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Effect of Baduanjin Exercise on Insomnia Patients with End-Stage Renal Disease

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Abstract

Objective: To explore the effect of Baduanjin exercise on sleep quality, negative emotion and fatigue state of patients with insomnia in end-stage renal disease. **Methods:** This study was a non-contemporaneous controlled study. Using the convenient sampling method, patients with end-stage renal disease who met the inclusion and exclusion criteria in the Department of Nephrology of the Affiliated Hospital of Youjiang Medical university for Nationalities from April to August 2024 were selected as the research objects. A total of 43 cases hospitalized from April to June 2024 were set as the control group, and 43 cases hospitalized from June to August 2024 were set as the intervention group. The control group was given routine nursing such as regular medication, diet guidance, activity guidance, and psychological counseling. On the basis of that in the control group, the intervention group was given Baduanjin exercise. Sleep quality, negative emotion and fatigue were compared between the two groups of end-stage renal disease patients with insomnia. **Results**: The improvement of subjective sleep quality, time to fall asleep, sleep duration, sleep efficiency and total score of Pittsburgh Sleep Quality Index in the intervention group were better than those in the control group, and the differences were statistically significant ($P < 0.05$). After the intervention, the scores of Hamilton Anxiety Scale and Hamilton Depression Scale in the intervention group were lower than those in the control group, and the differences were statistically significant ($P < 0.05$). After the intervention, the improvement of all dimensions and total score of the fatigue scale in the intervention group was better than that in the control group, and the differences were statistically significant ($P < 0.05$). **Conclusions:** Baduanjin exercise can improve sleep quality by shortening sleep onset time, increasing sleep duration and improving sleep efficiency. At the same time, Baduanjin exercise can improve the negative emotions and fatigue state of patients, which is worthy of further research and clinical promotion.

Keywords

End-Stage Renal Disease, Baduanjin Exercise, Insomnia, Negative Emotions, Fatigue

1. Introduction

Patients with End-Stage Renal Disease (ESRD) have decreased sleep quality due to physical discomfort, frequent urination, electrolyte disturbance, anemia, and mental and psychological factors. According to statistics, about 50% - 75% of ESRD patients have insomnia symptoms [1]. Sleep problems such as insomnia and sleep disorders are risk factors for health [2] and increase the risk [3] of death in ESRD patients. According to studies, poor sleep quality can easily trigger negative emotions, and there is a positive relationship between them. When sleep quality decreases, the severity of negative emotions increase, and vice versa [4]. And fatigue is associated with complications such as disorders, depression, and anemia [5]. More and more evidence has proved [6] [7] that regular and moderate exercise in ESRD patients not only does not aggravate the deterioration of renal function, but also can improve sleep quality, psychological state, fatigue degree, cardiopulmonary function, micro-inflammatory state, improve quality of life, and reduce the risk of death. In 2019, China released the Chinese adult patients with chronic kidney Disease [8], which proposed that individualized exercise rehabilitation prescriptions should be formulated according to the characteristics of ESRD patients, encouraging patients to participate in exercise, and including exercise rehabilitation in the comprehensive management of patients. As a traditional health cultivation qigong in China, Baduanjin is a kind of aerobic exercise of medium and small intensity, which has the functions of dredging meridians, qi and blood, regulating the balance of viscera, and smoothing the mind and emotions. It is not limited by the site and time, and is easy to learn and adhere to, which has become the favorite fitness method of different people. Zeng [9] Research shows that Baduanjin exercise has an impact on patients with end-stage renal disease suffering from insomnia. The research results are reported as follows.

2. Materials and Methods

2.1. Clinical Data

Using the convenient sampling method, ESRD patients hospitalized in the Department of Nephrology of the Affiliated Hospital of Youjiang Medical university for Nationalities from April 2024 to August 2024 were selected as the research objects. Inclusion criteria: 1) conform to 2024 to improve Global prognosis of Kidney Disease, Kidney diseases, Improving Global Outcomes, KDIGO) guidelines of end-stage renal Disease diagnostic criteria; 2) patients' age ≥ 18 years old; 3) The patient was conscious and able to communicate in normal language; 4) Pittsburgh sleep Quality Index score ≥ 7 [10]; 5) The patient's condition was stable, without

physical activity disorder, and could complete exercise under the guidance; 6) The patient gave informed consent and volunteered to participate in this study. Exclusion criteria: 1) Critically ill patients with serious cardiovascular and cerebrovascular diseases, fractures or joint disorders; 2) patients with severe mental illness; 3) extreme physical weakness or limb dysfunction; 4) patients with femoral vein dialysis pipeline; 5) patients with exercise contraindication; 6) patients participating in other exercise studies.

2.2. Sample Size Estimation

Based on the 4th edition of "Medical Statistics" by Sun Zhenqiu and Xu Yongyong [11], the sample size (n) for this trial was estimated. Referring to the research findings of Hou Chen [12], the difference in PSQI total scores between the intervention and control groups post-intervention was $\delta = 1.24$, with a maximum standard deviation of $\sigma = 1.9$. Assuming a significance level of $\alpha = 0.05$ and a power of $\beta = 0.2$, the formula indicated that a sample size of approximately 40 cases was required. Considering potential loss to follow-up and non-compliance among participants, it was planned to observe 48 samples in each group. The sample size calculation formula is as follows:

$$n_1 = n_2 = 2\left[\frac{u_\alpha + u_\beta}{\delta/\sigma}\right]^2 + \frac{1}{4}u_\alpha^2$$

The actual sample size included in this study was 101 cases, with 53 in the intervention group and 48 in the control group. During the intervention period, a total of 15 cases were lost to follow-up. Reasons for attrition included: in the control group, 3 participants failed to return for follow-up and could not complete the scale, 1 was transferred to another department due to illness, and 1 died; in the intervention group, 5 participants did not adhere to the exercise regimen, 3 failed to return for follow-up and could not complete the scale, and 2 were transferred to other hospitals due to disease progression. Ultimately, 43 cases in both the control and intervention groups completed the study, resulting in an overall attrition rate of 14.9%. There was no significant difference in general data between the two groups ($P > 0.05$), which was comparable (see Table 1). This study met the requirements of medical ethics and was approved by the Ethics Committee of Youjiang Medical university for Nationalities. (Ethics No.: 2022111126)

Table 1. Comparison of general data of patients [$\overline{x} \pm s$ /n (%)].

Items	Control group (n = 43)	Intervention group (n = 43)	χ^2 /t value	P
Gender				
male	27 (62.8)	18 (41.9)	3.776△	0.052
female	16 (37.2)	25 (58.1)		
Age	52.26 ± 11.26	48.72 ± 10.95	1.476#	0.144
BMI	22.42 ± 3.19	23.39 ± 4.19	−1.201#	0.233

Continued

Marriage and marriage				
Married	39 (90.7)	39 (90.7)	<0.001△	1.000
unmarried	4 (9.3)	4 (9.3)		
Degree of education				
Primary school and below	17 (39.5)	23 (53.5)	6.592△	0.086
Junior high	21 (48.8)	10 (23.3)		
High school	4 (9.3)	8 (18.5)		
College and above	1 (2.3)	2 (4.7)		
Career				
Farmer	34 (79.1)	30 (69.8)	1.655△	0.647
Workers	2 (4.7)	5 (11.6)		
Retiring	1 (2.3)	1 (2.3)		
Others	6 (14.0)	7 (16.3)		
Payment methods				
Out of pocket	1 (2.3)	0 (0.0)	4.859△	0.088
Medical insurance for urban residents	39 (90.7)	34 (79.1)		
Medical insurance for urban employees	3 (7.0)	9 (20.9)		
Company				
no	4 (9.3)	9 (20.9)	5.015△	0.081
Spouse	27 (62.8)	29 (67.4)		
Children	12 (27.9)	5 (11.6)		
Duration of illness				
<5 years	26 (60.5)	29 (67.4)	0.454△	0.500
>5 years	17 (39.5)	14 (32.6)		
Renal replacement therapy modalities				
no	7 (16.3)	2 (4.7)	5.384△	0.146
Hemodialysis	16 (37.2)	14 (32.6)		
Peritoneal dialysis	19 (44.2)	23 (53.5)		
Hemodialysis + peritoneal dialysis	1 (2.3)	4 (9.3)		
Complications/co-morbidities				
no	6 (11.8)	4 (8.3)	1.187△	0.756
hypertension	37 (72.5)	39 (81.3)		
Heart disease	4 (7.8)	3 (6.3)		
diabetes	4 (7.8)	2 (4.2)		

Note: △χ^2-value; #t-value.

2.3. Methods

Patients in the control group received routine care for end-stage renal disease, and hemodialysis patients received hemodialysis twice or three times a week according to their condition. Carbonate replacement solution (4 L/bag) from the same manufacturer was used. Peritoneal dialysis patients were treated with one 1.5% lactate

peritoneal dialysate bag (2 L/bag) four times a day according to the requirements of peritoneal dialysis; Sleep hygiene guidance and medication guidance were given. Dietary guidance was given according to doctor's advice and patients' dietary characteristics. Activity guidance: according to the health education guidance formulated by the department, explain the benefits and precautions of activities, and encourage patients to take more activities according to their own conditions; Psychological nursing, effective communication with patients to solve the patients' current psychological problems; Discharge guidance, regular follow-up of patients, given diet, sleep, activity, psychological guidance. The intervention group was given Baduanjin exercise intervention on the basis of the routine treatment and nursing of the control group.

2.3.1. Establishment of Baduanjin Exercise Intervention Group

This research group was composed of 6 members, including 1 team leader, 1 doctor and 6 nurses. The team leader was responsible for theoretical training, technical guidance and study design, one chief physician of nephrology was responsible for intervention program review and theoretical guidance, one deputy chief nurse of nephrology was responsible for organization and coordination, continuing exercise program question answering, one supervisor nurse was responsible for program formulation, data collection, implementation, follow-up supervision, quality control and data statistics, and two nurses were responsible for data collection and collation.

2.3.2. Formulation of the Research Plan

Through clinical observation with the research subject, based on literature retrieval, in accordance with the principle of PICOS draft formulated Baduanjin intervention, and invited experts in 11 from TCM and kidneys of the end-stage renal disease patients with insomnia Baduanjin Exercise scheme comprehensive analysis, discussion and modification, Experts coefficient (Cr) of 0.884. Five patients who met the inclusion and exclusion criteria were selected for a 4-week pre-experiment to determine the intervention plan and the use of evaluation tools.

Table 2. Final scheme of the ward intervention content for Baduanjin exercise.

Key Points of Implementation	Details
Intervention Time	08:00 - 09:30
Intervention Location	Renal Internal Medicine Ward
Interventionist	The specific implementation of Baduanjin exercises is the responsibility of the researcher.
Exercise Selection	The version of Baduanjin exercises compiled and created by the General Administration of Sport of China in 2003 and filmed by the Beijing Social Sports Management Center.
First Contact with Patients	1. Query patient records to understand their condition. 2. Introduce the purpose and significance of the study. For patients who agree to participate, assess their sleep conditions and have them sign the informed consent form. 3. Pay attention to communication skills and establish a good relationship with the patients.

Continued

Before Intervention	1. Form an intervention team consisting of renal internal medicine doctors, nurses from the renal internal medicine ward, and nurses from the traditional Chinese medicine department. 2. Train the team members. 3. Use the Pittsburgh Sleep Quality Index to assess the insomnia status of the patients. 4. Conduct a PPT lecture on Baduanjin exercises. Introduce the purpose and significance of the exercise therapy to the patients and their families, select the possible benefits and risks of Baduanjin exercises, as well as the exercise plan and precautions. Special emphasis should be placed on avoiding exercises that increase abdominal pressure for peritoneal dialysis patients and avoiding excessive movement during upward stretching for patients with long-term indwelling internal jugular vein catheters. 5. One day before the intervention, introduce knowledge about insomnia, the pros and cons of using drugs, the benefits of exercise therapy, and the efficacy and risks of Baduanjin exercises. 6. Suggest that patients perform the exercises one hour before or after dialysis. 7. Establish a "Baduanjin Practice Group" on WeChat. Post Baduanjin exercise videos in the group for patients to watch. 8. Assess the patient's vital signs, motor ability, sleep conditions, etc. Only when the patient's condition is stable can they start exercising. 9. Choose a well-ventilated venue, use the department's TV, and have the researcher follow along to exercise, guiding the patient to practice together. 10. Instruct the patient to wear appropriate sports shoes and clothing (flat-bottomed, shallow anti-slip patterned sports shoes and loose-fitting, comfortable sports clothes should be chosen). 11. Before exercising, assess the patient's heart, lung, kidney functions, blood pressure, tubes, and exercise contraindications, etc. Prepare devices such as sphygmomanometers and pulse oximeters to prevent any unforeseen circumstances during the exercise. 12. Exercise should be conducted after breakfast in the morning. Before exercising, perform about 10 minutes of warm-up exercises mainly focusing on stretching and loosening the muscles and joints to prevent accidents.
During intervention	1. Explain the techniques of practicing Baduanjin: It is best to choose the morning, a quiet environment with fresh air and good ventilation, and wear loose, breathable clothing. 2. Use on-site teaching combined with video viewing to explain the Baduanjin movements to the patient. At the same time, inform the patient to adjust their breathing according to the rhythm of the movements, inhaling when opening and exhaling when closing, completing one movement with one inhalation and one exhalation. 3. After mastering the key points of the movements, guide the patients to focus on the coordination of breathing and movements, maintaining deep and natural breathing. Try to relax the body and let the imagination flow along with the background music of Baduanjin, allowing the body to practice spontaneously with the music, achieving the state of regulating the body, breath, and mind. 4. During the practice, the researcher closely observes the performance of each subject. If the patient experiences discomfort such as weakness in the lower limbs, dizziness, or muscle pain, promptly assess whether the patient can continue the practice and take corresponding measures to alleviate or eliminate the discomfort. 5. During the intervention, pay attention to observing whether the patient's movements are in place. For patients who progress more slowly, provide one-on-one guidance.
After intervention:	1. The exercise should end when the patient feels slightly tired and has a light sweat, without palpitations or shortness of breath. 2. Use the Borg Rating of Perceived Exertion Scale to assess the patient's exercise tolerance intensity. 3. Upon completion of the exercise, inquire whether the patient experiences any discomforting symptoms, such as muscle strains, dizziness, chest tightness, chest pain, palpitations, knee pain, or severe back pain. In the event of such symptoms, the practice of Baduanjin should be immediately discontinued.

Continued

	4. After completing the Baduanjin practice, perform relaxation exercises to achieve the best exercise effect. 5. After the intervention, interact with the patient and discuss their experience after the exercise, and also arrange the time for the next exercise session. 6. Gradually increase the exercise volume and develop a personalized exercise plan based on the patient's exercise capacity.
Single session duration:	12 minutes and 1 second
Frequency	Once a day, at least 5 times a week.
Exercise duration	About 10 minutes of warm-up + 12 minutes of Baduanjin practice + about 10 minutes of cool-down, totaling 32 minutes. Patients can practice Baduanjin 1 to 2 times according to their own conditions.

Table 3. Final scheme of the content of the Baduanjin exercise home intervention.

Key Points of Implementation	Details
Exercise Timing	It is recommended to engage in physical activity 30 minutes after breakfast in the morning, either one hour before or after dialysis. Adjustments can be made based on the patient's daily routine, avoiding exercise before bedtime.
Exercise Location	At home or in a safe environment (preferably a spacious, comfortable, well-ventilated, and sunny area if conditions permit).
Exercise Selection	The Baduanjin version compiled and created by the General Administration of Sport of China in 2003, filmed by the Beijing Social Sports Management Center.
Pre-Exercise	Measure blood pressure to prevent any unexpected incidents during exercise.
During Exercise	If symptoms such as lower limb weakness, dizziness, or muscle pain occur, rest immediately and decide whether to continue based on personal physical condition.
Post-Exercise	1. The exercise should conclude with a feeling of slight fatigue and mild sweating, without palpitations or shortness of breath. 2. Use the Borg Rating of Perceived Exertion scale to assess exercise tolerance intensity.
Frequency	Once daily, at least five times per week.
Exercise Duration	Approximately 10 minutes of warm-up, 12 minutes of Baduanjin practice, and 10 minutes of cool-down, totaling 32 minutes. Patients may perform 1 - 2 sets of Baduanjin based on their condition.
Outpatient Exercise Control	Patients join a Baduanjin practice group established by researchers and use a WeChat mini-program for exercise monitoring. Additionally, periodic updates on the importance of exercise and the benefits of Baduanjin are shared to encourage consistent participation.

2.3.3. Specific Intervention Measures

The standard movements of Baduanjin are based on the video of Baduanjin compiled by the China National Sports Administration in 2003 and filmed by the Beijing Social Sports Management Center. Both Hands Hold Up the Heavens to Balance the Triple Warmer, Drawing the Bow to Left and Right Shooting the Vulture, Separating Heaven and Earth to Balance the Spleen and Stomach, Look Back to Prevent the Five Diseases and Seven Injuries, Sway the Head and Shake the Tail to Calm the Heart Fire, Hold the Feet with Both Hands to Strenghten Waist and

Kidneys, Clench the Fists with Angry Eyes to Strengthen the Body, Bouncing on the Toes to Cure Diseases, As well as ten movements including the preparatory posture and the concluding gesture.

During the patient's hospitalization, the researchers demonstrated the whole set of Baduanjin exercises and organized training courses. Before the demonstration of Baduanjin exercise, patients were organized to explain the importance of exercise rehabilitation and the advantages of Baduanjin exercise, so as to improve the compliance of patients. We focused on watching the Baduanjin video of General Administration of Sport of China, guided patients to practice and correct actions, and implemented the whole process of daily Baduanjin exercise intervention. After the training, the patients were assessed to ensure that they mastered the key points of Baduanjin movement. Borg subjective fatigue scale was used to evaluate the exercise tolerance of patients at the end of exercise. The score of Borg subjective fatigue scale was 6 - 20, and the higher the score, the more severe the fatigue. According to the scoring standard, the appropriate exercise intensity for patients was between 12 - 14 [13], At the same time, the discomfort and adverse conditions of patients during exercise were closely monitored and recorded. A wechat group for Baduanjin exercise was established, and the practice videos were sent to the group for patients to practice by themselves. The specific intervention plans (see **Table 2**) are shown.

During home exercise, researchers tracked and reminded patients of their exercise through a small program of clocking in once a day, and reminded patients to clock in after exercise every day, so as to effectively manage patients' exercise and self-care. In the wechat group, the researchers explained the hazards such as insomnia and negative emotions, the advantages and precautions of Baduanjin exercise from time to time, and encouraged the patients to persist in exercise. Using a small program to punch the card in the wechat group, pay attention to the patient's adherence to exercise, collect the exercise data of the participants every week, praise the participants with outstanding performance, and share their exercise experience or experience. Communication with patients should be strengthened. If patients feel uncomfortable during exercise, it is necessary to pause exercise practice. In addition, patients were encouraged to share their photos and impressions of exercise, and patients raised questions about Baduanjin exercise in the group, which were answered by the researchers in time. The specific intervention plans (see **Table 3**) are shown.

Exercise precautions: 1) Fully evaluate the pipeline of peritoneal dialysis and hemodialysis patients, inform the precautions to prevent the pipeline from falling off, and pay close attention to the pipeline before and after exercise; 2) The hospital exercise was carried out under the guidance of doctors and nurses, and the home exercise was accompanied by family members; 3) Peritoneal dialysis patients and/or patients who often have dizziness are not required to touch their feet with their hands when practicing the move of "Hold the Feet with Both Hands to Strenghten Waist and Kidneys", only the patients' hands to their knees are re-

quired to prevent the increase of abdominal pressure and head congestion, leading to accidents. 4) For the patients with temporary internal jugular vein catheterization, the Angle of head rotation should be reduced as far as possible when the movement of "Look Back to Prevent the Five Diseases and Seven Injuries" is used; 5) for patients with dialysis pipeline implantation and internal fistula, avoid the surgical site as far as possible; 6) For patients who could not adhere to exercise, the problems of patients were analyzed and personalized exercise guidance was given; 7) Blood pressure should be monitored before exercise and fasting should be avoided.

2.3.4. Research Tools

1) General information questionnaire Researchers compiled a general data questionnaire, including ESRD patients gender, age, marital status, educational level, occupation and other basic demographic data and renal replacement therapy and related complications such as disease data. The questionnaire can be collected from medical records or inquires from patients/family members.

2) Pittsburgh Sleep Quality Index (PSQI) was used to evaluate the quality of sleep. The PSQI mainly covers 7 aspects, including subjective sleep quality, sleep onset time, sleep duration, sleep efficiency, sleep disturbance, use of hypnotic drugs, and daytime dysfunction. The total score of PSQI ranged from 0 to 21, and higher PSQI total score indicated worse sleep quality. The criterion for the diagnosis of insomnia was a PSQI score greater than 7. The test-retest reliability of PSQI was 0.994, and the split-half reliability coefficient of PSQI was 0.824. The retest reliability of PSQI was 0.994 and the split-half reliability coefficient of PSQI was 0.824. The overall Cronbach's α coefficient was 0.845 [14], PSQI has good reliability and validity, and can comprehensively evaluate the overall sleep quality.

3) Hamilton Anxiety Scale (HAMA) was developed by Hamilton in 1959. It is often used to evaluate the anxiety symptoms of patients and is one of the most widely used anxiety scales in clinical practice. Each item was scored on a 5-point scale from 0 to 4, with 0 indicating no symptoms and 4 indicating severe symptoms. The total score ranged from 0 to 56, and the total score of HAMA ≤ 7 was normal, which was proportional to the degree of anxiety of patients. The overall Cronbach's α coefficient ranged from 0.8 to 0.9 [15].

4) Hamilton Depression Scale (HAMD) was developed by Hamilton in 1960. It is one of the most widely used depression scales in clinical practice. Hamd includes 17 items such as depression, guilt, difficulty sleeping and systemic symptoms, and 9 items are scored on a 5-point scale from 0 to 4. Nine items were scored from 0 to 4 points and 5 points. Eight items were scored from 0 to 2 points. The total score ranged from 0 to 52, with HAMD score ≤ 7 as normal. The score of HAMD was directly proportional to the degree of depression. The overall Cronbach's α coefficient was 0.832 [16].

5) Fatigue Scale (FS-14) This scale was developed by Trudie Chalder and his

team in the Department of Psychological Medicine, King's College Hospital, UK in 1992 and is commonly used to measure fatigue symptoms. The scale includes physical fatigue and mental fatigue. Each item contains two options of "yes" or "no", of which 1 to 8 items reflect physical fatigue and 9 to 14 items reflect mental fatigue. In addition to item 10, 13 and 14, 3 items were scored in the reverse direction, that is, the answer "yes" was scored as 0, the answer "no" was scored as 1, the other 11 items were scored in the positive direction. The scores of physical fatigue and mental fatigue were 0 to 8 and 0 to 6, respectively. The total score ranged from 0 to 14. The higher the score, the more obvious the fatigue. The overall Cronbach's α coefficient ranged from 0.88 to 0.90 [17].

2.3.5. Statistical Analysis Technique

After the researchers had checked the completeness and accuracy of the data and confirmed that the logic was correct, they conducted two rounds of data entry verification using the EpiData3.1 software, via computer logic error detection, export after verification, use SPSS27.0 statistical software processing data. Measurement data: For the measurement data that met the normal distribution, the mean ± standard deviation ($\bar{x} \pm s$) was used to describe the data, and the data were analyzed by t test. Otherwise, median and quartile were used for description, and non-parametric test was used for statistical analysis. Count data: frequency and percentage (%) were used for description, and test was used for statistical analysis. $P < 0.05$ was considered statistically significant.

3. Results

Observation of Adverse Events

During the intervention, there were 2 cases of adverse reactions in the intervention group, both of which occurred during hospitalization. Among them, 1 case had weakness of both lower limbs, which was mainly due to insufficient warm-up exercise, and 1 case had dizziness, which was mainly due to the first Baduanjin exercise, and the exercise activity was too large, which could be properly handled. The other patients had no adverse reactions such as muscle strain, sprain, falling injury, sweating, palpitation, etc.

Table 4. Comparison of PSQI scores between the two groups [M (*P*25, *P*75)].

Groups	Examples	Subjective sleep quality		Time to sleep		Duration of sleep	
		Before intervention	After intervention	Before intervention	After intervention	Before intervention	After intervention
Control group	43	2 (2, 3)	2 (2, 3)	3 (2, 3)	3 (2, 3)	3 (2, 3)	3 (2, 3)
Intervention group	43	3 (2, 3)	1 (1, 1)	3 (3, 3)	2 (1, 3)	3 (2, 3)	1 (1, 2)
Z-score		−0.113	−7.171	−1.607	−3.117	−0.991	−6.292
P		0.910	<0.001	0.108	0.002	0.322	<0.001

Groups	Examples	Sleep efficiency		Sleep disorders		Use of hypnotics	
		Before intervention	After intervention	Before intervention	After intervention	Before intervention	After intervention
Control group	43	3 (2, 3)	3 (1, 3)	1 (1, 1)	1 (1, 1)	0 (0, 0)	0 (0, 0)
Intervention group	43	3 (2, 3)	1 (0, 3)	1 (1, 2)	1 (0, 1)	0 (0, 0)	0 (0, 0)
Z-score		−0.466	−2.485	−3.100	−3.762	−0.392	−1.042
P		0.641	0.013	0.002	<0.001	0.695	0.298

Groups	Examples	Daytime dysfunction		Total score	
		Before intervention	After intervention	Before intervention	After intervention
Control group	43	2 (1, 2)	2 (1, 2)	13 (11, 15)	13 (11, 14)
Intervention group	43	2 (1, 2)	1 (0, 1)	14 (11, 15)	7 (5, 9)
Z-score		2.112	−5.489	−0.302	−6.256
P		0.035	<0.001	0.762	<0.001

Table 5. Comparison of negative emotion scores between the two groups [M (P25, P75)/ $\overline{x} \pm s$].

Groups	Examples	Hamilton Anxiety Scale		Hamilton Depression Rating Scale	
		Before intervention	After intervention	Before intervention	After intervention
Control group	43	12 (10, 14)	10.05 ± 2.77	10.65 ± 2.01	10 (8, 11)
Intervention group	43	14 (10, 18)	5.98 ± 2.92	11.67 ± 2.73	4 (2, 6)
Z/t values		1.771*	6.638#	−1.978#	6.436*
P		0.077	<0.001	0.051	<0.001

Note: *Z-value; #T-value.

Table 6. Comparison of fatigue scores between the two groups [M (P25, P75)].

Groups	Examples	Physical fatigue		Mental fatigue		Total score	
		Before intervention	After intervention	Before intervention	After intervention	Before intervention	After intervention
Control group	43	8 (6, 8)	7 (5, 8)	3 (2, 3)	3 (2, 3)	10 (8, 11)	6 (5, 10)
Intervention group	43	7 (6, 8)	3 (2, 3)	2 (2, 3)	2 (2, 3)	9 (8, 11)	1.5 (1, 2)
Z-score		−0.892	−7.064	−0.617	−2.831	−0.804	−7.108
P		0.372	<0.001	0.537	0.005	0.421	<0.001

4. Discussion

4.1. Sociodemographic Characteristics of the Subjects

Demographic data of this study showed (see Table 1) that among the 86 subjects who completed the intervention, there were 27 male patients (62.8%) and 16 female patients (37.2%) in the control group; There were 18 male patients (41.9%) and 25 female patients (58.1%) in the intervention group. The sex ratio included

in the control group was similar to that in recent studies [18]. According to the age classification standard of the World Health Organization, the subjects of the two groups were mainly middle-aged. The age of the control group was 52.26 ± 11.26 years old, and the age of the intervention group was 48.72 ± 10.95 years old, which was consistent with Singh's study [19]. In addition, 46.5% of the patients in this study had primary school education or below, 74.4% were farmers, and the patients generally had low education levels and lack of understanding ability. Therefore, in terms of scale filling, Baduanjin exercise skills and precautions, it is necessary to use plain language, watch videos and explain on site, and patiently guide the patients to master the scale filling and intervention plan. The study found that patients with company had a better psychological state, so we should pay attention to the psychological dynamic of patients without company in clinical practice.

4.2. Analysis of Clinical Disease Data of the Subjects

Among the subjects included in this study (see **Table 1**), 63.9% of them had a course of disease less than 5 years, and 1.16% had a course of disease more than 10 years. Among the renal replacement therapy patients, 34.88% were on hemodialysis, 48.83% were on peritoneal dialysis, and 5.8% were on hemodialysis and peritoneal dialysis. Most of the patients had long-term hemodialysis catheters or peritoneal dialysis catheters, and a small number of patients were treated with arteriovenous fistula for hemodialysis. As for the exercise contraindication of ESRD patients with catheters, according to the literature review, only the contents of unsuitable activity for surgical patients and avoidance of increasing negative pressure for peritoneal dialysis patients were included [8] [20]. Therefore, in the process of Baduanjin movement, it is necessary to avoid the above two points and closely observe the pipeline to avoid the pipeline falling off. During the course of this study, no adverse reactions were found in patients due to the tube. In this study, 88.37% of the subjects had complications, mainly hypertension. The reason for the high prevalence of hypertension is related to water and sodium retention, significant hypervolemia, sympathetic hyperactivity, and endothelial dysfunction in ESRD patients [21]. Therefore, patients' heart rate and blood pressure were monitored before and after Baduanjin exercise to avoid accidents during exercise. No adverse events such as dizziness and falls due to complications occurred during the study.

4.3. Baduanjin Exercise Can Improve the Sleep Quality of Patients with End-Stage Renal Disease

Good sleep is not only a physiological need for human beings, but also an important factor for maintaining mental health. Insufficient sleep can lead to decreased concentration, fatigue, anxiety and depression, etc. Long-term insufficient sleep can reduce immunity, increase cardiovascular risk, metabolic disorders, etc. Patients with end-stage renal disease are more likely to suffer from insomnia than normal people due to their own diseases, which can easily induce complications

such as hypertension, cerebrovascular accident, and cardiac dysfunction, increase the risk of all-cause death [22], and seriously affect the quality of life of patients.

This study implemented a 4-week intervention for ESRD patients with insomnia. The sleep quality of the two groups before the intervention was similar, and the PSQI total score was ≥7, among which the intervention group had 13 (11, 15) points, and the control group had 14 (11, 15) points, which indicated that there was no significant difference in insomnia between the two groups, and the deviation of the intervention results was reduced (see **Table 4**). The main symptoms of the two groups were sleep duration less than 6 hours at night, difficulty falling asleep, easy to wake up, and waking up early. A few patients could not sleep all night, and most patients slept for about 5 hours. It often takes more than 1 hour to fall asleep. Low sleep efficiency, with most patients having a sleep efficiency of less than 65%. After 4 weeks of Baduanjin exercise intervention, the total score of sleep quality in the intervention group was better than that in the control group ($P > 0.05$). However, there was no significant difference in the factor of using hypnotic drugs between the two groups. Fu Junxiang [13] explored the effect of Baduanjin on sleep quality and negative emotions in maintenance hemodialysis patients, and the results were consistent with the Pittsburgh Sleep Quality scale. The reason for this is mainly related to the small sample size of hypnotics and the difference in the proportion of patients taking hypnotics between the two groups.

Baduanjin exercise has a good effect on improving sleep quality. A network meta-analysis showed that Baduanjin exercise was the most effective in improving sleep quality [23]. The reasons are as follows. Firstly, Baduanjin exercises contribute to the smooth flow of meridians and the regulation of qi and blood, thereby enhancing sleep quality. Secondly, each movement of Baduanjin corresponds to specific internal organs. It can dredge the triple energizer, regulate the heart and lungs, condition the spleen and stomach, and strengthen kidney function, which promotes the balance of yin and yang and alleviates sleep problems caused by end-stage renal disease. Additionally, Baduanjin integrates the holistic concept into the practice of exercise, emphasizing the harmonious balance among the body, mind, and environment. Practicing Baduanjin in a quiet and comfortable environment, with slow and gentle movements, focused breathing, and meditation, helps to relieve mental stress, enhance psychological well-being, improve the exercise effect, and promote the improvement of sleep.

4.3.1. Baduanjin Exercise Can Improve the Subjective Sleep Quality and Sleep Duration of Patients with End-Stage Renal Disease

The analysis of data results of this study showed (see **Table 4**) that after 4 weeks of Baduanjin exercise, the subjective sleep quality of the intervention group was improved, and the sleep duration was significantly increased ($P < 0.05$), indicating that Baduanjin exercise had a good promoting effect on sleep. Baduanjin is a medium and low intensity aerobic exercise, which can enhance the activity of parasympathetic nerves, reduce the excitability of sympathetic nerves, and promote the balance of the autonomic nervous system. At the same time, moderate physical

activity can promote blood circulation, enhance cardiopulmonary function, and help patients to reach a deep state of rest during sleep, so as to prolong sleep time and improve sleep quality.

4.3.2. Baduanjin Exercise Can Improve the Sleep Time and Sleep Efficiency of Patients with End-Stage Renal Disease

Generally speaking, it takes more than 30 minutes to fall asleep to prove that there is a problem of sleep. In this study, it was found that some ESRD patients with insomnia had difficulty falling asleep all night. After 4 weeks of Baduanjin exercise, the sleep duration of ESRD patients with insomnia was improved, the nightmare was significantly reduced, and they could quickly fall back to sleep after waking up at night. Sleep efficiency was significantly improved ($P < 0.05$) (see **Table 4**). It shows that regular Baduanjin exercise can adjust the biological clock, promote the body's blood circulation, and enhance the function of various systems of the body. At the same time, appropriate exercise can also promote the secretion of melatonin in the brain, regulate the activity of cerebral cortex and awakening center to improve sleep quality, shorten the time for patients to fall asleep, and improve sleep efficiency.

4.4. Baduanjin Exercise Can Improve the Negative Emotions of Patients with End-Stage Renal Disease and Insomnia

Anxiety and depression are the most common negative emotions. ESRD patients often have higher incidence rates than general patients due to disease, dietary and activity restrictions, complications, personal role changes, and increased medical costs. Anxiety and depression can lead to sleep problems, and lack of sleep can aggravate anxiety and depression, thereby forming a vicious circle that affects the overall health and quality of life of patients [24] [25]. In this study, Hamilton Anxiety Scale and Hamilton Depression Scale were used to evaluate the negative emotions of patients, and it was found that patients had anxiety and depression.

In this study, Baduanjin exercise was used to improve the negative emotions of patients, and the results showed that the total scores of HAMA and HAMD in patients were reduced, with significant differences compared with the control group (see **Table 5**). Similar to the previous research results [26]. Analysis of the reasons may be related to the following aspects: 1) Baduanjin emphasizes the relaxation of the whole body, mental emptying and slow breathing. In the process of exercise, the body and mind are relaxed, so as to improve negative emotions. 2) Baduanjin exercise can regulate the physiological and biochemical indexes related to emotion, such as 5-hydroxytryptamine, endorphin, plasma adiponectin, etc, so as to make the mood happy [27]. 3) Regular exercise can improve sleep quality, thereby relieving anxiety and depression symptoms. 4) Patients' participation in group sports can enhance the communication and contact between patients and nurses. Through mutual understanding and disease communication, patients can objectively look at the disease and achieve the effect of physical and mental relaxation. 5) The background music of Baduanjin is beautiful and soft, which provides

a peaceful environment for the practitioners. At the same time, Baduanjin emphasizes the combination of "movement and stillness", so that the patients can achieve the harmony of mind, qi and shape, so as to effectively improve their mental state.

4.5. Baduanjin Exercise Can Relieve the Fatigue State of Patients with End-Stage Renal Disease and Insomnia

Multiple factors can lead to fatigue in ESRD patients. Sleep, negative emotion and fatigue often interact and cause each other. Insomnia and negative emotion can aggravate fatigue, and fatigue can also cause and aggravate insomnia and negative emotion. At the same time, the changes of albumin, urea nitrogen, creatinine levels and hemoglobin caused by renal function impairment can also cause patients to feel tired and decrease [28].

In this study, an individualized exercise program was developed according to the degree of physical fatigue in ESRD patients, and the amount of exercise was increased step by step. The difference between the intervention group and the control group after the implementation of Baduanjin exercise was statistically significant (see **Table 6**), which was similar to the research results of Chen Jiale [29] on the effect of Baduanjin exercise on fatigue and physical activity in middle-aged and elderly patients with chronic kidney disease in the stable stage. It is proved that Baduanjin is effective in improving fatigue in middle-aged and elderly patients. The reason is that the repeated lifting and abduction movements in Baduanjin practice can increase the thoracic volume, enhance the strength of respiratory muscle and improve respiratory function. At the same time, with deep and long breathing, the oxygen in the blood is increased, the circulation of qi and blood is promoted, and the symptoms of fatigue are improved. In addition, Baduanjin emphasizes stretching and relaxation, and the soft background music can relax the muscles and relieve the emotions, thus improving the mental state and further relieving the fatigue. In the stratification of fatigue scale, it was found that the patients in this study mainly improved physical fatigue, and whether mental fatigue can be improved by Baduanjin exercise still needs long-term observation. At the same time, in comparison with the control group, the factor of mental fatigue is still statistically significant. It is considered that Baduanjin exercise can promote the whole body blood circulation, increase the oxygen content in the blood, improve the metabolism of the body, and thus improve the oxygen supply and nutrition supply to the brain through deep breathing and gentle stretching movements. At the same time, focusing on the standardization of movements and physical feelings during exercise can help clear up distractions, improve mental concentration, and delay mental fatigue caused by diseases.

4.6. Analysis of Adverse Events of Baduanjin Exercise in This Study

During the intervention, there were 2 cases of adverse reactions to exercise in the hospital, with an incidence rate of 2.3%, including 1 case of weakness of both lower limbs and 1 case of dizziness. Both of them were mild discomfort, which was considered to be related to exercise intensity, body position changes or personal con-

stitution. After the exercise, the Borg subjective fatigue scale was used to evaluate the exercise of patients, and the score of patients was between 13 and 14. Some patients sweat slightly, and no serious adverse events such as tube falling off, sports injury, sweating, palpitation occurred, which suggests the superiority of Baduanjin exercise in safety and is worthy of clinical promotion and application.

During hospitalization, the researchers implemented the exercise intervention according to the ward intervention plan. During the home exercise intervention, the regular evaluation and adjustment of the home exercise plan, the release of Baduanjin video and popular science, the use of WeChat exercise clocking mini program, the use of reward mechanism, etc. To improve patients' exercise compliance. The results of intervention showed that Baduanjin could improve the sleep quality of patients, correct negative emotions and improve the fatigue state of patients. The intervention effect of Baduanjin is obvious, and the movements of Baduanjin are simple and easy to learn, soft, do not rely on sports places, do not need sports equipment, and easy to adhere to, which is very suitable for patients with end-stage renal disease. In future studies, we can consider extending the intervention period and observation time, using objective indicators (actigraphy or polysomnography) to evaluate the improvement of sleep of patients, and formulating a more complete home exercise plan to deeply analyze the effect of Baduanjin on sleep quality of patients. This will help to more comprehensively understand the role of Baduanjin exercise in improving the sleep quality of patients with end-stage renal disease, and provide a more solid scientific basis for its clinical application.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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