT studies showed that typical aerobic exercise is effective for adults with schizophrenia in terms of improving physical or psychological conditions associated with a sedentary lifestyle (8,13-17). Although the exercise interventions implemented by the present investigations were heterogeneous, effect size analyses of multiple studies demonstrate that aerobic interventions are powerful. More specifically, 16 of the 26 measurements that provided adequate information for statistical analysis yielded moderate or large ESs. These study findings indicate that basic aerobic exercise benefits the transition toward a healthier lifestyle for those with schizophrenia. Most of the studies in this review selected intervention sessions that lasted 30 to 40 minutes per day, three days a week, and for 10 to 16 weeks. This is consistent with the ACSM's guidelines for a healthy population (1).

In this review, it is unclear why some programs lead to a more significant improvement than others. There are four possibilities: (a) the rationale for intensity of some physical activities in the interventions may be insufficient; (b) the diversity of participants' conditions (e.g., weight and possible co-occurring disorders) is not adequately considered in intervention design and data analysis; (c) low engagement and high dropout rates may interfere with the efficacy of the interventions; and (d) no guidelines of supervision and individual/group delivery for exercise. Specifically, in this review, no study reported what determined the chosen exercise intensity and criteria for qualified instructors. Without specific rationale for the intensity, instructors and protocols for the development of exercise plans, we cannot determine the causative factors of beneficial exercise effects. This makes it difficult for researchers to replicate successful studies. Also, while three studies reported supervision in

providing exercises, detailed information on supervision (e.g., types and frequency) is not provided (8,14,15). These four issues might be obviated by detailed and exhaustive procedural guidelines for the implementation of exercise interventions.

One clearly identified pattern in this review is that the three studies reporting specific treatment protocols showed more effective training outcomes compared to other studies (8,13,15). In these protocols, there are descriptions of training modalities, goals and schedules. Although other studies showed some significant effects of exercise, the results are mixed and the interventions vary widely with regard to the types of exercises, settings, and dependent measures. These variations in procedures make replication and the determination of efficacy difficult at best.

After reviewing the literature, we recommend the development of manual based exercise interventions, which incorporate appropriate supervision and motivational interviewing to improve and maintain individuals' engagement in daily physical exercise. Studies to develop the manual based exercise and individualized/group exercise guidelines are necessary. This review found various implementations of aerobic exercise to be beneficial; however, without manualized delineation of standards for the individualization of exercise programs, the benefits of these interventions are difficult to realize and duplicate (8,15).

Many studies emphasize that in order to reduce the risks of health problems and maintain a healthy lifestyle, improving engagement in daily exercise is a key factor (11,15). Researchers suggest that although we can expect positive physical changes from the participation in aerobic exercise, amotivation and consequently decreased engagement with exercise is both a cause and an effect of returning to a sedentary lifestyle; amotivational features associated with both the underlying condition and with a lack of physical activity create a vicious cycle that contributes to increasing levels of inactivity and, consequently, to high incidences of cardiovascular disease and obesity (11,16). In order to facilitate sustained adherence to exercise regimens, aerobic exercise programs that are planned and executed by a multidisciplinary team should be used to maximize exposure to physical activities and promote energy expenditure (14). Further, the utilization of structured, treatment-integrated exercise programs with consistent supervision may provide counterinfluence to the motivational and cognitive obstacles faced by individuals with schizophrenia (15).

Ideally, manuals would define optimal ranges for specific, health-related physiological markers (e.g., BMI, body composition, resting heart rate, heart rate variability, VO_2Max, and postural/biomechanical measures), as well as define procedural guidelines for implementing exercise programs based on the individual's specific deconditioning pattern. That is, an ideal manual would provide processes that can reliably detect sub-optimal functional features (e.g., postural compensation accompanied by excess body weight), as well as guidelines for correcting those features (e.g., an exercise program that emphasizes postural restoration in conjunction with up-regulation of basal metabolic rate). Critically, the manuals would establish clear guidelines about exercise intensity using %HRR, %VO_2R, and exercise duration to achieve timely changes in physical and mental health while minimizing the risk of overtraining either local or systemic bodily systems.

Finally, the paramount concern in developing manuals for use with individuals with schizophrenia is to account for their needs and barriers to training, such as motivational issues, management of expectations, side effects from medication, and current mental health symptoms. The training process itself should be considered of secondary importance to factors influencing engagement; though, it should be noted that training factors have the capacity to influence engagement (e.g., individual vs. group exercise, accounting for participant status when determining exercise intensity/frequency). With regard to engagement, exercise professionals working with individuals who have schizophrenia might benefit from the application of established strategies for enhancing engagement in therapeutic settings (8,13,15,17).

Practical use of physical exercise in therapy

Many studies demonstrate the effectiveness of physical exercise on individuals with schizophrenia. Some suggest that physical exercise leads to physiological changes (increased level of neurotransmitters and hippocampal volumes) (18), while others suggest psychological changes (social support, self-esteem, and distraction) (19). Although these physiological and psychological changes are showed, the mechanism by which exercise decreases schizophrenia symptoms is not fully understood. Practitioners who develop individualized exercise plans need specialized education/training in psychiatry and basic counseling skills. According to Ryan & Deci, self-esteem is dependent on the need for autonomy, relatedness to others and competence (20). For example, in the perception of autonomy, individuals who participate in physical exercise have personal control, which could facilitate participation in exercise and influence goal success. This continuous education/training would help practitioners to be familiar with the disorder and patients to create an individual plan to take an interest in exercise.

In particular, practitioners should take into account the emotional and psychological limitations of those with schizophrenia (self-esteem, positive and negative symptoms) (13,14,16). For example, those with mental illness have low self-esteem due to social stigma about mental illness and high cardiometabolic risk due to long-term medication and related side effects. Practitioners should adapt to the individual's fitness conditions and the side effects of medications. Addressing individuals' barriers to utilizing exercise would be a good strategy for developing and completing the exercise plan successfully. Before beginning exercise programs, individuals with schizophrenia and practitioners could jointly explore

the barriers to attending exercise regularly and the main reasons for the high attrition rate in previous exercises (21,22). One effective strategy to motivate exercise attendance is to break down all the activities and praise the successful completion of small activities.

Additionally, the efforts of health care practitioners are required for successful completion of the programs. By applying unconditional support and listening skills (8,16,17,23), physical interventions for those with schizophrenia should be personalized with preferred activities (e.g., exercise alone vs. with others, physical exercise only vs. with yoga/meditation, exercise only vs. with dietary control/nutrition). For instance, mixed goals focusing on cardiorespiratory training and muscular strength training would be a useful goal as a preventive and curative strategy for those with schizophrenia. Education, including counseling and motivational interviewing strategy, would be beneficial for those with schizophrenia to improve their attendance rate in activities and having opportunities to change their lifestyles, as opposed to structured exercise regimens. In order to expect high participation and completion rates of exercise programs, health care practitioners should be familiar with lifestyle modification skills in designing and implementing the programs.

Recommendations from this review

Based on findings of this review, we recommend that supervised aerobic exercise interventions for individuals with schizophrenia should span 10 to 12 weeks, three days a week, and have a duration of 30 to 40 minutes per day; however, the ideal exercise intensity remains unclear. Also, while this review of the effectiveness of exercise programs for people with schizophrenia indicates positive outcomes, unclear methods in each study might reduce the generalizability of study findings and reliability. Issues including unclear methods would increase disparities in the exercise interventions of individuals living with serious mental illness and decrease the future systematic reviews of exercises.

Limitations of this review

This review has several limitations, which should be considered when interpreting the results. First, we only included studies that applied standard exercises that were similar to ACSM guidelines for physical activities, which allowed us to analyze a few studies. Many exercises could be applied to individuals with schizophrenia using different frameworks (e.g., mixed physical exercises with cognitive remediation and physical exercises with nutrition educations). Further research could consider more studies with reduced selection criteria for exploring the effectiveness of aerobic exercises. Second, no grading system was applied to assess the quality of collected studies, such as the Physiotherapy Evidence Database (PEDro) scale. In further research, the scale could be applied to indicate the range of scores for included articles. Third, differences in exercise prescription (intensity, duration, modality, frequency, and intervention length) and instruments for the pre-post test contributed to heterogeneity. In further research, more studies using similar exercise prescription and instruments could be collected and analyzed.

Conclusions

Aerobic activities are basic, easily implemented, effective, and low-cost forms of exercise in which individuals with schizophrenia can easily engage in a variety of settings, including the workplace, home, and public recreation areas. The development of manual-based physical activities and standard reporting methods could be expected to reduce disparities in the exercise interventions, reducing the risks of cardiovascular disease, metabolic disease, and other serious health problems, as well as improve both quality and length of life for individuals with mental illness.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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