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Original Research Article

PREVALENCE OF PREDIABETES AND TYPE-2 DIABETES MELLITUS AND ITS EPIDEMIOLOGICAL DETERMINANTS IN ADULT POPULATION OF FISHING COMMUNITIES OF PUDUCHERRY DISTRICT – A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) is a growing public health concern, particularly in vulnerable occupational groups. Fishing communities face lifestyle, economic, and psychosocial challenges that may increase the risk of diabetes. This study aimed to estimate the prevalence of prediabetes and T2DM and identify the associated determinants among adults in the fishing communities of Puducherry, India. **Materials and Methods:** A community-based cross-sectional study was conducted on 376 adults selected from four fishing villages. Data on sociodemographic profiles, lifestyle, dietary habits, physical activity, stress, sleep quality, and family history were collected using validated tools. Anthropometric measurements, blood pressure, and fasting blood glucose levels were measured. Statistical analyses included the chi-square test, ANOVA, and logistic regression. **Result:** The prevalence of prediabetes and T2DM was 17.5% (n=66) and 29% (n=109), respectively. Diabetes prevalence increased with age (1.9% in 19–30 years vs. 38.6% in >61 years, p<0.001). Females (32.1%) had a higher prevalence than males (26.4%), although this was not significant (p=0.47). Occupation was significant (p=0.021), with semi-skilled workers showing the highest prevalence (57.1%, OR=9.41, 95% CI: 1.93–45.8). Overweight (OR=1.94, 95% CI: 1.13–3.35) and obesity (OR=3.52, 95% CI: 1.27–9.69) were associated with diabetes. Waist–hip ratio ≥0.95 in males increased the risk (OR=2.10, 95% CI: 1.11–4.30). Psychosocial determinants were strongly linked: high stress (89.9% vs. 2.6%, p<0.001) and poor sleep (61.6% vs. 1.1%, p<0.001). Diabetics had higher systolic/diastolic pressures (139/90 mmHg, p<0.001). Low fruit intake (p=0.007), reduced vegetable intake (p=0.015), and family history of obesity (46.3%, p=0.033) were significant predictors, whereas smoking, alcohol consumption, education, and socioeconomic class were not. **Conclusion:** T2DM is highly prevalent in fishing communities, with age, occupation, central obesity, stress, poor sleep, diet, and family history of obesity being the major determinants.

INTRODUCTION

Non-communicable diseases (NCDs) are a major global health concern, with type 2 diabetes mellitus (T2DM) being one of the most common and rapidly increasing conditions. Diabetes is associated with serious complications, such as cardiovascular disease, kidney failure, and vision impairment, making it a significant public health challenge. Worldwide, an estimated 536.6 million adults had diabetes in 2021, and this number is projected to rise to 783.2 million by 2045.[1,2] In India, about 8.7% of adults aged 20 to 70 years are affected by diabetes, indicating a growing national burden.[3] Studies show that the prevalence of diabetes is higher in urban (12.1%) than rural areas (8.3%), and higher in high-income countries (11.1%) compared to low-income countries (5.5%).[4] Middle-income countries, including India, are expected to experience the largest percentage increase in diabetes prevalence by 2045.[5]

The rising prevalence of T2DM is closely linked to lifestyle and other risk factors. Unhealthy diets, physical inactivity, being overweight, and obesity are among the most important contributors.[6] In addition, socioeconomic factors, stress, and occupation-related challenges increase the risk of developing diabetes. Understanding the interplay between these determinants is essential for effective prevention and management.

Fishing is a physically demanding occupation, but communities dependent on it often face low income, limited education, irregular working hours, and poor access to healthcare.[7,8] These conditions, along with unhealthy habits such as irregular meals and tobacco or alcohol use, may increase vulnerability to chronic diseases, including diabetes mellitus. Fishing villages are often overcrowded with inadequate sanitation, further affecting overall health.[8] Despite these risks, there are limited data on the prevalence of diabetes and its determinants in these populations, particularly in southern India.

Given the diversity of livelihoods, culture, and lifestyle patterns across India, studies focusing on specific occupational communities are necessary to understand local risk factors.[9] Fishing communities are socially and economically vulnerable and may be at higher risk of developing prediabetes and T2DM due to their work environment, lifestyle, and limited awareness of healthy practices.[10] Assessing the prevalence and associated risk factors in these populations can provide valuable insights for public health planning and targeted interventions.

The present study was conducted to determine the prevalence of prediabetes and T2DM and to identify their epidemiological determinants among adults in the fishing communities of Puducherry district. This study aimed to fill the knowledge gap regarding diabetes in occupationally vulnerable populations and contribute to strategies for the prevention and early management of the disease.

MATERIALS AND METHODS

This cross-sectional study was conducted among 376 adults from fishing communities aged > 18 years who had resided in the Puducherry district for more than six months. This study was conducted in the field practice area of Mahatma Gandhi Medical College and Research Institute, Puducherry, between March 2021 and February 2022. Ethical clearance was obtained from the Institutional Human Ethical Committee, and written informed consent was obtained from all participants.

Sample size calculation

Assuming a prevalence of prediabetes and diabetes of 10.6%, the required sample size was calculated to be 314.[11] Considering a 20% non-response rate, the final sample size was adjusted to 376.

Sampling Method

The study was conducted in the field practice area of Mahatma Gandhi Medical College and Research Institute, Puducherry district, India, among adults aged above 18 years who had been residing in the district for more than six months. The list of fishing villages was obtained from the Puducherry Urban Development Agency, which identified 40 marine fishing villages in the Union Territory, of which 17 are located in the Puducherry district—the highest among all districts. From these, four villages were randomly selected for the study. Population proportion to size was used to determine the required number of participants from each village: Narambai (75), Pannithitu (73), Pudhukuppam (94), and Kurumbapet (134). In each village, the first household was chosen randomly by standing at the centre of the village, after which households were visited sequentially until the target sample size was achieved. If more than one eligible participant was present in a household, one was selected by simple random selection using balloting.

Inclusion and exclusion criteria

The study included adults from fishing communities aged above 18 years, residing in the Puducherry district for more than six months, who were willing to provide informed consent. Patients with severe cardiovascular or neurological conditions and pregnant women were excluded. In households with more than one eligible participant, only one person was randomly selected.

Methods

Permission was obtained from the village chief before the study was initiated. The Puducherry district has 17 marine fishing villages, the highest in the union territory, and four villages were randomly selected for the study. The sample from each village was determined using the population proportion to size: Narambai-75, Pannithitu-73, Pudhukuppam-94, and Kurumbapet-134. In each village, the first house was randomly selected from the centre of the village. Data were collected using a pretested interview schedule for sociodemographic details, and standardised questionnaires were used to assess physical activity, stress, alcohol use, smoking, sleep quality, and diet. The WHO STEPS protocol was followed for measuring risk factors, including anthropometry, blood pressure, and fasting capillary blood glucose levels. Participants with fasting glucose between 110–125 mg/dl were classified as prediabetes, and those above 126 mg/dl were classified as diabetic.[12,13]

Statistical Analysis

Data were analysed using descriptive statistics (frequencies, percentages, mean ± SD). Chi-square and ANOVA tests were used to assess associations, while logistic regression was used to identify factors linked to prediabetes and diabetes. Significance was set at $p < 0.05$, and all analyses were performed using SPSS software v23.

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RESULTS

Overall, the prevalence of prediabetes was 17.5% (n=66) and diabetes was 29% (n=109) among the study population (N=376). Prevalence increased significantly with age, from 1.9% in the 19–30 year group to 38.6% in those >61 years (p<0.001). Female participants had a slightly higher prevalence of diabetes (32.1%) than male participants (26.4%); however, the difference was not significant (p =0.47). Educational status was not associated with glycaemic status (p=0.17), although primary school participants showed lower odds of prediabetes (OR=0.24, 95% CI: 0.08–0.77). Occupational status was significant (p=0.021), with semi-skilled workers showing the highest diabetes prevalence (57.1%) and markedly increased odds (OR=9.41, 95% CI: 1.93–45.8) compared with skilled workers.

Socioeconomic status, smoking, and alcohol use were not significantly associated with diabetes (p>0.05). Physical inactivity was more common among patients with diabetes (31.5% vs. 16.9%); however, the overall association with MET score was not significant (p=0.35). Lack of moderate physical activity was significantly associated (p=0.019), while vigorous activity showed no association (p=0.067).
Anthropometric measurements showed significant associations. Overweight (OR=1.94, 95% CI: 1.13–3.35, p=0.02) and obesity (OR=3.52, 95% CI: 1.27–9.69, p=0.03) increased diabetes risk compared to normal BMI. In males, WHR ≥0.95 was associated with higher odds of diabetes (OR=2.10, 95% CI: 1.11–4.30, p=0.066). In females, WHR was not estimable as nearly all participants were ≥0.8. Elevated waist circumference showed higher, though nonsignificant, odds in both sexes (p>0.05). [Table 1]

Table 1: Distribution of prediabetes and T2DM by sociodemographic, lifestyle, and anthropometric characteristics of participants (N=376)

Characteristic		Normal (N=201, %)	Pre-diabetes (N=66, %)	OR (95%CI)	Type 2 DM (N=109, %)	OR (95% CI)	p value
Gender	Male (n=208)	115(55.3)	38 (18.3)	1.01(0.58 – 1.78)	55(26.4)	0.76(0.48 – 1.22)	0.47
	Female (n=168)	86(51.2)	28 (16.7)		54(32.1)		
Age group (years)	19-30(n=53)	46(86.8)	6(11.3)	1	1(1.9)	1	-
	31-45 (n=123)	62(50.4)	25(20.3)	3.09(1.17 – 8.14)	36(29.3)	26.7(3.53 – 202.01)	
	46-60 (n=143)	67(46.9)	26(18.2)	2.97(1.13 - 7.79)	50(35)	34.32(4.57 – 257.42)	
	>61 (n=57)	26(45.6)	9(15.8)	2.6(0.84 – 8.29)	22(38.6)	38.92(4.95 – 305.67)	
Education status	Illiterate	119(53.8)	40(18.1)	0.7(0.38-1.33)	62(28.1)	0.81(0.47-1.14)	0.17
	Primary School	35(62.5)	4(7.1)	0.24(0.077-0.77)	17(30.4)	0.76(0.36-1.592)	
	Middle School	47(47.5)	22(22.2)	1	30(30.3)	1	
Occupation	Unemployed	69(48.3)	28(19.6)	1.47(0.82-2.64)	46(32.2)	1.56(0.95-2.57)	0.021
	Unskilled Worker	10(66.7)	1(6.7)	3.6(1.39-9.47)	4(26.7)	0.94(0.28-3.14)	
	Semi-Skilled Worker	2(14.3)	4(28.6)	7.27(1.27 – 41.4)	8(57.1)	9.41(1.93-45.8)	
	Skilled Worker	120(58.8)	33(16.2)	1	51(25)	1	
Socio-Economic Class (Modified BG Prasad's Classification)	Upper	39(51.3)	10(13.2)	1	27(35.5)	1	0.605
	Upper Middle	8(50)	5(31.2)	2.4,(0.65-9.08)	3(18.7)	0.54(0.13-2.22)	
	Middle	83(51.5)	31(19.2)	1.45(0.64-3.26)	47(29.1)	0.81(0.44-1.50)	
	Lower middle	70(57.4)	20(16.4)	1.11(0.47-2.61)	32(26.2)	0.6(0.34-1.25)	
	Lower	1(100)	-	1.25(0.04-33.06),	-	0.47(0.018-12.19)	
Smoking Habit	Yes	36(45.6)	17(21.5)	1.59(0.82-3.07)	26(32.9)	1.43(0.81-2.53)	0.274
	No	165(55.6)	49(16.5)		83(27.9)		
Alcoholic	Yes	43(46.7)	20(21.7)	1.59(0.85-2.98)	29(31.5)	1.33(0.77-2.29)	0.285
	No	158(55.6)	46(16.2)		80(28.2)		
Physical activity (MET Score)	<600 (n=311)	163 (52.4)	50(16.1)	0.72(0.37-1.14)	98(31.5)	2.07(1.01-4.25)	0.35
	≥600 (n=65)	38(58.5)	16(24.6)		11(16.9)		
	Not engaged (n=352)	185(52.6%)	60(17%)	0.86(0.32-2.31)	107(30.4%)	4.62(1.04-20.51)	0.067

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Vigorous activity of 75min/ week	Engaged (n=24)	16(66.7%)	6(25%)		2(8.3%)		
Moderate activity of 150min/ week	Not Engaged (n=354)	189(53.4%)	58(16.4%)	0.46(0.17-1.18))	107(30.2%)	3.39(0.74-15.4)	0.019
	Engaged (n=22)	12(54.5%)	8(36.4%)		2(9.1%)		
WHO's International Body Mass Index (BMI) Classification	Underweight (n= 16)	8(4)	1(1.5)	0.47(0.05-3.87)	7(6.4)	2.15(0.74-6.22)	0.1835
	Normal (n= 165)	143(71.1)	38(57.6)	1	58(53.2)	1	
	Overweight (n=74)	43(21.4)	22(33.3)	1.92(1.02-3.60)	34(31.2)	1.94(1.13-3.35)	0.02
	Obese class (n=22)	7(3.5)	5(7.6)	2.68(0.80-8.9)	10(9.2)	3.52(1.27-9.69)	0.03
Waist-hip ratio in males	≥0.95	31 (56.4)	27(71.05)	1.9(0.78-4.5)	85(73.9)	2.1(1.11-4.3)	0.066
	<0.95	24(43.6)	11(28.9)		30(26.1)		
Waist circumference in males	≥90 cm	25(45.5)	17(44.7)	0.97(0.42-2.23)	71(61.7)	1.93(1.01-3.71)	0.602
	<90 cm	30(54.5)	21(55.3)		44(38.3)		
Waist-hip ratio in females	≥0.8	86(100)	28(100)	NA	52(96.3)	NA	NA
	< 0.80	0	0		2(3.7)		
Waist circumference in females	≥80	34(39.6)	16(57.2)	2.03(0.85-4.84)	29(53.7)	1.77(0.89-3.52)	0.131
	< 80	52(60.4)	12(42.8)		25(46.3)		

Dietary intake of vegetables was comparable across groups (p=0.105), whereas fruit intake was significantly lower among diabetics (p=0.007). The mean fasting blood glucose level rose progressively from normal (98.4 ± 6.2 mg/dl) to prediabetes (115.9 ± 4.2 mg/dl) and diabetes (197.0 ± 67.7 mg/dl), with a significant difference (p<0.001). Both systolic and diastolic blood pressures were significantly elevated in the prediabetes and diabetes groups compared with the normal group (p<0.001).

Sedentary time did not differ significantly between the groups (p=0.645). Stress levels showed a strong association: higher stress was reported by 89.9% of diabetics, compared with none in the normal group (p<0.001). Similarly, sleep disturbance was strongly linked, with 61.6% of patients with diabetes and 37.3% of patients with prediabetes reporting poor sleep quality versus only 1.1% of normal (p<0.001).

Family history of obesity was significantly more common among diabetics (46.3%) than among normal (39%) and prediabetics (14.6%) (p=0.033). Family history of hypertension, diabetes, cardiovascular disease, or cerebrovascular accidents was not significantly associated with the risk of diabetes (p>0.05). [Table 2]

Table 2: Comparative distribution of dietary, clinical, and lifestyle factors among normal, pre-diabetic, and diabetic participants

Characteristic		Normal	Prediabetes	Type 2 DM	p value
Diet (serving per week)	Vegetable	7±3	7±3	6±2	0.105
	Fruit	3±1	3±1	3±1	0.007
Fasting Blood Glucose		98.4± 6.2	115.9± 4.2	197.0 ± 67.7	<0.001
Blood Pressure	SBP	130 ±10	135± 11	139± 11	<0.001
	DBP	84 ±8	88 ±5	90 ±7	<0.001
Sedentary (hours/day)		104± 49	110± 56	110 ±52	0.645
Stress	Low Stress (n=193)	177(91.7)	11(5.7)	5(2.6)	<0.001
	Moderate Stress (n=104)	24(23.1)	47(45.2)	33(31.7)	
	Higher stress (n=79)	0	8(10.1)	71(89.9)	
Sleep (PSQI Score)	<5 (Good sleep quality)	199(100)	0	0	<0.001
	≥5 (Poor sleep quality)	2(1.1)	66(37.3)	109(61.6)	
Family history	Hypertension (n=246)	133(54.1)	37(15)	76(30.9)	0.174
	Diabetes mellitus (n=250)	135(54)	45(18)	70(28)	0.828
	Obesity (n=41)	16(39)	6(14.6)	19(46.3)	0.033
	CVD (n=73)	38(52.1)	16(21.9)	19(26)	0.525
	CVA (n=11)	6(54.5)	1(9.1)	4(36.4)	0.845

Perceived stress score was strongly associated with higher stress, increasing the odds of diabetes (Estimate = –0.383, 95% CI: –0.446 to –0.32, p<0.001). Waist–hip ratio also showed a significant positive association (estimate = 20.241, 95% CI: 5.568–34.914, p=0.007). Dietary intake demonstrated a protective role: higher vegetable servings reduced the risk of diabetes (estimate = –0.155, 95% CI: –0.28 to –0.03, p=0.015), whereas fruit intake did not show a significant effect (p=0.481).

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Among the clinical parameters, elevated diastolic blood pressure was significantly associated with diabetes (estimate = –0.078, 95% CI: –0.15 to –0.007, p=0.032), whereas systolic blood pressure did not reach significance (p=0.168). Body mass index, socioeconomic status, education, height, and age categories were not independently associated after adjustment (p>0.05). [Table 3]

Table 3: Logistic regression analysis of factors associated with prediabetes and T2DM

Variables		Estimate	Wald	p value	95% Confidence Interval	
					Lower Bound	Upper Bound
Diabetes		-1.977	0.078	0.78	-15.848	11.895
Pre-diabetes		0.647	0.008	0.927	-13.22	14.514
Perceived stress score		-0.383	141.999	0	-0.446	-0.32
Waist Hip Ratio (WHR)		20.241	7.31	0.007	5.568	34.914
Height		-0.093	0.003	0.955	-3.314	3.128
Fruit Servings		0.119	0.497	0.481	-0.211	0.448
Vegetable servings		-0.155	5.89	0.015	-0.28	-0.03
Socio-economic status		-0.098	0.639	0.424	-0.339	0.143
Body Mass Index		-0.022	0.255	0.613	-0.108	0.064
BP	Systolic blood pressure	-0.031	1.898	0.168	-0.076	0.013
	Diastolic blood pressure	-0.078	4.61	0.032	-0.15	-0.007
Education		-0.017	0.005	0.946	-0.512	0.478
Age group (years)	19-30	0.847	1.227	0.268	-0.651	2.344
	31-45	0.717	1.735	0.188	-0.35	1.783
	46-60	0.462	0.875	0.35	-0.506	1.43
	≥61	0	-	-	-	-

DISCUSSION

This study aimed to assess the prevalence and determinants of diabetes and prediabetes among adults, focusing on sociodemographic, lifestyle, anthropometric, dietary, psychosocial, and family history factors. Understanding these associations can help guide prevention and management strategies in similar populations. In a study of 376 participants, diabetes and prediabetes were prevalent and increased with age, and occupational status was significantly associated with a higher risk among semi-skilled and unemployed participants. Similarly, Rahim et al. found diabetes and prediabetes prevalence at 19.6% and 10.1% respectively, and also reported a mean participant age of 52.63 ± 14.[19] years.10 Chauhan et al. reported 51.2% in females and 48.8% in males.[14] Hedén Stahl et al. observed the highest cumulative incidence among unskilled and semi-skilled workers (16%) versus 11% among high officials.[15] Age and occupation strongly influence diabetes risk, with older and semi-skilled/unemployed individuals at higher prevalence.

In our study, smoking and alcohol use showed no significant association with diabetes, whereas low physical activity, particularly a lack of moderate exercise, was linked to a higher risk. Similarly, Agrawal and Ebrahim et al. reported no clear association between diabetes and smoking or alcohol use.[16] Ramamoorthy et al. found that 41.3% of adults in India were physically inactive, which increased the risk of T2DM.[17] Lifestyle factors, especially insufficient physical activity, contribute to diabetes risk, whereas smoking and alcohol use may not.

Our study shows overweight and obese participants had significantly higher odds of diabetes compared to those with normal BMI (OR=1.94 and OR=3.52, respectively). High waist–hip ratio was strongly associated with diabetes risk in males, while in females almost all participants had WHR ≥0.8, making estimates not calculable. Similarly, Purohit et al. reported a mean BMI of 23.94 ± 1.83 kg/m² in cases versus 22.8 ± 1.38 kg/m² in controls (p < 0.001), with 46% having an abnormal WHR.[18] Abe et al. found that men with a BMI >25.1 kg/m² and WC >88 cm had a 1.58-fold and 2.04-fold higher risk, respectively, and women with a BMI >24.4 kg/m² and WC ≥78.2 cm had more than double the risk.[19] Central obesity and BMI are key predictors of diabetes, emphasising the importance of anthropometric measures.

On multivariate analysis, perceived stress, waist–hip ratio, reduced vegetable intake, and elevated diastolic blood pressure emerged as independent determinants. Other factors including fruit intake, BMI, systolic BP, socio-economic status, education, and age groups were not significant after adjustment. Similarly, Thulaseedharan et al. found that adequate fruit and vegetable intake increased protection against diabetes 3.9-fold.[20] Janghorbani and Amini reported a progressive rise in fasting glucose across groups, and Hamer et al. noted that diabetics spent more time sedentary (662 vs. 636 min/day).[21,22] Diet and glycaemic measures are crucial indicators; sedentary behaviour shows weaker but relevant associations. Although crude analysis showed age strongly influenced diabetes prevalence, in adjusted models age was not independently significant, indicating its effect may be mediated through other factors such as obesity and blood pressure.

Our study showed that psychosocial factors, including high stress and poor sleep, and a family history of obesity, were strongly associated with diabetes. Similarly, Sendhilkumar et al. reported that 35% of patients with diabetes experienced high to very high stress.[23] Hamayal et al. found that 82% of patients with diabetes had poor sleep quality.[24]

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Ramezankhani et al. found that at age 20, obese men with a family history of diabetes had a 54% higher lifetime risk, and women had a 42% higher lifetime risk.[25] High stress, poor sleep, and a family history of obesity are key factors that increase the risk of diabetes.

In our study, high perceived stress, elevated waist–hip ratio, low vegetable intake, and high diastolic blood pressure were associated with an increased risk of developing T2DM. Fruit intake, BMI, systolic blood pressure, socioeconomic status, education, and age were not significant. Similarly, Novak et al. reported men with permanent stress had HR 1.52 (95% CI: 1.26–1.82).[26] Aghaei et al. found that participants over 50 had higher abnormal WHR ($p < 0.001$).27 Cooper et al. reported that higher fruit and vegetable intake lowered diabetes risk (RR 0.93, 95% CI: 0.87–1.00).[28] Mohan et al. found that hypertension (OR: 2.57, $p < 0.001$) was significantly associated.29 Stress, central obesity, vegetable intake, and blood pressure are strong predictors of diabetes; demographic factors are less influential. In our study, vegetable intake was protective, while fruit intake did not show a significant association, though other studies have reported protective effects. Both high perceived stress and poor sleep quality were strongly associated with diabetes in this population.

Our study highlights that diabetes prevalence increases with age and is influenced by occupation, physical inactivity, dietary habits, psychosocial stress, central obesity, and family history of obesity. Lifestyle modification, dietary improvement, and stress management are key interventions, whereas sociodemographic factors alone are less predictive.

Limitations

Its cross-sectional design prevents causal inference between risk factors and diabetes. Self-reported data on diet, physical activity, and stress may be affected by recall biases. This study focused only on adults from fishing communities in selected villages, limiting generalisability. Biochemical assessments were limited to fasting glucose levels without HbA1c levels. Unmeasured confounders, such as genetic predisposition and detailed socioeconomic factors, may have influenced our results.

CONCLUSION

The study found a high prevalence of prediabetes and T2DM among adults in fishing communities, which increased with age and certain occupations. The key risk factors included central obesity, high perceived stress, poor sleep, low vegetable intake, and elevated diastolic blood pressure. Lifestyle factors such as low physical activity and dietary habits significantly influenced diabetes risk, whereas sociodemographic factors such as education and socioeconomic status were less predictive. A family history of obesity also contributes to a higher susceptibility. These findings highlight the need for targeted interventions focusing on lifestyle modifications, stress management, and early screening to prevent and control diabetes in vulnerable occupational populations. Further longitudinal studies with HbA1c measurement and wider geographical coverage are recommended to validate these findings and inform targeted interventions.

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