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RESEARCH ARTICLE

Gender differences in risk factors for smokeless tobacco use: Insights from the latest nationally representative cross-sectional demographic and health survey (2019–2021) and their potential implications for smokeless tobacco control in the WHO South-East Asia region

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ABSTRACT

Introduction: The global prevalence of Smokeless Tobacco (SLT) use is estimated to be 4.72%, concentrated in South East Asia. Despite declining smoking rates, SLT usage remains high, resulting in 2.5 million DALYs and 90,791 deaths in 2017 due to cancers and heart diseases, with India contributing 70% of DALYs. This study examines risk factors for SLT use in Indian males and females aged 15–49 using 2019–2021 demographic and health survey data, also exploring gender differences. **Methods:** The study analyzed a substantial sample of 724,115 females and 93,267 males utilizing data from a nationally representative cross-sectional demographic and health survey conducted between 2019 and 2021. Gender-specific multivariable logistic regression analyses were performed to identify risk factors influencing SLT use. **Results:** The findings reveal gender-specific variations in SLT use risk factors. Among males, older age groups (35–49) were less likely to use SLT compared to those aged 30–34. In contrast, among females, SLT use increased with age, with the highest rates in the 40–44 and 45–49 age groups. Marital status played a significant role, with widowed, divorced, and separated females having higher odds of SLT use compared to currently married females. Tribe ethnicity was associated with increased odds of SLT use in females but not in males. Christian females had higher odds of SLT use than Hindu females, while Christian males had lower odds compared to Hindu males. **Conclusion:** These findings provide valuable insights for policymakers, healthcare professionals, and public health advocates in developing targeted interventions to combat SLT use in South-East Asia. By addressing gender-specific risk factors and tailoring strategies to different populations, progress can be made in reducing the burden of SLT use and improving public health outcomes in the region.

Keywords: health survey; smokeless tobacco; risk factors; public health; awareness; brief intervention

1. Introduction

The use of smokeless tobacco (SLT) is estimated to be prevalent among 274 million individuals aged 15 years and older globally, with the majority (83.29%) of users residing in the South Asian region. The global prevalence of SLT use is estimated to be 4.72%[1]. Despite a significant reduction in smoking tobacco use globally, the prevalence of SLT use has not decreased at the same rate[1,2]. In 2017, the use of SLT caused the

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loss of 2.5 million disability-adjusted life years (DALYs) and 90,791 human lives worldwide due to oral, pharyngeal, and esophageal cancers. Additionally, over 6 million DALYs and 258,006 lives were lost from ischemic heart disease attributed to SLT use. India was responsible for 70% of the total DALYs lost due to SLT[3].

The prevalence of smokeless tobacco use among Indians aged 15 and above is estimated to be 21.4%[4]. Among men, the prevalence was reported to be 29.6%, and among females, it was 12.8%. Among females, the three most commonly used smokeless tobacco products are betel quid with tobacco (4.5%), khaini (4.2%), and oral application products (4.3%), such as mishri, gul, and gudakhu, with each product being used almost equally[4].

Several studies have identified various factors that significantly influence the use of smokeless tobacco (SLT) among both females and males. These factors include lower education level, the lowest level of wealth index, and increasing age[5–7]. Additionally, SLT use is more prevalent among Indian males and females who are separated, divorced, or widowed, individuals who consume alcohol, and those residing in rural areas[8–10]. Furthermore, women from the north-eastern states of India who belong to tribe ethnicity and Christian religion have a higher likelihood of using smokeless tobacco[9–11]. In contrast to the aforementioned findings, certain studies have failed to identify the area of residence as a significant determinant of SLT use in females[6]. Similarly, another study found no significant association between the area of residence, tribe ethnicity, and the use of SLT in males[12].

Although smokeless tobacco use has predominantly been present in males in India, recent studies indicate that its use is becoming increasingly prevalent among females as well. The reasons for smokeless tobacco use among males and females may differ, owing to variations in social, cultural, and economic factors. Therefore, it is important to adopt a gender-specific approach to tobacco control efforts in South-East Asia Region. This study aimed to evaluate the risk factors for SLT use among females and males aged 15–49 years in India utilizing data from a nationally representative demographic and health survey conducted between 2019 and 2021. Additionally, it sought to investigate the gender differences in the risk factors for SLT use.

2. Methods

2.1. Study design and population

We analyzed data originating from the fifth round of the National Family Health Survey (NFHS-5), a large-scale cross-sectional survey that provides information for 707 districts, 28 states, and 8 union territories in India[13,14]. Data were collected in two phases—Phase I from 17 June 2019 to 30 January 2020 and Phase II from 2 January 2020 to 30 April 2021—and information was gathered from 636,699 households, 724,115 females aged 15–49 and 101,839 males aged 15–54. The NFHS-5 sample was a stratified two-stage sample. Each district was stratified into urban and rural areas. Primary sampling units (PSUs) were villages in rural areas and census enumeration blocks (CEBs) in urban areas. PSUs were selected from the 2011 census sampling frame with probability proportional to size (PPS). In the first stage, a total of 30,456 primary sampling units were identified. After conducting mapping and household listing operations in the selected first-stage PSUs, a fixed number of 22 households were selected in each primary sampling unit using systematic random sampling in the second stage. The response rate among women was 97%, whereas among males, it was 92%. The details of the selection process are provided in the final report of NFHS-5[13,14]. The analysis was restricted to individuals aged 15–49 years who reported using SLT, resulting in a sample size of 724,115 females and 93,267 males.

2.2. Data collection and measurement

The smokeless tobacco use status of participants was measured by asking the following two questions: (i) Do you currently smoke or use tobacco in any other form? (ii) In what other form do you currently smoke or use tobacco[13]? Additionally, the frequency of smokeless tobacco use was determined by asking participants one question: (i) How often do you use smokeless tobacco, with the responses being almost every day, approximately once a week or less than once a week[13]?

2.3. Outcome variable

The primary outcome of this study was smokeless tobacco use. Participants who reported using gutkha/paan masala with tobacco or paan with tobacco, khaini or snuff, or other chewing tobacco were classified as part of the "smokeless tobacco" group. The outcome variable was defined as the current use of at least one form of smokeless tobacco (SLT), such as gutkha/paan masala with tobacco or paan masala with tobacco or khaini or snuff, or other chewing tobacco, and was coded as '1' for current users of smokeless tobacco and '0' for nonusers.

2.4. Explanatory variables

To fulfil the aim of our study, we identified a set of useful independent variables related to females and males from the NFHS-5 survey. These variables were categorized into three levels, namely, demographic, socioeconomic, and spatial, and were chosen based on prior research and similar studies. Demographic factors such as age groups (15–19, 20–24, 25–29, 30–34, 35–39, 40–44, and 45–49 years) and marital status (never union, married, and separated/divorced/widow) were identified. Socioeconomic factors included education level (no education, primary, secondary, higher), household wealth index combined (poorest, poorer, middle, richer, and richest), alcohol consumption (yes or no), and ethnicity (caste, tribe, and no caste/tribe). Spatial factors included place of residence (urban and rural).

2.5. Statistical analysis

The study conducted separate analyses for both men and women. Descriptive statistics were used to provide an overview of the study sample's characteristics, while the chi-square test was utilized to determine the relationship between smokeless tobacco use and sociodemographic variables. The unadjusted and adjusted odds ratios (ORs) were computed using univariable logistic regression. Independent variables with p-values < 0.05 were considered for the multivariable logistic regression model to identify the factors that determine smokeless tobacco use for females and males individually. The findings were reported as ORs and 95% confidence intervals (CI). The statistical software package used for all analyses was SPSS version 25.0.

2.6. Ethical considerations

The study protocol of NFHS-5 was approved by the institutional review board of the International Institute for Population Sciences (IIPS) and ICF[13]. The U.S. Centers for Disease Control and Prevention (CDC) also reviewed the protocol. Prior to data collection, informed consent was taken from the study participants. We received approval from the Demographic and Health Surveys DHS program for using the NFHS-5 data for this study.

3. Results

3.1. Demographic and socioeconomic characteristics of female respondents

Tables 1 and **2** present the demographic and socioeconomic characteristics of female respondents. The study analyzed 724,115 females aged 15–49 years in India.

Table 1. Pattern and types of smokeless tobacco use among females and males of the 15–49 age group.

Type of smokeless tobacco	Females (*n* = 724,115)		Males (*n* = 93,267)		
	Smokeless tobacco use *n* (%)	Total N% (95% CI)	Smokeless tobacco use *n* (%)	Total N% (95% CI)	Z Test
Overall	41,129 (100)	5.7 (5.6–5.7)	27,346 (100)	29.3 (29.0–29.6)	-
Paan with tobacco use	16,512 (40.1)	2.3 (2.2–2.3)	5658 (20.7)	6.1 (5.9–6.2)	53.29*
Paan masala with tobacco or Gutkha	13,382 (32.5)	1.8 (1.8–1.9)	15,901 (58.1)	17.0 (16.8–17.3)	66.34*
Khaini	10,197 (24.8)	1.4 (1.4–1.4)	11,261 (41.1)	12.1 (11.9–12.3)	45.27*
Other chewing tobacco	5153 (12.5)	0.7 (0.7–0.7)	1997 (8.1)	2.1 (2.0–2.2)	21.90*
Snuff	572 (1.4)	0.1 (0.1–0.1)	74 (0.27)	0.1 (0.1–0.1)	14.85*
The pattern of smokeless tobacco use					
Almost every day	32,576 (79.2)	4.5 (4.5–4.5)	22,424 (82.0)	24 (24.0–24.0)	9.01*
About once a week	6217 (15.1)	0.9 (0.8–0.9)	3645 (13.3)	3.9 (3.8–4.0)	6.52*
Less than once a week	2336 (5.7)	0.3 (0.3–0.4)	1277 (4.7)	1.4 (1.3–1.5)	5.78*

*Value of $p < 0.001$ using the Z test for comparing proportions of different forms of smokeless tobacco use and patterns of use among female and male smokeless tobacco users (15–49 years).

Table 2. Demographic and socioeconomic characteristics of smokeless tobacco use among females and males in the 15–49 age group.

	Females			Males		
Variables	**Total N (%)**	**Smokeless tobacco *n* (%)**	***p* value% (95% CI)**	**Total N (%)**	**Smokeless tobacco *n* (%)**	***p* value% (95% CI)**
Overall	724,115 (100)	41,129 (100)	5.7 (5.6–5.7)	93,267 (100)	27,346 (100)	29.3 (29.0–29.6)
Age (years)	-	-	<0.001	-	-	<0.001
15–19	122,480 (16.9)	1582 (3.8)	1.3 (1.2–1.3)	16,657 (17.9)	1894 (6.9)	11.4 (11.0–12.0)
20–24	118,700 (16.4)	3424 (8.3)	2.9 (2.8–3.0)	14,413 (15.5)	3510 (12.8)	24.4 (24.0–25.0)
25–29	118,379 (16.3)	5905 (14.4)	5.0 (4.9–5.1)	14,360 (15.4)	4482 (16.4)	31.2 (30.0–32.0)
30–34	101,049 (14.0)	6720 (16.3)	6.7 (6.5–6.8)	13,292 (14.3)	4735 (17.3)	35.6 (35.0–36.0)
35–39	98,068 (13.5)	7768 (18.9)	7.9 (7.8–8.1)	12,874 (13.8)	4764 (17.4)	37.0 (36.0–38.0)
40–44	81,380 (11.2)	7480 (18.2)	9.2 (9.0–9.4)	10,838 (11.6)	3968 (14.5)	36.6 (36.0–38.0)
45–49	84,059 (11.6)	8250 (20.1)	9.8 (9.6–10.0)	10,833 (11.6)	3993 (14.6)	36.9 (36.0–38.0)
Residence	-	-	<0.001	-	-	<0.001
Urban	179,535 (24.8)	7333 (17.8)	4.1 (4.0–4.2)	24,211 (26)	5492 (20.1)	22.79 (22.0–23.0)
Rural	544,580 (75.2)	33,796 (82.2)	6.2 (6.1–6.3)	69,056 (74)	21,854 (79.9)	31.6 (31.0–32.0)
Pregnancy	-	-	<0.001	NA	NA	NA
Yes	28,408 (3.7)	1343 (3.3)	4.7 (4.5–5.0)	-	-	-
No/unsure	695,707 (96.1)	39,786 (96.7)	5.7 (5.7–5.8)	-	-	-
Currently breastfeeding	-	-	0.071	NA	NA	NA
Yes	106,816 (14.8)	5941 (14.4)	5.6 (5.4–5.7)	-	-	-
No	617,299 (85.2)	38,188 (85.6)	5.7 (5.6–5.8)	-	-	-
Current marital status	-	-	<0.001	-	-	-
Never in union	181,285 (25.0)	3603 (8.8)	2.0 (1.9–2.1)	36,754 (39.4)	6411 (23.4)	17.4 (17.0–18.0)
Married	512,408 (70.8)	33,665 (81.9)	6.6 (6.5–6.6)	55,280 (59.3)	20,398 (74.6)	36.9 (36.0–37.0)
Widowed	22,119 (3.1)	2558 (6.2)	11.6 (11–12)	491 (0.5)	236 (0.9)	48.1 (44.0–52.0)
Divorced	2808 (0.4)	492 (1.2)	17.5 (16–19)	331 (0.4)	136 (0.5)	41.1 (36.0–46.0)

Table 2. (*Continued*).

	Females			Males		
Variables	**Total N (%)**	**Smokeless tobacco *n* (%)**	***p* value% (95% CI)**	**Total N (%)**	**Smokeless tobacco *n* (%)**	***p* value% (95% CI)**
Separated	5495 (0.8)	811 (2.0)	14.8 (14–16)	411 (0.4)	165 (0.6)	40.1 (36.0–45.0)
Education	-	-	<0.001	-	-	<0.001
No education	167,304 (23.1)	16,410 (39.9)	9.8 (9.7–10)	9980 (10.7)	4434 (16.2)	44.4 (43.0–45.0)
Primary	84,983 (11.7)	8097 (19.7)	9.5 (9.3–9.7)	10,169 (10.9)	4656 (17.0)	45.8 (45.0–47.0)
Secondary	370,012 (51.1)	15,167 (36.9)	4.1 (4.0–4.2)	56,197 (60.3)	15,806 (57.8)	28.1 (28.0–28.5)
Higher	101,816 (14.1)	1455 (3.5)	1.4 (1.4–1.5)	16,921 (18.1)	2450 (9.0)	14.5 (14.0–15.0)
Religion	-	-	<0.001	-	-	<0.001
Hindu	546,007 (75.4)	24,764 (60.2)	4.5 (4.5–4.6)	70,608 (75.7)	21,438 (78.4)	30.4 (30.0–31.0)
Muslim	90,729 (12.5)	4195 (10.2)	4.6 (4.5–4.8)	11,317 (12.1)	2834 (10.4)	25.0 (24.0–26.0)
Christian	52,146 (7.2)	10,160 (24.7)	19.5 (19–20)	6591 (7.1)	2004 (7.3)	30.4 (29.0–32.0)
Sikh	16,200 (2.2)	13 (0.0)	0.08 (0.05–0.14)	2190 (2.3)	150 (0.5)	6.8 (5.9–8.0)
Buddhist	9076 (1.3)	656 (1.6)	7.2 (6.7–7.8)	1270 (1.4)	342 (1.3)	26.9 (25.0–29.0)
Jain	887 (0.1)	09 (0.0)	1.0 (0.53–1.9)	125 (0.1)	24 (0.1)	19.2 (13.0–27.0)
Other	9070 (1.3)	1332 (3.2)	14.7 (14–15)	1166 (1.3)	554 (2.0)	47.5 (45.0–50.0)
Ethnicity	-	-	<0.001	-	-	<0.001
Caste	583,167 (80.5)	22,318 (54.3)	3.8 (3.8–3.9)	75,381 (80.8)	21,238 (77.7)	28.2 (28.0–28.5)
Tribe	101,914 (14.1)	15,715 (38.2)	15.4 (15–16)	13,147 (14.1)	4930 (18.0)	37.5 (37.0–38.0)
No caste/tribe/ don't know	39,035 (5.3)	3096 (7.5)	7.9 (7.7–8.2)	4743 (5.1)	1178 (4.3)	24.8 (24.0–26.0)
Wealth index	-	-	<0.001	-	-	<0.001
Lowest (Poorest)	149,844 (20.7)	15,952 (38.8)	10.6 (10–11)	18,151 (19.5)	8412 (30.8)	46.3 (46.0–47.0)
Second (Poorer)	160,340 (22.1)	11,746 (28.6)	7.3 (7.2–7.5)	20,823 (22.3)	7562 (27.7)	36.3 (36.0–37.0)
Middle (Middle)	151,505 (20.9)	7669 (18.6)	5.1 (5.0–5.2)	19,928 (21.4)	5489 (20.1)	27.1 (27.0–28.0)
Fourth (Richer)	139,607 (19.3)	4274 (10.4)	3.1 (3.0–3.2)	18,494 (19.8)	3865 (14.1)	20.9 (20.0–21.0)
Highest (Richest)	122,819 (17)	1488 (3.6)	1.2 (1.2–1.3)	15,871 (17)	2018 (7.4)	12.7 (12.0–13.0)
Alcohol use	-	-	<0.001	-	-	<0.001
Yes	13,528 (1.9)	4554 (11.1)	33.7 (33–34)	23,715 (25.4)	11,572 (42.3)	48.8 (48.0–49.0)
No	710,587 (98.1)	36,575 (88.9)	5.1 (5.1–5.2)	69,552 (74.6)	15,774 (57.7)	22.7 (22.0–23.0)

3.2. Determinants of smokeless tobacco use in females

Table 3 displays the univariable and multivariable odds ratios of SLT use among females estimated through binary logistic regression. The analysis revealed that the odds of SLT use were 1.18 and 1.22 times higher among females in the age groups of 39–44 (OR = 1.18) and 45–49 (OR = 1.22), respectively, compared to those in the 35–39-year age group. The odds of using SLT were 1.86, 3.02, and 2.46 times higher for widowed, divorced, and separated females, respectively, than for currently married females. In contrast, never-married females were 72% less likely to use SLT than currently married females (OR = 0.28) after controlling for other variables. Education level had a protective effect on SLT use, with the odds of using SLT being 1.33 and 1.51 times higher among females with no education and primary education, respectively, compared to those with secondary education. Females in the poorest and poorer household wealth index had higher odds ratios than those in the middle household wealth index (OR = 2.23 and OR = 1.80), while those in the richer

and richest household wealth index were less likely to use SLT than those in the middle household wealth index (OR = 0.59 and OR = 0.29). Women from urban areas had a 14% greater likelihood of SLT use than those from rural areas in the multivariable logistic regression (OR = 0.86). Respondents from tribal ethnicity had higher odds of SLT consumption than those from caste ethnicity (OR = 1.95). Respondents from the Christian religious group had higher odds of SLT consumption than those from the Hindu religion (OR = 3.23) in both univariable and multivariable models. Both univariable and multivariable models showed a significant association between consuming alcohol and SLT use (OR = 4.56). Current pregnancy had a protective effect on SLT use, with pregnant females having a lower likelihood of SLT use than non-pregnant women (OR = 0.85).

Table 3. Unadjusted and adjusted odds ratio (95% CI) estimates of the determinants associated with smokeless tobacco use in females.

Characteristics	**Categories**	**Univariable odds ratio**			**Multivariable[$] odds ratio**		
		Estimate	**95% CI**	***p* value**	**Estimate**	**95% CI**	***p* value**
Age (years)	30–34[@]	ref	-	-	ref	-	-
	15–19	0.18	0.17, 0.19	<0.001	0.23	0.21, 0.24	<0.001
	20–24	0.41	0.40, 0.43	<0.001	0.52	0.49, 0.54	<0.001
	25–29	0.73	0.71, 0.76	<0.001	0.79	0.76, 0.82	<0.001
	35–39	1.20	1.16, 1.24	<0.001	1.14	1.10, 1.18	<0.001
	40–44	1.42	1.37, 1.47	<0.001	1.34	1.29, 1.39	<0.001
	45–49	1.52	1.47, 1.58	<0.001	1.40	1.34, 1.45	<0.001
Residence	Urban[@]	ref	-	-	ref	-	-
	Rural	1.55	1.51, 1.59	<0.001	0.67	0.65, 0.69	<0.001
Marital status	Married[@]	1.00	-	-	1.00	-	-
	Never in union	0.28	0.27, 0.29	<0.001	0.83	0.79, 0.87	<0.001
	Widowed	1.86	1.78, 1.94	<0.001	1.24	1.18, 1.30	<0.001
	Divorced	3.02	2.73, 3.33	<0.001	2.39	2.14, 2.66	<0.001
	Separated	2.46	2.28, 2.65	<0.001	1.82	1.68, 1.98	<0.001
Currently pregnant	No[@]	ref	-	-	ref	-	-
	Yes	0.81	0.77, 0.86	<0.001	0.85	0.80, 0.91	<0.001
Education level	secondary[@]	1.00	-	-	1.00	-	-
	Higher	0.33	0.32, 0.35	<0.001	0.51	0.48, 0.54	<0.001
	Primary	2.46	2.39, 2.53	<0.001	1.51	1.46, 1.56	<0.001
	No education	2.54	2.48, 2.60	<0.001	1.33	1.29, 1.37	<0.001
Religion	Hindu[@]	ref	-	-	ref	-	-
	Muslim	1.02	0.98, 1.05	0.23	1.02	0.98, 1.06	0.202
	Christian	5.09	4.96, 5.22	<0.001	3.23	3.12, 3.34	<0.001
	Sikh	0.01	0.01, 0.02	<0.001	0.03	0.02, 0.06	<0.001
	Buddhist/Neo-Buddhist	1.64	1.51, 1.77	<0.001	1.02	0.93, 1.11	0.629
	Jain	0.21	0.11, 0.41	<0.001	0.56	0.29, 1.08	0.088
	Other	3.62	3.41, 3.84	<0.001	1.41	1.32, 1.51	<0.001

Table 3. (*Continued*).

Characteristics	Categories	Univariable odds ratio			Multivariable[$] odds ratio		
		Estimate	**95% CI**	***p* value**	**Estimate**	**95% CI**	***p* value**
Ethnicity	Caste[@]	ref	-	-	ref	-	-
	Tribe	4.58	4.48, 4.68	<0.001	1.95	1.89, 2.01	<0.001
	No caste/tribe/do not know	2.16	2.08, 2.25	<0.001	1.99	1.90, 2.08	<0.001
Wealth index	Middle[@]	ref	-	-	ref	-	-
	Lowest (poorest)	2.23	2.17, 2.29	<0.001	1.86	1.80, 1.92	<0.001
	Second (poorer)	1.48	1.43, 1.52	<0.001	1.37	1.33, 1.41	<0.001
	Fourth (richer)	0.59	0.57, 0.61	<0.001	0.63	0.60, 0.65	<0.001
	Highest (richest)	0.23	0.21, 0.24	<0.001	0.29	0.27, 0.30	<0.001
Alcohol use	No[@]	ref	-	-	ref	-	-
	Yes	9.35	9.01, 9.70	<0.001	4.56	4.38–4.76	<0.001

@ Reference category.
$ Variables entered: Type of place of residence, current pregnancy, alcohol use, age, highest educational level, current marital status, religion, ethnicity, wealth index combined.

3.3. Demographic and socioeconomic characteristics of male respondents

Tables 1 and **2** present the demographic and socioeconomic characteristics of the male respondents. This study included 93,267 males in India aged 15–49 years.

3.4. Determinants of smokeless tobacco use in males

Table 4 displays the univariable and multivariable ORs of SLT use among males estimated using binary logistic regression. The binary logistic regression analysis revealed that males in the age groups 35–39, 40–44, and 45–49 had 6% (OR = 0.94), 8% (OR = 0.92), and 10% (OR = 0.90) lower likelihood of SLT use than men in the 30–34 age group. Multivariable logistic regression indicated that the odds of using SLT among widowed, divorced, and separated males were not significant, whereas never-married males had a 30% (OR = 0.70) lower likelihood of SLT use than currently married males. Education level had a protective effect on SLT use, with males with no education and primary education having higher odds of SLT use than those with secondary education (OR = 1.11 and OR = 1.29). Males in the poorest and poorer household wealth index had higher odds of using SLT than males in the middle household wealth index (OR = 2.09 and OR = 1.5), while males in the richer and richest household wealth index were less likely to use SLT (OR = 0.73 and OR = 0.45). Males from urban areas had a 14% (OR = 0.86) higher likelihood of SLT use than males in rural areas.

The odds of using SLT among male respondents from tribe ethnicity did not remain significant in the multivariable logistic regression model compared to caste ethnicity (OR = 1.05, $p = 0.132$). Male respondents from Christian, Sikh, and Buddhist/Neo-Buddhist religious groups had 27% (OR = 0.73), 77% (OR = 0.23), and 30% (OR = 0.70) lower likelihood of SLT use, respectively, than those from the Hindu religion. Both univariable and multivariable models showed a significant association between alcohol use and SLT use (OR = 2.42).

Table 4. Unadjusted and adjusted odds ratio (95% CI) estimates of the determinants associated with smokeless tobacco use in males.

Characteristics	**Categories**	**Univariable odds ratio**			**Multivariable[$] odds ratio**		
		Estimate	**95% CI**	***p* value**	**Estimate**	**95% CI**	***p* value**
Age (years)	30–34[@]	1.00	-	-	1.00	-	-
	15–19	0.23	0.21, 0.24	<0.001	0.32	0.29, 0.34	<0.001
	20–24	0.58	0.55, 0.61	<0.001	0.82	0.77, 0.87	<0.001
	25–29	0.82	0.78, 0.86	<0.001	0.93	0.88, 0.99	0.023
	35–39	1.06	1.009, 1.11	0.020	0.94	0.89, 0.99	0.028
	40–44	1.04	0.99, 1.10	0.112	0.92	0.87, 0.98	0.011
	45–49	1.05	1.001, 1.11	0.047	0.90	0.85, 0.96	0.001
Residence	Urban[@]	1.00	-	-	1.00	-	-
	Rural	1.57	1.52, 1.63	<0.001	0.86	0.83, 0.90	<0.001
Marital status	Married[@]	1.00	-	-	1.00	-	-
	Never in union	0.36	0.35, 0.37	<0.001	0.70	0.66, 0.73	<0.001
	Widowed	1.58	1.32, 1.89	<0.001	1.15	0.95, 1.39	0.136
	Divorced	1.19	0.95, 1.48	0.116	1.19	0.94, 1.51	0.133
	Separated	1.47	0.94, 1.39	0.175	0.86	0.70, 1.06	0.180
Education level	Secondary[@]	1.00	-	-	1.00	-	-
	Higher	0.43	0.41, 0.45	<0.001	0.52	0.50, 0.55	<0.001
	Primary	2.15	2.06, 2.25	<0.001	1.29	1.23, 1.36	<0.001
	No education	2.04	1.95, 2.13	<0.001	1.11	1.06, 1.17	<0.001
Religion	Hindu[@]	1.00	-	-	1.00	-	-
	Muslim	0.76	0.73, 0.80	<0.001	0.98	0.93, 1.04	0.625
	Christian	1.00	4.96, 5.22	0.942	0.73	0.68, 0.79	<0.001
	Sikh	0.16	0.14, 0.19	<0.001	0.23	0.19, 0.27	<0.001
	Buddhist/Neo-Buddhist	0.84	0.74, 0.95	0.008	0.70	0.61, 0.80	<0.001
	Jain	0.54	0.34, 0.85	0.008	1.28	0.80, 2.05	0.301
	Other	2.07	1.84, 2.33	<0.001	1.25	1.09, 1.42	<0.001
Ethnicity	Caste[@]	1.00	-	-	1.00	-	-
	Tribe	1.53	1.47, 1.59	<0.001	1.05	0.95, 1.11	0.132
	No caste/tribe/Do not know	0.84	0.78, 0.90	<0.001	0.82	0.76–0.89	<0.001
Wealth index	Middle[@]	1.00	-	-	1.00	-	-
	Lowest (Poorest)	2.27	2.17, 2.37	<0.001	2.09	1.99, 2.19	<0.001
	Second (Poorer)	1.50	1.43, 1.56	<0.001	1.50	1.43, 1.57	<0.001
	Fourth (Richer)	0.69	0.66, 0.72	<0.001	0.73	0.69, 0.77	<0.001
	Highest (Richest)	0.38	0.36, 0.40	<0.001	0.45	0.42, 0.47	<0.001
Alcohol use	No[@]	1.00	-	-	1.00	-	-
	Yes	3.24	3.15, 3.35	<0.001	2.42	2.34, 2.50	<0.001

@ Reference category.

$ Variables entered: Type of place of residence, current pregnancy, alcohol use, age, highest educational level, current marital status, religion, ethnicity, wealth index combined.

3.5. Comparison of determinants of smokeless tobacco use among males and females

The prevalence of smokeless tobacco use was significantly higher among males (29.3%; 95% CI 5.6–5.7) than females (5.7%; 95% CI 5.6–5.7). Paan with tobacco use was the most common smokeless tobacco among female users and was significantly different from male users (40.1% versus 20.7%, $p < 0.001$). While gutkha/paan masala with tobacco was the most common smokeless tobacco product among males, this was not so for female tobacco users (rate of use being 58.1% versus 32.5%, $p < 0.001$). Additionally, snuff use was more common among female smokeless tobacco users than male smokeless tobacco users (1.4% versus 0.27%, $p < 0.001$). Multivariable logistic regression analyses indicated that males in the age groups 35–39, 40–44 and 45–49 had 6% (OR = 0.94), 8% (OR = 0.92) and 10% (OR = 0.90) lower likelihoods of SLT use, respectively, than men in the 30–34-year age group. SLT use increased with age among females and was 1.18 times and 1.22 times higher among females aged 40–44 and 45–49, respectively, than among women aged 35–39. The odds of using SLT among widowed, divorced and separated females were 1.86, 3.02 and 2.46 times higher than those among currently married females. The odds of using SLT among widowed, divorced and separated males did not remain significant in the multivariable logic regression model.

Female respondents from tribe ethnicity had higher odds of SLT consumption than those from caste ethnicity (OR = 1.95). The odds of using SLT among male respondents from tribe ethnicity did not remain significant in the multivariable logistic regression model compared to caste ethnicity. Christian female respondents had higher odds of SLT consumption than Hindu females (OR = 3.23) in multivariable models. Female respondents from the Sikh religious group had a 97% lower likelihood of using SLT than those from the Hindu religious group (OR = 0.03). Male respondents from the Christian, Sikh and Buddhist/Neo-Buddhist religious groups had a 27% (OR = 0.73), 77% (OR = 0.23) and 30% (OR = 0.70) lower likelihood of SLT use, respectively, than Hindu males in multivariable models.

4. Discussion

SLT use is a significant public health concern in in the Southeast Asia region, as it is widely accepted in culture and prevalent among both genders. However, there are distinct disparities in the patterns and determinants of SLT use between males and females. This study aimed to evaluate the risk factors for SLT use among females and males aged 15–49 years in India utilizing data from a nationally representative cross-sectional demographic and health survey conducted between 2019 and 2021. Additionally, it sought to investigate the gender differences in the predictors of SLT use.

The study found that the prevalence of SLT use was significantly higher among males (29.3%) than females (5.7%). Paan with tobacco (40.1%) was the most common form of SLT use among female users, whereas gutkha/paan masala with tobacco (58.1%) was the most common form among male users. In addition, snuff use was more prevalent among female SLT users than male SLT users (1.4% versus 0.27%). This finding is consistent with prior research that indicates a higher prevalence of smokeless tobacco use among males than females[6,15]. This may reflect differences in cultural preferences and norms surrounding tobacco use among males and females in India.

Lower education level, the lowest level of wealth index, and alcohol use were significant determinants in both males and females, and among these factors, alcohol use exhibited the strongest association with SLT use. Our findings align with previous studies, indicating that taking public health measures to address alcohol consumption at the local level could potentially contribute to a reduction in tobacco consumption[9,12,16].

However, we found a significant association between the use of smokeless tobacco and geographic location, particularly residing in rural areas, in both males and females during univariate analysis. Surprisingly,

in contrast to previous research[5–7], we found that males and females from urban areas were more likely to use smokeless tobacco than those residing in rural areas during multivariable logistic regression. These findings suggest that the relationship between geographic location and smokeless tobacco use may be more complex than previously thought and require further investigation. Cultural practices significantly influence SLT use in South-East Asia, with some communities integrating SLT products into cultural or religious rituals. For example, certain Indian regions incorporate SLT into ceremonies and traditions[8]. Similarly, some South-East Asian communities socially accept or even encourage SLT use in specific settings due to peer pressure and societal conformity[11]. Geographic location plays a role in the availability of SLT types, with varying prevalence in rural areas, where local production may dominate. In conclusion, the connection between geographic location and SLT use in South Asia involves a complex interplay of cultural, economic, social, and regulatory factors.

The results also showed that age was a significant determinant of SLT use for both males and females. However, the association between age and SLT use varied by gender. Specifically, the study found that males aged 35–49 years were less likely to use SLT than those aged 30–34 years, whereas females aged 39–49 years were more likely to use SLT than those aged 35–39 years. The association between age and the use of SLT in females is consistent with previous studies[5,6,9]. However, in males, this relationship contradicts previous findings[5,6,12]. The variation in the association between age and smokeless tobacco (SLT) use across genders can be attributed to multiple factors. Older males may possess greater awareness of the health risks associated with SLT use, leading them to be more likely to quit it altogether. Conversely, older females may have less knowledge or concern regarding the health risks associated with SLT use, which could explain the higher prevalence of SLT use in older females[17]. Additionally, social factors may play a role; for example, in certain cultures or communities, smokeless tobacco use may be more socially acceptable for females than smoking.

The current study found that females who were widowed, divorced, or separated had a higher likelihood of using SLT than those who were currently married. This finding aligns with previous studies[8]. However, we did not observe the same association among males, which contradicts the findings of a previous study[12]. One possible explanation for this gender difference is that these women may experience elevated levels of stress and responsibilities, leading them to use tobacco as a coping mechanism[10].

The current study revealed significant gender-based differences in the relationship between ethnicity, religion, and the use of smokeless tobacco (SLT). Specifically, female respondents belonging to tribe ethnicity exhibited a higher likelihood of SLT use than those from caste ethnicity. In contrast, the study did not find a significant association between tribe ethnicity and SLT use in males. These findings align with previous studies that also reported a higher likelihood of SLT use among female respondents from tribe ethnicity, while no significant relationship was observed in males[9,12]. These findings suggest that cultural attitudes towards SLT use and access to tobacco products may differ across ethnic groups and gender. Therefore, the current tobacco control programs should be tailored to align with the cultural norms and language preferences of diverse female populations to maximize its positive impact.

In terms of religious affiliation, the use of SLT varied among respondents. Female participants belonging to the Christian religion demonstrated a higher likelihood of SLT use than their Hindu counterparts. On the other hand, male participants from the Christian religion exhibited a lower likelihood of SLT usage than males from the Hindu religion.

Gender-based differences in the relationship between ethnicity, religion, and the use of smokeless tobacco (SLT) can potentially be explained by several factors. One possible explanation is that the Christian population in certain northeastern states of India represents the tribe ethnicity prevalent in those regions[10,11]. In the

northeastern region, where these tribes are concentrated, the use of SLT is deeply rooted in their cultural practices and way of life. Moreover, factors such as limited awareness about the detrimental effects of tobacco use, inadequate access to healthcare services, and insufficient knowledge about tobacco cessation programs also contribute to the higher prevalence of smokeless tobacco use among tribe females[10,11].

Although both genders share several common predictors of SLT use, the study uncovers some predictors of smokeless tobacco use that differ between genders. Understanding these variations is crucial for tailoring effective prevention and control strategies that address the specific needs of each gender group. Hence targeted interventions should focus on older females, as well as widowed, divorced, and separated females, and individuals from specific ethnic and religious groups.

The integration of 5A's (Ask, Advise, Assess, Assist, Arrange) and 5R's (Relevance, Risks, Rewards, Roadblocks, Repetition) brief tobacco intervention into existing health programs is crucial for effective tobacco control. This integration should be seamlessly woven into primary and secondary healthcare systems, as well as other national health initiatives, to maximize the utilization of limited human and financial resources in Low- and Middle-Income Countries (LMICs). Moreover, it is imperative to include tobacco control measures within maternal and child health services. Antenatal clinics, in particular, should actively engage in screening and counselling pregnant women to discourage tobacco use and protect against second-hand smoke exposure.

Implementing gender-sensitive interventions to combat smokeless tobacco usage is crucial, especially among women with specific vulnerabilities, such as those from tribal backgrounds, lower household wealth index, limited education, or experiencing marital disruption. Tailored interventions for these groups can help address disparities in tobacco control and enhance overall public health outcomes.

Furthermore, empowering women to play an active role in promoting smokeless tobacco cessation within their communities can have a profound influence. This involves dispelling misconceptions about the safety of smokeless tobacco and launching gender-specific awareness campaigns to strengthen tobacco control efforts.

5. Policy implications

In order to effectively reach and assist vulnerable populations, there is an increasing need to employ tailored and innovative mass media campaigns. These campaigns should incorporate captivating visual and graphic elements to maximize their societal impact. To tackle these challenges effectively, engaging tribal leaders and integrating local cultural activities can significantly bolster community involvement and awareness. With the exception of Indonesia, all countries in the South-East Asia Region have ratified the WHO Framework Convention on Tobacco Control (FCTC). Vital steps in controlling both the supply and demand of tobacco products include the implementation of stringent legislation, the enhancement of warning labels, and the adoption of effective taxation policies. To mitigate geographic disparities, national tobacco control initiatives should be customized to address local-level inequalities.

Furthermore, it is imperative to strengthen infrastructure to counter the tactics employed by the tobacco industry in the battle against tobacco use. Prioritizing cost-effective cessation services, particularly tailored for women and smokeless tobacco (SLT) users, is essential. School health programs must address SLT use among students, offering indispensable education and support.

Lastly, recognizing the substantial environmental impact of tobacco, including pollution and its contribution to global warming, underscores the need for its inclusion in broader health and development agendas.

6. Strengths and limitations

The study has several notable strengths, such as its extensive sample size, national representativeness, and thorough data on demographic and socioeconomic features. Nevertheless, the study's cross-sectional design is a limitation, as it does not allow for establishing causality. Furthermore, the self-reported nature of the data may be prone to recall bias, which is another limitation that must be acknowledged.

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Conflict of interest

The author declares no conflict of interest.

Data availability statement

Publicly available datasets were analyzed in this study. The data can be accessed from the DHS program following proper procedure through this URL: https://dhsprogram.com/Data/

Institutional review board statement

The study protocol of NFHS-5 was approved by the institutional review board of the International Institute for Population Sciences (IIPS) and ICF[13]. The U.S. Centers for Disease Control and Prevention (CDC) also reviewed the protocol. Prior to data collection, informed consent was taken from the study participants. We received approval from DHS program for using the NFHS-5 data for this study.

Informed consent statement

Informed consent was obtained from all subjects involved in the study.

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