RESEARCH ARTICLE

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Smokeless Tobacco Use and Its Association with Type 2 Diabetes: A Case Control Study

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Abstract

Background: Type 2 diabetes mellitus (T2DM) is a prevalent metabolic disorder characterized by hyperglycemia and insulin resistance. Its incidence is increasing globally, with a significant impact on public health. Smokeless tobacco (SLT) is a form of tobacco consumption that has been associated with various health risks, including potential effects on glucose homeostasis. This case-control study aimed to investigate the association between SLT use and T2DM. Additionally, the study aimed to assess the relationship of age, gender, socioeconomic status (SES), body mass index (BMI), family history of diabetes, physical activity, and periodontal status with T2DM participants. **Methods:** The study was conducted over 24 months and included 82 T2DM cases and 164 non-diabetic controls. Demographic data, tobacco use, medical history, oral hygiene habits, BMI, and periodontal status were collected through a self-administered questionnaire and interviews. Statistical analyses were performed using Statistical Package for Social Sciences (SPSS) for Windows 26.0 (SPSS, Inc. Chicago, Illinois). **Results:** The majority of T2DM cases were in the age group of 31-50 years, and there was a significant association between gender and T2DM, with more males being diabetic. There was no significant association between SES and diabetes. Obesity was found to be a significant risk factor for T2DM. Among SLT users, gutkha was the most commonly used product. SLT use was significantly associated with T2DM. Family history of diabetes and physical inactivity were also significantly associated with diabetes. **Conclusion:** The study suggests that SLT use is a risk factor for T2DM and may be associated with increased diabetes risk. Further research is warranted to understand the underlying mechanisms and potential interventions to reduce the impact of SLT on diabetes risk.

Keywords: Smokeless tobacco-diabetes mellitus- type 2- India- case-control studies

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Introduction

Type 2 diabetes mellitus (T2DM), the most common type of Diabetes, is characterized by hyperglycemia, insulin resistance, and relative insulin insufficiency (World Health Organization, 1999). It is a long term, complex disorder that requires constant medical attention, patient self-management to reduce excessive glucose levels, and multidimensional risk reduction methods to regulate blood pressure, lipid levels, and sugar levels in order to prevent or reduce acute and long-term macrovascular complications as well as microvascular complications like retinopathy, nephropathy, and neuropathy (Garber et al., 2013; Inzucchi et al., 2012; Pozzilli et al., 2010). Patients with T2DM likely to have higher morbidity and mortality rates due to the condition's prevalence, subtle onset, and delayed diagnosis, particularly in developing nations like India (Walley et al., 2006). T2DM should be treated as a diversified pathophysiological anomalies with varying susceptibility to complications, and varied clinical responses to treatment intervention (Garber et al., 2013; Inzucchi et al., 2012; Pozzilli et al., 2010).

T2DM has grown to be a significant global public health issue. In 2019, 425 million persons aged 20–79 were diagnosed with diabetes globally, according to the 9th edition of the International Diabetes Federation. If this does not decrease, this amount is anticipated to climb to 700 million by 2045, and over 49.7% were undiagnosed (Cho et al., 2018). The prevalence of type 2 diabetes is rising in every country, with 80 percent of diabetics residing in low- and middle-income nations. China and India are particularly afflicted by this disease, as the prevalence of T2DM has increased substantially considering the low obesity (Hu, 2011). Asians often have more abdominal obesity, a higher body fat mass percentage, and less muscular mass, provided similar body mass index (Chan et al., 2009). This could explain their increased risk of T2DM. In addition, poor nutrition during

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pregnancy and infancy period, mixed with overnutrition in later adult life, can help to development of the T2DM epidemic, particularly in societies experiencing significant nutrition shifts marked by changing food patterns and reduced physical activity. Men have a marginally higher prevalence of T2DM than women (Cho et al., 2018b).

The incidence of type 2 diabetes varies considerably across geographic regions due to environmental and behavioral risk factors (Zimmet et al., 2001). Smokeless tobacco (SLT) is tobacco that is consumed orally rather than through smoking. It has existed for as long as other tobacco products, and its popularity has grown over time (Rogozinski, 1990). Orally or nasally, SLT can be ingested without burning. Oral SLT products are administered by placing them in the mouth, cheek, or lip and sucking (dipping) or chewing them. Chewing tobacco is produced from leaf tobacco that was cured with air, adding sweetening agents, and packed loosely. Plug chewing tobacco is produced from higher grade tobacco leaves that are harvested from the top of the plant and pressed into a plug (Djordjevic MV et al.,1995).

Numerous commercial and homemade smokeless tobacco products are available in India. The use of chewing tobacco is more prevalent than the use of snuff, as is the use of SLT products as a dentifrice. According to a 2015-2016 survey, 5.6 % of women and 29% men both use chewing tobacco. The most common form of tobacco consumption among men is chewing paan masala or gutkha among men. Chewing tobacco was more common in rural, impoverished, and less educated individuals and varied widely by state (<15% to >45% in men and <5% to >30% in women) (Pradhan et al., 2019).

SLT use may increase the risk of fetal morbidity and death, hypertension, peptic ulcers, cardiovascular disease, and peripheral vascular disease (Cullen et al., 1986). Many research, both experimental and clinical, indicate that smoking reduces insulin sensitivity, which therefore causes problems with glucose and lipid metabolism such hyperglycemia and dyslipidemia, including low High Density Lipoprotein (HDL) cholesterol and postprandial lipid intolerance (Borggreve et al., 2003; Després and Lemieux, 2006; Heine and Dekker, 2002; Smith et al., 1999). Especially in diabetic individuals, it is evident that this impairs metabolic regulation. Such patients require a greater insulin dose to achieve equal metabolic control (Madsbad et al., 1980). Yoshikawa et al. demonstrated that Acute nicotine administration at levels more than 1 mol/L inhibited high-glucose-induced insulin release in isolated human islets but not on isolated rat islets. On the other hand, nicotine administration for 48 hours decreased insulin secretion in both rat and human islets, even at basal glucose levels. These findings show that pancreatic islets and beta cells have functioning nicotinic receptors, suggesting that nicotine may negatively affect beta cells of pancreas. Thus, Tobacco toxicity may be influenced by the existence of nicotine-sensitive neuronal nicotinic receptors in pancreatic cells, which may operate as a switch to change the physiological activity of pancreatic cells via acetylcholine (Yoshikawa et al., 2005).

Despite emerging evidence of a correlation between SLT chewing and glycemic management in diabetic patients, the role of SLT in DM is not entirely acknowledged. Very few published articles have sought to make conclusions on SLT and its influence on DM and glycemic control. Therefore, the aim of this study was to conduct a case control study to establish an association between type 2 diabetes and SLT use.

Objectives

1. To find SLT use is a risk factor for type 2 diabetes.
2. To find demographic details of study participants.

Materials and Methods

Study Design

A case control study was conducted during period of 24 months (Dec 2020- Dec 2022) amongst subjects diagnosed with type-2 diabetes and subjects free of type-2 diabetes in medical hospital setting.

Study Setting

The study was done in a University-based hospital setting in Dr. D.Y.Patil Dental College and Hospital, Pimpri, Pune. Ethical approval was obtained from the Institutional Ethical and Scientific Committee. This clinical trial registration was done under Clinical Trials Registry-India (ICMR-NIMS) with CTRI Reg. No. CTRI/2021/10/037051 before commencing the trial.

Study Participants

Type 2 Diabetes patients, aged 18 and above, with or without use of SLT were included in the study. Patients in acute pain, patient with other comorbidity other than Type 2 Diabetes Mellitus, patients who are Smokers and or dual users and patients who refuse to take part in the study were excluded from the study. A written informed consent was obtained from the study participants who met the eligibility criteria before participation in the study. Matching was done by pairs for both cases and controls for age, sex was done.

A case in this study was defined as Type 2 diabetes patients diagnosed in the last one month onwards. While, the controls who were similar to cases and free from type 2 diabetes (as seen in investigation) was selected. Exposure to SLT use based on duration(years/months/days) and frequency of use (no of packets used per day) by questionnaire/interviews which was of similar duration for both cases and controls.

Study Sample Size and Sampling

Sample size was calculated using win- pepi software considering 95% Confidence Interval (CI), 80% power and 5% significance and 1:2 case to controls ratio and arrived at was cases 82 and controls 164. A simple random sampling technique using lottery technique was applied to recruit the required sample sizes of both groups (cases or controls).

An armamentarium of Mouth mirror, probe, CPI probe, kidney tray, gloves, measuring tape, weighing machine, case history form was used. Sterilization followed by autoclaving and chemically disinfecting the instruments used for oral examination.

Statistical analysis

Collected data was maintained in the data extraction sheet using MS Excel 2019.

The data was entered and analyzed using Statistical Package for Social Sciences (SPSS) for Windows 26.0 (SPSS, Inc. Chicago, Illinois). Confidence intervals were set at 95%, and a p-value ≤ 0.05 was considered as statistically significant. Descriptive statistics were used for demographic details. Number and percentage were calculated. In order to determine the association of age, gender, SES, SLT use, CPI, LOA, BMI, physical activity, family history of diabetes mellitus chi square test was applied.

Data Collection

A self-administered, interviewer-reviewed questionnaire was created to collect data on demographics, medical history, SES using modified kuppuswamy scale 2021 (Anjali M, 2021), blood investigation details for T2DM, oral hygiene habits, Family history of diabetes(Family Health History and Diabetes | CDC, 2022), history of alcohol use(Grover et al., 2020), history of smokeless tobacco use, body mass index (BMI)(Behl & Misra, 2017), and periodontal status using the Community Periodontal Index (CPI) and Loss of attachment(LOA) (World Health Organization, 1997). An interviewer gathered information using the questionnaire during the initial hospital visit from both cases and controls.

Participants were asked if they had ever used smokeless tobacco to specify, whether they were current users, former user, their ages at starting and stopping using smokeless tobacco, and average number of times per day they used smokeless tobacco. BMI(Behl & Misra, 2017) was calculated as the weight divided by height squared (kg/m2). Height was measured to the nearest centimeter with respondents standing on a hard surface against a wall, using a square and tape measure to the wall. All measurements were recorded to the nearest centimeter. Weight was measured to the nearest 100 g using an available weighing machine in the department.

A full periodontal examination was performed using a standard manual periodontal probe. The gingival sulci of teeth were examined for periodontitis and loss of attachment. Coding used for periodontitis was according to the WHO criteria 1997 for Community Periodontal Index (CPI) and loss of attachment (World Health Organization, 1997). All these criteria for examination were applied for both cases and controls. The index teeth were examined and registered on a chart.

Results

Participants

The study consists of 82 cases with diabetes and 164 controls without diabetes. Table 1 shows the demographic details of the participants. Majority of the participants 132 (53.7%) were from age group 31-50 years, among them cases were 44(33.3%) and controls were 88(66.7%). Participants were almost equally participated with Male 122 (49.6%) and Female 124 (50.4%). 151(61.4%) participants were from Lower Socioeconomic Status. Oral Hygiene practice amongst the participants showed that 229 (83.1%) participants brush once a day, 156 (63.4%) brush for more 2 mins and 230 (93.5%) use fluoridated tooth paste. Overall smokeless tobacco users (current and former) were 116 (47.2%) and 130 (52.8%) were non user of smokeless tobacco. Duration was less than 4 years among 104 (42.4%) participants and 84 (34.1%), 29 (11.8%) & 3(1.2%) participants use SLT for less than 3 times/day, 3-5 times/day and more than 5 times a day respectively.

Descriptive and Outcome Data

The Table 2 provides information about the distribution of SLT Products, Age, Gender, SES, CPI, LOA, BMI, alcohol use, physical activity, and family history of diabetes among participants, along with the association of these factors with diabetes.

The study investigated several factors and their association with diabetes among the participants. Table 2 revealed that there was a significant difference in the prevalence of Smokeless Tobacco (SLT) product use between diabetic and non-diabetic participants, with 19.1% of diabetics being SLT users compared to 14.2% non-diabetics. The association between age groups and diabetes approached significance (p=0.059). The study showed a significant gender difference in diabetes, with 21.1% of male participants being diabetic, compared to 12.2% of females. Moreover, 28.5% of male participants were non-diabetic, while 38.2% of females were non-diabetic. There was a no significant association between socioeconomic class and diabetes. However, there was a strong association between BMI and diabetes (p=0.000), with a higher percentage of diabetics being overweight or obese compared to non-diabetics. These findings underscore the importance of considering various factors such as SLT use, age, gender, BMI, alcohol consumption, physical activity, and family history in understanding and managing diabetes among individuals.

Table 3 shows a multiple regression was run to predict Diabetes from age, gender, SES, SLT use, CPI, LOA, BMI, Physical Activity, Family History Diabetes. There was a significant association between SLT use, Physical activity, Age, and family history of diabetes with diabetes ($p < 0.05$) , $R^2 = .606$.

Discussion

Type 2 Diabetes Mellitus is a prolonged metabolic disease. T2DM prevalence has been steadily rising, especially in emerging nations, which has resulted in an epidemic in several of these nations. T2DM is the multifactorial disorder which can be caused by various factors like age, diabetic history, obesity, physical activity (Okur et al., 2017). In addition to these factors, the tobacco use showed to be associated with development of T2DM, especially smoking.

Effect of nicotine or any other tobacco related substance affects the mechanism of glucose homeostasis. Pancreatic beta cells have been shown to have functioning nicotinic receptors (Yoshikawa et al., 2005). It is impossible to speculate about nicotine's direct and indirect

Table 1. Demographic Details of Study Participants

		Cases n (%)	Controls n (%)	Total (n)
Age	<18	0 (0)	0 (0)	0
	18-30	1 (5.6)	17 (9.4)	18
	31-50	44 (33.3)	88 (66.7)	132
	51-70	31 (38.3)	50 (61.7)	81
	>71	6 (40)	9 (60)	15
Gender	M	52 (42.6)	70 (57.4)	122
	F	30 (24.2)	94 (75.8)	124
Socio-economic Status	Lower	48 (31.8)	103 (68.2)	151
	Lower Middle	23 (35.4)	42 (64.6)	65
	Upper Middle	11 (36.7)	19 (63.3)	30
Family History of DM	Present	70 (28.5%)	108 (43.9%)	178
	Absent	12 (4.9%)	56 (22.8%)	68
Physical activity (MET/wk)	<600	72 (29.3%)	49 (19.9%)	121
	>600	10 (4.1%)	115 (46.7%)	125
BMI	<23 kg/m^2	44 (17.9%)	46 (18.7%)	90
	≥23.0kg/m^2	16 (6.5%)	76 (30.9%)	92
	≥25.0kg/m^2	22 (8.9%)	42 (17.1%)	64
Oral Hygiene				
Tooth Brushing				
Frequency	Once a day	77 (33.6)	152 (66.4)	229
	Two times a day	5 (29.4)	12 (70.6)	17
Duration	<1	9 (45)	11 (55)	20
	1-2	26 (37.1)	44 (62.9)	70
	>2	47 (30.1)	109 (69.9)	156
Tooth paste	Fluoridated	79 (34.3)	151 (65.7)	230
	Non-Fluoridated	3 (18.8)	13 (81.2)	16
	Colgate	70 (36.8)	120 (63.2)	190
	Pepsodent	4 (25)	12 (75)	16
	Closeup	5 (20.8)	19 (79.2)	24
	Vicco/Mishwak	3 (18.8)	6.5 (81.2)	16
Dental Visits	0-2	45 (33.1)	91 (66.9)	136
	3-5	24 (32.4)	50 (67.6)	75
	>5	13 (37.1)	22 (62.9)	35
Sweet Score	5	21 (33.3)	42 (66.7)	13
	10	51 (33.6)	101 (66.4)	152
	≥15	10 (40)	15 (60)	25
Smokeless Tobacco	User	47 (40.5)	69 (59.5)	116
	Non user	35 (26.9)	95 (73.1)	130
Products	Gutakha	22 (56.4)	17 (39)	39
	Gaychap	6 (31.6)	13 (68.4)	19
	Khaini	6 (66.7)	3 (33.7)	9
	Mishri	11 (28.9)	27 (71.1)	38
	Vimal	3 (100)	0 (0)	3
	Zarda	2 (25)	6 (75)	8
Swallowing Status	Swallowing	41 (41.4)	58 (58.6)	99
	Non-Swallowing	6 (35.3)	11 (64.7)	17
Duration	<4	42 (40.4)	62 (59.6)	104
	4-12	2 (28.6)	5 (71.6)	7
	>12	3 (60)	2 (40)	5

Table 1. Continued

		Cases n (%)	Controls n (%)	Total (n)
Frequency	<3 times/day	35 (41.7)	49 (58.3)	84
	3-5 times /day	11 (37.9)	18 (62.1)	29
	>5 times/ day	1 (33.3)	2 (66.7)	3
Diabetes Mellites				
Status	DM Present			82
	DM Absent			164
Duration	<5			20
	5-10			44
	>10			18

effects. Yet, it is possible to imagine a secondary impact of catecholamines. Catecholamine release is seen in tobacco use (Eliasson et al., 2004) which can hamper insulin sensitivity or insulin secretion. However, the effect of chewing tobacco is not clear. Thus, the goal of the current study was to determine whether using SLTs was associated with type 2 diabetes.

The present case control study reported 246 study participants with 82 cases and 164 controls were present. Majority of the diabetic users belonged to 31-50 years of age. The similar results were reported in many articles where the fact of T2DM occurs in the middle age group. (Afroz et al., 2019; Corbin et al., 2016; Deepthi et al., n.d.; Eliasson et al., 2004; Ghorpade et al., 2013; González-Rivas et al., 2017; Gyawali et al., 2015; Htet et al., 2016; Jahan et al., 2020; Latifi et al., 2016; Östenson et al., 2012; Pinto & Beltrán-Sánchez, 2015; Ramachandran et al., 2008; Rasouli et al., 2017; Saquib et al., 2013; Satman et al., 2013; Shrivastava & Ghorpade, 2014; Zou et al., 2017; Zuhara et al., 2019)

The 124 males and 122 females were present in the study. There was statistically significant difference seen

Table 2. Distribution of Participants in Relation with Various Factors and Diabetes

		Cases N (%)	Control N (%)	$\chi 2$	P-value
SLT	User	47 (19.1%)	69 (28.0%)	5.098	0.02*
	Non- User	35 (14.2%)	95 (38.6%)		
Age	18-30	1 (0.4%)	17 (6.9%)	7.439	0.05*
	31-50	44 (17.9%)	88 (35.8%)		
	51-70	31 (12.6%)	50 (20.3%)		
	>71	6 (2.4%)	9 (3.7%)		
Gender	Male	52 (21.1%)	70 (28.5%)	9.39	0.002*
	Female	30 (12.2%)	94 (38.2%)		
SES	Lower	48 (19.5%)	103 (41.9%)	0.435	0.8
	Lower Middle	23 (9.3%)	42 (17.1%)		
	Upper Middle	11 (4.5%)	19 (7.7%)		
CPI	0-4	32 (13.0%)	68 (27.6%)	0.135	0.71
	5-9	50 (20.3%)	96 (39.0%)		
LOA	0-2	71 (29.1%)	145 (59.4%)	0.09	0.76
	3-5	10 (4.1%)	18 (7.4%)		
BMI	<23	44 (17.9%)	46 (18.7%)	20.35	0.00*
	≥23.0kg/m^2	16 (6.5%)	76 (30.9%)		
	≥25.0kg/m^2	22 (8.9%)	42 (17.1%)		
Alcohol Use	Current	15 (6.1%)	13 (5.3%)	7.664	0.02*
	Former	7 (2.8%)	8 (3.3%)		
	Never	60 (24.4%)	143 (58.1%)		
Physical activity (MET/wk.)	<600	72 (29.3%)	49 (19.9%)	73.393	0.00*
	>600	10 (4.1%)	115 (46.7%)		
Family History of diabetes	Present	70 (28.5%)	108 (43.9%)	10.406	0.001*
	Absent	12 (4.9%)	56 (22.8%)		

Table 3. Multiple Logistic Regression Analysis

Sr.No	Diabetic/Non- Diabetic	Adjusted Odds ratio	Sig.	CI	
				Lower Bound	Upper Bound
1	Age	1.942	0.01*	1.131	3.337
2	Gender	0.844	0.68	0.375	1.896
3	SES	1.129	0.67	0.645	1.978
4	SLT use	0.3	0.01*	0.128	0.701
5	CPI	1.375	0.46	0.59	3.202
6	LOA	0.577	0.43	0.147	2.268
7	BMINEW	5.923	0.00*	3.094	11.34
8	Physical Activity	0.126	0.00*	0.05	0.316
9	Family History DM	0.614	0.27	0.257	1.464

* $p<0.05$

($p<0.05$) amongst diabetic and non-diabetic participants when associated with gender. This might be due to peer pressure which has led to deleterious habit of SLT use. Male diabetic patients were found to be more than females which is in contrast to the study results of Selim et al (Selim et al., 2016)which showed that uncontrolled diabetes was seen in 43.75% of the females and there was no statistically significant difference seen between males and females.

We used Modified Kuppuswamy socioeconomic scale 2021 (Anjali, 2021) for the assessment of socioeconomic status of the participants which provided information about the education, income, profession of the participants. This study reported majority (61.4%) of the participants from the lower socioeconomic status (SES). Among them (31.8%) were diabetics while (68.2%) reported to non- diabetics, but SES is not significantly associated with diabetes. Similar results was reported by Vibha et al., (2018) where they reported diabetes was present in 32.7%) and absent in 23.1% population. SES was not significantly associated with diabetes. The Low SESs suggests that un-awareness about the implications of use of smokeless tobacco as well as complications arise due the diabetes on overall health.

Body Mass Index (BMI) was calculated by using formula, the weight divided by height squared (kg/m^2). Study reported 18.7% diabetic and 12.2% non-diabetic participants reported as overweight while 10.6% diabetic and 3.3% non-diabetic participants reported as obese. In the study population, obesity was found to be a substantial risk factor for diabetes due to the considerable connection between high BMI and diabetes. These reports were consistent with the study done by Zuhara et al., (2019) where they reported that 26.6% diabetic participants were obese. The similar results were reported in the various previous studies (Afroz et al., 2019; Corbin et al., 2016; Deepthi et al., n.d.; Eliasson et al., 2004; Ghorpade et al., 2013; González-Rivas et al., 2017; Gyawali et al., 2015; Htet et al., 2016; Jahan et al., 2020; Latifi et al., 2016; Östenson et al., 2012; Pinto and Beltrán-Sánchez, 2015; Ramachandran et al., 2008; Rasouli et al., 2017; Saquib et al., 2013; Satman et al., 2013; Shrivastava and Ghorpade, 2014; Zou et al., 2017; Zuhara et al., 2019).

In the present study, SLT user were 40.5% in cases and 59.5% in control group, while there were 26.9% SLT non user in cases and 73.1% in control group. Similar results were reported by Zuhara et al., (2019) where they reported SLT users were 33.3 in cases and 66.7% in control group, while 20% non-SLT user in cases and 73.4% non-SLT users in control group. Also, Depthi et al., n.d.) reported and similar results where 48.4% participants were regular SLT users among Type 2DM and study done by Selim et al., (2016) where they reported 20.01% participants were user of SLT.

The current study reported the frequency (<3 times/ day) of SLT use was 41.7% in cases and 58.3% in control group. The duration (<4 years) of SLT use was 40.4% in cases and 59.6 in control group in the present study.

Carlsson et al., (2019) observed that elevated risks of T2DM at consumption levels above seven boxes of snus per week. The similar results were reported in the study conducted by Östenson et al., (2012) where the risk of diabetes increased with increasing weekly snus consumption. The present study reported various type of SLT products among the SLT users. Gutka was used among 15.9% SLT users, Gaychap was in 7.7% and 23% use other types of SLT products. Mishri use was frequent particularly in women participant. The similar results were reported in the study done by the Rooban et al., (2010) where there were a total of 1161 Smokeless Tobacco users were diagnosed with Type 2 Diabetes Mellitus out of which 102 (8.8%) were pan masala users, 81 (7%) were Gutka users and 187 (16.1%) were using other type of Smokeless Tobacco.

The study done by Zuhara et al., (2019) reported that diabetes family history was associated with diabetes among participants. 28.9% diabetic patients and 65.5% non-diabetic patients had family history of diabetes. Similar findings were reported in earlier research conducted in Kerala, which showed a substantial correlation between the frequency of diabetes in the population and family history of the disease (Ameesh and Murugan, 2017; Vijayakumar et al., 2009, Vijayakumar et al., 2019). This study had consistent results with the previous studies where 28.5% diabetic and 43.9% non-diabetic participants reported family history of diabetes.

The present study reported 29.3% diabetic participants had physical inactivity, while 19.9% non-diabetic

participants had physical inactivity which was significantly associated with T2DM. Similarly, study done by Deepthi et al., (2013) showed physical inactivity in 25.8% diabetic participants. These results were also consistent with other previous studies (Afroz et al., 2019; Carlsson et al., 2019; Htet et al., 2016; Östenson et al., 2012; Shrivastava and Ghorpade, 2014).

The present study reported that in diabetic patients (34.2%) showed CPI score 5-9 and 35.7% showed LOA score 3-5. The study conducted by Anand et al., (2013) concluded that When compared to never users, SLT users typically have more severe gingival recession, attachment loss, and a higher number of locations with higher values. Similar results were reported by Mahmud and Amin, (2016), where they conducted a study in the 120 T2DM participants and reported that The association between chewing betel leaf and periodontal illnesses offer compelling proof that tobacco products may be directly linked to the development of periodontal diseases. The present study shows that the SLT use is a risk factor for T2DM is 1.77 times more with C.I. 1.034- 3.033 compared to non-SLT use. Our results are in consistent with previous studies (Carlsson et al., 2017; Östenson et al., 2012; Persson et al., 2000; Saquib et al., 2013; Shrivastava and Ghorpade, 2014; Vibha et al., 2018). In the present we observed that use of SLT predicts increased risk of T2D. It is similar to another Swedish study that discovered excessive snus intake was independently associated with metabolic syndrome even after adjusting for smoking (Norberg et al., 2006). However, the contrary findings were found in the study conducted by Lee and Thornton (2017); Eliasson et al., (2004); Rasouli et al., (2017) and Rooban et al., (2010) where they reported that use of smokeless tobacco does not increase risk of T2DM.

Self-reported tobacco could be one of the limitation of the study, if assuming that users underestimate or deny consumption of tobacco. Nonetheless, a recent investigation on the intake of several nicotine-containing products revealed that the accuracy of self-reported SLT in comparison to biochemical measures appeared to be high (Rasouli et al., 2017). Different combination of tobacco product were used can also be limitation as it does not justify SLT use only as a risk factor. Public health initiatives should warrant attention considering diabetes epidemic and SLT use.

Tobacco cessation and diabetes control programs should be encouraged. According to our research, type 2 diabetes risk is increased by high SLT consumption. T2D risk is correlated with SLT use. Nicotine is therefore likely to act as a mediator in SLT's diabetes-promoting action. These findings imply that the risk of developing diabetes is not reduced as a result of switching from the use of SLT. Also, in view of the diabetes epidemic and the rising popularity of SLT, public health authorities should pay attention to these novel findings

Author Contribution Statement

All authors contributed equally in this study.

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