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EXPLORING DIETARY RISK FACTORS ASSOCIATED WITH PRE-DIABETES AND DIABETES DIABETIC POPULATIONS IN CHINA

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ABSTRACT

Pre-diabetes and diabetes are becoming more common in China, which presents a serious public health concern. A key factor in the onset and treatment of many disorders is dietary practices. A lifestyle change can prevent type 2 diabetes, which is more likely to occur in those with pre-diabetes. If diabetes is not treated, it can lead to severe health problems.The objectives were to assess the level of diabetes and pre-diabetes investigate the risk factors associated with these diseases. For this study, the diabetes outcomes for China from the 2019 Global Burden of Disease Study (GBD) were anticipated. All Chinese provinces' population sizes were retrieved, together with data on age, and sex from 2010 to 2023. According to preliminary research, a high intake of processed foods, sugar-filled drinks, and refined carbs is common among Chinese people who have pre-diabetes and diabetes. In contrast, it appears that this group does not consume enough fruits, vegetables, or meals high in fiber, which raises the risk of illness and results in poor glycemic control. The discovery of these dietary risk variables offers important new information for the development of focused nutritional education and intervention programs that encourage the adoption of healthy lifestyle choices and eating habits in Chinese citizens who are either at risk for or diagnosed with pre-diabetes and diabetes. In summary, addressing dietary risk factors through community-based, culturally relevant interventions can be crucial to managing and preventing pre-diabetes and diabetes in China, which will eventually lead to better public health outcomes and a lower cost of healthcare.**Keywords:** Dietary Risk Factors, Pre-diabetes, Diabetes, Chinese People, Global Burden of Disease Study (GBD) 2019.

1. INTRODUCTION

Diabetes mellitus, usually known as diabetes that is a metabolic disorder defined by inadequate insulin construction or resistance to its properties [1]. This causes blood sugar, or glucose, levels to rise, which is associated with several health issues [2]. Diabetes is linked to many other illnesses and represents a significant risk of total mortality. Diabetes has significant consequences; in 2019, it was linked to 1.5 million deaths worldwide. High blood sugar raises the risk of acquiring several illnesses, including heart disease, kidney failure, and Tuberculosis (TB), which accounted for 2.2 million deaths in 2012 [3]. Diabetes and its consequences have a major financial effect, especially for those who are less fortunate financially since the expenses of diabetes care and treatment it can exhaust household funds [4]. Furthermore, diabetes damages national economies by reducing earnings and productivity, which makes it difficult to achieve the objectives of sustainable development [5]. Nutritional risk factors are essential to the onset and treatment of diabetes. Unhealthy eating choices, such as consuming large amounts of sugar, processed foods and saturated fats have a role in the development of the illness.

1.1. Types of Diabetes

Over 90% of instances in diabetes are classified as Type 2 diabetes mellitus (T2DM) and Type 1 diabetes mellitus (T1DM). T2DM is mainly caused by insulin resistance, where the body fails to use insulin efficiently, resulting in high blood glucose levels. Adopting healthy eating habits can aid in the condition's recovery. Lifestyle elements, particularly nutrition, are important for the controlling type 2 diabetes. Comorbidities are more likely to occur in people with diabetes, which highlights the need for dietary interventions in the treatment of the condition [6]. Figure 1 depicts the T2DM mechanism.

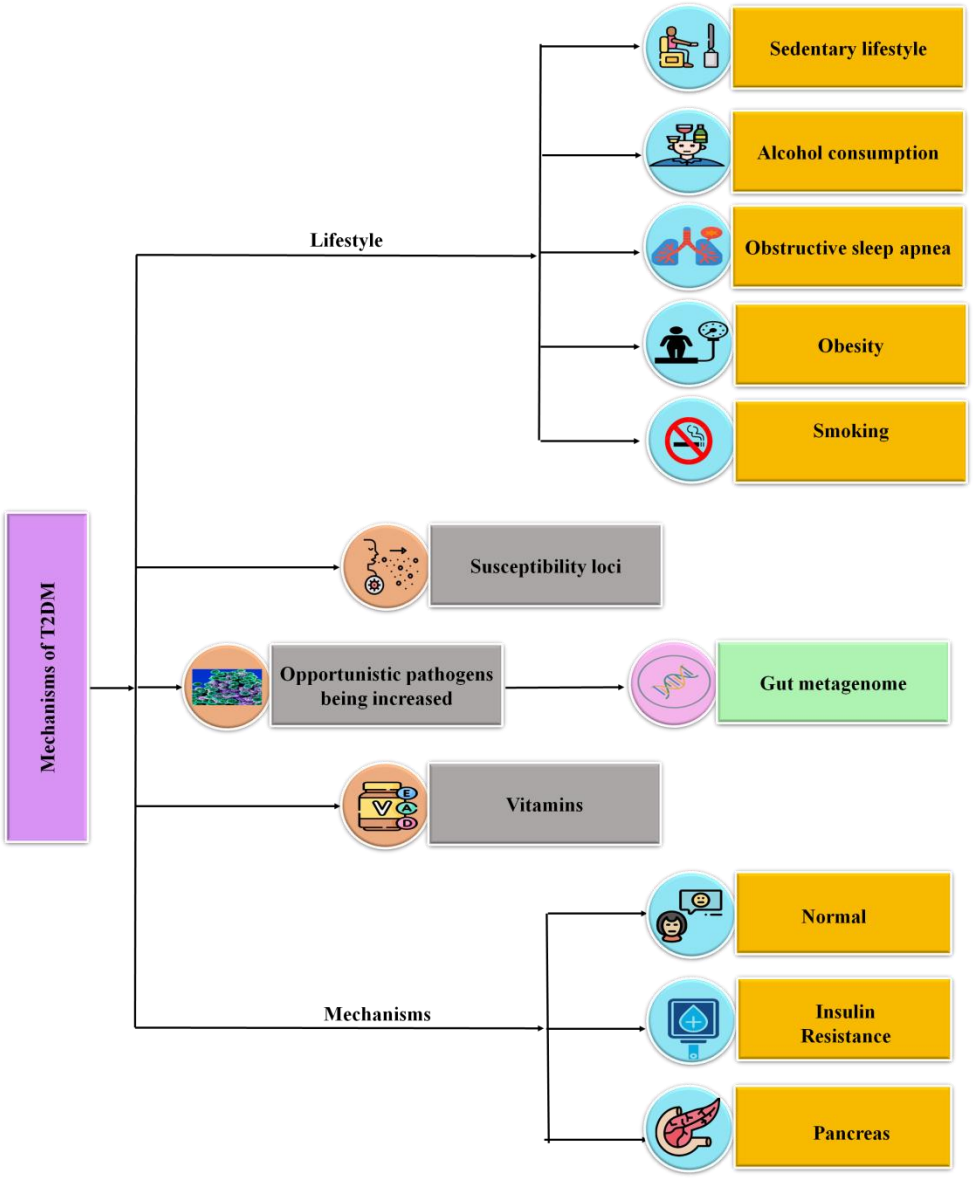

Figure 1: The mechanism of T2DM

Furthermore, diabetes raises the risk of COVID-19-related complications and death, underscoring the need for blood sugar regulation in lowering these risks. A nutritious diet high in fruits, vegetables, whole grains, and lean meats can help people with controlling their disease more effectively and lower their risk of complications [7]. The health problems caused by diabetes affect the person with the disease but also their family and the overall economy. Financial hardship can worsen if health issues limit a person's capacity to work which decreases household profits. Dietary contributors increase healthcare expenditures and decrease productivity, which adds to the economic burden of diabetes. Several risk factors involve eating high-calorie, low-nutrient meals and excessive alcohol use [8]. Diabetes is a metabolic condition that is complicated and it has a big impact on both health and the economy. Diabetes

must be prevented and managed by addressing dietary risk factors, which lessens the toll that the disease has people, families, and economies. This study contains Dietary habits that have a major role in the development and management of many illnesses. A lifestyle change can prevent type 2 diabetes, which is more likely to occur in those with pre-diabetes.

The rest of the paper is divided into sections. The objective-based relevant study is shown in section 2. The materials and methods and other procedures are shown in section 3. The result analysis and their discussion are shown in section 4. The paper was concluded in section 5.

2. RELATED WORKS

Risk variables for normal glucose maintenance and the prevention or delay of pre-diabetes in first-degree relatives of individuals with T2DM were investigated in previous studies [9]. The results indicate that women and older adults who consume larger amounts of fat, carbs, and protein have a higher chance of progressing to pre-diabetes. More studies are required to evaluate these relationships in broader groups. According to the author [10] described the independent variables that affect the change from the typical population first developing pre-diabetes, then diabetic. At the data from 5310 individuals was used to create clinical prediction algorithms. Nine factors had significant changes between the normal and pre-diabetes groups, and seven variables exhibited substantial variations between the groups with diabetes and pre-diabetes, corresponding to the statistics. A three separate diagnostic criteria to look at the Pre-diabetes is more common among middle-aged to elderly Irish people [11]. The prevalence's reported in the results are 43.9%, 14.5%, and 15.8%, respectively. Pre-diabetes is linked to several factors, including poor food quality, sex, age, marital status, health rating, and education. To evaluate the efficacy of a National Diabetes Prevention Program in Ireland, pre-diabetes monitoring is essential. It was to ascertain if regular dietary patterns were associated with the probability of developing T2DM [12] from pre-diabetes or with the likelihood of achieving normal glycemia again. In the Tehran Lipid and Glucose Study, 334 individuals took part and were monitored for nine years. The three main dietary trends that were processed foods, healthy eating, and Western-style eating. Mostly, because of lifestyle factors and environmental dangers, type 2 diabetes is one of the most common chronic diseases in Western nations. Places that are walkable and have green areas lower risk, while environmental variables like noise, air pollution, and socioeconomic disadvantage raise it. It is recommended that future research endeavors look on the long-term impacts of environmental modifications on the development of T2DM [13].

A cohort of Mexican health professionals, weight increase, metabolic syndrome, or uric acid, high alanine transaminase (ALT) [14] levels were linked to an increased risk of pre-diabetes or diabetes. The results emphasize the necessity of programs aimed at lowering excess weight and averting new instances of pre-diabetes and diabetes. The purpose was to identify risk factors for non-communicable diseases (NCDs) [15] among people residing in Myanmar. Findings indicate that three or more risk factors were present more than half of pre-diabetic individuals and 71.3% of untreated diabetics, emphasizing the need for focused treatments to lower the burden of NCDs. Adults in Tabriz, Iran who are pre-diabetic have poor attitudes and little information about making lifestyle modifications such as eating a healthier diet and exercising [16]. Pre-diabetes preventive and control programs can be more successful if people have more awareness and adopt more positive attitudes, according to a positive association between knowledge and practice. The potential benefits of resistant starch (RS) [17] in the management of type 2 diabetes in individuals with pre-diabetes and diabetes are explored. The findings indicate that RS consumption is associated with improved condition management, impacting postprandial insulin and glucose levels as well as inflammatory markers. Pre-diabetes and diabetes, as well as the 5-year incidence rate and the efficacy of diabetes care were evaluated in a study conducted in southeast Iran. Pre-diabetes prevalence was found to be 12%, diabetes mellitus prevalence to be 18.4%, and uncontrolled diabetes mellitus prevalence to be 48.8%. The lower prevalence of diabetes and its negative effects on health, suitable health treatments are required.

3. MATERIALS AND METHODS

The methods section contains data on lifestyle characteristics, anthropometrics, dietary habits, health indicators, and demographics that were gathered. To find independent risk variables, statistical methods included multivariate logistic regression, descriptive summaries, and evaluations of eating patterns.

3.1. Data collection

The study employed a matched case-control approach with 600 patients, comprising 300 instances of pre-diabetes and 300 cases of diabetes in both male and female populations. From 2010 to 2023, the population size of every province in China was extracted together with the age and sex. The frequency matching method was used to match the two groups according to age and sex. The following age-matched groups were: 30–40, 41–50, and 51–60 years old; the sexes of the two groups were thus

matched. Participant characteristics for Dilatory risk factors in both cases of diabetes and pre-diabetes (Number-No, Percentage-P) are displayed in Table 1.

Table 1: Dilatory risk factor in Diabetes and Pre-diabetes characteristics (No, P)

Variables	Pre-Diabetes (n=300)		Diabetes (n=300)		P*
	n	%	n	%	
Sex					
Female	198	66.0	198	66.0	0.5
Male	102	34.0	102	34.0	
Occupation					
Worker	20	6.7	20	6.7	0.5
Employee	42	14.0	60	20.0	
Housekeeper	142	47.3	130	43.3	
Retired/self-employed	92	30.7	80	26.7	
Unemployed	10	3.3	10	3.3	
Marital status					
Divorced/widow	24	8.0	20	6.7	0.2
Single	22	7.3	22	7.3	
Married	266	88.7	258	86.0	
Physical activity					
Moderate	60.7	28.0	84	182	<0.001
High	14.7	10.7	32	44	
Low	24.7	61.3	184	74	
Dietary supplement intake					
No	240	80.0	260	86.7	0.08
Yes	60	20.0	40	13.3	
Waist circumference (cm)					
<80 women to <90 men	38	12.6	86	28.6	<0.001
≥80 women to ≥90 men	262	87.4	214	71.4	
BMI (kg/m2)					
<25	40	13.4	86	28.7	<0.001
25–29.9	130	43.3	162	54.0	
≥30	130	43.3	52	17.3	

3.2. Assessment of Dietary factor

The measured food consumption from the year preceding the pre-diabetes evaluation, in the circumstance of controls, it measured food intake from the year prior. The frequency of consumption of every food item across several types (yearly, monthly, weekly, or daily) was inquired of the participants. To estimate daily food consumption, data from the food frequency questionnaire (FFQ) was translated to grams per day. To confirm the FFQ's reliability and validity, tests were carried out. The "sweet, solid fat, meat, and mayonnaise (SSMM) pattern and the vegetables, fruits, and legumes (VFL)" pattern were the two dietary patterns identified in the study. The intake of vegetables, nuts, fruits, l poultry, whole grains, legumes, fatty

dairy products, and fish was higher in the VFL pattern than the SSMM pattern, which was dominated by solid fats, processed meat, sweets, red meat and other high-fat dairy goods. Table 2 represents the Dietary factor food groups and their overall variance for these patterns.

Table 2: Major dietary factor-food groups and their pattern

Food groups	Dietary patterns	
	VFL	**SSMM**
Tomato	0·527	-
Nuts	0·372	-
Fruits	0·477	-
High-fat dairy products	-	0·580
Dried fruit	0.538	-
Refined grains	−0·313	0·456
Whole grains	0·402	-
Low-fat dairy products	0·465	-
Vegetable	0·723	-
Chicken	0·418	0·350
Liver and organic meat	-	0·305
Fish	0·371	-
Red and processed meat	-	0·667
Solid fat	-	0·713
Vegetable oil	0·465	-
Sweets and desserts	-	0·730
Legume	0·607	-
	11·9	16·2

3.3. Evaluation of physical activity, blood pressure, and anthropometry

Participants in the research had anthropometric assessments, which included weight, height, waist circumference, BMI, and systolic and diastolic blood pressure. A flexible tape was used to measure waist circumference, the Seca stadiometer was used to measure height and the Seca scale was used to assess weight. A manual sphygmomanometer was used to measure the diastolic and systolic blood pressure. ≥90 cm for males and ≥80 cm for women in waist circumference was the threshold for abdominal obesity; a BMI of ≥30 kg/m^2 was the threshold for general obesity. Data were categorized into three categories: "low physical activity" (600 MET/h per week), "moderate physical activity" (<600–3000 MET/h per week), and "high physical activity" (<3000 MET/h per week). Participant characteristics for Dilatory risk factors both case diabetes and pre-diabetes (Mean value-M, Standard Deviation-SD) are displayed in Table 3.

Table 3: Dilatory risk factor in Diabetes and Pre-diabetes characteristics (M, SD)

Quantities variables	Pre-diabetes (n=300) M(SD)	Diabetes (n=300) M(SD)	P ("†" Spearman's correlation)
Age (years)	47.6 (7.7)	47.9 (7.4)	0·7*
2-h glucose (mmol/l)	8.0 (1.2)	6.9(0.55)	<0·001*
Waist circumference (cm)	94.4 (11.6)	88.8 (10.1)	<0·001†
Energy intake (kcal/d)	2423.3 (290.9)	2231.6 (297.7)	<0·001†
Diastolic blood pressure (mmHg)	78.8 (10.7)	73.6 (7.9)	<0·001*
Weight (kg)	78.1 (13.0)	72.6 (11.6)	<0·001†
Fasting blood glucose (mmol/l)	6.3 (0.37)	4.8 (0.41)	<0·001*
BMI (kg/m²)	29.6 (4.4)	27.3 (3.8)	<0·001†

3.4. Statistical Analysis

After the acquired data was entered into the Microsoft Access application, the dataset was created. The dataset was moved to Version 23.0 of the "Statistical Package for the Social Sciences (SPSS)" application to do descriptive analysis and frequency calculations. To investigate independent risk variables, multivariate logistic regression analysis was used.

4. RESULT ANALYSIS

The study looks into how dietary habits affect several health markers, including pre-diabetes. The findings demonstrate opposing trends: SSMM is linked to increased chances of pre-diabetes, but the VFL pattern indicates decreased odds. These results highlight the importance of food choices in determining one's health. The percentage of people in each age group who are pre-diabetic and diabetic is shown in Figure 2. Overall age categories, there is a declining tendency in pre-diabetics and non-diabetics, whereas there is a rising trend in diabetics.

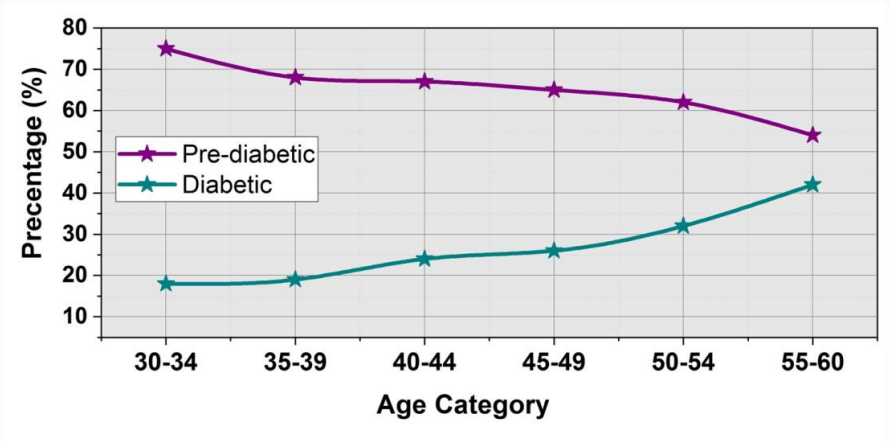

Figure 2: Different age groups diabetic status

4.1. Comparing Dietary Patterns

Data on dietary pattern score tertiles (low, medium, and high) in a sample of 200 people are shown in the accompanying table. It displays correlations between food habits and several factors, including age, weight, waist circumference, energy consumption, BMI fasting blood sugar, diastolic blood pressure and glucose levels after two hours. There are noteworthy correlations that show lower scores are linked to lower blood pressure and higher scores are related to several health indicators including increased weight, waist circumference, BMI, fasting blood glucose (FBG), and 2-hour glucose levels. These results raise possible concerns about how dietary treatments can be used to control health outcomes are shown in Table 4.

Table 4: Comparing Dietary Patterns score teritles

Dietary pattern score tertiles (n=200)										
Variables	**SSMM**					**VFL**				
	I (low)	**II**	**III (high)**	**r**	**P (“‡”Pearson correlation, “*” χ2 test)**	**I (low)**	**II**	**III (high)**	**r**	**P (“‡”Pearson correlation, “*” χ2 test)**
	M(SD)	**M(SD)**	**M(SD)**			**M(SD)**	**M(SD)**	**M(SD)**		
Case/control (n (%))	22 (11.0)/178 (89.0)	120 (60.0)/80 (40.0)	158 (79.0)/42 (21.0)	-	<0.001*	144 (72.0)/56 (28.0)	106 (53.0)/94 (47.0)	50 (25.0)/150 (75.0)	-	<0.001*
Age (years)	48.7 (7.7)	47.11(7.9)	46.4 (6.7)	-0.17	0·07†	51 (7·10)	46·10(7·6)	47·10 (6·9)	0·004	0·4†
Diastolic blood pressure (mmHg)	118.9(11·9)	118·8 (11·9)	124·7 (11·6)	0·22	<0·001†	121·6 (13·2)	121·2 (11·8)	119·6 (11·2)	−0·08	0·3†
Waist circumference (cm)	88.3 (10·4)	91·5 (11·3)	94·9 (10·10)	0·33	<0·001‡	93·6 (11·6)	91·2 (10·10)	89·10 (10·8)	−0·15	0·02‡
2-h glucose (mmol/l)	7.2 (1·2)	7·5 (0·93)	7·8 (1·2)	0·31	<0·001†	7·10 (0·97)	7·4 (1·3)	7·0 (0·91)	−0·40	<0·001†
Energy intake (kcal/d)	10214.11 (1220·7)	9561·5 (1414·8)	9498·10 (1135·3)	−0·08	0·2‡	10 273·6 (1241·2)	9861·5 (1341·2)	9139·10 (1046·11)	−0·39	<0·001‡
Weight (kg)	71.2 (12·8)	75·5 (10·8)	79·2 (12·7)	0.31	0·07†	76·11 (13·2)	75·7 (12·8)	73·3 (11·8)	−0·16	0·01‡
BMI (kg/m²)	27.4 (4·6)	28·2 (3·6)	29·7 (4·2)	0·32	<0·001‡	28·10 (3·10)	28·6 (4·5)	27·6 (3·10)	−0·20	0·002‡

FBG (mmol/l)	4.99 (0·85)	5·5 (0·10)	5·9 (0·75)	0·37	<0·001†	5·10 (0·59)	5·3 (0·86)	4·9 (0·76)	−0·52	<0·001†

4.2. Patterns of dietary

Using three models with a sample size of 600 each, the study examined the connection between food habits and pre-diabetes. There variables are denoted in table as "§" further modified for energy consumption, "*" Multivariate logistic regression analysis, "‡" Adjusted for physical activity, age, and BMI. The findings demonstrated that the VFL eating regimen had lower odds ratios (ORs) for pre-diabetes than the reference, with ORs ranging from 0.17 to 0.18 across the models and statistically significant p-values (<0.001). In contrast, the SSMM dietary pattern had substantial confidence intervals and p-values along with consistently higher ORs for pre-diabetes, ranging from 2.58 to 5.47 across the models. The possible influence of dietary decisions on the development of pre-diabetes is highlighted by these studies are shown in Table 5.

Table 5: Comparison of Dietary patterns in SSMM and VFL

Dietary patterns								
	SSMM				**VFL**			
Models	**n**	**95% CI**	**OR**	**P**	**n**	**95% CI**	**OR**	**P**
Model 1‡	600	1.78, 3.76	2.58	<0.001	600	0.12, 0.27	0.17	<0.001
Model 2§	600	3.24, 9.25	5.47	<0.001	600	0.12, 0.27	0.18	<0.001

This study investigates the relationship between dietary practices and pre-diabetes morbidity. The findings indicate that there is a positive correlation between the SSMM eating pattern and weight, waist circumference, BMI, calorie consumption, diastolic blood pressure, glucose levels during fasting and two hours later, as well as Dietary patterns associated with VFL and SSMM are directly correlated with pre-diabetes mortality. There exists a positive and inverse relationship between insulin resistance and healthy dietary patterns. Conversely, large Consumption of pickles, vegetables, marine algae, seafood, vegetables, soybeans, and green tea is related with an enhanced risk of acquire insulin struggle in their lifestyle. Following a nutritious diet was linked to a lower occurrence of T2D, according to a meta-analysis of considerably a probable trials. It has been demonstrated that individuals with a high

risk of cardiovascular disease can effectively avoid the occurrence of diabetes by following a Mediterranean diet.

5. Conclusion

The prevalence of dietary in pre-diabetes and diabetes was similar to data from other regions of the nation, and the correlation between risk variables and diabetes was likewise consistent with earlier research. Controlling and preventing pre-diabetes and diabetes requires addressing dietary risk factors through focused treatments. Reducing healthcare expenses and improving public health can be accomplished by implementing culturally appropriate initiatives that encourage healthy lifestyle choices. In this study, the main risk factors for diabetes were found to be central obesity, growing age, gender, etc. The pre-diabetic morbidity is directly and negatively correlated with the VFL and SSMM eating patterns, correspondingly. Furthermore, the VFL eating pattern raises the possibility of obesity and hypertension, two disorders linked to poor glucose metabolism, the start of diabetes, and coronary heart disease. Therefore, more research is required to validate findings in different populations. To contribute to long-term advances in diabetes prevention and treatment, future research might examine novel approaches to encourage long-term adherence to good eating habits and evaluate the efficacy of these interventions across a variety of their communities.

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