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Assessment of Knowledge, Attitudes, and Practices Among Patients with End-Stage Kidney Disease Towards Hyperkalemia Management at the Dialysis Center In Ibb City, Yemen

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Abstract

Background: End-stage kidney disease (ESKD) is a prevalent condition, with hyperkalemia representing a life-threatening complication. This study assessed knowledge, attitudes, and practices (KAP) regarding hyperkalemia management among ESKD patients at the dialysis center in Ibb.

City, Yemen.

Methods: A descriptive cross-sectional study was conducted on 246 ESKD patients selected through convenience sampling. Data were collected using a structured questionnaire that underwent expert review and pilot testing (n=25). Analysis employed SPSS 27.

Results: Participants were predominantly male (57.3%), aged <50 years (67.1%), and urban residents (52.8%). Low educational attainment (illiterate/primary only) characterized 68.7% of participants. Mean scores were: knowledge 7.37/14 (52.6%), attitudes 26.00/36 (72.2%), and practices 24.65/36 (68.5%). Significant correlations existed between all KAP domains: knowledge-attitudes (r=0.350), attitudes-practices (r=0.436), and knowledge-practices (r=0.219), all p=0.001. Regression analysis identified younger age (p=0.001) and higher education (p=0.003) as predictors of better knowledge, while kidney removal was associated with lower scores (p=0.029). Hypertension was negatively associated with attitudes (p=0.002), whereas longer dialysis duration was positively associated with attitudes (p=0.018). Regular medication use negatively predicted practice scores (p=0.043).

Conclusions: Patients with ESKD enrolled in this study have moderate knowledge and practices regarding hyperkalemia management, and their attitudes are predominantly positive. Demographic and clinical factors, particularly education, age, and comorbidities, significantly influence KAP. Tailored educational interventions to address low health literacy and bridge the knowledge-practice gap are urgently needed.

Introduction

End-stage kidney disease (ESKD) represents the final, irreversible stage of chronic kidney disease (CKD), in which renal replacement therapy, such as dialysis, becomes essential for patient survival (Sarnowski et al., 2022). Patients with ESKD face a complex treatment regimen, with hyperkalemia being one of the most critical and potentially life-threatening complications. Hyperkalemia, defined as serum potassium levels exceeding 5.0 mmol/L, disrupts normal myocardial electrophysiology and increases the risk of fatal cardiac arrhythmias and sudden cardiac death (Palmer et al., 2021).

The prevalence of hyperkalemia is notably high among patients with ESKD, a trend further exacerbated by the widespread use of renin-angiotensin-aldosterone system inhibitors (RAASi), which can impair renal potassium excretion (Sarnowski et al., 2022; Costa et al., 2023). Effective management of hyperkalemia is therefore essential to reduce morbidity and mortality in this population.

The management of hyperkalemia in patients with ESKD is multifaceted, encompassing pharmacological interventions, dialysis prescription optimization, and strict dietary modifications.

(Bansal & Pergola, 2020). Traditionally, dietary potassium restriction has been a cornerstone of hyperkalemia management. Patients are often advised to avoid high-potassium foods such as bananas, oranges, tomatoes, and potatoes (Somaili et al., 2025). However, recent evidence has called the effectiveness of this restrictive approach into question.

A recent evidence-based practice review by MacLaughlin et al. (2024) found no direct association between dietary potassium intake and serum potassium levels in observational studies of ESKD populations. The review also noted that no studies have explicitly evaluated dietary potassium reduction as a therapeutic intervention for hyperkalemia. These findings suggest that other factors, including potassium additives in processed foods and the overall quality of the diet, may play a more significant role than previously recognized (MacLaughlin et al., 2024).

In addition, newer oral potassium binders, such as patiromer and sodium zirconium cyclosilicate, offer promising options for the management of chronic hyperkalemia. These agents may reduce the need for overly restrictive diets and allow patients to continue essential RAASi therapy safely (Palmer et al., 2021; Costa et al., 2023).

Despite advances in clinical management strategies, the effectiveness of any treatment plan for hyperkalemia in ESKD patients largely depends on the patient's knowledge, beliefs, and daily behaviors. This relationship is conceptualized through the Knowledge, Attitudes, and Practices (KAP) framework. Within this model, **knowledge** refers to the patient's understanding of hyperkalemia, its causes, and its management. **Attitudes** encompass beliefs, perceptions, and willingness to adhere to medical advice. **Practices** represent the tangible actions and behaviors that patients implement in their daily lives, particularly regarding diet and medication adherence.

A persistent knowledge-practice gap has been documented in this population. For example, a study conducted in Jazan, Saudi Arabia, reported that 79.8% of ESKD patients had limited knowledge of potassium-rich foods, and only 26% routinely checked food labels for potassium content (Somaili et al., 2025). Similarly, research in South India found that although 86% of hemodialysis patients possessed a moderate level of knowledge about dietary management, their practical application of this knowledge remained suboptimal (Shanmugapriya et al., 2024). These findings underscore the critical need to address both patient education and behavior modification in the management of hyperkalemia.

The interplay among the KAP dimensions is complex. Chen et al. (2024) identified two distinct latent profiles in hemodialysis patients: one group (40.2% of the sample) exhibited general knowledge and positive attitudes but low practice, while the other group (59.8%) demonstrated general knowledge, positive attitudes, and high practice. Their structural equation model indicated that knowledge positively influences attitudes, which in turn strongly affect practices. These findings underscore that knowledge alone is insufficient; fostering positive attitudes is critical for translating knowledge into proactive self-care behaviors.

A recent cross-sectional study in Shenzhen, China, that specifically examined hyperkalemia management in ESKD patients found that participants had sufficient knowledge and favorable attitudes toward hyperkalemia management. However, the study revealed that attitudes exerted a much stronger direct effect on practices (coefficient = 0.549) than knowledge did (coefficient = -0.130), highlighting the mediating role of attitudes in promoting effective self-management (Li et al., 2025).

Socio-demographic factors further influence the KAP landscape in ESKD patients. Education level, income, and employment status have been significantly associated with KAP scores. In Saudi Arabia, lower educational attainment was associated with poorer knowledge and less favorable attitudes toward ESKD prevention (Alghamdi et al., 2023). Similarly, in India, knowledge levels were significantly associated with age, occupation, and dialysis duration (Shanmugapriya et al., 2024). These findings emphasize the importance of providing tailored, individualized patient education that accounts for each patient's specific socioeconomic and educational background.

In Yemen, years of conflict have severely damaged the healthcare system, resulting in crippled infrastructure, limited resources, and reduced access to specialized care. Ibb City, a major urban center, experiences these challenges particularly acutely. Dialysis patients are especially vulnerable in this context. Despite this, there is a critical gap in the literature regarding the hyperkalemia-specific knowledge, attitudes, and practices of ESKD patients receiving care in resource-limited settings. Understanding these patients' perspectives, challenges, and current practices is essential for developing effective, context-appropriate educational and clinical interventions. Therefore, this study aimed to assess knowledge, attitudes, and practices regarding hyperkalemia management among patients with end-stage kidney disease at a dialysis center in Ibb City, Yemen.

Methods

Study Design and Setting

A descriptive cross-sectional design was employed to assess the knowledge, attitudes, and practices regarding hyperkalemia management among patients with end-stage kidney disease (ESKD) attending the dialysis center at Al-Thawra Hospital in Ibb City, Yemen. The study was conducted over seven months from April to October 2025.

Study Population and Selection Criteria

The target population comprised all adult patients with kidney failure receiving care at the dialysis center in Ibb City during the study period.

Inclusion criteria

Adult patients aged 18 years or older. Confirmed diagnosis of kidney failure (acute or chronic). Regular attendance at the dialysis center during the study period. Willingness to participate. Patients with ESKD

undergoing hemodialysis

Exclusion criteria

Patients with severe comorbid conditions impairing communication or cognitive function. Patients who declined to participate in the study. Critically ill patients are admitted to intensive care units.

Sample Size and Sampling Method

The sample size was calculated using the standard formula for cross-sectional studies: $N = Z^2 \times P \times (1-P) / d^2$. Based on an expected proportion (P) of 0.80, a 95% confidence level (Z = 1.96), and a margin of error (d) of 0.05, the minimum required sample size was determined to be 246 participants. A convenience sampling method was utilized to select participants who met the inclusion criteria during the study period.

Data Collection Tool

The data collection instrument was a researcher-administered questionnaire developed following a comprehensive review of relevant literature, particularly informed by the work of Li et al. (2025). The questionnaire comprised five distinct sections: **Demographic information** (age, gender, residence, educational level, occupation, and marital status). **Medical history**: duration of kidney disease, history of kidney removal, dialysis status and duration, frequency of hospitalization, comorbidities (diabetes mellitus, hypertension, heart disease), and regular medication use.

Knowledge assessment

14 items with true/false response options, designed to evaluate patients' understanding of hyperkalemia causes, symptoms, and management

Attitude assessment

12 items measured on a three-point scale (negative, moderate, positive) to assess patients' beliefs and perceptions regarding hyperkalemia management

Practice assessment

12 items measured on a three-point scale (low, moderate, high) to evaluate patients' actual behaviors in managing their condition

Validity Tool

The validity of the questionnaire was established through two complementary approaches:

Content validity

The preliminary version of the questionnaire was reviewed by a panel of nephrology and public health experts, who evaluated the instrument for clarity, comprehensiveness, and relevance. Modifications, additions, and deletions were made based on their feedback to ensure content adequacy.

Construct validity

A pilot study was conducted with 25 patients to assess the instrument's objectivity, applicability, clarity, and feasibility. Item-total correlations were calculated using Spearman's rank correlation coefficient to examine the relationship between each item and its respective construct. All items demonstrated statistically significant correlations ($p < 0.001$), indicating strong construct validity (Table 1).

Table 1
Spearman's Rho Correlation Coefficients for Pilot Study Items.

Items		knowledge	Items	Attitude	Items	Practice
a1	Correlation Coefficient	.616**	b1	.557**	c1	.521**
	Sig. (2-tailed)	0.001		0.000		0.000
a2	Correlation Coefficient	.493**	b2	.509**	c2	.507**
	Sig. (2-tailed)	0.000		0.000		0.000
a3	Correlation Coefficient	.615**	b3	.417**	c3	.542**
	Sig. (2-tailed)	0.000		0.000		0.000
a4	Correlation Coefficient	.686**	b4	.259**	c4	.375**
	Sig. (2-tailed)	0.000		0.000		0.000
a5	Correlation Coefficient	.558**	b5	.599**	c5	.415**
	Sig. (2-tailed)	0.000		0.000		0.000
a6	Correlation Coefficient	.543**	b6	.324**	c6	.380**
	Sig. (2-tailed)	0.000		0.000		0.000
a7	Correlation Coefficient	.444**	b7	.308**	c7	.339**
	Sig. (2-tailed)	0.000		0.000		0.000
a8	Correlation Coefficient	.550**	b8	.136*	c8	.466**
	Sig. (2-tailed)	0.000		0.033		0.000
a9	Correlation Coefficient	.252**	b9	.319**	c9	.210**
	Sig. (2-tailed)	0.000		0.000		0.001
a10	Correlation Coefficient	.617**	b10	.657**	c10	.317**
	Sig. (2-tailed)	0.000		0.000		0.000
a11	Correlation Coefficient	.421**	b11	.267**	c11	.581**
	Sig. (2-tailed)	0.000		0.000		0.000
a12	Correlation Coefficient	.421**	b12	.265**	c12	.420**
	Sig. (2-tailed)	0.000		0.000		0.000
a13	Correlation Coefficient	.460**				

Items		knowledge	Items	Attitude	Items	Practice
	Sig. (2-tailed)	0.000				
a14	Correlation Coefficient	.435**				
	Sig. (2-tailed)	0.000				

Reliability Tool

The questionnaire's internal consistency was evaluated using Cronbach's alpha. The reliability coefficients were as follows: knowledge domain α = 0.75, attitude domain α = 0.76, practice domain α = 0.74, and overall questionnaire α = 0.82. These values indicate acceptable to good internal consistency across all domains.

KAP Scores

Knowledge Score: Knowledge was assessed using 14 binary items (0 = incorrect, 1 = correct). The total knowledge score was calculated by summing correct responses, yielding a possible range of 0 to 14. Based on the percentage of the maximum possible score, knowledge levels were categorized as: Very poor (1–20%), Poor (21–40%), Moderate (41–60%), High (61–80%), and Very high (81–100%). **Attitude Score**: Attitudes were assessed using 12 items on a three-point Likert scale, with scores assigned as follows: negative attitude = 1, moderate attitude = 2, positive attitude = 3. The total attitude score ranged from 12 to 36. Attitude levels were categorized based on percentage scores as: Very negative (1–20%), Negative (21–40%), Moderate (41–60%), Positive (61–80%), and very positive (81–100%). **Practice Score**: Practices were assessed using 12 items on a three-point scale: low practice = 1, moderate practice = 2, high practice = 3. The total practice score ranged from 12 to 36. Practice levels were categorized based on percentage scores as: Very poor: 1–20%, Poor: 21–40%, Moderate: 41–60%, High: 61–80%, Very high: 81–100%

Data Analysis

Data were coded, entered into Microsoft Excel, and subsequently transferred to the Statistical Package for the Social Sciences (SPSS) version 27 for analysis. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were calculated to summarize participant characteristics and KAP scores. The Kolmogorov-Smirnov test was employed to assess the normality of data distribution, which revealed a non-normal distribution. Consequently, non-parametric tests were utilized for inferential analyses. Spearman's rank correlation coefficient was calculated to examine relationships between knowledge, attitude, and practice scores, as well as between KAP domains and demographic variables. Correlation strength was interpreted as: weak (r = 0-0.25), fair (r = 0.25–0.5), good (r = 0.5–0.75), and excellent (r > 0.75). The Mann-Whitney U test and the Kruskal-Wallis H test were used to compare KAP scores across demographic and clinical subgroups. Variables demonstrating statistically significant

associations ($p < 0.05$) in bivariate analyses were entered into multivariate linear regression models to identify independent predictors of knowledge, attitude, and practice scores. Results were presented using unstandardized coefficients (B), standardized coefficients (β), 95% confidence intervals, and p-values. A significance level of $p < 0.05$ was adopted for all statistical tests.

Result

A total of 246 valid questionnaires were included in the final analysis. Among the participants, the majority were male (141, 57.3%), aged under 50 years (165, 67.1%), and residing in urban areas (130, 52.8%). Regarding educational attainment, a substantial proportion of participants were illiterate (95, 38.6%) or had completed only primary education (74, 30.1%). The vast majority were unemployed (215, 87.4%) and married (201, 81.7%). Clinically, most participants had been diagnosed with kidney disease for more than five years (118, 48.0%) and were receiving hemodialysis (242, 98.4%). Among those undergoing dialysis, the largest group had been receiving treatment for one to five years (124, 50.4%). The most prevalent comorbidity was hypertension (208, 84.6%), followed by heart disease (85, 34.6%) and diabetes mellitus (52, 21.1%). Nearly all participants reported regular medication use (220, 89.4%). In Table 2

Table 2
Demographic and Clinical Characteristics of Study Participants (N = 246)

Variable	Group	Frequency	Percent
Gender	Male	141	57.3
	Female	105	42.7
Age	< 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 state	Married	201	81.7
	Unmarried	34	13.8
	Widowed	11	4.5
Duration of kidney disease	Less than 1 year	22	8.9
	1 to 5 Years	106	43.1
	More than 5 years	118	48.0
History of kidney removal	Yes	15	6.1
	No	231	93.9
Dialysis status	On hemodialysis	242	98.4
	Not on hemodialysis	4	1.6
Duration of dialysis	Less than 1 year	36	14.6
	1 to 5 Years	124	50.4
	More than 5 years	86	35.0
How many times in the last year	1 to 2 times	97	39.4
	3 to 6 times	132	53.7

Variable	Group	Frequency	Percent
	More than 6 times	17	6.9
Diabetes mellitus	Yes	52	21.1
	No	194	78.9
Hypertension	Yes	208	84.6
	No	38	15.4
Heart disease	Yes	85	34.6
	No	161	65.4
Regular drug use	Yes	220	89.4
	No	26	10.6

Knowledge about Hyperkalemia

The maximum possible knowledge score was 14. The mean knowledge score was 7.37 (95% CI: 6.99–7.76) with a standard deviation of ± 3.12, and scores ranged from 0 to 12. The overall knowledge level regarding hyperkalemia management was moderate (52.6% of the maximum score). Analysis of knowledge categorization revealed that 41.9% of participants demonstrated high knowledge, 30.9% moderate knowledge, 12.6% low knowledge, and 12.2% very low knowledge. Only 2.4% of participants possessed very high knowledge—Figure 1.

Table 3 presents the frequency and percentage of correct and incorrect responses for each knowledge item. The three knowledge items with the highest correct response rates were: Item 5: "Some foods can cause an increase in blood potassium levels, requiring caution in consumption" (80.9% correct). Item 2: "Patients with kidney failure should avoid potassium-rich foods, such as dried seafood, and closely monitor their diet" (75.6% correct) Item 13: "Meal planning and monitoring potassium content are not necessary if the patient adheres to their medications" (73.2% correct; correctly identified as "not necessary") Conversely, several items demonstrated notably low correct response rates. The knowledge item with the lowest correct response rate was Item 7: "Certain types of diuretics are used to lower potassium levels" (21.5% correct). This was followed by Item 14: "Kidney failure is the only cause of elevated blood potassium" (31.3% correct) and Item 11: "Dried fruits are a healthy alternative to fresh fruits for patients with kidney failure" (37.0% correct).

Table 3
Knowledge about Hyperkalemia Among Participants (N = 246)

Item	Knowledge (F & %)	
	Incorrect	Correct
1. All patients with kidney failure need medications as part of their treatment.	227 (92.3%)	19 (7.7%)
2. Patients with kidney failure should avoid potassium-rich foods, such as dried seafood, and closely monitor their diet.	60 (24.4%)	186 (75.6%)
3. High blood potassium levels can be detected through a blood potassium test.	76 (30.9%)	170 (69.1%)
4. Doctors check blood potassium levels to determine if a person has hyperkalemia.	67 (27.2%)	179 (72.8%)
5. Some foods can cause an increase in blood potassium levels, requiring caution in consumption.	47 (19.1%)	199 (80.9%)
6. Not adhering to medications can lead to elevated blood potassium levels.	108 (43.9%)	138 (56.1%)
7. Certain types of diuretics are used to lower potassium levels.	193 (78.5%)	53 (21.5%)
8. Feeling tired and weak is a symptom of high blood potassium.	115 (46.7%)	131 (53.3%)
9. Patients with kidney failure should completely avoid leafy vegetables.	104 (42.3%)	142 (57.7%)
10. High blood potassium is a common health problem among patients with kidney failure.	102 (41.5%)	144 (58.5%)
11. Dried fruits are a healthy alternative to fresh fruits for patients with kidney failure.	155 (63.0%)	91 (37.0%)
12. Over-the-counter medications can cause elevated potassium levels.	143 (58.1%)	103 (41.9%)
13. Meal planning and monitoring potassium content are not necessary if the patient adheres to their medications.	66 (26.8%)	180 (73.2%)
14. Kidney failure is the only cause of elevated blood potassium.	169 (68.7%)	77 (31.3%)

F=Frequency; %=Percentage

4.3. Attitudes towards Hyperkalemia Management

The maximum possible attitude score was 36. The mean attitude score was 26.00 (95% CI: 25.5–26.5) with a standard deviation of ± 3.82, and scores ranged from 12 to 33. The overall attitude toward

hyperkalemia management was positive, with a score of 72.2% of the maximum possible. Analysis of attitude categorization revealed that 58.9% of participants demonstrated positive attitudes, 30.9% exhibited moderate attitudes, and 10.2% showed negative attitudes toward hyperkalemia management (Fig. 2).

Table 4 presents the detailed responses to each attitude item. A notable majority of patients expressed positive attitudes toward hyperkalemia management. The highest rate of positive attitudes was observed for Item 9: Belief in the value of sharing experiences with other patients (73.2%). Item 6: Complete trust in therapeutic strategies recommended by doctors (72.8%). Item 3: Willingness to follow prescribed medication regimens (69.9%). Item 7: Belief in the necessity of a comprehensive management approach (69.1%). Item 10: Willingness to learn more about foods to avoid for potassium control (67.9%). However, the findings revealed several areas of concern. A substantial proportion of patients (74.4%) correctly rejected the notion that disease prevention lies mainly with doctors (Item 4), affirming their own role in the process. Despite this, only 47.2% of participants expressed confidence in their personal ability to prevent elevated blood potassium (Item 5). Additionally, while most patients (69.5%) correctly disagreed that diet is insignificant when medications are taken as prescribed (Item 8), 20.3% held this misconception.

Table 4
Attitudes towards Hyperkalemia Management Among Participants (N = 246)

Variable	Attitude n(%)		
tem	**Positive**	**Moderate**	**Negative**
1. Having sufficient knowledge about high blood potassium is very important to me	151 (61.4%)	30 (12.2%)	65 (26.4%)
2. I believe regular medical check-ups play a key role in preventing high blood potassium.	166 (67.5%)	39 (15.9%)	41 (16.7%)
3. I am always willing to follow my prescribed medication regimen to prevent high blood potassium	172 (69.9%)	52 (21.1%)	22 (8.9%)
4. I believe that the responsibility for disease prevention lies mainly with doctors, not patients	28 (11.4%)	35 (14.2%)	183 (74.4%)
5. I trust my personal ability to prevent elevated blood potassium	116 (47.2%)	58 (23.6%)	72 (29.3%)
6. I fully trust the therapeutic strategies recommended by my doctors	179 (72.8%)	50 (20.3%)	17 (6.9%)
7. I believe managing high blood potassium requires a comprehensive approach integrating multiple aspects	170 (69.1%)	40 (16.3%)	36 (14.6%)
8. I believe diet does not significantly affect potassium levels if I adhere to my medications.	50 (20.3%)	25 (10.2%)	171 (69.5%)
9. I think sharing my experiences with other patients may help me manage my condition better.	180 (73.2%)	24 (9.8%)	42 (17.1%)
10. I am willing to learn more about the foods I should avoid to control potassium levels	167 (67.9%)	26 (10.6%)	53 (21.5%)
11. I believe exercise is not relevant to controlling blood potassium levels.	54 (22.0%)	44 (17.9%)	148 (60.2%)
12. I think psychological support is not necessary for dealing with kidney failure.	73 (29.7%)	10 (4.1%)	163 (66.3%)
Mean Score and Std. Deviation	26.00 (3.82), 72%		

Practices Related to Hyperkalemia

The maximum possible practice score was 36. The mean practice score was 24.65 (95% CI: 24.1–26.1) with a standard deviation of ± 3.86, and scores ranged from 12 to 36. The overall practice level for hyperkalemia management was moderate, accounting for 68.5% of the maximum possible score. Analysis of practice categorization revealed that 65.9% of participants demonstrated high practice levels, 14.2% very high, 19.1% moderate, and 0.8% low (Fig. 3).

Table 5 presents the detailed responses to each practice item. In the practice dimension, the results revealed strong adherence to certain clinical routines but significant gaps in daily self-management behaviors. A large majority of participants demonstrated high compliance with core medical instructions: Regular monitoring of weight changes (Item 7): 88.6%. Informing healthcare team about new medications or supplements (Item 12): 81.3%. Actively inquiring about new symptoms (Item 8): 81.3%. Strict adherence to medication regimens (Item 2): 71.1%. Following medical recommendations and attending check-ups (Item 3): 58.1%. Adjusting diet based on potassium test results (Item 11): 55.7%/

However, several key self-management practices were performed at low levels: Recording daily food intake (Item 6): 66.3% low practice. Preparing meals personally to control potassium (Item 10): 72.4% low practice. Joining patient support groups (Item 9): 85.0% low practice. Practicing healthy habits and exercise (Item 5): 60.6% low practice. Seeking psychological support online (Item 4): 71.5% low practice. Seeking reliable health information (Item 1): 46.3% low practice

Table 5
Practices Related to Hyperkalemia Management Among Participants (N = 246)

Variable	**Practices(F&%)**		
item	**High**	**Moderate**	**Low**
1. Seek reliable health information.	78 (31.7%)	54 (22.0%)	114 (46.3%)
2. Adhere strictly to medication	175 (71.1%)	49 (19.9%)	22 (8.9%)
3. Follow medical recommendations and check-ups	143 (58.1%)	73 (29.7%)	30 (12.2%)
4. Seek psychological support online	37 (15.0%)	33 (13.4%)	176 (71.5%)
5. Practice healthy habits and exercise, including high potassium.	48 (19.5%)	49 (19.9%)	149 (60.6%)
6. Record daily food intake	42 (17.1%)	41 (16.7%)	163 (66.3%)
7. Monitor weight changes regularly	218 (88.6%)	14 (5.7%)	14 (5.7%)
8. Inquire about new symptoms	200 (81.3%)	22 (8.9%)	24 (9.8%)
9. Join patient support groups.	22 (8.9%)	15 (6.1%)	209 (85.0%)
10 I prepare my meals myself to control their ingredients and potassium content	42 (17.1%)	26 (10.6%)	178 (72.4%)
11. Adjust diet based on the results of the potassium tests.	137 (55.7%)	35 (14.2%)	74 (30.1%)
12. Inform team of new medications/supplements	200 (81.3%)	17 (6.9%)	29 (11.8%)
Mean and SD	24.65(3.86), 68.5%		

Correlations between Knowledge, Attitudes, and Practices

Significant positive correlations were observed among all three KAP domains (Table 6, Figs. 4–6). There was a significant correlation between total knowledge and attitude scores ($r = 0.350$, $p = 0.001$). A significant correlation was found between total attitude and practice scores ($r = 0.436$, $p = 0.001$). A significant correlation was observed between total knowledge and practice scores ($r = 0.219$, $p = 0.001$). The strongest correlation was between attitudes and practices, while the weakest was between knowledge and practices.

Differences in KAP Scores by Participant Characteristics

Non-parametric tests (Mann-Whitney U and Kruskal-Wallis H) were performed to identify differences in knowledge, attitude, and practice scores across various demographic and clinical characteristics (Table 6).

Factors Associated with Knowledge Score

The analysis revealed that several factors were significantly associated with knowledge scores. Age was a strong predictor ($p = 0.001$), with participants under 50 years (mean rank = 135.07) demonstrating significantly higher knowledge than those aged 50 years or above (mean rank = 99.93). Occupation also showed a significant association ($p = 0.001$), with employed individuals (mean rank = 163.97) having higher knowledge scores than unemployed participants (mean rank = 117.67). Furthermore, a history of kidney removal was significantly associated with knowledge ($p = 0.026$), with affected patients showing a higher mean rank (162.87). Most notably, educational level demonstrated a highly significant association with knowledge ($p = 0.001$), showing a clear gradient: knowledge scores increased progressively from illiterate participants (mean rank = 101.77) to those with primary education (125.17), secondary education (138.26), and university education or higher (169.17).

Factors Associated with Attitude Score

Attitude scores were significantly influenced by age ($p = 0.001$) and educational level ($p = 0.003$), mirroring the pattern observed for knowledge. Younger participants and those with higher educational attainment reported more positive attitudes. Hypertension was also significantly associated with attitude scores ($p = 0.018$); however, contrary to expectations, participants without hypertension had lower mean attitude ranks (98.39) than those with hypertension (128.09). No other variables showed significant associations with attitude scores.

Factors Associated with Practice Score

Practice scores were significantly associated with age ($p = 0.013$), with younger participants again scoring higher. Occupation was a significant factor ($p = 0.041$), with employed individuals (mean rank = 147.87) reporting better practices than unemployed participants (mean rank = 119.99). Hypertension was also significantly associated with higher practice scores ($p = 0.024$). Regular medication use showed a strong negative association with practice scores ($p = 0.006$), with patients not on regular medication having a markedly lower mean rank (87.06) than those on regular medication (127.81). Finally, educational level was significantly associated with practice scores ($p = 0.045$), with participants holding university education or higher reporting the best practices (mean rank = 154.67).

Table 6
Factors associated with mean KAP scores towards Hyperkalemia Management (n = 246).

Variable	Group	N	Knowledge Mean Rank	p-value	Attitude Mean Rank	p-value	Practice Mean Rank	p-value
Gender	Male	141	124.35	0.827	126.02	0.518	127.79	0.271
	Female	105	122.36		120.11		117.73	
Age	< 50	165	135.07	0.001	136.44	0.001	131.39	0.013
	≥ 50	81	99.93		97.14		107.43	
Residence	Rural	116	116.42	0.138	115.01	0.076	118.91	0.338
	Urban	130	129.82		131.08		127.59	
Occupation	Employed	31	163.97	0.001	138.26	0.215	147.87	0.041
	Unemployed	215	117.67		121.37		119.99	
History of kidney removal	Yes	15	162.87	0.026	125.67	0.903	96.27	0.125
	No	231	120.94		123.36		125.27	
Dialysis status	On hemodialysis	242	123.45	0.932	124.31	0.163	123.85	0.548
	Not on hemodialysis	4	126.50		74.50		102.38	
Diabetes mellitus	Yes	52	113.54	0.252	107.93	0.074	113.74	0.264
	No	194	126.17		127.67		126.12	
Hypertension	Yes	208	122.88	0.748	128.09	0.018	127.85	0.024
	No	38	126.88		98.39		99.71	
Heart disease	Yes	85	128.44	0.426	126.93	0.581	120.37	0.615
	No	161	120.89		121.69		125.15	
Regular drug use	Yes	220	124.37	0.576	124.97	0.345	127.81	0.006
	No	26	116.17		111.10		87.06	
Educational	Illiterate	95	101.77	0.001	104.34	0.003	111.54	0.045
	Primary	74	125.17		126.19		124.05	
	Secondary	51	138.26		143.11		129.09	

Variable	Group	N	Knowledge Mean Rank	p-value	Attitude Mean Rank	p-value	Practice Mean Rank	p-value
	University or >	26	169.17		147.38		154.67	
Marital state	Married	201	121.64	0.058	122.54	0.647	124.64	0.809
	Unmarried	34	145.10		132.71		120.69	
	Widowed	11	90.64		112.64		111.41	
Duration of dialysis	< 1 year	36	108.88	0.288	104.85	0.058	123.75	0.982
	1 to 5 years	124	129.37		119.92		124.24	
	> 5 years	86	121.16		136.47		122.33	
How many times in the last year	1 to 2 times	97	122.16	0.709	136.47	0.063	134.66	0.127
	3 to 6 times	132	122.72		114.24		115.38	
	> 6 times	17	137.18		121.38		122.85	

Linear Regression Analyses for KAP

Multivariate linear regression analyses were performed to identify independent factors associated with knowledge, attitude, and practice scores (Table 7). For the knowledge score, the multivariate analysis revealed that younger age (B = -1.372, β = -0.207, p = 0.001) and higher educational level (B = 0.627, β = 0.202, p = 0.003) were significant independent predictors of higher knowledge. Furthermore, a history of kidney removal was associated with a significant decrease in knowledge scores (B = -1.688, β = -0.129, p = 0.029). Regarding the attitude score, several factors emerged as significant independent predictors. Younger age (B = -1.246, β = -0.154, p = 0.021) and higher educational level (B = 0.785, β = 0.207, p = 0.002) were positive predictors of more favorable attitudes. A longer duration of dialysis was also independently associated with more positive attitudes (B = 0.815, β = 0.144, p = 0.018). Conversely, a diagnosis of hypertension was a significant negative predictor, associated with lower attitude scores (B = -2.028, β = -0.192, p = 0.002). For the practice score, regular medication use was the only significant independent predictor identified, demonstrating a negative association with practice scores (B = -1.755, β = -0.140, p = 0.043). Patients who reported regular medication use had lower practice scores compared to those who did not use medications regularly.

Table 7
Multivariate Linear Regression Analysis for Factors Associated with KAP Scores

Variables	Unstandardized Coefficients		Standardized Coefficients	Sig.	95.0% Confidence	
	B	Std. Error	Beta		Lower Bound	Upper Bound
knowledge						
Age	-1.372	0.422	-0.207	0.001	-2.204	-0.540
Residence	0.298	0.377	0.048	0.429	-0.444	1.040
Educational level	0.627	0.208	0.202	0.003	0.216	1.038
Occupation	-1.142	0.585	-0.121	0.052	-2.294	0.011
History of kidney removal	-1.688	0.771	-0.129	0.029	-3.206	-0.170
Heart disease	-0.550	0.387	-0.084	0.156	-1.313	0.212
Attitude						
Age	-1.246	0.535	-0.154	0.021	-2.301	-0.192
Educational level	0.785	0.247	0.207	0.002	0.299	1.271
History of kidney removal	-0.143	0.955	-0.009	0.881	-2.024	1.738
Duration of dialysis	0.815	0.343	0.144	0.018	0.140	1.491
How many times in the last year	-0.483	0.392	-0.076	0.219	-1.256	0.290
Hypertension	-2.028	0.639	-0.192	0.002	-3.287	-0.769
Practice						
Age	-0.739	0.548	-0.090	0.179	-1.818	0.341
Educational level	0.489	0.273	0.128	0.074	-0.048	1.026
Occupation	-1.153	0.757	-0.099	0.129	-2.644	0.337
Hypertension	-1.036	0.747	-0.097	0.166	-2.507	0.434
Regular drug use	-1.755	0.864	-0.140	0.043	-3.458	-0.053

Discussion

This study aimed to assess knowledge, attitudes, and practices regarding hyperkalemia management among patients with end-stage kidney disease attending the dialysis center in Ibb City, Yemen. As the first

investigation of this topic in a conflict-affected setting, the findings provide unique insights into the challenges and opportunities for improving ESKD care in resource-limited environments.

Knowledge Levels and Associated Factors

Consistent with the moderate knowledge levels observed (52% of maximum score), the finding that only 41.9% of participants achieved high knowledge scores suggests substantial room for improvement in patient education regarding hyperkalemia management. This level of knowledge is notably higher than that reported by Somaili et al. (2025) in Saudi Arabia, where 79.8% of CKD patients demonstrated low knowledge about potassium-rich diets. This discrepancy likely reflects differences in sample composition: 98.4% of participants in the current study were undergoing hemodialysis, which typically entails ongoing clinical monitoring and repeated nutritional counseling (Mahmoud et al., 2022), whereas the Jazan study included patients across all CKD stages, many of whom may not have received structured dietary education (Alharbi et al., 2021).

However, the proportion of patients with high knowledge in this study (41.9%) was substantially lower than the 60.3% reported by Kanagarajah et al. (2022) among Indian hemodialysis patients. This disparity may be attributed to differences in healthcare infrastructure—India has more developed renal dietetic services—as well as variations in assessment tools and educational attainment between populations. Notably, Li et al. (2025) reported median knowledge scores of 9 out of 9 among Chinese ESKD patients, suggesting that higher-resource settings achieve more consistent knowledge levels than those observed in Yemen's conflict-affected context.

Educational level emerged as the strongest predictor of knowledge ($p = 0.001$), demonstrating a clear gradient: knowledge scores increased progressively from illiterate participants (mean rank = 101.77) to those with university education (mean rank = 169.17). This finding aligns with multiple studies across diverse cultural contexts (Chen et al., 2024; Kanagarajah et al., 2022; Shanmugapriya et al., 2024), underscoring the universal importance of education in health literacy and disease management (Zaki et al., 2022). The practical implication is clear: educational interventions must be tailored to patients' literacy levels, utilizing visual aids, simplified language, and oral instruction for those with limited formal education.

Age was also significantly associated with knowledge ($p = 0.001$), with participants under 50 years demonstrating higher scores than older patients. This inverse relationship may reflect generational differences in educational opportunities, greater familiarity with digital health information sources among younger individuals, or age-related cognitive changes affecting information retention (Li et al., 2025). Similarly, employed participants showed higher knowledge scores than unemployed individuals ($p = 0.001$), consistent with Alghamdi et al. (2023), suggesting that employment may provide cognitive stimulation, social interaction, and resources that facilitate the acquisition of health information.

Since 2015, protracted conflict has resulted in healthcare infrastructure collapse, severe medication shortages, the displacement of healthcare workers, and the disruption of medical education. Dialysis

centers operate under extreme constraints, with intermittent electricity, limited water supply, and frequent shortages of essential supplies. The moderate knowledge levels observed may actually represent a remarkable achievement given these challenges, reflecting the resilience of both patients and providers. However, the significant gaps in self-management practices may be exacerbated by food insecurity, limited access to low-potassium alternatives, and the high cost of fresh produce in a conflict economy. Future interventions must be designed with these realities in mind, emphasizing practical, low-cost strategies that are feasible despite resource limitations.

Attitudes Towards Hyperkalemia Management

Attitudes toward hyperkalemia management were predominantly positive (72% of maximum score), with 58.9% of participants demonstrating positive attitudes. This finding is consistent with Chen et al. (2024), who reported normalized average attitude scores of 0.82 among hemodialysis patients, and Kanagarajah et al. (2022), who found that 60% of their participants had excellent attitudes toward renal diet management. The consistency of positive attitudes across studies suggests that ESKD patients generally recognize the importance of managing their condition, regardless of geographical location or healthcare context (Shah et al., 2020).

Encouragingly, high proportions of participants expressed trust in their doctors' therapeutic strategies (72.8%), willingness to share experiences with other patients (73.2%), and commitment to medication adherence (69.9%). These findings indicate strong patient-provider relationships and recognition of the value of peer support—assets that can be leveraged in intervention design. However, only 47.2% expressed confidence in their ability to prevent elevated potassium levels, revealing a critical gap between trusting healthcare providers and developing self-efficacy. This gap represents an important target for educational interventions that empower patients to take an active role in their own care (Khalil & Salim, 2019).

Younger age ($p = 0.001$) and higher education ($p = 0.003$) were associated with more positive attitudes, mirroring the pattern observed for knowledge. Younger patients may be more receptive to health education or more motivated to maintain health for long-term quality of life. The duration of dialysis was independently associated with more favorable attitudes in regression analysis ($B = 0.815$, $p = 0.018$), suggesting psychological adaptation over time. This longitudinal perspective has important clinical implications: newly initiated dialysis patients may require additional psychological support and more intensive education to foster positive attitudes during the vulnerable early treatment period.

A unique finding was the association between hypertension and higher attitude scores ($p = 0.018$). While initially counterintuitive, this may reflect that patients already engaged in managing one chronic condition have developed more positive orientations toward health management generally. Alternatively, healthcare providers may allocate more educational resources to patients with complex comorbidities, inadvertently reinforcing positive attitudes in this subgroup. This finding underscores the importance of ensuring that all ESKD patients receive adequate support for developing positive health attitudes, regardless of their comorbidity profile.

Practices in Hyperkalemia Management

Practice levels were moderate (68.5% of maximum score), comparable to the normalized average of 0.58 reported by Chen et al. (2024) and higher than the 40% excellent practice rate observed by Kanagarajah et al. (2022). However, examination of individual practice items revealed a striking pattern: strong adherence to clinically supervised activities contrasted sharply with poor engagement in autonomous self-management behaviors.

High compliance was observed for activities directly linked to clinical encounters: regular weight monitoring (88.6%), informing healthcare teams about new medications (81.3%), inquiring about new symptoms (81.3%), and medication adherence (71.1%). In contrast, self-management behaviors requiring proactive information seeking and behavioral modification were rarely performed: recording daily food intake (66.3% low practice), preparing meals personally (72.4% low), joining patient support groups (85.0% low), and seeking reliable health information (46.3% low). This discrepancy mirrors findings from Somaili et al. (2025), who reported that while 53% of participants avoided potassium-rich foods, only 26% read potassium content on food labels.

These patterns suggest that patients are more compliant with directive, externally reinforced activities than with autonomous behaviors requiring internal motivation and practical skills. This interpretation aligns with Khalil and Salim's (2019) observation that behavioral modification requires not only knowledge but also self-efficacy, environmental support, and practical skills. The findings highlight the need for educational interventions that go beyond information provision to include skills training, goal setting, and problem-solving.

Educational level was significantly associated with practice scores ($p = 0.045$), with a clear gradient from illiterate participants (mean rank = 111.54) to university-educated participants (154.67). This finding underscores the role of health literacy in translating knowledge and attitudes into actual behaviors. Age ($p = 0.013$) and occupation ($p = 0.041$) were also significant, with younger and employed individuals demonstrating better practices, suggesting that socioeconomic resources and cognitive capacity influence the ability to implement recommended behaviors (Chen et al., 2024).

Correlations Between Knowledge, Attitudes, and Practices

Significant positive correlations were observed between all KAP domains, consistent with previous research (Chen et al., 2024; Kanagarajah et al., 2022; Li et al., 2025; Somaili et al., 2025). The strongest correlation was between attitudes and practices ($r = 0.436$), indicating a moderate-to-strong association that explains approximately 19% of the variance in practice scores. This substantial effect size underscores the potential impact of attitude-focused interventions and aligns with theoretical models positing that attitudes mediate the relationship between knowledge and action (Chen et al., 2024).

The correlation between knowledge and practice, while significant, was relatively modest ($r = 0.219$), accounting for less than 5% of the variance in practice. This knowledge-practice gap was evident in

specific items: while 80.9% correctly identified that some foods require caution, only 55.7% reported adjusting their diet based on potassium test results. This gap highlights the need for interventions that address barriers to behavior change beyond knowledge deficits, including practical skills, social support, and environmental modifications (Li et al., 2025). The findings suggest that improving knowledge alone is insufficient; interventions must also foster positive attitudes and build self-efficacy to translate knowledge into sustained behavior change.

Conclusions

This study demonstrates that ESKD patients in conflict-affected Yemen have moderate knowledge and practices but predominantly positive attitudes toward hyperkalemia management. Educational level, age, and comorbid conditions significantly influence all KAP dimensions, with education emerging as the strongest and most consistent predictor. The significant correlations between KAP domains, particularly the strong attitude-practice association, suggest that interventions targeting attitudes may be more effective than those focused solely on knowledge enhancement. The identified knowledge-practice gap underscores the need for interventions addressing barriers to behavior change beyond information provision. In Yemen's challenging context, interventions must be tailored to low literacy levels, adapted to resource limitations, and designed to build self-efficacy through practical skills training. Future research should employ longitudinal and qualitative designs to explore the mechanisms underlying these findings and test intervention effectiveness in this unique setting.

Several clinical implications emerge from these findings. First, the strong association between educational level and all KAP dimensions underscores the need for tailored educational approaches. For patients with limited literacy, interventions should utilize visual aids, simplified language, oral instruction, and teach-back methods to ensure comprehension. Second, the knowledge-practice gap indicates that traditional didactic education is insufficient; interventions should incorporate skills training, goal setting, and problem-solving to build self-efficacy. Third, the positive attitudes observed provide a foundation for behavior change, but the gap between trusting providers and developing self-efficacy must be addressed through empowerment-focused approaches.

At the policy level, the Ministry of Health in Yemen, in collaboration with humanitarian organizations, should prioritize integrating structured nutritional counseling into routine dialysis care. This could include training dialysis nurses to deliver brief educational interventions during treatment sessions, developing culturally appropriate, low-literacy educational materials, and establishing peer support programs that leverage positive attitudes toward shared experiences.

Recommendations

At the policy level, the Ministry of Health in Yemen, in collaboration with international humanitarian organizations, should prioritize integrating structured nutritional counseling into routine dialysis care. This could include training dialysis nurses to deliver brief educational interventions during treatment sessions, developing culturally appropriate low-literacy educational materials on potassium management, and

establishing peer support programs to leverage the positive attitudes observed toward shared experiences. For clinical practice, healthcare providers should implement routine KAP assessments for all ESKD patients, with particular attention to those with low educational attainment, older age, and unemployment. Educational interventions should move beyond didactic approaches to include practical skills training—such as meal planning, reading food labels, and potassium-friendly cooking demonstrations—that address the identified gaps in self-management behaviors. Future research should employ longitudinal designs to examine how KAP evolves over the course of dialysis treatment and whether improvements in KAP translate to better clinical outcomes, including reduced hyperkalemia episodes and hospitalizations. Qualitative studies are needed to explore the barriers to self-management from patients' perspectives, particularly in the context of food insecurity and resource limitations. Intervention research should test the effectiveness of tailored educational programs adapted to patients' literacy levels and cultural contexts.

Study Strengths and Limitations

This study has several strengths, including its focus on an understudied conflict-affected population, its comprehensive assessment of all three KAP domains, its use of a validated questionnaire, and its application of appropriate statistical methods, including multivariate analysis. The sample size was adequate, and the response rate was high. However, several limitations should be acknowledged. First, the cross-sectional design precludes establishing causal relationships; only associations can be inferred. Second, convenience sampling may introduce selection bias and limit generalizability to all ESKD patients in Yemen. Third, self-report data are subject to recall and social desirability biases, potentially leading to overestimates of positive attitudes and practices. Fourth, the single-center design may not represent experiences in other regions with different resource availability. Fifth, the absence of serum potassium measurements precluded objective correlation between KAP scores and clinical outcomes. Finally, the questionnaire, while validated, used closed-ended questions that may not capture the full complexity of patients' understanding and behaviors.

Declarations

Ethics Approval and Consent to Participate

The study protocol received approval from the Institutional Review Board of Ibb University (approval number: IU-RB-2025-018, dated March 14th, 2025). Given the retrospective nature of the research involving anonymized data collected during routine clinical care, the requirement for informed consent was waived by the ethics committee. Patient confidentiality was safeguarded throughout by anonymizing all data during collection and analysis, with no personal identifiers included in the research database. The study was conducted in accordance with the principles of the Declaration of Helsinki and applicable local regulations governing observational research.

Consent for Publication

Not applicable.

Competing Interests

The authors declare no competing interests.

Contributors

KA, AS : Investigation, Methodology, Project Administration, Writing – Review & Editing

MS, ST : Conceptualization, Data Curation, Formal Analysis, Writing – Original Draft

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Reem A, Asala A, SA ,Asma'a A: Conceptualization, Data Curation, Formal Analysis, Writing – Original Draft

WA: Supervision, Validation, Visualization, Writing – Review & Editing

WA: Writing – Review & Editing, Corresponding Author

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Data Availability

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

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Figures

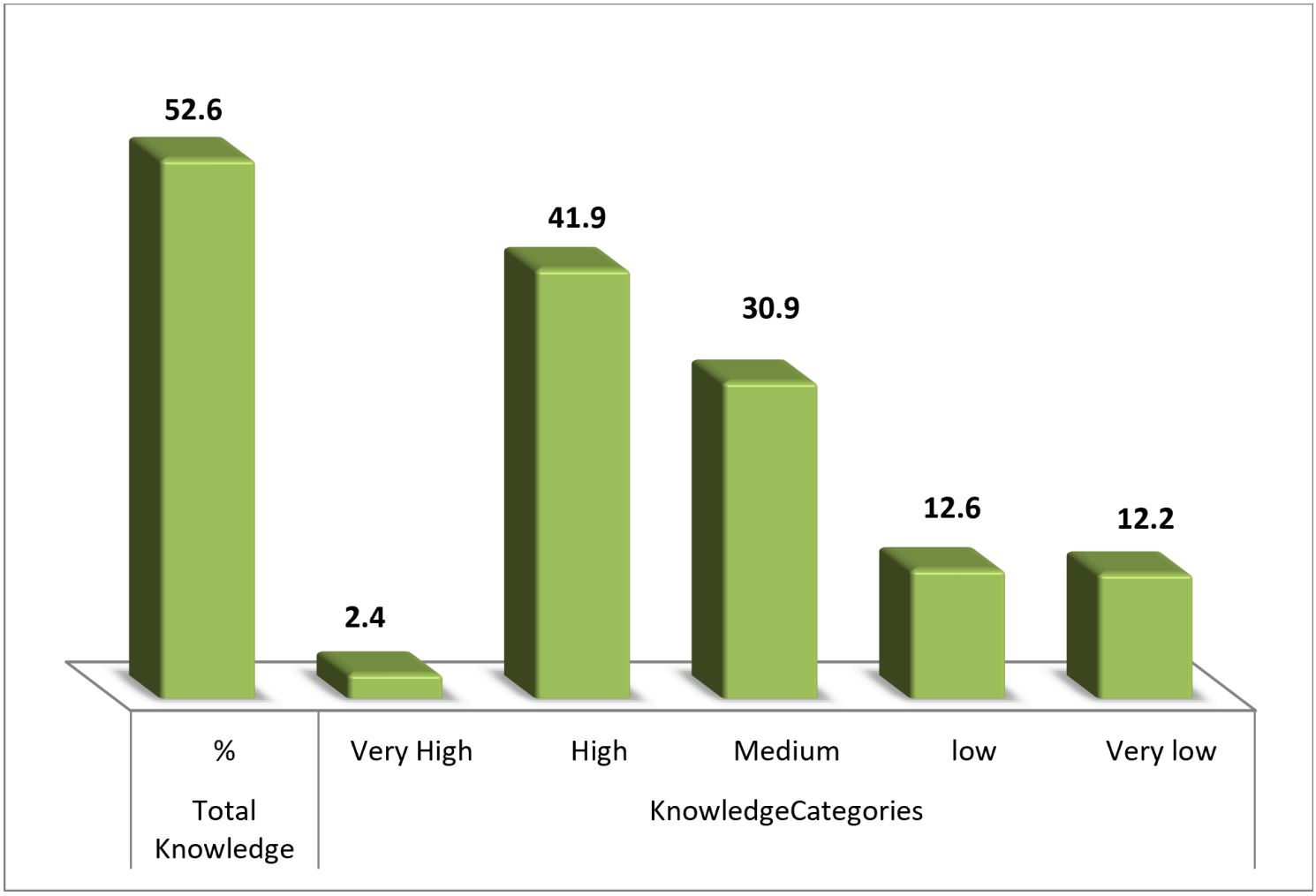


Figure 1

Distribution of Knowledge Levels Regarding Hyperkalemia Among Participants (N=246)

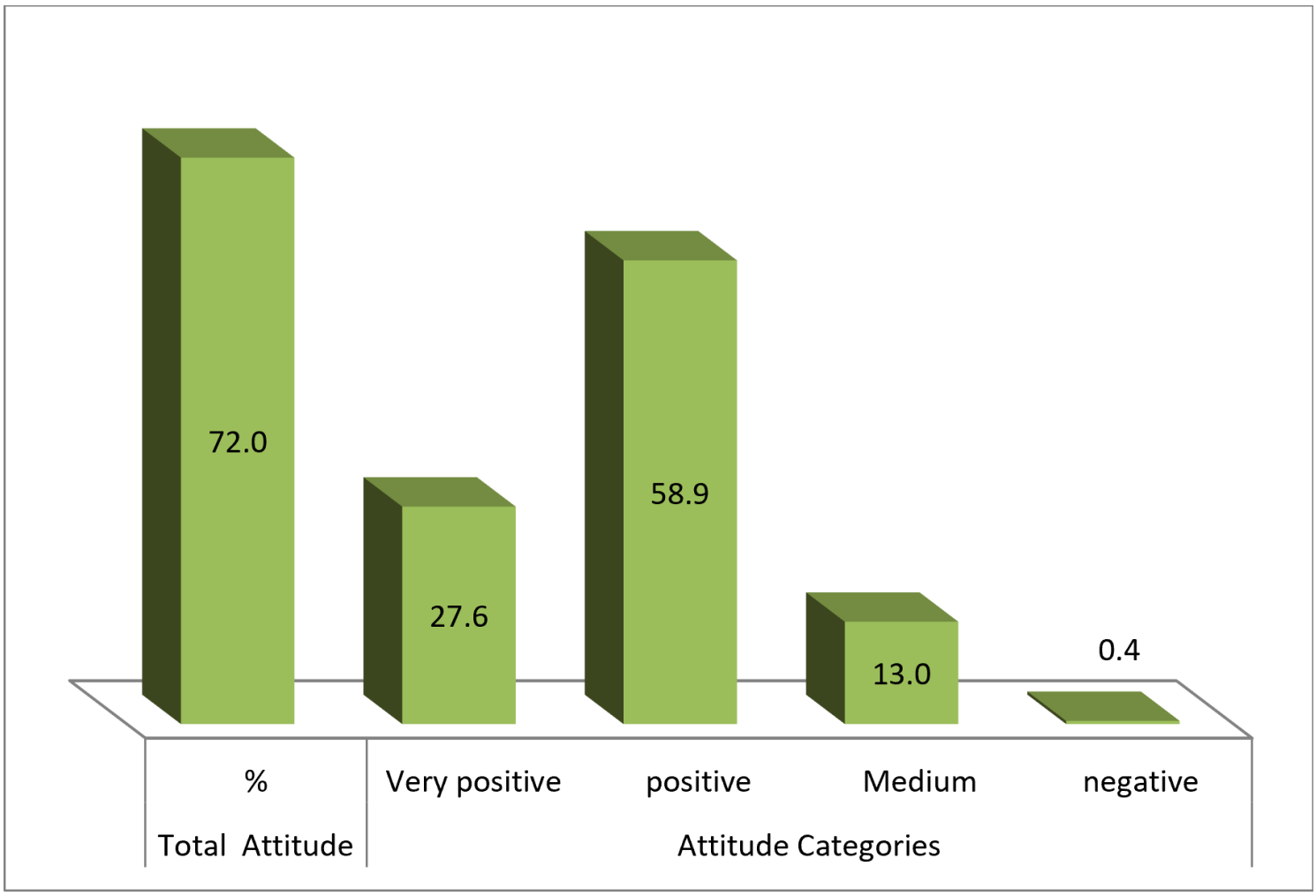


Figure 2

Distribution of Attitude Levels Towards Hyperkalemia Management Among Participants (N=246)

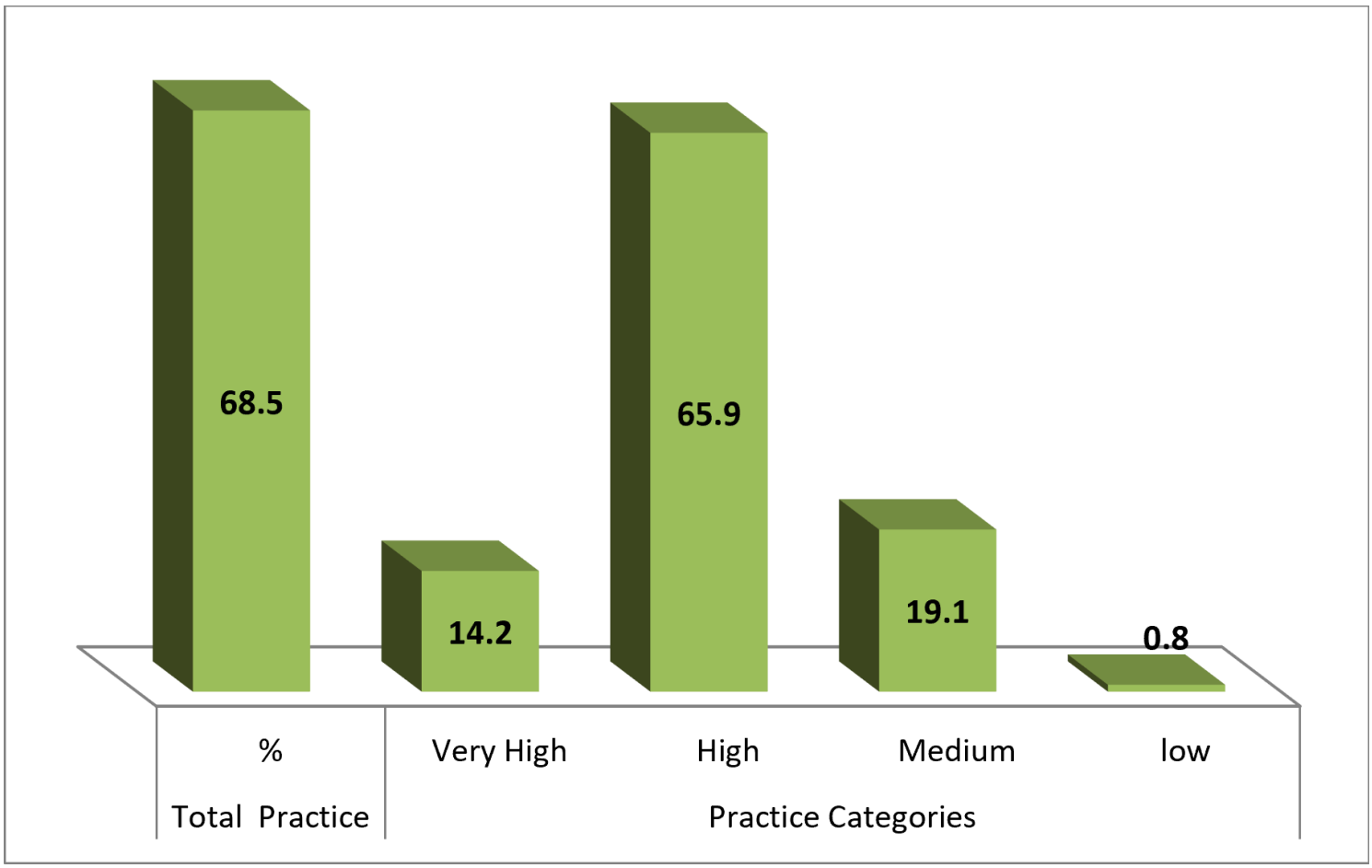


Figure 3

Distribution of Practice Levels Towards Hyperkalemia Management Among Participants (N=246)

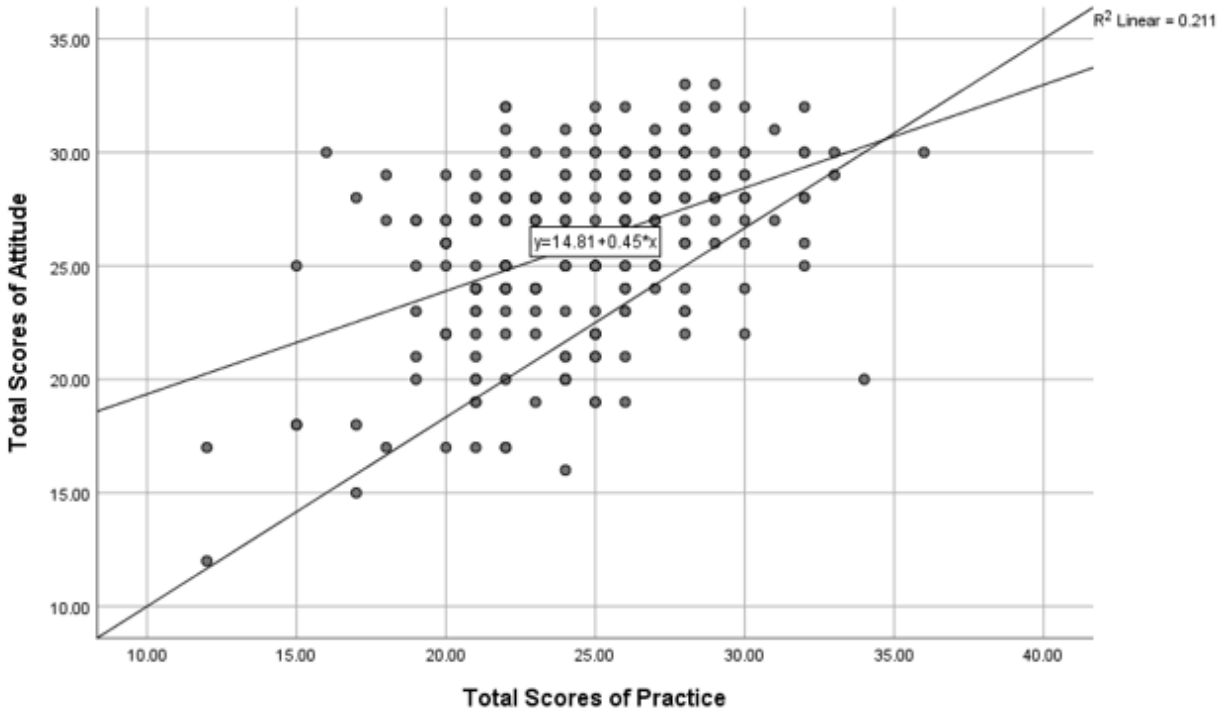


Figure 4

Scatter Plot Showing Correlation between Knowledge and Attitude Scores

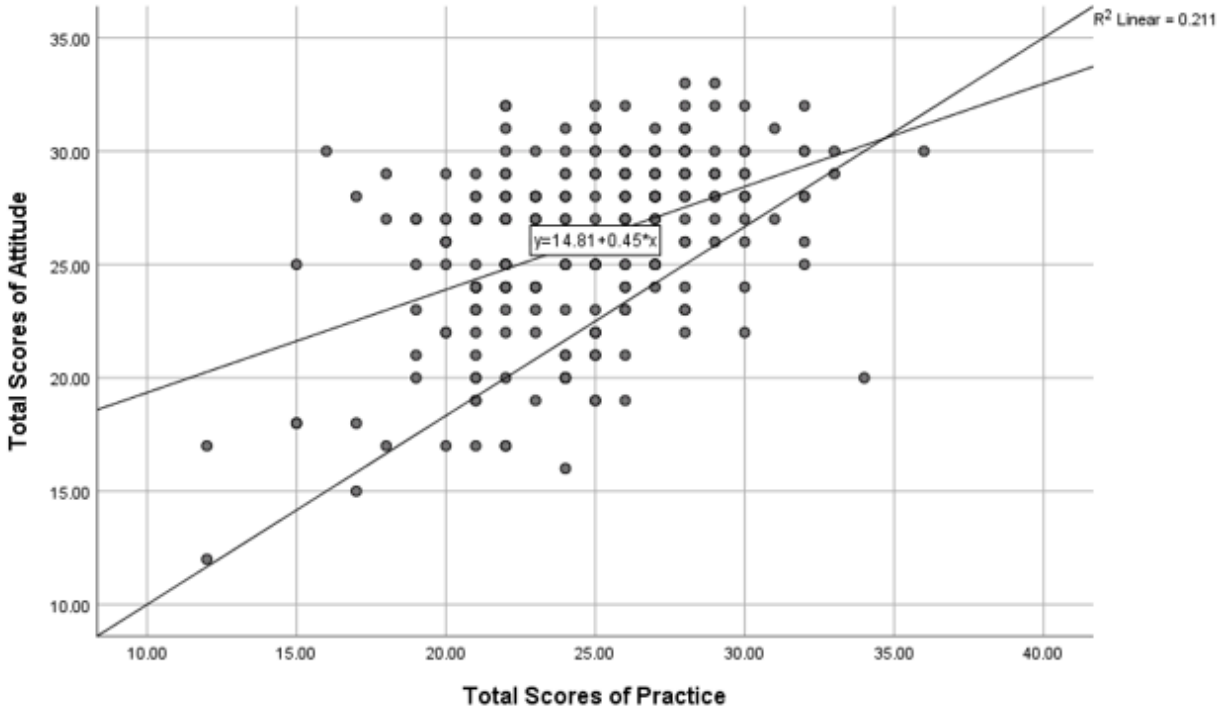


Figure 5

Scatter Plot Showing Correlation between Attitude and Practice Scores

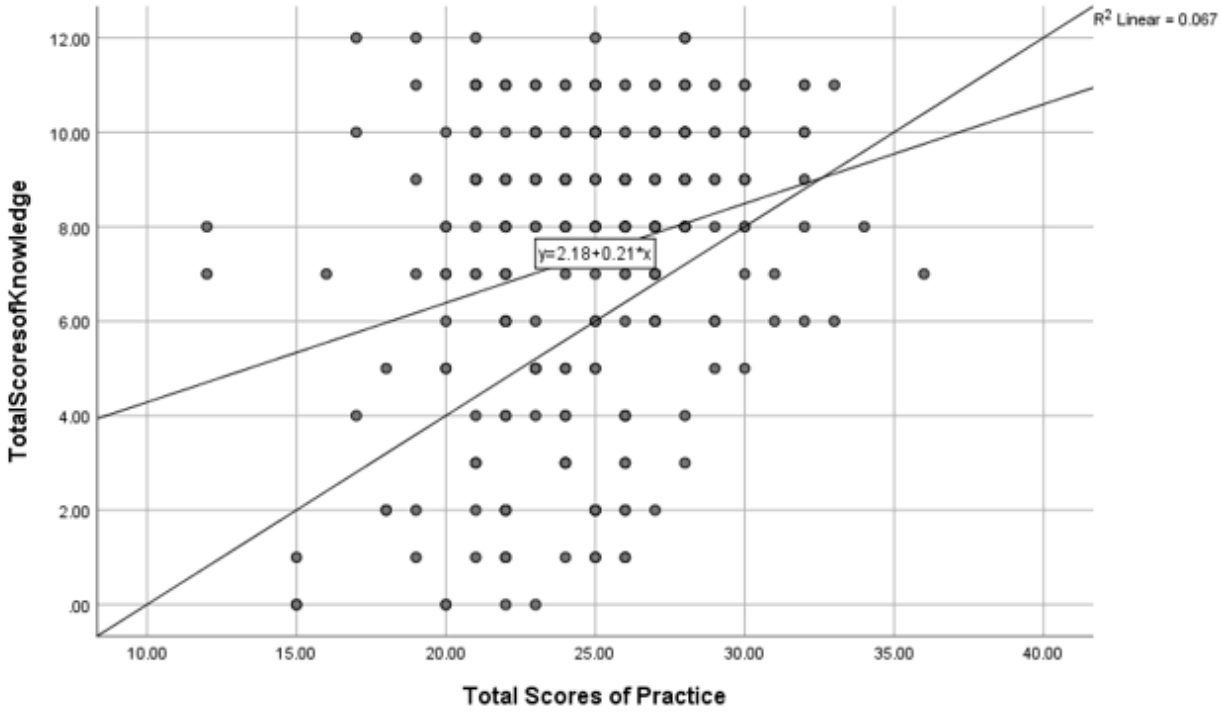


Figure 6

Scatter Plot Showing Correlation between Knowledge and Practice Scores