Uncorrected Proof

Zahedan J Res Med Sci. 2026 October; 28(4): e169554 https://doi.org/10.5812/zjrms-169554

Published Online: 2026 October 31 **Research Article**

# Knowledge, Attitudes, and Practices Regarding Hyperkalemia Management and Associated Factors Among Hemodialysis Patients in Yemen: A Cross-sectional Study

Khaled Alzanen [1], Basheer Ali Abdo [1,*], Nabil Albaadani [1], Faisal Mohammed Ahmed [2]

[1] Department of Internal Medicine, School of Medicine, Ibb University, Ibb, Yemen
[2] Department of Urology, School of Medicine, Ibb University, Ibb, Yemen

[*] ***Corresponding Author:*** Department of Internal Medicine, School of Medicine, Ibb University, Ibb, Yemen. Email: abdobasheer500@gmail.com

**Received:** 30 December, 2025; **Revised:** 29 April, 2026; **Accepted:** 26 May, 2026

## Abstract

**Background:** Hyperkalemia is a serious complication in patients with end-stage kidney disease undergoing hemodialysis. Effective management depends on patients' knowledge, attitudes, and practices (KAP), particularly in resource-limited settings.

**Objectives:** To assess knowledge, attitudes, and practices (KAP) regarding hyperkalemia management among hemodialysis patients in Yemen and to identify associated factors.

**Methods:** This hospital-based cross-sectional study included 246 hemodialysis patients at a tertiary-care center in Ibb, Yemen (April–June 2025). Data were collected using a structured questionnaire assessing knowledge (14 items), attitudes (12 items), and practices (12 items). Scores were summarized descriptively and categorized into tertiles. Associations were evaluated using Spearman's correlation and multivariate linear regression. Structural equation modeling (SEM) was performed to examine relationships between knowledge, attitudes, and practices (KAP) domains.

**Results:** Mean knowledge, attitude, and practice scores were 7.37 ± 3.13 (52.6%), 26.00 ± 3.82 (72.2%), and 24.65 ± 3.86 (68.5%), respectively. Low knowledge and practice levels were observed in 39.8% and 41.9% of participants, respectively. Knowledge was positively correlated with attitudes ($r = 0.350$, $P < 0.001$) and practices ($r = 0.219$, $P < 0.001$), and attitudes were positively correlated with practices ($r = 0.436$, $P < 0.001$). Younger age and higher education were associated with higher knowledge and attitude scores ($P < 0.05$). Regular prescribed medication use was negatively associated with practice scores ($\beta = -0.140$, $P = 0.043$). In structural equation modeling (SEM), attitudes were positively associated with practices ($\beta = 0.436$, $P < 0.001$), whereas knowledge showed a negative direct association with practices ($\beta = -0.172$, $P = 0.010$).

**Conclusions:** Hemodialysis patients demonstrated moderate knowledge, relatively positive attitudes, and suboptimal practices. Targeted, practical educational interventions are needed to improve self-management.

*Keywords:* Hyperkalemia, Renal Dialysis, Health Knowledge, Attitudes, Practice, Renal Insufficiency, Chronic, Cross-Sectional Studies, Yemen

## 1. Introduction

Hyperkalemia is a common and potentially life-threatening complication in patients with end-stage kidney disease (ESKD), particularly those receiving maintenance hemodialysis (1). Elevated serum potassium levels are associated with an increased risk of cardiac arrhythmias and mortality (2). Effective management requires a combination of medical treatment, dietary modification, and adherence to prescribed regimens (3, 4).

In hemodialysis patients, potassium control depends not only on dialysis adequacy but also on patient-related factors, including understanding of dietary potassium sources, medication use, and daily self-management practices (5). Previous studies indicate that inadequate knowledge and poor adherence contribute to suboptimal

Copyright © 2026, Alzanen et al. This open-access article is available under the Creative Commons Attribution 4.0 (CC BY 4.0) International License (https://creativecommons.org/licenses/by/4.0/), which allows for unrestricted use, distribution, and reproduction in any medium, provided that the original work is properly cited.

**How to Cite:** Alzanen K, Abdo BA, Albaadani N, Mohammed Ahmed F. Knowledge, Attitudes, and Practices Regarding Hyperkalemia Management and Associated Factors Among Hemodialysis Patients in Yemen: A Cross-sectional Study. Zahedan J Res Med Sci. 2026;28(4):e169554. doi: https://doi.org/10.5812/zjrms-169554

control (6-8). However, knowledge alone may not be sufficient, as attitudes and behaviors also influence outcomes.

The knowledge, attitudes, and practices (KAP) framework is widely used to assess patient-related factors in chronic disease management (5, 9). Studies in different settings have reported variable KAP levels among hemodialysis patients, often with discrepancies between knowledge and actual practices (10, 11).

In Yemen, data on patient awareness and self-management of hyperkalemia are limited (12). Differences in educational level, healthcare access, and dietary counseling may influence patient behavior (12-15).

## 2. Objectives

This study aimed to assess knowledge, attitudes, and practices (KAP) regarding hyperkalemia management among hemodialysis patients in Yemen and to identify associated factors.

## 3. Patients and Methods

### 3.1. Study Design and Setting

This hospital-based analytical cross-sectional study was conducted at the dialysis center of Al-Thawra Hospital, the main tertiary-care referral hospital in Ibb City, Yemen, between April and June 2025.

### 3.2. Study Population and Sampling

The study included adult patients (≥ 18 years) with ESKD receiving maintenance hemodialysis for at least 3 months.

A consecutive sampling approach was used. All eligible patients attending scheduled dialysis sessions across all shifts during the study period were approached, minimizing selection bias. Of 280 eligible patients, 246 participated (response rate: 87.9%).

Exclusion criteria included cognitive impairment, communication barriers, critical illness, or refusal to participate.

### 3.3. Data Collection Instrument

The questionnaire was adapted from previously published knowledge, attitudes, and practices (KAP) studies on chronic kidney disease and hyperkalemia, with modifications for the local context (5, 6, 16). Data were collected using a structured, interviewer-administered questionnaire developed in Arabic based on previous literature and adapted to the local context (Supplemental File 1).

The questionnaire consisted of four sections:

Socio-demographic and clinical characteristics Knowledge (14 items; true/false) Attitudes (12 items; 3-point Likert scale) Practices (12 items; 3-point Likert scale)

Negative attitude items were reverse-coded before analysis.

### 3.4. Validity and Reliability

Content validity was assessed by a panel of five experts, yielding a scale content validity index of 0.89. Face validity was evaluated through pilot testing with 10 patients, which led to minor modifications.

Reliability was assessed in a pilot study (n = 30), with acceptable internal consistency (Cronbach's α values: knowledge = 0.73, attitudes = 0.70, practices = 0.71). Inter-rater reliability showed high agreement (Cohen's κ = 0.85).

### 3.5. Data Collection Procedure

Data were collected through face-to-face interviews conducted by trained research assistants in a private setting in the dialysis unit. Interviews lasted approximately 20 – 25 minutes.

Data quality was ensured through regular supervision, random checks, and double data entry for a subset of questionnaires.

### 3.6. Scoring of Variables

Knowledge scores were calculated as the sum of correct responses (range: 0 – 14). Attitude and practice scores were calculated as the sums of Likert-scale responses (range: 12 – 36 each). Higher scores indicated better knowledge, more positive attitudes, and better practices.

For descriptive analysis, scores were categorized into tertiles (low, medium, and high) based on the sample distribution.

### 3.7. Statistical Analysis

Data were analyzed using SPSS version 25.0 and AMOS version 28 (IBM Corp.). Descriptive statistics were used to summarize participant characteristics and KAP scores. The Kolmogorov–Smirnov test indicated that KAP scores were

not normally distributed; therefore, nonparametric tests were applied.

Spearman's correlation was used to assess associations between variables. Group comparisons were performed using the Mann–Whitney U and Kruskal–Wallis tests.

Multivariate linear regression analysis was conducted to identify factors independently associated with KAP scores. Variables with $P < 0.10$ in bivariate analyses were included in the initial models, and backward elimination was applied. Multicollinearity was assessed using the variance inflation factor.

Structural equation modeling was performed to examine relationships between knowledge, attitudes, and practices. Model fit was evaluated using $\chi^2/df$, RMSEA, CFI, TLI, and SRMR indices. A $P < 0.05$ was considered statistically significant.

### 3.8. Ethical Considerations

The study was approved by the Research Ethics Committee of the Faculty of Medicine, Ibb University (Ref: FM-IBB-ERC2025-04). Written informed consent was obtained from all participants. For participants who were illiterate, the consent form was read aloud, and consent was documented using a thumbprint and a witness's signature. Confidentiality and anonymity were maintained throughout the study.

## 4. Results

### 4.1. Participant Characteristics

Of 280 eligible hemodialysis patients, 246 were included in the final analysis (87.9% response rate). Reasons for exclusion were refusal (n = 18), cognitive or communication impairment (n = 8), critical illness (n = 5), and incomplete data (n = 3).

Participant characteristics are summarized in Table 1. Most participants were male (57.3%) and aged < 50 years (67.1%). Over half resided in urban areas (52.8%). Low educational attainment was common (68.7% were illiterate or had primary education). Most participants were unemployed (87.4%). Hypertension (84.6%) was the most frequent comorbidity, followed by heart disease (34.6%) and diabetes (21.1%). Most participants (89.4%) reported regular medication use.

**Table 1.** Baseline Characteristics of Study Participants (n = 246) [a]

| Variables | Values |
|---|---|
| **Gender** | |
| Male | 141 (57.3) |
| Female | 105 (42.7) |
| **Age (y)** | |
| < 50 | 165 (67.1) |
| ≥ 50 | 81 (32.9) |
| **Residence** | |
| Rural | 116 (47.2) |
| Urban | 130 (52.8) |
| **Educational level** | |
| Illiterate | 95 (38.6) |
| Primary | 74 (30.1) |
| Secondary | 51 (20.7) |
| University or higher | 26 (10.6) |
| **Occupation** | |
| Employed | 31 (12.6) |
| Unemployed | 215 (87.4) |
| **Marital status** | |
| Married | 201 (81.7) |
| Unmarried | 34 (13.8) |
| Widowed | 11 (4.5) |
| **Duration of kidney disease** | |
| < 1 year | 22 (8.9) |
| 1-5 years | 106 (43.1) |
| > 5 years | 118 (48.0) |
| **Duration of dialysis** | |
| < 1 year | 36 (14.6) |
| 1-5 years | 124 (50.4) |
| > 5 years | 86 (35.0) |
| **Comorbidities** [b] | |
| Hypertension | 208 (84.6) |
| Heart disease | 85 (34.6) |
| Diabetes mellitus | 52 (21.1) |
| **Regular prescribed medication use** | |
| Yes | 220 (89.4) |
| No | 26 (10.6) |

[a] Values are expressed as No. (%).

[b] Multiple responses were allowed.

### 4.2. Knowledge, Attitudes, and Practices Scores

The mean knowledge score was 7.37 ± 3.13 (52.6%), the mean attitude score was 26.00 ± 3.82 (72.2%), and the mean practice score was 24.65 ± 3.86 (68.5%) (Table 2).

Based on tertile classification, 39.8% of participants had low knowledge scores and 41.9% had low practice scores,

**Table 2.** Knowledge, Attitudes, and Practices Scores (n = 246) [a]

| Domain and Category | Possible Range | Mean ± SD | % of Maximum | No. (%) |
|---|---|---|---|---|
| **Knowledge** | 0 - 14 | 7.37 ± 3.13 | 52.6 | |
| Low (0 – 6) | | | | 98 (39.8) |
| Medium (7 – 9) | | | | 82 (33.3) |
| High (10 – 14) | | | | 66 (26.8) |
| **Attitudes** | 12 - 36 | 26.00 ± 3.82 | 72.2 | |
| Low (12 – 24) | | | | 82 (33.3) |
| Medium (25 – 27) | | | | 82 (33.3) |
| High (28 – 36) | | | | 82 (33.3) |
| **Practices** | 12 - 36 | 24.65 ± 3.86 | 68.5 | |
| Low (12 – 23) | | | | 103 (41.9) |
| Medium (24 – 26) | | | | 72 (29.3) |
| High (27 – 36) | | | | 71 (28.9) |

[a] Scores were categorized into tertiles based on the sample distribution. Higher scores indicate better knowledge, more positive attitudes, and better practices. Abbreviation: SD, standard deviation.

**Table 3.** Bivariate Correlations Between KAP Scores and Participant Characteristics (n = 246) [a]

| Variables | Knowledge | Attitudes | Practices |
|---|---|---|---|
| **Knowledge** | 1.000 | 0.350 (< 0.001) | 0.219 (< 0.001) |
| **Attitudes** | 0.350 (< 0.001) | 1.000 | 0.436 (< 0.001) |
| **Practices** | 0.219 (< 0.001) | 0.436 (< 0.001) | 1.000 |
| **Age** | −0.234 (< 0.001) | −0.261 (< 0.001) | −0.155 (0.015) |
| **Education level** | 0.291 (< 0.001) | 0.237 (< 0.001) | 0.166 (0.009) |
| **Occupation** | −0.218 (< 0.001) | −0.079 (0.216) | −0.131 (0.040) |
| **History of kidney removal** | −0.142 (0.026) | −0.008 (0.903) | 0.098 (0.125) |
| **Hypertension** | 0.020 (0.749) | −0.152 (0.017) | −0.144 (0.024) |
| **Regular prescribed medication use** | −0.036 (0.577) | −0.060 (0.346) | −0.177 (0.005) |
| **Duration of kidney disease** | 0.038 (0.558) | 0.158 (0.013) | 0.035 (0.583) |
| **Duration of dialysis** | 0.019 (0.770) | 0.152 (0.017) | −0.010 (0.876) |

[a] Values are expressed as r (P-value); P-values are two-tailed. Abbreviations: r, Spearman's correlation coefficient; KAP, knowledge, attitudes, and practices.

whereas attitudes were evenly distributed across categories (Table 2).

Item-level analysis revealed specific knowledge gaps, particularly regarding diuretics and potassium control (21.5% correct) and the identification of dried fruits as high-potassium foods (37.0% correct) (Supplementary Table S1). Attitude responses indicated generally positive perceptions, with most participants agreeing on the importance of potassium control and expressing trust in health care providers (Supplementary Table S2). Regarding practices, medication adherence was relatively high (71.1% "always"), whereas self-management behaviors, such as food recording (14.2%), meal preparation for potassium control (12.6%), and food label checking (12.2%), were uncommon (Supplementary Table S3).

### 4.3. Bivariate Analysis

Knowledge, attitude, and practice scores were positively correlated (Table 3). The strongest association was observed between attitudes and practices ($r = 0.436$, $P < 0.001$), followed by knowledge–attitude ($r = 0.350$, $P < 0.001$) and knowledge–practice ($r = 0.219$, $P < 0.001$).

Age and education were positively associated with all KAP domains ($P < 0.05$). Hypertension showed negative correlations with attitudes ($r = -0.152$, $P = 0.017$) and practices ($r = -0.144$, $P = 0.024$). Regular medication use

**Table 4.** Multivariate Linear Regression Analysis of Factors Associated with KAP Scores (n = 246) [a]

| Variables | Knowledge | | Attitudes | | Practices | |
|---|---|---|---|---|---|---|
| | β (95% CI) | P-Value | β (95% CI) | P-Value | β (95% CI) | P-Value |
| **Age (< 50 vs ≥ 50)** | −0.249 (−1.372 to −0.540) | < 0.001 | −0.211 (−1.246 to −0.192) | 0.021 | −0.090 (−0.739 to 0.341) | 0.179 |
| **Education level** | 0.219 (0.627 to 1.038) | 0.001 | 0.207 (0.785 to 1.271) | 0.002 | 0.128 (0.489 to 1.026) | 0.074 |
| **Occupation** | −0.121 (−1.142 to 0.011) | 0.052 | — | — | −0.099 (−1.153 to 0.337) | 0.129 |
| **History of kidney removal** | −0.139 (−1.688 to −0.170) | 0.017 | — | — | — | — |
| **Hypertension** | — | — | −0.192 (−2.028 to −0.769) | 0.002 | −0.097 (−1.036 to 0.434) | 0.166 |
| **Duration of dialysis** | — | — | 0.144 (0.815 to 1.491) | 0.018 | — | — |
| **Regular prescribed medication use** | — | — | — | — | −0.140 (−1.755 to −0.053) | 0.043 |

[a] Reference groups: age (< 50 years), education (illiterate), occupation (employed), hypertension (no), and medication use (no). Abbreviations: β, standardized regression coefficient; CI, confidence interval; KAP, knowledge, attitudes, and practices.

was inversely associated with practice scores (r = −0.177, P = 0.005).

### 4.4. Multivariable Regression

In adjusted analyses (Table 4), higher education (β = 0.219, P = 0.001) and younger age (β = −0.249, P < 0.001) were independently associated with higher knowledge scores. A history of kidney removal was negatively associated with knowledge (β = −0.139, P = 0.017).

For attitudes, younger age (β = −0.211, P = 0.021), higher education (β = 0.207, P = 0.002), longer dialysis duration (β = 0.144, P = 0.018), and absence of hypertension (β = −0.192, P = 0.002) were significant predictors.

For practices, only regular medication use remained significant (β = −0.140, P = 0.043).

### 4.5. Structural Equation Modeling

Structural equation modeling (SEM) demonstrated acceptable fit ($\chi^2$/df = 3.842, RMSEA = 0.068, SRMR = 0.061, CFI = 0.887, TLI = 0.851).

Education was positively associated with knowledge, attitudes, and practices. Knowledge was positively associated with attitudes (β = 0.350, P < 0.001) but negatively associated with practices (β = −0.172, P = 0.010). Attitudes showed a strong positive association with practices (β = 0.436, P < 0.001). The model explained 24.7% of the variance in practice scores.

## 5. Discussion

In this study, we found that overall knowledge regarding hyperkalemia management among Yemeni hemodialysis patients was moderate, with a mean correct score of 52.6%. Attitudes were generally positive (72.2% of the maximum score), whereas self-reported practices were suboptimal (68.5% of the maximum). Younger age and higher education were associated with better scores across all domains. Given the cross-sectional design, all observed relationships should be interpreted as associations rather than causal effects.

Hyperkalemia can precipitate life-threatening cardiac arrhythmias by altering myocardial membrane potential (17). Therefore, effective self-management is essential for patient safety in hemodialysis populations (18-20).

In our study, the mean knowledge score was 7.37 out of 14 (52.6%). This finding is similar to findings from Jazan, Saudi Arabia, where only 20.2% of hemodialysis patients demonstrated adequate knowledge about potassium-rich diets (equivalent to approximately 55% correct on comparable items) (6). In Jordan, Khalil et al. reported that 61% of patients had poor dietary knowledge (21), and in Kuwait, expert consensus highlighted knowledge deficits in 68% of patients (22). In contrast, a study from Shenzhen, China, a higher-resource setting, reported a mean knowledge score of 12.9 out of 14 (92.1%) (5). These differences likely reflect disparities in healthcare infrastructure, access to dietitians, and structured patient education.

Examination of item-level knowledge responses identified important gaps in three key areas. First, pharmacological knowledge was limited: only 21.5% of patients were aware that some diuretics may help reduce potassium levels. Similarly low awareness (18%) was

reported for medication-related items in the Jazan study (6).

Second, recognition of high-potassium foods was suboptimal. Only 37.0% of participants correctly identified dried fruits (e.g., dates, figs, raisins) as high in potassium. This finding is notable given the frequent consumption of these foods in the local diet. A comparable Middle Eastern study reported a similar pattern, with 41% correctly identifying dates as high-potassium foods (6, 23).

Third, knowledge of practical dietary management strategies was limited. Only 30.9% of participants knew that boiling vegetables may reduce potassium content, and 27.2% understood the role of potassium binders. In contrast, a study from Shenzhen reported that more than 90% of patients answered similar items correctly (5).

These findings indicate specific knowledge deficits, particularly in pharmacological understanding, food identification, and practical dietary techniques. Clinically, these gaps are relevant in settings where dietary counseling may be limited and laboratory monitoring is not consistently accessible (12, 13). However, these observations reflect associations within the study population and should not be interpreted as causal determinants of behavior.

In this study, attitudes were generally positive, with most participants acknowledging the importance of potassium control and expressing trust in healthcare providers. However, self-efficacy remained limited, as only some patients felt confident in following a low-potassium diet. This mismatch between general attitudes and behavioral confidence has been widely reported in chronic disease populations (6, 24). Such discrepancies may reflect environmental constraints, limited dietary options, and low self-efficacy rather than a lack of awareness.

From a behavioral science perspective, this pattern aligns with established health behavior theories, such as the Health Belief Model and the Theory of Planned Behavior, which suggest that attitudes alone are insufficient to drive behavior without perceived control and enabling conditions (10, 11). In this context, attitudes may act as a key mediating construct between knowledge and practice rather than as a direct determinant of behavior.

In this study, practice levels were suboptimal, particularly for dietary self-management behaviors such as food labeling, dietary recording, and meal preparation. In contrast, medication adherence was relatively high. This pattern of high medication adherence but poor dietary self-management mirrors findings from South India, where 78% adhered to medications but only 34% followed dietary advice (8). These findings suggest that behavioral interventions should extend beyond knowledge provision and incorporate structured skill-building and reinforcement strategies.

Multivariable analysis showed that younger age and higher educational level were associated with better knowledge and attitudes. This finding is consistent with prior studies reporting a strong relationship between educational attainment and health literacy in chronic kidney disease populations (6, 21-23, 25). These associations likely reflect differences in comprehension, access to information, and ability to apply dietary recommendations.

Previous studies have identified a significant association between knowledge, attitudes, practices, and income (25). However, this relationship was not examined in the current study, which was conducted in a governmental setting where all participants were economically disadvantaged.

The negative association between regular medication use and practice scores may suggest that patients who rely more on pharmacological management may perceive less need for dietary control. However, this interpretation remains speculative. Given the cross-sectional design, this finding should be considered an association only and requires confirmation in longitudinal studies.

Although we did not directly measure socioeconomic status, the broader humanitarian context in Yemen, characterized by poverty, food insecurity, and disrupted healthcare systems, likely contributes to difficulties in dietary self-management. These contextual constraints may partially explain the suboptimal practices observed in this study.

Structural equation modeling indicated that attitudes were strongly associated with practices, whereas knowledge influenced practices indirectly through attitudes. This finding is consistent with previous findings from Shenzhen, where attitudes demonstrated a strong association with behavioral outcomes (5). These results support the role of attitudes as a key mediating construct in self-management behavior, in line with behavioral theory frameworks.

The model also showed a negative direct association between knowledge and practices. This finding should be interpreted cautiously and not as evidence of a causal inverse relationship. Several noncausal explanations may account for this observation. First, statistical suppression may occur when the indirect pathway (from knowledge through attitudes to practices) obscures the direct effect. Second, measurement differences between declarative knowledge ("knowing that") and procedural behavior ("knowing how") may contribute to inconsistent associations. Third, reverse causality may be possible, whereby patients experiencing poor control may seek more knowledge after clinical deterioration. Fourth, unmeasured confounding factors, such as health literacy, food insecurity, psychological distress, and cultural dietary practices, may influence both knowledge and behavior in opposite directions. Therefore, this result reflects a modeled statistical association rather than a true causal effect.

Regarding model performance, the SEM fit indices for CFI and TLI were slightly below conventional thresholds. However, the RMSEA and SRMR values were within acceptable ranges. Given the exploratory nature of this analysis and the complex humanitarian context, model fit was considered acceptable but not confirmatory. These findings should therefore be interpreted as hypothesis-generating.

Overall, the model explained a modest proportion of the variance in practice behavior, consistent with previous studies in hemodialysis populations. Dietary self-management is influenced by multiple interacting factors, including cultural habits, economic constraints, food availability, and psychosocial conditions (26-29), many of which were not captured in this model.

### 5.1. Implications

These findings suggest that improving knowledge alone is unlikely to meaningfully improve self-management behavior. Interventions should instead focus on strengthening attitudes, self-efficacy, and practical dietary skills. Given the associational nature of this study, these recommendations should be tested in future longitudinal or interventional research before implementation at scale (18, 19, 30).

### 5.2. Study Limitations

This study has several limitations. First, the single-center design limits generalizability. Second, self-reported practices may be subject to recall and social desirability bias. Third, important variables, including income, food security, health literacy, and psychological stress, were not measured. Fourth, the cross-sectional design precludes causal inference; therefore, all findings should be interpreted as associations only. Fifth, SEM fit indices were slightly below conventional thresholds, indicating that the results should be interpreted cautiously. Sixth, the modest explained variance suggests that additional determinants of dietary behavior remain unmeasured. Future multicenter, longitudinal, and interventional studies are needed to clarify causal pathways.

### 5.3. Conclusions

Hemodialysis patients demonstrated moderate knowledge, relatively positive attitudes, and suboptimal practices regarding hyperkalemia management. Age and educational level were associated with knowledge, attitudes, and practices (KAP) scores, and attitudes showed a strong association with practices.

These findings indicate the need for targeted and practical educational interventions to improve self-management among hemodialysis patients.

## Footnotes

**AI Use Disclosure:** The authors declare that they did not use generative AI tools to create this article.

**Authors' Contribution:** Study concept and design: Khaled Alzanen, Basheer Abdo, and Nabil Albaadani; data acquisition: Khaled Alzanen, Basheer Abdo, Nabil Albaadani, and Faisal Ahmed; data analysis and interpretation: Khaled Alzanen, Basheer Abdo, and Faisal Ahmed; drafting of the manuscript: Khaled Alzanen and Basheer Abdo; critical revision of the manuscript for important intellectual content: Nabil Albaadani and Faisal Ahmed; statistical analysis: Khaled Alzanen and Basheer Abdo; administrative, technical, and material support: Nabil Albaadani and Faisal Ahmed; study supervision: Basheer Abdo and Nabil Albaadani.

**Conflict of Interests Statement:** The authors do not declare any conflicts of interests for this study.

**Data Availability:** The dataset presented in this study is available from the corresponding author upon request. The data are not publicly available because of privacy and ethical restrictions, as they contain potentially identifiable information about patients in a vulnerable population within a conflict-affected region.

**Ethical Approval:** This study was approved by the Ethics Committee of the Faculty of Medicine and Health Sciences at Ibb University, Ibb, Yemen. The ethical approval code was FM-IBB-ERC2025-04. The approval letter is available for verification by the editorial office upon request.

**Funding/Support:** This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The study was conducted as part of the authors' academic and clinical duties, with institutional support from Ibb University, School of Medicine, and the participating hemodialysis center.

**Informed Consent:** Informed consent was obtained from all individual participants included in the study. Each potential participant received a written information sheet explaining the study's purpose, procedures, risks, benefits, and the right to withdraw. Written consent was obtained before questionnaire administration. The signed informed consent forms are retained by the principal investigator and are available for review by the journal upon request.

## References

1. Gupta S, Dominguez M, Golestaneh L. Diabetic kidney disease: An update. *Med Clin North Am*. 2023;**107**(4):689-705. [PubMed ID: 37258007]. https://doi.org/10.1016/j.mcna.2023.03.004.
2. Pun PH, Goldstein BA, Gallis JA, Middleton JP, Svetkey LP. Serum potassium levels and risk of sudden cardiac death among patients with chronic kidney disease and significant coronary artery disease. *Kidney Int Rep*. 2017;**2**(6):1122-1131. [PubMed ID: 29270520]. [PubMed Central ID: PMC5733834]. https://doi.org/10.1016/j.ekir.2017.07.001.
3. Bansal S, Pergola PE. Current management of hyperkalemia in patients on dialysis. *Kidney Int Rep*. 2020;**5**(6):779-789. [PubMed ID: 32518860]. [PubMed Central ID: PMC7270720]. https://doi.org/10.1016/j.ekir.2020.02.1028.
4. Kovesdy CP, Rowan CG, Conrad A, Spiegel DM, Fogli J, Oestreicher N, et al. Real-world evaluation of patiromer for the treatment of hyperkalemia in hemodialysis patients. *Kidney Int Rep*. 2019;**4**(2):301-309. [PubMed ID: 30775627]. [PubMed Central ID: PMC6365398]. https://doi.org/10.1016/j.ekir.2018.10.020.
5. Li G, Peng W, Kong H, Hu F, Huang J, Han X, et al. Knowledge, attitudes and practices among patients with end-stage kidney disease towards hyperkalaemia management in Shenzhen, China: A cross-sectional study. *BMJ Open*. 2025;**15**(3). e092619. [PubMed ID: 40122543]. [PubMed Central ID: PMC11934380]. https://doi.org/10.1136/bmjopen-2024-092619.
6. Somaili M, Akoor A, Refaei E, Deibaji M, Aqeel AA, Ghulaysi S, et al. Cross-sectional study for assessment of knowledge, attitudes and practices of chronic kidney disease patients toward potassium-rich diet intake in Jazan-Saudi Arabia. *Medicine (Baltimore)*. 2025;**104**(19). e42260. [PubMed ID: 40355184]. [PubMed Central ID: PMC12074114]. https://doi.org/10.1097/md.0000000000042260.
7. Li Z, Song L, Hua R, Xia F, Hu D, Luo Z, et al. Knowledge, attitudes, and practices toward cardiovascular complications among end-stage renal disease patients undergoing maintenance hemodialysis. *BMC Public Health*. 2024;**24**(1):1448. [PubMed ID: 38816734]. [PubMed Central ID: PMC11138052]. https://doi.org/10.1186/s12889-024-18945-5.
8. Shanmugapriya K, Yuvaraj S, Vishnupriya D, Vinitha K, Vijayanila G, Zamrun Begam T, et al. Assessment of knowledge on dietary management of chronic kidney disease among patients undergoing hemodialysis at a tertiary care hospital in south India: A cross-sectional analytical study. *Cureus*. 2024;**16**(3). e55342. [PubMed ID: 38559520]. [PubMed Central ID: PMC10981922]. https://doi.org/10.7759/cureus.55342.
9. Poudel P, Griffiths R, Wong VW, Arora A, Flack JR, Khoo CL, et al. Oral health knowledge, attitudes and care practices of people with diabetes: A systematic review. *BMC Public Health*. 2018;**18**(1):577. [PubMed ID: 29716561]. [PubMed Central ID: PMC5930945]. https://doi.org/10.1186/s12889-018-5485-7.
10. Khalid A, Haque S, Alvi S, Ferdous M, Genereux O, Chowdhury N, et al. Promoting health literacy about cancer screening among Muslim immigrants in Canada: Perspectives of imams on the role they can play in community. *J Prim Care Community Health*. 2022;**13**. [PubMed ID: 35118911]. [PubMed Central ID: PMC8819818]. https://doi.org/10.1177/21501319211063051.
11. Shubayr MA, Kruger E, Tennant M. Oral health providers' views of oral health promotion in Jazan, Saudi Arabia: A qualitative study. *BMC Health Serv Res*. 2023;**23**(1):214. [PubMed ID: 36879255]. [PubMed Central ID: PMC9990294]. https://doi.org/10.1186/s12913-023-09170-8.
12. Ghabisha A, AlShoaibi IA, Ahmed F, Ghabisha SA, Abdo B. Predictors of mortality among hemodialysis patients at Al-Thora General Hospital, Ibb Governate, Yemen: A retrospective study. *Cureus*. 2024;**16**(7). e65457. [PubMed ID: 39184771]. [PubMed Central ID: PMC11345099]. https://doi.org/10.7759/cureus.65457.
13. Salem A, Rosen A, Alharazi I, Gamallat Y, Aldbyani A, Amer B, et al. Healthcare accessibility in Yemen's conflict zones: Comprehensive review focused on strategies and solutions. *Confl Health*. 2025;**19**(1):42. [PubMed ID: 40660296]. [PubMed Central ID: PMC12261687]. https://doi.org/10.1186/s13031-025-00685-x.
14. Zevallos-Aquije A, Zevallos-Aquije A, Salas-Bolaños RA, Maravi-Cardenas A, Palomino-Salcedo K. Strategies for hyperkalemia management in dialysis patients: A systematic review. *Open Med (Wars)*. 2025;**20**(1):20251301. [PubMed ID: 41216195]. [PubMed Central ID: PMC12596852]. https://doi.org/10.1515/med-2025-1301.
15. Putcha N, Allon M. Management of hyperkalemia in dialysis patients. *Semin Dial*. 2007;**20**(5):431-439. [PubMed ID: 17897250]. https://doi.org/10.1111/j.1525-139X.2007.00312.x.
16. Chen Z, Xu N, Chen X, Zhang X, Yin S, Xiao G, et al. Dietary knowledge-attitude-practice status in hemodialysis patients: A latent profile

analysis. *BMC Public Health*. 2024;**24**(1):836. [PubMed ID: 38500120]. [PubMed Central ID: PMC10946152]. https://doi.org/10.1186/s12889-024-18066-z.

17. Hunter RW, Bailey MA. Hyperkalemia: Pathophysiology, risk factors and consequences. *Nephrol Dial Transplant*. 2019;**34**(Suppl 3):iii2-11. [PubMed ID: 31800080]. [PubMed Central ID: PMC6892421]. https://doi.org/10.1093/ndt/gfz206.
18. Azizi Z, Biparva Haghighi S, Haghighizadeh MH, Sayadi N, Shariati A, Tirom S. Effects of continuous nursing care on hemodialysis patients' quality of life and lifestyle: An application of the information, knowledge, attitude, and practice theory. *Jundishapur J Chronic Dis Care*. 2024;**13**(2). e141089. https://doi.org/10.5812/jjcdc-141089.
19. Rafiee-Vardanjani L, Arsalani N, Mohammadi-Shahbolaghi F, Norouzi Tabrizi K. Self-management in hemodialysis patients: A concept analysis. *J Nurs Midwifery Sci*. 2025;**12**(2). e158696. https://doi.org/10.5812/jnms-158696.
20. Alshalawi S, Aljedaani S, Fintyanh D, Salim S, Fairaq W, Refaei S. The effect of nurse-patient communication on patient satisfaction in the emergency department. *J Nurs Midwifery Sci*. 2025;**12**(1). e158740. https://doi.org/10.5812/jnms-158740.
21. Khalil AA, Darawad M, Al Gamal E, Hamdan-Mansour AM, Abed MA. Predictors of dietary and fluid non-adherence in Jordanian patients with end-stage renal disease receiving haemodialysis: A cross-sectional study. *J Clin Nurs*. 2013;**22**(1-2):127-136. [PubMed ID: 22686337]. https://doi.org/10.1111/j.1365-2702.2012.04117.x.
22. AlSahow A, Bulbanat B, Alhelal B, Alhumoud K, Alkharaza A, Alotaibi T, et al. Management of hyperkalemia: Expert consensus from Kuwait - a modified Delphi approach. *Int J Nephrol Renovasc Dis*. 2024;**17**:227-240. [PubMed ID: 39386062]. [PubMed Central ID: PMC11463172]. https://doi.org/10.2147/ijnrd.S476344.
23. AlSahow A, AbdulShafy M, Al-Ghamdi S, AlJoburi H, AlMogbel O, Al-Rowaie F, et al. Prevalence and management of hyperkalemia in chronic kidney disease and heart failure patients in the Gulf Cooperation Council (GCC). *J Clin Hypertens (Greenwich)*. 2023;**25**(3):251-258. [PubMed ID: 36715554]. [PubMed Central ID: PMC9994174]. https://doi.org/10.1111/jch.14633.
24. Kayamkani AK, Alawi GF, Ghaith MM, Kiki LR, Nakiti RH, Akondi BR. Assessment of knowledge and attitude regarding self-care among patients undergoing hemodialysis. *Medical Science*. 2023;**27**(137):1-11. https://doi.org/10.54905/disssi/v27i137/e300ms3100.
25. Kanagarajah S, Velraja S, Arambakkam HJ. Knowledge, attitude, and practices of renal diets among hemodialysis patients. *Biomed Biotechnol Res J*. 2022;**6**(1):86-92. https://doi.org/10.4103/bbrj.bbrj_200_21.
26. Lim JH, Chinna 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**(20):7479. [PubMed ID: 33066603]. [PubMed Central ID: PMC7602379]. https://doi.org/10.3390/ijerph17207479.
27. Yasin F, Khraim F, Santos M, Forgrave D, Hamad A. Factors influencing self-care management in adult hemodialysis patients: An integrative review. *Qatar Med J*. 2024;**2024**(1):12. [PubMed ID: 38654818]. [PubMed Central ID: PMC11037095]. https://doi.org/10.5339/qmj.2024.12.
28. Farris O, Orbell S, Lamarche VM, Smith R. Promoting self-management in chronic disease: A systematic review and meta-analysis of behaviour change interventions for patients on dialysis. *Health Psychol Rev*. 2025;**19**(2):368-408. [PubMed ID: 40035473]. https://doi.org/10.1080/17437199.2025.2471775.
29. Lockwood G, Davey L, McFarlane C, Gray NA, Wright HH. Factors influencing meal provision and dietary support behaviour of caregivers of people with chronic kidney disease: A cross-sectional study. *Nutrients*. 2024;**16**(20):3479. [PubMed ID: 39458474]. [PubMed Central ID: PMC11510062]. https://doi.org/10.3390/nu16203479.
30. Milazi M, Bonner A, Douglas C. Effectiveness of educational or behavioral interventions on adherence to phosphate control in adults receiving hemodialysis: A systematic review. *JBI Database System Rev Implement Rep*. 2017;**15**(4):971-1010. [PubMed ID: 28398983]. https://doi.org/10.11124/jbisrir-2017-003360.