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RESEARCH ARTICLE
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ASSOCIATION OF SMOKING HABITS WITH TYPE 2 DIABETES MELLITUS: A CROSS-SECTIONAL PERSPECTIVE

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Abstract

Background: Cigarette smoke contains various toxic substances, including nicotine, which has been shown to impair insulin action in the body. Additionally, smoking-induced inflammation and oxidative stress are thought to play a role in the development of insulin resistance, a hallmark of T2D.

Methodology: Patients more than 40 years of age and had a history of smoking for more than 5 years attending outpatient department of hospital were included. Participants were classified as diabetic according to the American Diabetes Association guidelines. Blood pressure was assessed following the guidelines of the International Society of Hypertension. Predictor variables analyzed for their association with T2DM risk included cigarette smoking, age, gender, body mass index, systolic and diastolic blood pressure and alcohol use.

Results: Increasing age and diastolic blood pressure were significantly associated with higher odds of T2DM in both analyses. Female gender showed no association in the univariate model but became significant after adjustment, indicating potential confounding. Cigarette smoking was a strong independent risk factor, with smokers having over 3 times higher odds of T2DM. BMI and systolic BP were significant in univariate analysis but lost significance after adjustment.

Conclusion: Strengthening public awareness, improving access to cessation support, and integrating smoking control into chronic disease prevention frameworks could potentially curb the twin epidemics of smoking and diabetes.

Keywords: Smoking, Type 2 Diabetes, Cross-Sectional Study

Introduction

Type 2 diabetes is a major global health concern, affecting millions of individuals worldwide. Characterized by insulin resistance and impaired insulin secretion, T2D is linked to various complications, including cardiovascular disease, neuropathy, and kidney failure.[1] The increasing prevalence of T2D, especially in urban populations, has prompted researchers to explore the numerous risk factors that contribute to its development. Among these factors, smoking has emerged as a critical behavioral risk factor that may significantly increase the risk of T2D.[2]

Smoking is a well-documented cause of many diseases, including lung cancer, respiratory conditions, and cardiovascular diseases.[3] However, its role in the development of metabolic disorders, particularly Type 2 diabetes, is less understood. The link between smoking and T2D has been investigated in numerous studies, with many indicating that smokers are at a significantly higher risk of developing the disease compared to non-smokers.[4] Despite this knowledge, the precise mechanisms through which smoking contributes to the development of T2D remain an area of active investigation.

One of the key factors believed to mediate the relationship between smoking and T2D is its effect on insulin sensitivity. Cigarette smoke contains various toxic substances, including nicotine, which has been shown to impair insulin action in the body.[5] Additionally, smoking-induced inflammation and oxidative stress are thought to play a role in the development of insulin resistance, a hallmark of T2D. It is also suggested that smoking may exacerbate other risk factors for T2D, such as obesity, hypertension, and dyslipidemia.[6] These findings have led to increased interest in understanding the extent of smoking's contribution to the pathogenesis of T2D.

Despite the wealth of evidence linking smoking to T2D, the literature remains inconsistent, with some studies showing a stronger association than others. A significant challenge in these studies is the confounding effects of other lifestyle factors, such as diet, physical activity, and alcohol consumption, which may also influence the risk of developing T2D. Furthermore, the dose-response relationship between smoking and T2D risk is still unclear, as some studies have suggested that both the intensity and duration of smoking may influence the degree of risk.[2] These uncertainties highlight the need for further investigation into the specific contribution of smoking to the risk of developing T2D.

This study aims to examine the relationship between smoking and the risk of developing Type 2 diabetes using a cross-sectional analytical approach. By analyzing the smoking habits and diabetes status of individuals from a specific population, we hope to gain a deeper understanding of how smoking contributes to the onset of T2D. Additionally, this study will explore potential confounding factors and attempt to isolate the effect of smoking on the likelihood of developing diabetes. Through this research, we aim to provide evidence that could inform public health interventions aimed at reducing smoking rates as a strategy to combat the growing prevalence of Type 2 diabetes.

Materials and Methods

An observational cross-sectional study was conducted over a period of 3 months from January-March 2025 at a tertiary care hospital in North India. Patients more than 35 years of age and had a history of smoking for more than 5 years attending out patient department of hospital were included in the study. However patients requiring emergency treatment procedures, severely ill and not willing to participate were excluded from the study. Based on findings of study done by Dhrubajyoti J. Debnath et. al [7] in similar settings, a total of 300 study subjects were enrolled for the study.

Diagnostic Criteria:

Participants were classified as diabetic according to the American Diabetes Association (ADA) guidelines.[8] A diagnosis was made if any of the following conditions were met:

- Hemoglobin A1c (HbA1c) level of 6.5% or higher,
- Fasting Plasma Glucose (FPG) of 126 mg/dL (7.0 mmol/L) or greater, where fasting was defined as no caloric intake for at least 8 hours,
- 2-hour Plasma Glucose value of 200 mg/dL (11.1 mmol/L) or above during an Oral Glucose Tolerance Test (OGTT).

Clinical Diagnosis:
Additionally, participants exhibiting classic symptoms of hyperglycemia or experiencing a hyperglycemic crisis were diagnosed as diabetic if their random plasma glucose level was 200 mg/dL (11.1 mmol/L) or more.[8]

Treatment-Based Classification:
Individuals already receiving treatment with oral hypoglycemic agents or insulin therapy were considered diabetic, irrespective of their current blood glucose levels.

Assessment of Smoking Habits
Classification of Smoking Status:
Participants were categorized into two distinct groups based on their smoking history:
- **Smoking Exposure Absent:** Individuals who had smoked fewer than 200 cigarettes prior to the diagnosis of Type 2 Diabetes Mellitus (T2DM) were classified as having no smoking exposure in this study.
- **Smoking Exposure Present:** Individuals who had smoked more than 200 cigarettes before the onset of T2DM were classified as having smoking exposure.[9, 10]

Demographic Information:
Participants' age and gender were recorded based on self-reports provided during the interview.

Anthropometric Measurements:
Body weight and height were measured using standardized procedures for each participant. The Body Mass Index (BMI) was calculated as weight in kilograms divided by height in meters squared (kg/m^2).

Blood Pressure Measurement:
Blood pressure was assessed following the guidelines of the International Society of Hypertension (ISH).[11] A digital sphygmomanometer was used for measurements. Hypertension was defined as any of the following:
- Systolic blood pressure of 140 mmHg or higher,
- Diastolic blood pressure of 90 mmHg or higher,
- Current use of antihypertensive medication.

Alcohol Consumption:
Alcohol use was defined as the intake of any alcoholic beverage within the past one year. [10]
- **Moderate alcohol consumption** was classified as the intake of one to three drinks (30 ml) per day.
- **Heavy alcohol consumption** was categorized as intake of more than three drinks (30 ml) per day.[12]

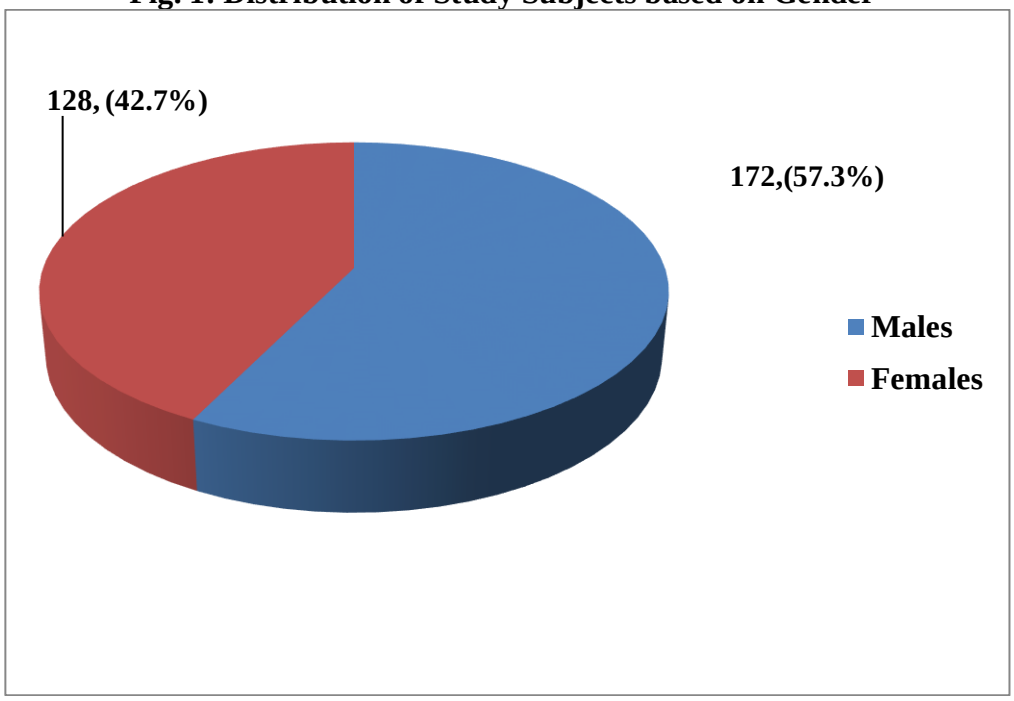
Information from the study participants was gathered using a semi-structured questionnaire. The primary outcome measured was the presence of Type 2 Diabetes Mellitus. Predictor variables analyzed for their association with T2DM risk included cigarette smoking, age, gender, body mass index (BMI), systolic and diastolic blood pressure, and alcohol use.

Statistical Analysis
The collected data was entered after checking and was analyzed using statistical package for social sciences (SPSS Version 22). Descriptive statistics, including frequency distributions and percentages, were generated for categorical variables. To examine associations between categorical variables, the Chi-square test was employed. A p-value of less than 0.05 was considered statistically significant. Simple logistic regression analysis was performed to estimate unadjusted odds ratios

(ORs) along with their 95% confidence intervals (CIs) to identify factors associated with Type 2 Diabetes Mellitus.

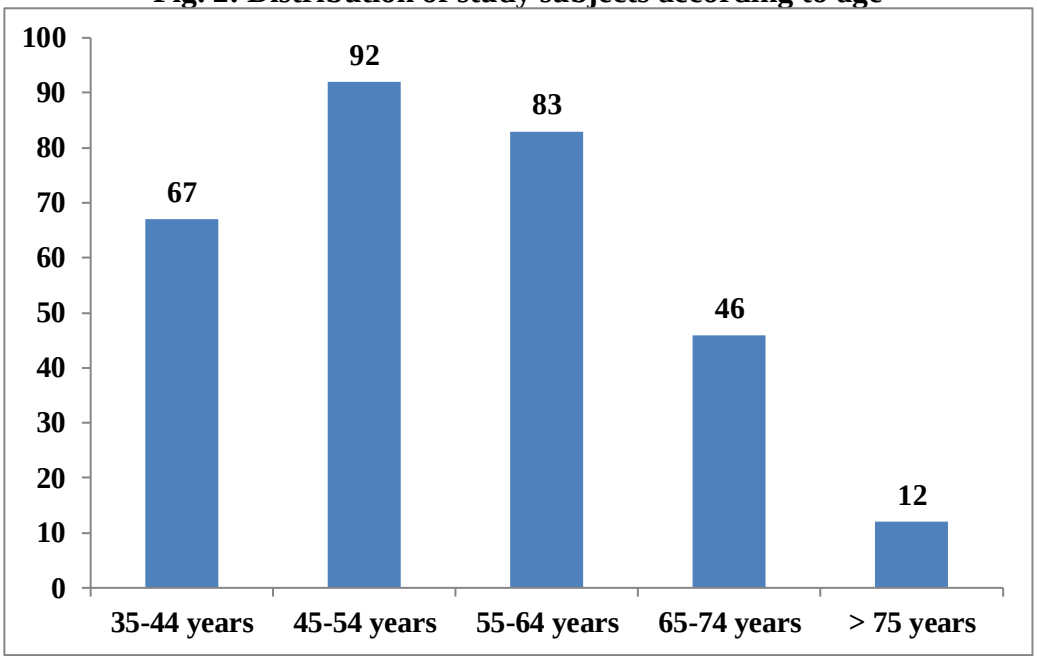
Results

Fig. 1: Distribution of Study Subjects based on Gender



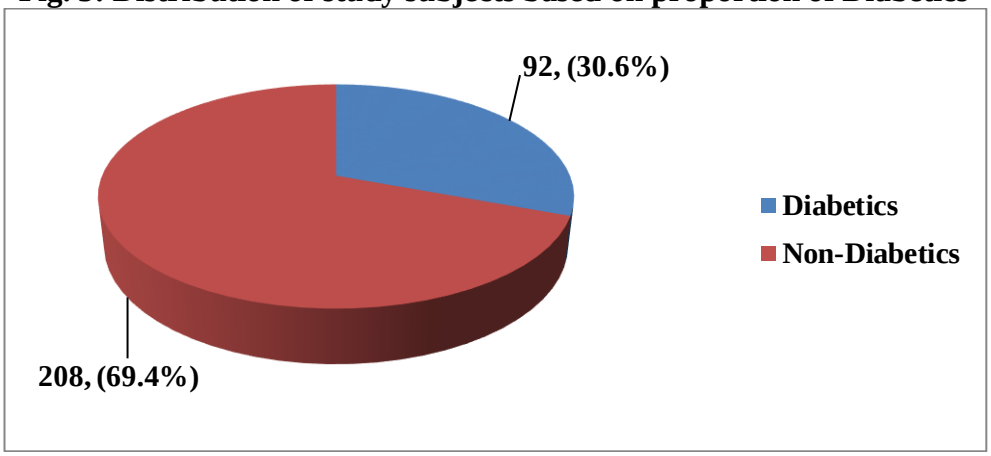
Of the total 300 study subjects, majority of the study subjects were males (57.3%) while rest were females.

Fig. 2: Distribution of study subjects according to age



Majority of the study subjects were in the age group of 45- 54 years (92) followed by 55-64 years age group (83).

Fig. 3: Distribution of study subjects based on proportion of Diabetics



Around 30.6% of study subjects were diagnosed cases of diabetes mellitus while rest were non-diabetics.

Table 1: Distribution of the Study Population by Type 2 Diabetes Mellitus (T2DM) Status

Variable	Characteristic	Diabetics (n=92)	Non- Diabetics (n= 208)
Age (years)	Range	40.5-87.0	31.0-83.5
	Mean age(SD)	56.5(9.1)	47.5(8.9)
BMI	Range	19.0-32.5	16.5-31.5
	Mean BMI(SD)	23.7(2.8)	22.6(2.6)
Systolic BP	Range	96-196	90-188
	Mean SBP(SD)	132.5(14.6)	124.3(16.8)
Diastolic BP	Range	66-106	62-114
	Mean DBP(SD)	87.6(8.1)	82.4(9.6)
Hypertension	Present	45(48.9)	67(32.2)
	Absent	47(51.1)	141(67.8)
Alcohol Intake	Present	24(26.1)	51(24.5)
	Absent	68(73.9)	157(75.5)
Cigarette Smoking	Present	33(35.8)	56(26.9)
	Absent	59(64.2)	152(73.1)

**SD: Standard Deviation*

Table 1 presents a comparison between diabetic (n=92) and non-diabetic (n=208) individuals based on various demographic and clinical parameters. Diabetics were generally older (mean age 56.5 vs. 47.5 years) and had higher BMI, systolic, and diastolic blood pressures. Hypertension was more prevalent among diabetics (48.9%) than non-diabetics (32.2%), suggesting a strong association. Alcohol consumption was similar across both groups. However, cigarette smoking was more common among diabetics (35.8%) compared to non-diabetics (26.9%), indicating a possible risk factor. Overall, age, hypertension, and smoking appear to be more closely linked with the presence of Type 2 Diabetes Mellitus in this population.

Table 2: Assessment of T2DM Risk Factors using Univariate and Multivariate Analysis

Variable	Unadjusted OR	Adjusted OR
Age (Continous)	1.1(1.05, 1.17)	1.06(1.03, 1.12)
Gender		
Male(Reference)		
Female	1.0(0.75, 1.26)	2.03(1.18, 3.78)
BMI(Continous)	1.013(1.01, 1.29)	1.02(0.89, 1.20)

Systolic BP(Continous)	1.06(1.01, 1.08)	1.03(0.97, 1.07)
Diastolic BP (Continous)	1.10(1.04, 1.13)	1.04(1.01,1.08)
Alcohol Intake		
Absent(Reference)		
Present	0.51(0.21,0.66)	0.39(0.21, 0.75)
Cigarette Smoking		
Absent(Reference)		
Present	2.02(1.40, 3.26)	3.30(1.54, 6.46)

**OR: Odds Ratio*

***Unadjusted Odds Ratio and Adjusted Odds Ratio @ 95% Confidence Interval*

Table 2 presents the univariate and multivariate analysis of risk factors associated with Type 2 Diabetes Mellitus (T2DM), using odds ratios (ORs) and 95% confidence intervals (CIs). Increasing age and diastolic blood pressure were significantly associated with higher odds of T2DM in both analyses. Female gender showed no association in the univariate model but became significant after adjustment, indicating potential confounding. Cigarette smoking was a strong independent risk factor, with smokers having over 3 times higher odds of T2DM. Alcohol intake showed a protective association, with significantly lower odds in both models. BMI and systolic BP were significant in univariate analysis but lost significance after adjustment. These findings highlight key modifiable and non-modifiable predictors of T2DM.

Discussion

The findings of this cross-sectional study provide substantial evidence supporting the association between smoking and an increased risk of developing Type 2 Diabetes Mellitus. These results are consistent with a growing body of International and Indian research that highlights smoking as a significant yet modifiable risk factor for T2DM.

Globally, various studies have established the link between smoking and impaired glucose metabolism. Willi et al. [13] performed a meta-analysis in 2007 encompassing over 1.2 million individuals and found that active smokers had a 44% increased risk of developing T2DM compared to non-smokers. Similarly, the U.S. Surgeon General's Report of 2014 [14] categorized smoking as an independent risk factor for diabetes, noting a clear dose-response relationship — the more an individual smokes, the higher their risk of diabetes. Findings from our study closely align with these global observations. In addition to demonstrating higher blood glucose levels among current smokers, we also found that former smokers continued to have an elevated risk, although slightly lower compared to current smokers. This persistence of risk after cessation has also been noted in the study done by Yeh et al in 2010 [15] who reported that former smokers remain at elevated risk for up to 10 years post-cessation, possibly due to sustained metabolic disruptions initiated during active smoking years.

In the Indian context, the burden of smoking-related diabetes is becoming increasingly concerning. India is home to over 77 million diabetics — the second-highest number globally — and smoking remains widespread, particularly among men. A large-scale study done by Gupta et al. in 2015 [16] involving urban Indian populations highlighted that current smokers had a significantly higher prevalence of insulin resistance and glucose intolerance compared to non-smokers. Another Indian study done by Madan et al. in 2011 [17] demonstrated that smoking worsens metabolic syndrome parameters, a key precursor to T2DM, among North Indian adults. These findings reinforce that smoking amplifies diabetes risk not just in Western populations but also among Indians, possibly compounded by genetic susceptibility and lifestyle factors unique to South Asia.

Biologically, smoking contributes to diabetes development through multiple pathways. Nicotine has been shown to induce insulin resistance by impairing insulin signaling pathways as quoted by

Chiolero et al. in their study done in 2008. [18] Additionally, smoking elevates systemic inflammation and oxidative stress, both of which are known to damage pancreatic β-cells and worsen glycemic control.

Furthermore, smoking affects body fat distribution, promoting visceral adiposity even in the absence of significant weight gain. Visceral fat, in turn, is a key driver of insulin resistance. This is particularly relevant in the Indian population, where even individuals with lower body mass indexes are prone to central obesity and higher visceral fat, a phenomenon often referred to as the "thin-fat" Indian phenotype as quoted by Misra & Khurana et. al in 2011. [19] Thus, smoking may have an even more pronounced diabetogenic effect in Indians compared to Western populations.

Importantly, our study underscores the need for integrating smoking cessation into diabetes prevention strategies. While public health policies in India have traditionally focused on smoking cessation to prevent cardiovascular diseases and cancer, our findings suggest that diabetes prevention programs must also prioritize smoking control. Smoking cessation interventions have been shown to improve insulin sensitivity and reduce diabetes risk over time as seen in finding of Pan et al. in 2015. [20] However, cessation often leads to weight gain, which itself is a risk factor for diabetes. Therefore, cessation programs must include strategies for weight management, such as physical activity promotion and dietary counseling.

Recommendations

Future research should employ longitudinal or cohort study designs to establish a clearer causal relationship between smoking and the onset of Type 2 Diabetes Mellitus (T2DM). Public health initiatives should incorporate smoking cessation programs as part of diabetes prevention strategies. Additionally, awareness campaigns should highlight the potential link between tobacco use and increased diabetes risk. More comprehensive studies that adjust for dietary habits, physical activity, and genetic predispositions are also recommended to better understand the interplay of risk factors contributing to T2DM in diverse populations.

Limitations

This cross-sectional study has several limitations. First, its design prevents establishing causal relationships between smoking and the onset of Type 2 Diabetes Mellitus (T2DM), as both exposure and outcome were assessed simultaneously. Second, reliance on self-reported smoking behavior may introduce recall or reporting bias. Third, confounding variables such as diet, physical activity, and genetic predisposition were not comprehensively controlled. Additionally, the study population may not be representative of the general population, limiting external validity. Finally, the possibility of reverse causation cannot be excluded, as individuals diagnosed with T2DM might have altered their smoking behavior post-diagnosis, affecting the observed associations.

Conclusion

In conclusion, this study provides compelling evidence that smoking significantly increases the risk of developing Type 2 Diabetes Mellitus. Given the high and growing burden of both smoking and diabetes in India, targeted public health interventions emphasizing smoking cessation should be a crucial component of diabetes prevention efforts. Strengthening public awareness, improving access to cessation support, and integrating smoking control into chronic disease prevention frameworks could potentially curb the twin epidemics of smoking and diabetes.

Conflict of Interest: None

Source of Funding: None

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