

Influencing Factors on the Efficacy of Aerobic Exercise Therapy in Depression: A Single-Centre Cross-Sectional Study

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Abstract

Background: Aerobic exercise therapy can improve brain function and promote positive emotions in patients with depression. This study aims to improve the efficacy of aerobic exercise therapy in depression by investigating the influencing factors therein.

Methods: This study conducted a single-centre cross-sectional analysis of clinical data from 211 depression patients who received aerobic exercise therapy at Heze Mudan People's Hospital from May 2021 to May 2023. After excluding 10 patients who did not meet the inclusion criteria, the final cohort included 201 patients. The clinical data of patients with effective treatment and patients with ineffective treatment were collected, such as socio-demographic characteristics, disease status, depression degree, treatment compliance, and social support. Binary Logistic regression was used to analyze the factors affecting the clinical efficacy of aerobic exercise therapy in patients.

Results: Among the 201 patients, the effective and ineffective rates of aerobic exercise therapy were 80.10% (161/201) and 19.90% (40/201), respectively. When analysed as groups, no significant differences were observed between the effective group (EG) and ineffective group (IG) regarding gender, body mass index, course of depression, age of first onset, mental symptoms, years of education, personal income, or marital status ($p > 0.05$). However, the EG exhibited a reduced probability of family history of mental illness, smoking history, and severity of depression

($p < 0.05$), along with higher treatment compliance and Social Support Rating Scale (SSRS) scores compared to the IG ($p < 0.05$). Binary logistic regression analysis revealed that smoking history, family history of mental illness, treatment compliance, depression, and SSRS score were the primary influencing factors on the efficacy of aerobic exercise therapy ($p < 0.05$).

Conclusion: Smoking history, family history of mental illness, treatment compliance, severity of depression, and social support are the primary influencing factors on the efficacy of aerobic exercise therapy in patients with depression. These factors should be emphasized during follow-up treatment to optimize the clinical treatment effect.

Keywords

aerobic exercise therapy; depression; efficacy; influencing factors

Introduction

Depression is a mood disorder with multifaceted origins including genetic and psychosocial factors and is characterized by notable and enduring depressive symptoms, low mood and diminished interest disproportionate to circumstances, often accompanied by anxiety or agitation [1]. The persistent clinical symptoms of depression seriously impair daily functioning. Compared with the normal population, patients with depression exhibit reduced quality of life, worse cardiopulmonary function, shorter life expectancy, and increased susceptibility to metabolic syndrome, hypertension, and hyperlipidemia. Consequently, reducing the increasing burden of mental disorders like depression has gradually become a global health priority [2], and improving the treatment of depression has become crucial.

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In clinical settings, conventional approaches to treating depression typically involve antidepressant therapy or psychological interventions. However, a mounting body of research indicates that exercise therapy, particularly aerobic exercise, exerts a discernible antidepressant effect [3,4]. Patients with depression commonly exhibit impaired executive ability, attention, and memory. Aerobic exercise is closely related to certain brain structures, which can alleviate depressive symptoms, improve brain function, generate positive emotions, enhance behavioral function, and improve emotional coping mechanisms by reconstructing brain structure [5]. Most studies have established that aerobic exercise therapy has a certain antidepressant effect, but there are few reports on the clinical effect of aerobic exercise in patients with depression. Given that the pathogenesis of depression is affected by various factors, treatment outcomes vary widely. Accordingly, this study explored the influencing factors on the efficacy of aerobic exercise therapy in the treatment of depression, hoping to provide a reference for improving the treatment effect of aerobic exercise.

Materials and Methods

Research Subjects

A total of 211 patients with depression who received aerobic exercise therapy in Heze Mudan People's Hospital from May 2021 to May 2023 were screened based on pre-defined inclusion and exclusion criteria.

Inclusion criteria: (1) Patients exhibited clear consciousness and normal speech function. (2) Patients were aged over 18 years. (3) Patients possessed complete clinical data. (4) Patients were diagnosed with depression by psychiatrists.

Exclusion Criteria: (1) Patients presenting comorbidities impacting exercise endurance, such as musculoskeletal system disorders and central movement disorders. (2) Patients diagnosed with chronic physical ailments like hypertension and diabetes, or organ dysfunctions such as renal failure. (3) Patients diagnosed with tumor diseases or brain organic lesions. (4) Patients who had undergone convulsive electroconvulsive therapy within one week prior to aerobic exercise therapy. (5) Depression resulting from drug usage or other psychoactive substances. (6) Patients with secondary mental illnesses.

After screening, 10 patients failing to meet the inclusion criteria were excluded, resulting in the final inclusion of 201 patients.

Aerobic Exercise Therapy

Aerobic exercise therapy included jogging, ball games, and square dance and was selected individually according to personal preferences. Aerobic exercise therapy was performed three times a week, lasting 30–60 min each. During exercise, heart rate was monitored using a smart band (model: 1S light-sensitive version; manufacturer: Xiaomi Corporation; origin: Beijing, China). Exercise intensity remained at a moderate intensity, ensuring that the target heart rate during exercise was 64%–76% of the maximum heart rate (maximum heart rate = 220 – age). The treatment lasted for 16 weeks [6].

Evaluation Criteria of Clinical Therapeutic Effect

The clinical therapeutic effect was evaluated by the score-reducing rate of the Hamilton Depression Scale-17 (HAMD-17) [7]. The score-reducing rates <25% and ≥25% were defined as ineffective treatment and effective treatment, respectively.

Clinical Data Collection

(1) Social demographic characteristics and the prevalence of depression were analyzed, including gender, age, body mass index, course of disease, age of first onset, mental symptoms, family history of mental illness, smoking history, years of education, marital status, and personal income.

(2) The severity of depression before treatment was assessed using HAMD-17, consisting of 17 items. The severity of depression was judged based on the final score (>24 points: severe depression; 17–24 points: moderate depression; 7–16 points: mild depression).

(3) Treatment compliance was evaluated using our hospital's self-made compliance scale, comprising exercise frequency, exercise mode, exercise time and exercise intensity, with a total score of 40 points. A score ≥23 points indicated good compliance, and <23 points indicated poor compliance. The Cronbach's coefficient alpha of the scale was 0.716.

(4) Social support was assessed using the Social Support Rating Scale (SSRS) compiled by Xiao Shuiyuan [8]. This scale contained 10 items, each of which was scored from 1 to 4 points. The results were divided into three dimensions: objective support (sum of items 2, 6, and 7), subjective support (sum of items 1, 3, 4, and 5), support utilization (sum of items 8, 9, and 10). Higher scores indicated greater social support.

Table 1. Baseline characteristics and treatment outcomes.

Items (n = 201)		n (%) / M (P ₂₅ , P ₇₅)
Gender	Male	69 (34.33)
	Female	132 (65.67)
Age (years)		36.00 (29.50, 41.50)
Body mass index (kg/m ²)		23.48 (21.27, 25.85)
Course of disease (months)	0–6 months	39 (19.40)
	7–12 months	109 (54.23)
	≥12 months	53 (26.37)
Age of first onset (years)	≤30 years	118 (58.71)
	>30 years	83 (41.29)
Mental symptoms	Yes	161 (80.10)
	No	40 (19.90)
Family history of mental illness	Yes	79 (39.30)
	No	122 (60.70)
Smoking history	Yes	161 (80.10)
	No	40 (19.90)
Years of education (years)		11.00 (8.50, 13.00)
Personal income	<568 USD	81 (40.30)
	≥568 USD	120 (59.70)
Marital status	Single	71 (35.32)
	Married	61 (30.35)
	Divorced	54 (26.87)
	Widowed	15 (7.46)
Severity of depression	Mild	75 (37.31)
	Moderate	77 (38.31)
	Severe	49 (24.38)
Treatment compliance	Good	161 (80.10)
	Poor	40 (19.90)
SSRS score (points)		25.00 (23.00, 27.00)
Treatment effect	Effective treatment	161 (80.10)
	Ineffective treatment	40 (19.90)

Notes. SSRS, Social Support Rating Scale.

Statistical Analysis

In this study, data analysis and processing were conducted using the Statistical Package for the Social Sciences (SPSS, version: 27.0; manufacturer: International Business Machines Corporation; origin: Armonk, NY, USA). Categorical variables were expressed as [n (%)] and tested using either the chi-square test or Fisher's exact test. The Shapiro-Wilk method was employed to assess the normality of continuous variables. For continuous variables not adhering to a normal distribution, the Mann-Whitney U test was applied, and results were expressed as median (P₂₅, P₇₅). Binary logistic regression analysis was utilized to analyze the influencing factors on the clinical efficacy of aerobic exercise therapy in patients. A significance level of $p < 0.05$ was considered statistically significant.

Results

Baseline Characteristics of Patients and Treatment Effects of Aerobic Exercise Therapy

Among the 201 patients, female accounted for 65.67% (132/201) of the sample; patients ≤30 years old accounted for 58.71% (118/201); patients with mental symptoms accounted for 80.10% (161/201); patients with family history of mental illness accounted for 39.30% (79/201); patients with smoking history accounted for 80.10% (161/201); patients with mild to moderate depression accounted for 75.62% (152/201); patients with good treatment compliance accounted for 80.10% (161/201); patients with effective treatment accounted for 80.10% (161/201); and patients with ineffective treatment accounted for 19.90% (40/201), as shown in Table 1.

Table 2. Single factor analysis of influencing factors on the efficacy of aerobic exercise therapy in depression [n (%)/M (P₂₅, P₇₅)].

Factors		Effective group (n = 161)	Ineffective group (n = 40)	χ^2/Z	<i>p</i>
Gender	Male	54 (33.54)	15 (37.50)	0.223	0.637
	Female	107 (66.46)	25 (62.50)		
Age (years)		36.00 (30.00, 41.00)	37.50 (29.00, 44.75)	-0.683	0.495
Body mass index (kg/m ²)		23.32 (21.27, 25.86)	24.05 (21.23, 25.77)	-0.703	0.482
Course of disease	0–6 months	27 (16.77)	12 (30.00)	3.710	0.156
	7–12 months	43 (26.71)	10 (25.00)		
	≥12 months	91 (56.52)	18 (45.00)		
Age of first onset	≤30 years	99 (61.49)	19 (47.50)	2.587	0.151
	>30 years	62 (38.51)	21 (52.50)		
Mental symptoms	Yes	90 (55.90)	21 (52.50)	0.150	0.725
	No	71 (44.10)	19 (47.50)		
Family history of mental illness	Yes	56 (34.78)	23 (57.50)	6.931	0.011
	No	105 (65.22)	17 (42.50)		
Smoking history	Yes	62 (38.51)	26 (65.00)	9.135	0.004
	No	99 (61.49)	14 (35.00)		
Years of education (years)		11.00 (8.00, 13.00)	12.00 (9.00, 14.00)	-1.084	0.278
Personal income	<568 USD	66 (40.99)	15 (37.50)	0.163	0.722
	≥568 USD	95 (59.01)	25 (62.50)		
Marital status	Single	56 (34.78)	15 (37.50)	-	0.993 [#]
	Married	49 (30.43)	12 (30.00)		
	Divorced	44 (27.33)	10 (25.00)		
	Widowed	12 (7.45)	3 (7.50)		
Severity of depression	Mild	69 (42.86)	6 (15.00)	20.254	<0.001
	Moderate	63 (39.13)	14 (35.00)		
	Severe	29 (18.01)	20 (50.00)		
Treatment compliance	Good	130 (80.75)	18 (45.00)	21.085	<0.001
	Poor	31 (19.25)	22 (55.00)		
SSRS score (points)		25.00 (23.00, 28.00)	23.00 (21.00, 24.00)	-5.638	<0.001

Notes. [#]indicated Fisher's exact test results. SSRS, Social Support Rating Scale.

Single Factor Analysis of Influencing Factors on the Efficacy of Aerobic Exercise Therapy in Depression

The social demographic characteristics, prevalence of disease, treatment compliance, and SSRS scores in the effective group (EG) and ineffective group (IG) were compared. No significant differences were observed in gender, body mass index, course of depression, age of first onset, mental symptoms, years of education, personal income, or marital status ($p > 0.05$) between groups. The EG exhibited a lower probability of family history of mental illness, smoking history, and severity of depression ($p < 0.05$), as well as increased treatment compliance and SSRS score than the IG ($p < 0.05$), as shown in Table 2.

Table 3. Variable assignment.

Variables	Assignment
Efficacy	1 = effective, 2 = ineffective
Family history of mental illness	1 = no, 2 = yes
Smoking history	1 = no, 2 = yes
Severity of depression	1 = mild, 2 = moderate, 3 = severe
Treatment compliance	1 = good, 2 = poor
SSRS score	Continuous variable

Notes. SSRS, Social Support Rating Scale.

Multivariate Analysis of Influencing Factors on the Efficacy of Aerobic Exercise Therapy in Depression

Efficacy served as the dependent variable, while family history of mental illness, smoking history, severity of depression, treatment compliance, and SSRS score were used as independent variables to assign values (efficacy: 1 = effective, 2 = ineffective; family history of mental illness: 1 =

Table 4. Logistic regression analysis of influencing factors on the efficacy of aerobic exercise therapy in depression.

Influencing factors	β	Standard error	Walds	p	OR	95% CI
Family history of mental illness	1.502	0.629	5.697	0.017	4.491*	1.308–15.414
Smoking history	2.293	0.673	11.612	0.001	9.902*	2.649–37.023
Severity of depression	0.830	0.397	4.369	0.037	2.294*	1.053–4.995
Treatment compliance	1.472	0.596	6.109	0.013	4.359*	1.356–14.011
SSRS score	0.365	0.131	7.783	0.005	0.694*	0.538–0.897
Constant	-7.724	3.977	3.773	0.052	0.000	-

Notes. * indicated $p < 0.05$. SSRS, Social Support Rating Scale; OR, odds ratio; CI, confidence interval.

no, 2 = yes; smoking history: 1 = no, 2 = yes; severity of depression: 1 = mild, 2 = moderate, 3 = severe; treatment compliance: 1 = good, 2 = poor; SSRS score: continuous variable), as shown in Table 3. The results of binary logistic regression analysis revealed that smoking history (odds ratio (OR) = 9.902, $p = 0.001$), family history of mental illness (OR = 4.491, $p = 0.017$), treatment compliance (OR = 4.359, $p = 0.013$), severity of depression (OR = 2.294, $p = 0.037$), and SSRS score (OR = 0.069, $p = 0.005$) were important influencing factors on the efficacy of aerobic exercise therapy in the treatment of depression ($p < 0.05$), as shown in Table 4.

Discussion

A retrospective analysis was conducted on 201 patients with depression who received aerobic exercise therapy. The study aimed to investigate the underlying reasons for divergent treatment outcomes, with the goal of identifying factors influencing the efficacy of depression management and ensuring effective control of depressive symptoms. Results indicated that 80.10% of the patients treated with aerobic exercise therapy were effective, and 19.90% of the patients were ineffective. Current literature suggests that aerobic exercise can reduce the risk of depression and anxiety [9,10], increase the production of neurotransmitters that modulate emotions [11], and ameliorate clinical symptoms of depression through numerous neurobiological pathways. However, in practical clinical applications, the efficacy of aerobic exercise therapy in depression is affected by many factors, and some patients may not achieve a pronounced control effect. According to this study, patients who responded effectively to aerobic exercise therapy had a lower probability of family history of mental illness, smoking history, and severity of depression, and higher treatment compliance and SSRS scores when compared to those who experienced ineffective treatment.

Binary logistic regression analysis identified smoking as an important factor affecting the efficacy of aerobic exercise therapy. Few studies exist that investigate the effect of

smoking on aerobic exercise therapy in the treatment of depression. Long-term smoking can cause damage to the respiratory mucosa, leading to symptoms such as cough, sputum production, difficulty breathing, and an increased risk of diseases like lung cancer and angina, further affecting the quality of life of patients and exacerbating depressive symptoms. Moreover, smoking is considered to be a risk factor for most mental disorders. For example, one study revealed that smoking is associated with an increased risk of various mental disorders, including depression and bipolar disorder [12]. Similarly, Smith Philip H *et al.* [13] established that smokers are clearly more likely to suffer from mental illness and have higher suicidal ideation than the general population. Interestingly, depression is also an important contributor to patient smoking status. Nicotine and other components in tobacco stimulate the nervous system, producing excitability and increasing the body's pleasure level [14], making patients more dependent on nicotine. Nicotine activates the cerebral limbic system and enhances the function of the dopaminergic system. Additionally, smoking activates multiple receptors in the brain, promoting the release of biogenic amine neurotransmitters like dopamine, serotonin, noradrenaline, and acetylcholine, which in turn increases the risk of depression and aggravates depressive symptoms.

Moreover, the results of this study established that family history of mental illness, treatment compliance, severity of depression, and SSRS score were also important influencing factors on the efficacy of aerobic exercise therapy in the treatment of depression. Mental illness is the result of the interaction of thousands of genetic variations. Patients need to constantly adjust and deal with the mental problems caused by heredity in the acquired living environment [15]. Treatment compliance refers to the degree of compliance with treatment and treatment behavior in patients with depression. Poor treatment compliance, such as non-compliance with medication, is an important cause for the recurrence and aggravation of depression and the increased risk of self-mutilation and suicide [16]. Patients exhibiting good treatment compliance usually demonstrate

a greater willingness to engage in active training, correct misconceptions about depression, and experience the enjoyment of exercise. These factors contribute to a gradual reduction in pessimism, enhancing the confidence of treatment and improving the efficacy of aerobic exercise therapy in depression.

Additional research has noted that high social support is conducive to the prevention of depressive symptoms [17]. Social support refers to help that can be obtained from family members, relatives, friends, and colleagues, which can reduce mental stress and improve social adaptability. Similarly, Zhou W *et al.* [18] revealed that high social support is beneficial to the rehabilitation of patients with depression, aligning with the results of this study. Patients with high social support usually have a good family support system, from which they can obtain more emotional support. Firm support and encouragement from family and friends can urge patients to perform regular aerobic exercise, and then improve the treatment effect.

This study is subject to some shortcomings. The pathogenesis of depression and the mechanisms underlying the effects of aerobic exercise therapy are relatively complex. Additionally, the study's sample size is small and lacks adequate clinical representation. In the future, it is necessary to expand the sample size and conduct multi-center, large-sample studies to confirm the objectivity of the research findings.

Conclusion

The results of this study demonstrate that the efficacy of aerobic exercise therapy in the treatment of depression is affected by many factors, including smoking history, family history of mental illness, treatment compliance, severity of depression, and social support. When treating depression with aerobic exercise therapy, the above influencing factors should be considered comprehensively, and personalized measures should be developed according to the specific conditions of each patient to improve depressive symptoms.

Availability of Data and Materials

The original contributions presented in the study are included in the article. Further inquiries can be directed to the corresponding author.

Author Contributions

GRC: Conception, Design, Supervision, Materials, Data Collection, Analysis, Literature Review, Writing. GRC contributed to editorial changes in the manuscript. GRC read and approved the final manuscript. GRC has participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This study conforming to the principles of the Declaration of Helsinki (2013) has been approved by the ethical committee of Heze Mudan People's Hospital (approval No.: MD2021031). Patients who were aware of the purpose and significance signed an informed consent.

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Conflict of Interest

The author declares no conflict of interest.

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