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ORIGINAL ARTICLE

DIETARY DIVERSITY SCORE AND THE INCIDENCE OF CHRONIC KIDNEY DISEASE IN AN AGRICULTURAL MOROCCAN ADULTS POPULATION

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ABSTRACT

Background. Healthy diet plays an important role in the management of chronic kidney disease (CKD) and in the prevention of related comorbidities. Dietary diversity score (DDS) is well recognized as an indicator for assessing diet quality and food security. However, its association with CKD has not been investigated.

Objective. The aim of this study was to estimate the prevalence of CKD and to evaluate its association with DDS among a Moroccan adults from Sidi Bennour province.

Materials and methods. A cross sectional study was conducted among 210 individuals. General information among others was collected. Weight, height and waist circumference were measured and body mass index (BMI) was calculated. Blood samples were collected and the serum creatinine was determined. Subsequent glomerular filtration rate (eGFR) was estimated by the modification of diet in renal disease (MDRD) formula and the chronic kidney disease was defined by an eGFR<60 ml/min/1.73m². Dietary intake was assessed using a 24-hours dietary recall, and DDS was computed according to the FAO guidelines.

Results. The participants mean age was 54.18±13.45 years, with a sex ratio of 0.38 and 4.4% as the prevalence of chronic kidney disease. The dietary diversity score was lower than 3 (lowest DDS) in 14.4% of the subjects, between 4 and 5 (medium DDS) in 72.5% and higher than 6 (high DDS) in 13.1% of the subjects. Subjects with higher DDS consistently have a higher level of eGFR compared to those with lower DDS while the DDS was not associated with the incidence of CKD in the present study.

Conclusion. Even if no statistically significant association was found between CKD and dietary diversity, there is a relationship of higher eGFR levels among the study participants with higher dietary diversity.

Key words: *chronic kidney disease, diet, dietary diversity score, food security, 24-h dietary recall*

INTRODUCTION

Chronic kidney disease (CKD) is recognized as a serious public health problem around the world and it is associated with high cardiovascular morbidity, mortality and low quality of life [1, 2, 3]. Several metabolic and cardiovascular disease (CVD) factors including obesity, diabetes, hypertension, and metabolic syndrome are in continuous increase worldwide including in Morocco [4, 5, 6]. In addition to these CKD risk, diet is thought to play a major role in the development of these diseases [7].

Dietary diversity is a best indicator of healthy diet [8, 9]. Dietary diversity score (DDS) is an easy and key index used to assess overall dietary quality and reflects the consumption of various foods between and within each food group [10]. The result of some studies among women of different age groups have displayed that higher dietary diversity score is related to increased nutrient adequacy of the diet [9].

Previous studies have also demonstrated the association between dietary diversity score and chronic diseases, as well as its correlation with prolonged longevity and improved health status [11]. According data from several investigations, an inverse relationship of dietary diversity score with metabolic syndrome [11], cardiovascular diseases [12], cancer [13], high blood pressure [14] and anxiety [15] has been reported.

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Furthermore, DDS is positively correlated with the intake of macronutrients and micronutrients [15].

The dietary diversity is a qualitative measure of food consumption, it also reflects household access to a variety of foods, and is also a proxy of nutrient adequacy of the individuals diet [6, 16, 17].

Ideally, the most adopted approach to measure dietary diversity is the qualitative recall over the previous 24-hours, a reference period, of all the foods consumed by the study sample [18, 19, 20]. The analysis of dietary diversity data is done by the measurement of DDS which is obtained by calculating the total number of food groups consumed over the previous 24-hours by the individuals. The total number of food groups consumed reflects, thus the degree of dietary diversity [9, 21].

Evidence suggests that diet play an important role in chronic kidney disease [22]. Dietary diversity score is well recognized as an indicator for assessing diet quality and food and nutrition security status [9, 18, 23]. In the present study, 9 food groups were selected for the calculation of the DDS in accordance with the classification proposed by the FAO [9]. The DDS therefore varied between 0 and 9. In fact, the higher dietary score indicated more diversification of the diet, and hence reflecting the nutritional quality of the food ration and therefore of the diet adopted [18]. To the best of our knowledge, no study has examined the relationship between dietary diversity score and chronic kidney disease.

The purpose of this study was therefore to determine the association between chronic kidney disease and dietary diversity score in an agricultural Moroccan adult's population attend the health centers.

MATERIALS AND METHODS

Sample

The current study was carried out between January and December 2017 on a sample of 210 subjects aged 18 years and over, living in an agricultural province, Sidi Bennour and randomly selected from primary health care. The study was supported by the Moroccan Ministry of Higher Education and Research and the Ministry of Health of Morocco. Only people aged 18 years old and older with normal mental health were included. Pregnant women, patients with paralysis and person with antecedent of kidney disease were excluded from this investigation.

Data collection

Information is mainly gathered using questionnaire to collect data on sociodemographic and socioeconomic status (age, sex, marital status, area of residence, profession, monthly income and education level), personal and family health history (hypertension, diabetes and kidney disease) and lifestyle (smoking, alcohol consumption, physical activity) and dietary habits. Blood pressure and anthropometric parameters (weight, height, waist and hip circumferences) were likewise carefully measured. All anthropometric and clinical measurements were performed by the same well trained nurse in order to reduce subjective errors.

Anthropometric measurement

The weight was measured in light clothing and without shoes to the nearest 0.1 kg on a mechanical scale, and height was recorded to the nearest of 0.1 cm with a stadiometer while the subjects were in a standing position, not wearing shoes and with shoulders in normal position. Body Mass Index (BMI) was calculated by dividing weight (kg) by the square of height (m^2). According to the World Health Organization (WHO) criteria, normal weight was defined as $18 \leq BMI \leq 24.9$ kg/m², overweight as $25 \leq BMI < 30$ kg/m² and overall obesity was defined as $BMI > 30$ kg/m². Waist circumference (WC) in (cm) was measured at midway between the lowest rib and the iliac crest and the hip circumference (HC) at the level of the greater trochanter using a flexible tape and expressed in (cm) and the waist to hip ratio (WHR) was calculated as WC divided by HC. WC is a marker for central obesity and WHR for body fat distribution. According to the NCEP-ATP III reference values, WC larger than 88 cm for females and 102 cm for males was considered to be high.

Laboratory measurements

Blood samples were collected by venipuncture after an overnight fast of at least 12 hr and all analyses were made on the day of blood collection. Serum creatinine was measured according to the standard colorimetric *Jaffe-Kinetic* reaction method.

Chronic kidney disease

Estimated glomerular filtration rate (eGFR) was calculated using the modification of diet in renal disease (MDRD) formula as follows [24, 25, 26]:

$$eGFR = 186 \times (\text{serum creatinine})^{-1.154} \times (\text{age})^{-0.203} \times (0.742 \text{ if female}) \times (1.210 \text{ if African- American})$$

Subjects were classified based on their eGFR levels by the national kidney foundation guidelines, when eGFR ≥ 60 ml/min/1.73 m² as without CKD and when eGFR < 60 ml/min/1.73 m² as with CKD.

Dietary diversity score (DDS)

A 24-hours dietary recall questionnaire was completed for a subsample of 160 participants in a face-to-face interview. According to the FAO guidelines, dietary diversity questionnaire was used to determine the dietary diversity score of each participant [9,18]. In accordance to the structure of this guideline, all the food items were categorized into 9 food groups, including: (1) cereals and white roots, (2) green leafy vegetables, (3) other vegetable and fruits, (4) vitamin A-rich vegetables and fruits, (5) organ meat, (6) meat, fish and sea food, (7) eggs, (8) nut, seeds and legumes, (9) milk and dairy products. The DDS was calculated using a minimum consumption of at least half serving of one food item from each of the mentioned food groups. The score of dietary diversity was the total number of all consumed food groups. The range of dietary diversity score was from 0 to 9. Dietary diversity score was classified into three groups; (1) low (≤3 food groups), (2) medium (between 4 and 5 food groups) and (3) high (≥6 food groups) [9,18].

Ethical consideration

The authorities were previously informed by the delegation of the Ministry of Health about the realization of the study, its objectives and terms. Also, the procedures and objectives of the study were clearly explained to the participants who provided written informed consent.

Statistical analyses

All calculations were performed using the SPSS statistics program version 24.0. Continuous variables were expressed by mean ± SD and categorical variables were reported by frequency and proportions. *Student's* t-test was used to compare differences in means and Chi-square test was used to compare differences in proportions. Analysis of variance (ANOVA) was used to determine the relationship between DDS categories and quantitative variables. In all statistical tests, p-value less than 0.05 was considered statistically significant.

RESULTS

Dietary diversity score

The mean age of the participants studied was 54.18 ±13.45 years. The prevalence of CKD (eGFR<60ml/min/1.73 m^2) was 4.4%. In our study, only a sub group of 160 individuals were able to complete their dietary questionnaire, the mean DDS was 4.49 ± 0.92 food groups, the dietary diversity value was between 2 and 7 and the median was 5 (Figure 1).

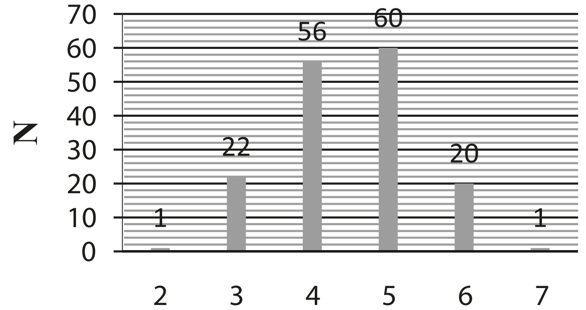

Figure 1. Individual dietary diversity score

Table 1 shows the distribution of the mean DDS according to the basic characteristics of the participants. Socio-economic status and education level were found to be associated with DDS (p<0.05). However, the analysis of dietary diversity according to gender and area of residence seems not to have any impact on the dietary diversity in this study population. On the other hand, for the age groups, a slight decrease in the mean value of the DDS was noted, going from 5.20 ± 0.63 for the youngest age category of (18-29) years old to 4.28 ± 0.75 for the category aged 70 years old and over, this difference is however not statistically significant. The same observation was made for the anthropometric status. Individuals with normal BMI have a higher mean of DDS than those with abnormal BMI. Regarding the incidence of CKD, it is noted that while not statistically significant, subjects without CKD have a relatively higher DDS value compared to those with CKD.

The respondents' dietary diversity score ranged from 2 to 7; 14.4% had low dietary diversity score, 72.5% had medium DDS and 13.1% had high DDS.

The table 2 gathered the results concerning the distribution of the participants according to their characteristics and dietary diversity scores categories. Generally, the majority of the study population (72.5%) had a medium DDS. The bivariate analysis is used to compare the proportions of these characteristics according to three categories qualified as low, medium or high DDS. With regard to age, the analysis shows that the youngest age group (18-29) was characterized by high DDS (30%) followed by the (30-44) age group (16.1%). However, no significant difference was reported regardless the age group. Concerning gender characteristics, it is noted that the proportion of high DDS is greater among men than women with a DDS mean nearly similar in both genders. The comparison by area of residence show that a medium DDS in both areas with a relatively higher DDS mean in urban areas (4.69 ± 0.89) than in rural ones (4.41 ± 0.92). This difference is not statistically significant.

The comparison of dietary diversity according to the SES showed that participants with a low SES had a low DDS with a clearly significant difference. Similarly the same observation is noted for education level, revealing a low DDS in participants with a low level of education.

With regard to the anthropometrical status, the comparison of dietary diversity revealed that the majority of subjects with normal weight, overweight and obese have a medium DDS whereas 22% of subjects with normal weight have a high DDS reflecting a diverse diet in this weight category. However, there was no significant difference between these groups.

Based on CKD incidence, the results show that the eGFR increases with the food diversity score,

Table 1. Comparison of DDS according to the study participants' characteristics

Characteristics	n (%)	DDS (mean ±SD)	P- value
Gender			
Men	45 (28.1)	4.69 ± 0.90	0.095
Women	115(71.9)	4.42 ± 0.92	
Age groups (years)			
18 – 29	10 (6.3)	5.20 ± 0.63	0.060
30 – 44	31 (19.4)	4.48 ± 1.02	
45 – 59	55 (34.4)	4.35 ± 0.94	
60 – 69	46 (28.8)	4.61 ± 0.88	
≥ 70	18 (11.3)	4.28 ± 0.75	
Area of residence			
Urban	49 (30.6)	4.69 ± 0.89	0.069
Rural	111 (69.4)	4.41 ± 0.92	
SES			
Low	95 (59.4)	4.25 ± 0.91	**0.000**
Medium	47 (29.4)	5.02 ± 0.76	
High	18 (11.3)	4.39 ± 0.85	
Education level			
Unable to read/write	116 (72.5)	4.38 ± 0.90	**0.007**
Koranic	8 (5.0)	4.38 ± 0.91	
Primary school	16 (10.0)	4.63 ± 0.80	
Secondary school	13 (8.1)	4.85 ± 1.06	
University	7 (4.4)	5.53 ± 0.53	
BMI categories			
Under weight	3 (1.9)	3.67 ± 1.15	0.113
Normal weight	41 (25.6)	4.73 ± 0.89	
Overweight	55 (34.4)	4.38 ± 0.95	
Obesity	61 (38.1)	4.48 ± 0.88	
Chronic kidney disease			
With CKD	7 (4.5)	4.29 ± 0.75	0.601
Without CKD	148 (95.5)	4.47 ± 0.92	

DDS: dietary diversity score; SD: standard deviation; SES: socio economic status;
BMI: body mass index; CKD: chronic kidney disease

Table 2. Association between the characteristics of study participants and the dietary diversity score

Characteristics	Low DDS 23 (14.4%)	DDS medium 116 (72.5%)	High DDS 21 (13.1%)	P-value
Gender, n (%)				
Men	5 (11.1)	32 (72.1)	8 (17.8)	0.469
Women	18 (15.7)	84 (73.0)	13 (11.3)	
Age, years, (mean±ET)	52.65±11.25	54.01±14.40	49.90±15.19	0.461
Ages groups, n (%)				
18 – 29	0 (0.0)	7 (70.0)	3 (30.0)	0.466
30 – 44	5 (16.1)	21 (67.8)	5 (16.1)	
45 – 59	11 (20.0)	39 (70.9)	5 (9.1)	
60 – 69	5 (10.9)	34 (73.9)	7 (15.2)	
≥ 70	2 (11.1)	15 (83.3)	1 (5.6)	
Area of residence, n (%)				
Urban	4 (8.2)	37 (75.5)	8 (16.3)	0.281
Rural	19 (17.1)	79 (71.2)	13 (11.7)	
SES, n (%)				
Low	20 (21.1)	67 (70.5)	8 (8.4)	**0.009**
Medium	1 (2.1)	35 (74.5)	11 (23.4)	
High	2 (11.1)	14 (77.8)	2 (11.1)	

Level of education, n (%)				
Unable to read/write	20 (17.2)	85 (73.3)	11 (9.5)	**0.006**
Koranic	1 (12.5)	6 (75.0)	1 (12.5)	
Primary school	0 (0.0)	15 (93.8)	1 (6.3)	
Secondary school	2 (15.4)	7 (53.8)	4 (30.8)	
University	0 (0.0)	3 (42.9)	4 (57.1)	
BMI categories, n (%)				
Underweight	2 (66.7)	1 (33.3)	0 (0.0)	0.059
Normal weight	3 (7.3)	29 (70.7)	9 (22.0)	
Overweight	10 (18.2)	39 (70.9)	6 (10.9)	
Obesity	8 (13.1)	47 (77.0)	6 (9.8)	
CKD, n (%)				
With CKD	1 (14.3)	6 (85.7)	0 (0.0)	0.587
Without CKD	22 (14.9)	107 (72.3)	19 (12.8)	
eGFR, ml/min/1.73m², mean± SD	88.83±18.98	91.72±21.57	96.84±25.76	0.487

DDS: dietary diversity score; BMI: body mass index; CKD: chronic kidney disease; SES: socioeconomic status; eGFR: estimated glomerular filtration rate.

which proves that people with normal kidney function have a more diverse diet. However, no significant difference was noted for this criterion ($p>0.05$). Also the participants with CKD do not achieve high DDS compared to those without CKD (12.8%).

Food consumption

The assessment of dietary diversity in the study population was also carried out by the consumption of the different food groups. Indeed, as shown in the (Figure 2), there is a predominance of the consumption of the cereals group as almost 100% of the individuals had consumed cereal products, 98.8% consumed vegetables and fruits, 88.1% meat and fish, 69.4% vegetables and fruits rich in vitamin A and 47.5% consumed milk and dairy products. The least consumed food groups were: eggs consumed by 21.9%, legumes by 21.3% and lastly green leafy vegetables and organ meat were consumed in a proportion of 1.3% each.

The distribution of food consumption between the three DDS categories is shown in Table 3. The intakes of cereal group were not different between the groups of dietary diversity score (100 %). About the same results are found for the fruits and vegetables group and the meat and fish group. However, the intake of the other groups, such as organ meats, eggs, nuts, seeds and legumes and milk and dairy products, were higher in subjects with higher DDS compared to the group with low DDS.

Table 4 shows the distribution of food consumption between the two groups of CKD status. Thus, the intake of all food groups seems to be independent of

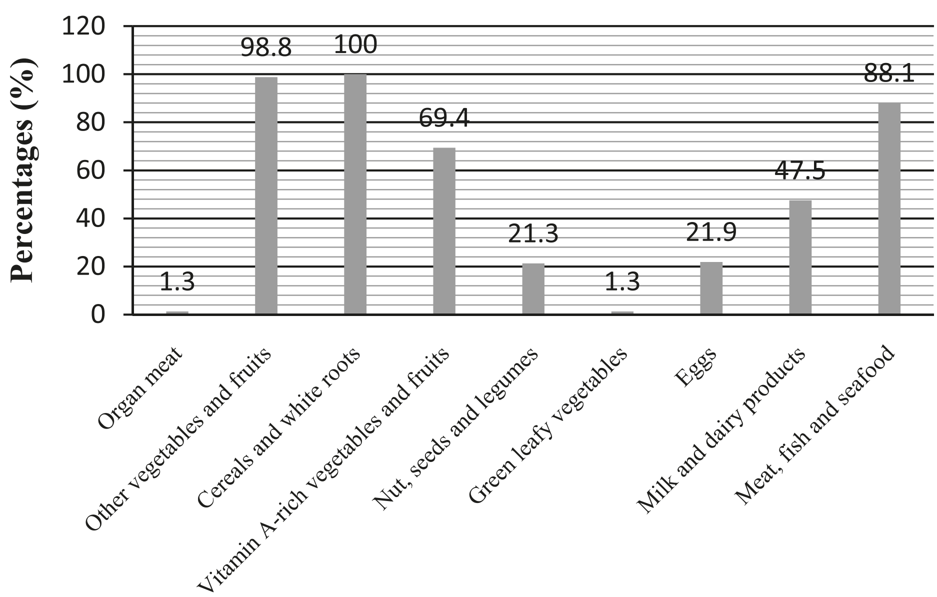

Figure 2. Food groups consumed by the study participants during the previous 24 hours

Table 3. Food groups consumption across the DDS categories in the study population

	Low DDS 23 (14.4%)	Medium DDS 116 (72.5%)	High DDS 21 (13.1%)	P-value
DDS (mean±SD)	2.96±0.20	4.52±0.50	6.05±0.21	0.000
Food groups, n (%)				
Cereals and white roots	23 (100)	116 (100)	21 (100)	1.00
Green leafy vegetables	0 (0.0)	2 (1.7)	0 (0.0)	0.681
Vitamin A-rich vegetables & fruits	2 (8.7)	91 (78.4)	18 (85.7)	0.000
Other vegetable and fruits	21 (91.3)	116 (100)	21 (100)	0.002
Organ meat	0 (0.0)	0 (0.0)	2 (9.65)	0.001
Meat, fish and sea food	12 (52.2)	108 (93.1)	21 (100)	0.000
Eggs	3 (13.0)	17 (14.7)	15 (71.4)	0.000
Nut, seeds and legumes	1 (4.3)	18 (15.5)	15 (71.4)	0.000
Milk and dairy products	6 (26.1)	56 (48.3)	14 (66.7)	0.025

DDS: Dietary diversity score; SD: standard deviation

Table 4. Food consumption across CKD status in the study population

	With CKD, n=7 (4.4%)	Without CKD, n=148 (95.6%)	p-value
DDS (mean±SD)	4.29±0.75	4.47±0.92	0.601
Food groups, n (%)			
ereals and white roots	7 (100)	148 (100)	1.00
Green leafy vegetables	0 (0.0)	2 (1.4)	0.757
Vitamin A-rich vegetables & fruits	5 (71.4)	101 (68.2)	0.859
Other vegetable and fruits	7 (100)	146 (98.6)	0.757
Organ meat	0 (0.0)	2 (1.4)	0.757
Meat, fish and sea food	7 (100)	129 (87.2)	0.312
Eggs	2 (28.6)	31 (20.9)	0.630
Nut, seeds and legumes	1 (14.3)	33 (22.3)	0.617
Milk and dairy products	1 (14.3)	70 (47.3)	0.087

CKD: chronic kidney disease; DDS: dietary diversity score; SD: standard deviation

this characteristic. DDS values are slightly similar between the two groups (p=0.601). Cereal products, fruits and vegetables, meats and fish are considerably consumed regardless the status of CKD. However, no significant difference was recorded in the consumption of the food groups according to this trait ($p > 0.05$).

DISCUSSION

This study is the first to explore the relationship between dietary diversity assessed by dietary diversity score (DDS) and the incidence of CKD. The present data revealed a consistent association of higher estimated glomerular filtration rate (eGFR) levels among the study participants with higher compared to those with lower dietary diversity. However no association was found between CKD and dietary diversity score.

Dietary diversity has already been pointed out as one of the best indicators of a healthy diet [8]. The latter is also found to be inversely associated with chronic diseases, including CKD risk factors such as diabetes and hypertension. Diet is indeed considered to be a modifiable factor involved in CKD that could contribute to impacting a major clinical and public health problem as well as preventing or delaying the renal function decline [7, 22].

The present data reports also the effects of the many factors examined in this study on DDS, especially education level and socio economic status. Thus, lower socioeconomic status and lower education level were associated with lower dietary diversity score. Similar finding was highlighted by other studies [23, 27, 28, 29]. However, gender, sex and anthropometric status of the participants were neither associated with their dietary diversity scores nor with the consumption of same food groups. This association being controversial in the literature, this result is in accordance with previous studies [30] but not with others [23].

The food quality assessment in the present study was performed using both the dietary diversity score and the consumption of different food groups. The calculation of the DDS and the list of foods used were established according to FAO recommendations [9, 31]. The seasonality factor was also taken into account since the survey took place over periods which covered approximately the 4 seasons of the year.

The diet of the majority of this population was moderately diversified, characterized by a DDS between 4 and 5 in a proportion of 72.5% with a mean DDS as 4.49±0.92. The maximum DDS of 9 points was never reached in this study population. We have The DDS was categorized according to the FAO recommendations, in 3 classes representing as low, medium, or high the dietary diversity [9, 27]. The food groups found to be the most consumed by the participants are: cereals and white roots, vegetables and fruits, meat, fish and seafood, vitamin A-rich vegetables and fruits, milk and dairy products; the least consumed were legumes, eggs, organ meats, and green leafy vegetables. The high consumption of the above foods can be explained by the abundance of these products in the weekly market especially in this agricultural region. Moreover, the consumption of cereals products also remains very important regardless of the factor studied. These are staple foods that characterize and dominate the food consumption pattern of the Moroccan population [32]. According a study revealed a great dietary diversity among 263 students adolescents of 12 to 16 years old, from Kenitra, another country agricultural province, reporting a DDS average of 10.2, out of 12 food groups that was slightly higher in rural than in urban area [32, 33]. At the African continent level, a study carried out among a representative sample of 691 mothers of young children living in a disadvantaged rural area of Burkina Faso has reported a mean DDS of 5.1±1.7 food groups. High diversity was mainly characterized by higher consumption of meat, legumes, fats and sugar. The DDS was also positively and mostly correlated with socio-economic characteristics of the participants [27].

With regards to the incidence of CKD, the present survey does not show any influence of the disease by food consumption. Indeed, the majority of subjects with CKD consumed more meat, fish and sea food compared to those without CKD. The latter had a relatively high consumption of legumes. Although, this difference was not statistically significant; this finding can probably highlight the value of plant proteins as a protective factor over those of animal products in the context of chronic kidney disease, This result is in agreement with the study of Miller et al. indicating that, the absence of legumes from the daily diet was significantly associated with hypertension [14]. Likewise, despite, the non-significant difference between the two groups, the mean DDS was slightly higher in the group without apparent CKD than in the group with CKD.

Limitations

This study has few limitations. Firstly, the sample size was relatively small. Secondly, like all other cross-sectional studies, we could not determine the causal-effect relationship between CKD and dietary diversity. Thirdly, the 24-hours recall relies on subject recall which may be prone to memory bias from the participants. Despite these limitations, this seems to be the first study to evaluate the link between CKD and dietary diversity.

CONCLUSION

In conclusion, even if no statistically significant association was found between CKD and dietary diversity, there is a relationship of higher eGFR levels among the study participants with higher dietary diversity. Further researches are also needed to confirm this finding. The study data suggest that further efforts should be made to increase the dietary diversity following the recommendations of dietary guidelines, in the aim to potentially prevent or delay the probability of having the chronic kidney disease and its related risk factors.

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Author Contributions

Moustakim R. and Belahsen R. were responsible for designing the review protocol, writing the protocol and report. Moustakim R. and Mziwira M. were responsible for collecting the data.

Moustakim R. and Belahsen R. contributed to analyzing the data and interpreting results.

Moustakim R. wrote the first draft of the article and then all co-authors contributed to finalize the manuscript.

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Competing interests
No conflicting financial interests exist.

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