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## Effects of health education based on self-determination theory on hemodialysis knowledge and self-management in maintenance hemodialysis patients

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The purpose of this study was to examine the impact of health education based on self-determination theory on hemodialysis knowledge, self-management, interdialytic weight gain and anxiety and depression in maintenance hemodialysis patients. The study is a quasi-randomized control trial, a total of 86 maintenance hemodialysis patients who met the inclusion criteria were included equally in the intervention and control groups. The control group received routine care, and the intervention group received health education based on self-determination theory. Three months after the intervention, the intervention effects were evaluated using the Hemodialysis Related Knowledge Scale, Self-Management Behavior Scale, Interdialytic Weight Gain, and Hospital Anxiety and Depression Scale. Three months after the intervention, the hemodialysis knowledge scores of the intervention group was higher than that of the control group and baseline; the scores of the intervention group in problem solving, partnership, emotional processing, executive self-care dimensions and the total self-management scores were higher than that of the control group and baseline; the interdialytic weight gain of the intervention group was lower than that of the control group and baseline; the anxiety and depression scores of the intervention group were lower than that of the control group and baseline. All these differences were statistically significant ( $P < 0.05$ ). Health education based on self-determination theory can improve the hemodialysis knowledge level and self-management ability of maintenance hemodialysis patients, and reduce the interdialytic weight gain and anxiety and depression level.

**Keywords** Maintenance hemodialysis, Self-management, Self-determination theory, Quasi-randomized control trial

### Abbreviations

CKD	Chronic kidney disease
MHD	Maintenance Hemodialysis
GFR	Glomerular filtration rate
ESRD	End-stage Renal Disease
SDT	Self-Determination theory
IDWG	Interdialytic Weight Gain
HADS	Anxiety and Depression Scale

Chronic kidney disease (CKD) is an abnormality of renal function caused by a variety of reasons, such as genetic or environmental, with proteinuria or glomerular filtration rate (GFR)  $< 60$  ml/min /  $1.73\text{m}^2 > 3$  months, according to the GFR, it can be divided into stages 1 to 5, and stage 5 is called End-stage renal disease (ESRD)<sup>1</sup>. CKD affects over 850 million people globally<sup>2</sup>, the prevalence of CKD in China is about 10.8%<sup>3</sup>, affecting more than 120 million people. The prevalence of adult CKD is projected to increase 16.7% by 2030<sup>4</sup>. The United States is expected to have more than 1 million people of end-stage renal disease by 2030<sup>5</sup>, the cost to Medicare

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already exceeding \$30 billion/year<sup>5</sup>. The total number of hemodialysis patients in China has reached more than 700,000 people, and the trend is rising year by year, and the overall mortality rate of hemodialysis patients is 14.4%<sup>6</sup>. CKD, with its poor prognosis and high medical costs, is a major public health problem worldwide and a significant burden on health care systems<sup>7</sup>. Although kidney transplantation is the first choice for ESRD patients, kidney transplantation is currently faced with the major problems of kidney scarcity and high treatment cost in the world. Maintenance hemodialysis (MHD), as the main treatment for ESRD, has been widely used in clinical practice<sup>8</sup>.

Starting with a CKD diagnosis, patients face profound changes, including coping with the diagnosis, the future outlook of the effects, physical symptoms, and social impact<sup>9</sup>. Patients receiving MHD are characterized by long disease cycles, frequent and regular dialysis, and more dialysis-related complications. Anxiety and depression are common negative emotions in MHD patients<sup>10</sup>. Reducing the level of anxiety and depression may be an important factor to improve the compliance and self-management ability of MHD patients. Self-management is a set of behaviors that patients adopt to enhance their organism's health and improve health outcomes, improving self-management of hemodialysis patients can reduce their complication rates<sup>11</sup>, and slows disease progression and reduces the risk of adverse health outcomes, improving quality of life and survival in the near and long term<sup>12</sup>. According to literature reports<sup>13</sup>, about 57.4% of hemodialysis patients had low levels of self-management ability. Health education can improve patients' self-management ability. However, conventional health education methods, such as the distribution of promotional brochures or group instruction, have certain limitations. These include complex guidance information that may confuse patients, a lack of emphasis on patients' active participation, and consequently, suboptimal outcomes of health education. In practice, support is provided according to the individual needs of the patient, by providing advice to help the patient change behavior, and to help the patient continuously learn and maintain complex self-management skills<sup>14</sup>.

As medical paradigms have gradually changed in recent years, the actual outcomes of chronic care have largely depended on the level of patient engagement and the motivation of patients to adopt and use these interventions over time. The Self-Determination theory (SDT) is an empirically based theory of motivation proposed by Ryan and Deci<sup>15</sup>. SDT suggests that maintaining healthy behaviors over time requires patients to internalize value, allowing patients to experience self-determination, and only when patients' behaviors tend to be self-determined can they feel the enhanced motivation and improve their self-management ability<sup>16,17</sup>. Lim<sup>18</sup> used a combination of personal counselling and a text message service providing autonomy support to meet the three basic psychological needs of autonomy, competence, and relationships, which can be effective in promoting workers to engage in smoking cessation. The outcome of an intervention based on SDT has shown that provide autonomy support to patients with rheumatoid arthritis, which resulted in positive changes in autonomy motivation, with patients being more motivated to carry out their exercise programs and improving their subjective vitality<sup>19</sup>. Regarding the significant effect of health education based on SDT on patients' autonomous motivation and healthy behaviors and the urgent need of MHD patients to improve these qualities, we investigated the effects of health education based on self-determination theory on hemodialysis knowledge, self-management, interdialytic weight gain and anxiety and depression in MHD patients.

## Methods

### Participants

The research was a quasi-randomized control trial. Eighty six MHD patients admitted to a tertiary hospital in Deyang City from June to December 2023 were selected according to the inclusion criteria: (1) age  $\geq 18$  years, meeting the diagnostic criteria of end-stage renal disease in K/DOQI guidelines<sup>20</sup>; (2) hemodialysis treatment time  $\geq 3$  months, 3 times/week, 4 h/session; (3) signed informed consent. Exclusion criteria were: (1) unstable condition or combined with other serious diseases; (2) history of mental illness; (3) a possibility of a kidney transplant in the near future.

**Sample size:** the sample size was calculated using the formula:  $n1 = n2 = 2[(Z\alpha + Z\beta)\sigma/\delta]^2$ , Taking bilateral  $\alpha = 0.05$ ,  $\beta = 0.1$ , checking the table, we get  $Z\alpha = 1.960$ ,  $Z\beta = 1.282$ , according to the literature research results<sup>21</sup>, based on the calculation of MHD patients' self-management scores,  $\delta = 8.7$ ,  $\sigma = 11.2$ , it comes out that  $n1 = n2 = 35$ , and considering 10% to 20% of lost follow-up, therefore, the actual sample size of 86 MHD patients was calculated.

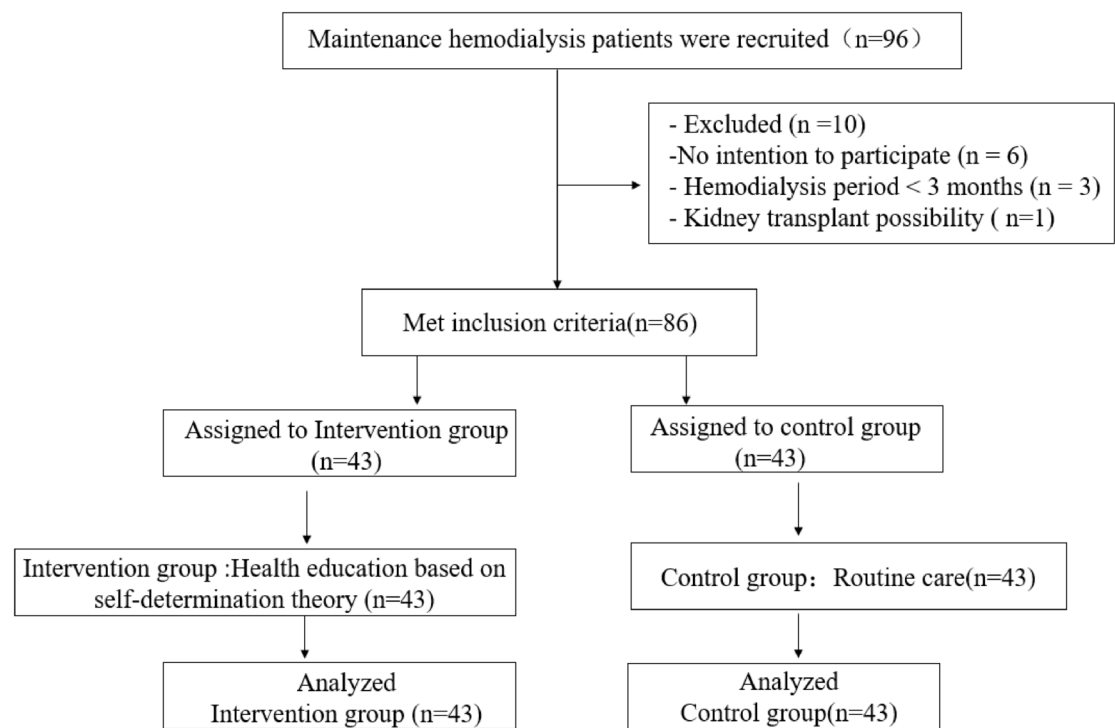
Hemodialysis nurses invited patients who met the inclusion criteria for this study after being fully informed of the aims and procedures. Forty three patients who were dialyzed on Monday, Wednesday and Friday were in group A. Forty three patients who were dialyzed on Tuesday, Thursday and Saturday were in group B. Groups A and B were randomly divided into the intervention group and the control group by using the method of flipping a coin, and all of the 86 people completed the three months of the intervention study. Figure 1 shows the Flowchart of the study.

### Setting

The control group received routine care, including health education manual, centralized education, bedside individualized guidance and telephone follow-up during dialysis. Concrete content included hemodialysis knowledge, exercise, diet, fluid intake, vascular access maintenance, complication prevention and medication knowledge. Centralized education was carried out in the health education room of the department, the individualized guidance session was conducted during hemodialysis treatment in the hemodialysis center.

### Intervention procedure

The intervention group received health education based on self-determination theory. (1) Establishment of intervention team: a nurse manager, eight hemodialysis specialist nurses, two clinicians, a dietician, a psychologist, and the members of the intervention team receive homogeneous training. (2) The doctors conducted collective



**Fig. 1.** Flowchart of the study.

health education for the patients in the intervention group in the form of PPT (once a month, 45 min/time). The specialist nurses evaluated the health education content received by the patients through the way of scenario simulation, and gave small gifts to the excellent evaluation. (3) Individual guided interviews (four times, 20 min/time): ① Autonomy needs: understanding the patient's disease process, guiding the patient to express positive or negative emotions and acknowledge the patient's point of view; listening to the patient's experience of self-management, guiding the patient to draw the weight gain curve in the last 2 weeks; encouraging the patient to talk about the important things in his/her life and hobbies, etc.; the dietician take into consideration the patient's financial ability and dietary preferences, etc., working with the patient to develop a home diet plan list. The doctor in charge develops an individualized exercise program with the patient according to the patient's exercise preferences and habits. ② Competence needs: guiding patients to formulate practical and progressive goals and plans, exploring possible obstacles in the implementation process, and assisting patients in finding solutions; using food models as teaching aids to guide patients to master the estimation of food water content, as well as cooking to reduce phosphorus and soaking to reduce potassium, and other interventions such as micro-telephone groups, one-on-one telephone follow-ups, and self-monitoring diaries to ensure the sustainability of the implementation. Sustainability. ③ Relationship needs: encouraging patients to express their own feelings, giving psychological support and channel bad emotions; encouraging patients to communicate with bedside patients during the dialysis process; advocating family accompaniment, and it is best for family members to participate in and supervise the whole process of behavioral change, so as to increase the patient's sense of family belonging needs.

### Pre-specified primary and secondary objectives (hypotheses)

#### Primary objectives (hypotheses)

Explain program's efficacy (Improve the hemodialysis knowledge level and self-management behavior of MHD patients). Hemodialysis Related Knowledge, measured using the Hemodialysis Related Knowledge Scale. Self-Management Behavior, measured using the Self-Management Behavior Scale.

#### Secondary objectives (hypotheses)

Decrease adherence difficulties (interdialytic weight gain) and mental difficulties (anxiety and depression). Interdialytic Weight Gain (IDWG), measured using the average value from the 3 most recent dialysis sessions. Anxiety and Depression, measured using the Hospital Anxiety and Depression Scale.

Examine change in knowledge /self-management behavior as a mediator of the effect of a health education program on mental health and adherence difficulties.

### Measures

#### Hemodialysis related knowledge scale

The Hemodialysis Related Knowledge Scale developed by Curtin<sup>22</sup>, the scale was translated, modified and culturally adjusted by scholar Li Hui to form a Chinese version of the hemodialysis related knowledge scale<sup>23</sup>.

The scale included diet, medication, dialysis treatment, rehabilitation nursing and other subject categories, with a total of 24 items. Correct answers were counted as 1 point, and incorrect answers or ignorance was counted as 0 points. The score range was 0–24 points. The Cronbach’s alpha coefficient was 0.701.

*Self-management behavior scale*

The Self-Management Behavior Scale developed by Li Hui and was used to evaluate the level of self-management behavior in hemodialysis patients<sup>24</sup>, including four dimensions of partnership (4 items), executive self-care (7 items), problem solving (5 items) and emotional processing (4 items), with a total of 20 items. The scale adopts Likert 4 scoring method, assigning 1–4 points, ranging from 20 to 80 points. The higher the total score, the better the self-management behavior of MHD patients. The Cronbach’s alpha coefficient was 0.862.

*Interdialytic weight gain*

Interdialytic Weight Gain (averaged from the 3 most recent dialysis sessions) was calculated as the average change in weight between dialysis sessions<sup>25</sup>.

*Hospital anxiety and depression scale*

Hospital Anxiety and Depression Scale (HADS) was developed by Zigmond and Snaith in 1983<sup>26</sup>, including two subscales of anxiety (Anxiety-Symptoms, HADS-A) and depression (Depressive-Symptoms, HADS-D), each with 7 items, and a total of 14 items in the total scale. Likert 4 scores were used for this scale, ranging from 0 to 3, and the total score ranged from 0 to 42. The higher the score, the more serious the degree of anxiety and depression. The Cronbach’s alpha coefficient was 0.890 for the total scale and 0.820 and 0.807 for the anxiety and depression subscales.

**Data analysis**

SPSS version 26.0 (IBM Corporation, Armonk, New York, USA) were used to analyze the data, Count data were expressed as frequencies and percentages. Mean and standard deviation ( $\bar{x} \pm s$ ) were used to describe continuous variables. Chi-square test ( $\chi^2$ ) was used for comparison between groups. 2-Independent-samples *t* test was used to compare the two groups before and after intervention. All statistical tests were conducted by two-sided tests, with differences considered statistically significant at  $P < 0.05$ .

**Ethical consideration**

The study followed the principles of the Declaration of Helsinki, informed consent was obtained from the patients and their families before the start of the intervention, and the project was reviewed and approved by the Ethics Committee of Deyang People’s Hospital (Ethical number: 2022-04-030-K01). Health education measures based on SDT were also conducted in the control group at the end of the study.

**Results**

**Participants characteristics**

A total of 86 patients participated in the study. The demographic characteristics of the participants are detailed in Table 1.

Variables	Intervention group (n = 43)	Control group (n = 43)	$\chi^2/t$	<i>P</i>
Age	60.25 ± 14.78	59.44 ± 14.38	0.259	0.796
Gender			1.720	0.190
Male	28 (65.1%)	15 (34.9%)		
Female	22 (51.2%)	21 (48.8%)		
Education			1.194	0.567
Junior high school and below	26 (60.5%)	21 (48.8%)		
High school and technical secondary school	12 (27.9%)	16 (37.2%)		
College or above	5 (11.6%)	6 (14.0%)		
Marital status			0.506	0.873
Unmarried	6 (14.0%)	4 (9.3%)		
Married	32(74.4%)	33 (76.7%)		
Divorced or widowhood	5(11.6%)	6 (14.0%)		
Monthly per capita family income			2.782	0.426
< 1000	7 (16.3%)	5 (11.6%)		
1000–3000	12 (27.9%)	7 (16.3%)		
3000–5000	10 (23.3%)	15 (34.9%)		
> 5000	14 (32.6%)	16 (37.2%)		

**Table 1.** Participants characteristics.

Variables	n	Timing of comparison	intervention group	Control group	t	P
Hemodialysis related knowledge	43	Baseline	14.33 ± 2.93	14.58 ± 2.04	-0.470	0.639
	43	After intervention	17.12 ± 2.16	15.65 ± 1.99	3.272	0.002

**Table 2.** Comparison of hemodialysis related knowledge scores between the two groups before and after intervention ( $\bar{x} \pm s$ , scores).

Timing of comparison	Group	n	Partnership	Problem solving	Emotional processing	Executive self-care	Total score
Baseline	Intervention group	43	9.12 ± 1.48	11.86 ± 1.71	7.84 ± 2.15	17.02 ± 2.74	45.84 ± 5.72
	Control group	43	9.58 ± 1.82	11.60 ± 1.75	7.67 ± 1.95	17.23 ± 2.47	46.09 ± 4.82
	t		-1.301	0.686	0.368	-0.372	-0.224
	P		0.197	0.495	0.714	0.711	0.823
After intervention	Intervention group	43	11.74 ± 1.56	13.44 ± 1.35	9.37 ± 1.25	20.23 ± 2.10	54.79 ± 4.34
	Control group	43	10.39 ± 1.37	12.33 ± 1.41	8.47 ± 1.52	18.42 ± 2.34	49.60 ± 4.05
	t		4.267	3.750	3.021	3.779	5.726
	P		<0.001	<0.001	<0.001	<0.001	<0.001

**Table 3.** Comparison of self-management behavior scores between the two groups before and after intervention ( $\bar{x} \pm s$ , scores).

Variables	n	Timing of comparison	intervention group	Control group	t	P
IDWG	43	Baseline	2.49 ± 0.36	2.35 ± 0.49	1.468	0.146
	43	After intervention	1.66 ± 0.54	1.93 ± 0.57	-2.238	0.028

**Table 4.** Comparison of IDWG between the two groups before and after intervention ( $\bar{x} \pm s$ ).

### Comparison of hemodialysis related knowledge scores between the two groups before and after intervention

After 3 months of intervention, the hemodialysis related knowledge scores of the intervention group was not only higher than that of the control group, but also higher than that of the baseline. The difference was statistically significant ( $P < 0.05$ ). Table 2 shows the comparison of hemodialysis related knowledge scores between the two groups before and after intervention.

### Comparison of self-management behavior scores between the two groups before and after intervention

After 3 months of intervention, the partnership, problem solving, emotion handling, executive self-care dimensions and total self-management scores of the intervention group were higher than those of the control group and baseline, and the difference was statistically significant ( $P < 0.05$ ). Table 3 shows the comparison of self-management ability between the two groups before and after the intervention.

### Comparison of IDWG between the two groups before and after intervention

After 3 months of intervention, the IDWG was lower in the intervention group than in the control group and baseline, these differences were statistically significant ( $P < 0.05$ ). Table 4 shows the comparison of IDWG between the two groups before and after the intervention.

### Comparison of anxiety and depression scores between the two groups before and after intervention

After 3 months of intervention, the intervention group was lower than the control group and baseline in anxiety, depression and total scores, these differences were statistically significant ( $P < 0.05$ ). Table 5 shows the comparison of anxiety and depression scores between the two groups before and after intervention.

## Discussion

The results of this study showed that there was no statistical difference in the score of hemodialysis related knowledge between the two groups before intervention. After three months of intervention, the score of hemodialysis related knowledge in the intervention group was  $17.12 \pm 2.16$ , which was higher than that in the control group, and the difference was statistically significant ( $P < 0.05$ ). Hemodialysis is an invasive, complex and time-consuming treatment, with lifestyle and dietary limitations and many serious complications<sup>27</sup>. Disease factors and lack of knowledge are common factors of malnutrition in hemodialysis patients<sup>28,29</sup>, and patients can better manage their daily behaviors only if they have the relevant knowledge, so mastering dialysis-related knowledge is the most basic and extremely important part. Routine health education used in clinical practice

Timing of comparison	Group	n	Anxiety	Depression	Total score
Baseline	Intervention group	43	8.42 ± 2.96	8.07 ± 2.22	16.49 ± 4.67
	Control group	43	8.28 ± 3.04	8.30 ± 2.58	16.58 ± 5.00
	<i>t</i>		0.216	− 0.447	− 0.089
	<i>P</i>		0.830	0.656	0.929
After intervention	Intervention group	43	6.42 ± 2.98	5.88 ± 2.21	12.30 ± 4.69
	Control group	43	7.86 ± 2.41	7.67 ± 2.10	15.53 ± 3.95
	<i>t</i>		− 2.466	− 3.844	− 3.454
	<i>P</i>		0.016	< 0.001	0.001

**Table 5.** Comparison of anxiety and depression scores between the two groups before and after intervention ( $\bar{x} \pm s$ ).

can also help hemodialysis patients to improve their knowledge level, while health education based on SDT, patients' knowledge level improvement is more significant, which may be due to the routine care adopted by the medical staff to explain the routine mission focused on theoretical knowledge inculcation, while the patient is passive mastery of the relevant knowledge, initiative and autonomy is low, resulting in the Poor effect of health guidance<sup>30</sup>. The intervention group is more to make the patients actively participate in the learning process, fully inform the patients of the importance of mastering knowledge, mobilize the patients' enthusiasm for learning through group discussions and other modes, give the dialysis patients the right to actively choose the learning mode, and make them actively participate in the process of mastering knowledge related to the disease.

The results of this study showed that there was no statistical difference in the scores of self-management behaviors between the two groups before intervention. After 3 months of intervention, the total scores and dimensions of self-management behaviors in the intervention group were higher than those in the control group, and the differences were statistically significant. Self-management in MHD patients can help correct bad habits, as well as increase one's ability to monitor disease status, increase treatment compliance and subjective motivation, thereby reducing complications and improving quality of life. Behavior change comes from internal motivation, and a healthy lifestyle is easier to implement and maintain, so increasing patients' awareness of psychological need satisfaction and self-determined motivation plays an important role in improving self-management. The result is consistent with the study by Yan Xiaoying et al.<sup>31</sup>, and it is possible that as the level of patients' knowledge related to hemodialysis improves, the patients' confidence and ability to manage their own symptoms increases, which in turn improves the level of self-management. As patients' level of knowledge about hemodialysis increases, their confidence and ability to manage their symptoms increases, leading to improved self-management. In addition, this study enabled patients to face up to their illnesses and accept themselves by meeting their basic psychological needs and developing motivation for self-management<sup>32</sup>. Throughout the intervention process, patients were informed of the importance of self-management by means of videos, verbal emphasis, group and other discussions, provided with reasons to reduce controlling behaviors, and trained in the skills they lacked; existing problems were discussed and exchanged by means of listening and a self-management plan was jointly developed. Individual guided interviews, on the other hand, took a step-by-step approach, adjusting goals and corresponding plans in a timely manner according to the patient's implementation, enhancing the patient's competence, and promoting autonomous motivation through the fulfilment of needs. The patients' motivation for self-management was strengthened, helping them to move from passive acceptance of care to active self-management, and promoting the establishment of their health behaviors<sup>33</sup>, by guiding patients to master diet management knowledge and cooking skills, such as cutting ingredients before washing, green leafy vegetables immersed in water for more than 30 min to reduce potassium intake. The dietitian works with the patient to develop an individualized nutrition plan, using the phosphorus/protein ratio concept to adjust the diet<sup>34</sup>, limiting the intake of potassium, phosphorus and other elements ensures adequate nutrient intake.

The results of this study showed that there was no statistical difference in IDWG between the two groups before intervention. After 3 months of intervention, IDWG in the intervention group was lower than that in the control group, and the difference was statistically significant. Excessive fluid intake and poor dietary management are major influences on imbalanced weight control during the interdialytic period, and weight gain during the interdialytic period in patients with MHD leads to increased volume loading and a 2.1-fold increase in the risk of death<sup>35,36</sup>. The better the self-management of MHD patients, the better the IDWG can control them, only when patients internalize their motivation and make choices autonomously can they develop health behaviors autonomously and adhere to them in the long term, and the autonomy process of motivation internalization needs to satisfy the three basic psychological needs of autonomy, competence, and belonging for patients to be able to change or maintain their health behaviors. In this study, patients were instructed on how to estimate the water content of food and how to manage fluids by using graduated water cups, which increased their interest and confidence in diet and fluid management. The results showed that IDWG in the intervention group was lower than that control group and baseline, which was basically similar to that reported by Wang et al.<sup>37</sup>. It is suggested that health education based on SDT reduces IDWG of MHD patients by improving self-management ability.

The results of this study showed that there was no statistical difference in anxiety and depression scores between the two groups before intervention. After three months of intervention, the total score of anxiety



and depression in the intervention group decreased from  $16.49 \pm 4.67$  to  $12.30 \pm 4.69$ , which was statistically significant compared with the control group. Because hemodialysis patients need long-term dialysis, the patient's negative emotion is obvious, easy to produce anxiety, depression phenomenon, which can lead to complications such as fatigue and sleep disorders, affecting their quality of life and treatment results<sup>38</sup>. Due to the similarity of symptoms between mood disorders and uremia, early diagnosis is often not possible<sup>39</sup>, and timely prevention is needed to reduce the disease burden of patients<sup>40</sup>. The results of this study are similar to Yu et al.<sup>41</sup>, which may be because the satisfaction of basic psychological needs can provide patients with emotion, information, companionship, etc., which is a protective factor for anxiety and depression. Firstly, in the process of communicating with patients, so that patients feel that they are cared for and accepted by others this study provides support for patients from multiple dimensions such as family members and patients' friends, which meets the relational needs of patients; secondly, in routine care, patients seldom take the initiative to look for caregivers to ask questions during the dialysis period, and health education measures based on SDT can allow patients to experience more attention and support for autonomy, patients emotions can be released more; Finally, praise and encouragement for patients who successfully complete the goal, affirm the efforts made by patients, thus prompting patients to produce a positive psychology; the positive concept throughout the study to improve emotional control, more conducive to the gradual transformation of patients' negative emotions, and positively cope with the problems of life.

### Limitations

The study has several limitations. First of all, this is a three-month single-center study, and there may be some limitations in sample selection, which may not represent all patients receiving MHD. Secondly, the intervention time was short, and there was no long-term health education. It is suggested that future studies should extend the intervention time and conduct a multi-center large-sample study to further explore the application effect of this theory in health education.

### Conclusion

In conclusion, health education based on self-determination theory can improve the hemodialysis knowledge level and self-management ability of maintenance hemodialysis patients, and reduce the interdialytic weight gain and anxiety and depression level.

### Data availability

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

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## Author contributions

JQZ, FX and WQ contributed to the study conception, design, drafting and revision of manuscript; YXX and ZHZ contributed to data collection and Writing—original draft; PMZ contributed to Software, Formal analysis and Writing—original draft.

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## Declarations

## Competing interests

The authors declare no competing interests.

## Additional information

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