

Socioeconomic inequality in smoking: Evidence from a decomposition analysis

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ABSTRACT

Problem: Vietnam is a lower-middle-income country with a very high prevalence of smoking among men. The poor are more likely to smoke than the better off. In this study, we examine socioeconomic inequality in smoking and factors associated with the wealth-related inequality of smoking in Vietnam.

Methods: We use data from the 2010 and 2015 Global Adult Tobacco Surveys (GATS). We use a concentration index approach to assess differences in smoking behavior over the distribution of wealth levels. We also use the regression-based decomposition method developed by Wagstaff et al. (2003) and Doorslaer and Koolman (2004) to decompose wealth-related inequality in smoking into inequalities in wealth and other explanatory variables, such as men's age and education.

Results: Poorer men are more likely to smoke and smoke more than those better off. In 2015, 47.9% in the poorest wealth quintile smoked every day compared to 29.1% in the richest quintile. In 2015, the concentration index of wealth-related inequality in daily smoking was estimated at -0.104 (CI: 0.135; -0.072). Education and occupation are important factors in wealth-related inequality in smoking, because the poor tend to have lower education levels and are employed in unskilled jobs but are more likely than the rich to be smokers. At 41.4%, unskilled workers make the largest contribution to wealth-related inequality in smoking.

Conclusions: Our findings suggest that tobacco prevention efforts should be focused on poor, less educated people. Policies that boost the access of the poor to education and better employment can help them not only increase their wealth level but also reduce smoking, thereby narrowing the wealth-inequality gap in smoking.

1. Introduction

Of the approximately 1.1 billion people who use tobacco products,³ it is estimated that more than 8 million deaths each year result from their consumption.⁴ The poor have lower incomes, poorer nutrition, less healthcare utilization, and worse health outcomes than the better off. Yet the former are more likely to smoke than the latter (e.g., Ciapponi, 2011; Casetta et al., 2017). Tobacco use can undermine health and create a heavy burden in healthcare spending for the poor. As a result, socioeconomic inequalities in smoking can contribute to socio-economic inequalities in health.^{5,6}

In this study, we examine socioeconomic inequality in smoking among men in Vietnam, using the 2010 and 2015 Global Adult Tobacco Surveys. We use a concentration index approach to assess where the

poor or rich tend to have higher smoking behaviors. We measure these behaviors by a wide range of indicators, including current smoking status, the number of cigarettes smoked per day, age of smoking initiation, and age of smoking cessation. Next, we use a regression-based decomposition method to decompose wealth-related inequality in smoking into an effect and concentration index of explanatory variables, such as age, education and employment.

Our main contribution is to provide empirical findings for Vietnam on socio-economic inequalities in smoking and factors associated with these inequalities. There are several studies on smoking behaviors in Vietnam, such as^{7,8}; and.⁹ A more relevant study is¹⁰, which examines socioeconomic inequalities among adult male hardcore smokers in Vietnam. This study finds a higher prevalence of hardcore smoking in the poorest group. Our study differentiates from¹⁰ in three ways. First,

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Table 1
Smoking variables for men by wealth index quintiles, 2015 (%).

Smoking variables	Poorest	Poor	Middle-income	Better off	Wealthiest	Total
Prevalence of tobacco use (%)	54.6	49.8	46.0	39.5	35.3	45.3
Prevalence of daily tobacco use (%)	47.9	43.0	40.9	31.5	29.1	38.7
Prevalence of manufactured cigarette smoking (%)	35.1	32.3	30.3	26.6	26.1	30.2
Number of tobacco products smoked daily	14.5	14.1	13.2	13.8	12.5	13.8
Number of manufactured cigarettes smoked daily	14.8	13.4	13.2	13.5	12.5	13.6
Age of smoking initiation (among smokers)	19.6	19.6	20.0	19.7	19.7	19.7
Rate of smoking cessation (among current and former smokers) (%)	25.8	35.4	39.5	44.3	44.2	37.4
Age of smoking cessation (among former smokers)	41.1	40.8	37.8	37.3	37.5	38.7

Source: Estimation from GATS 2015.

we look at the smoking behaviors of all male adults (measured by a number of smoking indicators) instead of only hardcore smokers among men aged 25 years and above.¹ Secondly, we look at socio-economic inequalities over a wider range of smoking indicators, including not only the prevalence of smoking but also its intensity, and smoking onset and cessation behaviors. Thirdly, we employ the decomposition method to explore several factors associated with socio-economic inequalities in smoking.

Vietnam is an important case to consider. It is a lower-middle-income country with a very high prevalence of smoking among men, amounting to 45.3% among male adults in 2015.¹¹ According to Ref. ¹², Vietnam has the third highest smoking rate in Southeast Asia, following Indonesia and Laos. In Vietnam, tobacco use is estimated to cause over 40,000 deaths each year.¹³ The poor have a lower level of health than the better off¹⁴ but are more likely to smoke.¹⁰ Understanding the factors associated with socio-economic inequalities in smoking can be important for policy makers in designing policies to reduce these inequalities not only in smoking but also in health.

2. Data sets and descriptive analysis

In this study, we use data from the 2010 and 2015 Global Adult Tobacco Surveys (GATS) of Vietnam. These GATS were conducted by Vietnam's General Statistics Office (GSO) with technical support and funding from the World Health Organization. The number of individuals who completed the questionnaires is 9925 and 8996 in 2010 and 2015, respectively. The surveys are nationally representative for adults aged

¹ ¹⁰ define a hardcore smoker as someone who smokes every day and who, at the time of the survey 1) had been smoking for at least 5 years or more, 2) smoked 15 cigarettes per day or more, 3) had made no attempt to quit in the past 12 months, and 4) had no intention of quitting smoking at all or in the next 12 months.

15 years and above. Our study focuses on this group, since smoking is mainly a phenomenon among men in Vietnam.²

The GATS of Vietnam contain detailed information on smoking behaviors and the perceptions of respondents, their demographic characteristics and living conditions. There are no data in the GATS on aggregate welfare indicators, such as income or expenditure. Following the approach of¹⁵, we constructed a wealth index as the first principal component of a vector of household assets, such as durable goods, and housing conditions. The principal component approach defines a wealth index in terms of the first principal component of the variables. Based on data availability, the assets used to compute the wealth index consist of flush latrine, telephone, television, radio, fridge, car, washing, air-conditioning, motorbike, electricity generator, grinder, computer, and internet connection. We do not include housing characteristics in the wealth index, since there is no information on housing conditions in the data sets. The wealth index is standardized with a mean of zero and standard deviation of one. A higher index value means better living standards and level of wealth.

Vietnam has made progress in tobacco control. The law on tobacco control – the Law on the Prevention and Control of Harm from Tobacco – was enacted by the National Assembly of Vietnam in June 2012 and took effect on May 1, 2013. The law prohibits tobacco advertising, promotion, and direct tobacco marketing in any form. It also bans those under 18 from using, buying, or selling tobacco. In addition to a value added tax of 10%, tobacco products are subject to a special consumption tax (also called an excise tax). In recent years, the special consumption tax has increased. Before 2006, this tax rate was 45% on the factory price but was increased to 55% in 2006, to 65% in 2008, and to 70% in 2016.

Table 1 presents estimates of smoking variables for men by quintiles of wealth in 2015. The estimates for the year 2010 are presented in Table A1 in the Appendix. The prevalence of tobacco use among men was 47.4% in 2010 and 45.3% in 2015. Men who smoke every day account for 85% of all smokers in Vietnam. In both 2010 and 2015, the percentage of daily smokers (all tobacco products) among men was 38.7%. A major tobacco product consumed in Vietnam is manufactured cigarettes. In 2015, around 31% of men smoked manufactured cigarettes every day, for a daily average of 14 manufactured cigarettes.

Table 1 shows a negative correlation between level of wealth and smoking in Vietnam. In 2015, the daily smoking ratio was 47.9% in the poorest quintile and 29.1% in the richest. The poorest also have a higher rate of daily cigarette smoking. People in higher quintiles are more likely to quit smoking. The rate of smoking cessation (among current and former smokers) in the lowest and the higher wealth quintiles was 25.8% and 44.2%, respectively. People in higher wealth quintiles also quit smoking at a lower age than those in lower wealth quintiles.

3. Estimation method

Concentration indices have long been used to quantify inequality in one variable across the distribution of a related variable.¹⁶ The concentration index is equal to twice the area between the concentration curve between the two variables and the 45-degree line. The concentration curve graphs the cumulative proportion of a variable of interest (in this study, the number of cigarettes smoked daily) in the vertical axis against the cumulative proportion of individuals (in the horizontal axis) ranked by the wealth index, from poorest to richest. The concentration index is computed using the following formula^{16,17}:

$$C_S = \frac{2}{\mu} Cov(S_i, R_i), \quad (1)$$

where S_i is a variable indicating an individual smoker i (in this study,

² According to the 2015 Global Adult Tobacco Survey of Vietnam, the prevalence of smoking among women was only 1.1% in 2015.

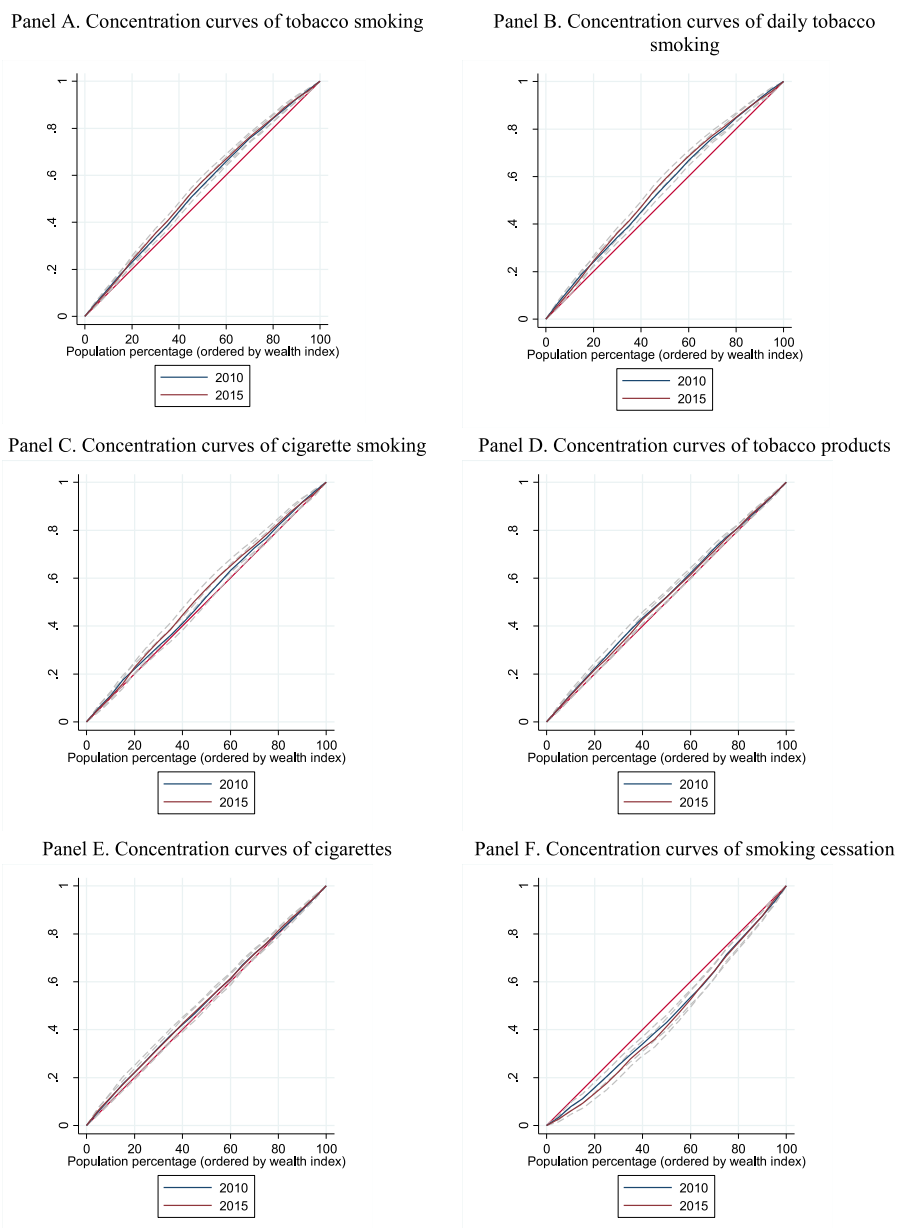


Fig. 1. Smoking concentration curves, with individuals ranked by asset index. Source: Estimates from GATS 2010–2015

smoking status or the daily number of cigarettes), and μ is the mean of the smoking variable. R_i is the ratio of the rank (r_i) of individual i in the wealth distribution to the total number of people, i.e., $R_i = r_i/N$. The poorest person has an r_i equal to 1, while the richest has an r_i equal to N . The concentration index ranges from -1 to 1 . A concentration index close to -1 means a higher level of smoking among the poor, while a concentration index close to 1 indicates a higher level smoking among the rich. For a binary variable, such as smoking status (1 for smokers and 0 otherwise), we use the Wagstaff and Erreygers normalized concentration indices.^{18,19}

To examine factors associated with socio-economic inequality in smoking, we apply a regression-based decomposition method adopted from ¹ and ². First, we estimate the smoking variable using a linear explanatory variable model, as follows:

$$S = \alpha + \sum_k \beta_k x_k + \varepsilon, \tag{2}$$

where x_k indicates explanatory variables, such as demographic characteristics, education and the geographic location of individuals. The concentration index C for the smoking variable S can be decomposed as follows:

$$C_S = \sum_k (\beta_k \bar{x}_k / \mu) C_k + C_\varepsilon / \mu, \tag{3}$$

where μ still denotes the mean of the smoking variable, \bar{x}_k is the mean of variable x_k , and C_k is the concentration index of x_k related to the wealth distribution. C_ε is the concentration index of the error term, which can also be estimated by the difference between the concentration index C and $\sum_k (\beta_k \bar{x}_k / \mu) C_k$. This residual element reflects an unexplained component in wealth-related inequality in smoking. Equation (3) suggests that the concentration index C_S is decomposed into weighted concentration indices of explanatory variables in the regression model, and into weights for each explanatory variable equal to $(\beta_k \bar{x}_k / \mu)$.

We can compute the contribution (in percent) of explanatory vari-

Table 2
Concentration indices with individuals ranked by wealth index.

Variables	GATS 2010		GATS 2015	
	Estimate	Standard error	Estimate	Standard error
	(1)	(2)	(3)	(4)
Tobacco smoking	-0.0744***	0.0117	-0.0895***	0.0143
Daily smoking	-0.0865***	0.0133	-0.1038***	0.0160
Manufactured cigarette consumption	-0.0361**	0.0169	-0.0605***	0.0209
Number of tobacco products smoked daily	-0.0379**	0.0160	-0.0284***	0.0114
Number of manufactured cigarettes smoked daily	-0.0275	0.0189	-0.0318***	0.0124
Age of smoking initiation (among smokers)	0.0097***	0.0036	0.0025	0.0035
Smoking cessation (among current and former smokers)	0.0861***	0.0180	0.1071***	0.0199
Age of smoking cessation (among former smokers)	-0.0083	0.0087	-0.0238***	0.0085
<i>Wagstaff indices</i>				
Tobacco smoking	-0.1414***	0.0223	-0.1638***	0.0262
Daily smoking	-0.1412***	0.0217	-0.1694***	0.0261
Cigarette smoking	-0.0522**	0.0244	-0.0867***	0.0300
Smoking cessation (among current and former smokers)	0.1395***	0.0291	0.1710***	0.0318
<i>Erreygers indices</i>				
Tobacco smoking	-0.1411***	0.0223	-0.1624***	0.0260
Daily smoking	-0.1340***	0.0206	-0.1608***	0.0248
Cigarette smoking	-0.0446**	0.0208	-0.0732***	0.0253
Smoking cessation (among current and former smokers)	0.1318***	0.0275	0.1601***	0.0298

The asterisks represent the significance of the difference from zero: ***p < 0.01, **p < 0.05, *p < 0.1.

Source: Estimates from GATS 2010–2015

ables to the concentration index C_S :

$$P_k = \frac{(\beta_k \bar{x}_k / \mu) C_k}{C_S} \cdot 100 \tag{4}$$

The standard error of the contribution in Equation (4) is computed using a non-parametric bootstrap with 500 replications. (4).

It should be noted that in this study we are not able to estimate the causal effect of endogenous explanatory variables, such as education and employment, on smoking because of the endogeneity problem. Thus, the contribution of endogenous variables should be interpreted as a matter of association with wealth-related inequality in smoking rather than the causal effect of these variables.

4. Estimation results

4.1. Concentration curve and index

Fig. 1 presents the concentration curves of different smoking variables against the cumulative percentage of men ranked by the wealth index for 2010 and 2015. The 95% confidence interval is depicted with dash lines. For all smoking variables, the 95% confidence interval lines of the 2010 and 2015 curves overlap, indicating that there is no statistically significant difference in wealth-related inequalities in smoking variables between 2010 and 2015. Except for smoking cessation, other smoking variables have concentration curves above the 45-degree line,

suggesting that people with a lower wealth index smoke more than those with a higher wealth index. On the other hand, the concentration curve of smoking cessation lies below the 45-degree line, pointing to a higher rate of smoking cessation among the rich than the poor.

Table 2 reports concentration indices, which quantify inequalities in smoking variables across the wealth index. Results from these indices are consistent with results from concentration curves. The concentration indices of smoking status and smoking quantity (measured by the number of tobacco products and cigarettes smoked each day) are all negative, highlighting that smoking is more concentrated among the poor than the rich. The concentration index of smoking cessation (among current and former smokers) has a negative sign, which means the rich are more likely to quit smoking than the poor. The concentration index of smoking cessation age was negative and statistically significant in 2015. This means that among people who stop smoking, the rich tend to quit smoking at a younger age than the poor.

4.2. Decomposition analysis

In this section, we conduct a decomposition analysis of wealth-related inequalities in smoking. There are several variables for measuring smoking behaviors. For compactness in presentation and interpretation, we report only the decomposition of the wealth-related concentration index of daily smoking status. The variable of wealth has the highest magnitude in the concentration index, reflecting higher inequality in smoking status between the poor and the rich. Smoking cessation also is highly correlated with the wealth index, but information on smoking cessation is included in the smoking status variable. Since wealth-related inequalities in other smoking variables are of small magnitude, we do not conduct decomposition analysis for these variables.

The first step in decomposition analysis is to estimate the regression of the number of cigarettes per day on explanatory variables (Equation (1)). These include age, marital status, education level, occupation, Kinh majority, household size, urban dummy and wealth index.³ The summary statistics of variables is given in Table A2 in the Appendix. We run separate regressions for 2010 and 2015. It should be noted that a linear regression of smoking status is used for decomposition analysis (the current method does not allow for the decomposition of non-linear models, such as logit or probit). The regression results are presented in Table A3 in the Appendix. Overall, we find that people with higher levels of education and wealth are less likely to smoke than those with lower levels of education and wealth. There is an inverted U-shaped relation between age and smoking. With increasing age, more people are likely to be smokers, but tend to quit smoking after a peak in middle age.

The decomposition of the concentration index of daily smoking status for the 2015 GATS is presented in Table 3. The decomposition results for the 2010 GATS are somewhat similar and are given in Table A.4 in the Appendix. We use the 2015 estimates for interpretation. Columns 1 and 2 of Table 3 present the elasticity of the number of cigarettes to explanatory variables $(\beta_k \bar{x}_k / \mu)$ and the concentration indices of the explanatory variables (C_k) , respectively. Column 3 shows the absolute contribution of the explanatory variables, $(\beta_k \bar{x}_k / \mu) C_k$. Column 4 reports the relative contribution of the explanatory variables, $[(\beta_k \bar{x}_k / \mu) C_k] / C_S$, and their standard errors are reported in column 5. We use the percentage contributed by explanatory variables in column 4 for interpretation. Wealth-related inequality in age and marital status does not make a significant contribution to wealth-related inequality in daily smoking. The Kinh variable also is significant in smoking inequality. The positive concentration index (column 1) and the negative contribution (column 4) of the Kinh variable mean that Kinh people enjoy greater wealth than

³ There are 54 ethnic groups in Vietnam, of which the Kinh people account for 85% of the total population. Compared with the other ethnic minorities, Kinh people tend to live in delta areas and have higher living standards.

Table 3
Decomposition of the wealth-related concentration index of daily smoking in the 2015 GATS

Variables	Elasticity of explanatory variables	Concentration index of explanatory variables	Contribution of explanatory variables	Relative contribution of explanatory variables (%)	Standard error of relative contribution
	(1)	(2)	(3)=(1)x(2)	(4)	(5)
Age	2.8331	0.0038	0.0108	-10.40	13.88
Age squared	-1.2761	-0.0012	0.0015	-1.44	11.18
Married	0.0092	0.0160	0.0001	-0.14	1.25
Divorced	0.0012	-0.1854	-0.0002	0.22	0.48
Widowed	0.0003	-0.2082	-0.0001	0.06	0.55
Kinh majority (Kinh = 1, ethnic minorities = 0)	0.1530	0.1058	0.0162	-15.59**	7.19
Primary education	-0.0220	-0.2459	0.0054	-5.22	4.44
Lower-secondary education	-0.0779	-0.0030	0.0002	-0.23	1.20
Upper-secondary education	-0.0824	0.1976	-0.0163	15.69***	4.41
College and above	-0.0804	0.4959	-0.0399	38.42***	10.79
Professionals/technicians	0.0124	0.5297	0.0066	-6.34	6.36
Clerks/service workers	0.0455	0.2630	0.0120	-11.54**	4.91
Skilled workers	0.0661	0.1195	0.0079	-7.62**	3.77
Unskilled workers	0.1901	-0.2258	-0.0429	41.36**	17.60
Not working	0.0054	0.0853	0.0005	-0.45	2.90
Household size	-0.0704	0.0181	-0.0013	1.23	1.16
Wealth index	-0.0026	28.7749	-0.0745	71.83***	13.86
Urban areas (urban = 1, rural = 0)	0.0292	0.3506	0.0103	-9.88	6.15
Residuals				0.20	2.23

Note: This table reports the decomposition of the concentration index into the contributions of socio-economic factors. Point estimates are reported for elasticities, concentration indices, and the contribution of socio-economic factors. For the contribution in percent, standard errors are estimated using a bootstrap with 500 replications.

Asterisks represent the significance of the contribution: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: Estimates from GATS 2015.

the ethnic minorities, but at the same time Kinh people are also more likely to be smokers than the ethnic minorities. As a result, the Kinh variable reduces wealth-related inequality in smoking.

It should be noted that the ratio of daily smoking of Kinh and ethnic minorities in 2015 and 2010 was 38.3% and 38.8%, respectively. However, in the regression reported in Table A3 in the Appendix, once other explanatory variables are controlled for, Kinh men have a higher probability of smoking than ethnic minorities. Specifically, compared with men from ethnic minorities of similar age, education, occupation and wealth level, the probability that Kinh men will be daily smokers is around 0.07 higher than for other groups.

Education is one of the main factors associated with inequality in smoking. Having upper-secondary education or tertiary education (college and above) account for 15.7% and 38.4% of smoking inequality, respectively. Higher education improves the level of wealth and at the same time reduces daily smoking. Put differently, the poor tend to have lower levels of education but a higher probability of smoking than the rich. We further examine inequality in smoking across education levels by estimating the concentration index of smoking variables in relation to the wealth index. Reported in Table A.5 in the Appendix, the results show that people with lower education tend to smoke more and smoke more frequently than those with higher education. For smoking inequality overall, education-related inequality is higher than wealth-related inequality.

Among occupational variables, unskilled workers have the closest association with wealth-related inequality in smoking, accounting for 41.4% of wealth-related inequality. The unskilled worker group has a lower level of wealth but tends to have a higher smoking rate. Finally, the wealth index contributes the most to inequality in smoking since this is the variable against which the distribution of smoking is assessed.

5. Discussion and conclusions

Employing a concentration index, this study investigates social inequalities in smoking among men in Vietnam. Men with lower levels of wealth and education are more likely to smoke and smoke more than

those with greater wealth and more education. Our findings on socioeconomic inequalities in smoking habits are consistent with recent studies from other countries (e.g., Refs. ^{20, 21}; and ²² Using a sample of 54 low- and middle-income countries (LMIC)²³ showed that socioeconomic inequalities in tobacco use are prevalent in these countries, and are much more widespread in the lowest income countries. A study by²⁴, which analyzed data from 50 countries, reported results similar to ours, that smoking inequalities favored the rich in most countries. Social inequalities in smoking quantity, such as the number of tobacco products and cigarettes smoked each day, are less documented than inequalities in the prevalence of smoking.²⁵

Findings from the decomposition analysis show that education and occupation are the main factors associated with wealth-related inequality in smoking. Better education helps raise the level of wealth and at the same time reduces smoking quantity. Thus, higher education is one of the main factors associated with wealth-related inequality in smoking. These findings contribute to the growing evidence for the strong association between educational attainment and the prevalence of smoking (e.g., Refs. ^{20, 26} Nagelhout et al. (2012) found that less educated respondents were significantly more likely to be smokers and smoked more cigarettes per day than more educated respondents. Educational inequalities had the same effect on smoking as income inequalities, but the latter were less significant than the former.²⁷

Our findings suggest several policy implications. Tobacco control should be targeted at the poor and those with lower education. Policies that improve education and employment for the poor can help reduce smoking, thereby reducing wealth-related inequality in smoking. Tobacco taxation is also an important tobacco control intervention and has the greatest potential for reducing socioeconomic (e.g., Ref. ²⁸ and health inequalities in smoking.²⁹ The taxation of tobacco is a 'pro-poor' policy since it is low-income groups that can benefit the most from lower medical costs and reduced illness and impoverishment associated with tobacco use, while the extra revenue from tobacco taxation can be channeled into public services, such as health and education, that help lift people out of poverty.³⁰

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Declarations of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.cegh.2022.101213>.

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