

BMJ Open Changes in the prevalence of adolescent tobacco use and its associated factors in Indonesia: analysis of repeated cross-sectional survey 2009–2019

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ABSTRACT

Background Adolescent tobacco use (ATU) is a global public health concern, causing significant morbidity and premature death. This study aimed to assess trends in the prevalence of ATU in Indonesia between 2009 and 2019 and to identify factors contributing to the observed changes.

Methods This study performed secondary data analysis of three consecutive waves (2009, 2014, and 2019) of the Indonesian Global Youth Tobacco Survey (IGYTS). Weighted prevalence estimates and complex survey data analysed using multivariate logistic regression were established across the three-wave surveys. A pooled IGYTS data set was explored to determine the risk factors of the ATU. A multivariate decomposition analysis (MDA) was used to determine factors contributing to the prevalence change in male adolescents over the last two surveys.

Results The prevalence of ATUs was 21.1% (38.2% in males; 6.4% in females), 18.6% (32.7% in males; 3.9% in females) and 19.8% (36.8% in males; 3.5% in females) for the three consecutive surveys, respectively. Being older adolescents, male, exposed to SHS (secondhand smoke) at home, tobacco industry promotion, not knowledgeable of the dangers of tobacco smoke and SHS, and against banning smoking in public places were associated with ATU consistently across the surveys. In addition, inadequate anti-cigarette media and not being knowledgeable of the difficulty of quitting smoking were also identified as risk factors in the pooled data. MDA showed that 88.94% of the explained change was due to differences in the composition of explanatory variables between the last two surveys.

Conclusions This study suggests that social influence and tobacco industry promotion significantly impact ATU in Indonesia. Governments should emphasise these factors in their tobacco control interventions.

INTRODUCTION

Adolescent tobacco use (ATU) is a worldwide public health problem. It is the leading preventable cause of premature death, chronic disease and disability in the world. More than 8 million people die from the

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This study analysed three waves of nationally representative Indonesian Global Youth Tobacco Survey data, allowing assessment of temporal changes in adolescent tobacco use (ATU).
- ⇒ This study performed multivariate decomposition analysis adjusting for complex sample survey design to enable examination of both prevalence trends and contributors to changes over time.
- ⇒ Standardised survey instruments across survey years improved comparability of measurements.
- ⇒ The cross-sectional design of each survey wave limited causal inference between associated factors and ATU.
- ⇒ All measures were self-reported and may be subject to recall and social desirability bias, particularly among female adolescents.

tobacco epidemic each year, including over 1.2 million fatalities from exposure to secondhand smoke (SHS), making it one of the greatest public health hazards the world has ever faced.^{1 2} Globally, ATU trends have been increasing. Approximately 24 million adolescents aged 13–15 years worldwide were smoking. Of the total number of youth smokers worldwide (23.6 million), South East Asia (6.4 million or 27%) and Western Pacific (4.7 million or 19.9%) areas have the highest prevalence.³ Indonesia was one of the world's most prevalent ATUs, with 38.3% of youth (ages 10–18) smoking in 2019, with smoking initiation starting from 16.8 years.^{3 4}

Over 80% of the world's 1.3 billion tobacco users live in low-income and middle-income nations, which bear the greatest cost of tobacco-related sickness and mortality.^{1–3} In 2019, tobacco was associated with about 290 000 deaths annually or 17% of total deaths in Indonesia.⁵ The overall cost of treating diseases linked to smoking ranged from

US\$1.1 billion to US\$1.8 billion, or 0.1% to 0.2% of Gross Domestic Product (GDP). The total economic cost of smoking was estimated to be up to US\$25 billion or 2.5% of the GDP.⁶ Indonesia has not signed nor ratified the WHO Framework Convention on Tobacco Control (FCTC). Therefore, Indonesia is struggling to employ the MPOWER (Monitor, Protect, Offer, Warn, Enforce, Raise) package to reduce tobacco use.²

Monitoring ATU is a problem of crucial importance in making public health decisions since tobacco addiction among adolescents bears significant long-term effects on tobacco prevalence, as tobacco is highly addictive; making ATU critical for tobacco control.^{7,8} In addition, young smokers are susceptible to acute respiratory disorders in addition to the long-term health effects of tobacco use, which include heart disease, cancer and pulmonary diseases which usually manifest only after many years of smoking. Furthermore, mortality rates are increasing among younger people starting smoking.^{9,10}

Social influences, media exposure, tobacco industry promotion, attitude towards tobacco use and adolescent characteristics have been found to reflect ATU determinants. Having smoking parent(s), being exposed to SHS in the home or public places, being exposed to TAPS (Tobacco advertisement, promotion and sponsorship), having poor knowledge of tobacco danger, being against banning smoking and older age were some of the previously known risk factors of current tobacco use among adolescents in several countries.^{4,11–16}

The nationally representative survey, the Indonesian Global Youth Tobacco Survey (IGYTS), has been implemented to monitor tobacco use in Indonesian adolescents since 2006. Since the implementation, the ATU prevalence has risen from 12% in 2006 to 19% in 2019.¹⁷ However, the underlying factors for the observed temporal shift remained unexplored. Identifying factors which contributed to the change in ATU prevalence was crucial for decision-makers to assess past and ongoing efforts and develop strategies to reduce it to 8.7% by 2024, as per the National Mid-term Development Plan.¹⁸ No prior study in our setting has implemented decomposition analysis to monitor the changes and identify the factors which contributed to ATU's prevalence using consecutive nationwide surveys. Therefore, this study aimed to examine trends in the prevalence of ATU in Indonesia from 2009 to 2019 and to identify demographic, social and environmental factors which contributed to these changes using repeated cross-sectional national survey data.

METHODS

Data source

This study extracted data from three waves of IGYTSs conducted in 2009, 2014 and 2019, publicly accessible at the WHO microdata repository for non-communicable diseases.^{19–21} These surveys were cross-sectional, nationally representative and school-based surveys that used

a self-administered questionnaire to monitor youth tobacco use and guide the implementation and evaluation of tobacco prevention and control programmes.²² In short, a two-stage cluster sampling design was used to generate nationally representative samples. Initially, junior and senior high schools were selected with a probability proportionate to the enrolment size. Classes from each school selected during the first sampling stage were randomly selected for the second stage, which involved systematic equal probability sampling. All students in the randomly chosen classes within the chosen schools were eligible to participate in the survey.^{22,23} Demographic characteristics, social influences, anti-tobacco education and media, knowledge and attitude towards smoking, TAPS and financial access were included in the IGYTS questionnaire. The surveys were anonymous and self-administered to maintain confidentiality.²² In total, this study identified 5077, 5986 and 9992 adolescents included in the 2009, 2014 and 2019 surveys, respectively (figure 1). Detailed IGYTS survey reports and procedures were available in prior publications.²²

Outcome

This study's main outcome was the ATU. ATU was defined as smoking cigarettes, and/or smoking other types of tobacco, and/or using smokeless tobacco anytime during the past 30 days prior to the surveys.²⁴ ATU was determined by respondents' self-reported response of one or more days to the questions: 'During the past 30 days, on how many days did you smoke cigarettes?', 'During the past 30 days, did you use any form of smoked tobacco products other than cigarettes (such as traditional hand-rolled tobacco (*klobot*, *klembak menyany*, *tingwe*) and water pipe tobacco)?' and 'During the past 30 days, did you use any form of smokeless tobacco products (such as chewing tobacco, betel leaf with a cane, and betel nut with tobacco)?'. For dichotomous outcomes, either 'yes' or 'no' was used to represent dependent variables.

Potential covariates

The theoretical framework from Flay's Theory of Triadic Influence was adopted to determine the association between potential covariates available in the dataset and ATU status among school youth (figure 2). It considered several determinants, including the personal, societal and environmental factors of behaviours, and then categorised them into three distinct, but interrelated streams.²⁵ This study selected potential covariates if available in the last version of the survey and at least in one other previous survey. In total, 15 potential covariates were explored of ATU, including demographic characteristics, social influences, anti-tobacco education and media, knowledge and attitude towards tobacco usage, TAPS and financial access.

There were four variables under demographic characteristics, ie, age, sex, grade and weekly allowance (pocket money). In the social influences, six variables were included, that is, exposure to SHS at home, people in

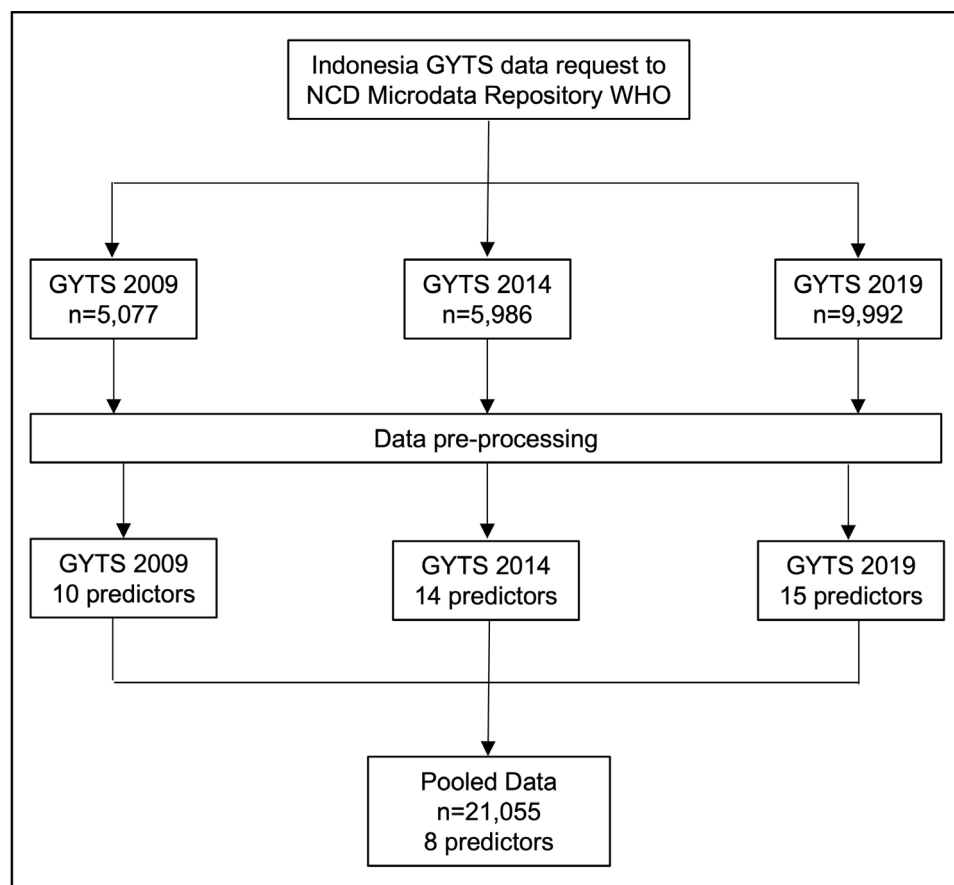


Figure 1 Study's participants selection. GYTS, Global Youth Tobacco Survey; NCD, non-communicable disease.

school smoking, parents smoking, teachers smoking, and exposure to SHS in outdoor and indoor public spaces. For anti-tobacco education and media, this study used two variables, ie, anti-smoking education at school and anti-cigarette media messages seen or heard.

In the knowledge and attitude towards smoking, this study included three variables, ie, knowledge about the dangers of tobacco smoke and SHS, knowledge about the difficulty of quitting smoking and favour banning smoking in public places. For TAPS, this study used two variables, that is, exposure to tobacco industry promotion and advertisements in outdoor media. Details of the operational definitions of interested variable are available in online supplemental table S1.

Statistical analysis

Initially, this study explored the 2009, 2014, and 2019 Indonesia GYTSs separately. A weighting factor was applied to each student record to adjust for the probability of selection, non-response and post-stratification adjustment to population estimates.²³ Missing data of predictors for each dataset ranged from 0% to 1.52%. Therefore, a complete case analysis was implemented for the whole analysis. A descriptive analysis of each year's predictors and sample characteristics was established and presented using weighted frequencies and percentages.

The χ^2 test was used to compare the baseline characteristics of adolescents and tobacco-related factors for each year.

Univariate logistic regression with robust SD for complex survey design was applied to determine predictors associated with ATU. Unadjusted OR along with 95% CIs and p value were considered to select predictor candidates. Predictors with p values of ≤ 0.25 in the univariate logistic regression were included in the multivariate logistic regression. Multivariate logistic regression with a stepwise selection method was conducted to develop a fitted model prediction, including sex adjustment. A $p < 0.05$ was considered significant for all inferential statistics.

Furthermore, this study combined all three surveys to ascertain the magnitude of the association of selected predictors of ATU and adjusted them by the survey's year. A similar stepwise selection method was performed to achieve a parsimonious model, except no weighting factor was applied. The Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) were used to compare pooled models, with lower values indicating a better balance between fit and parsimony. This study focused on finding a parsimonious model to explain the relationship between variables using the fewest predictors necessary. Detailed steps in statistical analysis were described in online supplemental appendix A. STATA

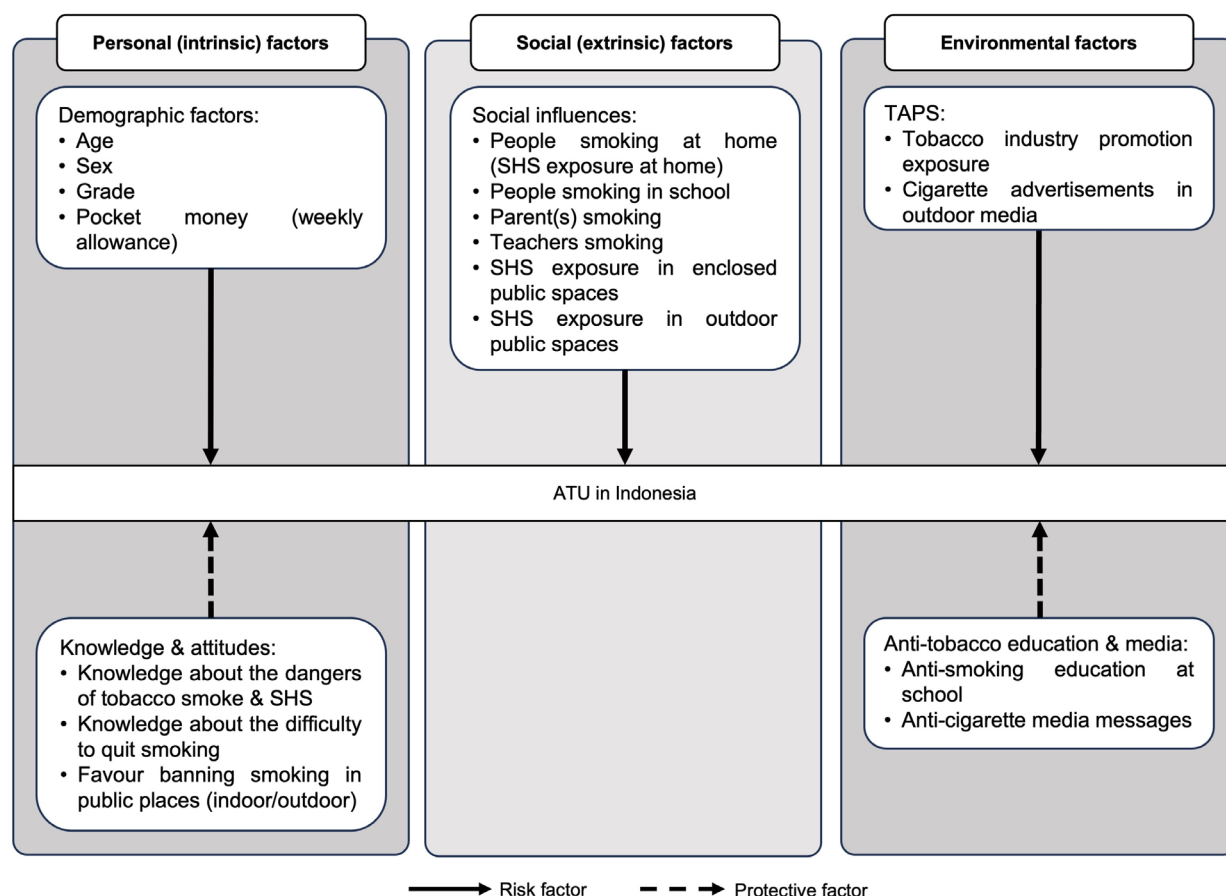


Figure 2 Conceptual framework illustrating several determinants of ATU in Indonesia, adopted from Flay's Theory of Triadic Influence. ATU, adolescent tobacco use; SHS, secondary hand smoke; TAPS, tobacco advertisement, promotion and sponsorship.

V.17 was used to perform all data analysis. Complete reports on each modelling step were presented in online supplemental tables S5 and S6.

Finally, the change in ATU rates among males between the last two surveys (2014 and 2019) periods and its associated factors were examined using the multivariate decomposition analysis (MDA) for the nonlinear response variables, using the 'mvdcmp' command based on the logit link function.²⁶ The changes in the ATU were explained by the difference in composition between the surveys (E) and/or the difference in the effects of the explanatory variables across the surveys (C). The E component referred to the overall changes in the ATU composition or characteristics of the study participants across the surveys. The C component was defined as the percentage of the overall changes in the ATU attributable to the differences in coefficients or effects of the covariates. In addition, MDA between 2014 and 2019 surveys was explained to ascertain the significant contribution of the predictors among male adolescents.

RESULTS

Characteristics of the study participants

Details of tobacco use characteristics among school-going adolescents in Indonesia from 2009 to 2019 were

summarised in online supplemental table S2. Overall, 5077, 5986 and 9992 students from grades 7 to 12 participated in the 2009, 2014 and 2019 surveys, respectively. In 2009 and 2019, over half of the participants were female (51.1% to 54.2%), while in 2014, 50.8% of students were male.

Most of the students were 14 years old or younger (2009: 90.2%, 2014: 85.6% and 2019: 58.7%) for the three consecutive surveys, respectively. The proportion of students receiving pocket money ranged from IDR11 000 to IDR30 000 per week, which was almost one-third, with 31.5% and 32.7% for 2014 and 2019, respectively.

More than 50% of the students were exposed to SHS at home (ranging from 55.8% to 65.5%), primarily from their parents (42.5% to 70.6%). The weighted percentage of participants exposed to SHS in enclosed public areas increased from 58.4% to 66.2% in 2019, compared with 2014. Similarly, outdoor venues saw a rise from 61.8% to 67.4% during the same period.

The weighted percentage of anti-smoking education at school and anti-cigarette media exposure decreased during the 2009 and 2019 periods. Likewise, cigarette advertisements in outdoor media declined from 88.7% to 60.8%. Meanwhile, there was an increase in the prevalence of knowledge regarding the challenges of quitting

smoking (ranging from 42.6% to 79.0%) and support for banning smoking in public places (ranging from 84.0% to 92.2%) during the three periods of surveys (online supplemental table S2).

As each survey was conducted independently with different samples, the distribution of key demographic variables varied significantly between the years. χ^2 tests confirmed these differences, with almost all variables showing statistically significant variations across the survey periods.

Prevalence and epidemiology of ATU

The overall ATU prevalence was 21.1% (95% CI 18.5% to 23.9%), 18.6% (95% CI 14.4% to 23.7%) and 19.8% (95% CI 18.2% to 21.5%) for the three consecutive surveys of 2009, 2014 and 2019, respectively.

The prevalence of ATU in males was up to 10 times higher than in females for the three waves of surveys (2009: 38.2% vs 6.4%, 2014: 32.7% vs 3.9%, and 2019: 36.8% vs 3.5%). ATU prevalence in male students slightly increased from 32.7% in 2014 to 36.8% in 2019, while the prevalence in female students remained constant. Most ATUs were aged 15 years or above. About a quarter of ATUs had been exposed to people smoking at home and SHS (2009: 26.0%, 2014: 27.3% and 2019: 27.7%). Over 20% of ATU participants either had parents who were smokers or were exposed to SHS at school in all waves (table 1).

The prevalence of ATU in the three surveys was higher among adolescents who were exposed to SHS, either in enclosed public places (24.8% in 2014 to 25.4% in 2019) or at outdoor public places (24.4% in 2019 to 24.5% 2014). Differences between exposed and unexposed groups were consistently large across the two most recent surveys.

Marked contrasts were observed for tobacco advertising, promotion and sponsorship (TAPS). Adolescents exposed to tobacco industry promotion consistently had substantially higher prevalence of ATU than those unexposed (approximately 39% vs 15–17%), with a small but steady increase in prevalence across the survey waves. In contrast, exposure to outdoor cigarette advertising alone showed minimal change over time.

Substantial differences were also evident across knowledge and attitude-related factors. Adolescents lacking knowledge about the dangers of tobacco smoke consistently showed much higher prevalence of ATU compared with those who were knowledgeable (eg, 35.4% vs 17.6% in 2019). Similarly, adolescents who did not favour banning smoking in public places had persistently higher prevalence across surveys.

Trends of possible associated factors of ATU

Univariate logistic regression

ATU in 2009 was found to be significantly more likely among 15 years old or above compared with younger (OR 3.57; 95% CI 2.28 to 5.59), male compared with female (9.80; 95% CI 6.91 to 13.89), exposed to SHS

at home compared with unexposed (2.69; 95% CI 2.20 to 3.29), having at least one parent smoking compared with none (1.46; 95% CI 1.21 to 1.76), having inadequate anti-smoking School education compared with having adequate school smoking education (1.42; 95% CI 1.12 to 1.80), exposed to tobacco industry promotion compared with unexposed (2.85; 95% CI 2.38 to 3.42), not knowledgeable of the harmful effects of tobacco use and SHS compared with knowledgeable (3.26; 95% CI 2.29 to 4.63) and against banning smoking in public places compared with pro banning (2.03; 95% CI 1.58 to 2.60) (online supplemental table S3).

Several important factors associated with ATU in 2014 were: older age group, for example, 15 years old or above (3.83; 95% CI 2.46 to 5.97), male adolescents (12.12; 95% CI 9.18 to 16.01), receiving pocket money less than IDR11 000 per week (1.87; 95% CI 1.12 to 3.11), exposure to SHS at home (4.54; 95% CI 3.31 to 6.22), parent(s) smoking (2.11; 95% CI 1.44 to 3.08), saw people (1.54; 95% CI 1.11 to 2.13) and teacher (2.20; 95% CI 1.61 to 3.02) smoking on school premises, exposure to SHS in enclosed (3.35; 95% CI 2.69 to 4.17) and outdoor (3.18; 95% CI 2.56 to 3.94) public places, exposure to tobacco industry promotion (3.58; 95% CI 2.70 to 4.73), not knowledgeable of the harmful effects of tobacco use and SHS (2.32; 95% CI 1.74 to 3.09) and against banning smoking in public places (1.81; 95% CI 1.34 to 2.46).

In 2019, ATU was found to be significantly associated with: the age group 15 years old or above (1.29; 95% CI 1.01 to 1.64), male adolescents (15.79; 95% CI 12.01 to 20.76), receiving pocket money less than IDR11 000 per week (1.34; 95% CI 1.12 to 1.59), exposure to SHS at home (3.65; 95% CI 3.14 to 4.26), saw anyone (1.62; 95% CI 1.40 to 1.87) and teacher (2.18; 95% CI 1.84 to 2.57) smoking on school premises, exposure to SHS in enclosed (3.13; 95% CI 2.62 to 3.74) and outdoor (2.96; 95% CI 2.48 to 3.54) public places, exposure to tobacco industry promotion (3.50; 95% CI 2.97 to 4.11), not knowledgeable of the harmful effects of tobacco use and SHS (2.51; 95% CI 2.11 to 2.98) or the difficulty to quit smoking (1.78; 95% CI 1.51 to 2.09) and against banning smoking in public places (1.61; 95% CI 1.37 to 1.90).

Multivariate logistic regression

In the final multivariate model of the 2009 survey, this study observed that the following covariates remained associated with ATU: age group 15 years old or above (adjusted OR 2.61; 95% CI 1.62 to 4.21), exposure to SHS at home (2.41; 95% CI 1.93 to 3.01), exposed to tobacco industry promotion (1.80; 95% CI 1.39 to 2.32), not knowledgeable about the dangers of tobacco smoke and SHS (2.30; 95% CI 1.48 to 3.59), against banning smoking in public places (1.60; 95% CI 1.27 to 2.02) and not knowledgeable of the difficulties to quit smoking (0.78; 95% CI 0.62 to 0.98) (see table 2).

In 2014, this study found that the following factors were associated with a higher risk of ATU including: age group 14 years old (1.63; 95% CI 1.15 to 2.31), age group 15

Table 1 Comparisons of the prevalence of ATU in Indonesia of the three surveys (2009, 2014 and 2019)

Covariates	ATU % (95% CI)			Point difference in ATU % between surveys		
	2009	2014	2019	2009–2014	2014–2019	2009–2019
Baseline characteristics						
Age						
12 years old or younger	16.2% (12.2% to 21.3%)	11.6% (8.0% to 16.6%)	17.6% (14.8% to 20.9%)	–4.6%	6.0%	1.4%
13 years old	19.7% (15.4% to 24.8%)	15.4% (11.3% to 20.7%)	17.3% (14.7% to 20.2%)	–4.3%	1.9%	–2.4%
14 years old	21.5% (18.0% to 25.5%)	20.2% (15.0% to 26.6%)	21.3% (18.2% to 24.9%)	–1.3%	1.1%	–0.2%
15 years old or older	39.8% (34.0% to 45.9%)	33.6% (27.8% to 39.8%)	21.1% (19.1% to 23.4%)	–6.2%	–12.5%	–18.7%
Sex						
Male	38.2% (33.4% to 43.2%)	32.7% (25.5% to 40.9%)	36.8% (33.6% to 40.1%)	–5.5%	4.1%	–1.4%
Female	6.4% (4.7% to 8.5%)	3.9% (2.8% to 5.4%)	3.5% (2.7% to 4.5%)	–2.5%	–0.4%	–2.9%
Grade						
7	17.3% (13.2% to 22.3%)	16.1% (11.5% to 22.2%)	17.8% (15.1% to 20.9%)	–1.2%	1.7%	0.5%
8	21.3% (16.4% to 27.3%)	17.9% (13.0% to 24.2%)	19.2% (16.0% to 22.8%)	–3.4%	1.3%	–2.1%
9	25.0% (20.2% to 30.4%)	22.3% (16.0% to 30.3%)	21.5% (18.5% to 24.9%)	–2.7%	–0.8%	–3.5%
10	N/A	N/A	18.3% (14.5% to 22.9%)	N/A	N/A	N/A
11	N/A	N/A	18.6% (15.5% to 22.1%)	N/A	N/A	N/A
12	N/A	N/A	24.6% (21.2% to 28.4%)	N/A	N/A	N/A
Pocket money (weekly)						
Less than IDR11 000	N/A	21.8% (17.7% to 26.6%)	23.0% (20.6% to 25.5%)	N/A	1.2%	N/A
IDR11 000–IDR30 000	N/A	19.4% (14.8% to 24.9%)	20.2% (18.1% to 22.4%)	N/A	0.8%	N/A
IDR31 000–IDR50 000	N/A	15.0% (10.2% to 21.5%)	17.0% (14.7% to 19.6%)	N/A	2.0%	N/A
More than IDR50 000	N/A	13.1% (7.9% to 21.0%)	18.1% (15.7% to 20.8%)	N/A	5.0%	N/A
Social influences						
People smoke at home (SHS exposure at home)						
Yes	26.0% (23.2% to 28.9%)	27.3% (23.1% to 32.0%)	27.7% (25.9% to 29.6%)	1.3%	0.4%	1.7%
No	11.8% (9.3% to 14.9%)	7.7% (5.1% to 11.3%)	9.7% (8.3% to 11.3%)	–4.1%	2.0%	–2.1%
People smoke in school						
Yes	N/A	20.6% (16.3% to 25.6%)	22.9% (21.2% to 24.7%)	N/A	2.3%	N/A
No	N/A	14.6% (10.0% to 20.8%)	15.5% (13.7% to 17.5%)	N/A	0.9%	N/A
Parent(s) smoke						
Yes	22.7% (20.3% to 25.3%)	22.0% (18.3% to 26.3%)	21.2% (19.0% to 23.5%)	–0.7%	–0.8%	–1.5%
No	17.3% (14.0% to 21.2%)	12.0% (7.6% to 18.3%)	18.7% (16.9% to 20.5%)	–5.3%	6.7%	1.4%
Teachers smoke on school premises (indoor/outdoor)						
Yes	N/A	25.2% (20.1% to 31.2%)	26.5% (24.3% to 28.9%)	N/A	1.3%	N/A
No	N/A	13.4% (9.6% to 18.4%)	14.3% (12.6% to 16.2%)	N/A	0.9%	N/A
SHS exposure in enclosed public places						
Yes	N/A	25.4% (20.9% to 30.5%)	24.8% (22.9% to 26.9%)	N/A	–0.6%	N/A
No	N/A	9.1% (6.5% to 12.6%)	9.9% (8.4% to 11.5%)	N/A	0.8%	N/A
SHS exposure at outdoor public places						
Yes	N/A	24.5% (20.0% to 29.6%)	24.4% (22.4% to 26.7%)	N/A	–0.1%	N/A
No	N/A	9.2% (6.4% to 12.9%)	10.1% (8.7% to 11.7%)	N/A	0.9%	N/A
Anti-tobacco education and media						
Anti-smoking education at school						
Yes	18.5% (16.0% to 21.2%)	19.4% (15.2% to 24.3%)	19.2% (17.6% to 21.0%)	0.9%	–0.2%	0.7%
No	25.5% (21.1% to 30.4%)	16.9% (12.3% to 22.7%)	20.5% (18.2% to 23.0%)	–8.6%	3.6%	–5.0%
Anti-cigarette media messages seen or heard						
Yes	20.0% (17.5% to 22.8%)	18.9% (14.4% to 24.5%)	18.8% (17.1% to 20.6%)	–1.1%	–0.1%	–1.2%
No	24.8% (19.0% to 31.7%)	17.8% (13.9% to 22.6%)	22.7% (20.3% to 25.4%)	–7.0%	4.9%	–2.1%

Continued

Table 1 Continued

Covariates	ATU % (95% CI)			Point difference in ATU % between surveys		
	2009	2014	2019	2009–2014	2014–2019	2009–2019
TAPS						
Tobacco industry promotion exposure						
Yes	38.5% (34.2% to 43.1%)	39.0% (32.5% to 46.0%)	39.7% (36.3% to 43.1%)	0.5%	0.7%	1.2%
No	17.4% (15.3% to 19.8%)	15.3% (11.5% to 19.9%)	15.5% (14.0% to 17.0%)	–2.1%	0.2%	–1.9%
Cigarette advertisements in outdoor media						
Yes	21.1% (18.4% to 24.0%)	N/A	20.0% (18.1% to 22.1%)	N/A	N/A	–1.1%
No	18.2% (12.2% to 26.2%)	N/A	18.9% (17.2% to 20.8%)	N/A	N/A	0.7%
Knowledge and attitude						
Knowledge about the dangers of tobacco smoke and SHS						
Yes	18.7% (16.3% to 21.3%)	17.1% (12.8% to 22.3%)	17.6% (16.0% to 19.4%)	–1.6%	0.5%	–1.1%
No	44.0% (35.1% to 53.3%)	32.5% (28.3% to 37.0%)	35.4% (32.4% to 38.6%)	–11.5%	2.9%	–8.6%
Knowledge about the difficulty to quit smoking						
Yes	25.8% (21.3% to 30.9%)	17.5% (13.0% to 23.2%)	17.6% (16.0% to 19.3%)	–8.3%	–0.5%	–8.8%
No	17.7% (15.9% to 19.8%)	22.9% (19.2% to 27.1%)	27.9% (25.1% to 31.0%)	5.2%	4.1%	9.3%
Favour banning smoking in public places (indoor/outdoor)						
Yes	18.3% (16.0% to 20.9%)	17.8% (13.5% to 23.0%)	19.1% (17.5% to 20.8%)	–0.5%	1.3%	0.8%
No	31.1% (26.9% to 35.8%)	28.5% (23.7% to 34.0%)	28.1% (24.7% to 31.7%)	–2.6%	–0.4%	–3.0%

ATU, adolescent tobacco use; IDR, Indonesian Rupiah; N/A, not applicable; SHS, secondhand smoke; TAPS, tobacco advertisement, promotion, and sponsorship.

years old or above (2.74; 95% CI 1.68 to 4.44), exposed to SHS at home (2.76; 95% CI 2.03 to 3.77), teachers smoking at school (1.43; 95% CI 1.11 to 1.84), exposed to SHS in enclosed public places (1.82; 95% CI 1.36 to 2.42), exposed to SHS at outdoor public places (1.47; 95% CI 1.14 to 1.91), exposed to tobacco industry promotion (1.95; 95% CI 1.53 to 2.47), not knowledgeable of the dangers of tobacco smoke and SHS (1.90; 95% CI 1.39 to 2.59), and against banning smoking in public places (1.89; 95% CI 1.41 to 2.53).

According to the 2019 survey, this study discovered that the predictors of ATU were: age group 15 years old or above (1.45; 95% CI 1.16 to 1.81), receiving pocket money IDR31 000–IDR50 000 per week (0.76; 95% CI 0.61 to 0.96), exposed to SHS at home (2.62; 95% CI 2.20 to 3.13), teachers smoking at school (1.49; 95% CI 1.26 to 1.78), exposed to SHS in enclosed public places (1.66; 95% CI 1.37 to 2.00), exposed to SHS at outside public places (1.38; 95% CI 1.14 to 1.67), missing anti-cigarettes media message (1.20; 95% CI 1.00 to 1.44), exposed to tobacco industry promotion (2.23; 95% CI 1.87 to 2.67), not knowledgeable of the dangers of tobacco smoke and SHS (1.53; 95% CI 1.28 to 1.84) or the difficulty to quit smoking (1.25; 95% CI 1.02 to 1.52), and against banning smoking in public places (1.23; 95% CI 0.96 to 1.57).

Pooled data

Pooled data analysis of three consecutive surveys (n=21 055) showed that age group 13 years old (1.20; 95% CI 1.07 to 1.34), age group 14 years old (1.42; 95% CI 1.27 to 1.60), age group 15 years old or above (1.71; 95% CI 1.53

to 1.91), exposed to SHS at home (3.30; 95% CI 3.02 to 3.60), missing anti-cigarettes media message (1.11; 95% CI 1.01 to 1.21), exposed to tobacco industry promotion (2.73; 95% CI 2.51 to 2.98), not knowledgeable of the dangers of tobacco smoke and SHS (2.16; 95% CI 1.94 to 2.40), not knowledgeable of the difficulty to quit smoking (1.10; 95% CI 1.01 to 1.20), and against banning smoking in public places (1.56; 95% CI 1.39 to 1.75) were significantly associated with ATU in this study's settings (online supplemental table S4).

Model performance

In the 2009 and 2014 surveys, the F-adjusted mean residual goodness-of-fit (GOF) test of the final model resulted in p values of 0.058 and 0.568, failing to reject the null hypothesis, suggesting a good performance between the predicted and observed values (see online supplemental table S4).

The parsimonious model achieved the lowest AIC and BIC scores, reinforcing its selection as the most appropriate model (online supplemental table S5). Meanwhile, the final pooled model reported a GOF p value of 0.037, implying the model may not fit the data perfectly. However, as this study's goal was to balance simplicity and predictive power, the lower AIC and BIC suggest that the current model may still be preferable despite the GOF p-value.

Decomposition analysis of ATU

The prevalence of ATU in males climbed from 32.7% (95% CI 25.5% to 40.9%) in 2014 to 36.8% (95% CI

Table 2 Predictors of ATU in Indonesia of the three surveys (2009, 2014 and 2019) by multivariate logistic regression analysis adjusted by sex (model III)

Covariates	2009			2014			2019		
	AOR	95% CI	P value	AOR	95% CI	P value	AOR	95% CI	P value
Demographics									
Age†									
12 years old or younger	1.00			1.00			1.00		
13 years old	1.20	(0.86 to 1.66)	0.266	1.31	(0.93 to 1.86)	0.122	1.16	(0.94 to 1.43)	0.166
14 years old	1.45	(0.85 to 2.45)	0.159	1.63	(1.15 to 2.31)	0.008**	1.29	(0.98 to 1.69)	0.065
15 years old or older	2.61	(1.62 to 4.21)	<0.001**	2.74	(1.68 to 4.44)	<0.001**	1.45	(1.16 to 1.81)	0.002**
Pocket money‡									
Less than IDR11 000	–	–	–	...	...	...	1.04	(0.85 to 1.28)	0.691
IDR11 000–IDR30 000	–	–	–	...	...	...	0.98	(0.79 to 1.20)	0.831
IDR31 000–IDR50 000	–	–	–	...	...	...	0.76	(0.61 to 0.96)	0.019*
More than IDR50 000	–	–	–	...	...	...	1.00		
Social influences									
People smoke at home (SHS exposure at home)†									
Yes	2.41	(1.93 to 3.01)	<0.001**	2.76	(2.03 to 3.77)	<0.001**	2.62	(2.20 to 3.13)	<0.001**
No	1.00			1.00			1.00		
Teachers smoke on school premises (indoor/outdoor)§									
Yes	–	–	–	1.43	(1.11 to 1.84)	0.007**	1.49	(1.26 to 1.78)	<0.001**
No	–	–	–	1.00			1.00		
SHS exposure in enclosed public places§									
Yes	–	–	–	1.82	(1.36 to 2.42)	<0.001**	1.66	(1.37 to 2.00)	<0.001**
No	–	–	–	1.00			1.00		
SHS exposure at outdoor public places§									
Yes	–	–	–	1.47	(1.14 to 1.91)	0.004**	1.38	(1.14 to 1.67)	0.001**
No	–	–	–	1.00			1.00		
Anti-tobacco education and media									
Anti-cigarette media messages seen or heard‡									
Yes	...	...	...	...	...	...	1.00		
No	...	...	...	...	...	...	1.20	(1.00 to 1.44)	0.045*
TAPS									
Tobacco industry promotion exposure†									
Yes	1.80	(1.39 to 2.32)	<0.001**	1.95	(1.53 to 2.47)	<0.001**	2.23	(1.87 to 2.67)	<0.001**
No	1.00			1.00			1.00		
Knowledge and attitude									
Knowledge about the dangers of tobacco smoke and SHS†									
Yes	1.00			1.00			1.00		
No	2.30	(1.48 to 3.59)	0.001**	1.90	(1.39 to 2.59)	<0.001**	1.53	(1.28 to 1.84)	<0.001**
Knowledge about the difficulty to quit smoking									
Yes	1.00			...	...	...	1.00		
No	0.78	(0.62 to 0.98)	0.035*	...	...	...	1.25	(1.02 to 1.52)	0.029*
Favour banning smoking in public places (indoor/outdoor)†									
Yes	1.00			1.00			1.00		
No	1.60	(1.27 to 2.02)	<0.001**	1.89	(1.41 to 2.53)	<0.001**	1.23	(0.96 to 1.57)	0.101

‡Predictors were only significantly associated with ATU in the most recent survey (2019).

*p<0.05; **p<0.01.

†Predictors were significantly and consistently associated with ATU across three periods of surveys (2009, 2014 and 2019).

§Predictors in the two most recent surveys (2014 and 2019).

AOR, adjusted OR; ATU, adolescent tobacco use; ellipsis (...), not significant; hyphen (-), not available; IDR, Indonesian Rupiah; SHS, secondhand smoke; TAPS, tobacco advertisement, promotion and sponsorship.

33.6% to 40.1%) in 2019 despite government efforts to halt it. The MDA of the changes in the ATU showed that each covariate's relative contributions differed between the two surveys (table 3).

Overall, 88.94% of the explained change was attributable to differences in the compositions of explanatory variables between the two surveys. The difference in the composition of older adolescents (15 and older) between the two surveys accounted for 51.36% of the percentage change in ATU prevalence in 2019 ($\beta=0.01746$, 95% CI 0.00616 to 0.02876). Similarly, the difference in the composition of SHS exposure in enclosed ($\beta=0.00891$, 95% CI 0.00488 to 0.01295) and outdoor ($\beta=0.00602$, 95% CI 0.00317 to 0.00887) public spaces contributed to 26.22% and 17.71% of the percentage change, respectively. Furthermore, tobacco industry promotion accounted for 15.34% of the percentage change ($\beta=0.00521$, 95% CI 0.00365 to 0.00678).

The difference in the composition of the lack of knowledge about the dangers of tobacco smoke ($\beta=0.00186$, 95% CI 0.00062 to 0.00311) and the difficulty of quitting smoking ($\beta=0.00130$, 95% CI 0.00015 to 0.00245) between the two surveys accounted for 5.48% and 3.82% of the percentage change, respectively. Moreover, SHS exposure at home ($\beta=0.00127$, 95% CI 0.00101 to 0.00152) and teacher smoking at school ($\beta=0.00062$, 95% CI 0.00037 to 0.00086) had small yet significant contributions to the percentage change, 3.73% and 1.81%, respectively. On the other hand, the difference in the composition of adolescents who received pocket money of IDR31 000–IDR50 000 between the two surveys has a significant counteracted effect (−5.38%) compared with those receiving >IDR50 000 on the change in ATU ($\beta=-0.00183$, 95% CI −0.00318 to 0.00048). This study found that the covariates (C) effects did not significantly contribute to the change in ATU prevalence (table 3).

DISCUSSION

From 2014 to 2019 the overall prevalence of ATU remained relatively stable, increasing by one percentage point. The 2019 Indonesia's ATU prevalence was 1.5 to 4 times higher than several LMICs (low-income and middle-income countries)^{15 16 27} and almost double those in 22 African countries.¹² ATU was more prevalent in males, about ten times more so than females. Despite ongoing tobacco control efforts, the increase in ATU among male adolescents during this period suggests that existing interventions may have been insufficient to counter prevailing social and environmental influences.

Taken together, the findings indicate that demographic characteristics (older age, male and received less pocket money), social influences, tobacco industry promotion and poor knowledge were important predictors of ATU in all surveys. In particular, exposure to SHS at home and exposure to tobacco industry promotion emerged as the most consistent predictors across survey waves. In addition, MDA showed that the change in the ATU prevalence

in males between the last two surveys was largely attributed to differences in the population composition, particularly the proportion of adolescents aged 15 years old, tobacco industry promotion exposure and SHS exposure in both home and public places.

Age and sex differences in ATU followed patterns widely observed in other settings. Older adolescents were more likely to report current tobacco use than younger age groups, consistent with evidence from multiple countries.^{13 15 16} Similarly, the markedly higher prevalence among males has reflected entrenched gender norms surrounding smoking in many Asian and African contexts, where tobacco use is socially more acceptable among males than females.^{11 12 15} These patterns highlight the importance of early preventive interventions before smoking behaviours become established during late adolescence.

An inverse association between pocket money and ATU was observed in the two most recent surveys, which contrasts with findings from several countries where higher disposable income has been linked to increased ATU.^{15 16} However, similar findings have been reported in Ghana, suggesting that the relationship between financial access and tobacco use may vary by context.¹⁴ Globally, tobacco use varies by socioeconomic level, although according to reports in several countries, the poor and poorest males tend to smoke more tobacco than their more affluent peers.²⁸ In Indonesia, lower pocket money may reflect broader socioeconomic disadvantage, including lower parental education, awareness of tobacco harms, reduced parental supervision and socially normative smoking environments. Adolescents from lower socioeconomic backgrounds may also experience stronger peer pressure and social norms that favour smoking, increasing susceptibility to tobacco use as a social behaviour.²⁹ Moreover, the widespread availability of inexpensive, single-stick cigarettes and the informal sharing of tobacco products among peers substantially lower financial barriers to tobacco access, which effectively decouples purchasing power from smoking behaviour. Consequently, pocket money may not accurately represent adolescents' effective access to tobacco products in the Indonesian context.^{30–32}

Social influence appears to play a central role in shaping ATU in Indonesia, reflecting the broader social normalisation of smoking in everyday environments. The high prevalence of adolescents exposed to SHS at home and in public spaces suggests that tobacco use is widely visible and socially accepted, potentially weakening perceptions of risk and discouraging avoidance behaviours. In this context, sustained exposure to SHS at home may represent a more pervasive and influential form of social modelling than the smoking behaviour of specific individuals, such as parents or peers. Similar patterns have been observed in several African countries, where environmental exposure to smoking has been shown to exert a strong influence on ATU, underscoring the importance of social and contextual factors in shaping smoking behaviour.^{12–14 33}

Table 3 Decomposition analysis of ATU among male adolescents in Indonesia between 2014 and 2019 survey period

Reference group: year=1 (2019)					
Comparison group: year=0 (2014)					
		95% CI			
Overall decomposition results	Coef.	LB	UB	P value	Percent
E (Endowment/characteristics)	0.03024	0.0146	0.04588	<0.001**	88.94
C (Coefficient)	0.00376	−0.03939	0.04691	0.864	11.06
R (Residual)	0.03399	−0.00609	0.07408	0.096	
Variables	Difference due to characteristics (E)		Difference due to coefficients (C)		
	Coef. (95% CI)	Percent	Coef. (95% CI)	Percent	
Demographics					
Age					
12 years old or younger	Ref.		Ref.		
13 years old	−0.00451 (−0.01117 to 0.00215)	−13.26	−0.00088 (−0.01033 to 0.00857)	−2.58	
14 years old	−0.00307 (−0.00657 to 0.00043)	−9.03	−0.00596 (−0.05363 to 0.04171)	−17.54	
15 years old or older	0.01746 (0.00616 to 0.02876)**	51.36	−0.00558 (−0.05122 to 0.04005)	−16.43	
Pocket money					
Less than IDR11 000	−0.00032 (−0.00531 to 0.00467)	−0.95	−0.00728 (−0.06628 to 0.05172)	−21.41	
IDR11 000–IDR30 000	−0.00014 (−0.00095 to 0.00068)	−0.4	−0.00604 (−0.05537 to 0.04329)	−17.76	
IDR31 000–IDR50 000	−0.00183 (−0.00318 to 0.00048)**	−5.38	−0.00268 (−0.02403 to 0.01868)	−7.87	
More than IDR50 000	Ref.		Ref.		
Social influences					
People smoke at home (SHS exposure at home)					
Yes	0.00127 (0.00101 to 0.00152)**	3.73	0.00114 (−0.01128 to 0.01356)	3.35	
No	Ref.		Ref.		
People smoke in school					
Yes	−0.00086 (−0.00385 to 0.00213)	−2.52	0.00246 (−0.01972 to 0.02464)	7.25	
No	Ref.		Ref.		
Parent(s) smoke					
Yes	0.00031 (−0.00684 to 0.00747)	0.92	−0.01436 (−0.12980 to 0.10107)	−42.25	
No	Ref.		Ref.		
Teachers smoke on school premises					
Yes	0.00062 (0.00037 to 0.00086)**	1.81	0.00289 (−0.02125 to 0.02703)	8.51	
No	Ref.		Ref.		
SHS exposure in enclosed public places					
Yes	0.00891 (0.00488 to 0.01295)**	26.22	−0.00139 (−0.01585 to 0.01307)	−4.08	
No	Ref.		Ref.		
SHS exposure at outdoor public places					
Yes	0.00602 (0.00317 to 0.00887)**	17.71	−0.00295 (−0.02949 to 0.02358)	−8.68	
No	Ref.		Ref.		
Anti-tobacco education and media					
Anti-smoking education at school					
Yes	Ref.		Ref.		
No	−0.00019 (−0.00393 to 0.00356)	−0.55	0.00012 (−0.00553 to 0.00577)	0.35	
Anti-cigarette media messages seen or heard					
Yes	Ref.		Ref.		
No	−0.00192 (−0.00401 to 0.00016)	−5.66	0.00270 (−0.01842 to 0.02382)	7.94	

Continued

Table 3 Continued

Variables	Difference due to characteristics (E)		Difference due to coefficients (C)	
	Coef. (95% CI)	Percent	Coef. (95% CI)	Percent
TAPS				
Tobacco industry promotion exposure				
Yes	0.00521 (0.00365 to 0.00678)**	15.34	0.00116 (−0.00884 to 0.01115)	3.4
No	Ref.		Ref.	
Knowledge and attitude				
Knowledge about the dangers of tobacco smoke and SHS				
Yes	Ref.		Ref.	
No	0.00186 (0.00062 to 0.00311)**	5.48	−0.00165 (−0.01601 to 0.01272)	−4.84
Knowledge about the difficulty to quit smoking				
Yes	Ref.		Ref.	
No	0.00130 (0.00015 to 0.00245)*	3.82	0.00267 (−0.01830 to 0.02364)	7.85
Favour banning smoking in public places (indoor/outdoor)				
Yes	Ref.		Ref.	
No	0.00009 (−0.00002 to 0.00021)	0.27	−0.00126 (−0.01160 to 0.00908)	−3.71
Constant			0.04064 (−0.30581 to 0.3871)	119.56

*p<0.05; **p<0.01.

ATU, adolescent tobacco use; Coef., coefficient; IDR, Indonesian Rupiah; LB, lower bound; Ref, reference group; SHS, secondhand smoke; TAPS, tobacco advertisement, promotion, and sponsorship; UB, upper bound.

This study found that exposure to smoking by teachers on school premises and to SHS in public places, particularly enclosed public spaces, was associated with ATU in the two most recent surveys. This study's findings have suggested that tobacco use by role models and society (ie, their families at home, teachers in school and community members in public spaces) influences adolescents to use tobacco as well. Strong enforcement of smoke-free policies at home, schools and public places may reduce ATU.³⁴

Regarding TAPS, exposure to tobacco industry promotion—such as free tobacco products and merchandise with tobacco industry logos—appears to play an important role in shaping ATU, even though outdoor cigarette advertising alone showed less consistent associations. This finding aligned with several previous studies highlighting the influence of tobacco industry promotion on ATU.^{11 15 16 27} Furthermore, MDA showed that increases in adolescents' exposure to tobacco industry promotion contributed to changes in ATU prevalence between the last two surveys. The positive framing of the tobacco industry's contribution to income, the labour force and so-called corporate social responsibility programmes helped the tobacco industry gain substantial political and popular support. Between 2014 and 2019, there was no revision nor improvement in the TAPS policies at the national level, which contributed to the failure to reduce ATU in 2019.^{30 35 36} This finding indicates the urgent need for a total TAPS ban in Indonesia. The Indonesian Government recently launched the new Government

Rule No. 28 of 2024, incorporating TAPS regulations,³⁷ yet it falls short of a total TAPS ban.

This study highlights the potential importance of improving adolescents' knowledge about the harmful effects of tobacco and fostering positive attitudes towards tobacco control measures as part of smoking prevention efforts. Inadequate understanding of the dangers of tobacco smoke and SHS, limited awareness of the difficulty of quitting smoking and opposition to smoking bans in public places may reflect broader gaps in health literacy and risk perception that increase vulnerability to tobacco use. Similar patterns have been reported in studies conducted in several African countries, which have underscored the role of knowledge and attitudes in shaping adolescent smoking behaviour across different contexts.¹² In addition, changes in the population distribution of knowledge-related factors over time may help to explain shifts in the ATU prevalence, suggesting that persistent information gaps can have important population-level implications.

Relying solely on school-based interventions may be insufficient to prevent ATU. Teaching about the harmful effects of tobacco within the school curriculum alone may be undermined by broader social and environmental influences that normalise smoking. Instead of relying only on the school curriculum to improve knowledge about the dangers of tobacco use, Indonesia should also consider socio-cultural intervention.³¹ Hence, this study has suggested public health intervention incorporating deep cultural adaptation along with

environmental, psychological and social aspects.³⁸ The association between limited exposure to anti-cigarette media messages and higher likelihood of ATU further suggests that mass media and digital platforms, including social media, could serve as important complementary tools for tobacco prevention among adolescents. These findings highlight the need for a more comprehensive tobacco control approach in Indonesia. As Indonesia has not yet ratified the WHO FCTC, ratification could provide a stronger policy framework to support evidence-based measures for adolescent tobacco prevention, including comprehensive implementation of the WHO MPOWER package for tobacco control—particularly measures to protect people from tobacco smoke and to enforce a total ban on TAPS.

Strengths and limitations

This study used data from the three waves of nationally representative surveys in Indonesia assessing the trend and multiple determinants of ATU over time. To the best of the study team's knowledge, this was the first study using big data in Indonesia exploring factors associated with ATU and their changes over time periods.

The limitation of this study was that the factors analysed depended on the availability of each year's IGYTS data. second, all estimations in this study were self-reported, which might have been influenced by reporting bias. It was also possible that the current tobacco use report might suffer from social desirability bias because tobacco use is not socially acceptable in some settings, especially in females. These surveys were cross-sectional in design, which limited causal inference.

CONCLUSIONS

This study has successfully performed pooled data analysis using three consecutive IGYTSs. Tobacco usage and SHS exposure are highly prevalent among adolescents in Indonesia. Being male, 15 years old or older, exposed to SHS at home, tobacco industry promotion, not knowledgeable of the dangers of tobacco smoke and SHS, and not being in favour of banning smoking in public places were consistent predictors of current tobacco use in all surveys. Other significant predictors based on the latest survey were having smoking teachers, being exposed to SHS in public places (especially indoors), not being exposed to anti-cigarette media messages, not being knowledgeable of the difficulty of quitting smoking, and having less than IDR11 000 per week to spend. The Indonesian Government needs to implement an update on the tobacco control policy as soon as possible, accompanied by strict supervision.

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