Dietary Diversity and its Association with Non-Communicable Diseases among Adult Outpatients in a Tertiary Care Hospital in Tiruppur, Tamil Nadu: A Cross-Sectional Study

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Abstract

Background: Dietary diversity is commonly used as an indicator of diet quality and nutritional adequacy, yet its relationship with non-communicable diseases (NCDs) remains inconsistent across populations. Understanding dietary patterns in relation to NCDs is essential for developing effective preventive strategies in clinical and public health settings. **Objectives:** To assess dietary diversity patterns and examine their association with selected non-communicable diseases among adult outpatients attending a tertiary care hospital in Tiruppur, Tamil Nadu. **Methods:** A hospital-based cross-sectional analytical study was conducted among 1,054 adult outpatients. Data on socio-demographic characteristics, lifestyle factors, and dietary habits prior to NCD diagnosis were collected using a pre-tested questionnaire. Dietary diversity score (DDS) was calculated based on consumption frequencies of eight food groups and categorized as low, intermediate, or high. Associations between food group consumption, DDS categories, and NCD prevalence were analyzed using chi-square tests and multivariable logistic regression. **Results:** Most participants had an intermediate DDS. No statistically significant association was observed between DDS categories and the prevalence of diabetes mellitus, hypertension, heart disease, cancer, or their common comorbidities. However, significant associations were identified between specific food group consumption frequencies and NCD outcomes, particularly diabetes mellitus and hypertension. Weekly consumption of aerated drinks and fried foods showed higher odds of hypertension, while certain animal-source foods were associated with higher odds of diabetes. **Conclusion:** Overall dietary diversity alone was not significantly associated with NCD prevalence, whereas specific dietary components demonstrated meaningful associations. Nutritional interventions should prioritize diet quality alongside diversity to support NCD prevention.

Keywords: Dietary diversity; Non-communicable diseases; Diet quality; Tertiary care hospital; Cross-sectional study

Introduction

Non-communicable diseases (NCDs) represent a major global public health challenge due to their chronic nature, long duration, and significant contribution to premature mortality and disability.[1]Cardiovascular diseases, diabetes mellitus, cancers, and chronic respiratory diseases collectively account for a substantial proportion of global morbidity and mortality. [2] According to the World Health Organization, NCDs are responsible for nearly 71% of all deaths worldwide, with a considerable share occurring in low- and middle-income countries.[3] The growing burden of NCDs not only affects individual health outcomes but also poses serious socioeconomic consequences by increasing healthcare expenditure and reducing productivity during the most economically active years of life.[4]

India is undergoing a rapid epidemiological transition characterized by a decline in communicable diseases and a concomitant rise in NCDs.[5] Recent national estimates indicate that NCDs account for more than 60% of all deaths in the country, with a marked increase observed over the past three decades.[6] This shift has been attributed to demographic changes, urbanization, lifestyle transitions, and alterations in dietary patterns.[7] The burden is evident across both rural and urban populations, highlighting the need for comprehensive preventive strategies that address modifiable risk factors at the population level.[8]

Among the major behavioral risk factors for NCDs, unhealthy dietary practices play a pivotal role.[9] Diets characterized by high intake of refined carbohydrates, saturated fats, fried foods, and sugar-sweetened beverages have been consistently associated with an increased risk of metabolic and cardiovascular disorders.[10] Conversely, consumption of a balanced and diversified diet rich in fruits, vegetables, pulses, animal protein, and dairy products is considered essential for maintaining metabolic health and preventing diet-related NCDs. Understanding dietary patterns within communities is therefore crucial for designing effective nutrition-sensitive interventions aimed at NCD prevention.[11]

Dietary diversity score (DDS) has emerged as a simple and widely used indicator for assessing diet quality at both household and individual levels. DDS reflects the number of different food groups consumed over a specified reference period and serves as a proxy measure for nutrient adequacy.[12] While several studies have demonstrated an inverse relationship between low dietary diversity and undernutrition or metabolic disorders, evidence on the association between dietary diversity and NCD prevalence remains inconsistent.[13] Furthermore, most existing studies rely on short-term dietary recall methods and do not adequately explore dietary patterns prior to the diagnosis of chronic diseases.[14-15]

In the Indian context, limited evidence is available on the relationship between dietary diversity and NCDs, particularly within populations enrolled in government-led health programs. The MakkalaiThediMaruthuvam (MTM) scheme of Tamil Nadu is a doorstep healthcare initiative aimed at improving access to NCD screening and

management.[16] Studying dietary patterns among individuals covered under such programs provides an opportunity to generate program-relevant evidence that can inform policy and practice. However, data linking pre-diagnosis dietary diversity with NCD prevalence among beneficiaries of such schemes are scarce.

In this background, the present study was undertaken to assess dietary diversity patterns and examine their association with the prevalence of selected non-communicable diseases among individuals enrolled under the Makkalai Thedi Maruthuvam scheme in Tiruppur district, Tamil Nadu. By evaluating dietary habits prior to NCD diagnosis and analyzing their relationship with different NCD categories, this study seeks to contribute to the existing literature and provide insights that may support dietary guidance and preventive strategies within community-based NCD control programs.

Objectives

- To estimate the prevalence of major non-communicable diseases, including diabetes mellitus, hypertension, heart disease, cancer, and their common comorbid combinations, among patients attending the outpatient department of a tertiary care hospital in Tiruppur.
- To examine the association between dietary diversity patterns and non-communicable diseases by analyzing dietary diversity scores and selected food group consumption frequencies in relation to the prevalence and odds of these diseases.

Materials and Methods:

Study Design and Setting

A hospital-based cross-sectional analytical study was conducted in the outpatient department (OPD) of a tertiary care teaching hospital located in Tiruppur district, Tamil Nadu. The hospital caters to patients from urban, semi-urban, and rural areas of the district, providing services for screening and management of non-communicable diseases.

Study Population

The study population comprised adult patients attending the OPD of the tertiary care hospital who had been previously diagnosed with one or more selected non-communicable diseases, namely diabetes mellitus, hypertension, heart disease, and cancer. Eligible participants were interviewed regarding their dietary habits prior to the diagnosis of NCDs.

Study Duration

The study was conducted over a period of one year from June 2024 to May 2025, including data collection, entry, and analysis.

Inclusion and Exclusion Criteria

Inclusion criteria

- Adults aged ≥20 years attending the OPD of the tertiary care hospital
- Patients diagnosed with diabetes mellitus, hypertension, heart disease, cancer, or combinations of these conditions
- Patients with a duration of diagnosis not exceeding 10–15 years
- Individuals who were able to recall their dietary habits prior to the diagnosis of NCD
- Patients who provided informed consent to participate in the study

Exclusion criteria

- Patients with acute medical conditions requiring emergency care
- Individuals unable to recall past dietary habits reliably
- Patients unwilling to provide informed consent

Sample Size and Sampling Technique

The sample size was calculated using the formula for estimating proportions:

$$N = \frac{Z^2 \times p(1-p)}{e^2}$$

Where Z = 1.96 (95% confidence level), p = 0.5, and e = 0.05. The minimum required sample size was 384. However, a total of 1054 participants were included in the study to improve the precision and reliability of estimates.

Participants were selected using a consecutive sampling technique, whereby all eligible patients attending the OPD during the study period were enrolled until the desired sample size was achieved.

Study Procedure

Data were collected using a pre-tested, semi-structured questionnaire administered to eligible participants. The questionnaire captured information on socio-demographic characteristics, clinical history of non-communicable diseases, lifestyle factors, and dietary habits prior to NCD diagnosis.

Dietary information was obtained using a structured recall approach focusing on the frequency of consumption of selected food groups before the onset of the diagnosed NCD. Data collection was carried out through direct interviews, and responses were recorded using an electronic data collection tool.

Operational Definitions

- Non-communicable diseases (NCDs): Chronic diseases including diabetes mellitus, hypertension, heart disease, and cancer, diagnosed by a qualified medical practitioner.

- Dietary Diversity Score (DDS): A composite score calculated based on the weighted sum of consumption frequencies of eight food groups: milk/curd, pulses/beans, dark green leafy vegetables, fruits, eggs, chicken/meat, fried foods, and aerated drinks.

- **DDS classification:**
  - Low dietary diversity: ≤13
  - Intermediate dietary diversity: 14–26
  - High dietary diversity: ≥27

- **Prevalence:** Proportion of participants diagnosed with a specific NCD at the time of the study.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 25. Descriptive statistics were used to summarize socio-demographic characteristics, dietary diversity patterns, and prevalence of NCDs.Associations between dietary diversity, food group consumption frequencies, and NCD prevalence were assessed using the Chi-square test, with a significance level set at $p< 0.05$. Multivariable logistic regression analysis was performed to estimate the odds ratios (ORs) and identify factors associated with the occurrence of selected non-communicable diseases. Results were presented with appropriate measures of association.

Ethical Consideration

The study protocol was reviewed and approved by the Institutional Ethics Committee of the tertiary care hospital, Tiruppur. Informed consent was obtained from all participants prior to data collection. Confidentiality of participant information was maintained throughout the study, and participation was entirely voluntary, with the option to withdraw at any stage without any consequences.

Results:

A total of 1,054 participants were included in the study. The gender distribution was nearly equal, with 530 (50.3%) males and 524 (49.7%) females. The majority of participants belonged to the 40–60 years age group (609; 57.8%), followed by those aged above 60 years (350; 33.2%), while 95 participants (9.0%) were in the 20–40 years age group; no participants were below 20 years of age. Most participants resided in rural areas (737; 69.6%), whereas 207 (19.6%) were from semi-urban areas and 110 (10.4%) from urban areas. Regarding the age at diagnosis of non-communicable diseases, the majority were diagnosed between 40 and 60 years of age (626; 59.4%), followed by those diagnosed after 60 years (318; 30.2%), while 110 participants (10.4%) were diagnosed between 20 and 40 years. Based on the revised Kuppuswamy

socioeconomic classification, a large proportion of participants belonged to the upper-lower socioeconomic class (775; 73.5%), followed by lower-middle (140; 13.3%) and upper-middle classes (81; 7.7%); only a small proportion belonged to the upper (3; 0.3%) and lower (55; 5.2%) socioeconomic classes. With respect to lifestyle characteristics, 166 participants (15.8%) reported a history of smoking, while 151 (14.3%) reported alcohol consumption. A positive family history of non-communicable diseases was reported by 340 participants (32.3%), whereas 714 (67.7%) reported no such history. (Table 1)

Table 1. Socio-demographic and Clinical Characteristics of Study Participants (N = 1054)

Characteristic	Category	Frequency	Percentage
Gender	Male	530	50.3
	Female	524	49.7
Age (years)	< 20	0	0.0
	20–40	95	9.0
	40–60	609	57.8
	> 60	350	33.2
Place of residence	Rural	737	69.6
	Semi-urban	207	19.6
	Urban	110	10.4
Age at NCD diagnosis (years)	< 20	0	0.0
	20–40	110	10.4
	40–60	626	59.4
	> 60	318	30.2
Socioeconomic status*	Upper	3	0.3
	Upper middle	81	7.7
	Lower middle	140	13.3
	Upper lower	775	73.5
	Lower	55	5.2
Smoking status	Yes	166	15.8
	No	888	84.2
Alcohol consumption	Yes	151	14.3
	No	903	85.7
Family history of NCD	Yes	340	32.3
	No	714	67.7

*Socioeconomic status was assessed using the Modified Kuppuswamy Scale (2025)

The dietary diversity patterns of the study participants are presented in Table 2. Milk and curd were the most frequently consumed food group, with 865 participants (82.1%) reporting daily consumption, followed by 110 (10.4%) consuming them four to six times per week. Pulses and beans were predominantly consumed four to six times

per week by 732 participants (69.4%), while 242 (23.0%) reported consumption two to three times per week; only 80 participants (7.6%) consumed pulses daily. Consumption of dark green leafy vegetables was mainly reported at a frequency of two to three times per week by 684 participants (64.9%), followed by four to six times per week by 287 participants (27.2%), whereas daily consumption was reported by 76 participants (7.2%).Fruit intake was largely occasional, with 1,026 participants (97.3%) reporting infrequent consumption, and very few participants consuming fruits daily (2; 0.2%). Egg consumption showed a varied pattern, with 365 participants (34.6%) consuming eggs two to three times per week and 361 (34.3%) consuming them occasionally; weekly consumption was reported by 250 participants (23.7%), while daily consumption was uncommon (47; 4.5%). Chicken or meat consumption was primarily weekly, reported by 680 participants (64.5%), followed by occasional consumption in 348 participants (33.0%). Fried foods were most commonly consumed occasionally (585; 55.5%) or two to three times per week (422; 40.0%), with minimal daily intake (3; 0.3%). Aerated drink consumption was predominantly occasional (1,024; 97.2%), with very few participants reporting weekly or more frequent intake.

Table 2. Dietary Diversity Patterns and Food Group Consumption Frequencies among Study Participants (N = 1054)

Food group	Frequency of consumption	Frequency	Percentage
Milk / curd	Daily	865	82.1
	4–6 times/week	110	10.4
	2–3 times/week	69	6.5
	Occasionally / rarely	10	0.9
Pulses / beans	Daily	80	7.6
	4–6 times/week	732	69.4
	2–3 times/week	242	23.0
Dark green leafy vegetables	Daily	76	7.2
	4–6 times/week	287	27.2
	2–3 times/week	684	64.9
	Occasionally	7	0.7
Fruits	Daily	2	0.2
	2–3 times/week	17	1.6
	Weekly	9	0.9
	Occasionally	1,026	97.3
Eggs	Daily	47	4.5
	4–6 times/week	23	2.2
	2–3 times/week	365	34.6
	Weekly	250	23.7
	Occasionally	361	34.3
	Never	8	0.8

Chicken / meat	2–3 times/week	26	2.5
	Weekly	680	64.5
	Occasionally	348	33.0
Fried foods	2–3 times/week	422	40.0
	Weekly	44	4.2
	Occasionally	585	55.5
	Daily	3	0.3
Aerated drinks	2–3 times/week	18	1.7
	Weekly	9	0.9
	Occasionally	1,024	97.2
	Never	3	0.3

The prevalence of selected non-communicable diseases according to socio-demographic and lifestyle characteristics is presented in Table 3. Diabetes mellitus prevalence was higher among females (21.4%) compared with males (17.9%), whereas hypertension and heart disease were more prevalent among males (25.3% and 29.4%, respectively). Cancer prevalence was low across both genders, with a slightly higher proportion observed among females (0.6%). With respect to age at diagnosis, diabetes prevalence was highest among participants diagnosed between 20 and 40 years (28.2%) and decreased with advancing age, while hypertension prevalence was highest among those diagnosed after 60 years (30.2%). Heart disease prevalence was also higher in the older age group (>60 years; 25.5%), whereas cancer prevalence remained low across all age categories. Based on place of residence, diabetes prevalence was highest among participants from semi-urban areas (26.6%), while hypertension and heart disease were more prevalent among rural residents (28.2% and 22.4%, respectively). Urban residents demonstrated comparatively lower prevalence of diabetes (12.7%) and no reported cases of cancer. When socioeconomic status was considered, similar prevalence patterns were observed across categories, with diabetes prevalence of 19.9% among lower and upper-lower classes and 19.1% among lower-middle and above classes; hypertension and heart disease prevalence showed minimal variation across socioeconomic groups. Lifestyle characteristics revealed that heart disease prevalence was higher among participants who reported smoking (31.9%) and alcohol consumption (30.5%) compared with non-smokers and non-drinkers. Hypertension prevalence was also higher among individuals reporting alcohol use (30.5%). Diabetes prevalence was lower among smokers (14.5%) and alcohol users (13.3%) compared with their counterparts. Participants with a positive family history of non-communicable diseases demonstrated a higher prevalence of diabetes (42.0%) and hypertension (30.9%), whereas heart disease prevalence was comparatively higher among those without a family history (84.2%). Cancer prevalence remained low across all socio-demographic and lifestyle categories.

Table 3. Prevalence of Selected Non-Communicable Diseases According to Socio-demographic and Lifestyle Characteristics (N = 1054)

Characteristic	Category	Diabetes Mellitus %	Hypertension %	Heart Disease %	Cancer %
Gender	Male	17.9	25.3	29.4	0.0
	Female	21.4	30.0	12.6	0.6
Age at diagnosis (years)	20–40	28.2	26.4	23.6	0.0
	40–60	22.8	26.5	18.4	0.3
	> 60	10.4	30.2	25.5	0.3
Place of residence	Rural	18.7	28.2	22.4	0.3
	Semi-urban	26.6	26.6	16.4	0.5
	Urban	12.7	25.5	20.9	0.0
Socioeconomic status	Lower / Upper-lower	19.9	27.4	21.2	0.3
	Lower-middle & above	19.1	28.7	20.4	0.0
Smoking status	Yes	14.5	29.5	31.9	0.0
	No	20.6	27.3	19.0	0.3
Alcohol consumption	Yes	13.3	30.5	30.5	0.0
	No	20.7	27.1	19.5	0.3
Family history of NCD	Yes	42.0	30.9	15.8	0.0
	No	58.0	69.1	84.2	0.4

The association between food group consumption frequencies and the prevalence of selected non-communicable diseases is presented in Table 4. A statistically significant association was observed between daily consumption of milk or curd and the prevalence of diabetes mellitus, with a higher prevalence among daily consumers (21.2%) compared with those consuming milk or curd three times per week or less (13.9%) (p value = 0.008). Similarly, consumption of pulses or beans four to six times per week was significantly associated with diabetes prevalence (21.3%) compared with daily consumption (17.5%) (p value = 0.031).Consumption of dark green leafy vegetables four to six times per week showed a significantly higher prevalence of diabetes (24.7%) compared with daily consumption (15.8%) (p value = 0.010). Fruit consumption two to three times per week was also significantly associated with diabetes prevalence (41.2%) when compared with occasional consumption (19.5%) (p value = 0.024). Egg consumption patterns demonstrated a significant association with hypertension, with a higher prevalence among participants who never or occasionally consumed eggs (29.6%) compared with those consuming eggs at least two to three

times per week (25.8%) (p value = 0.002).Weekly consumption of chicken or meat was significantly associated with a higher prevalence of diabetes (22.2%) compared with consumption two to three times per week or less (19.2%) (p value = 0.004). Fried food consumption on a weekly basis was significantly associated with diabetes prevalence (22.7%) and showed a lower prevalence of hypertension (18.2%) compared with occasional consumption (p value = 0.020). Aerated drink consumption demonstrated a significant association with hypertension, with a markedly higher prevalence among weekly consumers (55.6%) compared with those consuming aerated drinks occasionally or never (27.3%) (p value = 0.007). No statistically significant associations were observed between food group consumption frequencies and cancer prevalence.

Table 4. Association between Food Group Consumption Frequencies and Prevalence of Selected Non-Communicable Diseases (N = 1054)

Food group	Consumption frequency	Diabetes Mellitus %	Hypertension %	Heart Disease %	p value†
Milk / curd	Daily	21.2	27.4	20.3	**0.008***
	≤ 3 times/week	13.9	28.9	16.7	
Pulses / beans	4–6 times/week	21.3	25.7	21.7	**0.031***
	Daily	17.5	28.8	26.3	
Dark green leafy vegetables	4–6 times/week	24.7	25.1	19.5	**0.010***
	Daily	15.8	30.3	26.3	
Fruits	2–3 times/week	41.2	23.5	11.8	**0.024***
	Occasional	19.5	27.7	21.4	
Eggs	Never / occasional	15.0	29.6	22.7	**0.002***
	≥ 2–3 times/week	23.3	25.8	18.1	
Chicken / meat	Weekly	22.2	26.5	20.9	**0.004***
	≤ 2–3 times/week	19.2	19.2	11.5	
Fried foods	Weekly	22.7	18.2	9.1	**0.020***
	Occasional	17.5	28.8	21.4	
Aerated drinks	Weekly	11.1	55.6	11.1	**0.007***
	Occasional / never	19.7	27.3	21.4	

*-statistically significant

The distribution of dietary diversity score (DDS) categories and the prevalence of non-communicable diseases are presented in Table 5. Across all disease categories, the majority of cases were observed among participants with an intermediate dietary diversity score. Among individuals with diabetes mellitus, 204 cases (98.6%) belonged to the intermediate DDS category, while only 1 case (0.5%) and 2 cases (1.0%) were observed in the low and high DDS categories, respectively (p value = 0.61). A similar pattern was noted for hypertension, with 288 cases (99.0%) in the intermediate DDS category, compared with 2 cases (0.7%) in the low DDS category and 1 case (0.3%) in

the high DDS category (p value = 0.86).For heart disease, 219 cases (98.7%) were observed among participants with intermediate DDS, whereas low and high DDS categories accounted for 2 cases (0.9%) and 1 case (0.5%), respectively (p value = 0.77). All reported cancer cases were observed exclusively in the intermediate DDS category (3 cases; 100.0%), with no cases reported in the low or high DDS categories (p value = 0.88). Among participants with both diabetes and hypertension, 286 cases (97.6%) were categorized under intermediate DDS, while 3 cases (1.0%) and 4 cases (1.4%) were observed in the low and high DDS categories, respectively (p value = 0.53).Similarly, all cases of combined hypertension and heart disease (29 cases; 100.0%) and combined diabetes and heart disease (9 cases; 100.0%) were observed among participants with intermediate dietary diversity scores, with no cases reported in the low or high DDS categories (p value = 0.63 and p value = 0.79, respectively). Overall, no statistically significant association was observed between dietary diversity score categories and the prevalence of the studied non-communicable diseases.

Table 5. Distribution of Dietary Diversity Score Categories and Prevalence of Non-Communicable Diseases (N = 1054)

Non-communicable disease	Low DDS n (%)	Intermediate DDS n (%)	High DDS n (%)	p value
Diabetes mellitus	1 (0.5)	204 (98.6)	2 (1.0)	0.61
Hypertension	2 (0.7)	288 (99.0)	1 (0.3)	0.86
Heart disease	2 (0.9)	219 (98.7)	1 (0.5)	0.77
Cancer	0 (0.0)	3 (100.0)	0 (0.0)	0.88
Diabetes + Hypertension	3 (1.0)	286 (97.6)	4 (1.4)	0.53
Hypertension + Heart disease	0 (0.0)	29 (100.0)	0 (0.0)	0.63
Diabetes + Heart disease	0 (0.0)	9 (100.0)	0 (0.0)	0.79

The results of the multivariable logistic regression analysis assessing factors associated with selected non-communicable diseases are presented in Table 6. With respect to dietary diversity score (DDS), participants with high DDS demonstrated higher odds of diabetes mellitus (OR = 1.37) and combined diabetes with hypertension (OR = 2.62) compared with those in the low DDS category. Participants with intermediate DDS showed higher odds of hypertension (OR = 1.66) and heart disease (OR = 1.16), while lower odds were observed for combined diabetes and hypertension (OR = 0.49) relative to the low DDS category.Daily consumption of milk or curd was associated with higher odds of diabetes mellitus (OR = 1.84) when compared with less frequent consumption. Consumption of pulses or beans four to six times per week, compared with daily consumption, was associated with increased odds of diabetes mellitus (OR = 1.43) and heart disease (OR = 1.13). Intake of dark green leafy vegetables two to three times per week, relative to daily intake, showed increased odds of hypertension (OR = 1.17) and combined diabetes with hypertension (OR = 1.13).Daily fruit consumption

was associated with higher odds of diabetes mellitus (OR = 4.11) and hypertension (OR = 2.63) compared with less frequent consumption. Participants who never consumed eggs demonstrated markedly higher odds of hypertension (OR = 8.01) compared with those who consumed eggs daily. Weekly consumption of chicken or meat, compared with consumption two to three times per week, was associated with higher odds of diabetes mellitus (OR = 1.62). Weekly consumption of fried foods was associated with increased odds of combined diabetes with hypertension (OR = 2.04), while weekly consumption of aerated drinks was associated with higher odds of hypertension (OR = 3.32) compared with occasional consumption.

Table 6. Multivariable Logistic Regression Analysis Showing Factors Associated with Selected Non-Communicable Diseases (N = 1054)

Predictor variable	Category / comparison	Diabetes Mellitus OR	Hypertension OR	Heart Disease OR	Diabetes + Hypertension OR
Dietary Diversity Score	Low (reference)	0.58	0.87	1.25	1.56
	Intermediate	1.06	1.66	1.16	0.49
	High	1.37	0.37	0.53	2.62
Milk / curd consumption	Daily vs others	1.84	0.94	0.79	0.99
Pulses / beans consumption	4–6 times/week vs daily	1.43	0.73	1.13	1.01
Dark green leafy vegetables	2–3 times/week vs daily	0.73	1.17	0.98	1.13
Fruit consumption	Daily vs others	4.11	2.63	–	–
Egg consumption	Never vs daily	–	8.01	–	–
Chicken / meat consumption	Weekly vs 2–3 times/week	1.62	0.85	0.97	0.83
Fried food consumption	Weekly vs occasional	1.21	0.57	0.36	2.04
Aerated drink consumption	Weekly vs occasional	0.51	3.32	0.47	0.32

Discussion

In the present study, most NCD cases clustered within the intermediate DDS category, and no statistically significant association was observed between DDS categories and

the prevalence of diabetes, hypertension, heart disease, cancer, or major comorbidity combinations. This overall null association differs from several studies reporting a protective relationship between higher dietary diversity and cardiometabolic risk. For example, Azadbakht et al. reported an inverse association between overall DDS quartiles and cardiovascular risk factors, including hypertension and diabetes, although obesity increased with higher DDS [1]. In the CARRS study among South Asian adults, higher dietary diversity was associated with a lower adjusted prevalence of diagnosed diabetes and hypertension [2]. Similarly, a national Thai survey among older adults found higher DDS to be negatively associated with hypertension and diabetes, alongside lower predicted cardiovascular risk [7]. In contrast, evidence from India using NFHS-4 adult men showed a positive association where high DDS increased the odds of diabetes, while moderate DDS decreased the odds of heart disease and cancer [6]. The heterogeneity across settings suggests that DDS–NCD relationships may depend on how DDS is constructed, the food groups that drive higher diversity, and the extent to which higher DDS reflects "healthy diversity" versus inclusion of energy-dense or processed items.

In multivariable analysis in the current study, intermediate DDS showed higher odds of hypertension while high DDS showed lower odds relative to the low DDS reference category. This mixed pattern aligns with literature indicating that DDS does not uniformly predict hypertension when confounding and diet-quality context are considered. Motamedi et al. reported that diet quality indices such as the Mediterranean Diet Score and HEI-2015 were inversely related to hypertension risk, but DDS itself was not associated with hypertension in their cohort [4]. In the Thai national study, DDS showed a significant negative association with hypertension [7], supporting the view that diet diversity dominated by nutrient-dense items may be protective. Findings from the CARRS cohort similarly suggested lower prevalence of both diagnosed and undiagnosed hypertension in the highest DDS quartile [2]. However, a systematic review and meta-analysis highlights that DDS associations with cardiometabolic outcomes are not consistent across populations, and results vary depending on scoring systems, dietary assessment tools, and adjustment for adiposity and other confounders [14]. Taken together, the present findings add to evidence that DDS may not act as a standalone proxy for cardiometabolic health unless the composition of "diverse diet" is explicitly characterized.

The dietary intake pattern observed in the present study showed high routine intake of milk/curd and pulses, moderate intake of green leafy vegetables, and very low regular fruit consumption, with fruits being consumed only occasionally by most participants. This pattern is comparable to evidence from clinical and population-based studies where diets are dominated by staple foods and legumes, while fruit intake remains relatively low. In a hospital-based study among diabetic patients in Ethiopia, Beyene et al. reported low mean dietary diversity and very low consumption of fruits and eggs, despite frequent consumption of grains and pulses [3]. In the Indian

Migration Study, Joy et al. identified distinct dietary patterns with notable variation in dietary diversity and fruit consumption across socio-demographic groups, indicating that diversity and fruit intake often track education and urbanicity [9]. Findings from young adults in China also showed insufficient dietary diversity in most participants, and sugary beverage practices were linked to poorer diversity, suggesting that "diversity" and "diet quality" can diverge depending on food choices [5]. Additionally, cohort evidence from Korea indicated that higher DDS tends to co-occur with higher intake of fruits and non-salted vegetables and is associated with lower metabolic syndrome risk, especially among men [10]. Compared with these studies, the present low fruit intake underscores an important diet-quality gap that may limit any protective role of diversity if diversity is not driven by nutrient-rich food groups.

In the current study, several food-group frequency variables showed associations with NCD outcomes in adjusted models, including higher odds of diabetes with daily milk/curd and weekly chicken/meat intake, and higher odds of hypertension with weekly aerated drink intake; the magnitude and direction of such associations should be interpreted in light of broader diet patterns and possible residual confounding. Population-based evidence from South Asia indicates that prudent or healthier dietary patterns and higher DDS are associated with lower prevalence of diabetes and hypertension, implying that the quality and combination of foods matter beyond individual items [2]. Evidence from Thailand similarly supports that higher DDS is linked with lower risk of diabetes and hypertension, but simultaneously observed positive associations with total cholesterol and LDL-C, highlighting that dietary diversity can involve both beneficial and adverse components depending on dietary composition [7]. Findings from NFHS-4 adult men in India reported increased odds of diabetes at high DDS, suggesting that higher "diversity" may sometimes reflect greater inclusion of calorie-dense or processed foods [6]. Broader synthesis from meta-analytic evidence supports the view that DDS associations with cardiometabolic risk are context-dependent and influenced by how diversity relates to overall diet quality and adiposity [14]. Therefore, the present food-group associations should be discussed as indicative of complex dietary behaviours rather than isolated causal effects, particularly given the cross-sectional design and recall-based exposure assessment.

Limitations

The cross-sectional design of the study limits causal inference between dietary diversity and non-communicable diseases, and dietary intake was assessed using recall of pre-diagnosis habits, which may be subject to recall bias. Additionally, the hospital-based OPD setting may limit the generalizability of the findings to the wider community.

Conclusion and Recommendations

The present study assessed dietary diversity patterns and their association with selected non-communicable diseases among adult outpatients in a tertiary care

hospital setting. Although most participants demonstrated an intermediate level of dietary diversity, no statistically significant association was observed between dietary diversity score categories and the prevalence of major non-communicable diseases. However, specific food group consumption frequencies showed significant associations with diabetes mellitus and hypertension, indicating that dietary composition, rather than overall diversity alone, may play a more critical role in influencing cardiometabolic health. These findings highlight the complexity of dietary behaviors and suggest that dietary diversity, when not adequately driven by nutrient-rich food groups, may not uniformly confer protection against non-communicable diseases.

Based on these observations, dietary counselling strategies in outpatient and community health settings should emphasize not only increasing dietary diversity but also improving the quality of foods consumed, particularly by promoting regular intake of fruits and vegetables and reducing consumption of fried foods and sugar-sweetened beverages. Future research employing longitudinal designs and standardized dietary assessment tools is recommended to better elucidate the temporal relationship between dietary diversity, diet quality, and non-communicable disease outcomes, thereby informing more targeted and evidence-based nutritional interventions.

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