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Effect of mental state on sleep quality in patients receiving maintenance hemodialysis

A multiple mediation model of hope and family function

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Abstract

The objective of this study was to investigate the current situation of sleep quality in patients receiving maintenance hemodialysis (MHD), and whether hope and family function play a mediating role between negative emotions and sleep quality. The Athens Insomnia Scale, Hospital Anxiety and Depression Scale, Herth Hope Index and Family Adaptation, Partnership, Growth, Affection and Resolve (APGAR) Index were used to investigate 227 MHD patients. The correlations among study variables were analyzed by Pearson correlation analysis. Structural equation model was used to construct and evaluate the mediation model. The sleep quality score of 227 patients receiving MHD was (7.57 ± 4.74), anxiety score was (4.36 ± 4.02), depression score was (5.91 ± 4.37), hope score was (34.64 ± 7.21), family function score was (6.21 ± 2.90). The negative emotions can directly predict sleep quality ($\beta = 0.17$, $P = .046$), positively predict sleep quality through hope ($\beta = 0.12$, $P = .017$), positively predict sleep quality through family function ($\beta = 0.20$, $P < .001$), and positively predict sleep quality through the chain mediating of hope and family function ($\beta = 0.10$, $P < .001$). The total effect size was 71.19%. It is concluded that negative emotions had a direct impact on the sleep quality of patients receiving MHD, and that improving the levels of family function and hope can help them sleep better.

Abbreviations: CI = confidence interval, H = hypothesis, MHD = maintenance hemodialysis.

Keywords: anxiety, depression, family function, hope, maintenance hemodialysis, sleep quality

1. Introduction

Chronic kidney disease is a growing, public health threat with an estimated global prevalence of 11% to 13%.[1] Chronic kidney disease without treatment will eventually progress to the stage of end-stage renal disease (ESRD). According to 2021 annual data released by the United States Renal Data System, the number of ESRD epidemics has increased almost uniformly and linearly since 2009.[2] The incidence of ESRD in China is increasing at a rate of about 2% per year, much faster than the population growth rate of 1.1% per year.[3] Maintenance hemodialysis (MHD) has become the most common alternative treatment for ESRD. The number of patients with ESRD receiving MHD is also increasing rapidly.[4]

However, MHD treatment can lead to changes in the mind, body, and social function, as a result of alimentary control, lifestyle changes, and strict pharmaceutical administration and treatment regiments.[5] Patients undergoing MHD not only suffer from the disease and financial burden, but also suffer from the complication caused by the MHD treatment itself, which causes a lot of sleep problems in most patients, such as insomnia, restless legs syndrome, etc.[6] Sleep disorders are a common public health problem and are also common among dialysis patients. Research suggests that the average prevalence of sleep disorders in hemodialysis patients is 40% to 80%, and the prevalence of peritoneal dialysis patients is 71%.[7] It has been reported that the decrease of sleep quality can lead to the change of physiological rhythm and the decrease of activity ability of patients receiving MHD, which not only seriously affects their quality of life and dialysis quality, but also increases their mortality.[8] According to the China Sleep Research Report (2022), the average sleep duration of Chinese people in the past 10 years has shrunk from 8.5 hours in 2012 to 7.06 hours in 2021, and only 35% of Chinese people can sleep enough for 8 hours. Sleep deprivation and sleep disorders can reduce patients' overall quality of life.[9] It can trigger a host of complications, including a compromised immune system and

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

We disclosed that this was a secondary study for full transparency. This study is an extended study based on the research results of the research group, and has good reliability. This study is based on the same research database as Wang et al, but the analysis Angle is different, which has certain innovation and research value.

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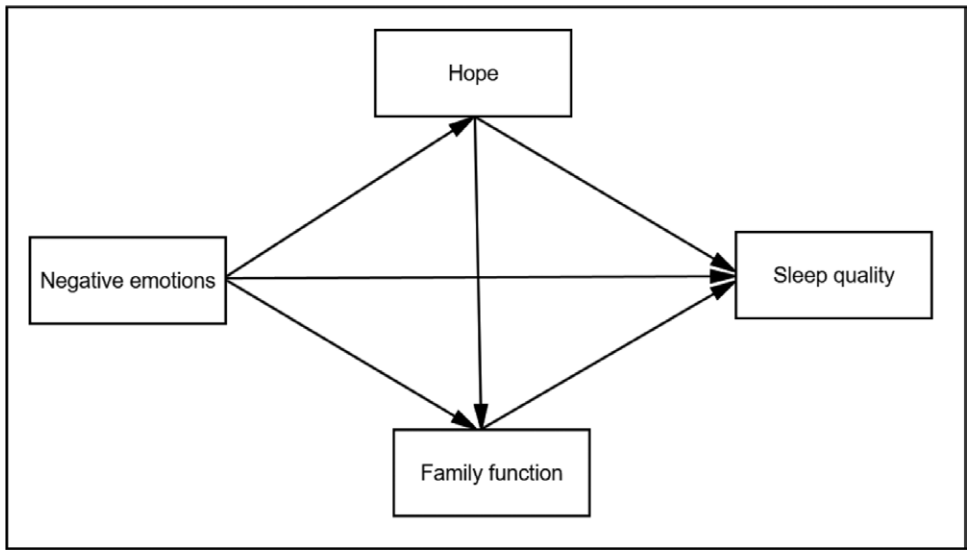

Figure 1. Study hypothesis chart.

the risk of cardiovascular disease, and even increased mortality.[8] Compared with non-dialysis patients, sleep disorders will cause the patient's immunity to decline, endocrine dysfunction, directly affect the effect of hemodialysis, and then accelerate the deterioration of the disease. The inadequate hemodialysis, the patient's body of macromolecular substances can't be removed, will lead to dry skin, itching, further lead to sleep disorders, the formation of a vicious cycle.[10] Adequate and high-quality sleep is 1 of the guarantees of effective hemodialysis treatment, which is conducive to promoting the mental and physical recovery in MHD patients. The improvement of sleep quality can reduce the occurrence of anxiety, depression, hypotension in patients receiving MHD, which can enhancing the immunity and prolong the life cycle of patients receiving MHD.

Anxiety and depression are the most common mental symptoms in patients receiving MHD and are the predominant expressions of negative emotions. Anxiety and depression often occur simultaneously and are mutually reinforcing through a combination of effects.[11] A multicenter study found that the morbidity of anxiety and depression in MHD patients was 29.4% and 35.9%, respectively.[12] Depression and anxiety significantly increase the risk of death in patients receiving MHD and can seriously impair their quality of life.[13] It has been reported that serum brain-derived neurotrophic factor levels are correlated with anxiety and depression.[14] Anxiety and depression can change cognitive function by reducing serum Brain-derived neurotrophic factor levels.[15] Negative emotions can also directly affect sleep quality. It is in line with the internalization of psychological disturbances model of insomnia etiology theory. These unresolved and internalized psychological conflicts (negative emotions) lead to emotional arousal and, in turn, physiological activation during sleep and make individuals unable to sleep.[16] In addition, the occurrence of sleep problems will further aggravate the accumulation of negative emotions in patients.[17] It is reported that the increase of negative emotions in patients will affect the relationship between their family members, and then reduce the levels of family function, while a higher levels of family function can alleviate the mental stress of individuals.[18]

Hope is a multidimensional dynamic life force characterized by a confident yet uncertain expectation of achieving good, which to the hoping person, is realistically possible and personally significant.[19,20] Patients with a high level of hope can not only actively regulate emotions, provide intrinsic motivation for disease treatment, and improve sleep quality,[21] but also reduce symptoms of anxiety and depression.[22] Family function refers to the role that the family plays in human life and social development, including the relationship between family members, intimacy, role allocation, active communication and problem solving.[23] Family is the intimate social support system that can provide patients with realistic care. Family function is reported to be an important source of hope and plays a key role in maintaining hope, while patients with higher levels of hope also receive more family support.[24] Research suggests that good family function is beneficial to the improvement of patients' sleep quality.[24]

Based on the above analysis, 4 research hypotheses were proposed, and structural equation model was used to construct and evaluate a multiple mediating effect model. This study will provide nursing team with new intervention paths to improve the sleep quality of patients receiving MHD. Patients maintain a positive mental state through positive coping behaviors, thus having higher sleep quality, recovering faster, and returning to work and life earlier. This results in both physical and mental improvements for patients.

2. Hypotheses

Based on previous research, 4 hypotheses and the study hypothesis chart shown in Figure 1 are proposed:

Hypotheses 1: Low negative emotions predict better sleep quality.

Hypotheses 2: Hope mediates the relationship between negative emotions and sleep quality.

Hypotheses 3: Family function mediates the relationship between negative emotions and sleep quality.

Hypotheses 4: Hope and family function plays a chain mediating effect in the relationship between negative emotions and sleep quality.

3. Methods

3.1. Design

This study was written in accordance with the STROBE statement. From June to September 2021, 227 convenience samples were recruited from the Hemodialysis Centers of 2 tertiary hospitals in Wuhan, Hubei Province, China. Inclusion criteria: receiving MHD for more than 3 months; over 18 years old;

Table 1

Sample characteristics (n = 227).

Variables	Categories	N (%)
Gender	Male	129 (56.80)
	Female	98 (43.20)
Age	<45	72 (31.70)
	45 to 60	74 (32.60)
	>60	81 (35.70)
Education	Primary	63 (27.80)
	Secondary	99 (43.60)
	Higher	65 (28.60)
Marital status	Married	177 (78.00)
	Single	38 (16.70)
	Divorced/widowed	12 (5.30)
Duration of dialysis (yr)	<1	55 (24.20)
	1 to 3	56 (24.70)
	>3	116 (51.10)
Type of vascular access	Autogenous arteriovenous fistula	137 (60.40)
	Artificial blood vessels	16 (7.00)
	Central venous catheter	74 (32.60)
Diabetes	Yes	91 (40.10)
	No	136 (59.90)

voluntary participation. Exclusion criteria: suffering from acute/critical illness; mental illness (i.e., DSM diagnosis); participating in other clinical trials. A total of 235 MHD patients agreed to participate in the study, and 8 questionnaires were excluded due to obvious logic errors or completion time of <180 seconds, so 227 questionnaires were included in the analysis. This study was approved by the Renmin hospital of Wuhan University ethics committee (number WDRY2022-K192). All participants signed written informed consent.

3.2. Sample

It has been reported that the sample size of structural equation model should be 10 to 15 times the observed variables (these include anxiety, depression, factors 1, 2, and 3 of hope, adaptation, partnership, growth, affection, resolve, sleep quality).[25] There were 11 observed variables in this study. Assuming a sample loss of 30%, the sample size should be 143 to 215, that is, 227 samples met the criteria.

3.3. Measurement

3.3.1. Athens insomnia scale:. The scale is a self-assessment psychometric instrument designed for quantifying sleep difficulty based on the ICD-10 criteria. [26] Using a 4-point Likert scale, a total of 8 items, the higher the score indicates the worse the quality of sleep. The internal consistency reliability was 0.890.

3.3.2. Hospital anxiety and depression scale:. The scale is divided into 2 parts: an assessment containing anxiety and depression. [27] Using a 4-point Likert scale, which includes 14 entries, higher cumulative scores indicate more severe symptoms of anxiety and depression. The internal consistency reliability was 0.894.[28]

3.3.3. Herth hope index:. The scale includes 3 factors: temporality and future, positive readiness and expectancy, and interconnectedness. [20] Using Likert 4-component scale, a total of 12 items, the higher the cumulative score, indicating the higher the levels of hope. The internal consistency reliability was 0.870.[29]

3.3.4. Family APGAR index:. The acronym APGAR[30] has been applied to the functional components of Adaptation, Partnership, Growth, Affection, and Resolve. Using a 3-point Likert scale, a total of 5 items, a higher score indicates better family functioning. The internal consistency reliability was 0.894.[31]

3.4. Data collection

We contacted the nursing departments of the 2 tertiary hospitals to brief them on the purpose and process of our study and to qualify participants. The survey was conducted between 1 hour after dialysis began and 1 hour before dialysis ended, when the circulation was stable during this period. The questionnaire was completed online. Participants signed written informed consent. The criteria for identifying invalid questionnaires are obvious logical errors and <180 seconds of filling time.

3.5. Data analysis

All analyses were performed using SPSS version 26.0 (Chicago) and AMOS version 24.0 (Chicago). The results show that the data in this study were in line with normal distribution. The correlations among study variables were analyzed by Pearson correlation analysis. The mediating effect was examined by Bias-corrected bootstrapping method.[32] The mediation model is constructed by structural equation model.[33–35] A P value < 0.05 was considered statistically significant.

4. Results

4.1. Sample characteristics

The average age was 54.15 (standard deviation = 15.12; range from 18 to 90) years. Most participants were male (56.80%). Most participants received dialysis for more than 1 year (75.80%). Additional information on sample characteristics is provided in Table 1.

4.2. Sleep quality, anxiety, depression, hope, family function scores

Table 2 shows the means and standard deviations among the study variables. The results of this study indicate that there were no sleep disorders in 35 cases, suspected insomnia in 79 cases and insomnia in 113 cases. The prevalence of anxiety

was 35.24% (80/227). The prevalence of depression was 22.03% (50/227). Hope and family function are at a moderate level.

4.3. Correlations of anxiety, depression, hope, family function, and sleep quality

There was positive correlation between sleep quality and anxiety ($r = 0.474$, $P < .01$), positive correlation between sleep quality and depression ($r = 0.472$, $P < .01$), negative correlation between sleep quality and hope ($r = -0.585$, $P < .01$), and negative correlation between sleep quality and family function ($r = -0.652$, $P < .01$). There was positive correlation between family function and hope ($r = 0.467$, $P < .01$). See Table 3 for more information.

4.4. Test of common method variance biases

Test of common method variance bias is required when using self-reported data. There were 10 variables with characteristic roots >1. The first factor could only explain 26.84% of the key standards, <40%,[36,37] indicating that there were no severe common method biases in this study.

4.5. Mediating effect analysis

We utilized structural equation model to design a mediation model with negative emotions as the independent variable, hope and family function as the mediating variables, and sleep quality as the dependent variable. Negative emotions, hope and family function were latent variables, while sleep quality was manifest variables. Anxiety and depression as response indicators of negative emotions. The results show that the initial model fits poorly. Therefore, we use the maximum likelihood method to fit the path coefficient of the model, and modify the model by modified index.[32] Finally, a modified model with good fitting is obtained, and the fitting situation is shown in Table 4.

Figure 2 shows a model with standardized path coefficients. Negative emotions positively predicted sleep quality ($\beta = 0.17$, $P = .046$). *Hypotheses 1* was supported. Negative emotions negatively predicted hope ($\beta = -0.47$, $P = .001$) and family function ($\beta = -0.41$, $P = .001$). Hope positively predicted family function ($\beta = 0.42$, $P = .001$), and negatively predicted sleep quality ($\beta = -0.25$, $P = .001$). Family function negatively predicted sleep quality ($\beta = -0.48$, $P = .001$). All pathways reached a statistically significant level ($P < .05$).

Indirect effect (mediating effect) was identified as significant when the 95% bootstrap CI of an effect did not include 0.[32] The results showed that the upper and lower bounds of the 95% CI (0.01–0.32) of the direct effect of negative emotions on sleep quality didn't include 0, indicating that the direct effect was significant, again supporting *Hypotheses 1*. Therefore, the types of mediation in this study were partial mediation.[32] The upper and lower bounds of the 95% CI (0.03–0.21) of the indirect effect 1 between hope on negative emotions and sleep quality didn't include 0, indicating that the indirect effect 1 was significant. These results support *Hypotheses 2*. The upper and lower bounds of the 95% CI (0.12–0.32) of the indirect effect 2 between family function on negative emotions and sleep quality didn't include 0, indicating that the indirect effect 2 was significant. These results support *Hypotheses 3*. The upper and lower bounds of the 95% CI (0.04–0.20) of the indirect effect 3 (chain mediating effect) between hope and family function on negative emotions and sleep quality didn't include 0, indicating that the indirect effect 3 was significant. These results support *Hypotheses 4*. The total effect size was 71.19% (0.42/0.59). Table 5 shows the mediation effects decomposition.

5. Discussion

The results will provide nurses with new intervention paths to improve the sleep quality of patients receiving MHD. The results could also raise our awareness of sleep quality, hope, family function, anxiety and depression, and provide a reference for improving the sleep quality of this population. Therefore, this study is valuable.

5.1. Current status of sleep quality, anxiety, depression, hope and family function

Current status of sleep quality in MHD patients. The patients receiving MHD with suspected insomnia and insomnia accounted for 81.01%, indicating that sleep disorders are relatively serious. The reasons may include the following 4 points: First, sample characteristics showed that 91 MHD patients were complicated with diabetes. It has been reported that diabetes can induce the damage of many organs in the body, hinder the transmission of neurotransmitters in the central nervous system, lead to autonomic nervous disorder, and then cause various sleep disorders.[38]

Table 2

Mean and standard deviations among the variables (n = 227).

Variables	Mean	SD
Sleep quality	7.57	4.74
Anxiety	4.36	4.02
Depression	5.91	4.37
Hope	34.64	7.21
Temporality and future	11.73	2.45
Positive readiness and expectancy	11.55	2.89
Interconnectedness	11.37	2.66
Family function	6.21	2.90
Adaptation	1.33	0.76
Partnership	1.17	0.79
Growth	1.15	0.81
Affection	1.12	0.78
Resolve	1.28	0.84

SD = standard deviation.

Table 3

Correlations between observed variables (n = 227).

Variables	1	2	3	4	5
1. Sleep quality	1.000				
2. Anxiety	0.474*	1.000			
3. Depression	0.472*	0.685*	1.000		
4. Hope	−0.585*	−0.314*	−0.432*	1.000	
5. Family function	−0.652*	−0.475*	−0.443*	0.467*	1.000

*$P < .01$.

Second, the mean age of participants was 54.15 years. It has been reported that age was a risk factor for sleep disorders.[39] Third, patients receiving MHD generally have low immunity. During the period of regular epidemic prevention and control, patients still have to travel to and from hospitals frequently, which increases the risk of viral infection and psychological burden, and further aggravates sleep disorders. Fourth, 75.80% of the participants in this study received dialysis treatment for more than 1 year. It has been reported that the sleep quality of patients is worse with longer duration of dialysis treatment. This may be because frequent hemodialysis treatment has completely changed the patient's original lifestyle, and the mind and body impact on the patient has gradually become prominent with the increase of dialysis time, thus reducing the sleep quality.

The prevalence of anxiety and depression in the study population was similar to that in the prevalence of this population.[13] According to the literature review, dialysis treatment may lead to mental weakness in patients, which in turn affects their own mental health.[3] The hypothesis of "kidney-brain axis" neurodegeneration suggests that MHD patients may have varying degrees of cognition impairment due to various reasons.[40] Therefore, MHD patients must be treated with regular hemodialysis to remove toxins and improve anemia, thereby reducing the incidence of cognition impairment.

Table 4

The fitting situation of modified model.

Categories	χ^2/df	GFI	AGFI	CFI	TLI	RMSEA
Standard	<3.00[33]	>0.90[35]	>0.90[33]	>0.90[35]	>0.90[35]	(90% CI)[34]
Modified model	1.96	0.94	0.91	0.97	0.96	0.043–0.087 0.065

AGFI = adjusted goodness-of-fit index, CFI = comparative fit index, CI = confidence interval, GFI = goodness-of-fit index, RMSEA = root mean square error of approximation, TLI = Tucker-lewis index, χ^2/df = ratio of chi-square to degrees of freedom.

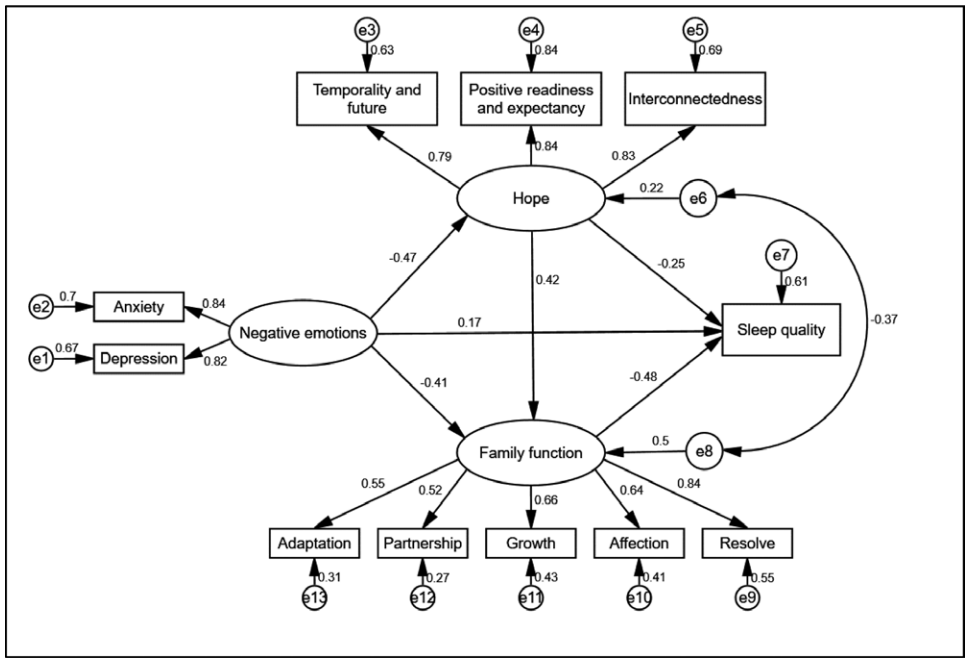

Figure 2. The mediating effect of hope and family function in the relationship between mental state and sleep quality in maintenance hemodialysis patients (standard coefficients).

Table 5

Total, direct, total indirect and specific indirect effects.

Structural paths	Standard coefficients (effect value/β)	Effect size	95% CI		*P*
			Lower	Upper	
Total effect	0.59	100.00%	0.46	0.67	<.001
Direct effect	0.17	28.81%	0.01	0.32	.046
Total indirect effect	0.42	71.19%	0.32	0.54	<.001
Indirect effect 1	0.12	20.34%	0.03	0.21	.017
Indirect effect 2	0.20	33.90%	0.12	0.32	<.001
Indirect effect 3	0.10	16.95%	0.04	0.20	<.001

Indirect effect 1: negative emotions → hope → sleep quality; indirect effect 2: negative emotions →family function → sleep quality; indirect effect 3: negative emotions → hope → family function → sleep quality. CI = confidence interval.

The levels of hope for MHD patients in this study was moderate, which could be related to a number of reasons. Dialysis time of the participants selected in this study was more than 3 months, their physical health was stable, and they could adapt to the hemodialysis treatment psychologically, according to the descriptive analysis. However, due to lifelong dialysis treatment and serious complications, patients may develop psychological fears, resulting in low levels of hope.[41]

This study found that MHD patients had moderate levels of family function, which is consistent with previous findings.[18] Family as the closest social support system. Family caregivers experience more and more positive feelings in the process of care,[42] thus giving patients more care and spiritual sustenance. Hope and confidence for patients in life are established and they can actively deal with the negative effects of the disease. Patients receiving MHD have more serious anxiety and depression, and pinned their hopes on dialysis treatment, resulting in reduced adaptation. Meanwhile, patients with a long course of disease or family busy work and other reasons, resulting in reduced resolve. Therefore, this could be the reason for the moderate level of family function.

5.2. Correlations of sleep quality, anxiety, depression, hope and family function

The study results show that there was a significant negative correlation between negative emotions and sleep quality, which was basically consistent with previous literature evidence.[43] Negative emotions may interfere with rapid eye movement sleep by disrupting the regulation of neurotransmitters associated with hypoxemia or sleep apnea hypopnea syndrome, thereby affecting sleep quality.

The results showed that hope scores were negatively correlated with sleep quality scores. It is verified that hope plays a crucial role in improving sleep quality. Hope can promote patients' positive cognition of the disease, guide the positive evaluation of the significance of the disease, build up the confidence and courage to deal with the disease, and thus improve the quality of sleep.[41] In previous research, hope, as positive psychological resources, enable older adults to be resistant to the negative impacts of stress from psychological and physiological aspects, which have a positive influence on sleep in older adults. Hope levels are considered "the only cheap and universal cure "for improving sleep quality.[44]

The study results show that family function scores were negatively correlated with sleep quality scores. That is, patients with better family function have better sleep quality, which is similar to the study results of Qiu and Wen.[45] Family function is a protective factor to improve patients' sleep quality, and the support of family members can improve patients' sleep quality by alleviating their perceived stress. This is also consistent with the theory of sleep quality in Traditional Chinese medicine. The patient's negative emotions are relieved, the physiological function of viscera is gradually stable, blood unobstructed, Yin and Yang balance, consciousness and peace, thus improving insomnia, less sleep and other Traditional Chinese medicine categories.

The study results show that patients with good family function are conducive to the improvement and maintenance of their hope level. Hope is an internal resource of patients, and family is an important source of hope. Patients with better family function received more caring and spiritual backing from family members, and their mental state and belief were better.[46] It also helps to relieve and improve patients' negative emotions.

5.3. Multiple mediating effect

The study results show that the total indirect effect is much higher than the direct effect. This means that the result is of great significance in explaining the effects of negative emotions on sleep quality. Patients receiving MHD bear the high burden of economy and life and the mental weakness brought by treatment itself, which is easy to produce negative emotions.[5] Negative emotions can affect hope levels by causing patients to lose confidence in treatment and recovery from illness. Patients with low hope will lose their expectations for life and the future and tend to adopt negative coping strategies, such as refusing to share their true thoughts with their family members, and gradually become withdrawn, which affects family function.[46] The patient's closest social support system (family) is unable to relieve patient's perceived stress, resulting in increased sleep disorders. This suggests that negative emotions can affect the sleep quality of MHD patients through the pathways of hope and family function. Thus, the less negative emotions patients receiving MHD have, the higher their levels of hope, which improves family function and ultimately sleep quality. This suggest that nursing staff and family caregivers should pay attention to guiding patients to establish positive cognitive concepts, reduce negative emotional influence, improve their hope levels of returning to family and society, and timely evaluate family function and pay attention to the important role and function of family, so as to improve sleep quality and prolong the dialysis duration of patients.

5.4. Implications for clinical practice

Our findings suggest that negative emotions can affect sleep quality in MHD patients through multiple pathways. Based on this result, we have made suggestions to improve patients' sleep quality. First, to improve negative emotions in MHD patients. The nursing team should strengthen the psychological counseling of patients, take relaxation techniques, mindfulness therapy, 5 elements of music therapy, appropriate exercise and other ways to relieve their negative emotions.[47–49] Second, to improve family function in MHD patients. The nursing team conducts health education workshops to guide family caregivers to establish supportive relationships with patients and help family caregivers pay attention to the physical and mental health of patients.[23] Third, to improve the levels of hope in MHD patients. Nursing staff and family caregivers work together to help patients establish appropriate self-management methods, promote improved positive coping styles,[41] and adopt effective symptom management measures to increase hope levels.

5.5. Limitations

There are many factors that affect the sleep quality of MHD patients, but this study only discusses the influence paths of negative emotions, hope and family function. Future research should incorporate sample characteristics and serum biochemical indicators into structural equation model for analysis and discussion.

6. Conclusion

The multiple mediating effect model constructed and evaluated in this study can provide new intervention paths for nursing staff to improve sleep quality in patients receiving MHD. Patients maintain a positive mental state through positive coping behaviors, thus having higher sleep quality, recovering faster, and returning to work and life earlier.

Author contributions

Conceptualization: Qiang Li, Fuhai Xia, Rui Chen.
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Writing – original draft: Qiang Li, Fuhai Xia.
Writing – review & editing: Qiang Li, Fuhai Xia.

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