Seventeen-year trends in tobacco and nicotine product use, secondhand smoke exposure, and related behaviors among adolescents aged 13–15 years in Belarus: A cross-sectional study of Global Youth Tobacco Surveys 2004, 2015, 2021

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ABSTRACT

INTRODUCTION Tobacco use remains a leading cause of preventable death worldwide, with most users initiating before the age of 18 years. Long-term monitoring of adolescent tobacco use is essential for evaluating public health policy and guiding prevention strategies. This study analyzes 17-year trends (2004–2021) in tobacco and nicotine product use, secondhand smoke exposure, and related behaviors among adolescents aged 13–15 years in Belarus.

METHODS This study is a secondary data analysis of three cross-sectional rounds of the global Youth Tobacco Survey (GYTS) conducted in Belarus in 2004, 2015, and 2021, comprising 12049 students (2004, n=4012; 2015, n=4018; 2021, n=4019). All participants were school-attending adolescents aged 13–15 years. The survey employed a standardized two-stage cluster sample design. Data were collected using self-administered anonymous questionnaires assessing cigarette smoking, e-cigarette use, smokeless tobacco use, secondhand smoke exposure, cessation attempts, and attitudes toward tobacco. Prevalence estimates for key indicators were calculated with 95% confidence intervals, and trends were assessed using chi-squared tests.

RESULTS Current cigarette smoking decreased from 26.5% (95% CI: 25.2–27.8) in 2004 to 7.5% (95% CI: 6.9–8.1) in 2015 and 4.7% (95% CI: 4.2–5.2) in 2021 (p<0.001). Ever smoking declined from 62.5% (95% CI: 61.0–64.0) to 20.7% (95% CI: 19.6–21.8, p<0.001). Susceptibility to initiation fell from 48.9% (95% CI: 47.4–50.4) to 14.6% (95% CI: 13.7–15.5, p<0.001). However, by 2021, current e-cigarette use reached 15.1% (95% CI: 14.2–16.0), with no statistically significant gender difference. Smokeless tobacco use, after declining, rebounded from 0.6% in 2015 to 1.7% in 2021 (p<0.001). A gender reversal was observed: in 2021, current tobacco use was higher among girls (9.0%, 95% CI: 8.2–9.8) than boys (6.1%, 95% CI: 5.4–6.8, p<0.001). Exposure to secondhand smoke at home decreased from 75.3% (95% CI: 73.9–76.7) to 20.7% (95% CI: 19.6–21.8, p<0.001). Quit attempts among current smokers declined from 77.4% (2004) to 46.9% (2021) (p<0.001).

CONCLUSIONS Belarus has achieved substantial reductions in traditional cigarette smoking among adolescents over 2004–2021. However, the rapid adoption of e-cigarettes and the resurgence of smokeless tobacco use may partially offset these gains. The observed shift toward higher tobacco use among girls and the decline in cessation attempts warrant further investigation. Future longitudinal studies are needed to establish causal relationships and to evaluate the long-term effectiveness of targeted prevention programs addressing all nicotine products, gender-specific vulnerabilities, and health messaging strategies.

INTRODUCTION

Tobacco use remains the leading cause of preventable death worldwide, with most users initiating before the age of 18 years[1]. The adolescent brain is particularly vulnerable to nicotine addiction, making youth prevention a cornerstone of global tobacco control[2]. The World Health Organization (WHO) Framework Convention on Tobacco Control (WHO FCTC) and its MPOWER package provide evidence-based measures to reduce tobacco demand, including monitoring, smoke-free policies, cessation support, health warnings, advertising bans, and taxation[3,4].

Belarus has implemented comprehensive national legislation, most notably Presidential Decree No. 28 (2002), which regulates the production, sale, and consumption of tobacco products. Key provisions include a ban on sales to minors (aged <18 years), smoke-free policies in educational and healthcare facilities, public transport, and playgrounds, and restrictions on tobacco advertising and sponsorship[5]. These measures are reinforced by the Law on Advertising (2007, amended 2021), which now also bans advertising of non-tobacco nicotine-containing products and e-liquids. As a result, the WHO Report on the Global Tobacco Epidemic 2023 recognized Belarus as one of three countries globally that improved its tobacco monitoring to best-practice level[4].

To monitor the impact of these policies on youth, Belarus has conducted the Global Youth Tobacco Survey (GYTS) three times: in 2004, 2015, and 2021[5]. The GYTS is a standardized, school-based survey that provides nationally representative data on tobacco use, secondhand smoke exposure, cessation, and related attitudes among students aged 13–15 years[6].

The 17-year span offers an opportunity to assess long-term trends against a backdrop of evolving policies and a changing nicotine product landscape, including the emergence of electronic cigarettes (e-cigarettes)[4].

This study aims to provide a comprehensive analysis of trends in all forms of tobacco and nicotine product use among Belarusian adolescents from 2004 to 2021.

METHODS

Study design and data source

This study is a secondary analysis of data from three cross-sectional rounds of the Global Youth Tobacco Survey (GYTS) conducted in Belarus in 2004, 2015, and 2021. The GYTS is a school-based survey of students aged 13–15 years, employing standardized methodology developed by WHO and the US Centers for Disease Control and Prevention (CDC) to ensure international comparability[5,6]. The GYTS protocol was approved by the WHO Ethics Review Committee and by relevant institutional review boards in Belarus. Parental/guardian consent and student assent were obtained prior to participation.

Sampling

A two-stage cluster sample design was used in each survey round. In the first stage, schools were selected with probability proportional to enrollment size. In the second stage, classes within selected schools were randomly chosen, and all students in those classes were eligible to participate. The total sample across three rounds included 12049 students (2004, n=4012; 2015, n=4018; 2021, n=4019). All participants were school-attending adolescents aged 13–15 years.

Variables and data collection

Data were collected using a self-administered, anonymous questionnaire; demographic variables, including sex (male, female) and school grade (7th, 8th, 9th), were collected. Current cigarette smoking was defined as smoking at least one cigarette in the past 30 days; ever smoking was defined as having ever tried or experimented with cigarette smoking, even one or two puffs; frequent smoking was defined as smoking >20 cigarettes in the past 30 days. With regard to electronic cigarette use, current e-cigarette use was defined as using an electronic cigarette at least once in the past 30 days; awareness was defined as having heard about e-cigarettes. Smokeless tobacco use was defined as using chewing tobacco, snuff, or dipping tobacco in the past 30 days. Cessation behaviors including having tried to quit smoking in the past 12 months (among current smokers) and thinking about quitting due to health warnings, were also collected. Secondhand smoke exposure was assessed, separately for exposure at home and exposure inside public places in the past 7 days.

Other variables included access and availability (including purchasing cigarettes from stores and being refused sale due to age), media and advertising (including exposure to anti-tobacco messages in mass media), and knowledge and attitudes (including beliefs about health effects of smoking) and susceptibility to initiation (defined as never smokers who are not firm non-smokers).

Statistical analysis

All statistical analyses were performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Data were weighted to adjust for non-response and selection probability. Prevalence estimates for key indicators were calculated with 95% confidence intervals. To assess trends over the 17-year period, we compared estimates across survey rounds using chi-squared tests for linear trends. Statistical significance was set at $p<0.05$. Gender differences within each survey round were also examined using chi-squared tests. Given the cross-sectional design, multivariable regression models were not applied; however, future studies may benefit from such approaches to control for potential confounding factors.

RESULTS

Sample characteristics

The study sample comprised 12049 adolescents aged 13–15 years across the three survey rounds. In the 2021 round (n=4019), the mean age was 14.1 years (SD=0.8), and the

proportion of female participants was 51.2% (n=2058). Similar age and sex distributions were observed in the 2004 and 2015 rounds. Table 1 presents the descriptive characteristics of the sample by survey year.

Trends in cigarette smoking

Over the 17-year period, current cigarette smoking among adolescents fell from 26.5% (95% CI: 25.2–27.8) in 2004 to 7.5% (95% CI: 6.9–8.1) in 2015 and further to 4.7% (95% CI: 4.2–5.2) in 2021 (p<0.001 for trend). Ever smoking decreased from 62.5% (95% CI: 61.0–64.0) to 20.7% (95% CI: 19.6–21.8, p<0.001). Frequent smoking (>20 cigarettes in the past month) decreased from 8.3% (95% CI: 7.4–9.2) to 1.2% (95% CI: 0.9–1.5, p<0.001). Susceptibility to initiating tobacco use fell from 48.9% (95% CI: 47.4–50.4) in 2004 to 6.5% (95% CI: 5.8–7.2) in 2015 and then increased slightly to 14.6% (95% CI: 13.7–15.5) in 2021 (p<0.001 for overall trend) (Table 1).

E-cigarette and smokeless tobacco use

Data on e-cigarette use were first collected in Belarus in 2021. Current e-cigarette use prevalence was 15.1% (95% CI: 14.2–16.0), with no statistically significant gender difference (boys: 14.8%, girls: 15.4%, p=0.34). Awareness of e-cigarettes was high: 92.6% of girls and 89.2% of boys reported having heard about e-cigarettes (p<0.05). Use increased with grade: prevalence was 7.2% in 7th grade, 14.5% in 8th grade, and 24.5% in 9th grade (p<0.001 for trend).

Smokeless tobacco use decreased from 3.1% (95% CI: 2.6–3.6) in 2004 to 0.6% (95% CI: 0.4–0.8) in 2015 (p<0.001), then increased to 1.7% (95% CI: 1.4–2.0) in 2021 (p<0.001 for 2021 vs 2015).

Gender differences

In 2004, boys had higher rates of current cigarette smoking than girls (31.2%, 95% CI: 29.3–33.1 vs 21.7%, 95% CI: 20.0–23.4, p<0.001). In 2021, this pattern reversed: current any tobacco use was higher among girls (9.0%, 95% CI: 8.2–9.8) than boys (6.1%, 95% CI: 5.4–6.8, p<0.001). Current cigarette smoking was also higher in girls (5.7%, 95% CI: 5.0–6.4) than boys (3.7%, 95% CI: 3.1–4.3, p=0.002).

Age of initiation

The proportion of adolescents who reported trying their first cigarette before the age of 10 years decreased from 31.1% (95% CI: 29.2–33.0) in 2004 to 15.8% (95% CI: 14.4–17.2) in 2015, and further to 11.7% (95% CI: 10.6–12.8) in 2021 (p<0.001 for all comparisons).

Secondhand smoke exposure

Exposure to secondhand smoke at home fell from 75.3% (95% CI: 73.9–76.7) in 2004 to 25.1% (95% CI: 23.8–26.4) in 2015 and to 20.7% (95% CI: 19.6–21.8) in 2021 (p<0.001). Exposure inside public places fell from 90.1% (95% CI: 88.9–91.3) in 2004 to 30.3% (95% CI: 29.0–31.6) in 2015 and to 21.3% (95% CI: 20.2–22.4) in 2021 (p<0.001). Girls reported higher exposure than boys in all settings.

Cessation behaviors

Among current smokers, the proportion who had tried to quit in the past 12 months declined from 77.4% (95% CI: 75.2–79.6) in 2004 to 46.9% (95% CI: 43.7–50.1) in 2021 (p<0.001). The proportion thinking about quitting due to

Table 1. Sample characteristics of adolescents and trends in cigarette smoking among adolescents aged 13–15 years, GYTS Belarus, 2004–2021 (N=12049)

Variables	GYTS 2004 (N=4012) %	GYTS 2015 (N=4018) %	GYTS 2021 (N=4019) %	
Age (years), mean (SD)	14.0 (0.8)	14.1 (0.8)	14.1 (0.8)	
Female (%)	50.8	51.0	51.2	
School grade				
Grade 7	33.5	33.2	33.0	
Grade 8	33.3	33.4	33.5	
Grade 9	33.2	33.4	33.5	
Smoking status	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**	**p for trend**
Current cigarette smoker	26.5 (25.2–27.8)	7.5 (6.9–8.1)	4.7 (4.2–5.2)	<0.001
Ever cigarette smoker	62.5 (61.0–64.0)	35.7 (34.3–37.1)	20.7 (19.6–21.8)	<0.001
Frequent smoker (>20 days/month)	8.3 (7.4–9.2)		1.2 (0.9–1.5)	<0.001
Susceptible to initiating tobacco use	48.9 (47.4–50.4)	6.5 (5.8–7.2)	14.6 (13.7–15.5)	<0.001

Percentages are weighted.

health warnings on cigarette packs fell among girls from 40.8% (95% CI: 37.5–44.1) in 2015 to 8.3% (95% CI: 6.4–10.2) in 2021 (p<0.001). Over 90% of current smokers across all years reported confidence that they could quit if they wanted to.

Access, availability and exposure to anti-tobacco media

Purchasing cigarettes from stores remained the primary source for minors, though this proportion declined from 47.0% (95% CI: 45.1–48.9) in 2004 to 26.4% (95% CI: 24.8–28.0) in 2021 (p<0.001). In 2021, 45.3% (95% CI: 42.1–48.5) of current smokers reported not being refused purchase due to age. Girls were less likely than boys to be refused sale in all survey years (e.g. 2021: 50.1% vs 37.8%, p<0.001).

The proportion of students who had seen anti-tobacco messages in mass media decreased from 97.2% (95% CI: 96.5–97.9) in 2004 to 70.2% (95% CI: 68.9–71.5) in 2015 and to 49.2% (95% CI: 47.7–50.7) in 2021 (p<0.001).

Knowledge and attitudes towards smoking

The percentage of students who definitely thought that smoking was harmful to others decreased from 69.0% (95% CI: 67.6–70.4) in 2015 to 54.8% (95% CI: 53.3–56.3) in 2021 (p<0.001). Support for smoking bans in enclosed public places decreased from 92.8% (95% CI: 92.0–93.6) in 2015 to 85.2% (95% CI: 84.2–86.2) in 2021 (p<0.001). The belief that smoking helps people feel more comfortable socially increased from 20.1% (95% CI: 18.9–21.3) in 2015 to 31.0% (95% CI: 29.6–32.4) in 2021 (p<0.001).

DISCUSSION

This analysis of three GYTS rounds over 17 years documents substantial declines in traditional cigarette smoking among Belarusian adolescents aged 13–15 years. The prevalence of current cigarette smoking decreased from 26.5% in 2004 to 4.7% in 2021. This decline aligns with trends observed in other countries in the European Region that have implemented strong tobacco control measures[4,5]. The consistency of this trend with the implementation of comprehensive national policies – including Decree No. 28, smoke-free laws, sales bans to minors, and advertising restrictions[5]– suggests an association between policy implementation and reduced smoking rates. The delay in age of initiation further supports this interpretation.

The sharp decline in susceptibility to tobacco use from 48.9% in 2004 to 14.6% in 2021 is a notable leading indicator. However, the slight increase in susceptibility observed in 2021 (14.6% vs 6.5% in 2015) warrants attention and may reflect the influence of novel nicotine products.

E-cigarettes and smokeless tobacco

The finding that 15.1% of adolescents reported current e-cigarette use in 2021 – more than three times the rate of cigarette smoking – represents a significant epidemiological shift. This pattern mirrors a global trend identified in the WHO 2023 report, where the tobacco industry has promoted e-cigarettes as alternatives to traditional cigarettes[4]. The high awareness (over 90%) and increasing use with grade level, indicate that these products have penetrated the youth market. The observation that half of surveyed students did not perceive e-cigarettes as harmful highlights a knowledge gap that may be addressed through targeted health education.

The resurgence of smokeless tobacco use in 2021 (1.7%) after a period of decline (from 3.1% in 2004 to 0.6% in 2015) is also concerning. This may be linked to experimentation with novel products or the misconception that 'smokeless' implies 'harmless'. Belarus responded by amending its advertising law in 2021 to ban products similar in appearance or name to tobacco products[5].

Gender differences

A notable finding is the reversal of the gender gap. The shift from higher smoking rates among boys in 2004 to higher rates among girls in 2021 requires further investigation. Girls showed a slower decline in smoking rates (3.8-fold vs 8.5-fold for boys) and higher current use of both tobacco and e-cigarettes in 2021. The data indicate several potential vulnerabilities for girls: they were less likely to be refused cigarette purchases, reported higher exposure to secondhand smoke, and were 2.5 times more likely to be unaware of e-cigarette risks. The sharp decline in response to health warning labels among girls (from 40.8% to 8.3% considering quitting) suggests that current messaging strategies may be less effective for this subgroup.

Cessation, media exposure, attitudes and social norms

The decline in quit attempts among current smokers (from 77.4% to 46.9%) coincided with a reduction in anti-tobacco message exposure (from 97.2% to 49.2%). This temporal association suggests that reduced reach of health promotion campaigns may partially explain lower cessation motivation. The WHO 2023 report emphasizes that maintaining consistent messaging is crucial, as progress can be eroded[4]. Most adolescents who smoke attempt to quit without professional support, indicating a potential role for school-based or digital cessation interventions.

The observed decrease in perceived harm of smoking to others (from 69.0% to 54.8%) and in support for smoking bans (from 92.8% to 85.2%) suggests a shift in social norms that may undermine past progress. The increase in the belief that smoking helps people feel more comfortable socially (from 20.1% to 31.0%) may indicate a partial normalization of smoking behavior among adolescents.

Limitations

Several limitations should be acknowledged. First, the cross-sectional design of each GYTS round prevents establishing causal relationships between policy implementation and observed trends. Second, data were self-reported and may

be subject to recall bias or social desirability bias, potentially leading to underestimation of tobacco use prevalence. Third, the survey was limited to school-attending adolescents, excluding out-of-school youth who may have higher risk profiles. Fourth, e-cigarette data were collected only in 2021, precluding trend analysis for this product category. Fifth, residual confounding may be present as not all potential confounders (e.g. parental smoking, socioeconomic status) were measured or adjusted for. Future studies using longitudinal designs and multivariable regression models are needed to confirm these findings and to establish causal relationships.

Future research

Given the cross-sectional nature of this study, further research is required. Longitudinal cohort studies could establish temporal sequences between policy implementation, product availability, and behavioral change. Qualitative studies could explore the social and cultural factors underlying the gender reversal observed in tobacco use. Intervention studies are needed to evaluate the effectiveness of gender-specific prevention programs and novel health messaging strategies targeting e-cigarettes. Finally, continued monitoring through subsequent GYTS rounds will be essential to track emerging trends and evaluate policy responses.

CONCLUSIONS

Over 17 years, Belarus achieved substantial reductions in traditional cigarette smoking among adolescents. These reductions temporally coincided with the implementation of sustained, evidence-based policies aligned with the WHO FCTC, and Belarus has been recognized by WHO for best-practice monitoring. However, the rapid adoption of e-cigarettes and the resurgence of smokeless tobacco use observed in 2021, may partially offset these gains. The observed shift toward higher tobacco use among girls and the decline in cessation attempts signal new challenges that warrant further investigation.

Future longitudinal and intervention studies are needed to establish any causal relationships between policies and outcomes and to evaluate the effectiveness of targeted prevention programs. Such studies should address all nicotine-containing products, gender-specific vulnerabilities, and innovative health messaging strategies. Continued surveillance through subsequent GYTS rounds will be essential to monitor emerging trends and to inform evidence-based policy adaptations.

The experience of Belarus offers lessons for other countries: comprehensive policy frameworks can reduce traditional smoking, but evolving product landscapes and shifting demographic patterns require ongoing research and adaptive prevention strategies.

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CONFLICTS OF INTEREST

The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none was reported.

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ETHICAL APPROVAL AND INFORMED CONSENT

Ethical approval and informed consent were not required for this study as it is a secondary analysis of existing data.

DATA AVAILABILITY

The data supporting this research are available from the authors on reasonable request.

PROVENANCE AND PEER REVIEW

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