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A Cross-sectional Study on Dietary Diversity and Diet Cost in Type 2 Diabetic Population

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Abstract

Background: Globally, Type 2 Diabetes Mellitus is considered a major public health disease, influenced by nutrition and lifestyle patterns. The majority of people worldwide consume nutritionally poor, cereal-based diets. Therefore, assessing dietary diversity, macronutrient intake, and food costs is essential for better diabetes management.

Objective: To compare the dietary diversity of the Type 2 diabetic population with estimated dietary costs and other relevant parameters.

Methodology: A descriptive cross-sectional study was conducted among 150 adult Type 2 adult diabetic population. A pre-structured questionnaire was used to elicit information on dietary diversity using the Individual Dietary Diversity Score (IDDS), Food Variety Score (FVS) and diet cost estimation using semi-quantitative food frequency questionnaire. FVS was associated with nutrition status, Glycated Haemoglobin (HbA1c), macronutrient consumption, socio economic status and the average daily diet cost of the study population.

Results: The majority of the population were overweight. 50% of the population had low dietary diversity and had uncontrolled diabetes with HbA1c of 7-8%. Dietary diversity influenced the nutritional status of diabetic people. There was no difference between socioeconomic and living status, HbA1c and FVS. Females had higher per day cost when compared to males. Mean per day increased with the increase in the macronutrient consumption.

Conclusion: Diabetic patients often have low dietary diversity, which affects their nutritional status. Therefore, dietary diversity, along with diet cost, is integral to the effective nutritional care of the diabetic population.

Keywords: diet diversity, macronutrients, nutritional status, socioeconomic status, diet cost, nutritional status, population, nutrients, public health, body mass index, adult.

Highlights

- Diabetic patients tend to have poor dietary diversity, making it important to assess this diversity for effective nutritional management.
- Higher macronutrient consumption was seen among population who had larger monetary diet cost.
- Regardless of socioeconomic class, the daily diet was not diverse. Interestingly, females had a higher daily diet cost, contradicting gender bias.
- The diversity in the food consumption directly influences diabetes management.

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Estudio transversal sobre la diversidad y el coste de la dieta en la población diabética de tipo 2

Resumen

Antecedentes: a nivel mundial, la diabetes mellitus tipo 2 se considera una importante enfermedad de salud pública, influenciada por los patrones de nutrición y estilo de vida. En todo el mundo, la mayoría de las personas consume una dieta nutricionalmente pobre, generalmente basada en cereales. Por lo tanto, es importante evaluar la diversidad dietética, el consumo de macronutrientes y el costo de los alimentos para un mejor control de la diabetes.

Objetivo: comparar la diversidad de la dieta de la población con diabetes tipo 2 con el costo de la dieta estimado y otros parámetros.

Metodología: se realizó un estudio descriptivo transversal entre 150 adultos con diabetes tipo 2. Se utilizó un cuestionario preestructurado para obtener información sobre la diversidad dietética mediante el puntaje de diversidad dietética individual (IDDS), el puntaje de variedad de alimentos (FVS) y la estimación del costo de la dieta mediante un cuestionario semicuantitativo de frecuencia de alimentos. FVS se asoció con el estado nutricional, la hemoglobina glucosilada (HbA1c), el consumo de macronutrientes, el estado socioeconómico y el costo promedio diario de la dieta de la población de estudio.

Resultados: la mayoría de la población tenía sobrepeso. El 50 % de la población tenía baja diversidad dietética y diabetes no controlada con HbA1c de 7-8 %. La diversidad dietética influyó en el estado nutricional de las personas diabéticas. No hubo diferencias entre el nivel socioeconómico, el estado de vida, la HbA1c y la FVS. Las mujeres tuvieron un costo diario más alto en comparación con los hombres. La media diaria aumentó con el aumento del consumo de macronutrientes.

Conclusión: los pacientes diabéticos tienden a tener una baja diversidad dietética, lo que impacta su estado nutricional. Por lo tanto, la diversidad dietética junto con el costo de la dieta es parte integral de la atención nutricional eficaz de la población diabética.

Palabras clave: diversidad de dieta, macronutrientes, estado nutricional, nivel socioeconómico, costo de la dieta, estado nutricional, población, nutrientes, salud pública, índice de masa corporal, adulto.

Destacados

- Los pacientes diabéticos tienden a tener una dieta pobre en diversidad y, por lo tanto, es importante evaluar la diversidad dietética para un manejo nutricional efectivo.
- Se observó un mayor consumo de macronutrientes entre la población que tenía un mayor costo monetario de la dieta.
- Independientemente de la clase socioeconómica, el costo de la dieta por día no fue diverso. Las mujeres tenían un mayor costo por día, lo que contradice el sesgo de género en el consumo de alimentos.
- La diversidad en el consumo de alimentos influye directamente en la diabetes.

Introduction

Dietary diversity is a widely accepted strategy in the management of Non-Communicable Diseases (NCDs) like diabetes, hypertension, dyslipidaemia, and other lifestyle disorders in later stages of life. Type 2 Diabetes Mellitus (T2DM) has affected many people globally and poses considerable socioeconomic issues. As per the global report on diabetes by the World Health Organization (WHO), 1.5 million deaths were attributed to diabetes in 2019, with 48% of these occurring before the age of 70. Diabetes also caused nearly 460,000 deaths from kidney disease, while raised blood glucose levels contributed to 20% of cardiovascular deaths. There was a 3% increase in age-standardized mortality rates from diabetes between 2000 and 2019. By 2025, it is anticipated that 80% of all new diabetes cases will occur in emerging countries. In poorer countries, T2DM affects 85-95% of the general population. Hence, dietary management becomes crucial for preventing diabetes, managing various health conditions and preventing the risk of associated complications [1].

The development of an effective diabetes management intervention requires assessment of the diet quality. Better dietary habits were found to have a wide range of benefits on health outcomes. All-cause mortality was reduced by

17-42%, cardiovascular disease (CVD) mortality was reduced by 18-53%, and CVD risks were reduced by 14-28% [2]. Inadequate consumption of fruits and vegetables is estimated to contribute to 5% of excess mortality globally. The importance of supporting individuals in achieving a healthy balanced diet has been reinstated in national and international policies. Dietary guidelines emphasize the importance of consumption of varied diets from different food groups [3].

There is an observed correlation where a more varied diet tends to result in higher diet costs. According to a study, participants who consumed all five food groups had 18% higher adjusted mean cost than those who consumed only three or fewer groups. In light of the global five-a-day campaign promoting fruit and vegetable diversity, public health initiatives must acknowledge that adopting diverse diets rich in fruits and vegetables may not be financially feasible for all consumers, potentially exacerbating socioeconomic disparities in diet [3].

Since there are few studies related to dietary diversity and diet cost in the diabetic population, this study focuses on exploring diet diversity with diet cost in the urban population. The study could be used to assess the impact of diet diversity on diabetes. Furthermore, it will assist policymakers and nutritionists in developing viable and long-term diet diversification strategies to aid in better diabetes management.

Material and Methods

Study design

A cross-sectional study was conducted on a total of 150 Type 2 diabetic population, aged 18-55 years, who attended diabetic centers in Narayan Nethralaya Eye Hospital Bangalore, India, from November 2021 to February 2022. The study was approved by the Institutional Human Ethical Committee, Mount Carmel College, Autonomous, Bengaluru (IHEC-MCC No. 007 M.Sc./2021-22). All the subjects were interviewed using a pre-structured questionnaire after informed consent.

Baseline information

Baseline information on age, gender, education level, occupation and family status were collected. As per the Kuppuswamy scale (2022), the socioeconomic status (SES) of the population was classified into the upper, upper middle, lower middle, upper lower and lower upper class [3]. Anthropometric measures such as weight (kg.) and height (in m.) were recorded using standardized procedures, and Body Mass Index (BMI) was calculated using the WHO Asian population classification. (Underweight: <18.5 kg/m^2, normal: 18.5-22.9 kg/m^2, overweight: 23-24.9 kg/m2, Obese: >25 kg/m^2) [4]. Fasting blood sugar (mg/dl), postprandial blood glucose level (mg/dl) and glycated hemoglobin (HbA1c %), were noted from their latest report in the hospital record (Table 1).

Dietary diversity

Dietary diversity was assessed using validated Food Variety Score (FVS) and Individual Diet Diversity Score (IDDS). A semi-quantitative food frequency questionnaire on consumption of food groups like cereals, pulses, vegetables, fruits, nuts, fats and oils, eggs, and meat was used to assess FVS. High scores were assigned to a higher frequency of consumption (rarely or never: 1, once a week: 2, 3 times a week: 3, 4-5 times a week: 4, once a day, 2 or more times a day: 6). To classify the FVS as "low" or "high", the minimum and maximum scores were calculated for each food group and the overall score was estimated. Above the mid-point, the score qualified as "high FVS", and below as "low FVS" [5]. Another standardized tool used to calculate dietary diversity was IDDS. The data of food items (meals and snacks) consumed the previous day during the day and night was collected with yes or no scores (yes – 1 and no- 0) [6].

Diet cost

The monetary diet cost was determined using a semi-quantitative food frequency questionnaire, where the data on the portion size of each food item consumed, along with the frequency of

consumption was collected. Per day consumption of each food item was calculated by cross multiplication of portion size with frequency of consumption. The retail price per food item from Karnataka state's list was utilized to calculate the daily consumption cost of each food item, representing the total expenditure on food per individual per day. The mean daily cost (in INR) was then determined [3].

Statistical analysis

The data analysis was done using IBM SPSS version 20.0. Categorical and continuous variables were expressed as frequency or percentages and mean ± SD, respectively. Based on the analysis, a conclusion was drawn.

Results

Table 1. Baseline information

Characteristics	N (N= 150)	Percentage%
Gender		
Male	61	40.7
Female	89	59.3
Age (years)		
<25	5	3.3
25-35	22	14.6
35-45	15	10
45-55	45	30
>55	76	50.6
Education		
Profession or Honors	6	4
College degree	24	16
School certificate	104	69.3
Illiterate	16	10.7
Socio Economic Status (SES)		
Upper lower	15	10
Lower middle	27	18
Upper middle	77	51.3
Upper	21	20.7

Biochemical parameters		
FBS (mg/dl) *		
<110	23	15.3
110-126	50	33.3
>126	77	51.3
PPBS (mg/dl) *		
<180	33	22
180-199	76	50.7
>200	41	27.3
HbA1C (%) *		
4-7	32	21.3
7-8	79	52.7
>8	39	26

Note: *N= total number of participants, *FBS= Fasting Blood Sugar level, *PPBS= Post Prandial Blood Sugar level, *HbA1c= Glycated Hemoglobin

Source: own elaboration.

A total of 150 subjects with a mean age of 51 years participated in the study. Most of the study population were females (59.3%), had completed schooling (69.3%) and belonged to upper middle class (51.3%). More than half of the subjects had poor diabetic control with HbA1c of 7-8%, accompanied by post prandial blood glucose values greater than 180 mg/dL (Table 1).

Figure 1 shows that the majority of the population (67%) had medium Individual Dietary Diversity Scores (IDDS), with only 33% achieving high IDDS, indicating consumption from eight out of fourteen food groups. None of the participants fell into the low diet diversity category. As detailed in Table 2, dietary diversity assessed by Food Variety Score (FVS) was generally low across all food groups, including vegetables (62%) and fruits (50.7%), except for energy-dense foods, where cereal consumption (45%) was relatively higher.

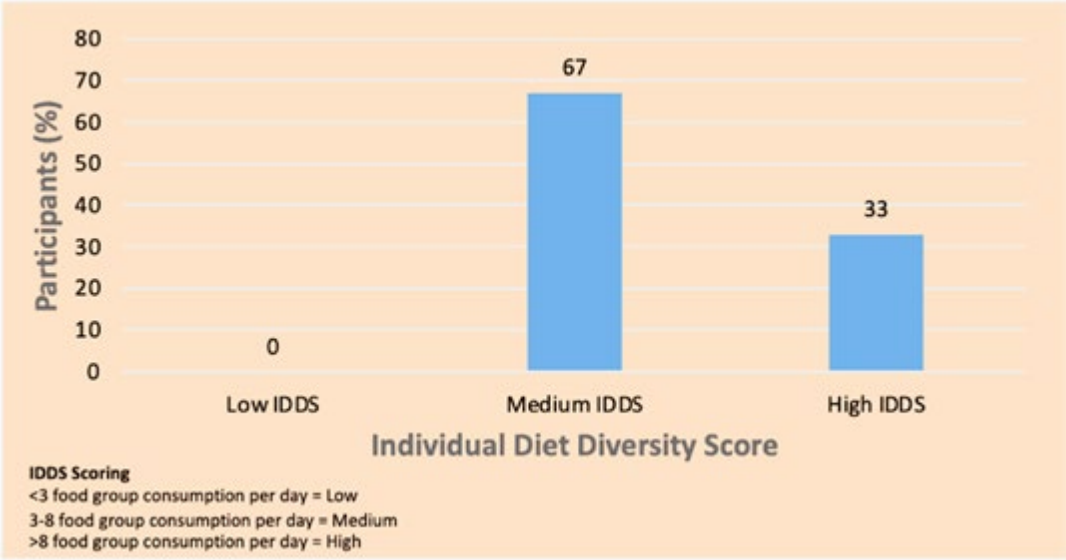

Figure 1. Distribution of Individual Diet Diversity Score (IDDS)
Note: *IDDS= Individual Diet Diversity Score
Source: own elaboration.

Table 2. Dietary diversity of food groups

Food group	Mean(min-max) ± (SD)	Low FVS n (%)	High FVS n (%)
Cereals	25.19 (12-60) ± 7.73	82 (54.7%)	68 (45.3%)
Pulses	12.05 (5-28) ±4.27	82 (54.7%)	68 (45.3%)
Fruits	20.39 (10-50) ±7.07	76 (50.7%)	74 (49.3%)
Vegetables	10.59 (4-18) ±2.93	93 (62%)	57 (38%)
Dairy	14.32 (6-31) ±4.32	76 (50.7%)	74 (49.3%)
Poultry and meat	8.23 (5-26) ±3.54	78 (52%)	72 (48%)
Energy dense foods	14.91 (12-50) ±4.98	75 (50%)	75 (50%)
Fried foods	5.75 (4-26) ±2.59	106 (70.7%)	44 (29.3%)
Beverages	17.73 (7-30) ±3.77	89 (59.3%)	61 (40.7%)
Overall	17.73 (7-30) ±26.60	74 (49.3%)	76 (50.7%)

Note: *n= number of participants, *FVS= Food Variety Score.
Source: own elaboration.

Table 3 depicts factors associated with diet diversity. The mean IDDS was higher for the participants with high FVS (8.37 ± 2.47). High FVS was observed in participants belonging to upper-middle-class SES (59.5%), living with their spouse and children (55.4%) and with lower HbA1c (24.3%).

Table 3. IDDS, Sociodemographic Characteristics, BMI, and HbA1c Status in Low and High Diet Diversity Groups

Characteristics	*FVS	
	Low n=76 *n (%)	High n=74 *n (%)
***IDDS** Mean ± SD 7.81± 2.36	7.26 ±2.13	8.37± 2.47
Lower	1 (1.3%)	0 (0%)
Upper lower	9 (11.8%)	8 (10.8%)
Lower middle	17 (22.4%)	9 (12.2%)
Upper middle	31 (40.8%)	44 (59.5%)
Upper	18 (23.7%)	13 (17.6%)
Alone	5 (6.6%)	3 (4.1%)
With spouse	11 (14.5%)	9 (12.2%)
Spouse and children	40 (52.6%)	41 (55.4%)
Joint family	20 (26.3%)	21 (28.4%)
Normal	19 (25%)	7 (9.5%)
Overweight	32 (42.1%)	38 (51.4%)
Obese	25 (32.9%)	29 (39.2%)
HbA1c (%)		
4-7	14 (18.4%)	18 (24.3%)
7-8	46 (60.5%)	33 (44.6%)
>8	16 (21.1%)	23 (31.1%)

Note: n= number of participants, FVS= Food Variety Score, IDDS=Individual Diet Diversity Score, SES= Socio Economic Status, BMI = Body Mass Index, HbA1c=Glycated Hemoglobin.

Source: own elaboration.

As indicated in Table 4, the mean per day cost was higher for females (INR 80.54± 44.76) and lower in middle SES group (INR 78.24±38.69).

Table 4. Factors influencing per day cost

Variable	Per day cost (INR) Mean ±SD
Low (<=124)	69.98± 34.33
High (>=124)	75.13 ±33.32
Male	68.16± 25.22
Female	80.54± 44.76
Upper lower class	71.09 ± 33.48
Lower middle class	78.24 ± 38.69
Upper middle class	73.38 ± 34.26
Upper class	66.02 ± 28.57

Note: FVS= Food Variety Score, SES= Socio Economic Status.
Source: own elaboration.

Regarding Table 5, the per day cost increased with increased consumption of macronutrients.

Table 5. Correlation of per day cost with macronutrients consumption

Macronutrients	Mean ±SD
Per day cost (INR)*	72.53 ±33.81
Energy (kcal)*	966.32 ±388.51
Carbohydrates (gram)	136.13 ±61.61
Protein(gram)	47.32 ±17.68
Fat (gram)	22.291±0.86

Note: INR: =Indian Rupee, Kcal=Kilo Calories
Source: own elaboration.

Discussion and conclusions

Diabetes presents a growing challenge in India, with a prevalence of 8.7% among individuals aged 20-70 years [7]. It affects an estimated 537 million adults worldwide between the age of 20 to 79 years. By 2030, 643 million people will have diabetes globally, increasing to 783 million by 2045 [8]. Many factors influence its management with diet diversity being a significant contributor. It evaluates the diet quality of individuals and households.

In our study, the majority of participants were aged 55 years or older. Similar results were found in a cross-sectional study on 194 patients with T2DM where it was established that 162 (83.5%) of the participants were 55 years old, females (53.6%) outnumbered males (46.4%), 8.2 percent were illiterate, 49.0% were homemakers, and 82% were middle class [9]. Another study included participants categorized into age groups: 18–44 years, 45–59 years, and 60 years or older, comprising 18.61%, 41.44%, and 39.95% of the total sample, respectively. Most respondents were married (86.44%) with a primary school education or lower (59.05%). In addition, 17.28% of the population were diabetic [10]. Socioeconomic status, living status and HbA1c did not impact diet diversity. In a systematic search of peer-reviewed literature for longitudinal studies, it was observed that reduced risk of T2DM was linked to greater dietary diversity across major food groups and diversity within the consumption of fruits and/or vegetables. Greater adiposity was associated with less healthy foods concluding that public health efforts should promote varied diets as a healthy eating strategy to prevent metabolic-related diseases [11]. Contrary results were seen in a study where high-socioeconomic status (P-value = 0.046) were significantly correlated with adherence to dietary-recommendations [12]. Additionally, a study identified that single males, single females, and households headed by individuals with no secondary school education or aged over 75 years were more likely to experience lower levels of dietary diversity [13].

Similar results were observed in a study on FVS in T2DM population, which reported that dairy and fruits were the least frequently consumed foods among five food groups. A significant number of individuals with Type 2 diabetes who did not adhere to national dietary guidelines were identified, highlighting the importance of promoting a well-balanced diet according to these guidelines through straightforward approaches, particularly among those with lower educational levels [14]. A study concluded that lower diet diversity score was associated with high fasting blood glucose. Therefore, it seems that increase in dietary diversity scores could prevent the prediabetes development to overt diabetes [15]. Contradictory findings were observed in a study where increased dietary diversity was positively linked with diabesity after adjusting for confounding factors. The study concluded that a more diverse diet could potentially be a risk factor for obesity among Algerian Type 2 diabetic patients [16].

Most of the study population had moderate dietary diversity, indicative that only 3-8 food groups were consumed. Interestingly, none of them had a low dietary diversity. The results were in line with a study where only one percent consumed three or fewer food groups, whereas roughly 40% had diets ranging from four to six major food groups, with a moderate dietary diversity [17]. A study on participants at risk of diabetes who consumed a diet low in DD indicated DD was not associated with nutritional status [18]. However, higher diet quality was associated with lower risk of T2D [19]. The mean IDDS score of 7.81 was contrary to a study in T2DM patients, where the mean IDDS was 5.6 ± 1.58. Hence, it was concluded that efforts are required to ensure people have better access to knowledge about adequate nutrition [20].

Per-day diet cost was higher for almost all the food groups except for energy-dense food, fried foods, and beverages. The mean diet cost for the lower-income group was higher compared to the high-income group viz. INR 78.24 vs INR 68.02/-. The per day cost for females was high compared to males viz. (Indian Rupee) INR 80.54 vs INR 68.16/-. However, a contrary result was seen where the lowest income group had a mean diet cost of (dollar) $1.37 lower than the diet cost in the highest income group ($8.36 vs. $9.73, p <0.001), and the monetary value of the diet ($/

day) was higher for men corresponding to higher quantity of food consumed [21]. Moreover, a study concluded on an average, the most affordable nutrient adequate diet exceeds the cost of adequate energy by a factor of 2.66, costing US$1.35 per day to meet median requirements of healthy adult women in 2011 [22]. The calculation of individual diet costs can offer insights into economic factors influencing food choices, diet quality, and health outcomes [23].

In the present study, it was seen that nearly half of the diabetic population had moderate dietary diversity which is a concern. Irrespective of socioeconomic class, the per day cost was unaffected however the diet cost had an impact on the macronutrient consumption. The study provides sufficient evidence that a diverse diet influences diabetes and its management.

In conclusion, extending this study to diverse populations to evaluate unique dietary practices, diet diversity, and socio-economic factors in Colombia could enhance the management of diabetes burden and improve overall health outcomes. The study could further influence nutrition education and public health initiatives in Colombia. As suggested by a study, another practice that can be adapted to improve dietary diversity and impart education, is the recognition of importance of inclusion of nutritionally balanced traditional foods. Acknowledging and accepting this simple fact can help to develop and advance more effective and sustainable policy measures to enhance traditional food and nutritional diversity in contemporary diets for improving the health, livelihood, and well-being of the population [24]. Hence, it is crucial to recognize and consider dietary diversity with diet cost as an integral component in the management of diabetes.

Ethical statement

The study was approved by the Institutional Human Ethical Committee, Mount Carmel College, Autonomous, Bengaluru (IHEC-MCC No. 007 M.Sc./2021-22). All the subjects were interviewed using a pre-structured questionnaire after informed consent.

Conflict of Interest

None declared by the authors.

Funding

None declared by the authors.

Author's contributions

Kruti Rathore: Conceptualization, Data Curation, Analysis, Methodology, Resources, Writing (Original Draft), Writing (Reviewing and Editing); Geetha Santhosh: Conceptualization, Methodology, Validation, Supervision, Visualization, Writing (Reviewing and Editing).

References

[1] World Health Organization. Diabetes [Internet]. WHO; 2023 April [Cited June 23, 2024]. Available from: https://www.who.int/news-room/fact-sheets/detail/diabetes

[2] Pradeepa R, Mohan V. Epidemiology of type 2 diabetes in India. Indian J Ophthalmol. 2021;69(11):2932-2938. https://doi.org/10.4103/ijo.IJO_1627_21

[3] Conklin AI, Monsivais P, Khaw K-T, Wareham NJ, Forouhi NG. Dietary Diversity, Diet Cost, and Incidence of Type 2 Diabetes in the United Kingdom: A Prospective Cohort Study. PLoS Med. 2016;13(7):e1002085. https://doi.org/10.1371/journal.pmed.1002085

[4] Sood P, Bindra S. Modified Kuppuswamy socioeconomic scale: 2022 update of India. Int J Community Med Public Health. 2022;9(10):3841–3844. https://doi.org/10.18203/2394-6040.ijcmph20222581

[5] Weir CB, Jan A. BMI Classification Percentile And Cut Off Points. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023. Available from: http://www.ncbi.nlm.nih.gov/books/NBK541070/

[6] Aneesh M, Patil RS. Diet diversity of urban households in India during the

COVID-19 lockdown. Nutr Health. 2022 Dec;28(4):685–91. https://doi.org/10.1177/02601060211019676

[7] Déré KAL, Djohan Y, Koffi KG, Manhan K, Nimaké AG, Tiahou GG. Individual Dietary Diversity Score for Diabetic and Hypertensive Patients in Cote d'Ivoire. IJN. 2016 Apr 8;2(1):38–47. https://doi.org/10.14302/issn.2379-7835.ijn-16-943

[8] Kumar A, Gangwar R, Zargar AA, Kumar R, Sharma A. Prevalence of Diabetes in India: A Review of IDF Diabetes Atlas 10th Edition. Curr Diab Rev. 2024;20(1): e130423215752. https://doi.org/10.2174/1573399819666230413094200

[9] World Health Organization. World Diabetes Day [Internet]. WHO;2019 [Cited June 23, 2024]. Available at: https://www.who.int/india/campaigns/world-diabetes-day

[10] Zhang L, Chang H, Chen Y, Ruan W, Cai L, Song F, et al. Socio-Demographic Factors Associated with Rural Residents' Dietary Diversity and Dietary Pattern: A Cross-Sectional Study in Pingnan, China. Nutrients. 2023 Jan;15(13):2955. https://doi.org/10.3390/nu15132955

[11] Yerrapragada DB, Rao CR, Karunakaran K, Lee HSE. Cognitive Dysfunction Among Adults with Type 2 Diabetes Mellitus in Karnataka, India. Ochsner J. 2019;19(3):227–34. https://doi.org/10.31486/toj.18.0160

[12] Doglikuu BID, Abubakari A, Yaseri M, Shakibazadeh E, Djazayery A, Mirzaei K. Association of household socioeconomic status, neighborhood support system and adherence to dietary recommendation among persons with T2DM, a facility-based cross-sectional study in Ghana. BMC Public Health. 2021 May 13;21(1):911. https://doi.org/10.1186/s12889-021-10963-x

[13] Pullen R, Kent K, Sharman MJ, Schumacher TL, Brown LJ. A Comparison of Diet Quality in a Sample of Rural and Urban Australian Adults. Nutrients. 2021 Nov 13(11):4130. https://doi.org/10.3390/nu13114130

[14] Mozaffari H, Hosseini Z, Lafrenière J, Conklin AI. The role of dietary diversity in preventing metabolic-related outcomes: Findings from a systematic review. Obesity Reviews. 2021;22(6): e13174. https://doi.org/10.1111/obr.13174

[15] Gholizadeh F, Moludi J, Yagin NL, Alizadeh M, Nachvak SM, Abdollahzad H, et al. The relation of Dietary diversity score and food insecurity to metabolic syndrome features and glucose level among pre-diabetes subjects. Primary Care Diabetes. 2018 Aug 1;12(4):338–44. https://doi.org/10.1016/j.pcd.2018.03.003

[16] Bounihi A, Saidi H, Bouazza A, Benbaibeche H, Azzouz M, Koceir EA. Dietary Diversity as a Risk Factor for Obesity in Algerian Patients with Type 2 Diabetes Mellitus. Healthcare. 2021 Sep;9(9):1229. https://doi.org/10.3390/healthcare9091229

[17] Tiew KF, Chan YM, Lye MS, Loke SC. Factors Associated with Dietary Diversity Score among Individuals with Type 2 Diabetes Mellitus. J Health Popul Nutr. 2014 Dec;32(4):665–76.

[18] Madlala SS, Hill J, Kunneke E, Kengne AP, Peer N, Faber M. Dietary Diversity and its Association with Nutritional Status, Cardiometabolic Risk Factors and Food Choices of Adults at Risk for Type 2 Diabetes Mellitus in Cape Town, South Africa. Nutrients, 2022;14(15):3191. https://doi.org/10.3390/nu14153191

[19] de Oliveira O, Padhye NS, Bertoni AG, Jacobs DR Jr, Mozaffarian D. Everything in Moderation – Dietary Diversity and Quality, Central Obesity and Risk of Diabetes. PLoS ONE 10(10):e0141341. https://doi.org/10.1371/journal.pone.0141341

[20] Aneesh M, Patil RS. Diet diversity of urban households in India during the COVID-19 lockdown. Nutr Health. 2022 Dec;28(4):685–91. https://doi.org/10.1177/02601060211019676

[21] Monsivais P, Aggarwal A, Drewnowski A. Are socio-economic disparities in

diet quality explained by diet cost? J Epidemiol Community Health. 2012 Jun 1;66(6):5305. https://doi.org/10.1136/jech.2010.122333

[22] Bai Y, Alemu R, Block SA, Headey D, Masters WA. Cost and affordability of nutritious diets at retail prices: Evidence from 177 countries. Food Policy. 2021 Feb 1;99:101983. https://doi.org/10.1016/j.foodpol.2020.101983

[23] Monsivais P, Perrigue MM, Adams SL, Drewnowski A. Measuring diet cost at the individual level: a comparison of three methods. Eur. J. Clin. Nutr, 2013;67:1220–1225.

[24] Sarkar D, Walker-Swaney J, Shetty K. Food Diversity and Indigenous Food Systems to Combat Diet-Linked Chronic Diseases. Current Developments in Nutrition. 2020 Jan 1;4:3–11. https://doi.org/10.1093/cdn/nzz099