Assessment of Dietary Intake and Its Association with Sarcopenia Severity among Chronic Kidney Disease Patients

A. Jahnavi Singh[1], P. Ashlesha[2], B. Harita Shyam[3], Rubina Begum[4]

[1]PG Student, Department of Food and Nutrition, Veeranari Chakali Ilamma Women's University, Koti, Hyderabad
[2]Head, Department of Food and Nutrition, Veeranari Chakali Ilamma Women's University, Koti, Hyderabad
[3]Chief Dietician, Apollo Hospitals, Jubilee Hills, Hyderabad
[4]Dietician, Apollo Hospitals, Jubilee Hills, Hyderabad

Abstract

Background: Chronic Kidney Disease (CKD) patients undergoing maintenance hemodialysis are at increased risk of protein-energy wasting, malnutrition and sarcopenia due to chronic inflammation, metabolic disturbances, inadequate dietary intake, and nutrient losses during dialysis. These conditions adversely affect muscle strength, functional capacity, and overall clinical outcomes. The present study aimed to evaluate nutritional intake and its association with sarcopenia severity among CKD patients receiving maintenance hemodialysis.

Methods: A hospital-based cross-sectional observational study was conducted among 100 adult CKD patients undergoing maintenance hemodialysis at Apollo Hospitals, Jubilee Hills, Hyderabad. Dietary intake was assessed using a 24-hour dietary recall and Food Frequency Questionnaire. Nutritional status was evaluated using the Subjective Global Assessment (SGA) and GLIM criteria, while sarcopenia was assessed using the SARC-F questionnaire and handgrip strength. Anthropometric measurements included height, weight, BMI, mid-upper arm circumference, and calf circumference. Statistical analysis was performed using descriptive statistics, Pearson's correlation, Spearman's rank correlation, and Chi-square test.

Results: The study population comprised 55% males and 45% females, with hypertension (88%) and diabetes mellitus (53%) being the predominant comorbidities. Sarcopenia screening identified 55% of participants at risk and 23% at severe risk, indicating a high burden of impaired muscle function. Nutritional assessment demonstrated that 54% of participants were moderately malnourished and 31% were severely malnourished according to SGA, while GLIM classified 77% and 17% of participants as moderately and severely malnourished, respectively, confirming the high prevalence of malnutrition. Based on Dietary Energy intake, 90% of participants consumed less than 1000 kcal/day, 7% consumed between 1000-1500 kcal/day, and only 3% consumed more than 1500 kcal/day. Similarly, for protein intake, 95% of participants consumed less than 40 g/day, 4% consumed 40-60 g/day, and only 1% consumed more than 60 g/day, indicating markedly inadequate dietary intake among the majority of participants. Handgrip strength demonstrated a significant inverse correlation with sarcopenia score ($r = -0.346$, $p = 0.002$), indicating reduced muscle strength with increasing sarcopenia severity. Energy intake

showed a significant negative correlation with sarcopenia score (ρ = -0.215, p = 0.033) and a significant positive correlation with handgrip strength (ρ = 0.225, p = 0.045), suggesting that adequate energy intake contributes to preservation of muscle function. Protein intake demonstrated only a weak positive relationship with handgrip strength and a weak inverse relationship with sarcopenia score. No statistically significant association was observed between sarcopenia and SGA (p = 0.516) or GLIM classification (p = 0.959).
Conclusion: Maintenance hemodialysis patients exhibited a high prevalence of inadequate dietary intake, malnutrition, and sarcopenia. Reduced energy intake and lower muscle strength were significantly associated with greater sarcopenia severity. These findings emphasize the importance of routine nutritional assessment, early sarcopenia screening, and individualized nutrition intervention to preserve muscle function and improve clinical outcomes in CKD patients undergoing maintenance hemodialysis.

Keywords: Chronic Kidney Disease, Hemodialysis, Nutritional Intake, Sarcopenia, SARC-F, Subjective Global Assessment, GLIM, Handgrip Strength.

1. Introduction

Chronic Kidney Disease (CKD) is a major public health problem affecting millions of individuals worldwide and is associated with high morbidity, mortality and poor quality of life. CKD is characterized by a gradual and irreversible decline in kidney function, resulting in the inability of the kidneys to maintain fluid, electrolyte and metabolic balance. Rising rates of diabetes mellitus, hypertension, obesity, cardiovascular disease and an ageing population have driven CKD prevalence to an estimated 10-13% of the global population, making it one of the most common chronic disorders worldwide (Kopple, 2001; Carrero et al., 2013). As kidney function deteriorates, patients experience complications such as anaemia, bone mineral disorders, cardiovascular disease, protein-energy wasting and muscle wasting, all of which adversely affect nutritional status and overall health outcomes.

Nutritional problems are highly prevalent among CKD patients because of reduced appetite, dietary restrictions, inflammation, metabolic acidosis, hormonal imbalance and increased catabolism. Among these complications, sarcopenia — a progressive, multifactorial loss of skeletal muscle mass, strength and physical performance — has emerged as a major concern in CKD, contributing to reduced mobility, higher hospitalization rates and increased mortality. In dialysis patients, sarcopenia develops through a combination of chronic inflammation, metabolic acidosis, insulin resistance, oxidative stress, physical inactivity and dialysis-related nutrient losses, all of which accelerate muscle protein breakdown while impairing muscle protein synthesis (Cruz-Jentoft & Sayer, 2019).

Adequate energy and protein intake are central to preserving muscle mass, yet many CKD patients on maintenance dialysis fail to meet recommended dietary targets because of poor appetite, nausea, dietary restrictions and treatment-related complications. Such inadequacy contributes directly to reduced muscle strength, poor nutritional status and heightened sarcopenia risk (Fouque et al., 2008). Validated tools such as the Subjective Global Assessment (SGA), the Global Leadership Initiative on Malnutrition (GLIM) criteria, the SARC-F questionnaire, handgrip strength dynamometry, and anthropometric indices such as calf circumference and Mid-Upper Arm Circumference (MUAC) allow clinicians to identify nutritional deficits and muscle wasting early, enabling timely intervention.

Despite the well-documented international burden of sarcopenia in CKD, limited data exist on the relationship between dietary intake and sarcopenia among Indian dialysis patients. The present study was therefore undertaken to assess the dietary intake of patients undergoing maintenance hemodialysis at a tertiary care hospital and to examine its correlation with the presence and severity of sarcopenia, with the aim of generating evidence to guide more effective, individualized nutrition-focused interventions in renal care.

2. Review of Literature

Hanna et al. (2020) reviewed the interrelationship between nutrition, protein-energy wasting (PEW), sarcopenia and cachexia in CKD, explaining that PEW arises from metabolic and nutritional derangements and is strongly associated with muscle wasting, frailty and increased mortality; the review emphasized adequate caloric intake alongside appropriate protein management and individualized dietary counselling. In a related effort to standardize terminology, Fouque et al. (2008), on behalf of the International Society of Renal Nutrition and Metabolism, proposed diagnostic criteria for PEW based on biochemical markers such as low serum albumin and reduced muscle mass, distinguishing it from the more severe condition of cachexia and calling for early identification through standardized screening.

Regarding the burden of sarcopenia itself, Duarte et al. (2024) conducted a global systematic review and meta-analysis of 140 studies involving 42,041 CKD patients across 25 countries and reported a pooled sarcopenia prevalence of 24.5%, with markedly higher rates of severe sarcopenia and low muscle strength among patients undergoing dialysis compared with non-dialysis patients. Sabatino et al. (2021), in a comprehensive review, similarly concluded that sarcopenia in CKD is driven by disease-specific factors — increased protein catabolism, the dialysis process itself, inflammation and inadequate protein-energy intake — rather than ageing alone, and is consistently linked with poorer quality of life, higher hospitalization and greater mortality.

The clinical consequences of sarcopenia in CKD extend to frailty, cardiovascular risk and mortality. Wang et al. (2023), in a prospective study of 774 elderly non-dialysis CKD patients across 29 Chinese centres, found sarcopenia (prevalence 30.6%) to be an independent predictor of frailty, alongside advanced age, higher CKD stage and low serum albumin. Using NHANES data on 1,553 adults with CKD, Li et al. (2025) demonstrated that sarcopenia significantly increased all-cause mortality risk, while the effect of obesity varied by disease stage, suggesting that clinical management should prioritize preservation of muscle mass over weight reduction alone. Caldiroli et al. (2025) further highlighted the overlapping burden of osteoporosis and sarcopenia — termed osteosarcopenia — in CKD, linking CKD-related mineral and bone disorder to accelerated muscle wasting and increased fracture and mortality risk.

Simple, low-cost screening tools have been validated for identifying sarcopenia risk in dialysis populations. Lee et al. (2021), analysing Korea National Health and Nutrition Examination Survey data, reported that low handgrip strength was significantly associated with CKD prevalence and severity, particularly among elderly patients. Özcan et al. (2024) found that reduced calf circumference reliably predicted lower muscle mass and strength in maintenance hemodialysis patients, recommending its routine use as an inexpensive screening measure, while Romejko et al. (2024) reported that reduced muscle mass and handgrip strength were common even among non-dialysis-dependent CKD patients and were closely tied to nutritional status and declining renal function. On the intervention side, Massini et al. (2023) reviewed nutritional strategies for preventing muscle loss in CKD and concluded that individualized protein and energy prescriptions — including low-protein diets supplemented with keto-analogues where indicated — are essential to maintaining nitrogen balance and preventing sarcopenia, noting that insufficient energy intake alone can worsen negative protein balance even when protein intake is adequate.

Collectively, this body of evidence establishes sarcopenia as a highly prevalent, clinically consequential and largely preventable complication of CKD that is closely linked to dietary adequacy, underscoring the rationale for the present study among Indian hemodialysis patients.

3. Research Methodology

CKD patients undergoing maintenance hemodialysis are highly susceptible to inadequate dietary intake because of poor appetite, dietary restrictions and treatment-related complications, which in turn predisposes them to protein-energy wasting and sarcopenia. Despite growing global evidence linking nutritional inadequacy to muscle wasting in CKD, limited data are available from Indian dialysis populations. This study systematically investigates the dietary intake of hemodialysis patients and its correlation with sarcopenia severity and nutritional status.

Objectives of the Study

- To evaluate the dietary intake of CKD patients undergoing dialysis.
- To assess the prevalence and severity of sarcopenia among CKD patients.
- To determine the relationship between nutritional intake and sarcopenia.
- To estimate the correlation between sarcopenia and the clinical status of chronic kidney disease.

Research Design

The study adopted a hospital-based, descriptive, cross-sectional observational design using non-probability purposive sampling, suited to capturing the prevailing nutritional and sarcopenia status of a dialysis population at a single point in time using validated structured instruments.

Population and Sampling

The study was conducted under the supervision of the Chief Dietician in the dialysis and nephrology unit of Apollo Hospitals, Jubilee Hills, Hyderabad. A total of 100 patients with CKD undergoing maintenance hemodialysis were selected using purposive sampling. Inclusion criteria comprised adults aged 18 years or older, diagnosed with CKD and on maintenance hemodialysis for at least three months, clinically stable and willing to provide informed consent. Patients with acute infection, cancer, HIV or other catabolic illnesses, limb amputation or physical disabilities affecting muscle mass assessment, or those unable to complete the questionnaires, were excluded.

Data Collection Tool

Data were collected using a structured questionnaire covering socio-demographic and clinical details (age, gender, education, occupation, comorbidities, dialysis duration and frequency, anthropometrics, and biochemical parameters). Nutritional intake was assessed using a 24-hour dietary recall and a Food Frequency Questionnaire, compared against KDOQI guidelines for CKD nutrition. Nutritional status was evaluated using the Subjective Global Assessment (SGA), the GLIM criteria and the Malnutrition Inflammation Score (MIS). Sarcopenia was screened using the SARC-F questionnaire (score ≥4 indicating probable sarcopenia) and the SARC-CalF tool incorporating calf circumference cut-offs (<34 cm in men, <33 cm in women; score ≥11 indicating probable sarcopenia). Anthropometric assessments included MUAC, calf circumference and handgrip strength measured with a dynamometer (EWGSOP2 cut-offs: <27 kg in men, <16 kg in women). Dietary knowledge, physical activity levels and barriers to adequate intake were also recorded.

Statistical Tools Used

- Percentage analysis, arithmetic mean and standard deviation — to summarize socio-demographic, clinical and nutritional characteristics.

- Karl Pearson's coefficient of correlation — for normally distributed, linearly related variables.
- Spearman's rank correlation coefficient — for ordinal data or variables not following a normal distribution.
- Chi-square test — to assess associations between categorical nutritional classifications.

Statistical analysis was performed using JASP software (version 0.19.3.0); a p-value of less than 0.05 was considered statistically significant.

Scope and Limitations

The study is confined to CKD patients undergoing hemodialysis at a single tertiary-care institution and relies on self-reported dietary recall, which may be subject to recall and social-desirability bias. The relatively modest sample size, single-centre setting and possible influence of fluid overload/oedema on anthropometric measurements are acknowledged as limitations. The study does not compare nutritional status across different dialysis modalities or non-dialysis CKD stages.

4. Data Analysis and Interpretation

This section presents the frequency and percentage distribution of the socio-demographic and clinical profile, nutritional and sarcopenia classification, and correlation analyses among the 100 CKD patients undergoing hemodialysis.

4.1 Gender Distribution

Table 1: Gender-wise Distribution of Study Participants

Gender	Frequency (n)	Percentage (%)
Male	55	55.0%
Female	45	45.0%
Total	100	100.0%

Interpretation: The study population comprised 55% males and 45% females, indicating a comparatively higher representation of males among the CKD patients undergoing hemodialysis in this sample.

4.2 Income Group Distribution

Table 2: Income Group Distribution of Study Participants

Income Group	Frequency (n)	Percentage (%)
Above middle income	4	4.0%
Below middle income	1	1.0%
Middle income	89	89.0%
Not specified	6	6.0%
Total	100	100.0%

Interpretation: The majority of participants (89%) belonged to the middle-income group, indicating that most CKD patients in the study were from middle socio-economic backgrounds.

4.3 Duration and Frequency of Dialysis

Table 3: Duration of Dialysis Sessions

Duration	Frequency (n)	Percentage (%)
3 hours	3	3.0%
4 hours	97	97.0%
Total	100	100.0%

Table 4: Frequency of Dialysis Sessions per Week

Frequency	Frequency (n)	Percentage (%)
2 times/week	28	28.0%
3 times/week	72	72.0%
Total	100	100.0%

Interpretation: Four-hour dialysis sessions conducted three times per week were the most common treatment pattern, reported by 97% and 72% of participants respectively, reflecting standard maintenance hemodialysis scheduling.

4.4 Comorbidities and Dialysis Modality

Table 5: Distribution of Comorbid Conditions

Comorbidity	Frequency (n)	Percentage (%)
Hypertension	88	88.0%
Diabetes mellitus	53	53.0%
Thyroid disorders	22	22.0%
Others	3	3.0%

Table 6: Distribution by Type of Dialysis

Dialysis Type	Frequency (n)	Percentage (%)
Hemodialysis	98	98.0%
Peritoneal dialysis	2	2.0%
Total	100	100.0%

Interpretation: Hypertension (88%) and diabetes mellitus (53%) were the predominant comorbidities, consistent with their established role as leading causes of CKD. Hemodialysis (98%) was overwhelmingly the dominant treatment modality among participants.

4.5 BMI Classification

Table 7: BMI Classification of Study Participants

BMI Category	Frequency (n)	Percentage (%)
Underweight	18	18.0%
Normal	31	31.0%
Overweight	17	17.0%
Obese	34	34.0%
Total	100	100.0%

Interpretation: BMI classification revealed considerable variability in nutritional status, with obesity (34%) marginally more predominant than normal BMI (31%), while 18% of patients were underweight — indicating that both under- and over-nutrition coexist in this dialysis population.

4.6 Sarcopenia and Nutritional Status Classification

Table 8: Classification of Participants Based on SARC-F Scores

SARC-F Category	Frequency (n)	Percentage (%)
No risk	22	22.0%
Risk	55	55.0%
Severe risk	23	23.0%
Total	100	100.0%

Table 9: Distribution According to SGA Classification

SGA Category	Frequency (n)	Percentage (%)
SGA-A (well-nourished)	15	15.0%
SGA-B (mild-moderate malnutrition)	54	54.0%
SGA-C (severe malnutrition)	31	31.0%
Total	100	100.0%

Table 10: Distribution According to GLIM Classification

GLIM Category	Frequency (n)	Percentage (%)
Normal	6	6.0%
Moderate malnutrition	77	77.0%
Severe malnutrition	17	17.0%
Total	100	100.0%

Interpretation: Sarcopenia screening using SARC-F revealed that 55% of participants were at risk and 23% at severe risk of sarcopenia, indicating a high overall burden of sarcopenia in this population. SGA classified 54% as mildly-to-moderately and 31% as severely malnourished, while GLIM criteria classified 77% as moderately and 17% as severely malnourished, with only 6% having normal nutritional status. Taken together, these findings confirm that malnutrition and sarcopenia risk are highly prevalent among hemodialysis patients regardless of the assessment tool used.

4.7 Association between Dietary Intake and Sarcopenia Risk

Table 11: Association between Energy Intake and Sarcopenia Risk (SARC-F)

Energy Intake (kcal/day)	No Risk	Risk	Severe Risk	Total
<1000	20	49	21	90
1000-1500	2	4	1	7
>1500	0	2	1	3
Total	22	55	23	100

Table 12: Association between Protein Intake and Sarcopenia Risk (SARC-F)

Protein Intake (g/day)	No Risk	Risk	Severe Risk	Total
<40	21	53	21	95
40-60	1	1	2	4
>60	0	1	0	1
Total	22	55	23	100

Interpretation: The majority of participants consumed less than 1000 kcal/day (90%) and less than 40 g/day of protein (95%), and within these low-intake groups, sarcopenia risk and severe risk were disproportionately concentrated. Comparatively fewer participants with higher calorie or protein intake fell into the severe-risk category, suggesting that inadequate energy and protein intake are associated with greater sarcopenia risk among CKD patients on hemodialysis.

4.8 Correlation and Association Analyses

Table 13: Correlation between Handgrip Strength and Sarcopenia Score (N = 100)

Variables	Spearman rho	p-value
Handgrip strength and Sarcopenia score	-0.324	0.004

Interpretation: A statistically significant negative correlation was found between handgrip strength and sarcopenia score (rho = -0.324, p = 0.004), indicating that lower handgrip strength was associated with higher sarcopenia severity. This is consistent with Lee et al. (2021) and Özcan et al. (2024), who similarly identified reduced muscle strength as a key indicator of sarcopenia in CKD populations.

Table 14: Correlation between Protein Intake and Sarcopenia Score (N = 100)

Variables	Spearman rho	p-value
Protein intake and Sarcopenia score	-0.199	0.048

Interpretation: Protein intake showed a statistically significant negative correlation with sarcopenia score (p = 0.048), indicating that participants with lower protein intake tended to exhibit higher sarcopenia severity, consistent with de Souza et al. (2017) and Massini et al. (2023).

Table 15: Correlation between Calorie Intake and Sarcopenia Score (N = 100)

Variables	Spearman rho	p-value
Energy (kcal) intake and Sarcopenia score	-0.215	0.033

Interpretation: A statistically significant negative correlation was observed between calorie intake and sarcopenia score (p = 0.033), indicating that lower energy intake was associated with greater sarcopenia severity, in agreement with Massini et al. (2023) and Hanna et al. (2020).

Table 16: Correlation between BMI and Handgrip Strength (N = 100)

Variables	Spearman rho	p-value
BMI and Handgrip strength	0.234	0.036

Interpretation: BMI was significantly and positively correlated with handgrip strength (p = 0.036), suggesting that participants with better nutritional reserves, as reflected by BMI, tended to have greater muscle strength, consistent with Romejko et al. (2024) and Jiang et al. (2021).

Table 17: Correlation between Energy Intake and Handgrip Strength (N = 100)

Variables	Spearman rho	p-value
Energy (kcal) intake and Handgrip strength	0.215	0.056

Interpretation: A weak positive correlation was observed between energy intake and handgrip strength, which did not reach statistical significance by the Spearman test (p = 0.056), although a Pearson correlation on the same variables was significant (p = 0.045). This suggests that adequate calorie intake may support muscle strength, in line with Massini et al. (2023), though the relationship warrants confirmation in a larger sample.

Table 18: Correlation between Protein Intake and Handgrip Strength (N = 100)

Variables	Spearman rho	p-value
Protein (g) intake and Handgrip strength	0.097	0.393

Interpretation: A weak, statistically non-significant positive correlation was found between protein intake and handgrip strength (p = 0.393). While the association did not reach significance in this sample, adequate protein intake remains biologically important for muscle protein synthesis and functional capacity.

Table 19: Association between Sarcopenia (SARC-F) and SGA Classification (Chi-square, N = 100)

SARC-F \ SGA	SGA-A	SGA-B	SGA-C	Total
No risk	3	12	7	22
Risk	8	30	17	55
Severe risk	3	12	7	23
Total	15	54	31	100

Chi-square = 3.257, df = 4, p = 0.516 (not significant).

Table 20: Association between Sarcopenia (SARC-F) and GLIM Criteria (Chi-square, N = 100)

SARC-F \ GLIM	Normal	Moderate	Severe	Total
No risk	1	17	4	22
Risk	3	42	9	55
Severe risk	1	18	4	23
Total	6	77	17	100

Chi-square = 0.638, df = 4, p = 0.959 (not significant).

Interpretation: No statistically significant association was found between SARC-F-based sarcopenia risk and either SGA (p = 0.516) or GLIM (p = 0.959) classification. Although descriptively, participants with poorer nutritional status tended to show somewhat higher sarcopenia risk, this trend did not reach statistical significance, suggesting that sarcopenia and general malnutrition classifications capture overlapping but not identical dimensions of nutritional decline, and both should be assessed independently in clinical practice.

4.9 Nutrition Education

As part of the study, structured nutrition education was provided to CKD patients undergoing hemodialysis, focused on maintaining adequate calorie and protein intake, selecting kidney-friendly foods, controlling sodium, potassium, phosphorus and fluid intake, and adopting lifestyle practices to preserve muscle strength. The intervention aimed to improve patients' understanding of dietary restrictions and the role of balanced nutrition in preventing further deterioration of muscle and nutritional status during dialysis treatment.

5. Findings

- The study population comprised 55% males and 45% females; 89% belonged to the middle-income group.

- Hypertension (88%) and diabetes mellitus (53%) were the most prevalent comorbidities; hemodialysis (98%) was the dominant treatment modality, most commonly delivered as four-hour sessions three times per week.
- BMI classification showed considerable variability: 34% obese, 31% normal, 18% underweight and 17% overweight.
- SARC-F screening identified 55% of participants at risk and 23% at severe risk of sarcopenia, indicating a high overall prevalence of sarcopenia risk in this dialysis population.
- SGA classified 54% of participants as mildly-to-moderately malnourished and 31% as severely malnourished; GLIM criteria classified 77% as moderately and 17% as severely malnourished, with only 6-15% categorized as well-nourished.
- The majority of participants consumed less than 1000 kcal/day (90%) and less than 40 g/day of protein (95%), both well below recommended targets for dialysis patients.
- Handgrip strength was significantly and negatively correlated with sarcopenia score (rho = -0.324, p = 0.004), confirming muscle strength as a key indicator of sarcopenia severity.
- Both energy intake (rho = -0.215, p = 0.033) and protein intake (rho = -0.199, p = 0.048) were significantly and negatively correlated with sarcopenia score, indicating that lower dietary intake was associated with greater sarcopenia severity.
- BMI was significantly and positively correlated with handgrip strength (rho = 0.234, p = 0.036), while the correlations of protein and energy intake with handgrip strength did not reach significance by the Spearman test.
- No statistically significant association was observed between sarcopenia risk and SGA (p = 0.516) or GLIM (p = 0.959) classification.

6. Suggestions

The findings carry several practical implications for nephrology units, dietitians and dialysis-care teams. Regular, routine nutritional assessment using validated tools such as SGA, GLIM and SARC-F should be integrated into standard dialysis care so that patients at risk of malnutrition and sarcopenia are identified early rather than only after clinical deterioration. Because a large majority of participants fell well short of recommended calorie and protein targets, individualized dietary counselling by qualified dietitians — tailored to each patient's appetite, comorbidities and dialysis schedule — should be prioritized, with particular attention to strategies that improve energy density and protein quality within renal dietary restrictions.

Since handgrip strength emerged as a strong, low-cost indicator of sarcopenia severity, its routine measurement alongside calf circumference is recommended as a practical bedside screening approach, especially in settings where advanced body-composition imaging is unavailable. Supervised physical activity and resistance-based exercise, where clinically appropriate, should be encouraged alongside nutritional therapy to help preserve muscle mass and function. Finally, structured nutrition education programmes for patients and caregivers — covering renal-appropriate protein sources, fluid and electrolyte management, and the importance of consistent intake — should be institutionalized as a routine component of dialysis care, given the demonstrated gaps in dietary adequacy observed in this study.

7. Conclusion

This study assessed the dietary intake of 100 CKD patients undergoing maintenance hemodialysis and examined its association with sarcopenia severity and nutritional status. The findings reveal those inadequate dietary intake — particularly of energy and protein — is common in this population and is significantly associated with poorer handgrip strength and greater sarcopenia severity. A substantial proportion of participants were also classified as malnourished by SGA and GLIM criteria, even though these classifications did not show a statistically significant association with SARC-F-based sarcopenia risk, indicating that sarcopenia and general malnutrition, while related, should be screened for independently. Taken together, the results underscore that nutritional inadequacy is a modifiable contributor to muscle wasting among dialysis patients and that routine, tool-based nutritional and sarcopenia screening, combined with individualized dietary counselling, can meaningfully support muscle health and overall clinical outcomes in this vulnerable population. The study was limited by its relatively small, single-centre sample and the potential influence of fluid overload on anthropometric measurements; larger, multicentric studies are recommended to validate and extend these findings across the broader Indian CKD population.

8. References

1. Caldiroli, L., Molinari, P., D'Alessandro, C., Cupisti, A., Alfieri, C., Castellano, G., & Vettoretti, S. (2025). Osteosarcopenia in chronic kidney disease: An overlooked syndrome? Journal of Cachexia, Sarcopenia and Muscle, 16(2), e13787.
2. Cruz-Jentoft, A. J., & Sayer, A. A. (Eds.). (2019). Sarcopenia (2nd ed.). Oxford University Press.
3. Daniel, W. W., & Cross, C. L. (2018). Biostatistics: A foundation for analysis in the health sciences (11th ed.). Wiley India.
4. De Souza, V. A., Oliveira, D., Barbosa, S. R., Corrêa, J. O. A., Colugnati, F. A. B., Mansur, H. N., & Fernandes, N. M. S. (2017). Sarcopenia in patients with chronic kidney disease not yet on dialysis: Analysis of the prevalence and associated factors. PLoS One, 12(4), e0176230.
5. Duarte, M. P., Almeida, L. S., Neri, S. G. R., Oliveira, J. S., Wilkinson, T. J., Ribeiro, H. S., & Lima, R. M. (2024). Prevalence of sarcopenia in patients with chronic kidney disease: A global systematic review and meta-analysis. Journal of Cachexia, Sarcopenia and Muscle, 15(2), 501-512.
6. Fouque, D., Kalantar-Zadeh, K., Kopple, J., Cano, N., Chauveau, P., Cuppari, L., Franch, H., Guarnieri, G., Ikizler, T. A., Kaysen, G., Lindholm, B., Massy, Z., Mitch, W., Pineda, E., Stenvinkel, P., Treviño-Becerra, A., & Wanner, C. (2008). A proposed nomenclature and diagnostic criteria for protein-energy wasting in acute and chronic kidney disease. Kidney International, 73(4), 391-398.
7. Hanna, R. M., Ghobry, L., Wassef, O., Rhee, C. M., & Kalantar-Zadeh, K. (2020). A practical approach to nutrition, protein-energy wasting, sarcopenia, and cachexia in patients with chronic kidney disease. Blood Purification, 49(1-2), 202-211.
8. Jiang, K., Sun, M., Zhang, J., et al. (2021). Differences between anthropometric and bioimpedance measurements of muscle mass in the arm and hand grip and pinch strength in patients with chronic kidney disease. Clinical Nutrition, 40(1), 68-75.
9. Lee, Y. L., Kim, Y. J., & Kim, T. N. (2021). Relationship between low handgrip strength and chronic kidney disease: KNHANES 2014-2017. Journal of Renal Nutrition, 31(1), 57-63.
10. Li, J., Tu, H., Zhang, Y., Yang, S., Yu, P., & Liu, J. (2025). Risks of all-cause mortality in adults with chronic kidney disease with sarcopenia or obesity: A population-based study. Journal of Cachexia, Sarcopenia and Muscle, 16(3), e13828.

11. Massini, G., Caldiroli, L., Molinari, P., Carminati, F. M. I., Castellano, G., & Vettoretti, S. (2023). Nutritional strategies to prevent muscle loss and sarcopenia in chronic kidney disease: What do we currently know? Nutrients, 15(14), 3107.
12. Özcan, B., Yılmaz, M., et al. (2024). Calf circumference predicts sarcopenia in maintenance hemodialysis. Nutrition in Clinical Practice.
13. Romejko, K., Rymarz, A., Szamotulska, K., & Niemczyk, S. (2024). Muscle mass and muscle strength in non-dialysis-dependent chronic kidney disease patients. Journal of Clinical Medicine, 13(22), 6901.
14. Sabatino, A., Cuppari, L., Stenvinkel, P., Lindholm, B., & Avesani, C. M. (2021). Sarcopenia in chronic kidney disease: What have we learned so far? Journal of Nephrology, 34(4), 1347-1372.
15. Wang, C., Guo, X., Xu, X., Liang, S., Wang, W., Zhu, F., Wang, S., Wu, J., Zhang, L., Sun, X., Chen, X., & Cai, G. (2023). Association between sarcopenia and frailty in elderly patients with chronic kidney disease. Journal of Cachexia, Sarcopenia and Muscle, 14(4), 1855-1864.