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Multivariate Decomposition of Factors Contributing to Changes in Attempts to Quit Smoking in India and Bangladesh: Evidence from the Global Adult Tobacco Survey

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Abstract

Background:

Attempts to quit smoking (AQS) are a core indicator of the reach and effectiveness of cessation policy in low- and middle-income countries. This study applied multivariate decomposition to identify the demographic, socioeconomic and smoking-related factors associated with changes in AQS between two waves of the Global Adult Tobacco Survey (GATS) in India and Bangladesh, and to quantify each factor's contribution to that change.

Methods:

GATS Wave 1 (2009-10) and Wave 2 (2015-17) data for adults aged ≥ 15 years in India and Bangladesh were analysed. Adults who smoked at the time of the survey or in the preceding 12 months and gave a valid response to the AQS question were included. Relative changes (RCs), chi-square tests and z-tests compared sample characteristics and AQS prevalence between waves, overall and within categories. Survey-weighted logistic regression identified factors associated with AQS in each wave. Multivariate decomposition for logit models partitioned the between-wave change into an endowment effect (changes in the distribution of characteristics) and a composition effect (changes in the associations between those characteristics and AQS).

Results:

The prevalence of current or past-12-month smoking fell significantly in India (RC=−23.28%) and Bangladesh (RC=−16.08%). AQS rose in India, from 32.27% to 35.50% (RC=+10.00%, $p<0.001$), but fell in Bangladesh, from 49.23% to 44.59% (RC=−9.43%, $p<0.001$). In India, the endowment effect accounted for 95.74% of the increase, driven mainly by greater exposure to anti-smoking information in digital media (40.12%) and print media (31.53%) and by more smoke-free homes (27.32%). In Bangladesh, the decline was attributable to the composition effect (134.30%), partly offset by favourable changes in characteristics (endowment effect

–34.30%); a weakening association between workplace smoking restrictions and quit attempts accounted for 54.40% of the decline.

Conclusions:

Multivariate decomposition distinguishes changes in population characteristics from changes in behavioural associations as drivers of quit attempts. Anti-smoking media messages, smoke-free homes and advice from health professionals consistently favoured quit attempts, whereas the diminishing influence of workplace restrictions in Bangladesh points to the need for stronger enforcement. Context-specific strategies combining mass-media communication, smoke-free environments and professional cessation support are warranted.

Keywords: Smoking cessation; Quit attempts; Tobacco control; Global Adult Tobacco Survey; Multivariate decomposition; Health surveys; India; Bangladesh

Background

Tobacco use remains one of the leading preventable causes of death and disability worldwide, responsible for more than eight million deaths each year (1, 2). In 2020, 22.3% of the global population used tobacco, and more than four-fifths of people who use tobacco live in low- and middle-income countries (LMICs) (2, 3), where the burden of disease is highest and the challenges of tobacco control are greatest. Global Burden of Disease estimates attribute approximately 8.9% of all deaths in India and 11.9% in Bangladesh to tobacco (4), underscoring the magnitude of the problem in the region.

To address this global challenge, the World Health Organization (WHO) introduced the MPOWER package of tobacco control measures in 2007, which has been instrumental in global efforts to reduce smoking (1). Although the global prevalence of tobacco use is declining, the reduction has been comparatively smaller in LMICs, where the majority of people who use tobacco live. This may reflect differences in the implementation and impact of MPOWER measures in these settings (3), as well as other factors such as aggressive targeting by the tobacco industry, variation in public health infrastructure and healthcare resources, and differences in the strength and enforcement of tobacco control regulations (5). Attempts to quit smoking (AQS) are a key indicator for evaluating cessation efforts: a quit attempt represents an individual's transition from awareness to behaviour change, and population-level AQS can serve as a core indicator of the effectiveness of national tobacco control interventions (6).

AQS is shaped by a range of demographic, socioeconomic and contextual factors. While many studies have examined the associations between these factors and quit attempts (7), few, if any, have quantified how much each factor has contributed to observed changes in quit attempts

over time. Such evidence is essential for identifying which interventions are driving progress and which population groups require targeted support (8).

This study addresses this gap by applying multivariate decomposition analysis to two waves of the Global Adult Tobacco Survey (GATS; 2009–10 and 2016–17) in India and Bangladesh. These neighbouring countries share many socio-cultural characteristics but implemented different tobacco control policies and enforcement measures over this period, and both have completed two rounds of GATS. The decomposition approach separates the overall change in AQS into a component attributable to shifts in population characteristics (endowment effect) and a component attributable to changes in the associations between those characteristics and AQS, which may reflect behavioural or attitudinal change (composition effect). By distinguishing changes in population structure from changes in behaviour, the study aims to provide a more nuanced understanding of the drivers of quit attempts and to identify opportunities for tailored, context-specific policy action.

Methods

Data source and ethical approval

Data from the two waves of GATS in India and Bangladesh were obtained from the publicly available Global Tobacco Surveillance System data repository of the US Centers for Disease Control and Prevention (CDC) (9). GATS is a nationally representative household survey that monitors tobacco use among adults aged 15 years and older using a standardised protocol across participating countries. The first round was conducted in 2009–10 in India and in 2009 in Bangladesh, and the second round in 2016–17 in India and in 2017 in Bangladesh. Detailed information on survey design, sampling and implementation is available in the respective country reports (10, 11).

Ethical approval for this secondary analysis was obtained from the Institutional Ethics Committee of the Public Health Foundation of India (Ref. TRC-IEC 479/21) before the study began.

Analytic sample

The analytic sample comprised all participants who reported currently smoking tobacco or having smoked within the 12 months preceding each survey wave, and who provided a valid response to the cessation-related questions. Current smoking status was determined from responses to the question *“Do you currently smoke tobacco on a daily basis, less than daily, or not at all?”* Participants who answered “daily” or “less than daily” were classified as currently smoking. Those who answered “not at all” were asked *“In the past, have you smoked tobacco on a daily basis, less than daily, or not at all?”* Participants who reported daily or less-than-daily smoking in the past and who had stopped smoking within the past 12 months were classified as having smoked in the past 12 months.

Outcome variable

The outcome variable, AQS, was defined as having attempted to quit smoking in the past 12 months, regardless of whether the attempt was successful. It was assessed using the question *“During the past 12 months, have you tried to stop smoking?”*, which did not specify the type of smoked tobacco product. Respondents who answered “Yes” were classified as having made a quit attempt, and those who answered “No” as not having done so. Missing responses and responses of “don’t know” or “refused” (0.1%–0.9% across countries and waves) were excluded from the analyses.

Sociodemographic variables

Demographic and socioeconomic variables were included as background explanatory variables. Age was categorised as 15–24, 25–34, 35–44 and 45+ years. Sex (male/female) and place of residence (urban/rural) were dichotomous. Education was recategorised as no formal education; primary or less (any formal education up to completion of primary school); secondary or less (education beyond primary school up to completion of high school); and higher education. Employment status was dichotomised as employed (any type of employment) or not employed (including homemakers, students, retired people and others). The wealth index, derived in GATS by principal component analysis (PCA) of household assets and amenities such as electricity, television, car, radio, internet, washing machine, computer/laptop, motorbike, bicycle and tractor, was recategorised into three groups: low (combining the original ‘lowest’ and ‘low’ categories), medium, and high (combining ‘high’ and ‘highest’).

Smoking-related variables

Receipt of advice to quit smoking from a doctor or other health care provider in the past 12 months was dichotomised (yes/no) based on two questions: “During any visit to a doctor or health care provider in the past 12 months, were you advised to quit smoking tobacco?” and “During the past 12 months, did you use counselling, including at a smoking cessation clinic, to try to stop smoking tobacco?”

Responses to questions on the cessation methods used in the past 12 months, ranging from prescription and over-the-counter medications to traditional or complementary medicines and quitlines, together with a question on using “anything else to stop smoking”, were combined into a dichotomous composite variable indicating receipt of any other help to quit. Switching

to smokeless tobacco to stop smoking was retained as a separate variable because it does not represent quitting tobacco use. Because these questions were asked only of respondents who reported a quit attempt, all respondents in the 'yes' category of either variable had, by definition, attempted to quit; these two variables were therefore reported descriptively but were not entered into the regression or decomposition models.

Participants were asked whether, in the past 30 days, they had noticed information in a range of media about the dangers of smoking or encouraging people to quit smoking cigarettes or bidis. Responses were grouped into three dichotomous variables: print media (newspapers, magazines, posters, billboards and similar), digital media (television, radio, cinema, internet and similar) and any other location.

A composite variable, 'exposure to pro-smoking advertisements and promotions in the past 30 days', was created by combining positive responses to questions on noticing tobacco advertisements or signs in stores, in various media, on public transport vehicles or at stations, on public walls, and in other identifiable sources such as branded clothing. Exposure to advertisements and promotions that indirectly promoted smoking or tobacco products was captured in a second composite variable, 'exposure to surrogate advertisements in the past 30 days'.

Indoor smoking rules at home and indoor smoking policy at the workplace were each dichotomised as 'allowed' (combining 'allowed' and 'no rules/no policy') and 'not allowed' (combining 'never allowed' and 'not allowed but with exceptions/allowed only in some areas'), based on responses to the questions "Which of the following best describes the rules about smoking inside of your home?" and "Which of the following best describes the indoor smoking policy where you work?". For workplace policy, respondents to whom the question did not

apply were included in the reference category. This categorisation reflects the legislative context in India, and in several other South Asian countries, where large workplaces and some public places are permitted to have designated indoor smoking areas¹².

Other smoking-related variables, including smoking by family members, exposure to second-hand smoke and noticing health warnings on cigarette packages, were considered in preliminary analyses but were excluded from the final models because of insufficient observations in one or more categories.

Statistical analysis

Datasets were checked for completeness and cleaned before analysis. All analyses were conducted in Stata for Windows, version 17.0 (StataCorp, College Station, TX, USA). Statistical significance was set at $\alpha=0.05$.

The number and percentage of participants in each category of the independent variables differed between Wave 1 and Wave 2 because of independent sampling in each wave, differences in sampling procedures and missing responses. Differences in participant characteristics between waves were examined using chi-square tests, and the relative change (RC) was calculated to describe proportional shifts between waves as follows:

$$RC = \frac{(\% \text{ Wave 2} - \% \text{ Wave 1})}{\% \text{ Wave 1}} \times 100.$$

Z-tests were used to assess the statistical significance of changes between waves in sample size, in the percentage of participants who smoked currently or in the past 12 months, and in the percentage with a valid AQS response. These results are presented in Table 1, which summarises the unweighted characteristics of the analytic sample in each wave. These values

provide context for interpreting the subsequent analyses and are not intended as national estimates.

Survey-weighted multivariable logistic regression models were used to examine factors associated with AQS in each wave, with all variables entered simultaneously (Table 2). Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were estimated. In accordance with GATS/CDC analytic guidelines (13), the sampling weights and strata provided in the datasets were applied to account for the complex survey design and to obtain population-representative estimates. Model discrimination was assessed using receiver operating characteristic (ROC) curves.

Relative changes were also computed to quantify changes in AQS prevalence within each category of every independent variable between Wave 1 and Wave 2, and z-tests were used to assess the statistical significance of these within-category changes (Table 3). Because the aim of these analyses, and of the decomposition, was to examine how changes in the composition of the analytic samples related to changes in AQS, rather than to produce population estimates, GATS weights and strata were not applied. This preserved the observed differences in sample composition between waves, which weighting would otherwise have masked.

The primary analysis was a multivariate decomposition for non-linear (logit) models, which quantified the contribution of each factor to the overall change in AQS between Wave 1 and Wave 2. Although decomposition methods are well established in economics and increasingly used in health research, their application to repeated national tobacco surveys to explain changes in cessation behaviour is novel. The descriptive and regression analyses described above were conducted to support and contextualise the decomposition.

The decomposition used the `mvdcmp` procedure in Stata (14), which extends the Blinder–Oaxaca decomposition (15) to non-linear response models such as the logit model (Table 4). The raw difference in AQS prevalence between waves (R) is partitioned into two components, the endowment effect (E) and the composition effect (C), such that $E + C = R$. The endowment effect quantifies the part of the change in AQS attributable to differences in the distribution of characteristics between the two samples; for example, the difference in the proportion of participants who were female. The composition effect, also termed the coefficient effect, quantifies the part attributable to differences in the coefficients, that is, in the strength of the association between each characteristic and AQS, including the model intercept. It therefore reflects changes in the preferences, attitudes and behaviours of people within each category (for example, whether women in Wave 2 were more or less likely to attempt to quit than women in Wave 1), as well as the influence of unmeasured factors. For each component, the detailed decomposition reports the contribution of each variable as a coefficient and as a percentage of the raw difference (Pct.), with its statistical significance. In Table 4, R is expressed as a positive value for both countries, representing the magnitude of the increase in India and of the decrease in Bangladesh; positive percentages therefore indicate factors that contributed to the observed direction of change, and negative percentages indicate factors that counteracted it.

Results

Results are presented in four stages, progressing from descriptive comparisons to the decomposition analysis that quantifies the contribution of each factor to the overall change in AQS.

The first section of Table 1 summarises, for each wave and country, the total number of participants, the number and percentage who smoked currently or in the past 12 months, and the number and percentage with a valid response to the AQS question, with 95% CIs. The proportion of adults who smoked currently or in the past 12 months declined significantly in both countries: in India, from 17.18% (95% CI 16.87–17.49) in Wave 1 to 13.18% (95% CI 12.92–13.44) in Wave 2 (RC=–23.28%, $p<0.001$), and in Bangladesh, from 23.88% (95% CI 22.91–24.87) to 20.04% (95% CI 19.27–20.83) (RC=–16.08%, $p<0.001$).

Sample differences between Wave 1 and Wave 2 (Table 1)

In India, the proportion of participants aged 45+ years increased from Wave 1 to Wave 2, while the proportions in all other age groups decreased. Compared with Wave 1, the Wave 2 sample included significantly higher proportions of rural residents, participants with primary or secondary education, employed participants and those in the low wealth index category. The sex distribution did not change significantly, with men comprising almost 90% of both samples.

In India, the proportion who had received advice to quit from a doctor or other health care provider remained almost unchanged (22.01% vs 22.56%, $p=0.333$). However, there were significant increases in the proportions who received any other help to quit smoking, who noticed information about the dangers of smoking in print and digital media, and who reported that smoking was not allowed at home or in the workplace. Conversely, the proportions who tried to switch to smokeless tobacco to quit smoking, who noticed anti-smoking information in other locations, and who were exposed to pro-smoking advertisements and promotions or to surrogate advertisements decreased significantly.

Significant differences in sample characteristics between waves were also observed in Bangladesh. Compared with Wave 1, the Wave 2 sample included higher proportions of participants aged 35–44 and 45+ years, of men and of those in the medium wealth index category, and a lower proportion with no formal education. As in India, fewer than a quarter of participants in either wave reported receiving advice to quit from a doctor or other health care provider. The proportion who used other forms of help to quit smoking increased substantially (RC=224.81%). Fewer participants tried to switch to smokeless tobacco, while more noticed anti-smoking information in print media, digital media and other locations. Exposure to pro-smoking advertisements and promotions and to surrogate advertisements decreased.

Associations with AQS within each wave (Table 2)

Table 2 presents the AORs for the association of each variable with AQS within each wave. Age was significantly associated with AQS only in Wave 1 in India, where participants aged 35–44 and 45+ years were less likely to have attempted to quit than those aged 15–24 years. Sex was significantly associated with AQS only in Wave 2 in Bangladesh, where men were more likely than women to have attempted to quit (AOR=3.33, 95% CI 1.30–8.55, $p=0.012$). Rural residence was associated with higher odds of AQS in Wave 1 in India (AOR=1.18, 95% CI 1.01–1.37, $p=0.039$). Compared with those with no formal education, participants with primary education in Wave 2 in India were more likely (AOR=1.22, $p=0.034$), and those with higher education in Wave 1 in Bangladesh were less likely (AOR=0.51, $p=0.022$), to have attempted to quit. In India, participants in the high wealth index category had lower odds of AQS in Wave 1 (AOR=0.79, $p=0.024$).

Participants who reported receiving advice to quit from a doctor or other health care provider in the past 12 months had significantly higher odds of AQS in both waves in both countries

(AORs 2.11–2.71). In India, participants who noticed information about the dangers of smoking in print media in Wave 1 were significantly more likely to have attempted to quit (AOR=1.60, $p<0.001$). In Bangladesh, noticing anti-smoking information in digital media was associated with higher odds of AQS in both waves (AOR=1.64 in each). Exposure to surrogate advertisements was positively associated with AQS in Wave 1 in Bangladesh (AOR=1.52, $p=0.002$).

Not allowing smoking inside the home was significantly associated with higher odds of AQS in both waves in both countries, with AORs ranging from 1.31 (India, Wave 2) to 1.94 (Bangladesh, Wave 1). Workplace smoking restrictions were significantly associated with higher odds of AQS only in Wave 1 in Bangladesh (AOR=1.88, 95% CI 1.27–2.79, $p=0.002$).

Changes in AQS within categories (Table 3)

The overall prevalence of AQS among adults who smoked currently or in the past 12 months increased significantly in India (RC=10.00%, $p<0.001$) and decreased significantly in Bangladesh (RC=−9.43%, $p<0.001$). Table 3 also presents the relative change in AQS prevalence within each category of each variable between waves, together with the significance of these differences.

Among age groups, AQS increased significantly in India among participants aged 35–44 and 45+ years, whereas in Bangladesh it decreased significantly among those aged 25–34 years. Because both samples were predominantly male, men showed significant changes in AQS consistent with the overall trend in each country. In India, AQS increased significantly among both urban and rural residents, whereas in Bangladesh a significant decrease was observed only

among urban residents. In both countries, a significant change in AQS was observed among employed participants but not among those who were not employed.

In India, AQS increased significantly both among participants who had and among those who had not received advice to quit from a health care provider. In Bangladesh, a significant decrease was observed only among those who had not received such advice. In India, AQS increased significantly among those who noticed anti-smoking information in print and digital media and among those who were not exposed to pro-smoking advertisements, promotions or surrogate advertisements. In Bangladesh, by contrast, significant decreases in AQS, consistent with the overall national trend, were observed both among those who did and among those who did not notice anti-smoking information across the different media types.

In India, AQS increased significantly among participants living in homes where smoking was allowed (RC=10.29%, $p<0.001$) but did not change among those living in smoke-free homes ($p=0.818$). AQS also increased significantly among participants both with ($p=0.011$) and without ($p<0.001$) workplace smoking restrictions. In Bangladesh, AQS decreased significantly among those living in smoke-free homes (RC=−16.68%, $p<0.001$) and among those reporting workplace smoking restrictions (RC=−33.51%, $p<0.001$).

Multivariate decomposition of the change in AQS (Table 4)

The first section of Table 4 presents the overall decomposition into the endowment (E) and composition (C) effects, which together sum to the raw difference in AQS between waves (R). The raw difference was statistically significant in both countries (India: 0.032, an increase of 3.2 percentage points, $p<0.001$; Bangladesh: 0.046, a decrease of 4.6 percentage points, $p=0.001$). In India, the increase was almost entirely explained by the endowment effect (95.74%, $p<0.001$), whereas the composition effect was small and non-significant (4.26%,

$p=0.852$). This indicates that the rise in AQS reflected changes in the characteristics of people who smoked rather than changes in how those characteristics related to quit attempts. In Bangladesh, both components were significant but acted in opposite directions: changes in characteristics counteracted the decline ($E=-34.30\%$, $p=0.031$), whereas changes in coefficients accounted for more than the entire decline ($C=134.30\%$, $p<0.001$). Because the composition effect also absorbs the influence of unmeasured factors through the model intercept, this finding is consistent with smoking cessation being a complex behaviour influenced by a wide range of individual, social and environmental factors (7).

Endowment effect: contribution of changes in sample characteristics

The second section of Table 4 shows the contribution of changes in the distribution of each characteristic (Table 1) to the change in AQS. Although the Indian sample changed significantly across many characteristics, changes in only six characteristics made a statistically significant contribution to the change in AQS between waves.

The small increase in the proportion of participants who received advice from a doctor or other health care provider made a modest but significant positive contribution to the increase in AQS (3.86% , $p<0.001$), and the minor change in sex distribution made a negligible, although statistically significant, contribution ($p=0.009$). The largest contributions to the increase in AQS in India came from the rise in the proportions who noticed anti-smoking information in digital media (40.12%) and print media (31.53%) and who reported smoke-free homes (27.32%), all $p<0.001$. The increase in the proportion of rural residents made a significant negative contribution (-4.82% , $p=0.006$).

In Bangladesh, where the decomposition explains a decline in AQS, positive percentages indicate factors that contributed to the decline and negative percentages indicate factors that counteracted it. Changes in characteristics that significantly counteracted the decline, and thus favoured quit attempts, were the increases in the proportions who noticed anti-smoking information in digital media (-22.95% , $p<0.001$), print media (-9.51% , $p=0.004$) and other locations (-7.63% , $p<0.001$), who lived in smoke-free homes (-7.41% , $p<0.001$) and who reported workplace smoking restrictions (-1.12% , $p<0.001$), together with the marginal increase in those advised to quit by a health care provider (-0.03% , $p<0.001$). Changes that significantly contributed to the decline were the decrease in the proportion exposed to surrogate advertisements (11.24% , $p=0.014$) and the increase in the proportion with primary education (6.41% , $p=0.048$).

Composition effect: contribution of changes in associations with AQS

The third section of Table 4 shows that, in India, changes in the coefficients of individual variables made no statistically significant contribution to the change in AQS between waves, consistent with the non-significant overall composition effect.

In Bangladesh, only one variable made a significant contribution to the composition effect: the association between workplace smoking restrictions and AQS weakened markedly between waves, accounting for 54.40% of the overall decline in AQS ($p<0.001$).

Discussion

This study is among the first to apply multivariate decomposition to national tobacco cessation data. Whereas previous GATS analyses have mainly reported prevalence estimates or the presence or absence of statistically significant associations, this approach quantifies how much

of the observed change in quit attempts can be attributed to changes in population characteristics and how much to changes in the associations between those characteristics and quit attempts. This distinction provides a more precise understanding of the dynamics underlying cessation trends and allows the findings to be interpreted in light of the national tobacco control policies implemented between the two survey waves.

The decomposition revealed a complex interplay of socioeconomic, demographic and tobacco control factors influencing AQS. The findings support three components of the WHO MPOWER package: warning people about the dangers of tobacco through mass media (W), protecting people from tobacco smoke through smoke-free homes and workplaces (P), and offering help to quit, notably through advice from health care providers (O). The differences observed between the two countries suggest that the contribution of these measures to quit attempts depends on how they are implemented and enforced.

Several factors favoured quit attempts in both countries despite broader contextual differences. Receiving advice to quit from a doctor or other health care provider was strongly associated with AQS in both waves in both countries (Table 2), and changes in the proportion receiving such advice made statistically significant, although in Bangladesh negligible, contributions in the decomposition, reinforcing the critical role of health systems in promoting cessation. Similarly, noticing anti-smoking messages in print media (such as newspapers and posters) and digital media (including television and radio) contributed positively to AQS in both countries, highlighting the importance of mass media in tobacco control communication. Smoke-free homes were another consistent contributor, which may reflect both individual motivation and supportive household environments that discourage smoking and encourage cessation. In line with the 'P' component of MPOWER (protect people from tobacco smoke), these findings

suggest that strengthening health care engagement, sustaining anti-tobacco media campaigns and promoting smoke-free homes are key opportunities for tobacco control in both settings.

Country-specific findings are discussed below.

India

In India, AQS increased significantly between waves, and the decomposition attributed almost all of this increase to changes in population characteristics, particularly greater exposure to anti-smoking information and more smoke-free homes. These changes are likely to reflect, at least in part, coordinated public health efforts under the National Tobacco Control Programme (NTCP), which aimed to increase public awareness and integrate cessation support into health services (16). More recent initiatives, including the National Tobacco Quitline Services (NTQLS) (17) and its regional satellite centres, the mCessation programme (18), de-addiction services, and tobacco cessation centres (TCCs) in dental institutes under the National Oral Health Programme (16, 19), several of which were introduced around or after the second survey wave, are likely to further strengthen India's multifaceted approach to tobacco cessation.

Although the proportion of participants who received advice from a doctor or other health care provider increased only slightly and not significantly between waves, this change made a significant positive contribution to AQS in the decomposition. This reflects the strong association between professional advice and quit attempts, and suggests that even modest improvements in health care-based cessation support can yield measurable gains, supporting greater investment in brief interventions in clinical settings. Smoke-free homes also emerged as an important driver of quit attempts, underscoring the value of promoting household smoke-free norms as both a protective factor and a motivator for cessation. Public health messaging

should continue to emphasise not only the harms of tobacco use but also the benefits of establishing smoke-free homes.

Bangladesh

In Bangladesh, AQS decreased between waves; however, the findings suggest a complex interaction between tobacco control efforts and their influence on quit attempts over time. The positive effect of professional advice on smoking cessation is well established (20, 21), and Table 2 confirms significantly higher odds of AQS among those who received such advice in both waves. It is therefore concerning that the proportion who reported receiving cessation advice from a doctor or other health professional remained virtually unchanged between Wave 1 (23.74%) and Wave 2 (23.75%) (Table 1), indicating considerable scope for greater integration of cessation advice into routine health care.

The significant increase in exposure to anti-smoking information across media channels (Table 1) counteracted the decline in AQS between waves (Table 4), suggesting that future campaigns in Bangladesh should continue to prioritise these channels (22, 23).

This may be partly explained by legislative and policy changes in Bangladesh between the two waves. In 2013, Bangladesh amended the Smoking and Tobacco Products Usage (Control) Act 2005 (24), introducing stricter restrictions on tobacco advertising and promotion and strengthening anti-smoking communication.

Nevertheless, exposure to surrogate advertisements and tobacco promotions among adults who smoked remained high in Bangladesh (44.11% in Wave 1 and 35.38% in Wave 2) compared with India (6.32% and 4.62%, respectively). This is concerning and underscores the need for stricter enforcement and monitoring of tobacco advertising laws. The positive association between exposure to surrogate advertising and AQS in Wave 1 (Table 2) is counterintuitive and should be interpreted with caution; it may reflect greater overall media exposure, and hence

greater exposure to anti-smoking messages, among those who noticed such advertising, rather than a causal effect.

The largest contributor to the decline in AQS in Bangladesh was the change in the association between workplace smoking restrictions and quit attempts. Although the proportion of participants reporting workplace restrictions remained virtually unchanged between waves (Table 1), the association between these restrictions and AQS changed markedly, from AOR=1.88 ($p=0.002$) in Wave 1 to AOR=0.66 ($p=0.062$) in Wave 2 (Table 2). This shift was reflected in a significant decline in AQS prevalence within this group (RC=-33.51%, $p<0.001$; Table 3) and accounted for more than half of the overall decline in AQS in Bangladesh (Table 4). Possible explanations, such as weak enforcement of workplace restrictions or the normalisation of designated smoking areas, warrant further investigation. Strengthening workplace tobacco control policies, ensuring their enforcement and linking them with accessible cessation support should be a key policy consideration. In addition, the permissibility of designated smoking areas or sanctioned smoking breaks in workplaces should be critically re-evaluated, as such allowances may undermine the intended impact of restrictions.

Finally, in Wave 2 in Bangladesh, women were significantly less likely than men to have attempted to quit (Table 2), consistent with other studies (25). Although the number of women who smoked in the sample was small and declining, this finding warrants public health attention, including the provision of gender-sensitive cessation support.

Strengths

This study used two waves of nationally representative GATS data, enabling analysis of changes in cessation behaviour over time across diverse demographic and socioeconomic

groups. Including India and Bangladesh allowed a comparison between neighbouring countries with similar contexts but different tobacco control trajectories.

A key strength is the use of multivariate decomposition, which is still rarely applied in tobacco control research. Unlike conventional regression, which identifies factors associated with AQS at a single point in time, this approach quantifies the extent to which each factor contributed to the change in AQS over time. Such evidence is critical for identifying which policy- or population-level changes are driving, or hindering, progress in tobacco control. The analysis reports the contribution of each factor both as a coefficient and as a percentage of the overall change, together with its statistical significance.

Limitations

This study has several limitations. First, the repeated cross-sectional design of GATS precludes causal inference about the relationships between the factors studied and AQS. Second, although a broad range of explanatory variables was included, important factors such as cultural norms, social support, nicotine dependence and individual motivation were not included, and the study lacked qualitative insight into the psychological, cultural and social influences on cessation. Such unmeasured influences are absorbed into the composition effect through the model intercept, which may partly explain the large composition effect observed in Bangladesh. Third, as with all detailed decompositions involving categorical variables, the contributions of individual categories to the composition effect depend on the choice of reference category and should be interpreted with caution. Fourth, AQS was self-reported over a 12-month recall period and may be subject to recall bias. Fifth, Tables 1 and 3 and the decomposition were based on unweighted data in order to reflect differences in sample composition; these estimates may therefore differ from nationally weighted GATS figures and may partly reflect differences in survey design between waves.

Finally, as a secondary analysis, the study was constrained by the structure and wording of the GATS questions and response options. Some variables, particularly those related to media exposure and motivation to quit, might have been measured with greater nuance had the survey been designed for this purpose. Where the number of responses for specific media exposures was small, composite variables had to be constructed, which may have obscured more granular trends.

Conclusions

Advice from health care providers, exposure to anti-smoking messages in print and digital media, and smoke-free homes were key drivers of quit attempts in India and Bangladesh. In India, the increase in quit attempts was explained almost entirely by favourable changes in these characteristics. In Bangladesh, the diminishing influence of workplace smoking restrictions on quit attempts was the main contributor to the decline, highlighting the need for stronger enforcement and complementary cessation support. Integrated tobacco control policies that reinforce these elements are warranted. Future research should explore the cultural and contextual dimensions of cessation behaviour, use longitudinal designs, and evaluate the real-world impact of specific policy measures to inform more targeted public health strategies.

Abbreviations

AOR: adjusted odds ratio; AQS: attempts to quit smoking; CDC: Centers for Disease Control and Prevention; CI: confidence interval; GATS: Global Adult Tobacco Survey; LMICs: low- and middle-income countries; NTCP: National Tobacco Control Programme; NTQLS: National Tobacco Quitline Services; PCA: principal component analysis; RC: relative change; ROC: receiver operating characteristic; TCC: tobacco cessation centre; WHO: World Health Organization.

Declarations

Ethics approval and consent to participate

This study is a secondary analysis of de-identified, publicly available GATS data. Ethical approval was obtained from the Institutional Ethics Committee of the Public Health Foundation of India (Ref. TRC-IEC 479/21). Informed consent was obtained from all participants by the national implementing agencies at the time of the original surveys.

Consent for publication

Not applicable.

Availability of data and materials

The GATS datasets analysed in this study are publicly available from the CDC Global Tobacco Surveillance System Data (GTSSData) website.

Competing interests

The authors declare that they have no competing interests.

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Authors’ contributions

MA and MRM conceptualised the study, designed the analysis, interpreted the findings, drafted and revised the manuscript, supervised the work and acquired the funding. TR and SB contributed to the design of the analysis, the interpretation of the findings and the drafting and revision of the manuscript. NK and AG conducted the formal analysis, contributed to the

interpretation of the findings and contributed to the drafting and revision of the manuscript. All authors read and approved the final manuscript.

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Table 1: Change in participant characteristics between GATS Wave 1 and Wave 2, India and Bangladesh (14)

Country	India						Bangladesh					
GATS Wave	GATS-1 (2009-2010)		GATS-2 (2016-2017)		RC %	p-value*	GATS-1 (2009)		GATS-2 (2017)		RC %	p-value*
Measure	N	% of all participants (95% CI of %)	N	% of all participants (95% CI of %)	..	..	N	% of all participants (95% CI of %)	N	% of all participants (95% CI of %)	..	..
Total participants in GATS	69296	100	74037	100	6.84	<0.001	9,629	100	12783	100	32.76	<0.001
Participants who smoked currently or during the last 12 months	11903	17.18 (16.87-17.49)	9757	13.18 (12.92-13.44)	-23.28	<0.001	2299	23.88 (22.91-24.87)	2562	20.04 (19.27-20.83)	-16.08	<0.001
Valid responses to AQS in the past 12 months Question	11796	17.02 (16.72-17.33)	9748	13.17 (12.91-13.43)	-22.62	<0.001	2283	23.71 (22.75-24.70)	2552	19.96 (19.20-20.75)	-15.81	<0.001
Sample characteristics among those with AQS valid responses												
Explanatory/smoking-related independent variable	N in category	% of total (95% CI)	N of category	% of total (95% CI)	RC %	p-value	N in category	% of total (95% CI)	N of category	% of total (95% CI)	RC % of AQS+	p-value
Total	11796	100	9748	100	..	..	2283	100	2552	100	..	..
Age (year)												
15-24	962	8.16 (7.66-8.70)	586	6.01 (5.54-6.52)	-26.35	<0.001	244	10.69 (9.39-12.12)	169	6.62 (5.66-7.70)	-38.07	<0.001
25-34	2524	21.40 (20.57-22.25)	2077	21.31 (20.40-22.24)	-0.42		591	25.89 (23.84-28.06)	604	23.67 (21.82-25.63)	-8.58	
35-44	3425	29.04 (28.07-30.02)	2541	26.07 (25.06-27.10)	-10.23		660	28.91 (26.75-31.20)	744	29.15 (27.10-31.33)	0.83	
45+	4885	41.41 (40.26-42.59)	4544	46.61 (45.27-47.99)	12.56		788	34.08 (31.73-36.56)	1035	40.56 (38.12-43.10)	19.01	
Sex												
Female	1370	11.61 (11.01-12.25)	1108	11.37 (10.71-12.06)	-2.07	0.571	80	3.50 (2.78-4.36)	44	1.72 (1.25-2.32)	-50.86	<0.001
Male	10426	88.39 (86.70-90.10)	8640	88.63 (86.77-90.52)	0.27		2203	96.50 (92.51-100)	2508	98.28 (97.44-100)	1.85	
Residence												
Urban	3725	31.58 (30.57-32.61)	2595	26.62 (25.61-27.67)	-15.70	<0.001	1082	47.39 (44.61-50.30)	1200	47.02 (44.40-49.76)	-0.78	.796
Rural	8071	68.42 (66.94-69.93)	7153	73.38 (71.69-75.10)	7.25		1201	52.61 (49.67-55.67)	1352	52.98 (50.19-55.88)	0.70	
Education level												
No formal schooling	3587	30.51 (29.52-31.52)	2822	28.96 (27.90-30.05)	-5.08	<0.001	1052	46.08 (43.34-48.95)	915	35.85 (33.57-38.25)	-22.20	<0.001
Primary (or less)	3488	29.66 (28.69-30.67)	2987	30.65 (29.57-31.77)	3.34		607	26.59 (24.51-28.79)	815	31.94 (29.78-34.21)	20.12	
Secondary (or less)	3015	25.64 (24.73-26.57)	2749	28.21 (27.17-29.29)	10.02		464	20.32 (18.52-22.26)	600	23.51 (21.67-25.47)	15.70	
Higher education	1668	14.19 (13.51-14.88)	1186	12.17 (11.49-12.88)	-14.24		160	7.00 (5.96-8.18)	222	8.70 (7.59-9.92)	24.29	
Employment status												
Unemployed/other	2454	20.80 (19.99-21.64)	1846	18.94 (18.08-19.82)	-8.94	<0.001	303	13.27 (11.82-14.85)	304	11.91 (10.61-13.33)	-10.25	0.154
Employed	9342	79.20 (77.60-80.82)	7902	81.06 (79.29-82.87)	2.35		1980	86.73 (82.95-90.63)	2248	88.09 (84.48-91.81)	1.57	
Wealth Index												
Low	6054	51.33 (50.04-52.64)	5803	59.53 (58.01-61.08)	15.98	<0.001	1111	48.66 (45.84-51.61)	1182	46.32 (43.71-49.03)	-4.81	0.004
Medium	1975	16.74 (16.01-17.50)	1385	14.21 (13.47-14.98)	-15.11		413	18.09 (16.39-19.92)	559	21.90 (20.13-23.80)	21.06	
High	3766	31.93 (30.92-32.97)	2560	26.26 (25.25-27.30)	-17.76		759	33.25 (30.92-35.70)	811	31.78 (29.63-34.04)	-4.42	
Advised to quit smoking by a doctor or other health care provider in the past 12 months												
No	9200	77.99 (76.41-79.60)	7549	77.44 (75.70-79.21)	-0.71	0.333	1741	76.26 (72.72-79.93)	1946	76.25 (72.90-79.72)	-0.01	0.996
Yes	2596	22.01 (21.17-22.87)	2199	22.56 (21.63-23.52)	2.50		542	23.74 (21.78-25.83)	606	23.75 (21.89-25.71)	0.04	

Received any other help to quit smoking in the past 12 months												
No	11048	93.66 (91.92-95.42)	8751	89.77 (87.90-91.67)	-4.15	<0.001	2191	95.97 (91.99-100.07)	2218	86.91 (83.33-90.61)	-9.44	<0.001
Yes	748	6.34 (5.90-6.81)	997	10.23 (9.60- 10.88)	61.36		92	4.03 (3.25-4.94)	334	13.09 (11.72-14.57)	224.81	
Tried to switch to smokeless tobacco to quit smoking in the last 12 months												
No	11505	97.53 (95.76-99.33)	9607	98.55 (96.59- 100.54)	1.05	<0.001	2196	96.19 (92.21-100.30)	2510	98.35 (94.54-102.28)	2.25	<0.001
Yes	291	2.47 (2.19-2.77)	141	1.45 (1.22-1.71)	-41.30		87	3.81 (3.05-4.70)	42	1.64 (1.19-2.23)	-56.96	
Noticed any information related to dangers of smoking on print media in the last 30 days												
No	7017	59.49 (58.10-60.89)	4219	43.28 (41.98-44.61)	-27.25	<0.001	1547	67.76 (64.43-71.22)	1576	61.76 (58.74-64.88)	-8.85	<0.001
Yes	4779	40.51 (39.37-41.68)	5529	56.72 (55.23-58.23)	40.01		736	32.24 (29.95-34.65)	976	38.24 (35.88-40.72)	18.61	
Noticed any information related to dangers of smoking on digital media in the past 30 days												
No	6088	51.61 (50.32-52.92)	2517	25.82 (24.82-26.85)	-49.97	<0.001	1318	57.73 (54.66-60.93)	1220	47.81 (45.16-50.57)	-17.18	<0.001
Yes	5708	48.39 (47.14-49.66)	7231	74.18 (72.48-75.91)	53.30		965	42.27 (39.64-45.02)	1332	52.19 (49.43-55.07)	23.47	
Noticed any information related to danger of smoking anywhere else in the past 30 days												
No	11112	94.20 (92.46-95.97)	9595	98.43 (96.47-100.42)	4.49	<0.001	2197	96.23 (92.25-100.34)	2420	94.83 (91.09-98.68)	-16.32	0.019
Yes	684	5.80 (5.37-6.25)	153	1.57 (1.33-1.84)	-72.93		86	3.77 (3.01-4.65)	132	5.17 (4.33-6.13)	416.45	
Exposure to pro-smoking ads and promotions in the past 30 days												
No	7955	67.44 (65.96-68.94)	7128	73.12 (71.43-74.84)	8.42	<0.001	762	33.38 (31.05-35.83)	1463	57.33 (54.43-60.34)	71.75	<0.001
Yes	3841	32.56 (31.54-33.61)	2620	26.88 (25.86-27.93)	-17.44		1521	66.62 (63.32-70.06)	1089	42.67 (40.18-45.28)	-35.95	
Exposure to surrogated advertisements in the past 30 days												
No	11051	93.68 (91.95-95.25)	9298	95.38 (93.45-97.34)	1.81	<0.001	1276	55.89 (52.87-59.04)	1649	64.62 (61.53-67.81)	15.62	<0.001
Yes	745	6.32 (5.87-6.79)	450	4.62 (4.20-5.06)	-26.90		1007	44.11 (41.43-46.92)	903	35.38 (33.11-37.77)	-19.79	
Indoor smoking rule at home												
Allowed	8756	74.23 (72.68-75.80)	6074	62.31 (60.75-63.90)	-16.06	<0.001	1546	67.72 (64.38-71.18)	1673	65.56 (62.45-68.77)	-3.19	0.112
Not allowed	3040	25.77 (24.86-26.70)	3674	37.69 (36.48-38.93)	46.26		737	32.28 (29.99-34.70)	879	34.44 (32.20-36.80)	6.69	
Indoor smoking policy at workplace												
No rule/Not applicable	9660	81.89 (80.27-83.54)	7720	79.20 (77.44-80.98)	-3.29	<0.001	1958	85.76 (82.01-89.65)	2180	85.42 (81.87-89.09)	-0.40	0.736
Not allowed/Restrictions	2136	18.11 (17.35-18.89)	2028	20.80 (19.91-21.73)	14.85		325	14.24 (12.73-15.87)	372	14.58 (13.13-16.14)	2.39	

Note: AQS=attempted to quit smoking (in adults who smoked currently or over the last 12 months and tried to stop smoking in the past 12 months).

CI=confidence interval.

RC% = Relative change=[GATS-2(%)-GATS-1(%)/GATS-1(%)]*100.

p-values are obtained using Chi-square tests for contingencies testing the differences in the characteristics of participants between Wave 1 and Wave 2.

Rows with statistically significant differences (p<0.05) are bolded.

Analyses in Tables 1 and 3 were conducted without using GATS weight and strata to help understanding the contribution of background factors to changes in AQLT in the multivariate decomposition analysis. Estimates reflect the analytical sample used for decomposition and may differ slightly from nationally weighted GATS percentages.

Table 2: Adjusted odds ratios for attempts to quit smoking by GATS wave, India and Bangladesh (14)

Independent Factors	India						Bangladesh					
	GATS-1			GATS-2			GATS-1			GATS-2		
	AOR	95% CI	p-value	AOR	95% CI	p-value	AOR	95% CI	p-value	AOR	95% CI	p-value
<i>Age (year)</i>												
15-24	1.00	..	..	1.00	..	..	1.00	..	..	1.00	..	..
25-34	0.75	0.56-1.01	0.058	0.93	0.64-1.35	0.682	1.27	0.82-1.97	0.290	0.87	0.52-1.48	0.616
35-44	0.68	0.52-0.91	0.008	0.90	0.62-1.31	0.595	1.15	0.75-1.76	0.535	0.92	0.54-1.56	0.756
45+	0.64	0.49-0.85	0.002	0.80	0.56-1.14	0.217	1.24	0.82-1.89	0.311	1.44	0.86-2.44	0.170
<i>Sex</i>												
Female	1.00	..	..	1.00	..	..	1.00	..	..	1.00	..	..
Male	0.78	0.60-1.01	0.058	0.78	0.59-1.05	0.096	1.23	0.66-2.32	0.515	3.33	1.30-8.55	0.012
<i>Residence</i>												
Urban	1.00	..	..	1.00	..	..	1.00	..	..	1.00	..	..
Rural	1.18	1.01-1.37	0.039	0.91	0.76-1.09	0.307	0.83	0.62-1.10	0.201	1.09	0.82-1.46	0.560
<i>Education level</i>												
No formal education	1.00	..	..	1.00	..	..	1.00	..	..	1.00	..	..
Primary	0.94	0.78-1.14	0.527	1.22	1.02-1.48	0.034	0.76	0.56-1.02	0.070	0.96	0.72-1.28	0.771
Secondary	1.16	0.93-1.45	0.195	1.09	0.88-1.35	0.448	0.78	0.54-1.14	0.204	1.10	0.78-1.56	0.584
Higher education	1.02	0.76-1.37	0.894	1.08	0.80-1.47	0.605	0.51	0.29-0.91	0.022	0.83	0.42-1.63	0.582
<i>Employment status</i>												
Unemployed/other	1.00	..	..	1.00	..	..	1.00	..	..	1.00	..	..
Employed	0.94	0.77-1.14	0.507	1.13	0.92-1.40	0.251	0.85	0.58-1.28	0.436	0.81	0.55-1.20	0.286
<i>Wealth Index</i>												
Poor	1.00	..	..	1.00	..	..	1.00	..	..	1.00	..	..
Medium	0.89	0.73-1.10	0.284	1.03	0.83-1.27	0.780	0.98	0.71-1.35	0.898	0.76	0.57-1.02	0.064
High	0.79	0.65-0.97	0.024	0.94	0.77-1.15	0.544	1.14	0.81-1.61	0.440	0.94	0.67-1.33	0.735
<i>Advised to quit smoking by a doctor or other health care provider in the past 12 months</i>												
No	1.00	..	..	1.00	..	..	1.00	..	..	1.00	..	..
Yes	2.38	2.04-2.78	<0.001	2.71	2.31-3.17	<0.001	2.63	1.98-3.49	<0.001	2.11	1.59-2.82	<0.001
<i>Received any other help to quit smoking in the past 12 months</i>												
No	..	..	..	..	..	..	..	..	..	..	..	..
Yes	..	..	..	..	..	..	..	..	..	..	..	..
<i>Tried to switch to smokeless tobacco to quit smoking in the last 12 months</i>												
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
<i>Noticed any information related to dangers of smoking on print media in the last 30 days</i>												
No	1.00	..	..	1.00	..	..	1.00	..	..	1.00	..	..
Yes	1.60	1.34-1.90	<0.001	1.13	0.96-1.34	0.138	1.30	0.95-1.77	0.099	1.28	0.96-1.70	0.098
<i>Noticed any information related to dangers of smoking on digital media in the past 30 days</i>												
No	1.00	..	..	1.00	..	..	1.00	..	..	1.00	..	..
Yes	1.14	0.97-1.34	0.117	1.13	0.94-1.36	0.194	1.64	1.24-2.16	0.001	1.64	1.21-2.12	0.001
<i>Noticed any information related to dangers of smoking anywhere else in the past 30 days</i>												
No	1.00	..	..	1.00	..	..	1.00	..	..	1.00	..	..
Yes	1.07	0.79-1.46	0.653	1.39	0.73-2.65	0.316	2.06	0.92-4.61	0.078	1.11	0.61-2.02	0.741
<i>Exposure to Pro-smoking advertisement or promotions in the past 30 days</i>												
No	1.00	..	..	1.00	..	..	1.00	..	..	1.00	..	..
Yes	1.01	0.87-1.17	0.913	1.16	0.98-1.39	0.094	0.84	0.64-1.09	0.194	1.03	0.79-1.33	0.833
<i>Exposure to surrogated advertisements in the past 30 days</i>												
No	1.00	..	..	1.00	..	..	1.00	..	..	1.00	..	..
Yes	0.93	0.69-1.26	0.656	1.05	0.74-1.50	0.767	1.52	1.17-1.98	0.002	1.28	0.96-1.70	0.087
<i>Indoor smoking rule at home</i>												
Allowed	1.00	..	..	1.00	..	..	1.00	..	..	1.00	..	..
Not allowed	1.51	1.29-1.76	<0.001	1.31	1.13-1.52	<0.001	1.94	1.48-2.54	<0.001	1.71	1.32-2.22	<0.001
<i>Indoor smoking policy at workplace</i>												
No rule/Not applicable	1.00	..	..	1.00	..	..	1.00	..	..	1.00	..	..
Not allowed/Restrictions	1.00	0.81-1.23	0.993	0.94	0.78-1.14	0.555	1.88	1.27-2.79	0.002	0.66	0.43-1.02	0.062

Note: AOR- Adjusted odds ratio; adjustments made for all other variables.

CI = Confidence interval. Significant values at 0.05 level are indicated in bold.

Individuals with missing responses for any variable included in this model were excluded from the analysis.

*Variable was excluded from the model due to an insufficient number of observations in one category.

Table 3: Change in prevalence of attempts to quit smoking by participant characteristics, India and Bangladesh (14)

Country	India						Bangladesh					
GATS Wave	GATS-1 (2009-2010)		GATS-2 (2016-2017)		RC %	p-value*	GATS-1 (2009)		GATS-2 (2017)		RC %	p-value*
Explanatory/smoking-related independent variable	N of AQS	% in category (95% CI)	N of AQS	% in category (95% CI)	RC % of AQS+	p-value* (AQS change)	N of AQS	% in category (95% CI)	N of AQS	% in category (95% CI)	RC % of AQS+	p-value* (AQS change)
Total	3806	32.27 (31.25-33.31)	3461	35.50 (34.33-36.71)	10.00	<0.001	1124	49.23 (46.40-52.20)	1138	44.59 (42.04-74.26)	-9.43	<0.001
Age (year)												
15-24	339	35.24 (31.59-39.20)	186	31.74 (27.34-36.64)	-9.93	0.159	120	49.18 (40.78-58.81)	76	44.97 (35.43-56.29)	-8.56	0.401
25-34	814	32.25 (30.07-34.54)	743	35.77 (33.25-38.44)	10.91	0.121	303	51.27 (45.66-57.38)	250	41.39 (36.42-46.85)	-19.27	<0.001
35-44	1079	31.50 (29.65-33.44)	895	35.22 (32.95-37.61)	11.80	0.003	324	49.09 (43.89-54.74)	325	43.68 (39.06-48.70)	-11.02	0.119
45+	1574	32.22 (30.65-33.85)	1637	36.03 (34.30-37.81)	11.82	<0.001	377	47.84 (43.13-52.92)	487	47.05 (42.97-51.42)	-1.65	0.741
Sex												
Female	449	32.77 (29.81-35.95)	371	33.48 (30.16-37.07)	2.17	0.712	31	38.75 (26.33-55.00)	11	25.00 (12.48-44.73)	-35.48	0.121
Male	3357	32.20 (31.12-22.31)	3090	35.76 (34.51-37.05)	11.06	<0.001	1093	49.61 (46.72-52.64)	1127	44.94 (42.35-47.64)	-9.40	0.001
Residence												
Urban	1226	32.91 (31.10-34.81)	1025	39.50 (37.12-41.99)	20.02	<0.001	579	53.51 (49.24-58.05)	547	45.58 (41.84-49.57)	-14.82	<0.001
Rural	2580	31.97 (30.74-33.22)	2436	34.06 (32.72-35.44)	6.54	0.006	545	45.38 (41.65-49.35)	591	43.71 (40.26-47.38)	-3.68	0.395
Education level												
No formal schooling	1071	29.86 (28.10-31.70)	926	32.81 (30.73-35.00)	9.88	<0.001	492	46.77 (42.73-51.09)	382	41.75 (37.67-46.15)	-10.73	0.026
Primary (or less)	1107	31.74 (29.90-33.66)	1101	36.86 (34.71-39.10)	16.13	<0.001	288	47.45 (42.12-53.25)	356	43.68 (39.26-48.46)	-7.95	0.159
Secondary (or less)	1073	35.59 (33.49-37.78)	991	36.05 (33.84-38.37)	1.29	0.719	251	54.09 (47.61-61.22)	287	47.83 (42.46-53.70)	-11.57	0.042
Higher education	549	32.91 (30.22-35.79)	442	37.27 (33.87-40.91)	13.25	0.016	93	58.13 (46.91-71.21)	113	50.90 (41.95-61.20)	-13.83	0.162
Employment Status												
Unemployed/other	778	31.70 (29.51-34.01)	626	33.91 (31.31-36.67)	6.97	0.126	149	49.17 (41.60-57.74)	155	50.99 (43.28-59.68)	3.70	0.446
Employed	3028	32.41 (31.27-33.59)	2835	35.88 (34.57-37.22)	10.71	<0.001	975	49.24 (46.20-52.43)	983	43.73 (41.04-46.55)	-11.19	<0.001
Wealth Index												
Low	1979	32.69 (31.26-34.16)	1967	33.90 (32.41-35.43)	3.70	0.165	506	45.54 (41.66-49.69)	507	42.89 (39.24-46.79)	-5.82	0.201
Medium	648	32.81 (30.33-35.44)	523	37.76 (34.59-41.14)	15.09	0.003	202	48.91 (42.40-56.14)	238	42.58 (37.34-48.34)	-12.94	0.050
High	1178	31.28 (29.52-33.12)	971	37.93 (35.58-40.39)	21.26	<0.001	416	54.81 (49.67-60.34)	393	48.46 (43.79-53.49)	-11.59	0.012
Advised to quit smoking by a doctor or other health care provider in the past 12 months												
No	2459	26.73 (25.68-27.81)	2219	29.39 (28.18-30.64)	9.95	<0.001	768	44.11 (41.05-47.35)	764	39.26 (36.53-42.15)	-11.00	0.003
Yes	1347	51.89 (49.15-54.73)	1242	56.48 (53.38-59.71)	8.85	0.002	356	65.68 (59.04-72.87)	374	61.72 (55.62-68.30)	-6.03	0.165
Received any other help to quit smoking in the past 12 months												
No	3058	27.68 (26.71-28.68)	2464	28.16 (27.06-29.29)	1.73	0.459	1032	47.10 (44.27-50.07)	804	36.25 (33.79-38.84)	-23.04	<0.001
Yes	748	100 (92.96-100)	997	100 (93.89-100)	0	..	92	100 (80.61-100)	334	100 (89.56-100)	0	..
Tried to switch to smokeless tobacco to quit smoking in the last 12 months												
No	3515	30.55 (29.55-31.58)	3320	34.56 (33.39-35.75)	13.13	<0.001	1037	47.22 (44.39-50.19)	1096	43.67 (41.12-46.33)	-7.52	0.014
Yes	291	100 (88.84-100)	141	100 (84.18-100)	0	..	87	100 (80.10-100)	42	100 (72.07-100)	0	..
Noticed any information related to dangers of smoking on print media in the last 30 days												
No	2043	29.12 (27.87-30.41)	1246	29.53 (27.92-31.22)	1.41	0.638	680	43.96 (40.71-47.39)	620	39.34 (36.34-42.56)	-10.51	0.009
Yes	1763	36.89 (35.19-38.65)	2215	40.06 (38.41-41.77)	8.59	<0.001	444	60.33 (54.84-66.21)	518	53.07 (48.60-57.85)	-12.03	0.003
Noticed any information related to dangers of smoking on digital media in the last 30 days												

No	1821	29.91 (28.55-31.32)	702	27.89 (25.87-30.03)	-6.75	0.615	547	41.50 (38.10-45.13)	464	38.03 (34.65-41.66)	-8.36	0.016
Yes	1985	34.78 (33.26-36.34)	2759	38.16 (36.74-39.61)	9.72	<0.001	577	59.79 (55.01-64.88)	674	50.60 (46.85-54.57)	-15.37	<0.001
<i>Noticed any information related to dangers of smoking anywhere else in the last 30 days</i>												
No	3495	31.45 (30.42-32.51)	3393	35.36 (34.18-36.57)	12.43	<0.001	1053	47.93 (45.08-50.91)	1055	43.60 (41.00-46.31)	-9.03	0.003
Yes	311	45.47 (40.55-50.81)	68	44.44 (34.51-56.34)	-2.27	0.818	71	82.56 (64.48-100)	83	62.88 (50.08-77.95)	-23.84	0.002
<i>Exposure to Pro-smoking advertisement or promotions in the past 30 days</i>												
No	2437	30.63 (29.43-31.88)	2500	35.07 (33.71-36.48)	14.50	<0.001	340	44.62 (40.00-49.62)	610	41.70 (38.45-45.14)	-6.54	0.187
Yes	1369	35.64 (33.78-37.58)	961	36.68 (34.40-39.07)	2.92	0.395	784	51.55 (48.00-55.28)	528	48.48 (44.44-52.80)	-5.96	0.124
<i>Exposure to surrogated advertisements in the past 30 days</i>												
No	3523	31.88 (30.84-32.95)	3282	35.30 (34.10-36.53)	10.73	<0.001	563	44.12 (40.55-47.92)	671	40.69 (37.67-43.89)	-7.77	0.629
Yes	283	37.99 (33.69-42.68)	179	39.78 (34.16-46.05)	4.71	0.535	561	55.71 (51.91-60.52)	467	51.72 (47.13-56.63)	-7.16	0.080
<i>Indoor smoking rule at home</i>												
Allowed	2544	29.05 (27.94-30.21)	1946	32.04 (30.63-33.49)	10.29	<0.001	652	42.17 (39.00-45.54)	669	39.99 (37.01-43.14)	-5.17	0.208
Not allowed	1262	41.51 (39.25-43.87)	1515	41.24 (39.19-43.37)	-0.65	0.818	472	64.04 (58.40-70.09)	469	53.36 (48.64-58.41)	-16.68	<0.001
<i>Indoor smoking policy at workplace</i>												
No rule/Not applicable	3101	32.10 (30.98-33.25)	2715	35.17 (33.86-36.52)	-0.19	<0.001	898	45.86 (42.91-48.96)	966	44.31 (41.56-47.20)	-3.38	0.317
Not allowed/Restrictions	705	33.01 (30.61-35.53)	746	36.79 (34.19-39.52)	24.93	0.011	226	69.54 (60.77-79.22)	172	46.24 (39.58-53.69)	-33.51	<0.001

Note: CI=confidence interval.

RC% = Relative change=[GATS-2(%)-GATS-1(%)/GATS-1(%)]*100.

p-values are obtained using z-tests, testing the difference in percentages between Wave 1 and Wave 2 of each row.

Rows with statistically significant differences (p<0.05) are bolded.

Analyses in Tables 1 and 3 were conducted without using GATS weight and strata to help understanding the contribution of background factors to changes in AQSLT in the multivariate decomposition analysis. Estimates reflect the analytical sample used for decomposition and may differ slightly from nationally weighted GATS percentages.

*Variable was excluded from the statistical test due to an insufficient number of observations in at least one category.

Table 4: Multivariate decomposition of the change in attempts to quit smoking, India and Bangladesh (13)

	India					Bangladesh				
AQS	Coef.	p-value	95% CI		Pct.	Coef.	p-value	95% CI		Pct.
E	0.03060	<0.001	0.02274	0.03846	95.74	-0.01592	0.031	-0.03039	-0.00145	-34.30
C	0.00136	0.852	-0.01294	0.01566	4.26	0.06233	<0.001	0.03203	0.09262	134.30
R	0.03196	<0.001	0.01972	0.04420	..	0.04641	0.001	0.01977	0.07305	..
Endowment effect (E): Due to differences in characteristics										
Age (year)										
15-24	R	..	..	..	..	R	..	..	..	..
25-34	-0.00003	0.241	-0.00008	0.00002	-0.09	0.00088	0.307	-0.00081	0.00258	1.90
35-44	-0.00033	0.607	-0.00159	0.00093	-1.04	0.00002	0.868	-0.00017	0.00020	0.03
45+	0.00055	0.615	-0.00160	0.00270	1.73	-0.00064	0.785	-0.00527	0.00398	-1.39
Sex										
Female	R	..	..	..	..	R	..	..	..	..
Male	-0.00011	0.009	-0.00019	-0.00003	0.34	-0.00042	0.707	-0.00262	0.00178	-0.91
Residence										
Urban	R	..	..	..	..	R	..	..	..	..
Rural	-0.00154	0.006	-0.00265	-0.00044	-4.82	0.00014	0.105	-0.00003	0.00030	0.30
Education level										
No education	R	..	..	..	..	R	..	..	..	..
Primary (or less)	0.00015	0.228	-0.00010	0.00040	0.48	0.00298	0.048	0.00003	0.00593	6.41
Secondary (or less)	-0.00005	0.886	-0.00076	0.00066	-0.16	0.00180	0.101	-0.00035	0.00394	3.87
Higher and above	0.00017	0.651	-0.00057	0.00092	0.54	0.00127	0.153	-0.00047	0.00301	2.73
Employment status										
Unemployed/other	R	..	..	..	..	R	..	..	..	..
Employed	0.00031	0.238	-0.00020	0.00082	0.96	0.00045	0.330	-0.00045	0.00135	0.97
Wealth Index										
Low	R	..	..	..	..	R	..	..	..	..
Medium	-0.00014	0.700	-0.00084	0.00056	0.43	0.00028	0.810	-0.00199	0.00255	0.60
High	0.00060	0.421	-0.00085	0.00204	1.86	0.00003	0.948	-0.00083	0.00088	0.06
Advised to quit smoking by a doctor or other health care provider in the past 12 months										
No	R	..	..	..	..	R	..	..	..	..
Yes	0.00124	<0.001	0.00113	0.00134	3.86	-0.00001	<0.001	-0.00001	-0.00001	-0.03
Received any other help to quit smoking in the past 12 months										
No	..	..	..	..	..	..	..	..	..	..
Yes	..	..	..	..	..	..	..	..	..	..
Tried to switch to smokeless tobacco to quit smoking in the last 12 months										
No	..	..	..	..	..	..	..	..	..	..
Yes	..	..	..	..	..	..	..	..	..	..
Noticed any information related to dangers of smoking on print media in the last 30 days										
No	R	..	..	..	..	R	..	..	..	..
Yes	0.01008	<0.001	0.00656	0.01360	31.53	-0.00441	0.004	-0.00745	-0.00137	-9.51
Noticed any information related to dangers of smoking on digital media in the past 30 days										

No	R	..	..	..	..	R	..	..	..	..
Yes	0.01282	<0.001	0.00655	0.01910	40.12	-0.01065	<0.001	-0.01523	-0.00607	-22.95
Noticed any information related to danger of smoking anywhere else in the past 30 days										
No	R	..	..	..	..	R	..	..	..	..
Yes	-0.00223	0.143	-0.00521	0.00075	-6.97	-0.00354	<0.001	-0.00551	-0.00156	-7.63
Exposure to pro-smoking ads and promotions in the past 30 days										
No	R	..	..	..	..	R	..	..	..	..
Yes	0.00076	0.221	-0.00046	0.00198	2.38	-0.00533	0.352	-0.01655	0.00590	-11.48
Exposure to surrogated advertisements in the past 30 days										
No	R	..	..	..	..	R	..	..	..	..
Yes	0.00009	0.809	-0.00066	0.00085	0.29	0.00522	0.014	0.00106	0.00937	11.24
Indoor smoking rule at home										
Allowed	R	..	..	..	..	R	..	..	..	..
Not allowed	0.00873	<0.001	0.00646	0.01101	27.32	-0.00344	<0.001	-0.0045	-0.00231	-7.41
Indoor smoking policy at workplace										
No rule/Not applicable	R	..	..	..	..	R	..	..	..	..
Not allowed/Restrictions	-0.00047	0.143	-0.00110	0.00016	-1.48	-0.00052	<0.001	-0.00077	-0.00027	-1.12
	Total				95.74	Total				-34.30
Composition effect (C): Due to differences in coefficients										
AQS	Coef.	p-value	95% CI		Pct.	Coef.	p-value	95% CI		Pct.
Age (year)										
15-24	R	..	..	..	..	R	..	..	..	..
25-34	0.01076	0.272	-0.00844	0.02996	33.67	0.01202	0.344	-0.01288	0.03692	25.90
35-44	0.01219	0.291	-0.01043	0.03482	38.15	-0.00474	0.761	-0.03527	0.02579	-10.21
45+	0.01605	0.294	-0.01390	0.04600	50.20	-0.01802	0.403	-0.06023	0.02419	-38.83
Sex										
Female	R	..	..	..	..	R	..	..	..	..
Male	0.00847	0.640	-0.02698	0.04391	26.49	-0.19113	0.051	-0.38298	0.00073	-411.82
Residence										
Urban	R	..	..	..	..	R	..	..	..	..
Rural	-0.01894	0.292	-0.05417	0.01630	-59.24	-0.02788	0.064	-0.05742	0.00165	-60.08
Education level										
No education	R	..	..	..	..	R	..	..	..	..
Primary	0.00205	0.674	-0.00747	0.01156	6.40	-0.02046	0.059	-0.04166	0.00074	-44.08
Secondary	-0.01064	0.243	-0.02849	0.00721	- 33.29	-0.01679	0.077	-0.03538	0.00179	-36.18
Higher	-0.00363	0.379	-0.01171	0.00446	- 11.34	-0.00915	0.088	-0.01968	0.00137	-19.72
Employment status										

Unemployed/other	R	..	..	..	..	R	..	..	..	..
Employed	-0.00454	0.724	-0.02978	0.02070	-14.21	0.03097	0.413	-0.04319	0.10512	66.73
Wealth Index										
Low	R	..	..	..	..	R	..	..	..	..
Medium	0.00656	0.267	-0.00502	0.01814	20.53	0.00888	0.266	-0.00677	0.02454	19.14
High	0.01731	0.223	-0.01054	0.04517	54.17	0.01387	0.237	-0.00911	0.03685	29.89
Advised to quit smoking by a doctor or other health care provider in the past 12 months										
No	R	..	..	..	..	R	..	..	..	..
Yes	0.00074	0.813	-0.00539	0.00687	2.32	0.00265	0.728	-0.01229	0.01759	5.71
Received any other help to quit smoking in the past 12 months										
No	..	..	..	..	..	..	..	..	..	..
Yes	..	..	..	..	..	..	..	..	..	..
Tried to switch to smokeless tobacco to quit smoking in the last 12 months										
No	..	..	..	..	..	..	..	..	..	..
Yes	..	..	..	..	..	..	..	..	..	..
Noticed any information related to dangers of smoking on print media in the last 30 days										
No	R	..	..	..	..	R	..	..	..	..
Yes	0.00458	0.498	-0.00867	0.01783	14.32	-0.00265	0.824	-0.02600	0.02070	-5.71
Noticed any information related to dangers of smoking on digital media in the past 30 days										
No	R	..	..	..	..	R	..	..	..	..
Yes	0.01646	0.250	-0.01157	0.04449	51.51	0.01498	0.342	-0.01591	0.04587	32.28
Noticed any information related to dangers of smoking anywhere else in the past 30 days										
No	R	..	..	..	..	R	..	..	..	..
Yes	-0.00205	0.331	-0.00618	0.00208	-6.41	0.00655	0.100	-0.00126	0.01436	14.11
Exposure to Pro-smoking advertisement or promotions in the past 30 days										
No	R	..	..	..	..	R	..	..	..	..
Yes	-0.00960	0.241	-0.02564	0.00644	-30.04	-0.02054	0.101	-0.04510	0.00402	-44.26
Exposure to surrogated advertisements in the past 30 days										
No	R	..	..	..	..	R	..	..	..	..
Yes	-0.00071	0.667	-0.00396	0.00253	-2.23	0.00251	0.811	-0.01810	0.02313	5.42
Indoor smoking rule at home										
Allowed	R	..	..	..	..	R	..	..	..	..
Not allowed	-0.00881	0.208	-0.02252	0.00489	-27.57	0.00712	0.490	-0.01310	0.02735	15.35
Indoor smoking policy at workplace										
No rule/Not applicable	R	..	..	..	..	R	..	..	..	..

Not allowed/Restrictions	0.00154	0.597	- 0.00416	0.00723	4.81	0.02525	<0.001	0.01338	0.03711	54.40
	Total				4.26	Total				134.30

Note: Coeff.=Coefficient, Pct.=Percentage contribution, E=Endowment effect, C=Coefficient effect, R=Residual effect, CI=Confidence interval, R=Reference category.

Rows with statistically significant contribution ($p < 0.05$) are bolded.

*Variable was excluded from the model due to an insufficient number of observations in one category.