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Prevalence and influencing factors of malnutrition in maintenance hemodialysis patients in China: a systematic review

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Background: The number of patients with chronic kidney disease (CKD) continues to rise in China, where maintenance hemodialysis (MHD) is a primary treatment. However, long-term hemodialysis is frequently associated with malnutrition, which severely compromises patients' quality of life and prognosis.

Objective: To systematically evaluate the incidence and influencing factors of malnutrition in MHD patients by using Meta-analysis methods, thereby providing a basis for early clinical identification and intervention.

Methods: We systematically searched PubMed, Web of Science, the Cochrane Library, CINAHL, China National Knowledge Infrastructure (CNKI), VIP, Wan Fang Data and SinoMed. The search covered the period from database inception to October 10, 2025, for studies investigating factors influencing malnutrition in MHD patients. Data were analyzed using Stata 15.0. A random-effects model was applied in cases of substantial heterogeneity ($I^2 \geq 50\%$), otherwise a fixed-effects model was used. Publication bias was assessed using Egger's test, and the trim-and-fill method was employed if necessary.

Results: A total of 26 studies involving 5,055 patients were included, and the overall incidence of malnutrition in MHD patients was 46.9% (95% CI: 41.8–52%). Meta-analysis showed that age (OR = 1.509), body mass index (BMI) (OR = 1.544), dialysis vintage (OR = 2.265), urea clearance index (Kt/V) (OR = 2.019), serum C-reactive protein (CRP) (OR = 3.013), high-sensitivity C-reactive protein (hs-CRP) (OR = 2.104), protein intake (OR = 3.018), frequency of dialysis (OR = 2.100), depression (OR = 2.671), anxiety (OR = 2.531), monthly household income (OR = 1.563), serum albumin (ALB) (OR = 1.115), frequency of erythropoietin (EPO) use (OR = 1.506) and duration of dialysis per session (OR = 1.879) were the main influencing factors ($p < 0.05$).

Conclusion: Malnutrition is present in 46.9% of maintenance hemodialysis patients. Individualized assessment and intervention targeting these key factors are essential to improve nutritional status and patient prognosis.

Systematic review registration: <https://www.crd.york.ac.uk/PROSPERO/>, registration no. CRD42024596946.

KEYWORDS

influencing factors, maintenance hemodialysis, malnutrition, meta-analysis, prevalence

1 Introduction

Chronic kidney disease (CKD) is widely recognized as a major global health challenge and has garnered considerable international concern (1). It is characterized by a progressive decline in renal function and structural damage in the kidney. As CKD advances to End-stage renal disease (ESRD), patients typically require renal replacement therapy (RRT), with hemodialysis (HD) being the most commonly used modality. However, patients undergoing long-term maintenance hemodialysis (MHD) are prone to malnutrition. This condition arises from various factors, including the loss of nutrients and trace elements, insufficient protein intake, inadequate dialysis, and a chronic inflammatory state. Additionally, the economic burden of treatment can lead to anxiety and depression, further exacerbating the risk (2, 3). Malnutrition is one of the most common complications in MHD patients and has been shown to significantly increase the risk of infections, falls, adverse cardiovascular events, and mortality. Moreover, it severely impacts patients' quality of life and compromises treatment efficacy, with the severity of malnutrition correlating positively with mortality rise (4, 5). Therefore, understanding the incidence of malnutrition and related influencing factors in MHD population in China is of great significance for promoting the prevention and treatment of malnutrition. In recent years, with the popularization of maintenance hemodialysis technology and the extension of patient survival, the quality of life of MHD patients and the management of long-term complications have attracted more and more attention, among which nutrition issues have become a research hotspot (6). Early studies mainly focused on describing the epidemiological characteristics of malnutrition, and gradually developed to more in-depth explore its multi-dimensional influencing factors, the interaction with inflammatory state and psychological factors (7, 8), and the effect of personalized nutritional intervention strategies (9, 10). Although numerous studies on this topic have been conducted internationally, due to the differences in research methods, sample selection and regional differences, the results of existing studies are quite heterogeneous, and there is still a lack of systematic studies on the Chinese population. Therefore, this study aimed to systematically review the incidence of malnutrition and its main influencing factors among MHD patients in China through a meta-analysis, summarize the main influencing factors, and provide a scientific basis for early identification, intervention and management of MHD patients in clinical practice, so as to provide support for improving the prognosis and quality of life of patients.

2 Methods

2.1 Search strategy

We systematically searched the following electronic databases: PubMed, Web of Science, the Cochrane Library, CINAHL, China National Knowledge Infrastructure (CNKI), VIP, Wan Fang Data and SinoMed. Medical Subject Headings (MeSH) and free keywords were employed, covering terms related to dialysis, malnutrition, and influencing factors. The search period spanned from database inception to

October 10, 2025. The detailed search strategy for PubMed is provided as an example in Table 1.

2.2 Inclusion and exclusion criteria

Inclusion criteria were: (1) studies investigating malnutrition and its influencing factors in MHD patients; (2) cross-sectional or case-control study designs; (3) publication in either Chinese or English. Exclusion criteria included: (1) translated publications; (2) conference abstracts, guidelines, reviews, commentaries, or non-peer-reviewed materials; (3) studies rated as low quality or below in our methodological assessment.

2.3 Literature screening and data extraction

Two independent researchers screened for potential inclusion and extracted data according to predefined inclusion and exclusion criteria. If differences of opinion occurred during the screening process, third-party researchers were used to mediate and reach consensus. During data extraction, a prespecified data extraction form was used to collect and record the following key information: author, year, study region, sample size, prevalence of malnutrition, study type, assessment tools, influencing factors, quality evaluation tool and quality evaluation score. In case of missing data or unclear presentation, we have contacted the original authors for additional information. If the complete data could not be obtained, the article would be excluded.

2.4 Literature quality evaluation

The methodological quality of cross-sectional studies was assessed using the 11-item scale developed by the Agency for

TABLE 1 Search strategies of PubMed databases

Steps	Retrieval formula
1#	Renal dialysis [Mesh]
2#	(Dialyses, Renal [Title/Abstract] OR Dialysis, Renal [Title/Abstract] OR Hemodialysis [Title/Abstract] OR Dialysis, Extracorporeal [Title/Abstract] OR Extracorporeal Dialysis [Title/Abstract])
3#	1# OR 2#
4#	Malnutrition [Mesh]
5#	(Malnourishment [Title/Abstract] OR Undernutrition [Title/Abstract] OR Nutritional Deficiency [Title/Abstract] OR Nutritional Deficiencies [Title/Abstract] OR Malnutrition [Title/Abstract])
6#	4# OR 5#
7#	Risk factors [Mesh]
8#	(Influencing factors [Title/Abstract] OR Determinants [Title/Abstract] OR Associated factors [Title/Abstract])
9#	7# OR 8#
10#	3# AND 6# AND 9#

Healthcare Research and Quality (AHRQ) (11). Each item was scored as “yes” (1 point), “no,” or “unclear” (both 0 points), yielding a total score ranging from 0 to 11. Studies were then categorized as low (0–3 points), moderate (4–7 points), or high (≥ 8 points) quality. For case-control studies, quality was evaluated with the Newcastle-Ottawa Scale (NOS) (12), which comprises 8 items across three domains, with a maximum score of 9. Based on the NOS, studies scoring 1–3, 4–6, and 7–9 were rated as low, moderate, and high quality, respectively.

2.5 Statistical analysis

All data were analyzed by Stata 15.0 software. First, the heterogeneity test was performed, and the heterogeneity between studies was evaluated by the I^2 statistic. When $I^2 > 50\%$ and $p < 0.1$, it indicated that there was substantial heterogeneity, and the random-effects model was used for analysis. Otherwise, fixed-effects model was used for the meta-analysis. For studies with significant heterogeneity, subgroup analyses were performed to explore the source of heterogeneity. Simultaneously, sensitivity analysis was performed to verify the robustness of the analysis results, and Egger’s test was used to assess

publication bias. A p -value < 0.05 was considered statistically significant.

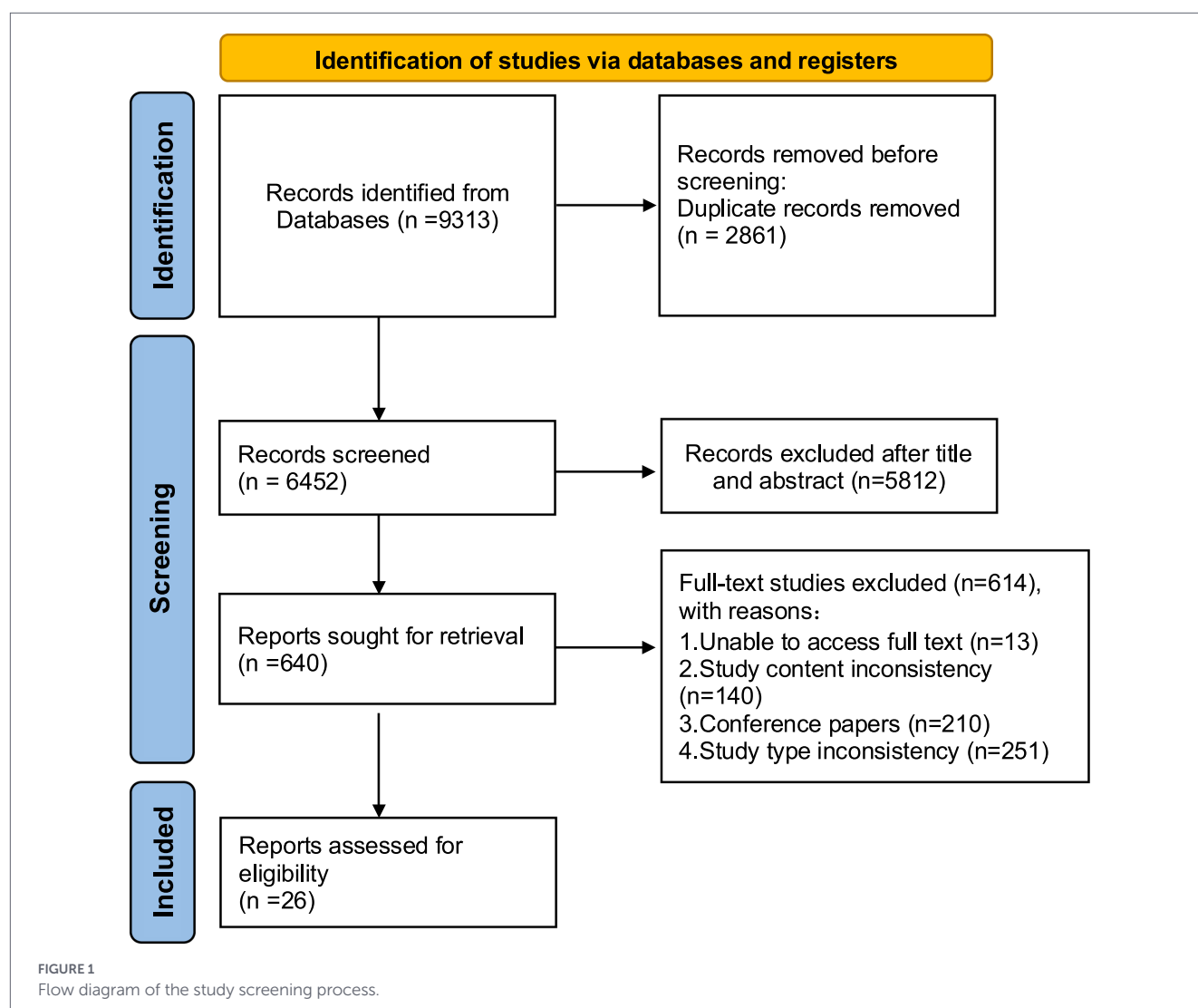
3 Results

3.1 Results of literature search

A total of 9,313 studies were retrieved, and 26 studies were included. The detailed study screening process is shown in Figure 1 and Table 1.

3.2 Basic information and quality evaluation of included studies

A total of 26 studies were included in this study (13–38), including 13 case-control studies and 13 cross-sectional studies, with a total sample of 5,055 cases, including 2,917 cases identified as well-nourished and 2,138 cases with malnutrition. Among the 26 articles, 20 were of medium quality and 6 were of high quality. The quality assessment results are



presented in [Supplementary Table 1](#). The basic information and quality evaluation results of the included literature are summarized in [Table 2](#).

3.3 Prevalence of malnutrition in Chinese MHD patients

3.3.1 The overall prevalence of malnutrition

The analysis of the 26 included studies showed that there was a substantial heterogeneity among the studies ($I^2 = 92.6\%$, $p < 0.001$). A random-effects model was therefore applied, and the results showed that the prevalence of malnutrition in Chinese MHD patients was 46.9% (95% CI: 41.8–52%) as detailed in [Figure 2](#). The assessment tools used to diagnose malnutrition in the original studies of this meta-analysis included the Subjective Global Assessment (SGA), Modified Quantitative Subjective Global Assessment (MQSGA), Quantitative Subjective Global Assessment (Q-SGA), the Malnutrition-Inflammation Score (MIS), the Geriatric Nutritional Risk Index (GNRI), and the Nutritional Risk Screening 2002 (NRS2002).

3.3.2 Subgroup analysis

Subgroup analysis was conducted according to study year, study region, study type, and assessment tool. The studies were stratified by publication year, using 2021 as the cutoff: the prevalence of malnutrition before 2021 (49.4%) was higher than that after 2021 (45.3%); the prevalence of malnutrition was 46.4% (95% CI: 37.5–55.4%) in the case-control study and 47.3% (95% CI: 42.4–52.1%) in the cross-sectional study. Regarding the assessment tools, the prevalence of malnutrition was 69.3% using Q-SGA and 22.6% using NRS2002. The prevalence of malnutrition was 49.0% (95% CI: 43.8–54.2%) in Southern China and 44.7% (95% CI: 36.5–52.9%) in Northern China. The results are shown in [Table 3](#).

3.3.3 Sensitivity analysis

To assess the robustness of the findings, we conducted a sensitivity analysis by excluding individual studies one at a time. The results demonstrated minimal fluctuation in the pooled effect size, thus supporting the stability of the meta-analysis conclusions ([Figure 3](#)).

3.3.4 Publication bias test

The risk of publication bias was analyzed for the incidence of malnutrition in MHD patients by drawing a funnel plot, and the funnel plot showed asymmetry, suggesting the presence of publication bias, as shown in [Figure 4](#). Egger's test was significant ($p < 0.05$). Following the trim-and-fill method, it was found that no hypothetical study was included, and the prevalence rate did not change significantly, indicating that the stability of the results was not affected by publication bias.

3.4 Influencing factors of malnutrition in Chinese MHD patients

3.4.1 Results of meta-analysis

The meta-analysis revealed multiple significant factors associated with malnutrition in Chinese MHD patients ($p < 0.05$), as detailed in

[Table 4](#). These included: age (and age ≥ 60), BMI, dialysis vintage, Kt/V, CRP, hs-CRP, protein intake, ALB, duration of dialysis per session, monthly household income, frequency of dialysis, frequency of EPO use, depression, and anxiety.

3.4.2 Sensitivity analysis

Sensitivity analysis was performed on studies with the same influencing factors (≥ 5), and the influencing factors were analyzed by switching between the fixed-effects and random-effects models. The results showed that there was no significant difference in the results except age ≥ 60 years, BMI, and frequency of EPO use, indicating that the results of meta-analysis were relatively stable, as shown in [Table 5](#).

3.5 Publication bias test

Egger's test showed that there was no significant publication bias for Kt/V ($p = 0.535$), ALB ($p = 0.913$), frequency of dialysis ($p = 0.239$) and hs-CRP ($p = 0.171$). Significant publication bias was found for age, age ≥ 60 years, and dialysis vintage (all $p < 0.05$).

4 Discussion

4.1 Prevalence of malnutrition in Chinese MHD patients

The results of Meta-analysis showed that the prevalence of malnutrition in Chinese MHD patients was 46.9%, which was consistent with the 30.0–66.7% prevalence of malnutrition reported in the guidelines (39). Due to the long-term dialysis treatment, MHD patients often face multiple adverse health factors, including renal failure, poor diet, and malabsorption of nutrients, which may lead to a high prevalence of malnutrition in patients. In addition, subgroup analysis showed that different time periods, regions and study types had certain effects on the prevalence of malnutrition. For example, the prevalence of malnutrition in MHD patients before 2021 and after 2021 was 49.4 and 45.3%, respectively, with a small difference, indicating that this problem has not been effectively alleviated in recent years. From the regional perspective, there was no significant difference in the prevalence of malnutrition between the southern and northern regions (49.0 and 44.7%, respectively), indicating that malnutrition is common in dialysis patients nationwide, and may be related to regional economy, medical resources and patients' lifestyle.

4.2 Age, BMI, dialysis vintage and monthly household income, were the main demographic influencing factors of malnutrition in Chinese MHD patients

Age ≥ 60 years constitutes a significant risk factor for malnutrition in patients undergoing maintenance hemodialysis (MHD). Advancing age is frequently associated with a decline in physiological function and diminished gastric acid secretion, which can impair digestion and nutrient absorption (40). Furthermore, older population often exhibit lower nutritional literacy, have limited

TABLE 2 Basic characteristics and evaluation results of included literature

Author, year	Study region	Sample Size	Prevalence of malnutrition (%)	Study type	Assessment tool	Influencing factors	Quality evaluation tool	Quality evaluation Score
Hu et al. 2023 (13)	Hanan	94	48.94	case-control study	MQSGA	1, 3, 4	NOS	7
Chen et al. 2024 (14)	Fujian	75	53.33	case-control study	MQSGA	3, 4, 5, 6	NOS	7
Han et al. 2022 (15)	Henan	118	55.93	case-control study	MQSGA	1, 3, 4, 19	NOS	6
Shi et al. 2016 (16)	Shanghai	120	58.33	case-control study	MQSGA	1, 3, 4, 19	NOS	6
Wang et al. 2012 (17)	Beijing	125	48.80	cross-sectional study	SGA	4, 7, 11	AHRQ	5
Li et al. 2023 (18)	Beijing	147	40.14	case-control study	MIS	1, 20, 21	NOS	5
Gong et al. 2025 (19)	Shandong	120	35.83	cross-sectional study	MQSGA	3, 29	AHRQ	4
Qiu et al. 2022 (20)	Jiangsu	1228	42.02	cross-sectional study	MQSGA	1, 3, 4, 14	AHRQ	4
Xiao et al. 2017 (21)	Hunan	103	42.72	cross-sectional study	MQSGA	1, 6, 11	AHRQ	4
Weng et al. 2018 (22)	Jiangsu	200	37.50	cross-sectional study	MQSGA	3, 10, 13, 14, 15, 16, 17, 18	AHRQ	4
Chen H, 2020 (23)	Sichuan	88	69.32	cross-sectional study	Q-SGA	1, 2, 3, 4, 8, 26	AHRQ	5
Han et al. 2023 (24)	Henan	195	41.54	cross-sectional study	SGA	1, 3, 8, 11, 14	AHRQ	4
Wang et al. 2016 (25)	Tianjin	955	22.62	case-control study	NRS2002	3, 9, 10, 12, 14, 15, 16, 17, 18, 24	NOS	5
Miu et al. 2018 (26)	Shanghai	142	55.63	cross-sectional study	MQSGA	1, 3, 4, 8, 23	AHRQ	5
Li et al. 2025 (27)	Jiangsu	80	45.00	cross-sectional study	MQSGA	1, 3, 19, 30, 31	AHRQ	4
Zhao et al. 2025 (28)	Beijing	234	42.31	case-control study	MQSGA	1, 2, 3, 4, 19	NOS	7
Zhang et al. 2022 (29)	Liaoning	110	53.64	cross-sectional study	GNRI	1, 8, 19, 27, 28	AHRQ	6
Wang et al. 2016 (30)	Guangdong	114	48.25	case-control study	MQSGA	1, 3, 4, 8, 19	NOS	5
Huang et al. 2023 (31)	Jiangxi	112	35.71	cross-sectional study	MQSGA	1, 3, 4, 14	AHRQ	5
Liu et al. 2024 (32)	Anhui	106	42.45	case-control study	MQSGA	1, 3, 4, 8, 19, 25	NOS	5
Dong et al. 2019 (33)	Hebei	70	64.29	case-control study	MQSGA	1, 3, 13	NOS	7
Fang et al. 2024 (34)	Hebei	166	49.40	cross-sectional study	MQSGA	1, 2, 3, 4, 5, 6, 7, 8	AHRQ	4
Guo et al. 2025 (35)	Henan	102	29.41	case-control study	MQSGA	6, 10, 14	NOS	5
Yan et al. 2025 (36)	Henan	186	53.76	case-control study	MQSGA	1, 3, 4, 8, 20, 21, 22, 32	NOS	7
Li et al. 2023 (37)	Shandong	85	47.06	case-control study	MQSGA	1, 3, 4	NOS	7
Song et al. 2023 (38)	Guizhou	80	62.50	cross-sectional study	MQSGA	1, 3, 11, 13	AHRQ	5

Assessment tools: MQSGA is the modified quantitative subjective assessment, Q-SGA is the quantitative subjective global assessment for dialysis patients, MIS is the malnutrition-inflammation score, SGA is the subjective global nutritional assessment, GNRI is the geriatric nutritional risk index, and NRS2002 is the nutritional risk screening table. Influencing factors: 1. Age; 2. Body mass index (BMI); 3. Dialysis vintage; 4. Urea clearance index (Kt/v); 5. Serum C-reactive protein (CRP); 6. The awareness rate of nutritional knowledge of kidney disease; 7. Insufficient protein intake; 8. Serum albumin (ALB); 9. Gender; 10. Duration of dialysis per session; 11. Diabetes mellitus; 12. Types of concomitant diseases; 13. Monthly household income; 14. Dialysis frequency; 15. frequency of EPO use; 16. dealing methods; 17. Family function; 18. Social support level; 19. High-sensitivity C-reactive protein (hs-CRP); 20. Depression; 21. Anxiety; 22.(Hb); 23. blood urea nitrogen level (BUN); 24. level of education; 25. live alone; 26. phosphorus (P); 27. parathyroid hormone; 28. Interleukin-6 (IL-6); 29. Hand Grip Strength (HGS); 30. Serum creatinine (Scr); 31. Total Cholesterol (TC); 32. Proprotein (PA).

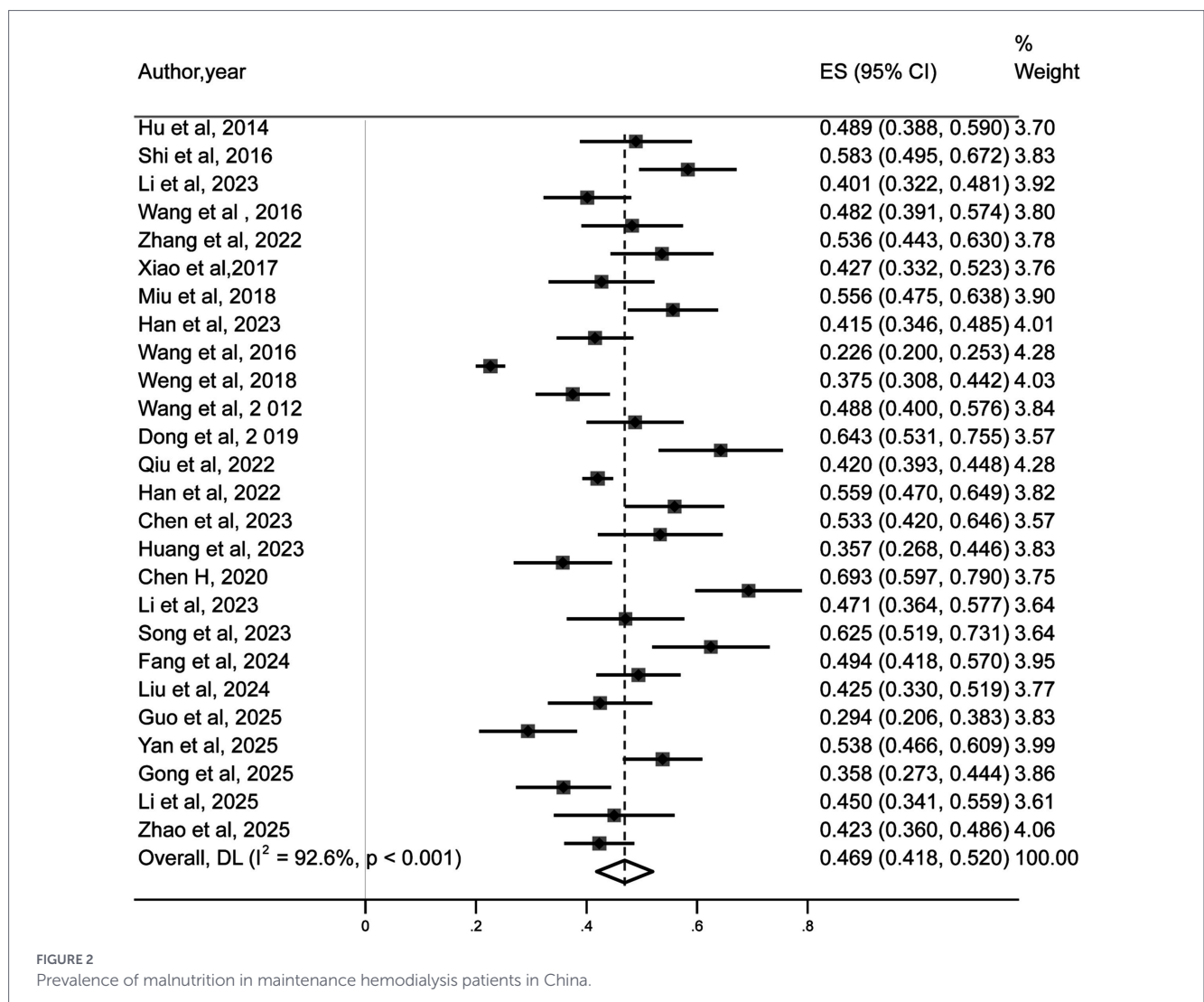


FIGURE 2 Prevalence of malnutrition in maintenance hemodialysis patients in China.

TABLE 3 Analysis results of malnutrition prevalence in subgroups

Subgroup	Number of studies	Prevalence analysis (I²) / (%)	Effect model	95%CI (%)	p-value
Study year					
Before 2021	10	96.2%	random	49.4%(37.5%-61.3%)	<0.001
After 2021	16	72%	random	45.3%(41.6%-49%)	<0.001
Study type					
Case - control study	13	95.3%	random	46.4%(37.5%-55.4%)	<0.001
Cross - sectional study	13	82.7%	random	47.3%(42.4 %-52.1%)	<0.001
Assessment tool					
MQSGA	20	76.4%	random-	47.1%(43.4%-50.9%)	<0.001
SGA	2	38.5%	fixed	44.3%(38.9%-49.8%)	0.202
MIS	1	-	-	40.1%(32.2%-48.1%)	<0.001
GNRI	1	-	-	53.6%(44.3%-63%)	<0.001
NRS2002	1	-	-	22.6%(20%-25.3%)	<0.001
Q-SGA	1	-	-	69.3%(59.7%-79%)	<0.001
Study Region					
Southern China	13	83.6%	random-	49.0%(43.8%-54.2%)	<0.001
Northern China	13	95.3%	random	44.7%(36.5%-52.9%)	<0.001

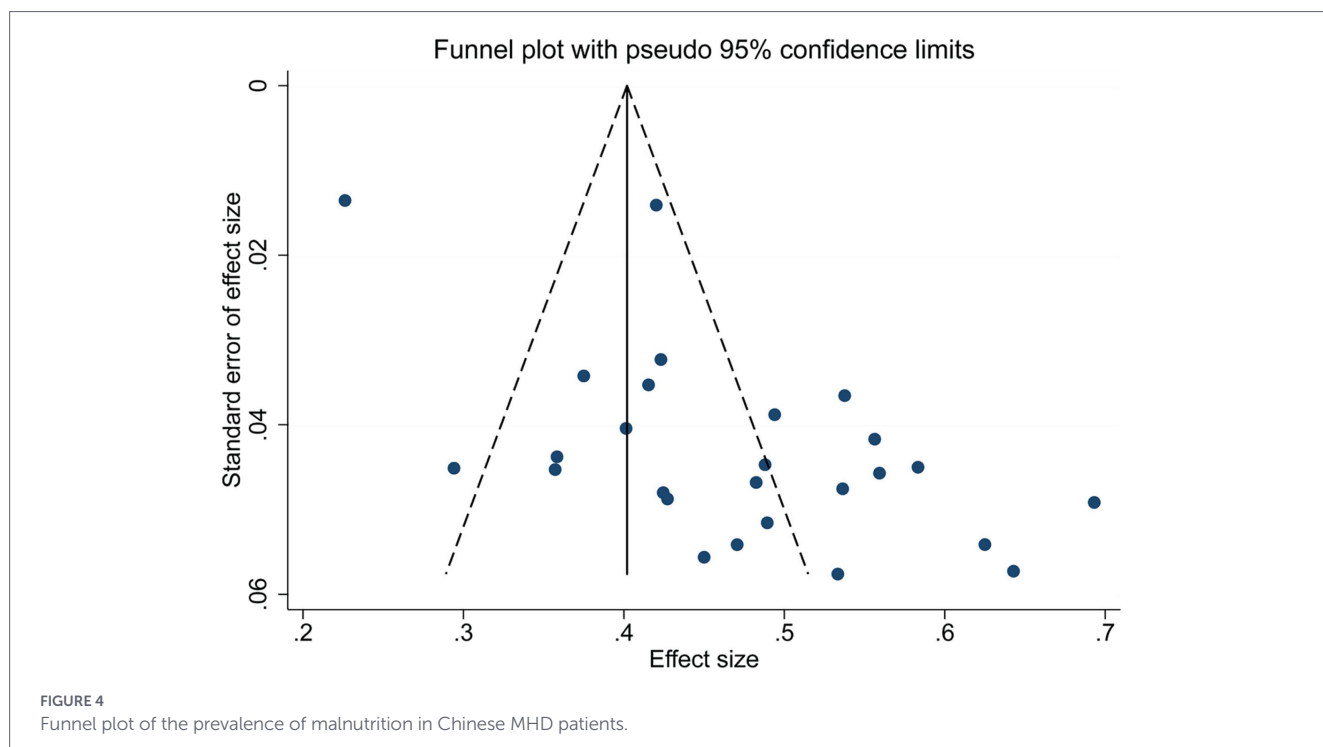


TABLE 4 Influencing factors malnutrition in Chinese MHD patients

Influencing factors	Number of studies	<i>I</i> ² (%)	Effect model	OR value(95%CI)	<i>p</i>
Age	20	92.4%	random	1.509(1.364-1.669)	<0.001
Age ≥60	9	81.5%	random	2.850(1.817-4.470)	<0.001
BMI	3	87.6%	random	1.544(0.518-4.602)	<0.001
Dialysis vintage	21	93%	random	2.265(1.813-2.831)	<0.001
Kt/v	15	95.2%	random	2.019(1.243-3.279)	<0.001
CRP	3	69.5%	random	3.013(1.976-4.593)	0.038
The awareness rate of nutritional knowledge of kidney disease	4	0%	fixed	4.495(2.820-7.164)	0.520
protein intake	2	91.4%	random	3.018(0.538 -16.933)	<0.001
ALB	8	93.2%	random	1.115(0.747-1.665)	<0.001
Duration of dialysis per session	3	89.5%	random	1.879(0.515-6.862)	<0.001
Diabetes mellitus	4	0.2%	fixed	2.339(1.882-2.907)	0.391
Monthly household income	3	96.3%	random	1.563(0.644-3.794)	<0.001
Frequency of dialysis	6	91.7%	random	2.100(0.742-5.941)	<0.001
Frequency of EPO use	3	94.4%	random	1.506(0.162-14.022)	<0.001
Family function	2	43.5%	fixed	2.152(1.531-3.024)	0.183
Social support level	2	61.6%	random	2.467(1.052-5.782)	0.106
hs-CRP	5	81.5%	random	2.104(1.393-3.177)	<0.001
Depression	2	96.7%	random	2.671(0.484-14.725)	<0.001
Anxiety	2	96.9%	random	2.531(0.467-13.727)	<0.001

metabolic disturbances, a negative nitrogen balance, and ultimately, malnutrition (48). Consequently, it is critical to ensure sufficient protein intake to compensate dialysis-related losses. In clinical practice,

dietary guidance should be individualized to balance the necessity of protein restriction with the imperative of adequate nutrition, thereby effectively preventing malnutrition.

TABLE 5 Sensitivity analysis of influencing factors of malnutrition in Chinese MHD patients.

Influencing factors	Fixed-effects model		Random-effects model	
	OR value (95%CI)	<i>p</i>	OR value (95%CI)	<i>p</i>
Age	1.088 (1.069–1.107)	<0.001	1.509 (1.364–1.669)	<0.001
Age ≥60	1.682 (1.456–1.943)	<0.001	2.850 (1.817–4.470)	<0.001
BMI	2.065 (1.675–2.545)	<0.001	1.544 (0.518–4.602)	<0.001
Dialysis vintage	1.054 (1.041–1.068)	<0.001	2.265 (1.813–2.831)	<0.001
Kt/v	2.333 (2.141–2.543)	<0.001	2.019 (1.243–3.279)	<0.001
CRP	2.760 (2.236–3.406)	0.038	3.013 (1.976–4.593)	0.038
The awareness rate of nutritional knowledge of kidney disease	4.495 (2.820–7.164)	0.520	4.495 (2.820–7.164)	0.520
Insufficient protein intake	2.525 (1.543–4.133)	<0.001	3.018 (0.538–16.933)	<0.001
ALB	1.020 (0.955–1.091)	<0.001	1.115 (0.747–1.665)	<0.001
Duration of dialysis per session	0.942 (0.695–1.278)	<0.001	1.879 (0.515–6.862)	<0.001
Diabetes mellitus	2.339 (1.882–2.907)	0.391	2.339 (1.881–2.908)	0.391
Monthly household income	1.041 (0.893–1.213)	<0.001	1.563 (0.644–3.794)	<0.001
Frequency of dialysis	1.705 (1.271–2.286)	<0.001	2.100 (0.742–5.941)	<0.001
Frequency of EPO use	0.644 (0.465–0.890)	<0.001	1.506 (0.162–14.022)	<0.001
Family function	2.152 (1.531–3.024)	0.183	2.148 (1.366–3.378)	0.183
Social support	2.131 (1.351–3.362)	0.106	2.467 (1.052–5.782)	0.106
hs-CRP	1.688 (1.454–1.959)	<0.001	2.104 (1.393–3.177)	<0.001
Depression	1.237 (1.090–1.404)	0.004	2.671 (0.484–14.725)	<0.001
Anxiety	1.131 (1.044–1.226)	<0.001	2.531 (0.467–13.727)	<0.001

4.4 Kt/V, duration of dialysis per session, frequency of dialysis and frequency of EPO use are dialysis-related factors of malnutrition in Chinese MHD patients

The urea clearance index (Kt/V), as the core metric for evaluating the adequacy of dialysis, directly reflects the efficiency of waste removal during dialysis, and is an important parameter to evaluate the quality of dialysis and the nutritional status of patients (49). Dialysis adequacy is closely related to the clearance of metabolic wastes in the patient's body, and insufficient dialysis clearance leads to the accumulation of urotoxins in the body, which can trigger digestive symptoms such as nausea and vomiting. These symptoms, in turn, may impair appetite and reduce nutritional intake. Studies have shown that if the duration of dialysis per session is less than 4 h per time, or the frequency of dialysis is less than 4 times per week, it is often unable to effectively remove metabolic waste in the body, which may lead to insufficient dialysis, thereby affecting the patient's nutrient absorption and increasing the risk of malnutrition (50). Thus, adequate dialysis is essential for MHD patients. Tailoring the dialysis prescription based on individual patient needs is crucial to ensure adequate solute removal, alleviate clinical symptoms, improve appetite, and thereby help prevent malnutrition.

In addition, Erythropoietin (EPO) is a hormone synthesized primarily by the kidneys, with its key physiological role being the stimulation of erythropoiesis in the bone marrow to maintain red blood cell count and systemic oxygen delivery. In the context of declining renal function, EPO production diminishes, frequently leading to renal anemia in MHD patients (51). Consequently, exogenous EPO is now widely used in the management of anemia associated with

MHD. Anemia, a common complication in dialysis patients, shares a close pathophysiological link with malnutrition. Anemia exacerbates tissue hypoxia, impairing cellular energy metabolism and the utilization efficiency of nutrients, thereby worsening pre-existing malnutrition (52). Evidence indicates that EPO administration effectively corrects anemia. Therefore, patients receiving standardized EPO therapy may have a relatively lower risk of developing malnutrition. This association underscores that in addition to ensuring dialysis adequacy, effective management of anemia is equally crucial for improving nutritional status in MHD patients.

4.5 Depression and anxiety as psychological influencing factors of malnutrition in Chinese MHD patients

Depression and anxiety are prevalent among MHD patients, often resulting from the high treatment costs and dialysis-related complications, such as fatigue and sleep disturbances (53). These psychological conditions not only manifest as low mood and anhedonia but also significantly impair appetite and eating behavior, leading to reduced or irregular food intake. Chronic loss of appetite and inadequate nutrient intake directly exacerbate malnutrition. Furthermore, depression and anxiety can disrupt gastrointestinal function, altering gastrointestinal motility and secretion, which further impairs nutrient absorption. Collectively, these physiological and psychological pathways significantly worsen the nutritional status of MHD patients (3). Therefore, it is essential for clinical medical staff to pay great attention to the mental health of patients, regularly assess their psychological status, and implement timely, individualized intervention, including psychological counseling, pharmacological treatment and enhanced

social support to alleviate symptoms, improve appetite and quality of life, and ultimately reduce the risk of malnutrition.

4.6 Limitations

Although this study integrated a substantial amount of data through meta-analysis, there are still several limitations. First, because the types of studies included in the literature were mainly cross-sectional studies and case-control studies, it is difficult to determine the causal relationship. In addition, variability in the quality of the included studies may affect the reliability of the findings. Although sensitivity analysis was performed to assess the influence of individual studies, the conclusions require validation through future prospective research. Second, this study only conducted statistical analysis on some influencing factors. Factors such as urea nitrogen level, educational level, and grip strength could not be further analyzed for the time being due to the limited number of included studies. In the future, high-quality and large-sample prospective cohort studies are needed to address these gaps. Finally, the studies included in this meta-analysis mainly focused on China, and there was considerable heterogeneity in assessment tools and regional focus. Expanding the sample scope to other countries and regions is essential to explore the incidence and influencing factors of malnutrition in MHD patients, thereby providing broader data support for the nutrition management of MHD patients worldwide.

5 Conclusion

Malnutrition remains highly prevalent among maintenance hemodialysis (MHD) patients in China. This meta-analysis identified several significant influencing factors, including advanced age, longer dialysis duration, and anxiety or depression. Additionally, several clinical indicators showed a strong positive correlation with malnutrition risk, including lower body mass index (BMI), reduced urea clearance index (Kt/V), elevated serum C-reactive protein (CRP) and high-sensitivity CRP levels, inadequate protein intake, insufficient dialysis frequency or duration per session, and low serum albumin levels. Socioeconomic factors such as lower monthly household income and infrequent use of EPO were also associated with a higher risk of malnutrition. These findings suggest that as these risk factors intensify, the likelihood of malnutrition increases accordingly. Therefore, clinicians should pay close attention to these key determinants, particularly in high-risk groups such as older population, long-term dialysis recipients, those with micro-inflammatory states, individuals with poor nutritional intake, and patients experiencing depression or anxiety. Timely individualized nutritional assessment and tailored intervention strategies are essential to improve nutritional status and overall prognosis in MHD patients.

Data availability statement

The original contributions presented in the study are included in the article/[Supplementary material](#), further inquiries can be directed to the corresponding author.

Author contributions

YB: Writing – original draft, Writing – review & editing, Conceptualization, Data curation, Formal analysis, Methodology, Software. HZ: Conceptualization, Data curation, Formal analysis, Methodology, Resources, Supervision, Writing – review & editing. QW: Data curation, Formal analysis, Methodology, Writing – review & editing. FC: Data curation, Formal analysis, Methodology, Writing – review & editing. XW: Data curation, Formal analysis, Writing – review & editing. LY: Resources, Writing – review & editing.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpubh.2026.1771997/full#supplementary-material>

References

- Yang C, Gao B, Zhao X, Su Z, Sun X, Wang H-Y, et al. Executive summary for China kidney disease network (CK-NET) 2016 annual data report. *Kidney Int.* (2020) 98:1419–23. doi: 10.1016/j.kint.2020.09.003
- Ishida J, Kato A. Recent advances in the nutritional screening, assessment, and treatment of Japanese patients on hemodialysis. *J Clin Med.* (2023) 12:2113. doi: 10.3390/jcm12062113
- Salazar-Robles E, Lerma A, Calderón-Juárez M, Ibarra A, Pérez-Grovas H, Bermúdez-Aceves LA, et al. Assessment of factors related to diminished appetite in hemodialysis patients with a new adapted and validated questionnaire. *Nutrients.* (2021) 13:1371. doi: 10.3390/nu13041371
- Visiedo L, Rey L, Rivas F, López F, Tortajada B, Giménez R, et al. The impact of nutritional status on health-related quality of life in hemodialysis patients. *Sci Rep.* (2022) 12:3029. doi: 10.1038/s41598-022-07055-0
- Pernas A, Pires S, Gomes I, Fonseca C, Ramos A. Technological nursing interventions on nutritional status of middle-aged and older adults undergoing hemodialysis: a systematic review. *Int J Nurs Sci.* (2025) 12:493–500. doi: 10.1016/j.ijnss.2025.08.008
- Huang C-H, Lu M-C, Koo M. Global research on hemodialysis nutrition and patient-centered priorities: a bibliometric analysis (2006–2025). *Healthcare.* (2025) 14:28. doi: 10.3390/healthcare14010028
- Huang L, Zhou J, Wang XL, Zhao YJ, Hu GC. Relationship between serum 25(OH)D level, chronic inflammatory state and malnutrition in maintenance hemodialysis patients. *J Pract Med.* (2016) 32:3318–20.
- Zhang J, Gao J, Gaowa S, Han P, Chen X, Cai P, et al. Association between geriatric nutrition risk index and depression in older hemodialysis patients with and without type 2 diabetes mellitus: a multicenter cross-sectional study. *Front Endocrinol.* (2025) 16:1646514. doi: 10.3389/fendo.2025.1646514
- Lea K, Ivana J, Armin A, Bojan J, Nikolina B-J. Oral nutritional supplement adherence and nutritional outcomes in hemodialysis patients—a prospective study. *J Clin Med.* (2025) 14:8337. doi: 10.3390/jcm14238337
- Yuan X, Xia Y. Effect of exercise on nutrition, inflammation, muscle health and cardio-cerebrovascular events in maintenance hemodialysis patients: a real-world prospective cohort study. *Ren Fail.* (2025) 47:1. doi: 10.1080/0886022X.2025.2598982
- Zeng X, Zhang Y, Kwong JSW, Zhang C, Li S, Sun F, et al. The methodological quality assessment tools for preclinical and clinical studies, systematic review and meta-analysis, and clinical practice guideline: a systematic review. *J Evid Based Med.* (2015) 8:2–10. doi: 10.1111/jebm.12141
- Stang A. Critical evaluation of the Newcastle-Ottawa scale for the assessment of the quality of nonrandomized studies in meta-analyses. *Eur J Epidemiol.* (2010) 25:603–5. doi: 10.1007/s10654-010-9491-z
- Hu XQ, Chen W, Li J. Analysis of nutritional status and its influencing factors in elderly patients with end-stage renal disease undergoing maintenance hemodialysis. *J Difficult Dis.* (2014) 13:527–528+531.
- Chen LP. Analysis of risk factors for malnutrition in uremic patients undergoing maintenance hemodialysis. *Med Equip.* (2023) 36:125–7.
- Han J. Influencing factors and nursing countermeasures of malnutrition in maintenance hemodialysis patients. *Xinjiang Med J.* (2022) 52:977–979+994.
- Shi LY, Ji LM, He HP, Wang L, Guo ZY. Nutritional status of patients with end-stage renal disease and underwent maintenance hemodialysis and its risk factors. *Prog Mod Biomed.* (2016) 16:478–80. doi: 10.13241/j.cnki.pmb.2016.03.019
- Wang SP, Yang L, Zhao LN, Wu HJ, Shao L. Nutritional status of elderly maintenance hemodialysis patients and its influencing factors. *J Nurs.* (2012) 19:21–4. doi: 10.16460/j.issn1008-9969.2012.20.015
- Li JJ, Shen YL, Liu HP, Liu HP. Analysis of influencing factors on nutritional status in patients undergoing maintenance hemodialysis. *Smart Healthcare.* (2023) 9:13–6. doi: 10.19335/j.cnki.2096-1219.2023.34.004
- Gong P, Li QQ, Zhang D. Study on nutritional status assessment in maintenance hemodialysis patients. *Pract Prev Med.* (2025) 32:880–3. doi: 10.3969/j.issn.1006-3110.2025.07.024
- Qiu SA, Yang JH, Wang B. Study on nutritional status and influencing factors in maintenance hemodialysis patients. *South China J Prev Med.* (2022) 48:81–3.
- Xiao L, Zhou QL, Xu H, and others. Nutritional status and influence factors of maintenance hemodialysis patients. *Int J Urol Nephrol* (2017) 37:411–415. doi: 10.3760/cma.j.issn.1673-4416.2017.03.027.
- Weng LN, Cui YH, Xu W. Nutritional status and analysis of its influencing factors in maintenance hemodialysis patients. *Hainan Med J.* (2018) 29:773–7.
- Chen H. *Analysis of nutritional status and influencing factors in maintenance hemodialysis patients. [master's thesis].* Kunming (Yunnan): Kunming Medical University (2020).
- Han H, Song MA. Investigation of nutritional status and analysis of influencing factors in patients with maintenance hemodialysis. *J Clin Med Eng.* (2023) 30:1771–2. doi: 10.3969/j.issn.1674-4659.2023.12.1771
- Wang Q. *Analysis of nutritional risk and influencing factors in maintenance hemodialysis patients. [master's thesis/dissertation].* Tangshan (Hebei): North China University of Science and Technology (2016).
- Miu M, Wang CJ, Wang Y, Jiang L, Bao XR. Analysis of prevalence of malnutrition and associated factors in maintenance hemodialysis patients. *Chin J Integr Tradit West Nephrol.* (2018) 19:301–4.
- Li HH, Zhang HH. Influencing factors of malnutrition in maintenance hemodialysis patients and nursing intervention effect. *Smart Healthcare.* (2025) 11:168–70. doi: 10.19335/j.cnki.2096-1219.2025.22.046
- Zhao YP, Zhao Y, Du MJ, Zou DX. Analysis of influencing factors and intervention strategies for malnutrition in maintenance hemodialysis patients. *Contemp Med Forum.* (2025) 22:162–5. doi: 10.3969/j.issn.2095-7629.2025.22.048
- Zhang HY, Jin RX. Analysis of influence factors of malnutrition in maintenance hemodialysis patient. *Chin Med Innov.* (2022) 19:152–6. doi: 10.3969/j.issn.1674-4985.2022.13.037
- Wang L, Zhong XQ, Zhu AJ, Zhu SL, Zeng HY, Xia PY. Nutritional status and its influence factors in maintenance hemodialysis patients: a case-control study. *J Nurs.* (2016) 23:1–4. doi: 10.16460/j.issn1008-9969.2016.10.001
- Huang PP, Yang Q, Han Y. Analysis of related risk factors for malnutrition in maintenance hemodialysis patients. *J Rare Dis.* (2023) 30:70–1. doi: 10.3969/j.issn.1009-3257.2023.12.029
- Liu NH, Li L, Ou XJ. Analysis of risk factors for malnutrition in maintenance hemodialysis patients and nursing strategies. *J Clin Nurs Pract.* (2024) 10:117–9. doi: 10.3969/j.issn.1009-3257.2023.12.029
- Dong GN, Wang K, Yang YP, Liu Q. Nutritional status, human component analysis and its influencing factors in patients with MHD. *Int J Lab Med.* (2019) 40:2212–4.
- Fang XF, Jia LM, Wei D, Zhao C. Analysis of related influencing factors for malnutrition in uremic patients undergoing maintenance hemodialysis. *Chin J Health Care Wellness.* (2024) 42:56–9.
- Guo YW, Wang HY, Qi HF. Study on nutritional status and influencing factors in MHD patients with chronic renal failure. *J Shandong Med Coll.* (2025) 47:59–61. doi: 10.3969/j.issn.1674-0947.2025.01.023
- Yan YQ, Sun K, Guo YX, Wang ZY. Analysis of high-risk factors for malnutrition in elderly chronic kidney disease patients undergoing maintenance hemodialysis. *Heilongjiang Med Pharm.* (2025) 48:63–6. doi: 10.3969/j.issn.1008-0104.2025.06.019
- Li SM, Gu XW. Risk factors of malnutrition in maintenance hemodialysis patients with end-stage renal disease. *Contemp Med.* (2023) 29:60–3.
- Song J, Ran GZ, Zhang YY, Liu Y. Analysis of influencing factors for malnutrition in maintenance hemodialysis patients. *Physician Online.* (2023) 13:31–3. doi: 10.3969/j.issn.2095-7165.2023.04.008
- Chinese Society of Nephrology, Chinese Medical Doctor Association; Nutrition Therapy Guideline Expert Collaborative Group, Professional Committee of Nephrology, Chinese Association of Integrative Medicine. Chinese clinical practice guidelines for nutritional therapy in chronic kidney disease (2021 edition). *Natl Med J China.* (2021) 101:539–59.
- Chen Y, Hu Y. Nutritional status of hemodialysis patients with end stage renal disease and selection and application of oral nutritional support. *Pak J Zool.* (2024) 56:0–6. doi: 10.17582/journal.pjz/20221202081241
- Lim J-H, Chinnna K, Khosla P, Karupaiah T, Daud ZAM. Understanding how nutrition literacy links to dietary adherence in patients undergoing maintenance hemodialysis: a theoretical exploration using partial least squares structural equation modeling. *Int J Environ Res Public Health.* (2020) 17:7479. doi: 10.3390/ijerph17207479
- Kalantar-Zadeh K, Rhee CM, Chou J, Ahmadi SF, Park J, Chen JL, et al. The obesity paradox in kidney disease: how to reconcile it with obesity management. *Kidney Int Rep.* (2017) 2:271–81. doi: 10.1016/j.ekir.2017.01.009
- Bramania P, Ruggajo P, Bramania R, Mahmoud M, Furia F. Nutritional status of patients on maintenance hemodialysis at muhimbili national hospital in Dar Es Salaam, tanzania: a cross-sectional study. *J Nutr Metab.* (2021) 2021:1–7. doi: 10.1155/2021/6672185
- Himmelfarb J, Vanholder R, Mehrotra R, Tonelli M. The current and future landscape of dialysis. *Nat Rev Nephrol.* (2020) 16:573–85. doi: 10.1038/s41581-020-0315-4
- Rizo-Téllez SA, Sekheri M, Filep JG. C-reactive protein: a target for therapy to reduce inflammation. *Front Immunol.* (2023) 14:1237729. doi: 10.3389/fimmu.2023.1237729
- Stumpf F, Keller B, Gressies C, Schuetz P. Inflammation and nutrition: friend or foe? *Nutrients.* (2023) 15:1159. doi: 10.3390/nu15051159
- Xi W-Z, Wu C, Liang Y-L, Wang L-L, Cao Y-H. Analysis of malnutrition factors for inpatients with chronic kidney disease. *Front Nutr.* (2023) 9:1002498. doi: 10.3389/fnut.2022.1002498
- Kim S, McClave SA, Martindale RG, Miller KR, Hurt RT. Hypoalbuminemia and clinical outcomes: what is the mechanism behind the relationship? *Am Surg.* (2017) 83:1220–7. doi: 10.1177/000313481708301123
- Torreggiani M, Fois A, Njandjo L, Longhitano E, Chatrenet A, Esposito C, et al. Toward an individualized determination of dialysis adequacy: a narrative review with special emphasis on incremental hemodialysis. *Expert Rev Mol Diagn.* (2021) 21:1119–37. doi: 10.1080/14737159.2021.1987216

50. Ashby D, Borman N, Burton J, Corbett R, Davenport A, Farrington K, et al. Renal association clinical practice guideline on haemodialysis. *BMC Nephrol.* (2019) 20:379. doi: 10.1186/s12882-019-1527-3
51. Tsiftoglou AS. Erythropoietin (EPO) as a key regulator of erythropoiesis, bone remodeling and endothelial transdifferentiation of multipotent mesenchymal stem cells (MSCs): implications in regenerative medicine. *Cells.* (2021) 10:2140. doi: 10.3390/cells10082140
52. Ikizler TA, Burrowes JD, Byham-Gray LD, Campbell KL, Carrero J-J, Chan W, et al. KDOQI clinical practice guideline for nutrition in CKD: 2020 update. *Am J Kidney Dis.* (2020) 76:S1–S107. doi: 10.1053/j.ajkd.2020.05.006
53. Al Naamani Z, Gormley K, Noble H, Santin O, Al Maqbali M. Fatigue, anxiety, depression and sleep quality in patients undergoing haemodialysis. *BMC Nephrol.* (2021) 22:157. doi: 10.1186/s12882-021-02349-3

Glossary

CKD - Chronic kidney disease

MHD - Maintenance hemodialysis

HD - Hemodialysis

ESRD - End-stage renal disease

RRT - Renal replacement therapy

Mesh - Medical Subject Headings

AHRQ - Agency for Healthcare Research and Quality

NOS - Newcastle Ottawa Scale

SGA - Subjective Global Assessment

MQSGA - Modified Quantitative Subjective Global Assessment

Q-SGA - Quantitative Subjective Global Assessment

MIS - Malnutrition-Inflammation Score

GNRI - Geriatric Nutritional Risk Index

NRS2002 - Nutritional Risk Screening 2002

BMI - Body mass index

CRP - C-reactive protein

hs-CRP - high-sensitivity CRP

ALB - Serum albumin

Kt/V - Urea clearance index

EPO - Erythropoietin