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Assessment of total dietary fiber in patients with Chronic Kidney Disease

1 Ms.Shruti Satra, 2 Dr.Rekha Battalwar

1 MSc. Specialized Dietetics (Renal Nutrition), Sir Vithaldas Thackersey College of Home Science (Empowered Autonomous Status), S.N.D.T. Women's University, Mumbai, Maharashtra, India

2 Professor, Department of Food, Nutrition and Dietetics, Sir Vithaldas Thackersey College of Home Science (Empowered Autonomous Status), S.N.D.T. Women's University, Mumbai, Maharashtra, India

Abstract :

Background: A fiber-rich diet may benefit chronic kidney disease (CKD) patients by potentially slowing disease progression and reducing complications. However, CKD dietary restrictions, particularly regarding potassium and phosphorus, can inadvertently lead to lower fiber intake.

Aim: To assess the total dietary fiber intake in patients with Chronic kidney disease.

Methodology: *Participants with diagnosed CKD (age ≥ 18) were recruited from a tertiary hospital. Data collection included sociodemographic details, medical history, dietary habits, and 24-hour dietary recall. Fiber intake was assessed using an 18-item fiber screen. Statistical analysis was conducted using SPSS v25.*

Results: Participants aged 45 or younger consumed more legumes ($p = 0.028$), energy ($p = 0.053$), and protein ($p = 0.002$) compared to older participants. Fiber intake was higher in stage 3 CKD patients than other stages ($p = 0.041$). However, overall fiber intake fell below recommended levels (16.7 g/day vs. 25-38 g/day).

Conclusion: The findings highlight a concerning gap between the observed average dietary fiber intake of 16.7 g per day among the CKD participants whereas the recommended dietary intake of fiber ranges between 25-38 g per day . This indicates that while there may be variations in fiber intake among different CKD stages, there is a general trend of insufficient fiber consumption across the stages. This highlights the importance of addressing and promoting adequate fiber intake in individuals with CKD to support their nutritional needs and overall health.

Keywords: Chronic kidney disease, dietary fiber, dietary patterns, nutritional status

INTRODUCTION

Chronic kidney disease (CKD) is defined as lasting kidney damage or an eGFR persistently below 60 ml/min/1.73 m2 for more than three months. This condition results in a gradual decline in kidney function, ultimately leading to the need for renal replacement therapy. Identifying kidney damage involves various methods like imaging, biopsy, or detecting abnormalities in urinary tests. The 2012 KDIGO CKD classification sorts CKD based on both causes and stages (G1 to G5, with further divisions in G3). (Vaidya SR & Aeddula NR, 2022).

The 5 categories include
Stage 1: Kidney function with a glomerular filtration rate (GFR) of 90 ml/min per 1.73 m2 and above.
Stage 2: Kidney function with a GFR ranging from 60 to 89 ml/min per 1.73 m2.
Stage 3a: GFR falls within the range of 45 to 59 ml/min per 1.73 m2.
Stage 3b: GFR is in the range of 30 to 44 ml/min per 1.73 m2.
Stage 4: GFR is between 15 and 29 ml/min per 1.73 m2.
Stage 5: GFR is less than 15 ml/min per 1.73 m2 or the individual is undergoing dialysis treatment.
(KDIGO, 2012)

Dietary fiber, as defined by the European Food Safety Authority, comprises non-digestible carbohydrate polymers and lignin, backed by scientific evidence for health benefits. It is categorized into four subgroups: non-starch polysaccharides (found in fruits, vegetables, cereals, and tubers), resistant oligosaccharides, resistant starch, and lignin associated with dietary fiber polysaccharides. The term "fiber" encompasses both dietary fiber (non-digestible carbohydrates and lignin in plants) and functional fiber (isolated non-digestible carbohydrates with proven physiological benefits in humans), including those with a degree of polymerization from 3 to 9.
(Barber, T. M.et al.,2020)

The recommended daily fiber intake for adults by EFSA is 25 g, consistent with broader guidelines suggesting 25–38 g per day. Notably, clinical guidelines for kidney patients (KDIGO, KDOQI, KHACARI) often omit specific fiber recommendations to avoid potential cases of hyperkalemia. Authors like Kalantar et al. propose a fiber intake of at least 25–30 g/day for optimal benefits. Despite these recommendations, the literature and clinical experience indicate an average fiber consumption of less than 16 g/day, significantly below the suggested values. (Sanjurjo Amado et al.,2022)

METHODOLOGY: The study recruited individuals aged 18 years and above with a diagnosis of Chronic Kidney Disease (CKD) from a tertiary hospital, following the acquisition of informed consent. The research methodology involved administering a comprehensive questionnaire comprising seven sections: Sociodemographic Characteristics: This section gathered information about participants' age, gender, education level, occupation, and marital status, providing a holistic view of their background. Anthropometry Measurements: Data on height, weight, and body mass index (BMI), were collected to assess participants' physical characteristics. Medical History: Participants' medical background, including CKD stage, and comorbidities, was recorded to understand their health status.
Physical Activity: The International Physical Activity Questionnaire (IPAQ) was utilized to assess participants' level of physical activity, including frequency, intensity, and duration of exercise. Dietary Habits: This section captured information about participants' dietary patterns, including their usual food choices, meal timings, and dietary preferences.
Assessment of Fiber Intake: Fiber intake was assessed using an 18-item fiber screen, which allowed for the quantification of daily fiber consumption based on participants' reported dietary habits. 24-Hour Dietary Recall: Participants were asked to recall all food and beverages consumed in the past 24 hours, providing a detailed snapshot of their recent dietary intake. The
Data analysis was conducted using the Statistical Package of Social Software Program (SPSS). Data were presented as frequency, mean, and standard deviation. P value(<0.05, <0.001 was considered to be statistically significant.

RESULTS :

Table 1: Sociodemographic characteristics of study participants

Variables	Characteristics	N	%
Gender	Male	32	61.5
	Female	20	38.5
Family size	Nuclear	33	63.5
	Joint	19	36.5
Marital status	Married	49	94.2
	Unmarried	3	5.8
Education level	High school or below	27	51.9
	Bachelor's degree	22	42.3
	Postgraduate	3	5.8
Employment status	Employed full time	9	17.3
	Employed part-time	12	23.1
	Housewife	11	21.2
	Businessman	13	25
	Retired	7	13.5
Household income	<25,000 Rs	2	3.8
	25,000-50,000 Rs	27	51.9
	>50,000 Rs	23	44.2

Table 1 gives the sociodemographic characteristics of study participants. The study's gender distribution shows that 32 out of 52 participants (61.5%) were males, while 20 out of 52 participants (38.5%) were females, indicating a higher proportion of male participants compared to female participants. Regarding the family type, 33 out of 52 participants (63.5%) lived in a Nuclear family, whereas 19 out of 52 participants (36.5%) resided in a Joint family, highlighting a higher prevalence of Nuclear families. The distribution of marital status revealed that a large majority (94.2%) of participants were married, reflecting common societal trends. In terms of education, a statistically significant portion completed high school or below (51.9%), followed by those with a Bachelor's degree (42.3%), and a smaller percentage had post-graduate degrees (5.8%). The employment status varied among participants: 17.3% were employed full-time, 23.1% were employed part-time, 21.2% were housewives, 25% were businessmen, and 13.5% were retired. Regarding income, 27(51.9%) participants had an income between 25000-50000 Rs, 23(44.2%) participants had an income of more than Rs 50000, and 2(3.8%) participants had an income of less than Rs 25000.

Table 2: Anthropometry of study participants when classified according to age and gender

Classification according to two age groups					
Parameters	45 or less years (n = 23)	46 or more years (n = 29)	Total (n = 52)	T value	P value
Height (cm)	162.4(8.5)	167.8(6.9)	165.4(8.1)	-2.508	**0.015***
Weight (kg)	61.8(10.5)	70.1(14.2)	66.4(13.3)	-2.350	**0.023***
BMI (kg/m.sq)	23.3(3.2)	24.9(5.0)	24.2(4.3)	-1.317	0.194
Classification according to gender					
Parameters	Male (n=32)	Female (n=20)	Total (n=52)	T value	P value
Height (cm)	169.9(6.55)	159.3(6.208)	165.4(8.1)	5.349	**0.001****
Weight (kg)	69.234(13.3)	61.91(12.2)	66.4(13.3)	1.995	**0.052***
BMI (kg/m.sq)	24.169(4.49)	24.31(4.07)	24.2(4.3)	-0.114	0.91

* p value <0.05 -statistically significant
* p value <0.001- statistically significant

The anthropometric data presented in Table 2 reveals a statistically significant difference in height and weight between participants aged 46 years or more compared to those aged 45 or less. Specifically, participants in the older age group were found to be taller(p=0.015) and have a higher weight(p=0.023). However, there was no statistically significant difference in BMI between the two age groups (p > 0.05). It also highlights statistically significant differences between the two genders. Specifically, males were found to be statistically significantly taller(p=0.001) and heavier(p=0.052) compared to females. However, there was no statistically significant difference in BMI between the two gender groups (p > 0.05).

Table 3: Anthropometry of Participants when classified according to CKD vs CKD with comorbidities

Parameters	CKD with other comorbidities (n=20)	CKD (n=32)	Total (n=52)	T value	P value
Height(cm)	168.3(7.96)	163.56(7.67)	165.4(8.1)	2.135	**0.038***

Weight(kg)	71.94(17.30)	62.96(8.56)	66.4(13.3)	2.495	**0.016***
BMI(kg/m.sq)	25.405(6.10)	23.484(2.47)	63.6(9.8)	1.591	0.118

* p value <0.05 - statistically significant

The anthropometric data presented in Table 3 reveals significant differences between participants with Chronic Kidney Disease (CKD) and those with CKD along with comorbidities. Specifically, participants with CKD and comorbidities were found to be taller(p=0.038) and heavier(p=0.016) compared to those with CKD alone. However, there was no statistically significant difference in BMI between the two groups (p > 0.05).

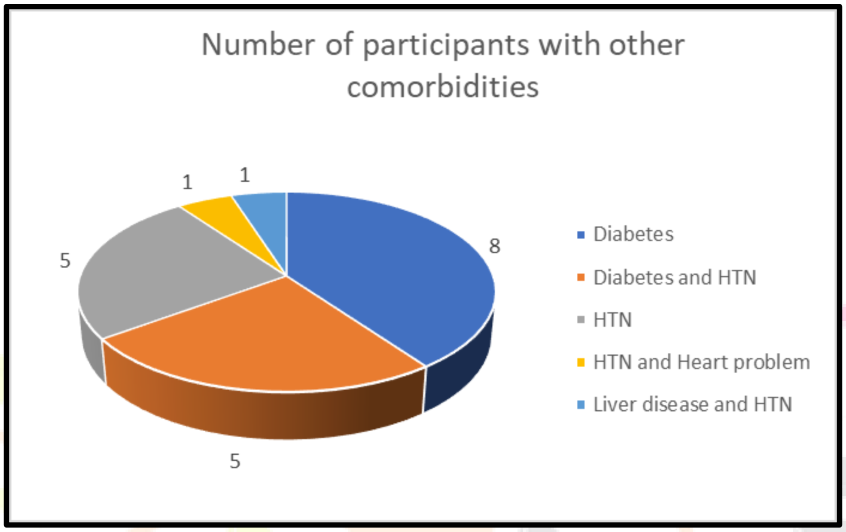

Figure 1: Number of participants with other comorbidities

20 participants (38.5%) had other comorbidities in addition to CKD, while 32 participants (61.5%) did not have any other comorbidities. 20 participants had other comorbidities, out of which 8 participants (15.4%) had Diabetes, 5 participants (9.6%) had diabetes and hypertension, 5 participants (9.6%) had hypertension, 1 participant (1.9%) had hypertension and heart problem and 1 participant (1.9%) had hypertension and liver disease.

In the assessment of physical activity among patients with chronic kidney disease (CKD), it was found that none of the participants reported engaging in regular physical activity. This result suggests a potential lack of emphasis on physical activity among individuals with CKD, which is concerning given the well-established benefits of exercise in managing CKD-related complications and improving overall health outcomes.

Table 4: Frequency of food items consumed when classified according to age

Food items	45 or less years (n = 23)	46 or more years (n = 29)	Total (n = 52)	T value	P value
Fruits	1.1(1.3)	1.2(1.6)	1.1(1.4)	-0.237	0.814
Dry fruits	0.2(0.1)	0.4(0.5)	0.3(0.4)	-1.014	0.315
Vegetable	3.1(0.9)	3.1(1.4)	3.1(1.2)	-0.216	0.830
White bread	1.4(2.1)	1.1(2.0)	1.2(2.0)	0.515	0.609

Brown bread	0.2(0.9)	0.3(0.9)	0.3(0.9)	-0.597	0.553
Multi-grain bread	0.1(0.4)	0.1(0.4)	0.1(0.4)	0.164	0.870
White rice	1.6(0.8)	1.4(0.7)	1.5(0.7)	1.067	0.291
Potatoes	0.7(1.3)	0.5(1.1)	0.6(1.2)	0.601	0.551
Beans	1.6(0.7)	1.7(0.7)	1.6(0.7)	-0.228	0.820
Legumes	7.9(2.2)	6.7(1.9)	7.2(2.1)	2.269	**0.028***
Nuts	0.2(0.1)	0.4(0.5)	0.3(0.4)	-1.017	0.314

* p value <0.05 -statistically significant

Table 4 presents the frequency of food consumption categorized by age group. The analysis in the table indicates that participants aged 45 or younger consumed legumes at a statistically significantly higher frequency compared to those aged 46 or older. This difference was found to be statistically significant with a p-value = 0.028 On the other hand, when comparing the consumption of other food groups across different age groups, the analysis did not reveal any statistically significant differences. The p-values for these comparisons were greater than 0.05, indicating that there was no statistically significant variation in the consumption of these food items based on age.

Table 5: Nutrient comparison between two age groups

Nutrients	45 or less years (n = 23)	46 or more years (n = 29)	Total (n = 52)	T value	P value
Energy (kcal)	969 (165)	778(163)	929.0	-1.981	**0.053***
RDA Energy (%)	50.6(7)	45.7(10)	48	-1.915	0.061
Protein(g)	25.2 (7.20)	18.3(4.5)	19.7	-2.035	**0.047***
Protein (%)	52.3 (14.04)	39.6 (14.5)	45.9	3.201	**0.002***
Carbohydrate (g)	122.6(28.7)	127.0(27.1)	124.8	-0.564	0.575
Carbohydrate (%)	49.0 (11.5)	50.9 (10.7)	49.9	-0.602	0.55
Fats (g)	23.0(6.4)	25.7(6.7)	24.3	-1.451	0.153
Fats (%)	36.4(10.4)	40.8(10.9)	38.6	-1.476	0.146
Fibre (g)	15.9(4.0)	17.3(3.6)	16.7	-1.293	0.202
RDA Fibre (%)	53.1(13.4)	57.7(11.9)	55.7	-1.289	0.203
Potassium (mg)	895.4(266.1)	966.2(235.3)	934.9	-1.017	0.314
RDA Potassium (%)	44.4(13.5)	48.3(11.8)	46.6	-1.110	0.272
Phosphorus (mg)	556.0(194.4)	606.5(147.5)	584.2	-1.066	0.291
RDA Phosphorus (%)	55.6(199.4)	60.7(14.8)	58.4	-1.066	0.291

* p value <0.05 -statistically significant

Table 5 presents a comparison of nutrient intake between two age groups: participants aged 45 or younger and those aged 46 or older. Energy Consumption: The analysis showed that participants aged 45 or younger consumed a higher amount of energy compared to those aged 46 or older. This difference was statistically significant with a p-value = 0.053. In practical terms, it means that younger participants were consuming more energy in their diet compared to older participants. Protein Consumption: Similarly, the study found that protein consumption was higher among participants aged 45 or younger compared to those aged 46 or older. This difference was statistically significant with a p-value = 0.047 Other Nutrients: In contrast to energy and protein, the analysis did not find any statistically significant differences in the consumption of other nutrients between the two age groups. The p-values for these comparisons were greater than 0.05, indicating that there were no statistically significant variations in the intake of these nutrients based on age.

Table 6: Nutrient comparison when classified according to different stages of CKD.

Nutrients	CKD Stages 1 & 2 (n=24)	CKD stage 3 (n=17)	CKD stage 4 (n=11)	Total (n = 52)	F value	P value
Energy (kcal)	935(135)	915(208)	934(182)	927(168)	0.076	0.92
RDA Energy(%)	49(8)	45(9)	49(10)	48 (9)	1.341	0.27
Protein(g)	21.5(8.4)	19.6 (4.7)	19.7(5.9)	20.2(6.3)	0.502	0.608
Protein (%)	48.6(14.4)	44.1(18.5)	39.6(11.4)	45.2(15.4)	1.371	0.263
Carbohydrate (g)	121.3(24.9)	128.6(28.1)	128(33.6)	125.1(27.6)	0.414	0.663
Carbohydrate (%)	48.5(9.9)	51.6(11.03)	51.2(13.4)	50.1(11.0)	0.467	0.63
Fats (g)	24.7(6.3)	24.7(7.4)	23.7(6.8)	24.5(6.7)	0.095	0.909
Fats (%)	39.3(10.3)	39.1(12.04)	37.4(10.7)	38.8(10.8)	0.117	0.89
Fibre(g)	17.48(3.2)	18.0(2.7)	15.07(2.9)	17.1(3.21)	3.426	**0.041** *
RDA Fibre(%)	58.2(11.0)	60.2(9.1)	50.2(9.94)	57.2(10.7)	3.426	**0.041** *
Potassium (mg)	946.7 (237.0)	856.7 (236.5)	1029.5 (279.1)	934.8 (249.4)	1.699	0.194
RDA Potassium (%)	47.02 (12.1)	42.83 (11.82)	51.57 (14.01)	46.62 (12.6)	1.665	0.2
Phosphorus (mg)	586.7 (152.6)	46.62 (12.6)	603.4 (214.3)	584.16 (169.9)	4318.01	0.144

RDA Phosphorus (%)	58.67 (15.2)	56.80 (17.1)	60.34 (21.43)	58.4 (16.9)	43.18	0.144

* p value <0.05 - statistically significant

Table 6 provides a nutrient comparison across different stages of Chronic Kidney Disease (CKD). Fiber Consumption: The analysis revealed that the consumption of fiber was generally low across all three stages of CKD when compared to the reference intake recommendation. However, there was a notable difference in fiber consumption based on the CKD stage. Participants in stage 3 consumed slightly more fiber than those in stages 1 and 2, followed by participants in stage 4. This difference was found to be statistically significant with a p-value=0.041. In essence, participants in stage 3 had a higher fiber intake compared to the other stages. Other Nutrients: In contrast to fiber, the study did not find any statistically significant differences in the consumption of other nutrients across the different stages of CKD.

DISCUSSION:

To our knowledge, currently, there are no Indian studies on assessing the total dietary fiber intake in patients with Chronic kidney disease. By doing this study, a baseline value for fiber intake was established in this specific patient population, considering the lack of Indian research on this subject. This study was intended to assess the fiber intake in participants diagnosed with chronic kidney disease through an 18-item fiber screen and 24-hour dietary recall.

In total, 52 participants who were diagnosed with chronic kidney disease participated in this study. 61.5% of the 32 participants were male and 38.5% of the 20 participants were female. This distribution reflects a higher proportion of male participants compared to female participants. The anthropometric data indicate a noteworthy contrast in height and weight between participants aged 46 years or older and those aged 45 or younger. Specifically, individuals in the older age group were observed to be taller(p=0.015) and have a higher weight(p=0.023), with statistical significance. This finding is consistent with previous research highlighting the natural progression of height and weight with age, as seen in studies such as those by Janssen et al. (2000) and Flegal et al. (2002).

The anthropometric data also revealed notable differences between male and female participants. Specifically, males were observed to be statistically significantly taller(p=0.001) and heavier(p=0.052)compared to females, with statistical significance. This finding is consistent with numerous studies that have investigated the differences in height and weight between genders. For instance, a study by Silventoinen et al. (2003) examined height and weight variations across different populations and reported statistically significant height and weight differences between males and females.

The finding that none of the participants reported engaging in regular physical activity among patients with Chronic Kidney Disease (CKD) suggests a potential lack of emphasis on physical activity in this population. This is concerning because regular physical activity has been shown to have numerous benefits for individuals with CKD, including managing CKD-related complications and improving overall health outcomes.A study by Greenwood et al.,2014 highlighted the benefits of exercise in CKD patients, showing improvements in cardiovascular fitness, muscle strength, and quality of life. Physical activity has also been linked to better management of blood pressure, blood sugar levels, and lipid profiles, all of which are critical for controlling CKD progression and reducing the risk of complications.

Participants aged 45 or younger consumed legumes statistically significantly more frequently than those aged 46 or older, with a statistically significant p-value =0.028.
Other Food Groups: No statistically significant differences were found in the consumption frequency of other food groups when comparing different age groups, as indicated by p-values greater than 0.05. Previous studies have highlighted the health benefits associated with legume consumption, including improved glycemic control,

cardiovascular health, and weight management Becerra-Tomás et al., 2017. The higher frequency of legume consumption among younger participants may reflect a growing awareness of these health benefits among younger demographics. Additionally, cultural and dietary trends, such as vegetarian and plant-based diets, could contribute to increased legume intake in younger age groups Satija et al., 2016.

Participants aged 45 or younger consumed more energy compared to those aged 46 or older, with a statistically significant p-value =0.053
Protein Consumption: Protein intake was higher among participants aged 45 or younger compared to those aged 46 or older, with a statistically significant p-value =0.047
Other Nutrients: There were no statistically significant differences in the consumption of other nutrients between the two age groups. The higher energy and protein consumption among younger participants aligns with previous studies highlighting the importance of adequate energy and protein intake for growth, development, and overall health in younger age groups Factors such as higher physical activity levels and metabolic rates among younger individuals may contribute to their increased energy and protein needs (Rodriguez et al., 2009).

Fiber intake was generally low across all CKD stages compared to reference intake recommendations. However, participants in stage 3 consumed slightly more fiber than those in stages 1 and 2, with stage 4 following but still lower. This difference was statistically significant with a p-value of less than 0.041. The finding of low fiber consumption across all CKD stages underscores the importance of addressing dietary fiber intake in CKD management. Fiber plays a crucial role in gastrointestinal health, blood sugar control, and cardiovascular health, which are particularly relevant for individuals with CKD (Koppe et al., 2019; McMahon et al., 2016).

Regarding dietary fiber intake, the average intake was 16.7 g per day falling well short of the intake recommendation of this nutrient which should be in the range of 25-38 g per day for adult subjects, which is associated with health benefits such as cardiovascular health, blood glucose levels, gastrointestinal health, and obesity and weight management.
According to data previously published by the National Food Survey in Chile, the low consumption of total fiber has been maintained, which is a situation similar to other countries with insufficient consumption such as Brazil (15.7 g/d), Argentina (9.3 g/d), Mexico (16 to 18 g/d), or the United States (18.3 g/d), while studies in European countries such as Sweden and Norway established a total fiber intake of 19.6 g/d and 24.0 g/d, respectively. (Stephen, A.M.,2017)

CONCLUSION:

The findings highlight a concerning gap between the observed average dietary fiber intake of 16.7 g per day among the CKD participants whereas the recommended dietary intake of fiber ranges between 25-38 g per day . This indicates that while there may be variations in fiber intake among different CKD stages, there is a general trend of insufficient fiber consumption across the stages. This highlights the importance of addressing and promoting adequate fiber intake in individuals with CKD to support their nutritional needs and overall health.

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