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Unravelling India's tobacco epidemic – priorities and recommendations for the second round of Global Adult Tobacco Survey (GATS)

Pranay Lal[1], Satyanarayana Srinath[1], Sonu Goel[2], Rana J. Singh[1], Deepak Sharma[2], Ravinder Kumar[1] and Om Bera[1]

Abstract: The Global Adult Tobacco Survey, or GATS, has proved to be an invaluable tool for policymakers. In India, it highlighted the alarming rates of prevalence of use and risks both nationally and at state level. However, a rapid analysis of GATS-India shows that there are limitations in methods (sampling, questionnaire, measures undertaken to ensure data quality and management), which may impact the estimates of prevalence. This review discusses these potential weaknesses and recommends measures that can be adopted in the next round of surveys to overcome the limitations.

Keywords: Global Adult Tobacco Survey, tobacco, tobacco control, prevalence, India

Background

According to WHO, nearly six million people die from tobacco-related causes every year. If present patterns of use persist, tobacco use could cause as many as one billion premature deaths globally during the 21st century (1). In developing countries such as India, a diverse variety of tobacco use results in complex consumption patterns which differ by geography, population, gender, age, socio-economic status and educational attainment. In the year 2008, one study (popularly termed the Million Death Study) estimated that at least 930,000 adult deaths in India could be attributed to smoking, which would rise to over one million annually from 2010 onwards if the current pattern of tobacco use continues (2). In the year 2012, a study estimated that smoking had caused nearly 100 million premature deaths in adult Indian men ≥ 35 years over the last 100 years (between 1910 and 2010). Some of these deaths will occur up to the middle of this century (3).

Previous nationally representative surveys such as the National Family Health Surveys 2 and 3 captured tobacco use prevalence, but they were primarily reproductive and child health focused (4,5). In light of the Indian Government's commitments after signing the Framework Convention on Tobacco Control (FCTC), a national survey to inform decision making for tobacco control was necessary. The Global Adult Tobacco Survey (GATS) was born from this commitment, with major support from the US Centers for Disease Control and Prevention (6). It was initiated in May 2008 and data released in 2010. GATS estimated that more than one-third (35% or 274.9 million) of adults in India use tobacco in one form or another. The number of tobacco users in India exceeds the population of Indonesia and Canada combined – by itself this number would be equivalent to the fourth largest country in the world. Nearly 21% of adults use only smokeless tobacco (163.7 million), 9% only smoke (68.9 million) and nearly 5% smoke as well as use smokeless tobacco (42.3 million) (6).

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Since its release, GATS has informed national and state level policymakers in focusing their attention on specific tobacco-related challenges. In terms of absolute numbers, 15 states are home to over 95% of all current tobacco users. Overall GATS confirms that India has high rates of chewing and smoking in men, chewing among women, early initiation of smoking in men and women, low quit ratios across all age groups and genders, and a significantly high burden from second-hand smoke (SHS), thereby reinforcing the need for efforts to prevent initiation, reduce exposure to SHS and provide cessation services, in order to reduce tobacco associated morbidity and mortality.

The GATS provides nationally representative data for the tobacco use behaviours of civilian, non-institutionalized individuals aged 15 years and older. Details of the methods and sampling strategy are discussed in the GATS-India report (6). The objectives of the GATS-India are to: one, measure the impact of tobacco control efforts through implementation of different provisions of India's tobacco control legislation (The Cigarettes and Other Tobacco Products Act, 2003, or COTPA 2003) and its regulations; and two, systematically monitor adult tobacco (smoking and smokeless) use and track key tobacco control indicators.

The objective of this paper is to highlight the issues and concerns with respect to GATS 2010 and from there recommend measures that need to be taken to improve the next round of GATS. The issues covered include objectives, indicators, choice of sample size and representation, quality assurance, and analysis.

Methodology

A small group of experts (users of GATS disaggregated data) met for a one-day meeting on April 8, 2013 in New Delhi, India; discussed the research framework upon which GATS 2010 was based; and deliberated upon the objectives of GATS, tobacco control indicators chosen, choice of sample size and representativeness, relevance of exclusion criteria, quality assurance measures, data inconsistencies and data analysis/interpretation. The survey instrument was discussed with respect to questions which should be added, deleted or modified in order to improve response and data quality. All possible deficiencies were listed and grouped into two major domains (objective of GATS and survey methods deployed). A discussion was moderated by the lead authors (PL, SS) to address each objective. In addition, the disaggregated dataset was independently analysed by two contributors (DS, OB) and validated by two others (SG, RK) for specific questions to assess the level of consistencies and validity of responses. A summary of the discussions and recommendations emanating from the meeting are listed here.

Section 1: revisiting the objectives of GATS

The GATS is a component of the Global Tobacco Surveillance System (GTSS) which was designed to enhance capacities to design, implement and evaluate tobacco control interventions, and monitor key indicators from the World Health Organization (WHO) FCTC and WHO MPOWER technical package among FCTC signatories (7). The GTSS includes: the Global Youth Tobacco Survey (GYTS) for youth, and the Global School Personnel Survey (GSPS) for school children, the Global Health Professional Survey (GHPS) for health professionals and, most recently, the GATS for adults (8). To the best of the authors' knowledge, the next round of GATS in India will be standalone and supersede the other three surveys.

Tobacco control efforts in the country presently encompass a wide range of activities conducted by both the Government and civil society organizations. The major policy regulatory framework includes COTPA 2003; the National Tobacco Control Programme (NTCP), 2007, under the 11th Five Year Plan; the Cable and Television Act, 2008; the Ban on Smoking in Public Places Act, ratified October 2, 2008; and the Finance Act (Union Budget), among others (8,9). India is also a signatory to the FCTC and has several obligations to fulfil in light of its requirements (10).

In order to assess tobacco epidemiology in a country, a survey should capture information on tobacco prevalence, incidence, health effects (including morbidity and mortality), and impact of the present tobacco control interventions. The objectives of the GATS 2009–10 were to:

1. Measure the impact of tobacco control efforts through implementation of different provisions of COTPA 2003 and its regulations.

2. Systematically monitor adult (smoking and smokeless) tobacco use and track key tobacco control indicators (6).

In light of the multiple tobacco control efforts in the country apart from COTPA, we propose that objective 2 should be the primary objective of the survey and objective 1 should be expanded to adequately capture and reflect current tobacco epidemiology and control efforts in the country, including the activities of the NTCP. Table 1 depicts indicators which are required to capture the effects of major tobacco epidemiology and control efforts in the country, aspects of the key current tobacco control efforts they reflect, and whether they are captured in the GATS source survey. The key indicators are based on a review of major tobacco control intervention literature and are categorized into the WHO MPOWER framework, as in the source survey (7-17). Some of the indicators that need to be included in subsequent surveys include level of support for tobacco control policies, proportion of < 18 year olds who believe it is easy to obtain tobacco products, proportion of adults who have been fined for smoking in public places, proportion of adults willing to ask someone not to smoke in their presence, indicators on detailed smoking cessation, indicators on self-reported health status, and more detailed and accurate indicators on socio-economic status.

Section 2: concerns with GATS-India survey methods

GATS adopted a stratified multi-stage cluster sampling approach using probability proportional to size (PPS) random selection methods, separately at urban and rural levels (6). The basic sampling strategies used design standardization to ensure cross-country comparisons and consistencies over time, while allowing individual countries flexibilities to adapt to country-specific requirements (18). Validity of the survey estimates was maintained by using probability sampling methods, effective sample recruitment strategies, computing sampling weights, accommodating sample design features such as stratification, cluster sampling, and planned disproportionate sample allocation (18). The primary purpose of the sampling was to produce prevalence rates for tobacco use behaviour, SHS exposure, economics of tobacco use, media exposure, knowledge and attitudes, and demographic characteristics. These prevalence rates were produced at the national level and for key reporting domains: urban–rural divide, gender and geographic region of the country (17). While these indicators are adequate for macro-level estimations, we propose certain modifications in future GATS.

First, as tobacco control efforts in India are planned by state governments and implemented at district level, therefore aggregate regional estimates may not be adequate to plan, implement and monitor the impact of tobacco control interventions. Further, our tabulations show that weightage over-estimates the central, west and southern regions, while under-sampling the north, east and north-east regions (Figure 1). When compared with the Census of India 2009 population projections, there is considerable under-sampling in the top 10 tobacco consuming states (Figure 2) (19), which may have led to lower prevalence estimates. According to GATS the population of those 15 and above in the state of Chhattisgarh is 45,930,500 but as per the Census of India population projections it was 23,600,000 in 2009 (including all ages). This has led to Chhattisgarh being classified as a high prevalence state, whereas it may or may not have been such.

Second, GATS-India is a household survey and hence includes only the household population and this defines its limitations. GATS used age, institutionalization status and military participation as status criteria for sample selection, since a considerable number of persons in the age group of 15 to 25 years may be at institutions (students) or employed as migrant workers and are away from their homes. This age group presents a vulnerable demographic to tobacco use (20), and it is especially important that they are adequately represented in the sample.

The GATS methodology does not mention how it estimates the proportion of the target population (Indian residents, age 15 and above, and non-institutionalized) from the total population of adults, and how and why it excludes the institutionalized while identifying its sample frame. A case in point is of migrants. According to Census of India 2001, internal migrants in India constitute a large population, nearly 309 million internal migrants or 30% of the population, and by more recent estimates 326 million or 28.5% of the

Table 1. Key tobacco control indicators capturing tobacco epidemiology and major control efforts in India.

Indicator[a]	*COTPA*	*NTCP*	*Finance acts*	*GATS captures*	*Comments*
Monitor tobacco use and prevention policies					
Current tobacco use	+	+		Yes	
Current tobacco smokers	+	+		Yes	
Current cigarette smokers	+	+		Yes	
Current *bidi* smokers	+	+		Yes	
Current smokeless tobacco use	+	+		Yes	
Average number of cigarettes smoked per day	+	+		Partial	Should also be captured for former users
Average number of *bidis* smoked per day	+	+		Partial	As above
Average units of smokeless tobacco consumed per day				Yes	
Average age at daily smoking initiation	+	+		Yes	
Average age at daily smokeless tobacco initiation	+	+		Yes	
Former tobacco smokers among ever daily smokers	+	+		Yes	
Former daily user of smokeless tobacco among ever daily users	+	+		Yes	
Percentage of households reporting tobacco use inside the home	+	+		Yes	Asked only for smoking
Percentage of adults reporting working in tobacco-free workplaces	+	+		Yes	
Level of awareness of national tobacco control policies	+	+		Partial	Indirect
Level of awareness of state and/or local tobacco control policies	+	+		Partial	Indirect
Level of support for enforcement of tobacco control policies in public places	+	+		No	
Level of support for enforcement of tobacco control policies in schools	+	+		No	
Perceived compliance with tobacco-free schools, hospitals and other public places	+	+		Partial	Indirect
Proportion of people <18 years who believe it is easy to obtain tobacco products	+	+		No	
Proportion of adults who have been fined for smoking in public places	+	+		No	
Protect people from second-hand smoke					
Percentage of adults exposed to second-hand smoke at home	+	+		Yes	
Percentage of adults exposed to second-hand smoke at work	+	+		Yes	
Percentage of adults exposed to second-hand smoke while commuting	+	+		Yes	Only for public transport
Exposure to second-hand smoke in public places	+	+		Yes	

(Continued)

Table 1. (Continued)

Indicator[a]	*COTPA*	*NTCP*	*Finance acts*	*GATS captures*	*Comments*
Level of awareness of media messages on second-hand smoke	+	+		Partial	Only for general media warnings
Percentage of adults willing to ask person not to smoke in their presence	+	+		No	
Offer help to quit tobacco use					
Percentages of smokers who made quit attempt in the past 12 months		+		Yes	Number of attempts and duration stayed quit is not asked
Level of awareness of available cessation services		+		No	
Percentage of adults who have been asked about their tobacco use status by health care providers		+		Partial	Only asked for last 12 months for current users, should be asked for all
Percentages of smokers who were advised to quit by a health care provider		+		Yes	Follow up question could be – did you quit, if so, for how long?
Percentage of adults who attempted to quit smoking using different cessation methods		+		Yes	
Made a smokeless tobacco quit attempt in the past 12 months		+		Yes	
Advised to quit smokeless tobacco by a healthcare provider		+		Yes	As above
Percentage of adults who attempted to quit using smokeless tobacco using different cessation methods		+		Yes	
Number of quit attempts made in the last 12 months by current tobacco users		+		No	
Percentage of current tobacco users interested in quitting tobacco use		+		Yes	What would make a user quit or stay quit? Price, pack warning, repeated media warnings, others/ specify
Percentage of current tobacco users reporting follow-up contact by health care provider		+		No	
Percentage of adults successfully quitting tobacco in the last 12 months		+		No	
Warn about the dangers of tobacco					
Percentage of adults who believe that tobacco smoking causes serious illness	+	+		Yes	
Percentage of adults who believe that tobacco smoking causes specific diseases	+	+		Yes	
Percentage of adults who believe smokeless tobacco smoking causes serious illness	+	+		Yes	
Percentage of adults who believe breathing other people's smoke causes serious illness	+	+		Yes	

(Continued)

Table 1. (Continued)

Indicator[a]	*COTPA*	*NTCP*	*Finance acts*	*GATS captures*	*Comments*
Percentage of adults who believe breathing second-hand smoke is harmful for children and pregnant women	+	+		No	
Percentage of adults who have discussed tobacco use with their children	+	+		No	
Level of receptivity to current pictorial health warnings on tobacco products	+	+		Yes	
Level of receptivity to anti-tobacco media messages	+	+		Yes	
Enforce bans on tobacco advertising or promotion					
Percentage of adults who noticed any cigarette advertisement, sponsorship or promotion	+	+		Yes	
Percentage of adults who noticed any *bidi* advertisement, sponsorship or promotion	+	+		Yes	
Percentage of adults who noticed any smokeless tobacco advertisement, sponsorship or promotion	+	+		Yes	
Percentage of adults who noticed anti-cigarette smoking information at any location	+	+		Yes	
Percentage of adults who noticed anti-*bidi* smoking information at any location	+	+		Yes	
Percentage of adults who noticed anti-smokeless tobacco information at any location	+	+		Yes	
Raise taxes on tobacco					
Average cigarette expenditure per month among current manufactured cigarette smokers			+	Yes	
Average *bidi* expenditure per month among current *bidi* smokers			+	Yes	
Average smokeless tobacco expenditure per month among current users			+	Yes	
Point of last tobacco purchase (store, street vendor)			+	Yes	
Level of support for increasing taxes on various tobacco products			+	No	
Health status					
Pregnancy status				No	
Confirmed non-communicable disease (from detailed list)				No	
Confirmed communicable disease (from detailed list)				No	
Confirmed lung disease				No	

(Continued)

Table 1. (Continued)

Indicator[a]	*COTPA*	*NTCP*	*Finance acts*	*GATS captures*	*Comments*
Confirmed cancer				No	
Self-reported health status				No	
Awareness of adverse health effects of tobacco				Partial	Only stroke, heart attack, and lung cancer captured
Socio-demographic variables					
Socio-economic status				Partial	Assets presently captured need to be expanded to adequately reflect SES

COTPA: The Cigarettes and Other Tobacco Products (Prohibition of Advertisement and Regulation of Trade and Commerce, Production, Supply and Distribution) Act, 2003; NTCP: The National Tobacco Control Programme; GATS: The Global Adult Tobacco Survey, 2009–10; SES: Socio-economic status.
[a]Classified according to the WHO MPOWER package (9).

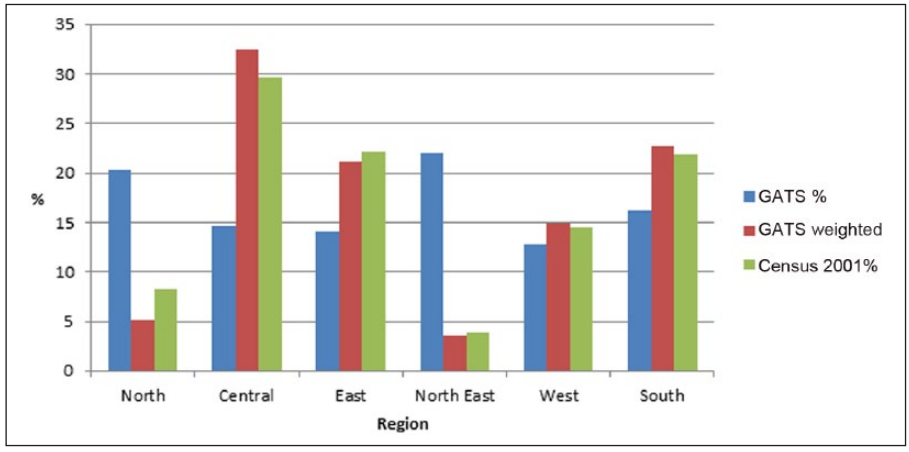

Figure 1. GATS-India 2009–10 and Census of India 2001 population estimates

population (21), and projections indicate that internal migrants may increase in number to approximately 400 million in Census 2011 (22). Because the Census of India fails to adequately capture flows of short-term migrants, it poses challenges in estimating to public health and in particular surveillance of disease prevalence (23). GATS does not mention how it addresses or corrects data for migrants (and other institutionalized populations), who comprise a large percentage of young adults, adolescents and women, who are more vulnerable to tobacco use. Some health surveys, like the sentinel survey of HIV, have taken adequate steps to include these populations and thereby provide more representative estimates, which has helped improve interventions (24). Given the lack of studies on tobacco use among vulnerable populations, GATS should incorporate population-focused survey strategies which provide a representative estimate of tobacco use among a significant population that comprises the 'institutionalized'. At a more fundamental level, there are inherent differences in definitions on institutional population across surveys methods globally (25) and that defined by Census of India (26). Given India's population, a small error in

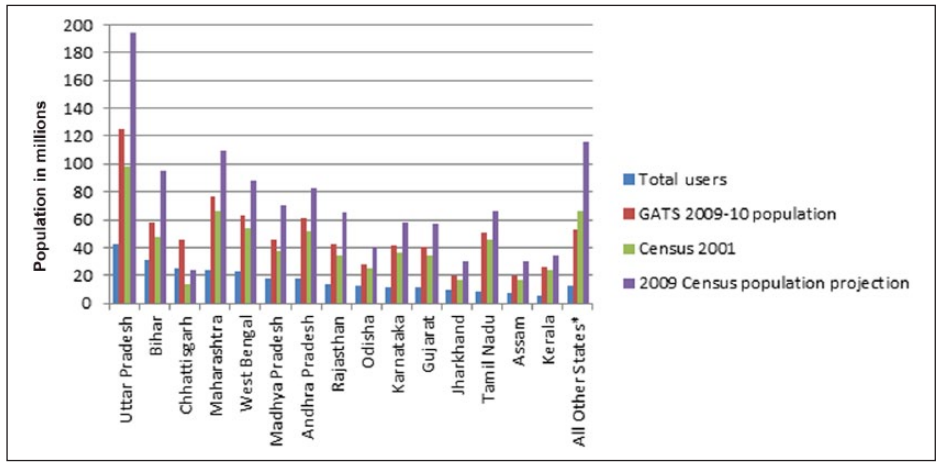

Figure 2. State-wise distribution of GATS 2009–10 among top 10 tobacco consuming states against Census 2001 and Census 2009 population projections

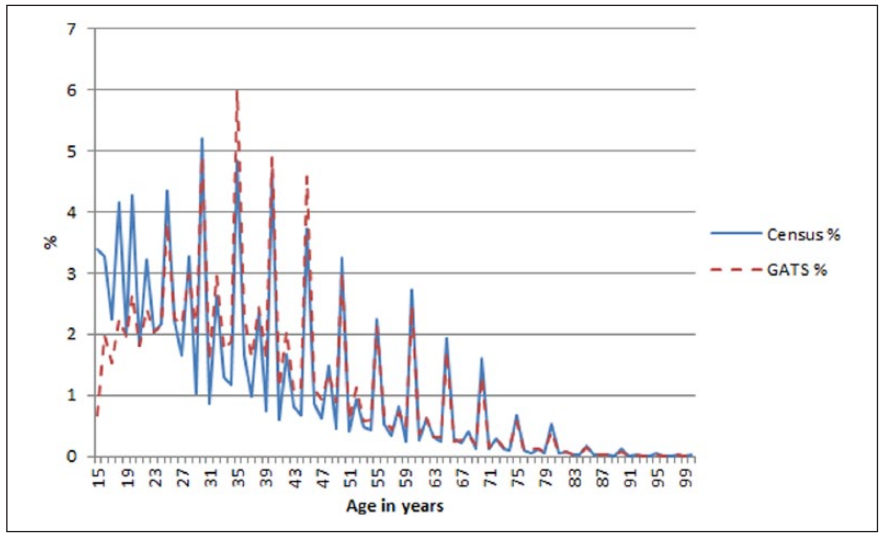

Figure 3. Age distribution of GATS 2009-10 sample and Census 2001

estimation at regional or national level reflects a large magnitude in absolute terms.

However, the GATS sampling strategy effectively excludes a significant number of this population (Figure 3). There is also a higher proportion of women in the 30–50 years age group (Figure 4) and a lower proportion of men in the 15–30 years age group, as compared with Census projections (Figure 5). As a result of this, we believe that the tobacco usage estimates at the national and regional levels could be compromised. In addition, because of under-representation of certain age groups, certain important indicators that are helpful in monitoring the tobacco epidemic and criteria are compromised. To cite one, the 15 to 19 and 20 to 24 age groups are under-represented for both males and females in the GATS when compared with their proportion in the underlying population (Figure 6). This impacts the

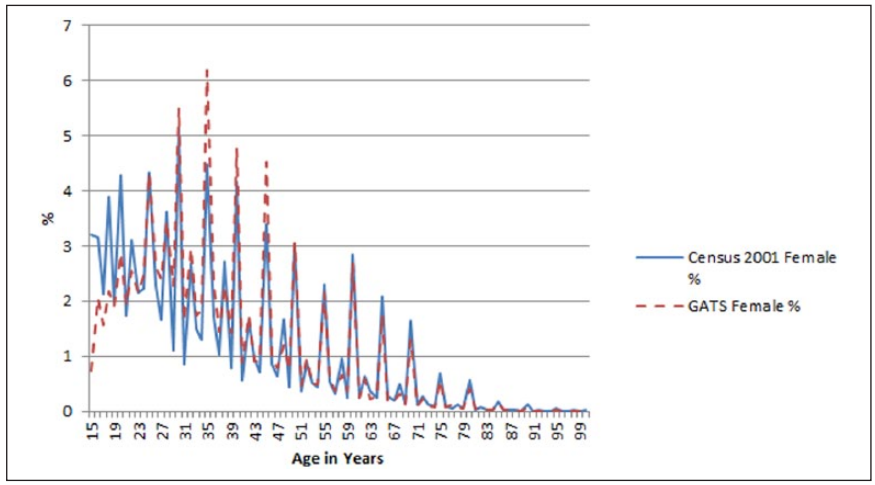

Figure 4. Female age distribution of GATS 2009-10 sample and Census 2001

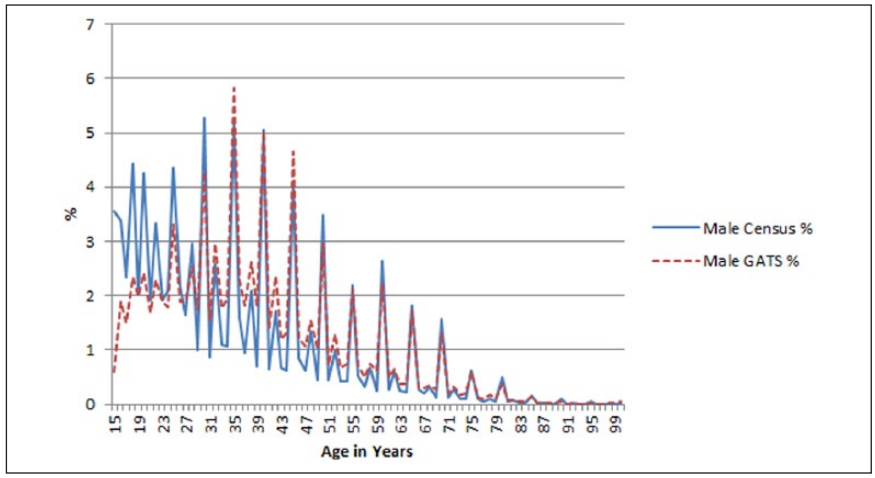

Figure 5. Male age distribution of GATS 2009-10 sample and Census 2001

numbers of those who initiate tobacco use and the age at which they initiate. The population estimates shown in Table 3.5 of the GATS-India report have a potential to cause misinterpretations and confusion amongst policy makers and programme managers because they are not properly normalized. Such errors have implications on tobacco control programme design and interventions.

Assessing the effects of population-focused interventions is important and necessitates the inclusion of these additional variables into the survey in order to provide a baseline and for inter-temporal comparisons. These include priority areas of interventions such as dual users, heavy users, information on former users and tobacco use trajectories, age of initiation and age of consistent use (based on present level of use), level of SHS exposure, and current morbidities that need to be captured for state-level estimates.

Third, there are discrepancies in the reporting of the procedures used for data collection and quality assurance. *The GATS India Report 2009–10* and

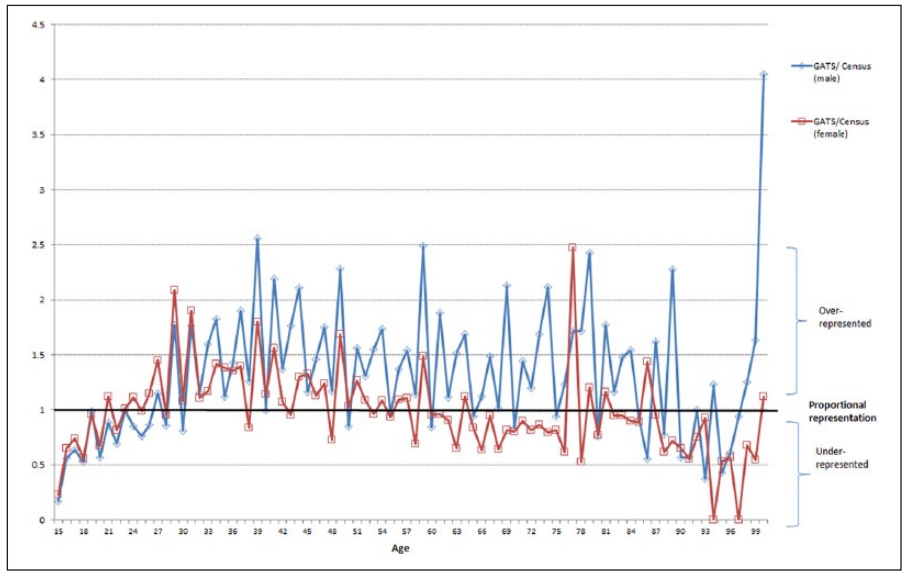

Figure 6. Variation in proportion of age distribution – comparing GATS 2009-10 sample versus Census 2001 for males and females

the *Quality Assurance: Guidelines and Documentation Report* outline the measures taken to ensure data validity (27,28). Measures were taken pre-, post- and during data collection to ensure quality. Considerable focus was placed on data collection through computer-assisted interviewing using iPAQ© handheld PDA computers, which were specially programmed with several quality checks (28). Pre-testing of the questionnaire was done in only one location (Indore), in the Hindi language. However, the survey has been conducted in 19 other languages as per the options in the data codebook, and it is not clear whether the survey instrument was pre-tested in all languages. Also, the pilot was undertaken in May 2008, well over a year before data collection commenced. Given these challenges, the quality control may not be assured. This is evident from the publicly available data, which highlights several logically conflicting and invalid responses. To illustrate a few: almost 1.3% of all smokers reported 'daily smoking' initiation before five years of age, with 0.26% reporting 'daily smoking' initiation at zero years old. Among smokeless users, more than 3% reported daily initiation before five years of age, with 0.86% reporting initiation at zero years. Of the 9223 current daily smokers, 187 (2%) reported smoking zero units of any smoking product daily and also had missing values for weekly consumption. Very high daily consumption was also found: 13 daily cigarette users used between 80 and 110 cigarettes a day and six *bidi* smokers consumed between 88 and 99 *bidis* a day. Among daily smokers, 66 reported smoking smokeless tobacco products like *gutka, khaini, zarda* and *gudaku* as 'other product(s) you currently smoke each day'. For the same question 28 responses were ambiguously classified as 'locally made tobacco with'; and 55 reported using cigarette, *bidi*, hookah, or cigars, which should have been captured in previous questions on these items. Among the 13,410 current daily smokeless users, 996 (almost 7.5%) reported nil daily use of betel quid with tobacco, *khaini, gutkha*, oral tobacco, pan masala and nasal tobacco. For the number of respondents who reported that smoking occurs inside their home on a daily, weekly or monthly basis, there is a discrepancy between tabulations with disaggregated data (28,377) and compiled report (37,369 according to Table 6.4 of the GATS report). Similarly, for exposure to second-hand smoke at work, there are inconsistencies between

disaggregated and reported data (according to the GATS codebook, summation value of 1 and 3 of E05 is 14,862 but if we sum up responses no. 1, 2, 7, 9 of Q E08, the total is 16,887).

GATS also presents information on cigarette and *bidi* brands consumed in the country. According to GATS more than 350 brands of cigarettes exist in India, although only 62 registered brands exist while another 19 are imported (29). The list of brands that is mentioned in the code book also does not reflect the most prevalent brands smoked. Since GATS has found regional preference for brands, regional language surveys done by different agencies could have pre-empted this. In its current format, the data for brands are redundant. There is therefore a need for greater emphasis for clarity on the method adopted for calculating data collected against indicators. Availability of an easy to use guide for replicating official tabulations is also required.

Fourth, there are conflicts of interest in agencies hired to conduct the GATS survey. Although this is an unrelated issue with respect to data quality, there is conflict of interest in the participation of some survey organizations in the GATS process. At least three organizations engaged in survey also work closely with the tobacco industry. Given that the Government of India and the WHO are bound by the principles of the FCTC (the authors are not clear about the exclusion criteria adopted by the Centers for Disease Control and Prevention and the International Institute for Population Sciences), participation of these organizations in the survey is a conflict of interest and a violation of the FCTC principles (a list of industry assignments done by some of these agencies is available at the website, Legacy Tobacco, http://legacy.library.ucsf.edu/ and within company websites).

The next round of the survey should address these four broad concerns, which perhaps overcome the inconsistencies. Clarity on the method of calculation of indicators and availability of a guide for replicating official tabulations is also required.

Conclusion and recommendations

GATS has proved to be an invaluable tool to support the designing of tobacco control strategies. As many countries, including India, prepare to repeat the next round of the GATS survey, we identify some major limitations in the current GATS methodology and propose the following recommendations to be considered in the next round:

- In order to make the data programmatically relevant, it is essential that the data be state-specific. Therefore, the region based sampling needs to be replaced by state based sampling which is locally relevant.
- India has a confounding variety of tobacco use, as a result of which it faces diverse epidemics which differ by geographies, populations, gender, age, socio-economic status and educational attainment. Current indicators need to be refined to bring in better understanding of existing and emerging public health concerns and in identifying priority areas of interventions. Therefore, PPS sampling needs to be supported with purposive sampling. There needs to be purposiveness in covering all populations (e.g. migrants), age groups with valid age and gender-specific sample. The sampled population of the state should reflect the age and gender distribution of the underlying population. Similarly, excluded populations have a bearing on the overall prevalence and must be captured in the sampling frame. If included, future surveys will produce state-wise prevalence rates and provide more accurate information in terms of product type and prevalence, and refine tobacco control efforts.
- The GATS strategy of sampling equal respondents of both genders also needs revisiting, as the lower prevalence of use among women suggests a need for larger samples.
- There is a need for greater methodological rigour in pre-testing of the questionnaire, data collection, ambiguity within and across questions, data quality, data entry and data validation, which pose serious concerns about the validity of the disaggregated data.
- Future surveys should be designed to be more inclusive and consultative by including members of civil society, academia, programme managers and statisticians from other disciplines. It is important to make available the questionnaire, survey methods, sampling frame and data validation process for review to independent reviewers prior to the survey.

This consultation and review identified limitations in the GATS methodology adopted for India. The

errors in sampling and measurement may have significantly affected the prevalence estimates presented by GATS. These errors may be large and have the potential to incorrectly inform regional or state-specific tobacco control policies and programmes. Some of the recommendations made here may require additional resources (human, managerial, financial), but to our understanding this will provide representative, more authoritative and rigorous data to enable informed choices within decision-making and make planning for, and measuring the impact of, interventions more effective.

Conflict of interest

None.

Contributors

PL designed and conceived the study; SS and SG designed the study; DS, OB, PL, SS and SG have made substantial contributions to data analysis and interpretation of data; SS, RJS, RK, SG and PL were responsible for drafting and revising the article; and SG, DS, RJS, RK and OB contributed with validating the research and the drafts. All authors approved the final submitted version.

Data sharing statement

No additional data are available from the authors. Open access to GATS data is available through the Centers for Disease Control and Prevention website: http://nccd.cdc.gov/gtssdata/Ancillary/Documentation.aspx?SUID=4&DOCT=1

Ethics approval

Not commissioned since it is a review of an open-sourced and publically available dataset.

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Provenance and peer review

Not commissioned; externally peer reviewed.

Key messages

As India prepares to undertake the next round of the GATS, we find some limitations in the methodology of the previous GATS and recommend the following measures for future surveys:

- Since tobacco control strategies are implemented at state level, PPS sampling has to be expanded to include all age groups, gender and 'excluded' populations. The sampling in future surveys should provide state-wise estimates of prevalence rates, as states differ widely in terms of tobacco product type, prevalence and other variables, which will be helpful in designing context specific tobacco control strategies and programmes.
- The GATS strategy of purposively sampling equal respondents of both genders also needs revisiting, as the lower prevalence of use among women suggests a need for larger samples. Similarly, proportionate sampling for the 15–25 years age group will enable better understanding of tobacco use behaviors in different age groups and thus support the design of effective control strategies.
- There is a need to enhance the methodological rigour in pre-testing of the questionnaire, addressing ambiguity within and across questions, data collection, data quality, data entry and data validation.

Strengths and limitations

Strengths of our study

- The analysis is based on the open-sourced and publically available dataset.
- It used simple tools for analyses and assessed representativeness of groups by age, gender and geography.

Limitations

- Only a few important areas have been covered in our review.
- We did not estimate the impact of not including 'missed' populations on the overall estimation of prevalence in the previous survey, but have recommended this as an area of further research.

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