Original Research Article

A comparative study on dietary diversity and nutritional adequacy between dementia patients and healthy individuals in Kolkata, West Bengal

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ABSTRACT

Background: Dementia is a chronic condition characterised by a progressive loss of memory, thinking and behaviour. Several studies indicate that nutritional status as well as dietary intake of many patients having dementia are not adequate. Malnutrition is a common problem faced by these patients. Dietary diversity is an important indicator of dietary quality. It is a well-known factor which influences the nutritional status of individuals. The current study aims to compare the dietary diversity and nutritional adequacy of dementia patients and healthy individuals.
Methods: 60 dementia patients and 60 controls were recruited as per the study protocol. 24-hour dietary intake was recorded. Dietary diversity was assessed in terms of Food Variety Score (FVS), Dietary Diversity Score (DDS) and Dietary Serving Score (DSS). Additionally, Nutrient Adequacy Ratio (NAR) was calculated for energy and 15 nutrients (Carbohydrate, Protein, Visible Fat, Thiamine, Riboflavin, Niacin, Pyridoxine, Vitamin B12, Folic Acid, Vitamin A, Vitamin C, Calcium, Magnesium, Iron and Zinc). Mean Adequacy Ratio (MAR) of the diet was also calculated.
Results: The mean values of FVS (7.2±2 versus 8.1±1.4), DDS (4.1±1 versus 4.8±0.5), DSS (10.8±2 versus 14.2±1.2) were significantly lower in the dementia group as compared to the healthy subjects. The NAR and MAR values were also lower in the dementia group except for vitamin B12. But the intake of vitamin B12 was lower than the Estimated Average Requirement.
Conclusions: In the present study it was observed that the diversity and nutritional adequacy of the diets consumed by dementia patients were poor as compared to the healthy individuals. Necessary measures should be taken to improve the dietary quality of dementia patients.

Keywords: Elderly, Dementia, Diet, Nutrition

INTRODUCTION

India is a country which is undergoing rapid demographic changes. A rise in longevity along with a reduction in fertility has contributed to an increase in the population of age 60 years and above.[1] Such an ageing population faces numerous problems among which health is an important one. Especially the rise in non-communicable diseases is a major challenge. The elderly population is particularly vulnerable to many a disease out of which dementia is an important one. It is a chronic condition characterised by a progressive loss of memory, thinking and behaviour. The capability to perform everyday activities is also lost day by day.[2] In 2013, it was estimated that around 44.35 million individuals were suffering from dementia globally which may reach 135.46 million by 2050.[3] About 3.7 million elderly people in India are having dementia which may increase two times by 2030.[4] Previous studies have shown

that malnutrition is a common problem faced by dementia patients.[5-8] The condition gets worse with the progression of the disease. The underlying mechanism is very complex and not completely understood. Many factors may be responsible for this including a reduction in appetite, interruption of eating and feeding behaviours etc. These conditions can be attributed to the impaired cognitive status and behaviour of the patients. There is also an impairment of central regulation of appetite and metabolism which eventually leads to undernutrition.[9] But if the feeding, nutritional care and dietary management is proper then malnutrition may not develop in dementia patients.

In India there is particularly a lack of such studies which have evaluated the dietary intake and adequacy of the dementia patients. Especially data regarding the quality and diversity of their diet is not properly available. So, it is essential to continuously monitor the quality and quantity of their diet and take relevant actions based on that. The current article thus targets to assess the dietary diversity and nutritional adequacy of the food consumed by non-institutionalized dementia patients and healthy individuals in Kolkata, West Bengal, India to find out the differences if any.

METHODS

A cross-sectional comparative study was carried out between dementia patients and controls of comparable age, sex and socioeconomic status. The subjects were selected from the psychiatric out patients' clinic of two tertiary hospitals (Calcutta National Medical College and Hospital and Baruipur Superspecialty Hospital) in Kolkata, West Bengal, India. Diagnosis of dementia was performed by two experienced psychiatrists according to the International Classification of Diseases (ICD)-10 criteria.[10] Mini Mental Status Examination (MMSE) Tool was used to assess the severity of dementia.[11]

Inclusion criteria for the dementia group were confirmation of dementia, age ≥60 years and willingness of the subjects or the care givers to provide informed consent. The non-blood relatives or friends of the patients identified by their care-givers were chosen as control. The inclusion criteria for this group were absence of any psychiatric and/or psychological morbidity, MMSE Score>=27, age ≥60 years, similar socio-demographic profile and willingness to provide informed consent. Subjects suffering from acute illness, uncontrolled diabetes or metabolic syndrome were excluded from both the groups.

Dementia patients who fulfilled the selection criteria were included by using a computer generated random number chart based on their appearance at the clinic. The control subjects were invited to participate in the study during the follow up visit. 60 patients and 60 controls finally completed the study. At the beginning the controls and care-givers of the dementia patients signed informed consents. A pre-designed, pre-tested, semi-structured questionnaire was used to collect socio-demographic information. Modified Kuppuswamy Scale was used to analyse socio-economic status.[12]

24-hour dietary recall method was used for the assessment of dietary diversity and adequacy of the participants. It is one of the most commonly used procedures for conducting dietary survey at the population and individual level.[13] Previous studies on geriatric population in India have used this procedure for assessing dietary intake.[14-17] It is also the recommended method by Food and Agricultural Organization (FAO) for analysing dietary diversity.[18] A standard protocol was developed by the research team based on literature review and discussion to collect data, convert cooked food to raw food and analyse the dietary diversity and nutritive value. The interviews were conducted by a trained interviewer. The care-givers of the dementia patients were interviewed in presence of the patients. The controls were interviewed separately. Supporting tools like standard cups, plates, spoons, photograph of serving sizes were used. The details of cooked food consumed by the participants were recorded and converted into raw food as per the protocol. Nutritive value was calculated based on the Indian Food Composition Table (2017).[19]

Assessment of dietary diversity

Dietary diversity (DD) refers to the number of different food groups present in the diet of an individual or a household. In simple words DD is the consumption of a variety of food items from all the food groups every day. It is a qualitative measure of dietary intake. In this study DD was assessed by using three parameters: Food Variety Score (FVS), Dietary Diversity Score (DDS) and Dietary Serving Score (DSS). [20]

Food variety score

This score was calculated by counting the individual food items consumed in the last 24 hours. Condiments, tea and coffee were excluded from the count.

Dietary diversity score

This score was calculated by counting the number of unique groups of food consumed on the previous day. While calculation 7 groups of food were considered: Cereals, Pulses, Roots & Tubers, Vegetables, Fruits, Milk/Milk Products and Meat/Fish/Egg. If the participants consumed at least half serving from a food group 1 mark was assigned. The highest possible score was 7.

Dietary serving score

The 7 food groups mentioned previously were used to develop this scale. The number of servings for each food group was decided based on the 'Indian Food Pyramid' and 'My Plate for the Day' adjusted for a 1700 kcal diet.[21-23]

The cereals group received 8 points for 8 recommended servings, pulses and meat/fish/egg received 2 points for 1 serving, roots & tubers and fruits received 1 point for 1 serving, vegetables received 3 points for 3 servings and milk/milk products received 3 points for 3 servings. Total score was 20. The details are given in Table 1.

Assessment of nutritional adequacy

Nutritional adequacy of the diet was measured using Nutrient Adequacy Ratio (NAR) and Mean Adequacy Ratio (MAR). These two are quantitative measures of dietary intake. NAR indicates how much of the requirement of a specific nutrient is being met whereas MAR indicates the overall nutritional adequacy of the diet. NAR was calculated for energy and 15 nutrients (Carbohydrate, Protein, Visible Fat, Thiamine, Riboflavin, Niacin, Pyridoxine, Vitamin B12, Folic Acid, Vitamin A, Vitamin C, Calcium, Magnesium, Iron and Zinc) individually. The following formulae were used for the calculation,

NAR (%) =

(Intake of a Nutrient (per day))/(Estimated Average Requirement (EAR) of the Nutrient)*100[20]

The denominators were set as per the Estimated Average Requirements (EAR) mentioned in the Nutrient Requirements for Indians, 2020.[23]

MAR =

(ΣNAR (each truncated at 100))/(Total Number of Nutrients)[20]

NAR% values were truncated at 100 so that a nutrient which has a high NAR% cannot compensate for a nutrient with low NAR%.

Additionally we compared the mean intake of phosphorus, copper, manganese, chromium, selenium, omega-3 fatty acids, mono unsaturated fatty acids (MUFA), poly unsaturated fatty acids (PUFA), saturated fatty acids (SFA), PUFA to SFA ratio and total dietary fibre.

Ethical approval

The study protocol was approved by the Institutional Ethics Committee of Calcutta National Medical College & Hospital and was in accordance with the Helsinki Declaration of 1975, as revised in 2000.

Statistical analysis

Data analysis was performed by using Microsoft Excel-2010 and Statistical Package for Social Sciences (SPSS, Version 16.0). Descriptive statistics was used. Mean and standard deviation were used for representing continuous data. Categorical data was expressed as frequencies. Kolmogorov-Smirnov test and Shapiro-Wilk test were used to check the normality of continuous variables for both the groups separately. For normally distributed variables Student's t-test and for non-normally distributed variables Mann-Whitney U-test were used to make comparison between two independent groups. Chi-square test was used to analyse categorical data. P<0.05 (two-sided) was considered to be statistically significant.

RESULTS

The general characteristics of the dementia patients and controls are shown in Table 2. The results suggest that both the groups were comparable to each other in terms of age, sex, socioeconomic status, educational level and place of residence. The 24-hour dietary recall of the participants generated valuable data regarding the dietary consumption of the participants. The consumption of different food by the participants during the previous day of study is shown in Figure-1. All the subjects in both the groups consumed cereals and fats/oils. Consumption of pulses, roots & tubers, vegetables and fish were higher in the control group. Whereas the intake of egg, meat, milk/milk products and fruits were comparatively higher in the dementia group. The mean values of the parameters used for assessing the dietary diversity were significantly (P<.001) lower in the dementia group as compared to the controls. This indicates that the quality of diet of the controls were better than the dementia patients. The FVS, DDS and DSS scores are shown in Figure 2.

Table 1: Recommended servings for each food group and assigned scores.

Food group	Number of serving	Weight per serving (g)	Assigned score
Cereals	8	30	8
Pulses	1	30	2
Roots and Tubers	½	100	1
Vegetables	3	100	3
Fruits	1	100	1
Milk/Milk Products	3	100	3
Meat/Fish/Egg	1	50	2
Total Score			20

The NAR% for energy and 15 nutrients and the MAR values are shown in Table 3. The NAR% values were significantly (p<0.001) higher in the control group than the dementia group for all the nutrients except Vitamin B12. The NAR% of Vitamin B12 of dementia patients was significantly (p<0.001) higher than the controls although it was far below the EAR.

Table 2: General characteristics of the participants.

General characteristics	Dementia (n=60)	Control (n=60)	Statistic	P value
Age in years, Mean±SD	65.5±5.9	64.0±5.0	U^a= 1518	0.12
Sex (Female) N (%)	32 (53.3)	29 (48.3)	$\chi^2(1)^c$= 0.3	0.58
Severity of Dementia N (%)				
Mild	21 (35.0)	-		
Moderate	19 (31.7)	-	-	-
Severe	20 (33.3)	-		
Socioeconomic Status N (%)				
Upper-Middle	3 (5.0)	3 (5.0)		
Lower-Middle	16 (26.7)	14 (23.3)	$\chi^2(2)^c$= 0.2	0.91
Upper-Lower	41 (68.3)	43 (71.7)		
Educational Level N (%)				
No Education	25 (41.7)	24 (40.0)		
Primary	9 (15.0)	7 (11.7)		
Secondary	18 (30.0)	23 (38.3)	$\chi^2(4)^c$= 1.2	0.88
Higher Secondary	5 (8.3)	4 (6.7)		
Graduate	3 (5.0)	2 (3.3)		
Residence N (%)				
Rural	45 (75.0)	47 (78.3)	$\chi^2(1)^c$= 0.2	0.66
Urban	15 (25.0)	13 (21.7)		

Foot Note: a Mann-Whitney U-Test, b Pearson's Chi Square Test.

Table 3: Comparison of NAR and MAR.

Parameters for Nutrient Adequacy Assessment		Dementia (Mean±SD)	Control (Mean±SD)	Statistic t^a	U^b	P value
NAR %	Energy	77.2±14.1	99.6±12.2	9.29	-	<0.001*
	Carbohydrate	205.9±39.1	273.2±39.4	-	422.0	<0.001*
	Protein	84.9±21.8	119.8±20.8	8.98	-	<0.001*
	Visible Fat	117.9±20.3	133.8±20.3	-	1060.0	<0.001*
	Thiamine	43.6±17.8	70.0±26.7	-	712.0	<0.001*
	Riboflavin	21.8±10.3	27.2±7.9	-	9240	<0.001*
	Niacin	72.2±19.9	105.4±17.3	9.73	-	<0.001*
	Pyridoxine	66.2±24.9	86.6±29.3	-	1060.0	<0.001*
	Vitamin B12	27.5±12.3	10.2±8.8	-	302.5	<0.001*
	Folic Acid	159.9±190.8	349.4±207.1	-	799.0	<0.001*
	Vitamin A	10.1±9.5	17.5±8.5	-	774.5	<0.001*
	Vitamin C	68.2±55.8	93.3±24.6	-	679.5	<0.001*
	Calcium	17.3±11.4	25.9±17.3	-	1001.0	<0.001*
	Magnesium	56.8±17.2	93.7±27.1	8.89	-	<0.001*
	Iron	55.3±20.8	83.0±28.5	-	782.5	<0.001*
	Zinc	38.1±9.9	57.1±11.9	9.5	-	<0.001*
MAR		55.5±8.9	69.8±6.6	-	385.0	<0.001*

Foot Note: *Values statistically significant, a Student's t-test, b Mann-Whitney U-test. NAR: Nutrient Adequacy Ratio, MAR: Mean Adequacy Ratio.

Table 3: Comparison of mean intake of phosphorus, copper, manganese, chromium, selenium, omega-3 fatty acids, mono unsaturated fatty acids (MUFA), poly unsaturated fatty acids (PUFA), saturated fatty acids (SFA), PUFA to SFA ratio and total dietary.

Nutrient	Dementia [Mean±SD]	Control [Mean±SD]	U^a	P value
Phosphorus (mg)	520.5±171.1	820.97±171.68	389.0	<0.001*
Copper (mg)	0.94±0.22	2.1±1.33	240.0	<0.001*
Manganese (mg)	2.95±0.97	4.72±1.58	568.5	<0.001*

Continued.

Nutrient	Dementia [Mean±SD]	Control [Mean±SD]	U ª	P value
Chromium (mg)	0.06±0.03	0.06±0.02	1651.0	0.43
Selenium (mcg)	40.34±23.08	84.28±33.72	501.0	<0.001*
Omega-3 fatty acids (mg)	175.21±103.21	228.89±71.79	819.0	<0.001*
Mono unsaturated fatty acids (MUFA) (g)	2.55±4.06	2.65±1.72	1452.0	0.07
Poly unsaturated fatty acids (PUFA) (g)	1.47±0.55	2.06±0.66	754.0	<0.001*
Saturated Fatty Acids (SFA) (g)	2.68±2.12	3.0±2.93	1598.0	0.29
PUFA: SFA	1.06±1.1	0.94±0.47	1610.0	0.32
Total dietary fibre (g)	14.79±5.33	25.64±6.88	343.0	<0.001*

Foot Note: *Values statistically significant, a Mann-Whitney U-test.
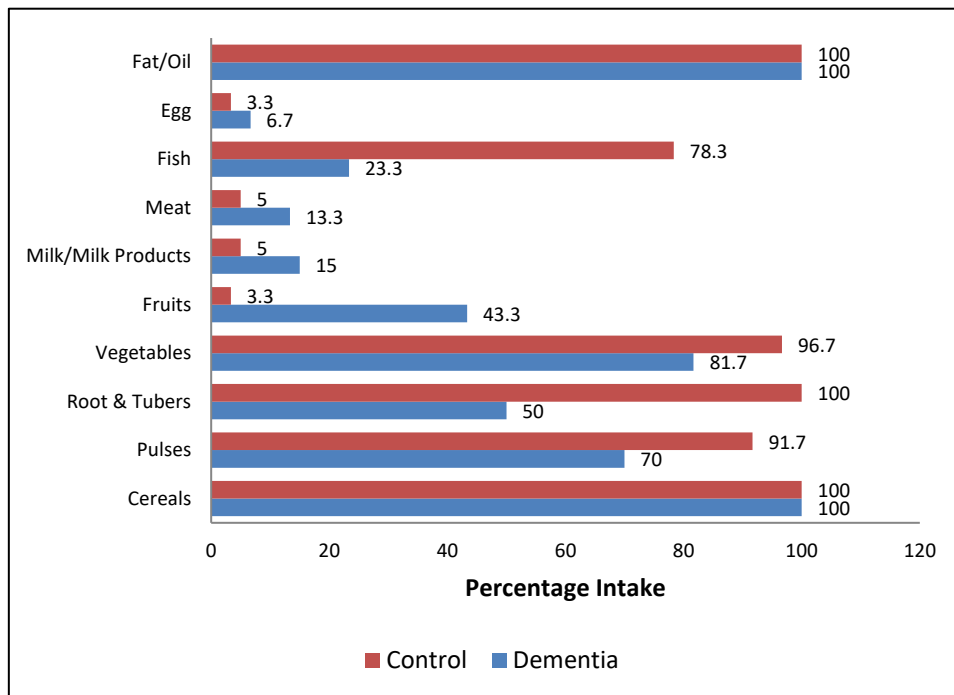

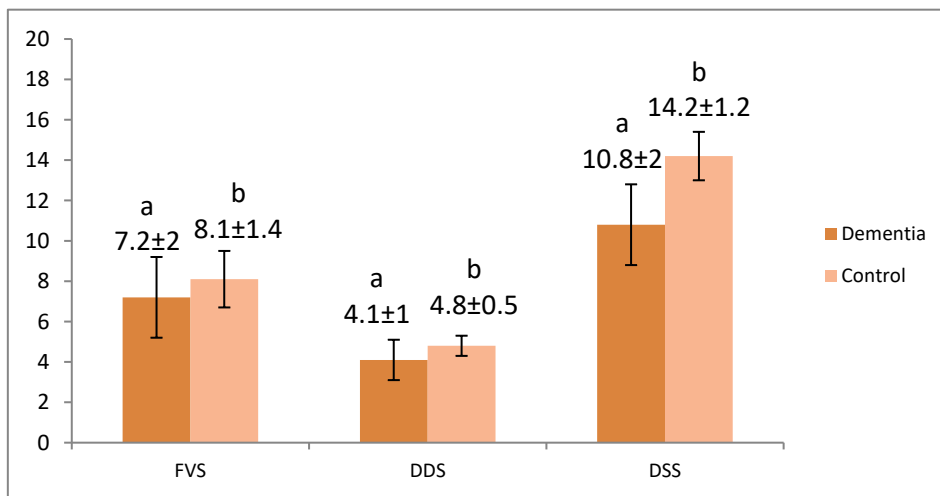**Figure 1: Consumption of different food during the previous day of study.**

Figure 2: FVS, DDS and DSS of the participants (mean±SD).

The requirement of carbohydrate, visible fat and folic acid were met by both the groups. The MAR value, which is the measure of overall nutritional adequacy, was significantly (p<0.001) higher in the control group than the dementia group. The mean intake of phosphorus, copper, manganese, chromium, selenium, omega-3 fatty acids, mono unsaturated fatty acids (MUFA), poly unsaturated fatty acids (PUFA), saturated fatty acids (SFA), PUFA to SFA ratio and total dietary fibre is summarized in Table 4. The intake of phosphorus, copper, manganese, selenium, omega-3 fatty acids, PUFA and dietary fibre were significantly (p<0.001) lower in the dementia group. Although we did not observe any significant difference in PUFA: SFA ratio.

DISCUSSION

The present study has compared the dietary diversity and nutritional adequacy of the diets consumed by dementia patients and healthy controls. The main results of our study show that the dietary diversity, assessed in terms of food variety score, dietary diversity score and dietary serving score, was lower in the patients having dementia as compared to the controls of comparable sociodemographic profile. Similarly, the adequacy of individual nutrients and the overall diet assessed in terms of NAR and MAR values were also lower in the dementia group except for vitamin B12. From earlier studies it can be observed that the dietary diversity of elderly people in general is not satisfactory in many parts of the world. Maila et al conducted a study with elderly persons of age ≥50 years in Zambia. 64.4% of the participants had a DDS less than the mean value. They also observed positive correlation between Body Mass Index (BMI) and DDS.[24] Rathnayake et al in a cross-sectional study in Sri Lanka found that the intake of pulses, egg, meat, fish, dairy products, vegetables and fruits were below the national recommendations in institutionalised elderly people. On the other hand, the intake of sugar was quite high.[25] Keshari et al found that the dietary diversity of urban geriatric subjects was not adequate and it was closely associated with their nutritional status and food security. Dietary diversity is positively associated with nutritional adequacy of the diet.[26] Rathnayake et al found that dietary diversity can be used as a proxy indicator of nutritional adequacy in elderly subjects.[27] Yin et al conducted a cross-sectional study with elderly people in China. It was found that poor dietary diversity was associated with poor cognitive function especially in the participants of age ≥80 years.[28] Thus it can be understood that dietary diversity is an important indicator of nutrition security of elderly individuals and may have considerable association with their cognitive status.

Several scientific studies have been conducted to assess the nutritional status of dementia patients. Different studies have used different parameters as indicators of nutritional status. Magri et al found a high prevalence of malnutrition in dementia patients particularly those with deeper impairment of cognitive status.[29] Jesus et al in a cross-sectional study observed a high prevalence of malnutrition in patients having dementia. They also found that the protein intake was satisfactory among the patients but energy consumption was insufficient.[30] Wengreen et al conducted a 11 years prospective study with subjects of age ≥65 years to evaluate the association between dietary quality and cognitive performance. They found that the persons with higher Recommended Food Score (RFS) had better cognitive performance than the persons with lower RFS. They concluded that the consumption of a diversified diet with a variety of recommended food may protect against age-related decline in cognition.[31] A comparative study on the dietary intake of Alzheimer's disease (AD) patients and non-demented individuals by Wlodarek et al revealed that the quality of the diet of AD patients was poor and unbalanced which make them more vulnerable to malnutrition.[32] Parvaresh et al in a case-control study with AD patients and controls found that higher intake of meat, fish, milk, milk products, vegetables and fruits were associated with lower odds of AD.[33]

Although such comparative studies are rare in India, especially West Bengal. Our study is the first one to compare the dietary quality and nutritional adequacy of demented and non-demented individuals in West Bengal, India which makes our study unique. The results are in consistence with the previous studies. We observed that the intake of pulses, roots & tubers, vegetables and fish were considerably low in the dementia group. The intake of energy, protein, thiamine, riboflavin, niacin, pyridoxine, vitamin A, vitamin C, calcium, magnesium, iron and zinc were not enough to meet the EAR and was significantly lower than the controls. The EAR for carbohydrate, visible fat and folic acid were met but significantly lower than the controls. Additionally, we observed a lower intake of phosphorus, copper, manganese, selenium, omega-3 fatty acids, PUFA and dietary fibre. We also observed a comparatively higher intake of vitamin B12 in the dementia patients but it was quite below the EAR. This may be due to slightly higher intake of meat, egg and milk products observed in the dementia group.

Protein Energy Malnutrition (PEM) is commonly observed among elderly individuals with chronic disorders including dementia.[34] It is associated with higher morbidity and mortality rates.[34] The protein and energy intakes of dementia patients in our study were lower than the controls and below EAR. Epidemiological studies show mixed results regarding the association of dietary fat and cognitive status. Although a Mediterranean dietary pattern with higher levels of dietary fibre, MUFA, omega-3-fats is found to be beneficial in dementia and cognitive impairment in various studies.[35] It has been found that omega-3-fatty acids and a high PUFA to saturated fat (PUFA: SFA) ratio is protective against dementia.[36] The N-3-PUFAs show anti-inflammatory and neuroprotective properties which can be beneficial in these patients.[37] In the current study, we however did not observe any significant difference in MUFA intake and PUFA: SFA. Strong associations have been found between dementia and certain micronutrients. Most importantly the beneficial

effect of B vitamins like thiamine, riboflavin, pyridoxine, vitamin B12, folic acid is well established.[38,39] Deficiency of vitamin B12 lead to impaired behavioural and cognitive status.[40] It also causes degeneration of spinal cord as well as peripheral neuropathy.[41] Vitamin B12 deficiency may cause a reversible form of dementia which is excluded during the diagnosis of AD.[42] Vitamin B12 along with folic acid modulates plasma homocysteine levels.[43] Increased homocysteine levels are associated with cardiovascular diseases, cerebrovascular diseases, brain ischaemia, cognitive deficits etc.[44] Niacin is also found to reduce the risk of AD and age-related cognitive decline.[45] Vitamin A and C have anti-oxidant properties and are found to be beneficial in AD and age-related cognitive decline.[46,47] Basheer et al found that serum calcium, magnesium and phosphorus are associated with cognitive status of elderly individuals. A higher calcium and magnesium level, unlike phosphorus, was found to be associated with better cognitive status. Higher serum phosphorus level, on the other hand, is a potential risk factor for dementia. In our study population phosphorus intake of both groups were within the daily recommendation (1000 mg/day).[48] Anaemia is also associated with increased risk of dementia in elderly subjects.[49] Lower consumption of iron is a well-known cause behind nutritional anaemia. A reduced dietary intake of zinc along with an impaired homeostasis in elderly subjects may increase the risk of dementia.[50] Du et al in a meta-analysis found that low serum manganese levels are common in patients having AD and Mild Cognitive Impairment (MCI) and deficiency of manganese may act as a risk factor for AD.[51] Loef et al in a systematic review found beneficial effects of selenium in AD patients. They suggested that the avoidance of a long-term selenium insufficient diet maybe helpful to prevent AD.[52] Daily consumption of these macro and micronutrients in proper amounts is thus essential.

The present study has few limitations. The sample size is relatively small. We have used 24-hour dietary recall method. It is quite suitable for capturing dietary diversity but the nutritional adequacy may differ from the actual consumption. Necessary measures were taken to minimize the gap which are mentioned in the methodology section. Moreover, dietary diversity can be used as a proxy indicator of nutritional adequacy of the diets. So, in the present study a lower dietary diversity in the dementia patients indirectly supports our observation regarding a lower nutritional adequacy. Further prospective studies with larger sample size are required.

CONCLUSION

From the present work it can be observed that the dietary diversity and nutritional adequacy of dementia patients under the study was poor as compared to the controls of similar sociodemographic profile. The intake of vitamin B12 was comparatively higher in the dementia group but it was quite below the EAR. Dietary diversification, certain macronutrients and micronutrients are associated with better nutritional and cognitive status among elderly individuals. A higher quality diet may be helpful for general health and wellbeing of dementia patients. Routine assessment of dietary intake and nutritional status of these patients is thus essential.

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