Systematic review and meta-analysis of the prevalence of smokeless tobacco consumption among adults in Bangladesh, India and Myanmar

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Abstract

Objective: To estimate the pooled prevalence of smokeless tobacco consumption (STC) by gender and location in Bangladesh, India and Myanmar and to identify periodic changes in STC prevalence using data extracted from published studies.

Methods: We searched for a combination of key words in electronic databases and used a standard form to extract data from each article. We undertook a meta-analysis to estimate pooled prevalence and confidence intervals within these countries. To compare periodic changes in STC prevalence, we grouped studies into five-year periods (2000-2004, 2005-2009, 2010-2014, 2015-2019).

Results: The pooled estimates of STC prevalence were 25% (95% CI: 22-28%), 22% (95% CI: 15-28%) and 21% (95% CI: 14-28%) for Bangladesh, India and Myanmar, respectively. In pooled estimates across these countries, we found higher STC prevalence for men (30%; 95% CI: 24-35%) than women (16%; 95% CI: 10-23%) and for rural dwellings (24%; 95% CI: 18-31%) than urban dwellings (17%; 95% CI: 10-24%). We found significant decrease of STC in Bangladesh and India in the period 2010-2014 and 2015-2019 respectively. In Myanmar, STC prevalence increased significantly and substantially in 2010-2014, to levels higher than in Bangladesh and India.

Conclusions: The prevalence of STC in Bangladesh, India and Myanmar is highest in rural areas and among men. Public health prevention strategies are needed to maintain decrease of STC in Bangladesh and India, and to reverse the increased use in Myanmar.

Keywords: Smokeless tobacco, prevalence, adult, Bangladesh, India, Myanmar

Introduction

Smokeless tobacco (ST) is the predominant form of tobacco used in many countries in Southeast Asia [1,2] and is available in diverse forms, such as pre-made (industrially manufactured and ready to use) or custom-made (prepared by the user or vendor according to user choice), that include a variety of ST products [3]. ST is included in the definition of tobacco products under the WHO Framework Convention on Tobacco Control [4]. ST contains more than 30 carcinogens and is strongly associated with oral cancer, oropharyngeal cancer, oesophageal and pancreatic cancer [3,5-7], cardiovascular disease [8], hypertension [9] and adverse pregnancy outcomes [10]. Several recent studies reported a high prevalence of smokeless tobacco consumption (STC) in South East Asia [3,11,12]. Many ST user are lured to STC due to its perceived medical value for curing toothache, headache and stomach ache [1,13,14]. STC has been a public health concern in these countries for decades [15,16]. Of the approximately 300 million people who consume ST globally, 269 million are from Southeast Asia [3]. A recent study [3] revealed that the countries with the highest prevalence of STC among adults in the world are Myanmar (29%), Bangladesh (27%) and India (25%). The Centre for Disease Control (CDC) has recommended a global target of STC prevalence of 10% or less [3], thus the prevalence of STC in South East Asia is over twice the CDC global target.

Many studies conducted on the prevalence of STC in South East Asia have been limited to specific regions within countries e.g. urban or rural settings [17-19], or to certain population groups, e.g., urban Indian women, adults in villages [20-22], and thus are not nationally representative. The types of ST consumed in these countries are similar [3]. The literature reports regional variation of STC prevalence among urban and rural areas in these countries [12,23]. Presenting estimate of STC prevalence in different geographical location of these countries led researchers and decision makers to consider different numbers and figures subject to their preferences and accessible information. Consequently, a meta-analysis pooling all estimate of STC prevalence would be beneficial for evidence-based decision making. The aim of this meta-analysis is to estimate the prevalence of STC in a broader scope including top three highest STC prevalent countries. Due to the range of coverage of STC prevalence by these three countries, pooled analysis of STC prevalence of these countries in terms of STC burden, nature of STC, gender and geographical differences will help policy makers and program managers to combat STC prevalence globally along with these highly prevalent countries.

The findings will help decision makers to visualize the circumstances both from national and international context and thus can help them to develop and evaluate integrated ST control policy and public health strategies to tackle the challenge globally. The findings will provide important information to the policy maker for advocating evidence-based prevention and cessation strategies. Though global prevalence has been estimated, no attempt has been made to examine and compare the overall pooled prevalence of STC prevalence in these three countries, where cross-border trade, both legal and illegal, is

common, particularly in border regions [24,25]. We will bridge that gap by conducting a systematic review and meta-analysis to estimate the prevalence of STC among the adult populations of Bangladesh, India and Myanmar and changes in STC prevalence over the period.

Methods

We followed the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) standards for the design and reporting of systematic reviews [26] and registered a protocol for this review with the International Prospective Register of Systematic Reviews (PROSPERO registration number: CRD42018104661).

Search strategy

We conducted comprehensive systematic computerised literature search following the Meta-analysis of Observational Studies in Epidemiology (MOOSE) guidelines [27] and the PRISMA statement [28]. We searched Medline via the PubMed interface, CINAHL, and EMBASE, with publication dates up to February 2019. The search was conducted using a combination of key words (e.g. 'smokeless tobacco', 'prevalence', 'adult', 'Bangladesh', 'India' and 'Myanmar'), MeSH terms and other free-text terms (see Appendix A). Types of ST searched were betel quid with tobacco, chewing tobacco, jarda, khaini, gul, sadapata, mishri, gutka, mawa, masheri, snuff, tobacco paste, toombak, Iqmik, dipping tobacco, dissolvable, naswer, tobacco gum, spit tobacco. We applied a snowball method using manual cross references from retrieved articles to ensure a complete collection. Additional searches were conducted of grey literature resources such as conference websites and government websites and informal sources such as conference abstracts. We also included additional studies, such as reports, identified through Google scholar search.

Selection of studies

We included studies/reports which estimated the prevalence of STC among adults, using primary and secondary data (i.e. demographic and health survey, family health survey) and were reported in English. We included data from people aged 15 years old and over, as most of the included national surveys in three countries defined adults as people aged 15 years and above [12,29,30].

We excluded non-empirical studies such as editorials, letters to the editor and methodological articles and studies that did not report STC prevalence estimates. Studies reporting primarily youth/adolescence prevalence, prevalence of tobacco use without mentioning ST use or duplicate data (i.e. literature review of national surveys) were excluded.

Two reviewers (EN and MEH) independently assessed titles and abstracts based on predefined

inclusion criteria and resolved disagreements by consensus. A third reviewer (AHM) was approached to arbitrate any issues that remained unresolved.

Data extraction

A data extraction form was developed to extract information from each of the selected articles including study sample, country settings, geographical location (e.g. rural or urban), gender, and prevalence of STC. Studies were excluded from the meta-analysis if data collection year was not found. For these studies the corresponding authors were contacted, and studies were included based on responses received. Studies reporting estimates from two or more data collection periods were classified independently.

Quality appraisal

We applied a modified quality scoring-method [31] by using the quality effect model [32] to take the advantage of bias adjustment corresponding to design specific bias, selection bias, adjustment bias, analytic bias, adjustment for potential confounders, information bias and analytic method [31]. The quality score was created considering seven criteria based on approach used by Hoque ME et al [33] as: whether target population was a close representation of national population, whether sampling frame was true representative of target population, was randomization considered during sample selection, was likelihood of non-response bias minimal, were data collected from the sample, was an acceptable definition used in the study and was the study instrument that measured the parameter shown to have reliability and validity. For the meta-analysis, the quality effect method manages heterogeneity by assessing the quality of studies and providing weight to each study based on the sample size and quality scoring method [34].

The quality of the individual studies affects the quality of the combined estimates. This allows an assessment of the effect of study quality on the outcome of interest and manages methodological heterogeneity within studies by combining heterogeneity effects in the overall analysis [32].

Two reviewers (EN and MEH) assigned a quality score for each criterion, scaled it to a value between 0 and 1 (inclusive) and then divided the maximum possible score by 7, based on the set criteria. We defined acceptable case definition of STC as current user of smokeless tobacco who consume ST at least once in a week. Based on these factors, we assigned points to reflect deficiencies in each of the studies and combined them into a quality score (Appendix B). Considering the sample size and the quality score weight, a % weight was calculated by meta-analysis software for each study to measure the pooled estimate. Finally, the two reviewers compared quality scores and reached a consensus for each study.

To produce a combined prevalence estimate, by gender and geographical location in the three

countries, we grouped STC prevalence studies according to male, female, urban and rural. In periodic STC prevalence analysis, studies were grouped in five-year periods (2000 to 2004, 2005 to 2009, 2010 to 2014 and 2015 to 2019). Though two region-specific studies [18,35] were available before 2000 in Bangladesh and India, there were too few of them for a pooled meta-analysis. Accordingly, studies were grouped into five periods from 2000 onwards to analyse changes in STC prevalence with pooled estimates.

Statistical analysis

Our outcome of interest was the prevalence of STC. We estimated the prevalence of STC in the adult population and performed the meta-analysis separately for each country. We used a quality effects model [32,36] for the meta-analysis, performed all analyses in Meta XL version 5.1 [36]. For each study, self-reported prevalence of STC, number of smokeless tobacco users and quality scores were entered in Meta XL software. We estimated pooled prevalence by gender and geographic location (urban and rural as defined by the respective studies). We classified low, medium and high degrees of heterogeneity based on the values of I^2 as <25%, 25-75% and above 75% respectively [37].

Results

Study characteristics (Systematic review)

Figure 1 presents a flow diagram of the study selection process. Of the 930 manuscripts and eight reports identified, we excluded 862 manuscripts that covered ineligible topics or were not empirical studies. We examined the remaining 76 full text articles (68 manuscripts and 8 reports). Of 68 manuscripts we then excluded 50 due to their not containing prevalence information, being focused on a specific group (e.g. prisoner, patient), or being conducted among populations residing outside their respective country of origin. Of the 26 studies assessed for full text review, 8 were from Bangladesh [12,15,23,29,35,38-40], 13 were from India [12,17-22,41-46] and five were from Myanmar [30,47,48]. After a second round of double-screening, we considered 21 studies as eligible for meta-analysis. The exclusion of five studies from meta-analysis was due to lack of information on data collection year, sample size <300 and being conducted before year 2000.

The 26 studies included in this review were conducted in several demographic and geographical settings, i.e., rural and urban combined (58%), urban (16%), rural (23%) and slum (3%) areas. The age of the study participants varied from 15 years to 64 years, and 77% of studies included both men and women, 8% included only men and 15% included only women. Eight studies were based on nationally representative surveys [12,23,29,30,45,47-49]. The remaining studies included in the systematic review were gender based (male/female) or conducted in local settings (urban/rural). All studies were conducted

between 1990 and 2019, and 97% were conducted between 2000 and 2015. Among the included studies, some national surveys in Bangladesh [23], India [41] and Myanmar [30,47] were conducted in successive years.

All studies included in this review were cross-sectional surveys, with a total of 808,870 participants. India contributed 65% of the sample, followed by Bangladesh (31%) and Myanmar (4%). Sample sizes varied from 262 [21] to 198,754 [12]. We estimated periodic STC prevalence in each country with studies grouped into different periods according to data collection year.

Pooled prevalence

Figure 2 presents forest plots of STC prevalence estimates for Bangladesh, India, and Myanmar, using rectangles to represent point estimates of each study and diamonds for the pooled estimate. The pooled prevalence of STC in Bangladesh, India and Myanmar was 23% (95% CI: 19-27%). The country-specific pooled STC prevalence estimates were 25% (95% CI: 22-28%), 22% (95% CI: 15-28%) and 21% (95% CI: 14-28%) in Bangladesh, India and Myanmar, respectively.

Gender and geographical difference

Table 2 presents combined STC prevalence by gender and geographical setting in three countries. Pooled analysis by three countries produced a higher point estimate in men (30%; 95% CI: 24-35%) than women (16%; 95% CI: 10-23%). In country-specific pooled analysis, prevalence of STC among women in Bangladesh (27%; 95% CI: 23-32%) was higher than men (23%; 95% CI: 17-30%). In India and Myanmar, the prevalence of STC among men was 33% (95% CI, 28-38%) and 38% (95% CI: 23-53%), respectively, versus 11% (95% CI: 6-16%) and 14% (95% CI: 7-22%), respectively, among women.

Across the three countries, rural people had a higher STC prevalence (24%; 95% CI: 18-31%) than urban people (17%; 95% CI: 10-24%), and this pattern was also present within country-specific data.

Periodic STC prevalence with pooled studies

Figure 3 presents STC prevalence over the period in Bangladesh, India and Myanmar with confidence intervals. The periodic pooled analysis of STC prevalence grouped into five-year periods showed a decline in STC in Bangladesh and India. Though STC prevalence increased in Bangladesh from 22% (95% CI: 14-31%) in 2000-2004, to 28% (95% CI: 22-35%) in 2005-2009, a decrease of STC was observed in 2010-2014, 22% (95% CI: 17-27%). The trend is statistically significant (chi square = 1241; $p<0.05$). In India STC prevalence increased from 21% (95% CI: 8-36%) in 2005-2009 to 24% (95% CI: 17-33%) in 2010-2014 and then decreased to 20% (95% CI: 13-29%) in 2015-2019. The trend is statistically significant (chi square = 445.56; $p<0.05$). In case of Myanmar, STC increased over the period, from 15% (95% CI: 10-21%) in 2000-

2004 to 23% (95% CI: 13-35%) in 2005-2009 and 37% (95% CI: 1-80%) in 2010-2014. The trend is statistically significant (chi square = 1402.93; p<0.05)..

Figure 4 presents a further pooled analysis of periodic STC prevalence among urban and rural dwellings. In Bangladesh, the prevalence of STC in urban dwelling increased from 16% (95% CI: 10-21%) in 2000 -2004 to 23% (95% CI: 17-30%) in 2005-2009 and then decreased to 18% (95% CI: 18-19%) in 2010-2014. In India, the prevalence of STC in urban dwelling increased from 14% (95% CI: 0-44%) in 2005 -2009 to 17% (95% CI: 9-27%) in 2010-2014 and then decreased to 15% (95% CI: 15-16%) in 2015-2019. In Myanmar, the prevalence of STC in urban dwelling increased from 13% (95% CI: 11-15%) in 2000 -2004 to 19% (95% CI: 17-21%) in 2005-2009.

In Bangladesh, the prevalence of STC in rural dwellings increased from 29% (95% CI: 26-32%) in 2000 -2004 to 31% (95% CI: 25-38%) in 2005-2009 and then decreased to 24% (95% CI: 22-26%) in 2010-2014. In India, the prevalence of STC in rural dwellings increased from 19% (95% CI: 0-45%) in 2005 -2009 to 28% (95% CI: 1-62%) in 2010-2014 and then decreased to 25% (95% CI: 24-25%) in 2015-2019. In Myanmar, the prevalence of STC in rural dwelling increased from 16% (95% CI: 15-17%) in 2000 -2004 to 21% (95% CI: 20-22%) in 2005-2009.

We could not conduct a meta-analysis for certain periods if studies were not available in that time period - India (2000-2004), Myanmar (2015-2019) and Bangladesh (2015-2019).

Sensitivity Analysis

A sensitivity analysis was conducted to explore whether the analysis was affected by nationally representative large studies (Supplementary file: S1 and S2). Two separate analyses were done by dividing studies into two groups – nationally representative surveys and small/local surveys. In Bangladesh and India, no difference in prevalence of STC was observed between prevalence of STC with all studies (national and local/small studies) compared to prevalence of STC considering nationally representative studies only.

In sensitivity analysis, prevalence of STC estimate with local/small studies in Bangladesh 23% (95% CI: 16-29%) is close to prevalence of STC estimate with all studies 25% (95% CI: 22-28%). This may be due to the local studies in Bangladesh being conducted with large sample. In India, when STC prevalence was estimated with local/small studies, large variation was found in STC prevalence 14% (95% CI: 9-19%) compared to prevalence of STC with all studies in this country 22% (95% CI: 15-29%). This indicates that the combined prevalence of STC (with all studies) is mainly influenced by nationally representative studies.

There were no small/local studies in Myanmar and pooled prevalence analysis was conducted with all

nationally representative surveys. Therefore, sensitivity analysis was not relevant for Myanmar.

Discussion

Our study showed very high STC prevalence in Bangladesh, India and Myanmar. We found the prevalence of STC in Bangladesh (25%), India (22%) and Myanmar (21%) to be much higher than the global target of 10% or less recommended by the CDC [3] , and there is great variation in prevalence between men (33%) and women (11%) in India and men (38%) and women (14%) in Myanmar, which is consistent with previous research [41,48]. Our findings corroborate those of other studies showing by a higher STC prevalence in rural areas (Bangladesh =27%, India=22% , Myanmar=17%) than in urban areas (Bangladesh=25%, India=15%, Myanmar=15%) [3,29,47].

We found a decrease of STC in India and Bangladesh but not in Myanmar, where use increased. Nigar et al [23] reported a decline in STC in Bangladesh from 2009 to 2012 where ST use decreased among both men and women, and urban and rural dwelling people. The Global Adult Tobacco Survey 2 (GATS2) found STC declined in India among men and women in urban and rural areas [41]. The Non Communicable Disease Risk Factor Survey found an increase of STC in Myanmar among both men and women from 2009 to 2014 [47,48]. Public health prevention strategies are urgently needed to maintain decrease of STC in Bangladesh and India and to reverse the increase of use in Myanmar.

A recent study also reported that the use of any form of tobacco including smoking in Bangladesh has plateaued and that a decline in use is expected in the near future [39]. The decrease of STC may be attributable to patterns of economic development, public health awareness, and tobacco control policy in the country. As low-cost cigarettes are available in these countries, with increased purchasing power, consumers may consider smokeless tobacco to be inferior and therefore switch to smoking western-style cigarettes. Thus, this decrease in STC prevalence over the period needs further investigation for indicators to inform tobacco control and cessation efforts in these regions. In case of Myanmar, ST use increased over time both in urban and rural areas. Therefore, it is necessary to monitor tobacco use in Myanmar, as it might also have an impact in the neighbouring countries due to cross-border trade.

A limitation of our research is the amalgamation of estimates from studies using dissimilar STC prevalence criteria. The included studies used various timeframes in their definition of current use; some used daily or multiple times a day, while others defined current use as weekly or monthly [15,19,21,23,29]. The current study provides a pooled estimate of prevalence of STC irrespective of the differing definitions of smokeless tobacco prevalence. We assigned a weight (between 0 to 1) to each study based on acceptable and considerable definition of smokeless tobacco use. Such weight assignment mitigated differences among studies in terms of the definition of STC. Another limitation is that we pooled studies conducted in

different regions of the countries, conducted under various circumstances, and covering a long period. Thus, considerable heterogeneity underlies the overall estimates. When subgroup analysis was performed the heterogeneity was still high, indicating that no single risk factor (gender, geographical location, country, publication year) contributed to the overall heterogenicity of the included studies, which means a combination of factors is responsible for the heterogenicity in the study.

In order to reduce the effect of publication bias, we used a quality effect model rather than a random effect model as the latter does not consider the quality of the study and thus provides equal weight to all studies irrespective of their sample size and design [31].

Conclusion

Our study provides combined, evidence-based information regarding STC prevalence and changes in STC prevalence over the period 2000-2019 among adults in Bangladesh, India and Myanmar across different geographical locations and gender. The prevalence of STC is very high in the adult populations of Bangladesh, India and Myanmar. Our review reveals that ST use is decreased in India and Bangladesh over the period and increased in Myanmar, though pooled prevalence shows ST use in all three countries is still higher than the global target. Regular monitoring of use of all forms of tobacco, and evidence-based prevention and cessation strategies are essential in these regions where STC is a great burden, as it increases health care cost both for individual and the country and reduces quality of life.

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Appendix A. Search strategy with Key words, MeSH Terms and other free text terms

Search strategy

1 Prevalence$

2 smokeless tobacco.mp. or tobacco, smokeless/

3 Spit* adj3 tobacco.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]

4 Snuf*.mp.

5 nasal snuf*.mp.[mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]

6 gutk?a.mp.

7 sada pata.mp.[mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]

8 (quid adj3 (betel or tobacco)).mp.[mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]

9 jarda.mp.[mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]

10 zarda.mp.

11 chew* adj3 tobacco.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]

12 dissovable*.mp.[mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]

13 snus*.mp.

14 dipp* tobacco.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]

15 Iqmik.mp.

16 N?swar.mp.

17 tobacco gum.mp.[mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]

18 toombak.mp.

19 ((loose leaf or tablet* or toothpaste) adj3 tobacco)..mp.[mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]

20 Adult*

21 Male

22 Female

23 Men

24 Women

25 Bangladesh* [All fields]

26 India* [All fields]

27 Myanmar* [All fields]

28 OR/2-19

29 OR / 20 – 24

30 OR/25- 27

31 #1 AND #28 AND #29 AND #30

32 Limits: English Language; Humans only

Databases:

Search engines included Medline, Embase, CINAHIL. Moreover, Google Scholar was searched.

Appendix B. Quality score table

Manuscript	1. Was the study's target population a close representation of the national population in relation to relevant variables, e.g age, sex, occupation?	2. Was the sampling frame a true or close representation of the target population	3. Was some form of random selection used to select the sample, OR, was a census undertaken	4. Was the likelihood of non-response bias minimal?	5. Were data collected from the subjects (as opposed to proxy)	6. Was an acceptable case definition used in the study?	7.was the study instrument that measured the parameter of interest (e.g prevalence of low back pain) shown to have reliability and validity (if necessary)?	Total score	Quality score
Hossain MS (2014)	0	1	1	1	1	0.5	1	5.5	0.79
NCD, 2010	1	1	1	1	1	1	1	7	1.00
Nargis N	1	1	1	1	1	1	1	7	1.00

(2015)									
Flora M S (2009)	0	0.5	0	1	1	1	1	4.5	0.64
GATS report, 2009	1	1	1	1	1	1	1	7	1.00
Sreeramareddy, BD (2014)	1	1	1	1	1	1	1	7	1.00
GATS report, India (2010)	1	1	1	1	1	1	1	7	1.00
GATS report, India (2016)	1	1	1	1	1	1	1	7	1.00
Chockalingam K et al (2013)	0	1	1	1	1	0.5	1	5.5	0.79
Pathak N	0	0	1	1	1	1	1	5	0.71
Sinalkar D.R et al	0	0	1	1	1	1	0.5	4.5	0.64

Rooban T & et all (2010)	1	1	1	1	1	1	1	7	1.00
Mishra G	0	1	1	0	1	0.5	1	4.5	0.64
Sreeramareddy CT et al (2014)	1	1	1	1	1	1	1	7	1.00
Dixit A	0	0	1	1	1	0.5	0.5	4	0.57
Kaur P (2011)	0	1	1	1	1	0.5	1	5.5	0.79
NCD survey, 2014, Myanmar	1	1	1	1	1	1	1	7	1.00
NCD survey, 2009, Myanmar	1	1	1	1	1	1	1	7	1.00
Sentinel prevalence survey, 2001	1	1	1	1	1	1	1	7	1.00
Sentinel prevalence survey, 2004	1	1	1	1	1	1	1	7	1.00
Sentinel	1	1	1	1	1	1	1	7	1.00

prevalence survey, 2007									

* (0=no, 0.5=partially agreed, 1=yes); 'quality score' = total score / 7

Table 1. Principal findings of studies included in the review

Study/report (year)	**Study year**	**STC definition**	**STC measurement**	**Sample size**	**Age (years)**	**Study settings**	**Prevalence (%) by gender**		**Prevalence (%) by geographical location**	
							Male	**Female**	**Urban**	**Rural**
Bangladesh										
Khandker N et al (2017)[38]	NA	NA	NA	M=255 F=252	25-64	Urban slum	32.6	48.8	NAp	NAp
Hossain MS et al (2014)[15]	2011	Current consumption	ST consumption: at least three times daily.	F=8074	≥18	Rural	NAp	25.1	NAp	NAp
Non-Communicable Disease Risk Factor Survey Bangladesh 2010[39]	2010	Current user	ST consumption in the past 30 days (daily+ non- daily)	R= 4646 U= 4629 M=4312 F=4963	≥25	Urban and Rural	29.4	33.6	30.8	35.1
Nargis N et al (2015)[23]	2009 and	Weekly use (regular+ occasional users	At least once a week	2009: R=63954 U=31500 M=4832	≥15	Urban and Rural	2009=26.8 2012=19.5	2009=30.4 2012=24.5	2009=22 2012=18	2009=31.5 2012=23.5

	2012			8 F=47125 2012: R=69816 U=27219 M=5023 7 F=46877						
Global Adult Tobacco Survey Bangladesh Report 2009[29]	2009	Current use	Daily user+ occasional user (less than daily)	R=4772 U=4857 M=4468 F=5161	≥15	Urban and Rural	26.4	27.9	22.5	28.8
Sreeramareddy CT et al (2014)[12]	2007	Current SLT user	Currently use smokeless tobacco	R=2328 U=1443	≥15	Urban and Rural	NAp	NA	20.19	22.53
Flora MS (2009)[40]	2001-2003	Current use	Daily consumption	Rural: M=8229 F=9851	≥18	Urban and Rural	U=12.5 R=30.5	U=18 R=28	NAp	NAp

				Urban: M=7967 F=9399						
Choudhury K (2007)[35]	1994	NA	NA	M=3448 F=3170	>15	Rural	0.8	3.7	NAp	NAp
India										
Global Adult Tobacco Survey, Second round (2016-2017)[41]	2016-2017	Current use	Daily + occasional use (less than daily)	M=33772 F=40265 U=26488 R=47549	≥15	Urban and Rural	29.6	12.8	15.2	24.6
Kathirvel S et al (2014)[21]	2014	Current use	one or more days within the past 30 days from the day of survey	F=262	≥30	Urban	NAp	NAp	11	NAp
Dixit MA (2015)[42]	2013	Tobacco user	Use of smokeless tobacco product at least ones every day or nearly every day over a period	M=954 F=456	>18	Rural	17.71	9.21	NAp	NAp

			of one month or more							
Sinalkar DR et al (2012)[43]	2011	Current user	ST consumption either daily or occasionally	F=313	>15	Rural	NAp	NAp	NAp	13
Mishra GA (2015)[20]	2010-2013	Current user	Daily use	F=5500	≥30	Urban	NAp	NAp	21.77	NAp
Pathak NK et al (2014)[44]	2010-2011	Current use	Daily use	M=896	≥15	Urban	NAp	NAp	26.4	NAp
Chockalingam K et al. (2013)[19]	2009-2011	Current use	Tobacco use in past 30 days	U=2648 R=2608	≥15	Urban and Rural	11.5	4.9	7.0	9.5
GATS report, India (2009-2010)[45]	2008-2010	Current use	Daily + occasional use (less than daily)	M=33767 F=35529 U=27471 R=41825		Urban and Rural	32.9	18.4	17.7	29.3
Kaur P et al (2011)[17]	2005 – 2007	Current use	NA	M = 4927 F = 5573	25 – 64	Rural	11.7	15.1	NAp	NAp

Sreeramareddy CT et al (2014)[12]	2005-2006	Current use	Currently use smokeless tobacco	M=74369 F=124385	≥15	Urban and Rural	NAp	NAp	M=31.26 F=5.99	M=39.87 F=10.47
Rooban T et al (2010)[46]	2005-2006	Current use	Currently use smokeless tobacco	M=74369	15-54	Urban and Rural	34.42	NAp	NA	NA
Sorensen G et al (2005)[18]	1992-1994	Current use	Current smokeless tobacco user	M=27141 F=54696	≥35	Urban	44.4	56.9	NAp	NAp
Santhanakrishnan I et al (2014)[22]	NA	Current daily user	Uses tobacco products every day, over a period of one month or more	M= 161 F = 154	>20	Rural	NAp	NAp	NAp	12.6
Myanmar										
Noncommunicable Disease Risk Factor Survey Myanmar 2014[48]	2014	Current use of ST	Used smokeless tobacco in the past 30 days (daily + non-daily)	M=3079; F=5678	25-64	Urban and Rural	62.2	24.1	NA	NA
Noncommunicabl	2009	Current use	daily and non-	M=2862	15-64	Urban	51.4	16.1	NA	NA

e Disease Risk Factor Survey Myanmar 2009[47]		of ST	daily	F=4567		and Rural				
Sentinel prevalence study, 2007[30]	2007	Current ST use>3 months	Daily + Occasional	U=1615; R=4799 M=3226; F=3187	>15	Urban and Rural	31.8	12.1	18.7	20.8
Sentinel prevalence study, 2004[30]	2004	Current ST use>3 months	Daily + Occasional	U=1615; R=4799 M=3226; F=3187	>15	Urban and Rural	25.6	4.3	11.6	16.4
Sentinel prevalence study, 2001[30]	2001	Current ST use>3 months	Daily + Occasional	U=1615; R=4799 M=3226; F=3187	>15	Urban and Rural	23.8	8.0	13.8	15.3

*NA: Not available; Nap: Not applicable

Table 2. Combined STC prevalence by gender and urban/rural setting in Bangladesh, India and Myanmar (proportions and 95% confidence intervals)

Country	**Gender**		**Geographic location**	
	Men	Women	Urban	Rural
Bangladesh	23% (17%- 30%)	27% (23%- 32%)	25% (20%- 29%)	27% (22%- 33%)
India	33% (28%- 38%)	11% (6%- 16%)	15% (4%- 27%)	22% (11%- 35%)
Myanmar	38% (23%- 53%)	14% (7%- 22%)	15% (11%- 19%)	17% (14%- 21%)
Total	30% (24%- 35%)	16% (10%- 23%)	17% (10%- 24%)	24% (18%- 31%)

Figure 1. Flow diagram of the study selection process

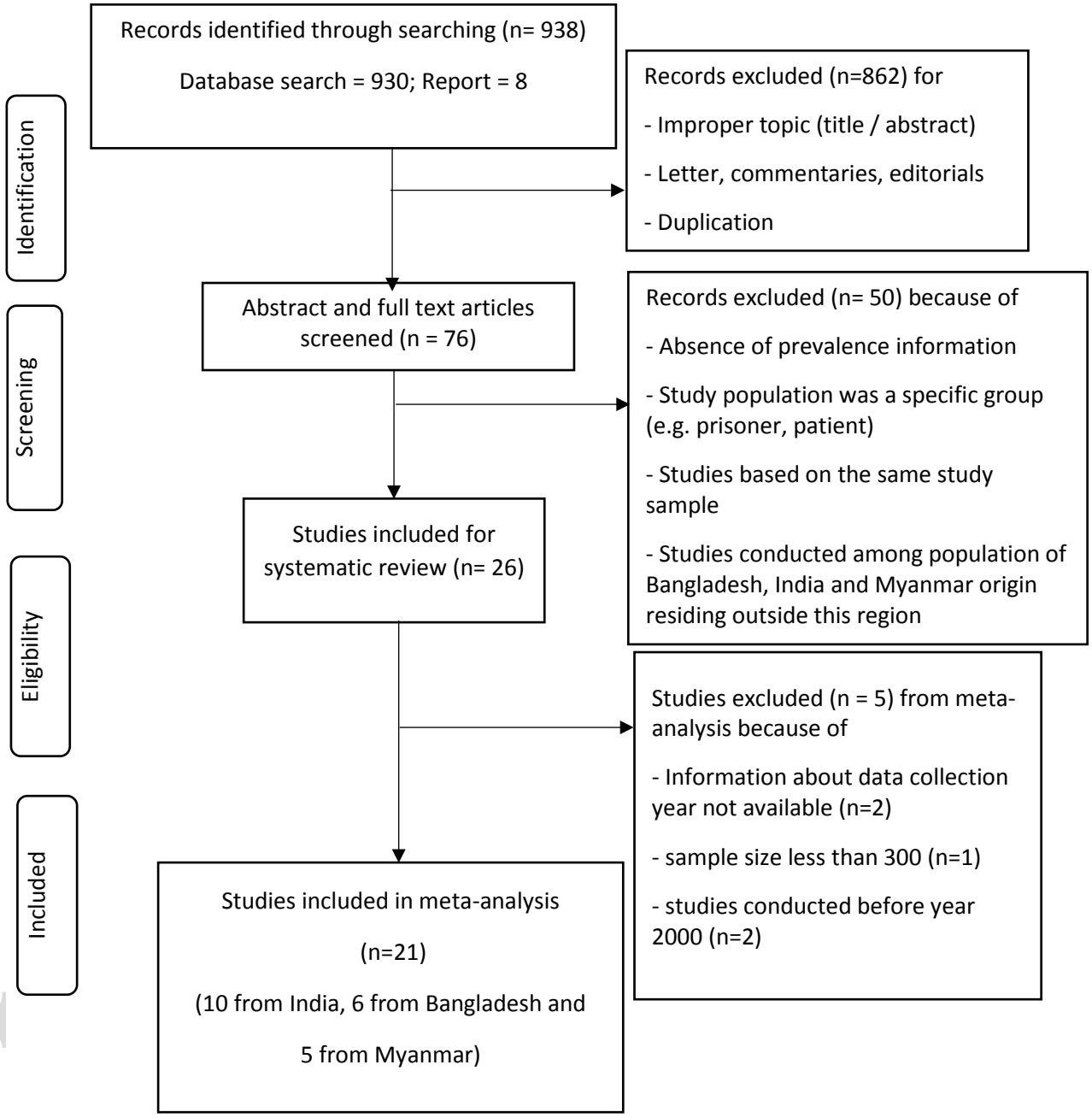
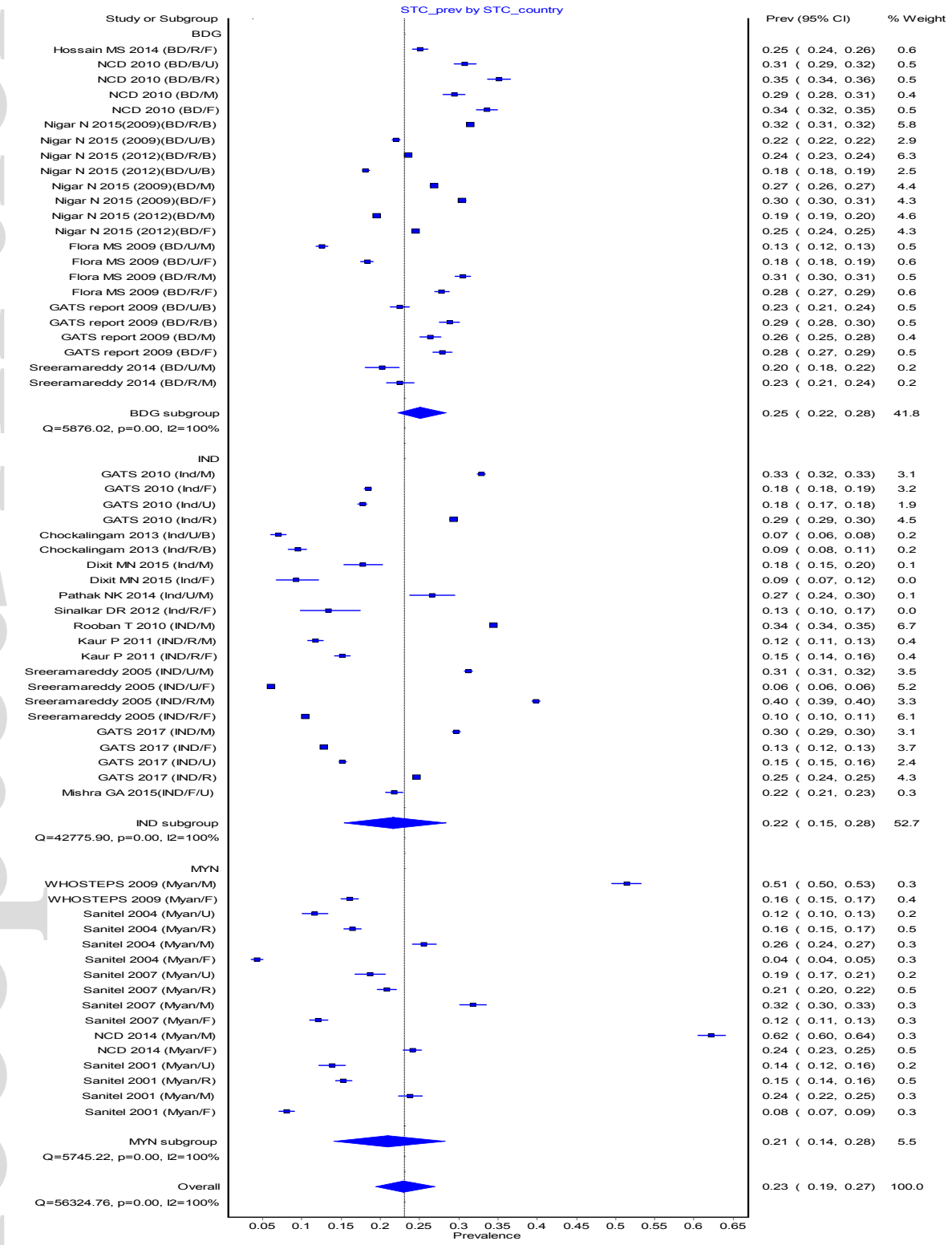


Figure 2. Forest plot on prevalence of STC in Bangladesh, India and Myanmar



*BDG/BD=Bangladesh; IND=India; MYN=Myanmar; M=male; F= Female; B=both male and female; U=urban; R=rural

Figure 3. STC prevalence in Bangladesh, India and Myanmar over the period (The bars indicate 95% confidence interval)

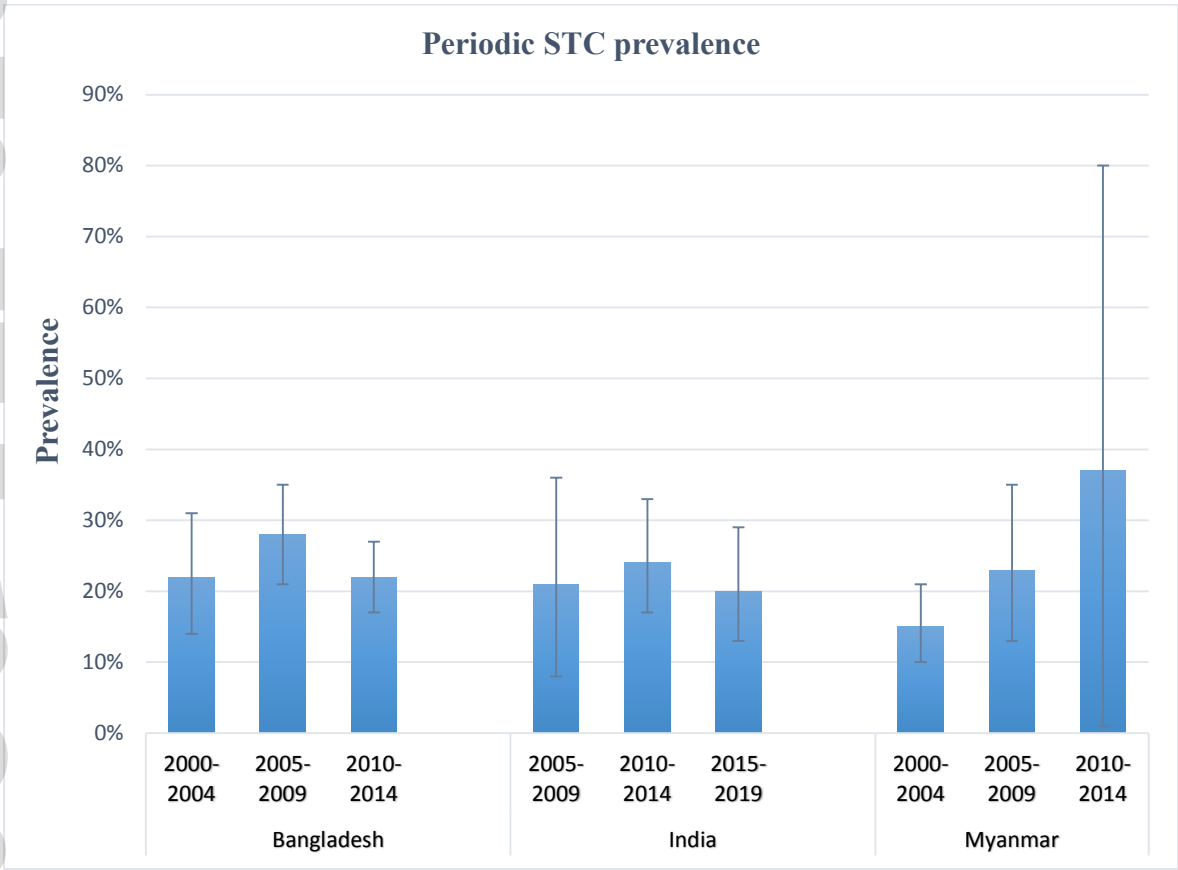


Figure 4. STC prevalence in Bangladesh, India and Myanmar over the period by urban/rural status of respondents (The bars indicate 95% confidence interval)