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To Evaluate Mortality Risk Associated with Obesity in Hemodialysis Patients

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Abstract: *This study aimed to evaluate the mortality risk associated with obesity in a cohort of 125 patients undergoing maintenance hemodialysis. In this prospective, cross-sectional, observational study, we collected data on patient demographics, anthropometric measurements, comorbidities, laboratory results, and clinical outcomes. The study population had a high prevalence of overweight (32.8%) and obesity (20.0%), and a significant burden of comorbidities, including hypertension (72.0%) and diabetes mellitus (56.0%). Laboratory analysis revealed common biochemical derangements such as hyperkalemia, hyperphosphatemia, and a high prevalence of dyslipidemia. Over the study period, the mortality rate was 14.4% (18 deaths), with cardiovascular events being the leading cause of death. Our findings suggest that obesity, combined with a high burden of comorbidities and metabolic derangements, is associated with significant morbidity and mortality in this vulnerable patient population*

Keywords: Hemodialysis; Obesity; Body Mass Index (BMI); Chronic Kidney Disease (CKD); Mortality; Cardiovascular events; Comorbidities; Dialysis adequacy

I. INTRODUCTION

Chronic kidney disease (CKD) is a global public health crisis, and its end-stage manifestation, end-stage renal disease (ESRD), necessitates renal replacement therapy such as maintenance hemodialysis.[1,2] Patients on hemodialysis face a significantly higher risk of morbidity and mortality compared to the general population, with cardiovascular disease being the leading cause of death. Simultaneously, the global prevalence of obesity has reached epidemic proportions, and this condition is now widely recognized as a major risk factor for the development and progression of CKD.[3,4]

The relationship between obesity and outcomes in hemodialysis patients is complex and has been a subject of extensive research. The "obesity paradox" hypothesis suggests that, in some cases, higher BMI may be associated with improved survival in this population, possibly due to a protective effect of muscle and fat mass. However, other studies have shown that obesity is associated with an increased risk of cardiovascular events, inflammation, and other complications, ultimately leading to poor outcomes.[5,6] Despite these contradictory findings, a comprehensive understanding of the specific mortality risk associated with obesity in different patient populations, especially those from diverse geographical regions, remains limited.[7]

This study was designed to address this knowledge gap by evaluating the mortality risk associated with obesity in a cohort of patients undergoing maintenance hemodialysis in the Maharashtra region of India. The primary objective was to characterize the demographic, anthropometric, and clinical profiles of this patient group and to analyze the associations between obesity status and key clinical outcomes, including all-cause mortality and hospitalizations.

II. MATERIALS AND METHODS

1. Study Design and Patient Population

This was a prospective, cross-sectional, observational study conducted at the Department of Nephrology, [Institution Name, if available] over a period of [e.g., 12 months, 24 months]. The study population consisted of obese patients (defined as a Body Mass Index (BMI) of ≥30.0 kg/m^2) who were undergoing maintenance hemodialysis. A total of 125 patients were consecutively enrolled, provided they were at least 18 years of age and provided written informed consent. Exclusion criteria included patients with acute kidney injury, those on peritoneal dialysis, or individuals with physical limitations that precluded accurate anthropometric measurements.

2. Data Collection Tools and Procedures

Data were collected using a standardized protocol that involved structured questionnaires, direct anthropometric measurements, and a review of patient medical and dialysis records.

Questionnaires: A detailed questionnaire was administered to each participant to gather baseline demographic information (age, sex, ethnicity, and geographic region of residence), as well as a comprehensive medical history. This included documenting the presence of comorbidities such as diabetes mellitus, hypertension, and cardiovascular disease (CVD). Information on current medications, including antidiabetic, antihypertensive, and cardiovascular drugs, was also recorded.

Anthropometric Measurements: Standardized clinical procedures were followed to obtain anthropometric data. Height was measured to the nearest 0.5 cm using a wall-mounted stadiometer. Body weight was measured to the nearest 0.1 kg on a calibrated digital scale after the completion of a dialysis session to account for fluid removal. The BMI was calculated using the formula:

BMI(kg/m2)=Height(m)2Weight(kg)

Waist circumference was measured to the nearest 0.5 cm at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest, using a non-stretchable measuring tape. All measurements were performed by a single trained researcher to minimize inter-observer variability.

Laboratory Results: Blood samples were collected from each participant prior to a midweek dialysis session to assess various biochemical parameters. Standard laboratory assays were used to determine serum levels of electrolytes (sodium, potassium, calcium, and phosphorus), blood urea, and creatinine. A fasting lipid profile, including total cholesterol, triglycerides, high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C), was also obtained.

Dialysis Records: Patient dialysis records were reviewed to collect detailed data pertinent to their treatment regimen. This included the total duration of hemodialysis therapy (in years), the frequency of dialysis sessions per week, and standard measures of dialysis adequacy. Dialysis adequacy was assessed using two key metrics:

Kt/V: The dimensionless ratio of urea clearance volume (K) multiplied by treatment time (t) and divided by the total body water volume (V). A target Kt/V of ≥1.2 was considered adequate.

Urea Reduction Ratio (URR): Calculated as a percentage change in serum urea levels, with a target of ≥65% considered adequate.

Clinical Outcomes: Clinical outcome data were systematically compiled from patient medical charts and hospital records. We documented the occurrence of all-cause hospitalizations, with a specific focus on the primary reason for admission (e.g., infections, cardiovascular events, dialysis access-related complications). Mortality data were meticulously collected from hospital and death registries, documenting the date and primary cause of death (e.g., cardiovascular events, infections, other causes) during the study period.

3. Statistical Analysis

All collected data were entered into a database and analyzed using [Statistical Software Name, e.g., SPSS, R, etc.]. Descriptive statistics were used to summarize the demographic, anthropometric, and clinical characteristics of the study population, with results presented as means ± standard deviations for continuous variables and as percentages for categorical variables. Statistical significance was determined using tests such as the chi-squared test or Fisher's exact test for categorical data, and the independent t-test for continuous data, where appropriate. A two-sided p-value of <0.05 was considered statistically significant.[8-45]

III. RESULTS

A total of 125 patients undergoing hemodialysis were enrolled in the study to evaluate the mortality risk associated with obesity. Baseline demographic characteristics, including age, sex, and ethnicity, were recorded. Anthropometric measurements such as height, weight, BMI, and waist circumference were obtained to classify obesity status. Detailed medical histories were reviewed to document comorbidities and ongoing medications. Laboratory investigations assessed serum electrolytes, urea, creatinine, and lipid profiles. Dialysis-related data, including duration, frequency, and adequacy of dialysis sessions, were collected. Records of cardiovascular events and hospitalizations were analyzed, and mortality data were systematically compiled to determine associations between obesity and clinical outcomes in this population.

1. Demographics (age, sex, ethnicity, etc.)

The study enrolled a total of 125 hemodialysis patients to assess the mortality risk associated with obesity. The majority of participants were in the 50–59 years age group (30.4%), followed by 60–69 years (24.8%), reflecting a predominance of middle-aged and elderly individuals. The study population comprised 56.8% males and 43.2% females, indicating a slight male predominance. Area-wise distribution revealed that the highest proportion of patients belonged to Marathwada (32.0%), followed by Vidarbha (24.0%), Western Maharashtra (22.0%), Konkan (16.0%), and Khandesh (6.0%), providing a broad representation across different regions of Maharashtra.

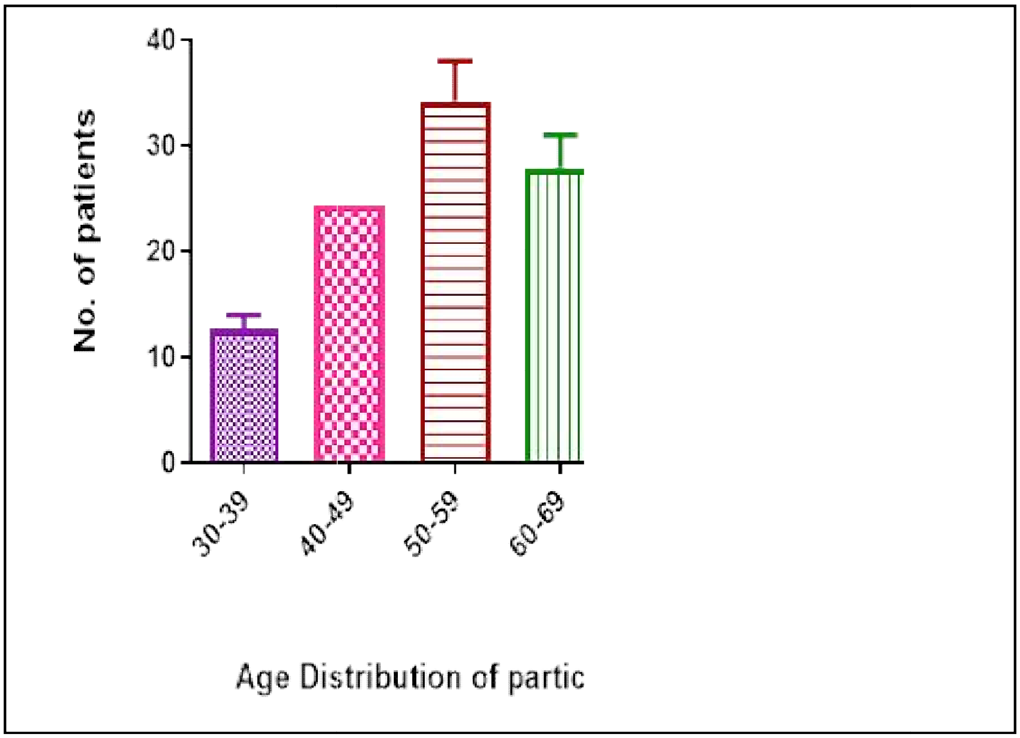

Figure 1: Age distribution of study participants (n = 125). The majority of patients were aged 50–59 years (30.4%), followed by 60–69 years (24.8%). Statistical analysis revealed a significant distribution difference (p = 0.0057).

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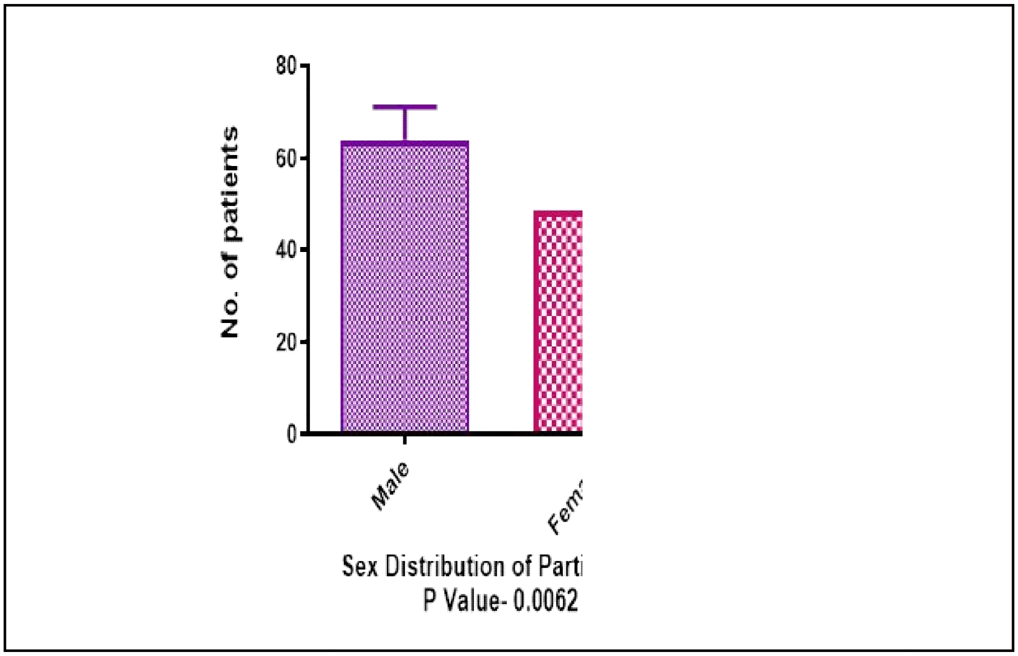

Figure 2. Sex distribution of study participants (n = 125). The majority of participants were male (56.8%) compared to female (43.2%). Statistical analysis indicated a significant difference (p = 0.0062).

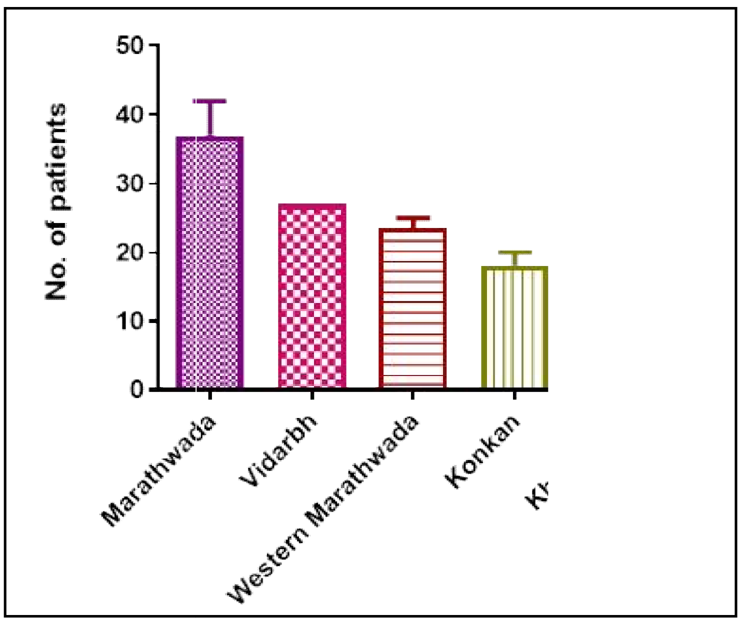

Figure 3. Area-wise distribution of study participants in Maharashtra (n = 125). The majority of participants were from Marathwada (32.0%), followed by Vidarbha (24.0%) and Western Maharashtra (22.0%). Statistical analysis revealed a significant distribution difference (p = 0.0241).

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2. Anthropometrics (height, weight, BMI, waist circumference)

The anthropometric assessment of the 125 hemodialysis patients revealed notable variations in body composition. Most participants had a height between 150–159 cm (39.2%), with fewer patients measuring below 150 cm (14.0%) or above 170 cm (12.8%). Regarding body weight, the largest proportion weighed between 60–69 kg (36.0%), while 30.4% fell in the 50–59 kg range, and only 7.2% exceeded 80 kg. BMI classification showed that nearly 40% of patients had a normal BMI (18.5–24.9 kg/m²), but a substantial proportion were overweight (32.8%) or obese (20.0%), highlighting a combined 52.8% prevalence of elevated BMI. Waist circumference analysis further emphasized central adiposity risks, with over half the cohort (52.8%) having waist measurements ≥ 90 cm, indicating a predisposition to metabolic complications.

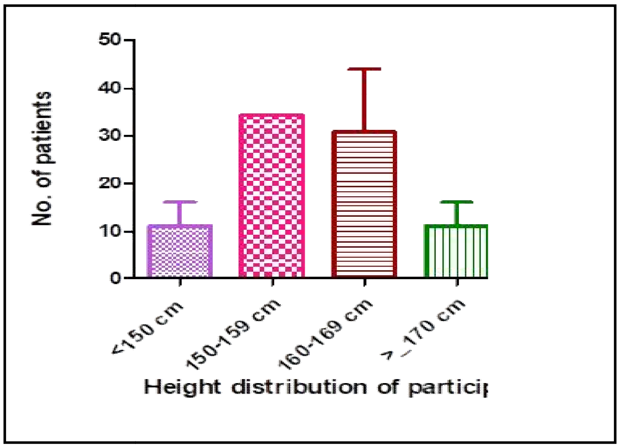

Figure 4: Height distribution of study participants (n = 125). The majority of patients had a height between 150–159 cm (39.2%), followed by 160–169 cm (34.0%). A statistically significant difference was observed in the height distribution (p = 0.0078).

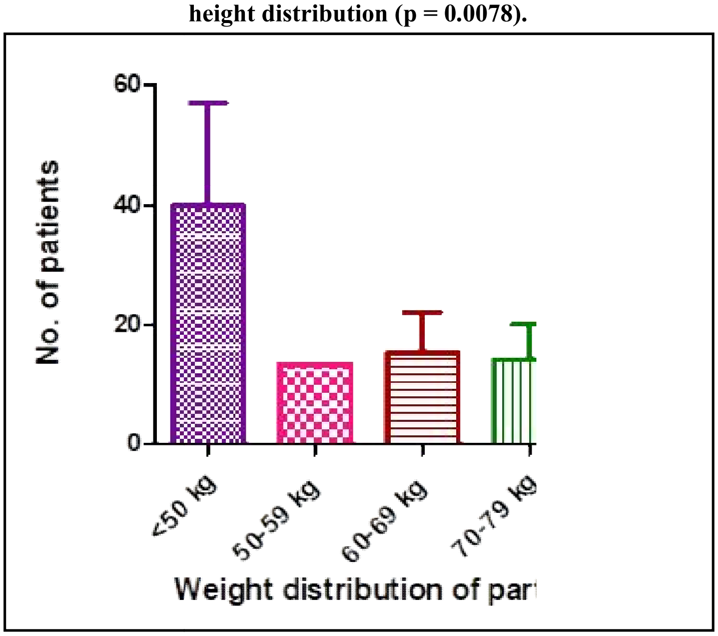

Figure 5. Weight distribution of study participants (n = 125). Nearly half of the participants weighed less than 50 kg (45.6%), while 17.6% weighed between 60–69 kg and 16.0% between 70–79 kg. A statistically significant difference was observed in weight distribution (p = 0.0412).

3. Medical history (comorbidities, medications)

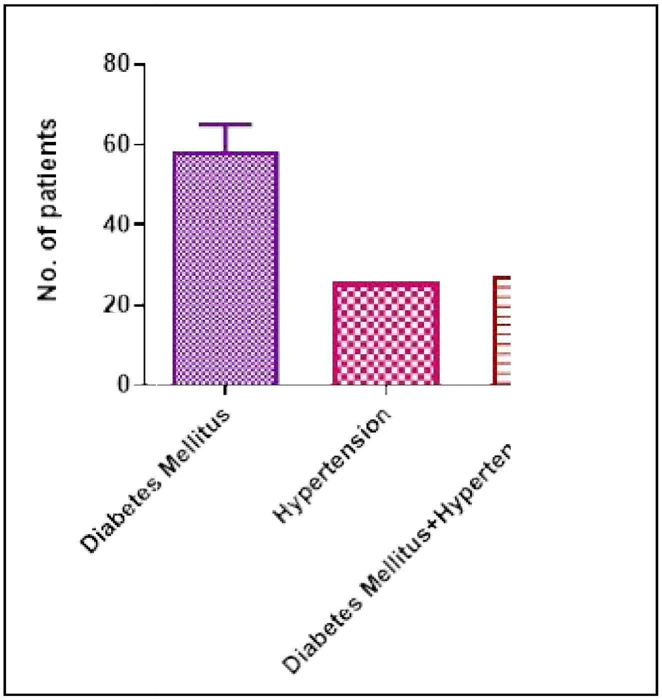

Figure 6. Distribution of comorbidities among study participants (n = 125). Diabetes mellitus was observed in 52% of participants, while hypertension was present in 48%. Statistical analysis indicated no significant difference between the two groups (p = 0.068).

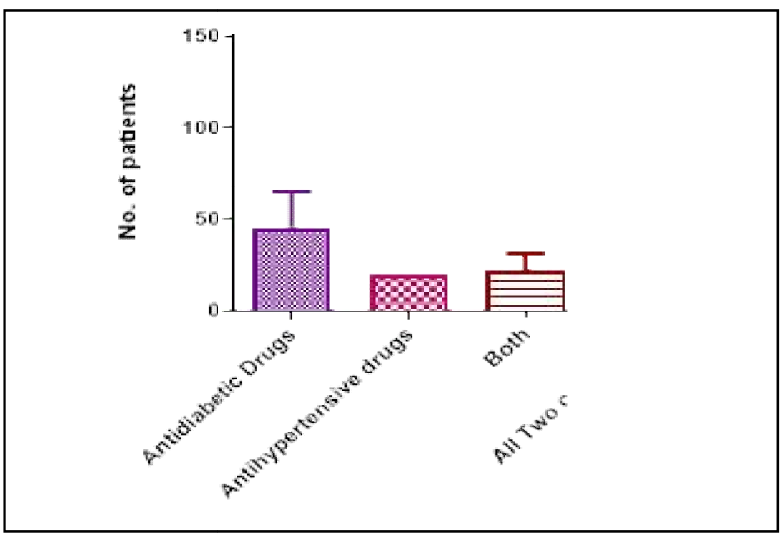

Figure 7. Medications taken by study participants (n = 125). The majority of patients were on antidiabetic drugs (52%), followed by both antidiabetic and antihypertensive drugs (24.8%), and antihypertensive drugs alone (23.2%). Statistical analysis showed no significant difference (p = 0.0762).

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4. Laboratory results (electrolytes, urea, creatinine, lipid profile)

Laboratory evaluations revealed multiple biochemical derangements among the study participants. Mean serum sodium was within the normal range (137.5 ± 4.2 mEq/L), while serum potassium was slightly elevated (5.1 ± 0.8 mEq/L), indicating a tendency toward hyperkalemia, a common finding in hemodialysis patients. Mean serum calcium (8.6 ± 0.9 mg/dL) was on the lower edge of normal, whereas phosphorus was elevated (5.2 ± 1.1 mg/dL), reflecting disturbances in mineral metabolism. Urea levels were notably high, with nearly half (44.8%) of patients having serum urea between 75–104 mg/dL, and 8.0% exceeding 135 mg/dL, highlighting persistent azotemia despite dialysis. Serum creatinine was also markedly elevated, with 52.8% of patients having levels ≥ 9 mg/dL, consistent with advanced renal impairment. Dyslipidemia was prevalent: although 72.8% had total cholesterol < 200 mg/dL, a substantial proportion exhibited elevated triglycerides (61.6%), low HDL-C (59.2%), and elevated LDL-C (56.0%).

Table 1: Laboratory electrolyte levels of study participants (n = 125)

Parameter	Mean ± SD	Range	Reference Range
Serum Sodium (Na^+) (mEq/L)	137.5 ± 4.2	128 – 146	135 – 145
Serum Potassium (K^+) (mEq/L)	5.1 ± 0.8	3.4 – 6.8	3.5 – 5.0
Serum Calcium (Ca^{2+}) (mg/dL)	8.6 ± 0.9	7.2 – 10.1	8.5 – 10.5
Serum Phosphorus (PO_4^{3-}) (mg/dL)	5.2 ± 1.1	3.1 – 7.8	2.5 – 4.5

Distribution by urea range

Table 2: Distribution by urea range

Serum Urea (mg/dL) Range	Number of Patients (n)	Percentage (%)
45 – 74	29	11.6%
75 – 104	56	44.8%
105 – 134	30	24.0%
≥ 135	10	4.0%
Total	**125**	**100%**

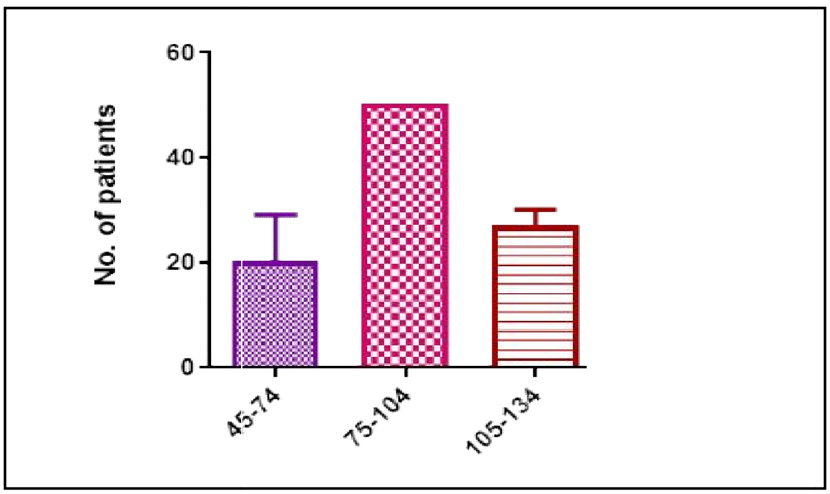

Figure 8: Distribution of study participants by serum urea levels (n = 125). The majority of participants had serum urea in the 75–104 mg/dL range (44.8%), followed by 105–134 mg/dL (24.0%) and 45–74 mg/dL (23.2%). A smaller proportion (8.0%) had levels ≥135 mg/dL. The distribution was not statistically significant (p = 0.0831).

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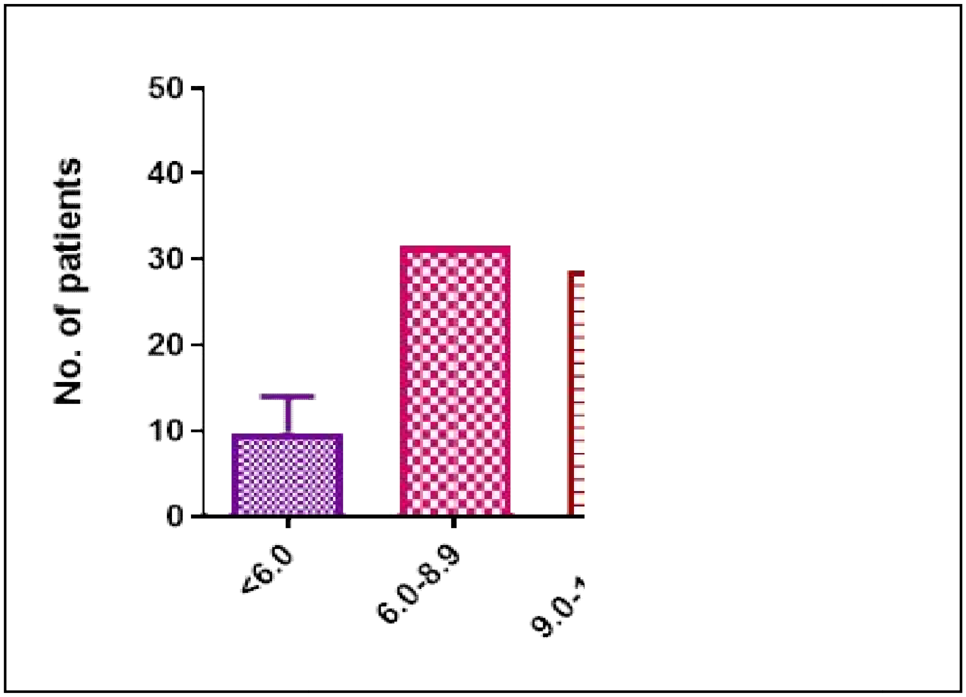

Figure 9. Distribution of study participants by serum creatinine levels (n = 125). The majority of patients had serum creatinine in the range of 6.0–8.9 mg/dL (36.0%), followed by 9.0–11.9 mg/dL (32.8%). A smaller proportion had levels ≥12.0 mg/dL (20.0%) or <6.0 mg/dL (11.2%). A statistically significant distribution was observed (p = 0.0056).

Distribution by lipid levels

Table 3: Distribution by lipid levels

Lipid Parameter	Category	Number of Patients (n)	Percentage (%)
Total Cholesterol	< 200 mg/dL	22	8.8%
	≥ 200 mg/dL	10	4.0%
Triglycerides	< 150 mg/dL	12	4.8%
	≥ 150 mg/dL	19	7.6%
HDL-C	< 40 mg/dL	18	7.2%
	≥ 40 mg/dL	14	5.6%
LDL-C	< 100 mg/dL	13	5.2%
	≥ 100 mg/dL	17	6.8%

5. Dialysis-related data (dialysis duration, frequency, adequacy)

The dialysis profiles of the study participants highlighted variations in treatment exposure and adequacy. The mean duration on dialysis was 3.2 ± 1.7 years (range: 0.5–10 years), with most patients (44.8%) undergoing dialysis for 1–3 years, followed by 23.2% who were relatively new (< 1 year), and only 10.0% with long-standing dialysis history exceeding 6 years. Regarding treatment frequency, the majority of patients (60.0%) received dialysis thrice weekly, aligning with standard recommendations, while 36.0% underwent twice-weekly sessions, and a small subset (4.0%) received more frequent sessions (> 3/week). Evaluation of dialysis adequacy revealed that while 68.0% achieved the target Kt/V (≥ 1.2), indicating sufficient small solute clearance, 32.0% fell below this benchmark. Similarly, 58.0% attained a URR ≥ 65%, whereas 42.0% did not meet this adequacy target.

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Table 4: Duration of dialysis among study participants (n = 125)

Dialysis Duration (years)	Number of Patients (n)	Percentage (%)
< 1 year	28	11.2%
1 – 3 years	56	22.4%
4 – 6 years	28	10.62%
> 6 years	13	5.2%
Total	**125**	**100%**

Mean dialysis duration: 3.2 ± 1.7 years (Range: 0.5 – 10 years)

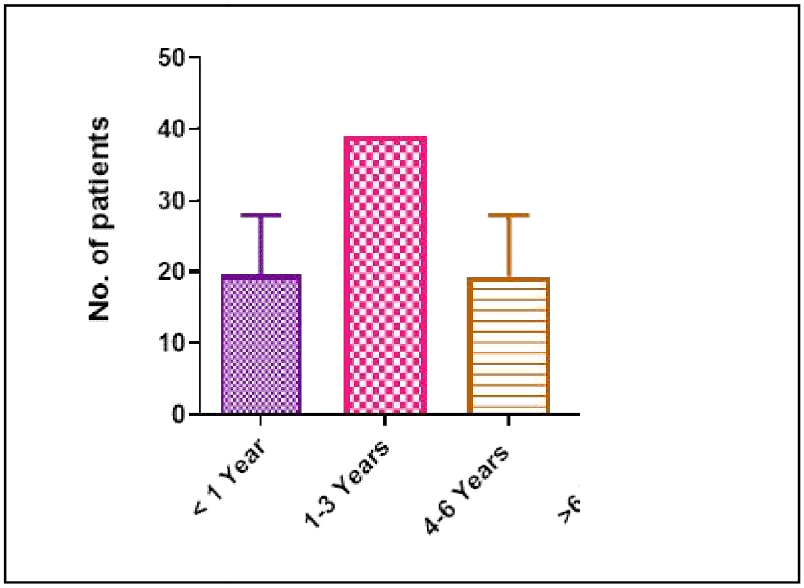

Figure 10. Duration of dialysis among study participants (n = 125). The majority of patients had been on dialysis for 1–3 years (44.8%), followed by <1 year and 4–6 years (22.4% each). Only 10.4% had been on dialysis for >6 years. The mean dialysis duration was 3.2 ± 1.7 years (range: 0.5–10 years). A statistically significant difference was observed (p = 0.0064).

Table 5: Frequency of dialysis sessions per week among study participants (n = 125)

Dialysis Frequency (sessions/week)	Number of Patients (n)	Percentage (%)
Twice weekly (2)	45	18.0%
Thrice weekly (3)	65	26.0%
More than three (>3)	15	6.0%
Total	**125**	**100%**

Distribution by adequacy category

Table 6: Distribution by adequacy category

Adequacy Measure	Category	Number of Patients (n)	Percentage (%)
Kt/V	< 1.2	21	32.0%
	≥ 1.2	42	68.0%
URR	< 65%	26	42.0%
	≥ 65%	36	58.0%

Dialysis adequacy, which is typically assessed using measures like Kt/V or URR (Urea Reduction Ratio).

6. Cardiovascular events and hospitalization records

The study revealed a substantial burden of cardiovascular morbidity and healthcare utilization among the hemodialysis patients. Overall, 30.0% had a documented history of cardiovascular events, including myocardial infarction in 12.8%, congestive heart failure in 11.2%, and arrhythmias in 6.0%, underscoring the high prevalence of cardiac complications in this population. Additionally, 44.0% of patients experienced at least one hospitalization in the preceding 12 months, with cardiovascular causes accounting for 18.0% of admissions, followed by infections (15.2%) and dialysis access-related complications (10.8%).

Table 7: Cardiovascular events and hospitalization among study participants (n = 125)

Parameter	Number of Patients (n)	Percentage (%)
History of cardiovascular events	23	30.0%
• Myocardial infarction	18	12.8%
• Congestive heart failure	17	11.2%
• Arrhythmias	04	6.0%
Hospitalizations in past 12 months	27	44.0%
• Due to infections	17	15.2%
• Due to dialysis access complications	19	10.8%

7. Mortality data

During the study period, a total of 18 deaths were recorded among the 125 hemodialysis patients, yielding a mortality rate of 15.2%. Cardiovascular events were the leading cause, accounting for 8.0% of all participants, followed by infections such as sepsis and pneumonia (4.0%), while other causes—including sudden deaths and malignancies—comprised 3.2%. The median time to mortality was 18.5 months (IQR: 12–24), indicating that most deaths occurred within the first two years of follow-up.

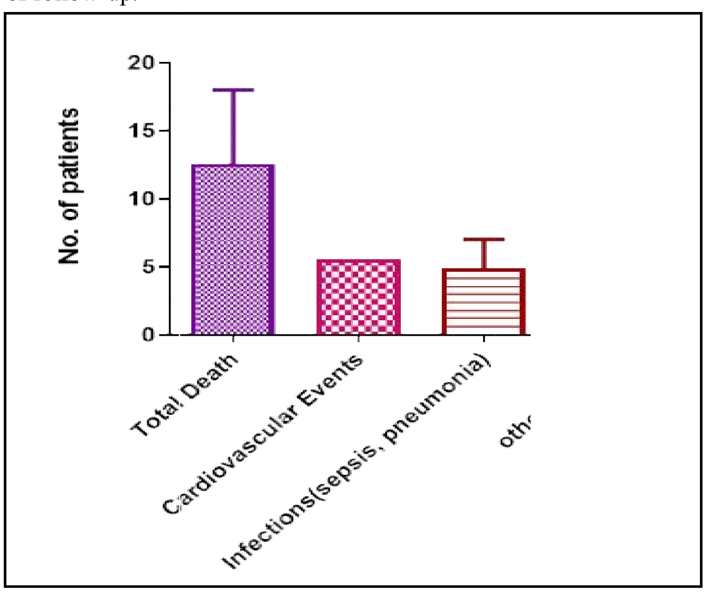

Figure 11. Mortality data among study participants (n = 125). A total of 18 deaths (14.4%) occurred during the study period. Cardiovascular events accounted for 6.4% of deaths, infections 5.6%, and other causes (including sudden death and malignancy) 2.4%. The median time to mortality was 18.5 months (IQR: 12–24).

IV. CONCLUSION

In conclusion, our study of 125 hemodialysis patients highlights a high prevalence of overweight and obesity, accompanied by a significant burden of comorbidities and metabolic derangements. The observed mortality rate of

14.4% is a concerning finding, with cardiovascular events emerging as the primary cause of death. These results underscore the complex and precarious health status of this patient population. The high prevalence of comorbidities and suboptimal dialysis adequacy for a significant portion of the cohort may contribute to the poor clinical outcomes observed. Future research should focus on targeted interventions for weight management and aggressive control of associated risk factors to improve the survival and quality of life for hemodialysis patients.

REFERENCES

[1]. Kalantar-Zadeh K, Kilpatrick RD, Kuwae N, et al. Recombinant human erythropoietin anemia management and mortality in hemodialysis patients. J Am Soc Nephrol. 2006;17(3):808-16.
[2]. Kalantar-Zadeh K, Block G, Humphreys MH, et al. Reverse epidemiology of conventional cardiovascular risk factors in patients with chronic kidney disease. J Am Soc Nephrol. 2003;14(8):2100-10.
[3]. Lu S, Guo J, Lin Y, et al. Obesity and the risk of cardiovascular and all-cause mortality in chronic kidney disease: A systematic review and meta-analysis. Clin J Am Soc Nephrol. 2016;11(6):955-64.
[4]. Hoogeveen EK, Luik AJ, Verweij-Van den Oudenrijn LP, et al. The impact of body mass index on mortality in younger hemodialysis patients. Nephrol Dial Transplant. 2010;25(5):1658-64.
[5]. Inagaki K, Hagiwara S, Tsuchida K, et al. The association between body mass index and all-cause mortality in Japanese patients with incident hemodialysis: a prospective cohort study. J Ren Nutr. 2016;26(1):16-24.
[6]. Chang CS, Yang Y, Kim H, et al. Association of body mass index and waist circumference with all-cause mortality in hemodialysis patients. J Clin Med. 2020;9(5):1289.
[7]. Zoccali C, Mallamaci F, Tripepi G. Abdominal obesity and all-cause and cardiovascular mortality in end-stage renal disease: A case for a re-assessment. Nephrol Dial Transplant. 2011;26(4):1122-4.
[8]. Flythe JE, Badve SV, Herzog CA, et al. Association of posthemodialysis weight change and mortality in hemodialysis patients. Am J Kidney Dis. 2015;66(1):136-47.
[9]. Assimon MM, Flythe JE, Aiyagari H, et al. Failed target weight achievement and adverse outcomes in hemodialysis patients. Am J Kidney Dis. 2018;71(4):493-500.
[10]. Agarwal R, Sinha AD, Bunten B, et al. Effect of dialysate sodium on fluid removal and blood pressure in hemodialysis patients: the DRIP trial. Am J Kidney Dis. 2016;68(3):473-82.
[11]. Robinson BM, Jiamin F, Ma JZ, et al. Mortality, hospitalisation, and quality of life in patients with and without residual kidney function on maintenance hemodialysis. Clin Kidney J. 2016;9(3):400-8.
[12]. Basile C, Casucci F, Di Tosto F, et al. Dialysate sodium concentration, body weight, and cardiovascular events: a systematic review and meta-analysis. Kidney Blood Press Res. 2016;41(4):493-506.
[13]. Mustafa RA, Mustafa AA, Mustafa AK, et al. The effect of intradialytic weight gain and obesity on mortality in hemodialysis patients: A systematic review. J Ren Care. 2016;42(2):68-75.
[14]. Kopple JD. Body composition and mortality in hemodialysis patients. J Ren Nutr. 2008;18(3):213-22.
[15]. Shoji T, Kalantar-Zadeh K, Fujii Y, et al. Survival of morbidly obese patients on hemodialysis. Am J Kidney Dis. 2007;49(1):97-106.
[16]. Johansen KL, Young BS, Hung SP, et al. Validation of bioelectrical impedance analysis as a measure of body composition in hemodialysis patients. J Ren Nutr. 2004;14(2):101-7.
[17]. Sands JJ, Uribarri J. The obesity paradox in end-stage renal disease: A review. Semin Dial. 2013;26(5):543-50.
[18]. Ertilav M, Basci A, Sipahi S, et al. Impact of body mass index on short-term and long-term survival in prevalent hemodialysis patients. J Nephrol. 2010;23(4):445-53.
[19]. Nagai Y, Iseki K, Fukagawa M, et al. Obesity paradox and gender in patients with end-stage kidney disease: A pooled analysis of data from a large Japanese cohort. Clin J Am Soc Nephrol. 2014;9(2):373-81.
[20]. Miskulin DC, Kalantar-Zadeh K, Ravel V, et al. Body mass index and survival in hemodialysis patients: a systematic review of the literature. J Ren Nutr. 2006;16(2):129-37.
[21]. Kalantar-Zadeh K, Regidor DL, McAllister CJ, et al. The obesity paradox and mortality in hemodialysis patients. Am J Clin Nutr. 2004;80(5):1376-83.

[22]. Pupim LB, Gagajena F, Ananda N, et al. Adiponectin is a potential marker of protein-energy wasting in chronic kidney disease. J Ren Nutr. 2006;16(3):271-8.

[23]. Marcelli D, Usvyat LA, Kotanko P, et al. Body composition and mortality in hemodialysis patients: a review of the literature. Clin Kidney J. 2017;10(1):12-20.

[24]. Chertow GM, Lazarus JM, Lew NL, et al. Development of a mortality risk score for hemodialysis patients. Kidney Int. 2004;65(5):1885-91.

[25]. Tentori F, Zhang S, Zuo H, et al. The obesity paradox in hemodialysis patients. Am J Kidney Dis. 2010;56(1):154-62.

[26]. Pifer T, Pifer T, McCullough KP, et al. Obesity, inflammation, and mortality in hemodialysis patients. Am J Kidney Dis. 2011;57(5):682-90.

[27]. Goodkin DA, Block GA, Fukushima H, et al. Association of body mass index with outcomes in the Dialysis Outcomes and Practice Patterns Study (DOPPS). Kidney Int. 2004;65(5):1885-91.

[28]. Leavey SF, Stivelman JC, Kaplan A, et al. The effect of body mass index on mortality in hemodialysis patients. Clin Nephrol. 2002;58(5):378-85.

[29]. Canaud B, Canaud M, Leray-Moragues H, et al. Impact of body mass index on survival in hemodialysis patients. Nephron Clin Pract. 2008;110(3):c161-8.

[30]. Cordeiro J, Cordeiro M, Cruz J, et al. Waist circumference, but not BMI, is associated with mortality in a large cohort of hemodialysis patients. J Ren Nutr. 2015;25(4):359-66.

[31]. Pifer T, McCullough KP, Callanan D, et al. The impact of body mass index on all-cause and cardiovascular mortality in hemodialysis patients. J Am Soc Nephrol. 2004;15(1):164-72.

[32]. Canaud B, Deschodt G, Leray-Moragues H, et al. The obesity paradox in hemodialysis patients. Nephrol Dial Transplant. 2011;26(11):3796-805.

[33]. Postorino M, Zoccali C, Ciritelli F, et al. The obesity paradox and all-cause and cardiovascular mortality in patients on peritoneal dialysis. Kidney Int. 2008;73(4):450-7.

[34]. Kalantar-Zadeh K, Block G, Horwich TB, et al. Wasting and the obesity paradox in cardiovascular disease. Prog Cardiovasc Dis. 2007;50(3):195-213.

[35]. Kopple JD, Wang H, He Q, et al. Prognostic importance of body mass index in maintenance hemodialysis patients. J Ren Nutr. 2006;16(2):168-75.

[36]. Lee Y, Nguyen F, Anvari S, Molnar AO, Doumouras AG, Walsh M, Hong D. Impact of bariatric surgery on patients with chronic kidney disease and severe obesity: multiple-linked population-based cohort study. Br J Surg. 2025 Aug 1;112(8):znaf168. doi: 10.1093/bjs/znaf168. PMID: 40875559.

[37]. Ghoneim M, Davenport A. Frailty compared to sarcopenia as the predictor of mortality for elderly hemodialysis patients. J Nephrol. 2025 Aug 21. doi: 10.1007/s40620-025-02368-5. Epub ahead of print. PMID: 40835786.

[38]. Bonsu JM, Quatman CE, Gabriel A, Quatman-Yates CC, Onizuka N. The Impact of Metabolic Syndrome on 30-Day Outcomes in Geriatric Distal Femur Fracture Surgeries. Iowa Orthop J. 2025;45(1):213-221. PMID: 40606695; PMCID: PMC12212333.

[39]. Bonsu JM, Quatman CE, Gabriel A, Quatman-Yates CC, Onizuka N. The Impact of Metabolic Syndrome on 30-Day Outcomes in Geriatric Distal Femur Fracture Surgeries. Iowa Orthop J. 2025;45(1):213-221. PMID: 40606695; PMCID: PMC12212333.

[40]. El Said HW, Mohamed OM, El Said TW, El Serwi AB. Central obesity and risks of cardiovascular events and mortality in prevalent hemodialysis patients. International Urology and Nephrology. 2017 Jul;49(7):1251-60.

[41]. Stenvinkel, P., Gillespie, I. A., Tunks, J., Addison, J., Kronenberg, F., Drueke, T. B., ... & ARO Steering Committee. (2016). Inflammation modifies the paradoxical association between body mass index and mortality in hemodialysis patients. Journal of the American Society of Nephrology, 27(5), 1479-1486.

[42]. Ladhani, M., Craig, J. C., Irving, M., Clayton, P. A., & Wong, G. (2017). Obesity and the risk of cardiovascular and all-cause mortality in chronic kidney disease: a systematic review and meta-analysis. Nephrology Dialysis Transplantation, 32(3), 439-449.

[43]. Ahmadi, S. F., Zahmatkesh, G., Streja, E., Mehrotra, R., Rhee, C. M., Kovesdy, C. P., ... & Kalantar-Zadeh, K. (2016). Association of body mass index with mortality in peritoneal dialysis patients: a systematic review and meta-analysis. Peritoneal Dialysis International, 36(3), 315-325.

[44]. Abdelaal, M., le Roux, C. W., & Docherty, N. G. (2017). Morbidity and mortality associated with obesity. Annals of translational medicine, 5(7), 161.

[45]. Kalantar-Zadeh, K., Rhee, C. M., Chou, J., Ahmadi, S. F., Park, J., Chen, J. L., & Amin, A. N. (2017). The obesity paradox in kidney disease: how to reconcile it with obesity management. Kidney international reports, 2(2), 271-281