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**Original Research Article**

# Actual dietary intake versus dietary recommendation among patients with chronic kidney disease!-an observational study

**Abhinaya S. S. Rao[1]*, Hemamalini A. J.[1], Soundararajan P.[2]**

[1]Department of Clinical Nutrition, Sri Ramachandra Institute of Higher Education and Research (DU), Chennai, Tamil Nadu, India
[2]Department of Nephrology, Saveetha Medical College and Hospital, Chennai, Tamil Nadu, India

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***Correspondence:**
Dr. Abhinaya S. S. Rao,
E-mail: abhinayassrao@gmail.com



## ABSTRACT

**Background:** As diet is an important component of chronic kidney disease management. It is important to understand the actual dietary intake of these patients and see if they are able to meet their respective recommended dietary allowance (RDA), failing which they are predisposed to malnutrition. Hence the study was carried out to assess the actual dietary intake of the subjects with chronic kidney disease to understand the gap between recommendation and actual intake. Aim of this study was to assess the dietary intake of patients with chronic kidney disease.
**Methods:** Patients with chronic kidney disease in stages 3 and 4 were recruited based on the inclusion criteria and the information on demographics, medical history, subjective data and seven-day dietary recall were obtained. The quantitative and qualitative estimation of the seven-day dietary intake was computed using "Dietcal" software.
**Results:** Anorexia was observed among 54% of the study participants. The mean calorie, protein and carbohydrate intake was 959.69±166.49 Kcals, 27.94±5.36 g and 160.5±26.7 g respectively while mean intake of sodium, potassium and phosphorous were 88.65±42.88 mg, 944.5±188.69 mg and 560.77±127.64 mg respectively.
**Conclusions:** The actual dietary intake was lesser than the recommended intake as influenced by anorexia, dysguesia, early satiety and dietary restrictions. Poor nutrient intake per se is the primary influential factor in the onset of malnutrition. Hence, it is important to adopt customized approach rather than generalized nutrient restrictions imposed upon these patients.

**Keywords:** Anorexia, Chronic kidney disease, Phosphorous, Recommended dietary allowance

## INTRODUCTION

Globally rise in the number of subjects with Chronic Kidney Disease is threatening. The prevalence of chronic kidney disease is estimated to be 8-16% worldwide.[1] Chronic kidney disease is a devitalizing condition increasing morbidity and mortality of the subjects which is a financial burden for the government and society due to the costs and complexity of its treatment.[2] The deterioration of kidney function might contribute to metabolic abnormalities that may accelerate atherosclerosis, hypertension, insulin resistance and dyslipidemia other than chronic kidney disease related risk factors. A change in approach to chronic kidney disease from treatment to prevention is therefore important.[3]

Subjects with chronic kidney disease are at a substantial risk for malnutrition characterized by protein energy wasting and micronutrient deficiency.[4] The underlying etiology includes metabolic acidosis, systemic

inflammation, anabolic hormone resistance, energy expenditure elevation, uremic toxin accumulation etc., These factors further worsens the kidney function, leading to poor prognosis.[5] Anorexia is very common in subjects with Chronic Kidney Disease and is a main cause for protein energy wasting.[6] Potential causes of anorexia include the disease condition per se, alterations in the taste perception, poly pharmacy and their associated complications of the gut.

Nutrition plays a major role in preserving kidney function, reducing co-morbidities and overall wellbeing of these subjects. Hence it is very important to assess the nutritional status with respect to their dietary intake as these subjects with CKD tend to have low protein stores regardless of their weight.[7] It has been observed in routine clinics that the actual dietary intake of patients with chronic kidney disease are suboptimal as influenced by underlying disease condition, anorexia, polypharmacy etc., The patients with chronic kidney disease are in general recommended to follow and adhere to various dietary restrictions. These imposed restrictions develops a fear and the patients end up in self restriction of food intake and are unaware of the healthy alternative options to maintain their nutritional status. These factors contribute to malnutrition among these patients. The metabolic abnormalities which are common complications of chronic kidney disease approximately begins at CKD stages 3 and 4.8. Hence, the dietary intake of these patients should be assessed quantitatively at this stage to be helpful for designing an individualized nutrition plan to prevent the onset of malnutrition and avoid undue dietary restrictions

This study was carried out to assess the actual dietary intake of the subjects with chronic kidney disease in stages III and IV, quantify their nutrient intake and compare with their respective Recommended Dietary Allowances (RDA).

## METHODS

### *Study design*

The Study was a prospective observational study and was approved by the Institutional Ethics Committee. The study was registered under clinical trial registry of India – CTRI - CTRI/2017/04/008442. The study was conducted between March 2017 to April 2018.

### *Criteria for sample selection*

Simple random sampling technique was adopted to recruit the study participants. A total of 67 patients diagnosed with chronic kidney disease in stages III and IV and those who filled in the informed consent form were included in the study, from among the patients visiting OPD at a government general hospital.

### *Data collection*

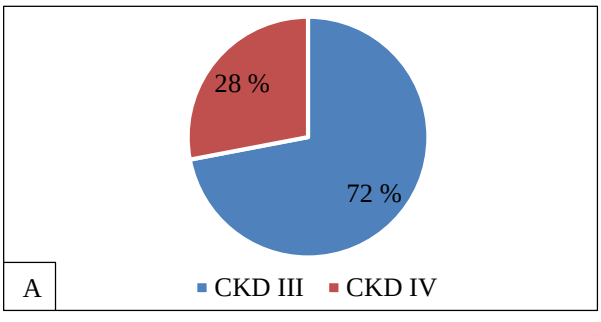
Anthropometric parameters such as height and weight of the subjects were assessed using standard procedures. Biochemical parameters such as hemoglobin, blood urea nitrogen, creatinine, sodium, potassium, total protein, albumin and eGFR were obtained from their respective medical records. The dietary intake of the study participants was assessed using a seven day dietary record prospectively. The participants were taught of house hold measures using measuring cups and spoons by the investigator on the first day of the assessment to facilitate ease of reporting, following which the telephonic follow up was carried out and the seven day diet record was filled on day to day basis by the investigator. The nutrient intake from the seven day dietary record was computed with the help of 'Dietcal' software developed based on the Indian Food composition table 2017.[9] The dietary requirements of the study participants were estimated individually according to the KDOQI guidelines (2010).

### *Data analysis*

The collected data was compared with their individualized recommended requirements. Statistical analysis was carried out using IBM.SPSS statistics software 23.0 version. Descriptive statistics such as frequency analysis, percentage analysis were used for categorical variables and the mean and standard deviation was used for continuous variables. Inferential statistical analysis was carried out using paired sample 't'-test to find the significance difference between the bivariate samples in paired groups. In the above statistical tools the probability value $p<0.05$ was considered to be significant.

## RESULTS

Sixty seven patients were included as study participants in the study based on the inclusion criteria and consent to participate. There was almost an equal proportion of male and female with males constituting 55% and females 45% of the study participants respectively as seen in Figure 1.




A higher prevalence of CKD among males over females have also been reported by Daniel et al.[10] The study also substantiates the observation of the current study that progression of the disease is more in males than in females.

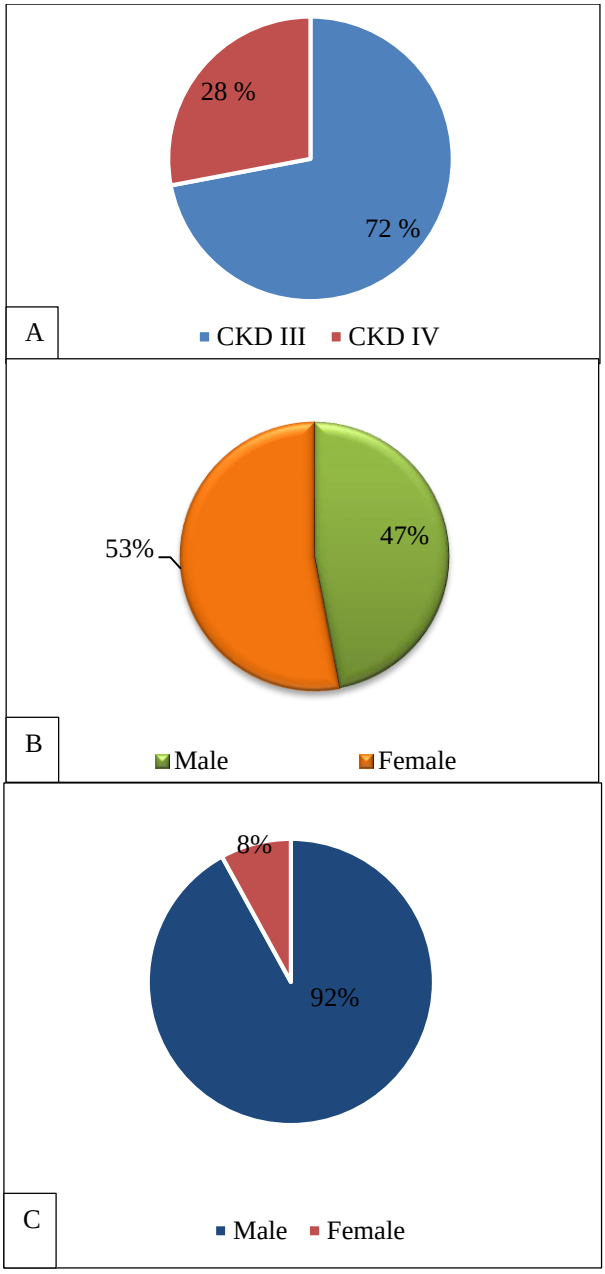



**Figure 1: Classification of subjects based on the stages of CKD. A) Stages of CKD; B) Stage III chronic kidney disease; C) Stage IV chronic kidney disease.**

The overall distribution of the study participants in stage III and stage IV CKD was 72% and 28% respectively. Among the stage III CKD group, females were comprising the majority (53%) while males were dominant (92%) in the stage IV CKD group.

Figure 2 shows that 18% of the study participants had hypertension and 27% had diabetes. Hypertension is both an important cause and consequence of chronic kidney disease. Hypertension is a major risk factor for cardiovascular and renal diseases.[11] Diabetes is the leading cause of chronic kidney disease and end stage renal disease. About eight percent of the newly diagnosed patients with type 2 diabetes mellitus already have proteinuria increasing their risk for CKD.[12] These studies have shown that diabetes and hypertension individually has a drastic effect on CKD. The current study shows that 52% of the study participants had both diabetes and hypertension indicating the risk of progression of the disease.

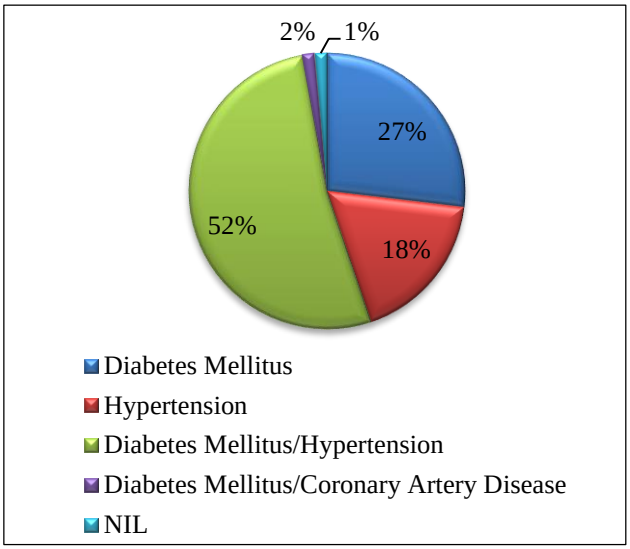



**Figure 2: Classification based on co-morbidities.**

***Nutrition status assessment-subjective data***

Nutritional assessment includes subjective and objective data. Subjective data includes the data about food habits and customs, meal patterns, food beliefs, supplemental use, and medical conditions affecting the nutritional status. In the current study the subjective information collected from the study participants include the data on their appetite and hunger, fluid intake and output, bowel habits and sleep patterns. The Figures 3 and 4 depicts the subjective data of the study participants.

Around forty-six percent of males and 63.3% of females were found to be anorexic among the study participants which also is reported to be the main contributor for malnutrition. Anorexia could be due to decreased taste and smell of food, increased oxidative stress and increased brain tryptophan.[13] In patients with chronic kidney disease dysbiotic microflora has been reported and an enhanced permeability of the intestinal barrier allowing the passage of endotoxins and other bacterial products to blood has been shown. The gut-derived uremic toxins and the increased permeability of the intestinal barrier in CKD have been associated with increased inflammation and oxidative stress which are involved in progression of the disease and mineral metabolic disorders impairing the appetite of these patients.[14] Oliguria is a valuable marker of kidney function and a criterion for diagnosing and staging kidney disease, also associated with adverse outcome with an increased risk of mortality.[15,16] Oliguria was reported by 24% of males and 40% of females in this study.

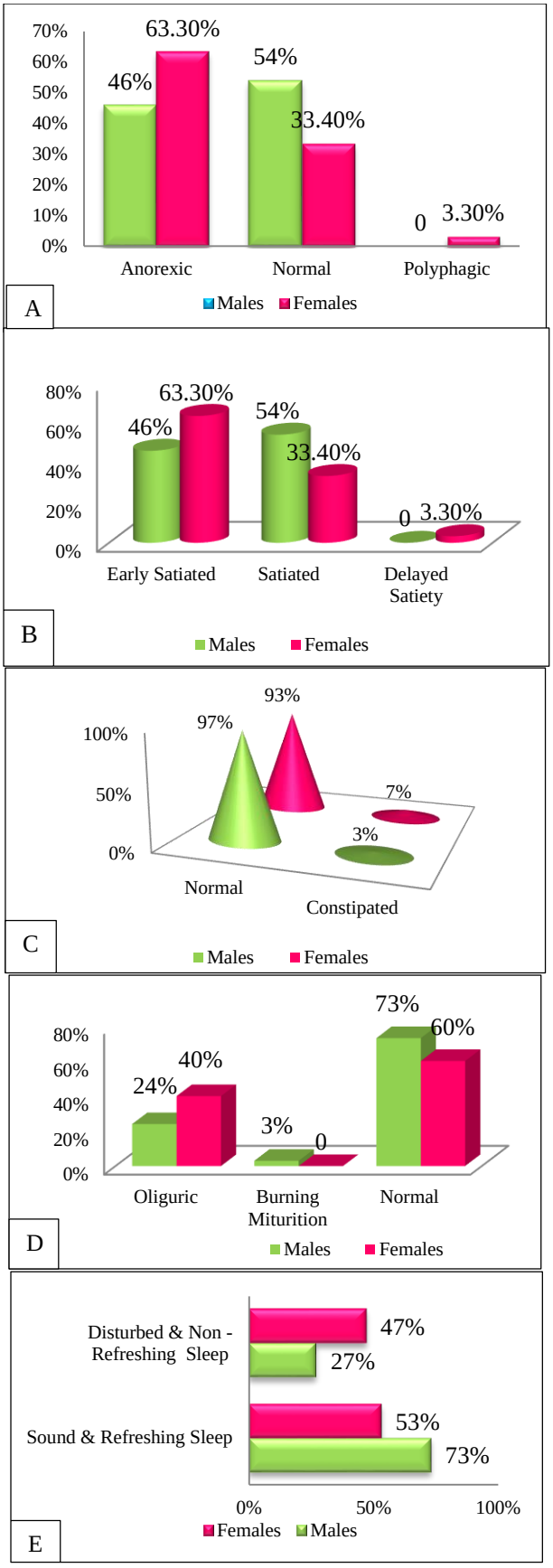



**Figure 3: Subjective data of the study participants, A) Appetite; B) Hunger; C) Bowel movement; D) Micturition; E) Sleep pattern.**

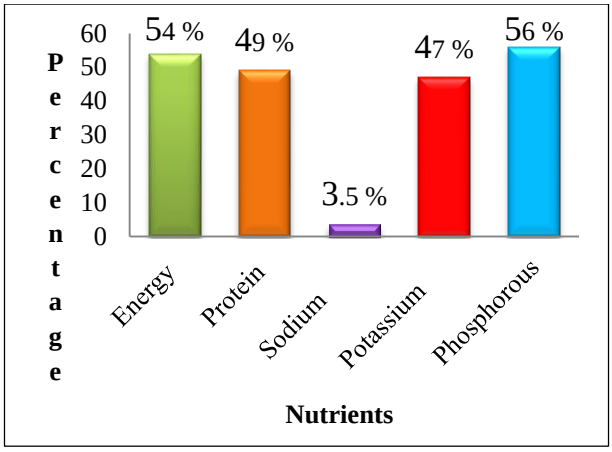



**Figure 4: Percentage nutrient intake of the study partipants.**

Table 1 shows the baseline anthropometric profile of the study participants. On comparison the males were found to be weighing significantly lower than their ideal body weight, while no such significance in weight was observed among the female participants.

Anaemia and azotemia were commonly observed among the study participants and there has been no significant difference between male and female participants with respect to their biochemical parameters. Studies have shown that kidney dysfunction leads to erythropoietin deficiency which is the predominant cause of anaemia in CKD as kidneys are the main source of erythropoietin.[17]

Majority (93%) of the subjects were found to be on mixed diet, that is they consumed both vegetarian and non-vegetarian food. However the seven day dietary record revealed that the consumption of non-vegetarian preparations were only once or twice a week. The dietary record also revealed that the participants consumed more of gravy rather than the actual pieces of any non-vegetarian preparations. Hence, their consumption of high biological value protein from these sources are questionable unlike their western counterparts.

***Nutrient intake of the study participants***

The RDA of the individual study participants was estimated as per the KDOQI guidelines. The nutrient intake of the subjects was recorded using a seven-day food record and the macro and micro nutrient intake were computed using the Dietcal software and the mean values of the nutrient intake is represented in Table 3.

Comparison of the actual nutrient intake with the RDA as per the KDOQI guidelines showed that only around 50% of estimated nutrient requirements are being met through the dietary intake of the study participants. This deficit observed could be due to poor appetite because of the underlying disease condition and the dietary restrictions imposed as also has been stated by Carrero et al, in their

review article.[18] These suboptimal nutrient intakes would culminate in cumulative macro and micronutrient deficits over time, resulting in progressive wasting of the stores leading to protein energy wasting, the most complicated form of malnutrition among the patients with renal failure.

**Table 1: Anthropometric profile of the study participants.**

| Parameter | Height (cm) | Actual body weight (kg) | Ideal body weight (kg) | P value |
|---|---|---|---|---|
| **Male (mean±SD) (n=37)** | 162.91±5.90 | 59.89±6.52 | 62.92 ±5.90 | 0.039* |
| **Female (mean±SD) (n=30)** | 155.3±3.46 | 53.76±3.94 | 55.3±3.46 | 0.115 |

**Table 2: Biochemical profile of the study participants.**

| Parameter | Male (Mean±SD) (n=37) | Female (Mean±SD) (n=30) | p value |
|---|---|---|---|
| **Hemoglobin (g/dl)** | 10.89±1.44 (↓) | 10.19±1.39 (↓) | 0.062 |
| **BUN (mg/dl)** | 36.13±16.44 (↑) | 32.4±12.37 (↑) | 0.614 |
| **Creatinine (mg/dl)** | 2.1±0.64 (↑) | 2.2±0.57 (↑) | 0.136 |
| **Sodium (mEq/l)** | 140.72±5.42 | 142.23±4.01 | 0.177 |
| **Potassium (mEq/l)** | 4.44±0.44 | 4.57±0.57 | 0.268 |
| **Total protein (g/dl)** | 6.05±0.44 | 6.05±0.41 | 0.99 |
| **Albumin (g/dl)** | 3.31±0.46 | 3.29±0.44 | 0.934 |
| **eGFR (ml/min/1.73m$^2$)** | 41.21±10.01 | 27.8±7.60 | <0.001 |

**Table 3: Comparison of nutrient intake between and within the groups.**

| Nutrient | Male (n=37) | | | | Female (n=30) | | | | P value |
|---|---|---|---|---|---|---|---|---|---|
| | RDA | Intake | % MET | p value | RDA | Intake | % MET | P value | |
| **Energy (Kcal)** | 1853.78±177.61 | 988.35±168.81 | 53.3 | <0.001 | 1653±105.21 | 923.5±160.97 | 55.8 | <0.001 | <0.001 |
| **Protein (g)** | 60.35±6.79 | 28.72±5.23 | 47.5 | <0.001 | 52.58±5.94 | 26.9±5.44 | 51.1 | <0.001 | <0.001 |
| **Sodium (mg)** | 2500±0 | 86.16±37.55 | 4.3 | <0.001 | 2500±0 | 91.76±49.29 | 4.5 | <0.001 | 0.9 |
| **Potassium (mg)** | 2000±0 | 971.27±175.83 | 38.8 | <0.001 | 2000±0 | 911.7±201.52 | 36.4 | <0.001 | 0.325 |
| **Phosphor-ous (mg)** | 1000±0 | 575.24±126.14 | 57.5 | <0.001 | 1000±0 | 543.2±129.41 | 54.3 | <0.001 | 0.203 |

**Table 4: Correlation of biochemical parameters with dietary intake.**

| Parameters | Energy (Kcal) | Protein (g) | Carbohydrates (g) | Fat (g) | Sodium (mg) | Potassium (mg) | Phosphorous (mg) |
|---|---|---|---|---|---|---|---|
| **Hemoglobin (g/dl) (p value)** | -0.152 (0.221) | -0.197 (0.111) | -0.138 (0.266) | -0.111 (0.371) | -0.059 (0.636) | -0.162 (0.190) | -0.252* (0.040) |
| **BUN (mg/dl) (p value)** | 0.126 (0.309) | 0.159 (0.200) | 0.091 (0.463) | 0.137 (0.268) | 0.016 (0.896) | 0.152 (0.219) | 0.178 (0.150) |
| **Creatinine (mg/dl) (p value)** | -0.058 (0.639) | -0.019 (0.882) | -0.082 (0.510) | -0.004 (0.972) | 0.037 (0.767) | -0.052 (0.675) | 0.045 (0.717) |
| **Sodium (mmol/l) (p value)** | -0.160 (0.196) | -0.098 (0.429) | -0.181 (0.143) | -0.087 (0.485) | -0.044 (0.725) | -0.068 (0.585) | -0.086 (0.491) |
| **Potassium (mmol/l) (p value)** | 0.050 (0.687) | 0.131 (0.292) | -0.009 (0.939) | 0.121 (0.329) | 0.108 (0.386) | 0.121 (0.331) | 0.155 (0.210) |
| **Total protein (g/dl) (p value)** | 0.025 (0.840) | 0.016 (0.899) | -0.010 (0.937) | 0.091 (0.463) | 0.017 (0.891) | 0.073 (0.558) | 0.019 (0.880) |
| **Albumin (g/dl) (p value)** | -0.056 (0.654) | -0.064 (0.605) | -0.018 (0.885) | -0.107 (0.388) | 0.029 (0.817) | -0.023 (0.856) | -0.078 (0.532) |
| **eGFR (ml/min$^3$) (p value)** | 0.090 (0.471) | 0.011 (0.929) | 0.111 (0.373) | 0.044 (0.722) | -0.091 (0.463) | 0.030 (0.809) | -0.050 (0.685) |

*Correlation is significant at 0.05 level.

In the current study, the influence of the nutrient intake on the relevant biochemical markers were evaluated and the observed results are presented in the Table 4. There was no significant correlation between the dietary intake of major nutrients and their respective biomarkers which shows us that their dietary intakes had no significant influence on their relevant biomarkers. However the serum hemoglobin levels seem to be significantly [$p<0.05$] negatively correlating with the dietary phosphorus intake which warrants further exploring for their associations. However as per available literature phosphorous loaded diet leads to secondary hyperparathyroidism in patients with CKD.[19] Secondary hyperparathyroidism could cause bone marrow fibrosis leading to decreased erythropoietin and increased resistance to erythropoietin causing anaemia in patients with CKD.[20]

The mean phosphorous intake observed in the study participants was on an average 500 mg/day as against 1000 mg/day, meeting roughly about 50% of the estimated requirements. Considering the 50% bioavailability of dietary phosphorous, it is to be speculated whether any further phosphorous restriction from dietary sources is to be emphasized.

## DISCUSSION

The prevalence of chronic kidney disease was more among males than in females as also was reported in the systematic review by Shrestha et al.[21] Classifying the study participants according to their stages of CKD, it was observed that majority of the females belonged to the stage III and majority of males belonged to stage IV CKD.

Diabetes and hypertension were reported as the major risk factors for CKD together accounting for 70% of end stage renal disease, in accordance with this report, diabetes and hypertension were observed to be the comorbidities among 52% of our study participants.[22]

Patients with CKD frequently experience anorexia which increases in severity on progression of the disease.[23] Among our study participants, 46% of the males and 63.3% of females were found to be anorexic. Oliguria which is a valuable marker of kidney function, was observed in 24% of males and 40% of females.

The anthropometric profile of the study participants showed that the males were weighing significantly lower compared to their ideal body weight while there was no significant difference found in females.

Biochemical profile of the subjects showed that anaemia and azotemia was commonly observed in both genders and there was no significant difference. The causes of anaemia include lack of erythropoietin due to kidney dysfunction, uraemia which leads to deformity in RBCs responsible for hemolysis, folate and Vitamin B12 and iron deficiency. eGFR was comparatively lower in females than males similar to that of the study by Fenton et al.[24] As females age there is a decline in GFR due to decline in estrogen levels which is interlinked with the renal hemodynamics and structural loss.[24]

Majority of the subjects were found to be on mixed diet, however non vegetarian intake was only once or twice a week. On comparing the nutrient intake with RDA, it was observed that the subjects met only around 50% of the nutrient recommendations. This could be due to anorexia caused by the uremic toxins and dietary restrictions imposed.

The influence of nutrient intake on the biochemical parameters showed that only serum haemoglobin levels significantly ($p<0.05$) negatively correlating with dietary phosphorous intake. The association of phosphorous with that of haemoglobin is that higher phosphorous intake leads to hyperparathyroidism which has direct effects on endogenous erythropoietin synthesis, bone marrow erythroid progenitors and red blood cells survival. Brancaccio et al, however the current study observed that the average dietary phosphorous intake was only about 500 mg/day compared to the recommendation of 1000 mg.day.[25]

Medical nutrition therapy in chronic kidney disease is quite complex. Kidney disease and its related complications affect the food intake due to physiological and psychological reasons affecting the nutritional status of the subjects. The nutrition guidelines for chronic kidney disease are based on the KDOQI guidelines which are based on the western standards are commonly recommended to our patients. In our study population it was observed that the study participants were meeting only around 50% of their estimated daily requirement. This could be attributed to the imposed dietary restrictions, anorexia due to the underlying disease condition, added on by the fear and uncertainity regarding nutritional informations. As reported by Zadeh et al, dietary restriction is an incorrect practice that may worsen nutritional derangements.[26] Although many studies have tried to see the beneficial effects of dietary restriction on patients with chronic kidney disease, the results have outweighed the benefit leading to greater mortality rate.[27]

This study's observation, leads us to the question, are the dietary restrictions justifiable to be continued, when their actual intake perse is inadequate to meet the requirements. It also leads us to the conclusion, that it is important to follow an encyclopedic assessment approach and customize the dietary recommendations based on the individual subjects to improve their intake and thereby their nutritional status instead of imposing too many undue dietary restrictions. It would be appropriate to carryout further studies, to assess the actual intake of the patient with renal disease and tailor make the dietary recommendation and evaluate its impact on renal specific biomarkers.

The limitations of the study include lesser availability and accessibility of the patients pertaining to the inclusion criteria and there was a dearth in literature about the study topic, hence the sample size for the study could not be calculated using previous research studies in Indian scenario and therefore simple random sampling technique was adopted for the study. The observed negative correlation between dietary phosphorus intake and haemoglobin levels requires further exploring.

## CONCLUSION

Studies highlight that a comprehensive diagnostic approach and a therapeutic plan is required to lower the complications in subjects with chronic kidney diseases. Due to the accumulation and inadequate clearance of the uremic toxins, most of the renal failure patients report nausea, vomiting, poor appetite, which hinders their overall nutritional intake as observed in this study. Further imposing of undue nutritional restrictions on the patients only would lead to deterioration of their nutritional status, resulting in protein energy wasting. Medical nutrition therapy is a major facet in management of CKD. The first step in nutrition therapy is focused in the prevention of malnutrition and to help in delaying the progression of the disease. The nutrition therapy needs to be aggressive and faultless to regulate the metabolic deviations and nutrient deficiencies. Studies have highlighted that a customized dietary approach is more appropriate in management of CKD. Appropriate nutrition interventions have found to improve the nutritional status and the overall quality of life of the subjects with CKD. It is conveyed through this observational study that the nutrition related challenges can be handled through dietary manipulations rather than restriction. A positive attitude by the treating health care professional and the client on the dietary aspects and principles would eventually strengthen the compliance to the therapy and support in maintenance of an adequate nutritional status.

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