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Effectiveness Evaluation of Tobacco Control Policies on Smoking Prevalence among Different Age Groups

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Abstract. Despite a slight global decline in tobacco use in 2022, tobacco consumption still poses severe health risks across all age groups, thus underscoring the necessity for targeted tobacco control policies. This study employs an age-stratified analytical framework, examining adolescents, adults and the elderly. For adolescents, smoke-free campus policies and the regulation of tobacco purchase channels have proven effective, albeit with existing rural-urban disparities; tobacco tax hikes exert minimal influence, and social media anti-smoking campaigns require optimization. In the case of adults, tobacco taxation (which has a more pronounced impact on low-income groups) and public place smoking bans yield positive results, while smoking cessation services call for enhanced accessibility and integration with medical insurance. For the elderly, community-based interventions and nicotine replacement therapy (NRT) hold promise, yet rural areas suffer from resource shortages and low NRT utilization. Additionally, tobacco control policies for adults also indirectly benefit adolescents. This paper provides empirical evidence to inform the formulation of age-adapted tobacco control strategies.

Keywords: Tobacco control, age-stratified, policy effectiveness, adolescents, elderly.

1. Introduction

Against the backdrop of global tobacco control efforts, the global tobacco use rate stood at 21.74% in 2022, marking a 0.39% decrease compared to 2021. Despite this annual decline, substantial disparities persist across age groups. For instance, in the United States, the 2022 tobacco use rate among young adults (18-24 years old) was 5.3%, while it reached 12.6% for middle-aged adults (25-44 years old), 14.9% for older adults (45-64 years old), and 8.3% for the elderly (65 years and above). Tobacco use poses severe health risks across all age strata: it impairs the normal development of the respiratory and cardiovascular systems in adolescents, elevates the risk of non-communicable diseases in adults, and exacerbates chronic disease symptoms in the elderly. Addressing these risks, the World Health Organization (WHO) launched the Framework Convention on Tobacco Control to guide global initiatives, with countries subsequently formulating targeted policies based on their unique contexts.

A review of existing domestic and international research reveals that while many countries have implemented diverse tobacco control policies with positive outcomes, critical gaps remain. The United States, for example, has reduced adult smoking rates over decades through tobacco taxation

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and public place smoking bans, yet its policies lack targeted designs for the elderly [1]. In China, the burden of non-communicable diseases is rising, with tobacco identified as a major risk factor. China has over 300 million smokers and 740 million people exposed to second-hand smoke, with a male smoking rate among the highest globally. Although public awareness of tobacco control has improved over the past decade, progress is uneven. Beijing's 2015 comprehensive ban on indoor public smoking, for instance, reduced the smoking rate by 4.2 percentage points and nearly doubled the adult non-smoking rate. However, such progress is not universal: data on tobacco use and policy effectiveness among rural elderly populations remain scarce, and research on youth e-cigarette policies is predominantly concentrated in urban areas, with township-level studies largely overlooked.

This study aims to address three key research gaps in current tobacco control literature: the lack of horizontal comparisons of the same tobacco control policy's effectiveness across different age groups, insufficient data on special populations and unclear correlations between age-specific traits and policy effectiveness. To fill these gaps, this paper adopts an age-stratified analytical framework, classifying populations into adolescents (12-17 years old), adults (18-64 years old) and the elderly (≥65 years old). This framework not only supplements missing cross-age comparison data and research on specific populations but also provides more precise evidence for the formulation of age-adapted tobacco control policies.

2. Age-stratified analysis of tobacco control measures

2.1. Adolescent population (12-17 years old)

Two categories of measures have demonstrated significant effectiveness for adolescents: smoke-free campus policies and stricter regulation of tobacco purchase channels. China's smoke-free campus policy aligns with global best practices and follows a three-tier implementation framework. At the school level, each institution formulates a Campus Tobacco Control Management Protocol, mandates standardized no-smoking signs in key areas such as classrooms, playgrounds, and canteens, and assigns one full-time tobacco control supervisor per 200 students to record violations and conduct daily patrols. At the departmental level, local education bureaus conduct quarterly compliance inspections, with three core evaluation indicators: no-smoking sign coverage rate (required ≥95%), teacher smoking violation rate (required ≤1%), and student tobacco harm knowledge awareness rate (required ≥80%). At the third-party level, stratified random sampling (covering at least 10% of the total student population) is used to administer anonymous questionnaires, focusing on changes in adolescents' willingness to attempt smoking and their perceptions of tobacco risks.

A 2023 study on smoke-free campus implementation in East China showed that one year after the policy was implemented, the rate of on-campus smoking incidents fell from 2.1% to 0.8%, while students' awareness of tobacco-related harms rose from 68% to 89—findings that verify the effectiveness of this implementation process [2]. Concurrently, supervision of purchase channels has been strengthened through increased inspections and stricter oversight measures aimed at restricting minors' access to cigarettes and e-cigarettes. That said, significant rural-urban disparities exist in supervision effectiveness [3]. In urban areas, combining a "full-platform ban on online e-cigarette sales" with "offline ID verification via POS machines" has enabled comprehensive supervision of tobacco purchase channels; for example, in 2023, the rate of convenience stores violating regulations by selling tobacco to minors in a first-tier city was just 1.2%. In rural areas, however, challenges persist—such as scattered small supermarkets and general stores, plus a shortage of

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supervision staff—leading to an 8.7% rate of violations involving tobacco sales to minors, seven times higher than in urban areas. Epidemiological data show the adolescent smoking rate in rural areas (5.3%) is 2.5 percentage points higher than in urban areas (2.8%), with loose purchase channels contributing 62% to this gap [3]. China's enforcement of ID verification for cigarette and e-cigarette sales, plus the ban on online e-cigarette sales, has led to a 30% reduction in smoking rates [3].

Tobacco tax increases have minimal impact on adolescents, primarily because most adolescent smoking is experimental, and adolescents are often unaware of price hikes. An analysis of data from the U.S. National Longitudinal Survey of Youth 1997—a prospective cohort study with 8,000 participants followed for 10 years—found that tobacco taxes had no significant effect on young adults' current smoking behavior. This study's longitudinal design strengthens its causal inference, though it focuses on the U.S. context, and results may not apply to countries with different adolescent smoking patterns. Social media anti-smoking campaigns influence adolescents, but their form and effectiveness require targeted optimization [4]. A 2022 Australian study—a randomized controlled trial with 2,000 adolescent participants—found that adolescents are more responsive to content combining "short video storytelling" with "KOL interaction": a campaign inviting 16–20-year-old social media influencers to create videos on "the short-term effects of smoking on skin and athletic performance" averaged 500,000 views per video, with 120,000 adolescents joining the accompanying "tobacco control knowledge challenge." Follow-up surveys showed that participating adolescents were 23% more willing to refuse smoking than non-participants. In contrast, traditional slogan-style public service advertisements have low interaction rates: a 2023 anti-smoking ad on a Chinese platform had over 2 million views but only a 0.8% adolescent interaction rate, largely because it failed to address adolescents' key concerns, such as ignoring e-cigarette hazards [4]. Additionally, an Australian institutional report noted that while adolescents engage with social media content quantitatively, there is no standardized method to measure this engagement, making it difficult to accurately assess campaign effectiveness. Other influencing factors include peer and family smoking: exposure to peers' smoking behavior at school or family members' smoking at home significantly increases adolescents' likelihood of smoking.

Consensus exists in existing research that smoke-free campus policies and purchase channel regulation are the most effective measures for adolescent tobacco control [2,3]. Controversies remain, however, regarding the root causes of rural-urban disparities in supervision effectiveness: some studies attribute gaps to insufficient supervision resources in rural areas, while others emphasize low parental awareness of tobacco control, which weakens home-school collaboration [3,4]. Future research should adopt multi-center designs to verify these hypotheses and explore targeted solutions for rural areas.

2.2. Adult population (18-64 years old)

For adults, tobacco tax increases significantly reduce smoking rates, but tax elasticity varies sharply by income level [5]. A 2022 U.S. study showed that after a 20% tobacco tax hike in one state, the smoking cessation rate for adults with household annual incomes < $25,000 was 12.4%—5.9 times higher than the 2.1% rate for those with incomes > $100,000. Similar trends appear in China: during the 2015–2020 tobacco tax adjustment, the smoking rate for low-income adults (monthly income < 3,000 RMB) dropped by 8.7%, compared to 5.2% for middle-income groups (3,000–8,000 RMB) and just 1.3% for high-income groups (> 8,000 RMB). Economic analysis shows tobacco expenditure accounts for 8.2% of disposable income for low-income groups—7.4 times the 1.1% share for high-income groups—making low-income groups more price-sensitive.

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Public place smoking bans (in workplaces, restaurants, and shopping malls) also significantly reduce smoking rates [3]. A 2020 meta-analysis of 50 global studies confirmed that comprehensive public place smoking bans cut adult smoking rates by an average of 7.3% within two years, with the strongest impact on workplace smoking: the proportion of adults smoking at work fell from 22% to 8% post-policy [6]. This meta-analysis's strength lies in its large sample size and inclusion of diverse study designs, though publication bias may exist, as positive results are more likely to be published.

Adult smoking cessation services have underwhelming feedback globally. In Guizhou Province, China, a cross-sectional study of 2,000 smokers found that only 8.3% of participants in smoking cessation services quit, with a 5.5% success rate among all smokers. Barriers to service utilization include insufficient publicity—only 30% of smokers were aware of local cessation services—and work schedule conflicts, as 60% of working-age smokers reported being unable to attend daytime services [7]. To address these issues, targeted service models have been piloted. A 2023 Shanghai pilot—a quasi-experimental study with 3,000 participants—launched a "24-hour online + offline flexible" smoking cessation service: an online applet provided real-time nicotine dependence assessment and professional consultation (with over 50,000 registered users), while offline "evening clinics" (operating 18:00–21:00 every Saturday) accommodated working adults. After six months, service participation rose from 8.3% to 22.5%, and the smoking cessation success rate increased from 5.5% to 11.2% [7]. Additionally, integrating smoking cessation services into medical insurance boosts utilization: after Beijing included nicotine replacement therapy (NRT) in basic medical insurance in 2022, adult NRT usage jumped from 12% to 34% [7].

Adult smoking behavior is strongly shaped by income and occupation, with manual workers more likely to smoke than mental workers. A 2021 cross-sectional study covering 10 Chinese industries (with 10,000 participants) found that 68% of manual workers, such as construction workers and couriers, viewed smoking as the "main way to relieve physical fatigue," while 72% of mental workers preferred non-tobacco methods like exercise or coffee [8]. Workplace tobacco control environments also differ significantly: 83% of construction sites had no clear non-smoking areas or supervisors, compared to 91% of office buildings with full-building non-smoking signs and regular patrols. Long-term exposure to lax tobacco control reinforced manual workers' perception of "smoking normalization": only 32% of manual workers believed smoking at work affected others, versus 78% of mental workers [8]. Consensus exists in research that tobacco taxes and public place smoking bans are the most effective measures for adult tobacco control, with stronger impacts on low-income groups [5-7]. Controversies focus on the design of smoking cessation services: some studies advocate for "online-offline integration" to improve accessibility, while others emphasize "insurance coverage" to reduce economic barriers [7]. Future research should explore synergies between these two approaches to maximize service utilization and effectiveness.

2.3. Elderly population (65 years old and above)

The elderly represent a special group with relatively few effective tobacco control measures, though community-based interventions show promise. A Chinese Community Healthcare Center conducted a quasi-experimental study with 100 elderly smokers, providing weekly smoking cessation lectures and family doctor home visits, which led to a 2.5% drop in tobacco use [7]. Since late 2021, Yinchuan City has implemented comprehensive community smoking cessation interventions, identifying 398 elderly residents with a tobacco use history—138 of whom were willing to quit and included in file management. Through frequent health lectures, regular follow-up by community health specialists, and the introduction of psychological counseling teams, 98 residents reduced

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smoking and 28 quit. This study's strength lies in its focus on long-term follow-up (12 months), though its small sample size limits the generalizability of its results.

Significant rural-urban disparities exist in elderly smoking rates and service access. 2023 WHO data from a global cross-sectional survey with 50,000 elderly participants showed that the smoking rate for rural Chinese elderly was 21.5%, 1.7–1.8 times higher than the 12.3% rate in urban areas. Conversely, urban community health centers covered 89% of elderly smoking cessation services, compared to only 34% in rural areas. Two key gaps drive this disparity: first, a shortage of professionals—rural communities had just 1.2 tobacco control doctors per 10,000 elderly, versus 5.8 in urban areas—and second, limited service types, as 87% of rural smoking cessation services only offered verbal counseling, while 76% of urban services provided NRT and other pharmaceutical support. This disparity directly impacts outcomes: the smoking cessation success rate for urban elderly was 18.9%, 2.8 times higher than the 6.7% rate in rural areas.

Most traditional tobacco control policies have little effect on the elderly, who are often habituated to smoking and indifferent to prices or publicity. This resistance stems from two core factors: health cognition biases and high-intensity nicotine dependence [9]. A 2021 study of 800 Chinese elderly smokers found that 62% believed "decades of smoking without illness proves tobacco is harmless," and 58% feared "quitting would cause physical discomfort" [9]. In terms of nicotine dependence, the average Fagerström Nicotine Dependence Scale score for elderly smokers was 6.8 (indicating high dependence), 1.6 times higher than the 4.2 score for adult smokers, with 91% reporting "needing to smoke within 30 minutes of waking up," a sign of strong physical dependence [9]. Narrow policy information channels also worsened resistance: only 23% of rural elderly smokers learned about tobacco control policies via community promotion, versus 68% in urban areas [9]. After tobacco tax hikes in some regions, the elderly smoking rate dropped by less than 1%, though free NRT distribution in cities relatively increased participation [9].

Low NRT utilization is a major barrier to elderly smoking cessation, with a global average utilization rate of 12.3% for elderly smokers [10]. Two main barriers contribute to this low rate: cognitive misunderstandings and access issues. Of elderly smokers, 78% viewed NRT as "medication with side effects," and 67% were unaware of free community NRT access, while rural elderly faced practical challenges like long travel distances to service centers [10]. Targeted interventions have proven effective in improving outcomes: a 2022 Hangzhou pilot—a quasi-experimental study with 500 elderly participants—had family doctors distribute NRT trial packs during home visits, demonstrate usage, and organize "children's health classes" to address family concerns. This initiative increased local elderly NRT utilization from 9.8% to 34.5% and smoking cessation success from 5.2% to 14.8% [10]. Internationally, Japan's "full medical insurance coverage for NRT" policy achieved a 47% elderly NRT utilization rate, 3.8 times higher than China's [10].

Consensus exists in research that community-based interventions and NRT are the most promising measures for elderly tobacco control, with rural areas requiring more professional resources and diverse service types [10]. Controversies focus on NRT delivery models: some studies advocate for "family doctor home delivery" to improve access, while others emphasize "insurance coverage" to reduce cost barriers [10]. Future research should test these models in rural areas to address existing disparities and improve overall effectiveness.

2.4. Cross-group correlation analysis

Adult tobacco control policies indirectly reduce adolescent smoking risks by improving environmental conditions. A 2019–2023 follow-up study in a Chinese megacity showed that after

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implementing a comprehensive public place smoking ban for adults, adolescent secondhand smoke exposure fell from 45% to 18%, and the adolescent smoking attempt rate dropped from 5.2% to 2.7% (Pearson correlation coefficient r=-0.68, P<0.01). Mechanistically, adult smoking bans reduced adolescents' exposure to smoking behavior: only 12% of adolescents reported "seeing adults smoke in public" post-policy, a 76% decrease, and logistic regression analysis showed that adolescents who saw adult smoking were 4.3 times more likely to try smoking (OR=4.3, 95%2.5 Optimization Suggestions for Age-Specific Tobacco Control Policies.

Based on the above age-stratified analysis, this paper compares age-specific tobacco control measures and proposes optimization suggestions. Tobacco taxes work quickly for adults but barely reduce adolescents' and the elderly's smoking rates (less than 2% drop). Educational campaigns help prevent adolescents' first tobacco use (3%–4% smoking rate reduction) yet have little effect on the elderly, while venue/channel control covers large groups but needs high investment, like ID verification and supervision costs.

For adolescents, integrate smoke-free campus indicators into school evaluations, cooperate with influencers to promote short-video tobacco control content (focusing on e-cig hazards and refusal skills), and expand rural "tobacco control coordinator" programs [2,4]. For adults, continue raising tobacco taxes with low-income subsidies, extend smoking bans to outdoor spaces, add cessation services to corporate insurance, and encourage smoke-free enterprises via incentives [5,7,8]. For the elderly, community health centers provide free NRT (simplified rural application), organize family activities, and develop simplified materials [9,10]. Policy optimization must rely on pre-research and local conditions, such as urban online supervision for adolescents and rural smoking hazard publicity for the elderly.

3. Conclusion

This paper centers on age-stratified tobacco control measures to address the heterogeneous impacts of tobacco use across different age cohorts. For adolescents, although measures such as smoke-free campus initiatives are effective, they encounter rural-urban implementation disparities, and social media anti-smoking campaigns necessitate refinement. Adults derive benefits from tobacco taxation (which exhibits income-related variations) and public place smoking bans. However, smoking cessation services grapple with accessibility challenges. For the elderly, community-based interventions and NRT show potential, yet rural resource deficiencies and low NRT uptake impede progress. Moreover, tobacco control policies targeting adults also exert an influence on adolescent smoking behaviors. The study is of significance as it emphasizes the requirement for tailored policies and elucidates cross-group policy effects. Nevertheless, it relies on existing research, which limits the availability of original data and lacks comprehensive global coverage. Future research should undertake multi-country empirical investigations and explore policy combinations to enhance effectiveness.

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