International Journal of Current Research and Techniques (IJCRT)
E-ISSN: 2349-3194 (Online) | P-ISSN: 2348-4446 (Print)
UGC Approved Journal No: 47722 [No: 2616]
DOI: https://doi.org/10.5281/ZENODO.16068128

A Comparative Study between Millet Consumers and Non-Millet Consumers and Its Impact on Blood Glucose Levels in Individuals with Type 2 Diabetes Mellitus

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Manuscript Received: Jul 12, 2025; Revised: Jul 14, 2025; Published: Jul 18, 2025

Abstract: Diabetes mellitus is a chronic metabolic disorder characterized by persistent high blood sugar levels, caused by impaired insulin secretion, resistance to insulin action, or both. It has become a growing global public health concern, with the number of affected individuals expected to rise significantly in the coming years. Millets have gained attention for their low Glycemic Index and high nutritional value. This study aims to compare between millet consumers and non-millet consumers and its impact on blood glucose levels in individuals with type 2 diabetes mellitus. A descriptive cross-sectional study was carried out among 150 male and female participants, out of which 75 participants were millet consumers and 75 participants were non-millet consumers participants aged 40 to 60 years residing in Mumbai, recruited through purposive and snowball sampling techniques. The mean age of participants was 52.3±6.2 years, with no significant sociodemographic differences between millet and non-millet consumers. The study revealed that millet consumers had significantly better fasting, postprandial blood glucose, and HbA1c levels compared to non-millet consumers ($p < 0.05$). The study found that the mean fasting blood glucose (139.4 ± 53.5 mg/dL), postprandial blood glucose (198.0 ± 88.8 mg/dL), and HbA1c levels (7.8 ± 1.5%) showed a significant difference between millet and non-millet consumers ($p < 0.05$). Sorghum (Jowar) was the most frequently consumed millet. A significant positive correlation was noted between HbA1c and Amaranth (rajgira) millet consumption ($r = 0.252$, $p = 0.029$). Energy and protein intakes were similar between groups. Millet consumers had significantly higher calcium and potassium intakes ($p < 0.05$), with a lower carbohydrate and slightly higher fat energy contribution, indicating better mineral adequacy with millet consumption. Calcium, potassium, and fiber intake were negatively correlated with glycemic markers, while sodium intake showed a positive correlation with postprandial glucose ($p < 0.05$). This study highlights that millet consumers showed better glycemic control, healthier eating habits, and higher calcium and potassium intakes.

Keywords: Millets, Type 2 Diabetes Mellitus, Glycemic Control, Blood Glucose Levels

1. Introduction:

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia. It may be due to impaired insulin secretion, resistance to peripheral actions of insulin, or both. According to the International Diabetes Federation (IDF), approximately 415 million adults between the ages of 20 to 79 years had diabetes mellitus in 2015. DM is proving to be a global public health burden as this number is expected to rise to another 200 million by 2040. DM is broadly classified into three types by etiology and clinical presentation, type 1 diabetes, type 2 diabetes, and gestational diabetes (GDM). Some other less common types of diabetes include monogenic diabetes and secondary diabetes (Rajeev G., et al, 2023). According to the International Diabetes Federation (IDF), 8.8% of the adult population have diabetes, with men having slightly higher rates (9.6%) than women (9.0%) (Mohan V. et al, 2021). Dietary factors are of paramount importance in the management and prevention of type 2 diabetes (Nita G Forouhi, et al, 2018). For individuals with diabetes, a healthy diet can help improve blood sugar control and reduce the risk of complications such as heart disease and nerve damage. A diet that emphasizes whole, minimally processed foods, and limits or eliminates added sugars, refined grains, and saturated and trans fats can help improve blood sugar control. Additionally, consuming foods high in fiber can help improve insulin sensitivity and reduce the risk of diabetes-related complications. (Lateef, et al, 2023). Fiber is a type of carbohydrate that the body can't break down, but it plays an important role in managing blood sugar. It slows the absorption of glucose into the bloodstream, which helps keep blood sugar levels steady and prevents sudden spikes or drops. Millets are a group of small, grained cereal food crops which are highly nutritious and are grown under marginal/low fertile soils with very low inputs such as fertilizers and pesticides (Prabhakar, et al, 2018). Millets stand by as the ideal food crop for people with diabetes according to the criteria set by leading associations. Millets reduce the duration of gastric emptying to maintain constant postprandial body glucose homeostasis. Compared to widely consumed rice, millet releases less glucose into the blood for a longer period of time, which is attributable to diabetes prevention. Millets help in the management of body weight, which is of utmost importance in diabetic patients (Agrawal, et al, 2023). Millets possess a low Glycemic Index (GI) and are known to play a role in reducing the risk of developing diabetes. A significant portion of the Indian diet is made up of millets like jowar (sorghum), ragi (finger millet), and bajra (pearl millet). Because millet has a high fiber content, blood sugar levels can be lowered. By eating millet every day, a diabetic can perhaps avoid the hazardous spikes in blood sugar that lead to many issues. Millets have slowly digested starch, which in the intestines prolongs the process of breaking down and absorbing carbohydrates. Millet contributes to the prevention of diabetes because it releases less glucose into the blood for a longer duration than commonly consumed rice. Millets are the future crops. They possess an energy content similar to that of regular cereals. In addition, because of their high fiber content, vitamin, mineral, and phytochemical content, as well as their ability to fight chronic illnesses, including DM, they offer greater health advantages, including antibacterial, antioxidant, and hypocholesterolemic properties. Balanced, healthful, and affordable meals can be served by including millet in a regular diet. People with diabetes can improve their general health and better regulate their blood sugar levels by using millets in their diet (Ansar A. VP, et al, 2024). It was observed that during germination and fermentation of millets, the dietary fiber, mineral, and vitamin content of most millets improved. (N. A. Gowda, et al, 2022). Millets are nutritional and hold a high promise for the therapeutic and pharmaceutical industry as nutraceuticals (Jinu J., et al, 2024).

Aim : To compare between millet consumers and non-millet consumers and its impact on blood glucose levels in individuals with type 2 diabetes mellitus.

2. Material and Methodology

A descriptive cross-sectional study was conducted among 150 participants, out of which 75 participants were millet consumers and 75 participants were non-millet consumers, both male and female, aged 40 - 60 years in Mumbai, using a purposive sampling and snowball sampling method. Selection of participants was carried out based on specified inclusion parameters, which included individuals diagnosed with type 2 diabetes mellitus for 5–10 years, of both genders, who consumed millets at least three times a week and engaged in a moderate level of physical activity, while individuals with other types of diabetes, those who had undergone recent major surgery or had severe comorbidities, and individuals with a slight rise in creatinine levels or mild fatty liver were excluded from the study. Ethical clearance was granted by the Inner System Biomedical Ethics Committee (ISBEC) prior to the initiation of data collection, and written informed consent was obtained from all participants to ensure voluntary participation and maintain confidentiality. Information was gathered using a structured questionnaire, which required around 10 minutes for completion. The questionnaire included self-structured tools for demographic information, anthropometric measurements, lifestyle behavior, clinical history, blood parameters, dietary habits, consumption of millets, food frequency questionnaire (millets), three day 24 hour recall, supplements and sweeteners consumption patterns. The collected data were analyzed using SPSS version 25 for Windows (version 25, 2017, IBM Corporation, Armonk, New York, United State). Cross tabulations were computed categorical data for millet and non-millet consumers and compared using chi-square test. Anthropometry, blood parameters and dietary data was compared between millet and non-millet consumers using Independent Sample T test. Data presented as Mean±SD (standard deviation) or frequency (percentage). $p < 0.05$ was considered to be statistically significant.

3. Results

The study included 150 participants, collecting their sociodemographic details such as age, gender, education, occupation, income, and type of family, along with frequency and percentage distributions. Anthropometric measurements were assessed through BMI categories (normal to grade 4 obesity) and waist-to-hip ratio (normal and high). The correlation between lifestyle behaviors — including physical activity, smoking, alcohol intake, sleep quality, and sleep duration — with anthropometric data and blood glucose levels was examined. Blood glucose levels of the study participants were assessed through fasting, postprandial, and HbA1c values, while mean blood glucose levels of study participants were also compared between millet and non-millet consumers. Nutrient intake (energy, protein, carbohydrates, fat, calcium, sodium, potassium, and dietary fiber) was correlated with glycemic parameters, and the relationship between the types of millets consumed and both anthropometric and glycemic parameters was evaluated.

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Table No. 1 : Sociodemographic Parameters of Study Participants

Sociodemographic Parameters	Millet Consumers (n = 75)		Non-Millet Consumers (n = 75)		Total (n = 150)		P value
	N	%	N	%	N	%	
Gender							
Males	29	38.7	31	41.3	60	40	0.739
Females	46	61.3	44	58.7	90	60	
Education Status							
High School	35	46.7	41	54.7	76	50.7	0.433
Graduate	24	32	16	21.3	40	26.7	
Post Graduate	9	12	7	9.3	16	10.7	
Less than 10th std	1	1.3	4	5.3	5	3.3	
Diploma	2	2.7	1	1.3	3	2	
Illiterate	3	4	5	6.7	8	5.3	
12th Std	0	0	1	1.3	1	0.7	
Phd	1	1.3	0	0	1	0.7	
Occupation							
Business	8	10.7	7	9.3	15	10	0.808
Service	33	44	28	37.3	61	40.7	
Retired	4	5.3	5	6.7	9	6.0	
At Home	30	40	35	46.7	65	43.3	
Monthly Income							
< 50,000	11	14.7	18	24	29	19.3	0.248
50,000 - 75,000	22	29.3	26	34.7	48	32	
75,000 - 1,00,000	17	22.7	15	20	32	21.3	
> 1,00,000	25	33.3	16	21.3	41	27.3	
Marital Status							

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Married	74	98.7	74	98.7	148	98.7	1.000
Unmarried	1	1.3	1	1.3	2	1.3	
Family Type							
Joint	16	21.3	14	18.7	30	20	0.683
Nuclear	59	78.7	61	81.3	120	80	

In table no. 1, most of the millet consumers were graduates followed by post graduates, whereas more non-millet consumers had completed high school education followed by graduates. The majority of both millet and non-millet consumers were engaged in service-related occupations. Income distribution among millet and non-millet consumers showed that most fell within the ₹ 50,000 – ₹ 75,000 range, followed by ₹ 75,000 – ₹ 1,00,000. A total of 148 individuals from both groups were married, while only 2 were unmarried. Both groups predominantly lived in nuclear families, with a smaller proportion residing in joint families. The sociodemographic parameters did not differ significantly across categories of millet consumption. ($p > 0.05$). The mean age of study participants was 52.3±6.2 years. There was no significant difference in age of millet and non-millet consumers ($p = 0.580$).

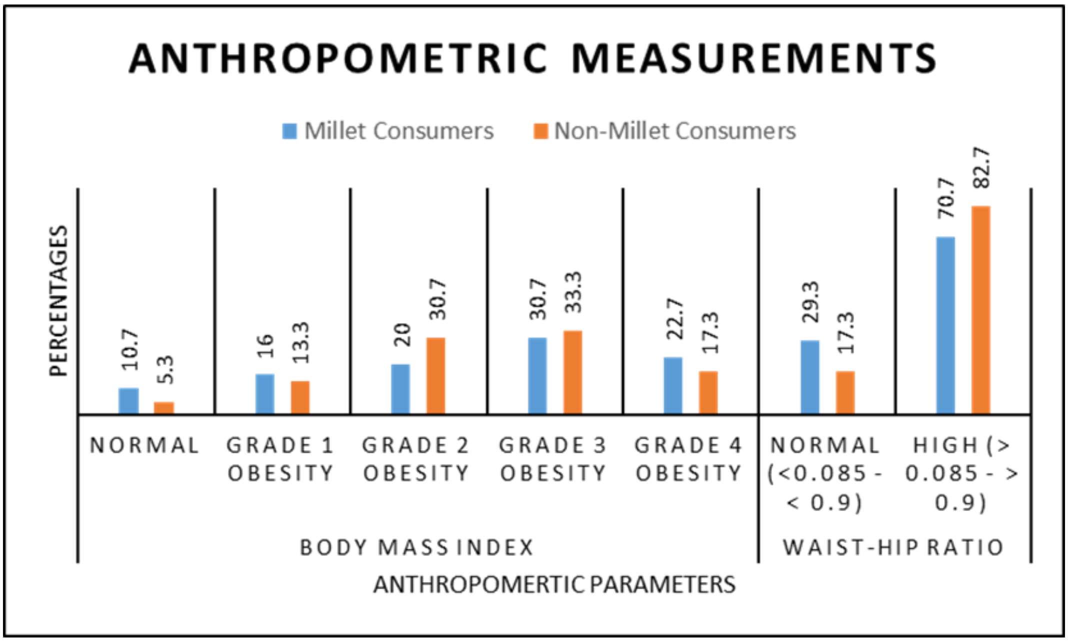

Figure No. 1 : Body Mass Index & Waist to Hip Ratio of Study Participants

Figure no. - 1 shows that the majority of individuals in both groups were classified under the Grade 3 BMI category, followed by Grade 2, with some in Grade 4 and Grade 1, and a very small proportion in the normal category. However, the association between BMI classification and the outcome variable was not statistically significant ($p > 0.05$). A higher proportion of millet consumers were in the normal category of waist-to-hip ratio, whereas more non-millet consumers fell into the high category. However, the association between WHR categories and Consumer Type was not statistically significant ($p > 0.05$).

Table No. 2 : Correlation between Lifestyle Behavior and Anthropometric Measurements, Blood Glucose Levels of Study Participants

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Lifestyle Behaviour	Frequency of Physical Activity		Frequency of Smoking		Frequency of Alcohol Intake		Rate ofSleep Quality		Hours of Sleep	
	Correlation Value	P value	Correlation Value	P value	Correlation Value	P value	Correlation Value	P value	Correlation Value	P value
Anthropometric Measurements										
Weight (kg)	-0.026	0.75	0.296	0.628	0.466*	0.016	0.014	0.865	-0.109	0.182
BMI (kg/m2)	-0.108	0.187	0.296	0.628	0.37	0.062	0.002	0.977	-0.122	0.136
Waist Cir (cm)	-0.058	0.477	0.289	0.638	0.256	0.208	0.097	0.237	-0.079	0.335
Waist-Hip Ratio	-0.011	0.893	0.289	0.638	0.228	0.263	0.175*	0.032*	-0.014	0.862
Blood Glucose Levels										
Fasting Blood Glucose	-0.125	0.127	0	1	-0.2	0.327	-0.14	0.088	-0.156	0.056
Post Prandial Blood Glucose	-0.122	0.138	0	1	-0.055	0.79	-0.174*	0.033*	-0.188*	0.021*
HbA1C Levels	-0.089	0.28	0	1	-0.086	0.675	-0.04	0.624	-0.042	0.609

Note: *P value being less than the typical significance level of 0.05 indicates statistically significant results, * Correlation is significant at the 0.05 level (2-tailed)

Table no. 2 explains that frequency of alcohol intake had a statistically significant positive correlation with weight ($r = 0.466$, $p = 0.016$) while rate of sleep quality had a statistically significant positive correlation with waist-hip ratio ($r = 0.175$, $p = 0.032$). Post prandial blood glucose levels had a statistically significant negative correlation with rate of sleep quality ($r = -0.174$, $p = 0.033$) and hours of sleep ($r = 0.188$, $p = 0.021$).

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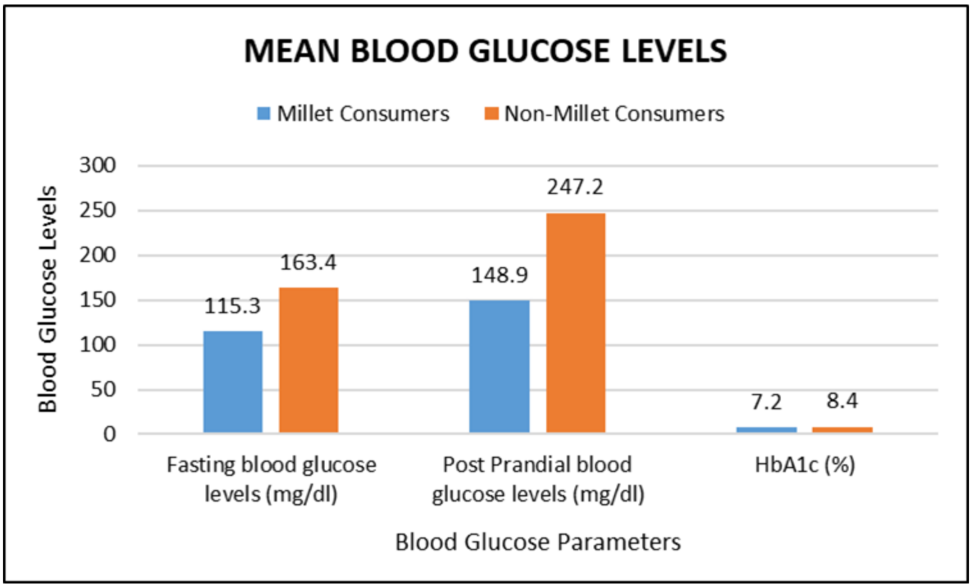

Figure No. 2 - Mean Blood Glucose Levels of Study Participants

Figure no. 2 explains the following -

Fasting blood glucose levels : The mean fasting blood glucose levels of study participants were

139.4±53.5 mg/dL. There was a significant difference in fasting blood glucose levels of millet and non-millet consumers ($p < 0.05$).

Post Prandial blood glucose levels : The mean post prandial blood glucose levels of study participants was 198.0±88.8 mg/dL. There was a significant difference in post prandial blood glucose levels of millet and non-millet consumers ($p < 0.05$).

HbA1c : The mean HbA1c levels of study participants was 7.8±1.5 %. There was a significant difference in HbA1c levels of millet and non-millet consumers ($p < 0.05$).

Table No. 3 - Blood Glucose Levels of Study Participants

Blood Parameters	Millet Consumers (n = 75)		Non-Millet Consumers (n = 75)		Total (n = 150)		P value
	N	%	N	%	N	%	
Fasting Blood Glucose Levels							
Low	22	29.3	7	9.3	29	19.3	**0.000***
Moderate	25	33.3	13	17.3	38	25.3	
High	28	37.3	55	73.3	83	55.3	
Post Prandial Blood Glucose Levels							
Low	34	45.3	7	9.3	41	27.3	**0.000***
Moderate	37	49.3	16	21.3	53	35.3	

High	4	5.3	52	69.3	56	37.3	
HbA1C Levels							
Low	4	5.3	1	1.3	5	3.3	**0.042***
Moderate	10	13.3	3	4	13	8.7	
High	61	81.3	71	94.7	132	88	

Note: *P value being less than the typical significance level of 0.05 indicates statistically significant results.

Table no. 3 explains that the fasting blood glucose levels differed notably between groups, with a higher proportion of millet consumers having low and moderate levels, while a greater number of non-millet consumers exhibited high levels. This difference was statistically significant ($p < 0.05$). Postprandial blood glucose levels varied significantly between groups, with a larger proportion of millet consumers showing low and moderate levels, while most non-millet consumers recorded high levels. This difference was statistically significant ($p < 0.05$). HbA1c levels were predominantly high in both groups, with a higher proportion of non-millet consumers falling in the high category. Low and moderate values were observed more frequently among millet consumers. The difference was statistically significant ($p < 0.05$).

Table No. 4 : Correlation between Nutrients & Blood Glucose Levels of Study Participants

Blood Parameters	**Fasting Blood Glucose**		**Post Prandial Blood Glucose**		**HbA1c**	
Nutrients	**Correlation Value**	**P value**	**Correlation Value**	**P value**	**Correlation Value**	**P value**
Energy (kcal)	-0.015	0.853	0.049	0.553	-0.058	0.483
Energy (EAR %)	-0.015	0.858	0.017	0.835	-0.101	0.217
Protein (g)	0.054	0.51	0.085	0.304	0.012	0.889
Protein (% of energy)	0.091	0.268	0.054	0.51	0.099	0.23
Protein (RDA %)	0.043	0.602	0.054	0.513	0.009	0.912
Protein (EAR %)	0.044	0.597	0.051	0.538	0.01	0.899
Calcium (mg)	-0.163*	0.046*	-0.243**	0.003*	-0.171*	0.037*

Calcium (RDA %)	-0.162*	0.048*	-0.244**	0.003*	-0.170*	0.038*
Calcium (EAR %)	-0.165*	0.043*	-0.236**	0.004*	-0.226**	0.005*
CHO (g)	-0.005	0.949	0.092	0.262	-0.052	0.527
CHO (% of energy)	0.014	0.866	0.111	0.177	0.016	0.847
Fat (g)	-0.043	0.603	-0.074	0.37	-0.092	0.265
Fat (% of energy)	-0.034	0.679	-0.162*	0.048*	-0.086	0.295
Sodium (mg)	0.157	0.055	0.180*	0.028*	0.116	0.156
Sodium (RDA %)	0.157	0.055	0.180*	0.028*	0.116	0.156
Potassium (mg)	-0.15	0.067	-0.183*	0.025*	-0.283**	0*
Potassium (RDA %)	-0.15	0.067	-0.183*	0.025*	-0.283**	0*
Fiber (g)	-0.143	0.081	-0.149	0.069	-0.228**	0.005*
Fiber (RDA %)	-0.143	0.081	-0.149	0.069	-0.228**	0.005*

Note: ***P value being less than the typical significance level of 0.05 indicates statistically significant results, * Correlation is significant at the 0.05 level (2-tailed), ** Correlation is significant at the 0.01 level (2-tailed)**

Table no. 4 revealed a statistically significant negative correlation between calcium (mg) and fasting blood glucose (r = -0.163, p = 0.046), post prandial blood glucose (r = -0.243, p = 0.003), HbA1c (r = -0.171, p = 0.037). Calcium (RDA %) showed a statistically significant negative correlation with fasting blood glucose (r = -0.162, p = 0.048), post prandial blood glucose (r =

-0.244, p = 0.003), HbA1c (r = -0.170, p = 0.038). Calcium (EAR %) had a statistically significant negative correlation with fasting blood glucose (-0.165, p = 0.043), post prandial blood glucose (r = -0.236, p = 0.004), HbA1c (r = -0.226, p = 0.005). Fat (% of energy) had a statistically significant negative correlation with postprandial blood glucose (r = -0.162, p = 0.048). Post prandial blood glucose level had a statistically significant positive correlation with sodium (mg) (r = 0.180, p = 0.028) and sodium (RDA %) (r = 0.180, p = 0.028). Potassium (mg) and potassium (RDA %) showed a statistically significant negative correlation with post prandial blood glucose (r = -0.183, p = 0.025) and HbA1c (r = -0.286, p = 0). Fiber (g) and fiber (RDA %) revealed a statistically significant negative correlation with HbA1c (r = -0.228, p = 0.005).

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Table No. 5 : Correlation between Types of Millets and Anthropometric Measurements, Blood Glucose Levels of Study Participants

Types of Millets	Finger Millet (Ragi)		Sorghum (Jowar)		Pearl Millet (Bajra)		Amaranth (Rajgira)	
	Correlation Value	P value	Correlation Value	P value	Correlation Value	P value	Correlation Value	P value
Anthropometric Measurements								
Weight (kg)	-0.084	0.474	0.106	0.366	0.055	0.637	-0.002	0.987
BMI (kg/m2)	-0.073	0.534	-0.023	0.844	0.115	0.326	0.024	0.841
Waist Cir (cm)	-0.056	0.632	-0.007	0.949	0.106	0.368	0.05	0.668
Waist-Hip Ratio	-0.105	0.37	-0.024	0.838	0.16	0.171	-0.088	0.452
Blood Glucose Levels								
Fasting Blood Glucose	0.133	0.255	-0.013	0.912	0.02	0.864	0.088	0.451
Post Prandial Blood Glucose	0.086	0.464	0.21	0.07	0.114	0.328	0.177	0.129
HbA1C Levels	0.091	0.438	0.106	0.366	0.009	0.94	0.252*	0.029*

Note: *P value being less than the typical significance level of 0.05 indicates statistically significant results, * Correlation is significant at the 0.05 level (2-tailed)

Table no. 5 has a statistically significant positive correlation between HbA1c and Amaranth (rajgira) millet ($r = 0.252$, $p = 0.029$).

4. Discussion

Sociodemographic factors were explored to understand their potential influence on millet consumption. In the present study of 150 participants, age distribution was relatively homogeneous, with a mean age of 52.3±6.2 years, and showed no statistically significant difference between millet and non-millet consumers. Similarly, gender distribution, education level, occupation, income range, marital status, and type of family demonstrated non-significant associations with millet consumption, indicating that these sociodemographic parameters were comparable across both groups. However, findings from a larger cross sectional study highlights that older age is a significant sociodemographic risk factor for non-communicable diseases such as prediabetes and type 2 diabetes mellitus (T2DM). Gender-based differences in disease risk, often finding women at varying risk levels for conditions like obesity and metabolic disorders, no significant difference in gender distribution was noted between the millet and non-millet groups in the current study. Furthermore, while existing literature confirms that lower socioeconomic status, including lower education and income, correlates with an increased risk for chronic diseases, the present study found no statistically significant differences in education level, income distribution, or occupational status between the two groups (Tavares V, et al, 2023).

In this study, most participants in both millet and non-millet groups were classified under Grade 3 BMI, with no significant difference between groups. Similarly, a higher proportion of millet consumers had a normal waist-to-hip ratio (WHR), while more non-millet consumers fell into the high WHR category; however, this difference was also not statistically significant ($p > 0.05$). In contrast, A. Awasti et al. (2017) demonstrated that BMI, waist circumference, and WHR strongly correlate with abdominal fat and are reliable predictors of metabolic and cardiovascular risk, with WHR often being the better predictor. Their findings also noted stronger correlations in females. Therefore, although BMI and WHR are important markers of metabolic health, in the current study, these anthropometric measures did not differ significantly between millet and non-millet consumers, indicating that millet consumption was not associated with differences in body fat distribution in this population.

The frequency of alcohol intake had a statistically significant positive correlation with weight. However, the BMC Public Health article (2023) presents a different finding. While harmful drinking patterns like binge drinking and high AUDIT-C (Alcohol Use Disorders Identification Test-Concise) scores were positively associated with higher waist circumference and obesity risk, the overall frequency of alcohol consumption showed a significant inverse relationship with obesity. In other words, people who drank more frequently — but not excessively — were less likely to be obese. This indicates that it's the pattern and quantity of alcohol intake, not frequency alone, that impacts weight.

The finding that postprandial blood glucose levels negatively correlate with sleep quality is strongly supported by Tsereteli et al. (2022). Their study in Diabetologia showed that both insufficient sleep and later sleep timing were significantly associated with higher post-meal glucose responses under standardized meal conditions. Additionally, even small deviations from an individual's usual sleep pattern adversely affected post-breakfast glucose levels. These results confirm that poorer sleep quality is linked to dysregulated postprandial glycemic control.

Fasting and postprandial blood glucose levels were significantly lower in millet consumers than non-millet consumers in this study, with a greater proportion of millet consumers showing low to moderate values ($p < 0.05$). HbA1c levels, though elevated in both groups, were significantly higher among non-millet consumers. These findings are consistent with R Vedamanickam et al.

Calcium intake was notably higher among millet consumers in this study, with fewer showing low intake compared to non-consumers. This is consistent with Yuan Y. C. et al. (2022), who reported millets — particularly finger millet — as rich calcium sources, contributing to better bone health and improved dietary calcium adequacy. The present study aligns with Al-Mssallem et al. (2020), who found that higher carbohydrate intake was linked to poorer glycemic control in type 2 diabetes. In both studies, lower carbohydrate and higher fiber intake, particularly from sources like millets, were associated with better fasting glucose, postprandial glucose, and HbA1c levels. These findings highlight the importance of reducing refined carbohydrates and promoting fiber-rich grains for improved diabetes management. Millet consumers showed higher fat intake than non-millet consumers. Similarly,

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DOI: https://doi.org/10.5281/ZENODO.16068128

Al-Mssallem et al. (2023) found higher total fat, especially saturated fat, was linked to poor glycemic control in T2DM. Both suggest that while fat intake varies by diet, the type and quality of fat are crucial for managing diabetes outcomes. In the present study, millet consumers had significantly higher potassium intake than non-millet consumers. This aligns with findings by Chen and Chen (2022), who associated higher dietary potassium with reduced risk of diabetic retinopathy. Both studies highlight the importance of potassium intake in improving diabetes-related health outcomes. A recent Japanese study by Fuyuko T., et al (2024) found that higher fiber intake (~11–12 g/day) was linked to better diet satisfaction and slightly lower HbA1c in type 2 diabetes patients. Similarly, the present study showed a modest negative correlation between fiber intake and HbA1c ($r = –0.228$, $p = 0.005$). Both suggest that increased dietary fiber benefits not just glycemic control but also dietary satisfaction in diabetes management (2020), who reported improved glycemic control with millet-based diets in diabetic patients. Together, the studies highlight the positive impact of millet consumption on blood glucose regulation and diabetes management. In the present study, Amaranth had a significant positive correlation with HbA1c levels.

Calcium intake was notably higher among millet consumers in this study, with fewer showing low intake compared to non-consumers. This is consistent with Yuan Y. C. et al. (2022), who reported millets — particularly finger millet — as rich calcium sources, contributing to better bone health and improved dietary calcium adequacy. The present study aligns with Al-Mssallem et al. (2020), who found that higher carbohydrate intake was linked to poorer glycemic control in type 2 diabetes. In both studies, lower carbohydrate and higher fiber intake, particularly from sources like millets, were associated with better fasting glucose, postprandial glucose, and HbA1c levels. These findings highlight the importance of reducing refined carbohydrates and promoting fiber-rich grains for improved diabetes management. Millet consumers showed higher fat intake than non-millet consumers. Similarly, Al-Mssallem et al. (2023) found higher total fat, especially saturated fat, was linked to poor glycemic control in T2DM. Both suggest that while fat intake varies by diet, the type and quality of fat are crucial for managing diabetes outcomes. In the present study, millet consumers had significantly higher potassium intake than non-millet consumers. This aligns with findings by Chen and Chen (2022), who associated higher dietary potassium with reduced risk of diabetic retinopathy. Both studies highlight the importance of potassium intake in improving diabetes-related health outcomes. A recent Japanese study by Fuyuko T., et al (2024) found that higher fiber intake (~11–12 g/day) was linked to better diet satisfaction and slightly lower HbA1c in type 2 diabetes patients. Similarly, the present study showed a modest negative correlation between fiber intake and HbA1c ($r = –0.228$, $p = 0.005$). Both suggest that increased dietary fiber benefits not just glycemic control but also dietary satisfaction in diabetes management.

5. Conclusion

This study assessed anthropometric measurements, lifestyle behaviors, dietary habits, and millet consumption patterns in individuals with type 2 diabetes mellitus. It was observed that most participants in both millet and non-millet groups had similar BMI and waist-to-hip ratios, with no significant differences between them. However, lifestyle factors such as alcohol intake showed a significant positive correlation with weight, and poor sleep quality was linked to higher postprandial blood glucose levels. The 24-hour diet recall highlighted varied dietary patterns, with a segment of participants incorporating millets into their meals. Millet consumption was not significantly associated with sociodemographic factors like age, gender, education, occupation, or income. Importantly, the study demonstrated that millet consumers had significantly better glycemic control, with lower fasting and postprandial blood glucose levels and reduced HbA1c values compared to non-consumers. These findings suggest that while sociodemographic and anthropometric factors may not directly influence millet consumption, including millets in the diet can positively impact blood glucose management in individuals with type 2 diabetes mellitus. The study underscores the potential metabolic benefits of millet consumption, especially in glycemic control and calcium adequacy, while highlighting persistent challenges in dietary behavior modification, supplement use, and multimorbidity management. Future public health interventions should focus on improving millet-based food accessibility, expanding consumer education, and promoting holistic lifestyle changes for better prevention and management of type 2 diabetes and related metabolic disorders.

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