Article

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Effect of a Nurse-Led Exercise Program on Depression in Elderly Patients with Diabetes: A Retrospective Study

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Abstract

Background: Patients with diabetes often face psychological challenges, particularly depression. The coexistence of these two conditions can significantly impact both the mental and physical health of individuals. This study aims to investigate the effects of nurse-led exercise training on elderly patients diagnosed with type 2 diabetes mellitus and comorbid depression through experimental research. By selecting appropriate exercise programs for patients, the study seeks to identify effective strategies for improving both their physical health and depressive symptoms. Additionally, it aims to offer tailored exercise recommendations to enhance the overall well-being of these patients.

Method: The observation group (n = 53) and the control group (n = 53) were selected based on the interventions documented in the patients' medical records, with eligible patients identified as research participants. The control group received standard medication, while the observation group engaged in intensive exercise training in addition to their standard treatment, dedicating 60–90 min per day to exercise. Prior to and following the intervention, blood glucose indices, levels of 5-hydroxytryptamine (5-HT) and norepinephrine (NE), self-rating depression scale (SDS), Self-Rating Anxiety Scale (SAS), Pittsburgh Sleep Quality Index (PSQI), and Generic Quality of Life Inventory (GQOLI-74) scores were assessed to evaluate the impact of the exercise training intervention.

Result: Following the intervention, levels of fasting blood glucose (FBG), 2-h postprandial blood glucose (PBG), and Hemoglobin A1c (HbA1c) were reduced compared to pre-intervention levels, with the exercise group exhibiting lower levels than the control group ($p < 0.05$). Additionally, post-intervention, patients' levels of 5-HT and NE increased, with the exercise group demonstrating higher levels than the control group ($p < 0.05$). Moreover, post-intervention, SDS and SAS scores decreased, with more significant improvements observed in the observation group ($p < 0.05$). Furthermore, the intervention improved sleep quality and quality of life among patients in the exercise group compared to those in the control group ($p < 0.05$).

Conclusion: Nurse-guided exercise training demonstrates a significant capacity to ameliorate glycemic indexes among patients with diabetes mellitus comorbid with depression. It not only diminishes depression and anxiety levels but also enhances the expression of 5-HT and NE. Furthermore, it effectively elevates patients' sleep quality and quality of life. These findings underscore the potential of nurse-led exercise interventions for clinical promotion and widespread application.

Keywords

exercise program; depression; diabetes; elderly

Introduction

Depression, a psychological and affective disorder, manifests clinically with persistent and profound low mood along with mild somatic symptoms or no clinical symptoms [1]. Without timely intervention and treatment, depression can recur and may precipitate cardiovascular and cerebrovascular diseases, and even suicide. Currently, depression accounts for approximately 6.2% of the total disease burden in China, ranking as the second-largest burden of disease. Among the elderly, changes in social status, prolonged separation from family, physical frailty, spousal loss, financial hardships, or illness can exacerbate feelings

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of helplessness, worthlessness, and loneliness, serving as triggers for depression and the prevalence of depression among the elderly is on the rise annually [2]. Delayed reaction, cognitive disorganization, irritability, and physical discomfort are all prominent manifestations of depression among the elderly, imposing significant psychological burdens and serving as major obstacles to their enjoyment of later life [3]. Depression, being a mood disorder, is a prevalent condition with high morbidity and mortality rates worldwide. It profoundly threatens the healthy development of the elderly population, necessitating society's attention and concerted efforts for intervention and support.

Psychological intervention stands as one of the most prevalent methods for addressing depression [4]. However, the prolonged duration and high cost associated with psychological intervention treatment often lead to lower consultation rates. Recognizing the preventive benefits of exercise on various chronic ailments and its positive impact on physical health, exercise rehabilitation therapy has garnered increasing attention. Moreover, it has demonstrated remarkable efficacy in managing psychological disorders such as depression and anxiety [5]. Recent research, has showcased that exercise enhances the body's capacity to stress and mitigates feelings of anxiety and depression. This effect may stem from various mechanisms, including increased in distraction, promotion of 5-hydroxytryptamine (5-HT) synthesis, reduction of inflammatory factors, hippocampal cell proliferation, modulation of neurotrophic factors, and regulation of the hypothalamic-pituitary-adrenal (HPA) axis [6].

Exercise stimulates the excitability of the right hemisphere of the brain, inducing sensations of joy, happiness, and fostering a positive and optimistic mindset among participants. This effect effectively alleviates clinical symptoms in patients with depression, and dispel feelings of fatigue, weakness, and emptiness [7]. Furthermore, exercise training offers the advantages of being cost-effective and simple to implement [7,8]. Engaging in regular, long-term exercise can effectively address psychological factors such as self-evaluation and self-efficacy, thereby ameliorating depressive mood and improving cardiorespiratory symptoms associated with depression [9]. Research indicates that even short-term exercise interventions yield notable benefits. For instance, an 8-week regimen of resistance exercise effectively improved depression among young adults, with similar outcomes observed in other experiments [10]. These findings underscore the capacity of exercise to enhance the physical well-being of individuals with depression, bolster their independence, and foster greater life satisfaction, all while effectively addressing depressive symptoms.

Diabetes mellitus, characterized by elevated blood glucose levels, is a metabolic disorder resulting from impaired insulin function and/or insufficient insulin secretion and production by the body. According to research, approximately 28% of individuals with type 2 diabetes mellitus (T2DM) experience depressive symptoms, with around 14.5% from suffering from severe depression [11]. Depression in such cases can be viewed as a complication of deteriorating diabetes rather than an independent condition [12]. The management of diabetes and its associated depressive symptoms are intricately linked [13]. In the presence of depression, the HPA axis becomes overactivated, leading to the excessive production and release of cortisol and related hormones [14]. This hormonal imbalance contributes to the accumulation of visceral fat, elevates inflammatory marker levels, disrupts serotonin neurotransmitter levels, and impacts mood regulation. Mental health considerations are integral to the comprehensive treatment of diabetes. A study has highlighted a significantly higher incidence of depression among diabetic patients compared to the general population, with the incidence rate continuing to rise [15].

Epidemiologic evidence indicates that depression can both result from diabetes and act as risk factor for its development [16]. Laird's research [17] revealed that adhering to the World Health Organization's recommended levels of physical activity correlated with depression remission among older diabetic individuals, and a higher level of physical activity was associated with a decreased risk of depressive symptoms.

Additionally, a randomized controlled study suggests that physical activity may serve as an effective augmentation therapy for alleviating symptoms of moderate to severe depression [18]. Although initial research on the mechanism of action of exercise to improve depressive symptoms in diabetic patients has shown promising results, further clinical trials and physiopathology investigations are warranted for a more comprehensive understanding and validation. Against, this backdrop, the present study aims to investigate the effects of nurse-led exercise training on elderly diabetic patients with depression.

Subjects and Methods

General Data about Patients

A total of 106 elderly patients diagnosed with diabetes mellitus and comorbid depression, admitted between July 2020 and July 2023, were enrolled in the study. The patients were stratified into two groups: the routine care group (control group) and the exercise intervention group (observation group), with 53 patients in each cohort. Group allocation was determined based on the interventions documented in the patients' medical records. The study protocol was approved by the Ethics Committee of Xingtai People's Hospital (Approval No.: [2018]032), and all participants provided informed consent. The research adhered to the principles outlined in the Declaration of Helsinki.

Inclusion and Exclusion Criteria

Inclusion criteria: (1) Diagnosis of T2DM with depression [19,20]; (2) Self-rating depression scale (SDS) score >53; (3) Age ≥60 years; (4) The patients did not undergo antidepressant treatment (antidepressant medication and psychotherapy) during the 12 weeks of exercise; (5) Complete clinical data.

Exclusion criteria: (1) Insulin therapy; (2) Combined cancer, serious heart, brain, vascular, liver, kidney comorbidities; (3) Combined serious neurological or musculoskeletal diseases; (4) Suicidal tendencies.

Method

All patients underwent conventional hypoglycemic therapy, which included Metformin tablets (Sino-American Shanghai Squibb Pharmaceutical Co., Ltd., H20023370, China) administered orally three times daily; Glimepiride (Sanofi Pharmaceuticals Ltd., H20057672, China) taken orally at a dosage of 2 mg once daily; and Glutamic acid (Tianjin Lisheng Pharmaceutical Co., Ltd., H12020231, China) at a dose of 10 mg administered orally three times daily. Dosage adjustments were made based on individual patient responses.

The control group received standard nursing care, encompassing health education, routine physical examinations, and instruction on medication administration and blood sugar monitoring. Nursing staff also provided patients and their families with information on depression and guidance on dietary management, emphasizing the significance of dietary control in improving blood glucose levels.

In addition to standard care, the exercise group participated in a nurse-led exercise training program for a duration of 3 months. The exercise regimen comprised the following components:

(1) Types of exercises: chorus singing, square dancing, and Tai Chi.

(2) Frequency: Patients in the exercise group engaged in physical activity wearing an exercise bracelet once daily for 60–90 min per session.

(3) Intensity: The target heart rate ranged from 108 to 129 beats per min.

(4) Duration: Both groups underwent treatment for a period of 12 weeks.

Observation Indicators

(1) Glycemic index: Before and after the intervention, 4 mL of peripheral venous blood was collected from the patients at the same moment, and fasting plasma glucose (FPG), postprandial blood glucose (PBG) and Hemoglobin A1c (HbA1c) were detected by automatic biochemical analyzer (Beckman-CX4CE, Brea, CA, USA) after routine anticoagulation treatment.

(2) 5-HT and norepinephrine (NE) levels: 5 mL of fasting venous blood was collected before and after the intervention, and the levels of 5-HT and NE were measured by Enzyme-Linked Immunosorbnent Assay (ELISA) (Shanghai Enzyme-linked Biotechnology Co., Ltd., ml063220, ml077135, China) after centrifugation (3000 r/min, 15 min).

(3) SDS and Self-Rating Anxiety Scale (SAS): SDS score can reveal the severity of depression and state changes, intuitively and accurately reflect the symptoms of depression in patients, and is a commonly used scale tool for evaluating depression [20]. The scoring index of the SDS scale is less than 53 for no depression, 53–62 for mild depression, 63–72 for moderate depression, and more than 72 for severe depression. SAS scale scores below 49 are normal, 50 to 59 are mild anxiety, 60 to 69 are moderate anxiety, and scores above 69 are severe anxiety [21].

(4) Sleep quality: The sleep quality of patients in both groups was counted and assessed by Pittsburgh Sleep Quality Index (PSQI), including 18 self-assessment entries and 5 other-assessment entries, with a total score of 21, and the lower the score the better the sleep quality [22].

(5) Life quality: Generic Quality of Life Inventory (GQOLI-74) scale was used to evaluate the quality of life of patients in the two groups [23]. The scale was composed of four dimensions: physical function, social function, psychological function and social function. Each dimension has a total score of 100, and the higher scores the better quality of life.

Table 1. General data of patients.

Group	Observation (n = 53)	Control (n = 53)	t/χ^2	p
Gender (Male/Female)	29/24	27/26	0.151	0.697
Age	66.98 ± 4.70	67.68 ± 4.30	0.798	0.427
BMI (kg/cm^2)	24.18 ± 1.37	24.05 ± 1.25	0.521	0.603
Course of disease (year)	0.5–4	0.6–4	-	-
Married	46	48	0.376	0.540
Diabetes	17	14	0.410	0.522
Hypertension	15	17	0.179	0.672
Smoking	23	19	0.631	0.427
Alcohol consumption	21	20	0.040	0.842
Psychotherapy	34	32	0.161	0.689
Exercise regularly	27	28	0.038	0.846

BMI, body mass index.

Table 2. Comparison of glycemic index.

Group	FBG (mmol/L)		2h PBG (ng/mL)		HbA1c	
	Before intervention	After intervention	Before intervention	After intervention	Before intervention	After intervention
Exercise (n = 53)	9.41 ± 2.11	6.13 ± 1.13*	13.87 ± 3.25	8.02 ± 1.13*	8.22 ± 1.25*	6.02 ± 0.58*
Control (n = 53)	9.53 ± 2.24	7.64 ± 1.57*	14.05 ± 3.14	9.35± 1.05*	8.16 ± 1.18*	7.13 ± 0.79*
t	0.282	5.663	0.285	6.290	0.281	8.218
p	0.779	<0.001	0.777	<0.001	0.779	<0.001

Note: Compared with before intervention, $^*p < 0.05$.

5-hydroxytryptamine (5-HT) and norepinephrine (NE) levels before and after intervention. FBG, fasting blood glucose; PBG, postprandial blood glucose; HbA1c, Hemoglobin A1c.

Statistical Analyses

Patient data were imported into SPSS 27.0 software (IBM Corporation, Chicago, IL, USA) for analysis. The Shapiro-Wilk method was employed to assess whether the measurement data adhered to a normal distribution. Data conforming to a normal distribution were presented as mean ± standard deviation ($\bar{x} \pm$ s) and analyzed using the t-test, while data not conforming to a normal distribution were analyzed using the median (interquartile range) and non-parametric tests. Categorical data such as gender, comorbidities, and the number of smokers and drinkers were expressed as frequencies (n), and the chi-square test was utilized to compare groups. A significance level of $p < 0.05$ was considered statistically significant.

Results

Baseline Information

At baseline (Table 1), no significant differences were observed between the two groups regarding age, gender, disease duration, marital status, smoking, drinking, presence of diabetes or hypertension, regular exercise habits, or psychotherapy utilization. These findings indicate that the two patient groups were comparable at the outset of the study.

Results of Glycemic Index

Compared to the time of enrollment, both groups exhibited a significant reduction in blood glucose levels at the conclusion of the intervention ($p < 0.05$). Moreover, post-intervention measurements in the observation group revealed significantly lower levels of FPG, 2h PBG, and HbA1c compared to baseline (Table 2, $p < 0.001$). These findings suggest that the hypoglycemic effect observed in the observation group surpassed that of the control group.

Before the intervention, the levels of 5-HT and NE were comparable between the exercise group (95.36 ± 10.23 pg/mL, 35.36 ± 3.57 ng/mL) and the control group (94.53 ± 9.87 pg/mL, 34.79 ± 3.21 ng/mL). Following the intervention, both groups exhibited increased levels of 5-HT and NE, with the exercise group demonstrating significantly higher levels compared to the control group (Table 3, $p < 0.001$).

Table 3. Comparison of 5-HT and NE levels before and after intervention.

Group	5-HT (pg/mL)		NE (ng/mL)	
	Before intervention	After intervention	Before intervention	After intervention
Exercise (n = 53)	95.36 ± 10.23	157.29 ± 15.42*	35.36 ± 3.57	53.26 ± 4.11*
Control (n = 53)	94.53 ± 9.87	128.63 ± 13.66*	34.79 ± 3.21	38.87 ± 3.23*
t	0.427	10.130	0.872	20.048
p	0.670	<0.001	0.385	<0.001

Note: Compared with before intervention, $^{*}p < 0.05$.

Table 4. SDS and SAS scores before and after intervention.

Group	SDS (score)		SAS (score)	
	Before intervention	After intervention	Before intervention	After intervention
Observation (n = 53)	60.43 ± 5.84	54.09 ± 4.48*	59.42 ± 4.85	51.94 ± 4.21*
Control (n = 53)	62.36 ± 5.76	57.23 ± 4.02*	59.72 ± 4.73	55.08 ± 4.30*
t	1.709	3.786	0.324	3.790
p	0.090	<0.001	0.746	<0.001

Note: Compared with before intervention, $^{*}p < 0.05$. SDS, self-rating depression scale; SAS, Self-Rating Anxiety Scale.

Results of SDS and SAS Score

Before the intervention, there were no significant differences in SDS and SAS scores between the two groups ($p > 0.05$). However, following the intervention, both SDS and SAS scores decreased. Importantly, the observation group exhibited lower scores compared to the control group ($p < 0.001$, Table 4). These findings underscore the beneficial effects of exercise intervention in alleviating anxiety and depression among patients.

Analysis of Sleep Quality and Life Quality

Before the intervention, there were no significant differences in the GQOLI-74 and PSQI of patients between the two groups ($p > 0.05$). However, following the intervention, both groups demonstrated increased GQOLI-74 scores and decreased PSQI scores compared to pre-intervention levels. Notably, the observation group exhibited higher GQOLI-74 scores and lower PSQI scores than the control group ($p < 0.001$, Table 5). These results indicate that the exercise intervention led to improved life quality and sleep quality among patients, with superior outcomes observed in the observation group.

Discussion

Patients with T2DM often experience insulin resistance, leading to elevated blood glucose levels as glucose is inefficiently transported and utilized by the body. Prolonged imbalance in blood glucose levels can contribute development of various T2DM complications. Fasting blood glucose (FBG), 2h PBG, and HbA1c are three laboratory markers that reflect the status of glycemic control at different levels, reflecting the level of control of the T2DM disease [24]. The normal range for FBG in adults typically falls between 3.9–6.1 mmol/L [25]. Studies have shown that FPG levels can predict the future incidence of hypertension in adults [26], emphasizing the importance of maintaining optimal FBG levels in T2DM management. Notably, FBG levels in the early morning following exercise can serve as a valuable indicator to assess the effectiveness of glycemic interventions [27]. This study confirmed that the nurse-led exercise group exhibited significantly lower FBG levels compared to the control group after the exercise intervention, demonstrating the efficacy of exercise in glycemic control.

HbA1c serves as a reliable indicator reflecting average blood glucose levels over the past 9–12 weeks, offering valuable insight into the stability of patient's blood glucose [28]. Although the management of HbA1c is directly related to the condition of T2DM, the current situation is that most T2DM patients do not have good control of HbA1c, and it is necessary to strengthen the attention and management of HbA1c in T2DM patients. The results of this experiment found that the HbA1c level of the observation group decreased after exercise intervention, and there was a significant difference between the groups compared to the control group, which confirms that exercise can effectively regulate the level of HbA1c. Furthermore, the results of 2h PBG measurement corroborated these conclusions.

Table 5. Comparison of intervention effect.

Group	PSQI (score)		GQOLI-74 (score)	
	Before intervention	After intervention	Before intervention	After intervention
Observation (n = 53)	15.64 ± 3.86	8.96 ± 2.11*	52.96 ± 5.61	63.28 ± 4.47*
Control (n = 53)	15.55 ± 3.57	11.08 ± 2.57*	53.28 ± 4.90	58.28 ± 4.07*
t	0.131	4.624	0.313	6.023
p	0.896	<0.001	0.755	<0.001

Note: Compared with before intervention, *$p < 0.05$. PSQI, Pittsburgh Sleep Quality Index; GQOLI-74, Generic Quality of Life Inventory.

With the evolving physiological-psychosocial medical model, there's a growing recognition of the psychological symptoms among patients with T2DM. However, research suggests that clinical staff assess depression symptoms in T2DM patients at a low rate, with only 40% receiving evaluation, highlighting the importance of addressing depression in this population [29]. Exercise has been shown to stimulate the secretion of specific hormones in the brain, promoting hippocampal plasticity and thereby enhancing mental well-being. Our findings indicate that SDS and SAS scores were lower in the nurse-led exercise group compared to the control group, suggesting that exercise training may ameliorate symptoms of depression and anxiety in elderly diabetic patients. The nervous system communicates via neurotransmitters through chemical synapses. 5-HT and NE are neurotransmitters found in key brain regions such as the limbic system, hippocampus, and amygdala, exerting anxiolytic effects by interacting with precursor agonist receptors. These neurotransmitters play pivotal roles in regulating mood, generating pleasurable emotions, and modulating mood states [30,31]. Dysregulation of central functioning in individuals with depression is closely associated with various symptoms, including depressed mood, anxiety, appetite disturbances, sexual dysfunction, sleep disturbances, cognitive impairment, aggression, and suicidal behaviors, among others [32]. Many antidepressant medications act by increasing the synaptic levels of 5-HT. NE, on the other hand, plays a crucial role in regulating sleep-wake cycles, emotional states, learning and memory, attention, stress responses, and arousal [33].

Different receptors, namely α and β receptors, play distinct roles in the central nervous system. When NE acts on the $\alpha1$ receptor on the postsynaptic membrane, it stimulates the central nervous system, resulting in positive manifestations such as heightened consciousness, improved mood, increased motor activity, enhanced defense reflexes, elevated blood pressure, and increased feeding behavior. Conversely, when NE acts on the β receptor on the postsynaptic membrane, it inhibits the central nervous system, leading to drowsiness, rigidity, depressed mood, and reduced blood pressure [34]. These receptors are implicated in the pathogenesis of depression. Prior research suggests that decreased production and release of NE in depressed patients may be attributable to heightened receptor activity [35,36]. A study has also reported significantly lower levels of 5-HT and NE in elderly individuals with depression [37]. Our study findings revealed increased levels of 5-HT and NE in patients following the intervention, suggesting that the exercise program effectively elevates 5-HT and NE levels in elderly depressed patients, thereby ameliorating negative mood states.

The study results revealed that following the intervention, the observation group exhibited lower PSQI scores and GQOLI-74 scores compared to the control group ($p <$ 0.05), indicating that exercise effectively enhances patients' quality of life and sleep. Research has demonstrated that physical activity exerts a positive influence on sleep quality, with increased physical activity being associated with improved sleep quality and reversibility [38]. Sato *et al.*'s study [39] suggested that maintaining daytime activity levels and engaging in moderate to vigorous intensity physical activity can promote better sleep at night. Planned exercise training has been shown to enhance sleep quality, prolong sleep duration, and consequently elevate quality of life. For instance, a study indicated that aerobic exercise improves sleep quality and quality of life in patients with RLS, facilitating recovery [40].

In conclusion, exercise intervention demonstrates efficacy in ameliorating negative mood and depression among elderly patients with diabetes mellitus and comorbid depression. Nonetheless, our study is subject to certain limitations. The small sample size may influence the robustness of the experimental findings. Future research endeavors should strive to enhance generalizability by recruiting larger sample sizes from diverse geographic regions, thereby minimizing the potential for sampling error. Furthermore, the assessment of depression in this study was limited to certain indicators. Future investigations could benefit from incorporating additional evaluation measures to provide a more comprehensive assessment of the impact of exercise intervention.

Conclusion

In conclusion, nurse-led exercise programs demonstrate significant benefits for patients with diabetes mellitus and comorbid depression. These interventions effectively alleviate adverse mood, reduce depression and anxiety, enhance sleep quality, improve quality of life, and promote social reintegration and rehabilitation among patients. Given these positive outcomes, the widespread implementation of nurse-led exercise programs in clinical settings is highly recommended.

Availability of Data and Materials

The datasets used and/or analyzed during the current study were available from the corresponding author on reasonable request.

Author Contributions

LP and RW designed the study. All authors conducted the study. RW and YL collected and analyzed the data. LP and YL participated in drafting the manuscript, and all authors contributed to the critical revision of the manuscript for important intellectual content. All authors gave final approval of the version to be published. All authors participated fully in the work, take public responsibility for appropriate portions of the content, and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or completeness of any part of the work are appropriately investigated and resolved.

Ethics Approval and Consent to Participate

This study has been approved by the Ethics Committee of Xingtai People's Hospital (Approval No.: [2018]032). All patients signed a consent form.

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Conflict of Interest

The authors declare no conflict of interest.

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