

# Campus Policy on Tobacco Prohibition and Tobacco Use among Youth in Sub-Saharan Africa: An Investigation Based on the Perspectives of School Personnel

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**Background:** Schools in sub-Saharan Africa respond to the widespread use of tobacco among youth with the tobacco-prohibition policies. This study empirically examined the impact of the strength of campus tobacco-prohibition policies on tobacco use among youth across 20 sub-Saharan countries.

**Methods:** This study used data from the Global School Personnel Survey across 20 sub-Saharan countries during 2005–2011. Respondents comprised 7,365 school personnel (valid sample size) from Cameroon, Central African Republic, Congo, Eritrea, Ghana, Guinea-Bissau, Lesotho, Malawi, Mauritania, Mauritius, Namibia, Niger, Rwanda, Senegal, Seychelles, Sierra Leone, South Africa, Swaziland, Togo, and Uganda. Considering the potential endogeneity-estimation bias occurring in the normal ordinary least square estimation, instrumental variable estimation was used to ensure the regression results were reliable.

**Results:** The interaction term “tobacco-prohibition policy × policy-enforcement strength” was found to negatively predict perceived seriousness of tobacco use among youth (−0.0053, 95% CI [−0.0101, −0.0005];  $p < 0.05$ ), which indicated that when campus tobacco-prohibition policy and enforcement were both sufficiently strict, the extent to which school personnel felt concerned or anxious about tobacco use among youth in the 20 countries was lowest. A series of identification tests using instrumental variable estimation demonstrated that these regression results were reliable and without endogeneity-estimation bias.

**Conclusion:** This study confirms the effectiveness of the interaction of tobacco-prohibition policy and policy-enforcement strength for alleviating the seriousness of tobacco use among youth in underdeveloped areas. A series of important policy implications are discussed to prevent fast development of tobacco use in this area.

**Keywords:** tobacco-prohibition policy, tobacco use, sub-Saharan African countries, youth

## Introduction

The social risk of exposure to tobacco products shows a disparity between richer and poorer areas. As estimated by the World Health Organization (WHO), among the approximately 1 billion current smokers around the world, about 80% live in low- and middle-income countries (LMICs).<sup>1–3</sup> Given that in many rich countries, current smoking prevalence continues to fall and marketing capacity is still restricted by bans on tobacco advertisements, the tobacco industry is turning its attention to LMICs for potential growth opportunities.<sup>3–5</sup> Among LMICs, African

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countries have younger populations and thus have become the most ideal marketing destination for the tobacco industry.<sup>6–8</sup> In this case, tobacco-control policies for youth-smoking prevention have inevitably become a priority in these regions.

At present, widespread use of tobacco among youth poses a major threat to sub-Saharan societies. In contrast to rich countries, where the initial smoking age of most smokers is higher,<sup>3</sup> most sub-Saharan countries report that the lower limit for tobacco-use initiation is 12–14 years old.<sup>9</sup> Since students of a tender age have limited conscientiousness and capacity to fully understand the harm of tobacco products, in the past few years the prevalence rate of tobacco use among youth has stayed at a high level in these regions. Prevalence of tobacco use among youth aged 13–15 years ranges from 3.6% in Ghana to 13.7% in Côte d'Ivoire.<sup>10</sup> The proportion of students offered free tobacco products by marketing personnel of tobacco companies ranges from 4.7% in Côte d'Ivoire to 12.1% in South Africa.<sup>10</sup>

As such, countries around the world place great emphasis on tobacco-control policies to prevent prevalence of tobacco use rising among youth. Even though there has been research regarding tobacco-control policies for reducing prevalence among adults and youth, limited information is available about the relationship between the level of restrictions/policy provision and effectiveness with regard to initiation, maintenance, and prevalence of tobacco use among school-aged youth and adolescents.<sup>11</sup> Existing research has not fully clarified this issue, and instead has left the effectiveness of tobacco-control policies for tobacco use among youth still in debate. Considering school culture serves as a proximal and important social influence that shapes student health behavior, the impact of school-based tobacco interventions and restrictions on tobacco use among students was examined in this study.

The existing empirical research focuses largely on youth-smoking behavior in developed countries. Some research has shown that the tobacco-control policies on campuses can help alleviate the problem of youth smoking. Specifically, students exposed to a smoke-free campus policy demonstrate significant favorable changes in smoking behavior.<sup>12</sup> School-based policies banning smoking on school property are associated with a small increased risk of occasional smoking among some students.<sup>13</sup> The transfer of a high-school student from a school without youth smokers to a school with 25% tobacco prevalence can significantly increase his/her probability of smoking by

14.5%,<sup>14</sup> which vividly shows the necessity for campus tobacco-control policies. The prevalence of last-30-day smoking behavior has been found to be inversely associated with the strictness of campus tobacco-control policies.<sup>15</sup>

However, there has also been empirical research arguing that the impact of tobacco-control policies on tobacco use among youth is unclear. For example, the influence of school tobacco-prohibition policies on students' visible smoking behavior was found to be insignificant in a study investigating a cohort of about 130 schools with grade 10 and 11 students in Canada.<sup>16</sup> Recent studies have also found that tobacco-control policies may play a less effective role in affecting youth and adolescent smoking behavior than the price of tobacco products.<sup>17</sup> The relationship between a policy against indoor smoking and daily smoking has been found to be statistically insignificant for 16-year-old boys.<sup>18</sup> Some studies have even shown that tobacco-control policies that forbid youth smoking but overlook smoking among adults can raise the desire of youth to smoke.<sup>19</sup>

Based on these controversies, the purpose of this study was to empirically examine the effectiveness of campus tobacco-prohibition policies in alleviating tobacco use among youth in less-developed areas, which are becoming important markets for the tobacco industry. The interaction of tobacco-prohibition policy and policy-enforcement strength was considered, in the hope of avoiding biased conclusions resulting from just examining the influence of policy itself but ignoring its enforcement strength and of providing a comprehensive investigation on the effectiveness of policy. Moreover, to improve generalization of our findings, this study focused on 20 sub-Saharan countries instead of a single country to examine the effectiveness of campus tobacco-prohibition policies on a larger scale. We used instrumental variable (IV) estimation to overcome potential estimation bias resulting from unobservable determinants omitted in the regression analysis (ie, endogeneity problem). This practice can help ensure the reliability of study findings. Finally, this study did not use self-scored questionnaire of students, but instead scores given by school personnel to avoid the problem of social desirability bias caused by self-report and thus to make the findings of this study robust and reliable.

## Methods

### Data Source and Description

The data used in the current study came from the Global School Personnel Survey (GSPS). This survey is led by the WHO; including headquarters and the six regional offices)

and the US Centers for Disease Control and Prevention (CDC). The six WHO regional offices collaborate with the national governments within their respective regions to select the appropriate research coordinator (institution and/or individual) to implement the survey. The research coordinator is responsible for the survey site and data collection within the country. The CDC provides financial and technical support for survey implementation, including survey design and sample selection.

The data set of the GSPS is published and can be publicly accessed on the website of the CDC (<https://nccd.cdc.gov/GTSSDataSurveyResources/Ancillary/Documentation.aspx>). This survey collects information on tobacco use, knowledge, and attitudes of school personnel toward tobacco, the existence and effectiveness of tobacco-control policies in schools, and training and materials available for implementing tobacco prevention and control interventions. School personnel from 20 sub-Saharan countries (Cameroon, 2008; Central African Republic, 2008; Congo, 2009; Eritrea, 2006; Ghana, 2006, 2009; Guinea-Bissau, 2008; Lesotho, 2008; Malawi, 2005, 2009; Mauritania, 2006, 2009; Mauritius, 2008; Namibia, 2008; Niger, 2009; Rwanda, 2008; Senegal, 2007; Seychelles, 2007; Sierra Leone, 2008; South Africa, 2008, 2011; Swaziland, 2005, 2009; Togo, 2007; and Uganda, 2007, 2011) participate in the GSPS. Valid observations on regression analysis in this paper numbered 7365 (valid sample size, excluding observations with any missing values for dependent variable, independent variables, and control variable).

### Dependent Variable

“Seriousness of tobacco use among the youth” scored by school personnel was used as the dependent variable in this study. It indicated the extent to which school personnel felt concerned or anxious about tobacco use among youth in the community.

### Independent Variables

The interaction term “tobacco-prohibition policy  $\times$  policy-enforcement strength” served as the independent variable in this study to reflect both policy regulation and enforcement. “Tobacco-prohibition policy (campus level)” indicates the degree of strictness regarding smoking prohibition on campus. It focuses on tobacco-prohibition regulations for students and school personnel in three places (ie, inside school buildings, outside school buildings on school property/premises, and school-sponsored

activities). It was scored according to the number of prohibition regulations instituted by schools. Higher values of this variable implied stricter prohibition of smoking on campus. “Policy-enforcement strength” indicates the enforcement strength of campus tobacco-prohibition policies. Higher scores implied stricter enforcement of campus tobacco-prohibition policies. Respondents gave scores from 0 (no efforts having been devoted to the enforcement of any tobacco-prohibition policy) to 6 (strictest enforcement).

### Control Variables

The foremost control variable was tobacco accessibility on campus through purchase.<sup>20</sup> This indicated the degree of ease of buying tobacco products on campus. Higher values of this variable implied easier access to tobacco products. Given it was scored by school personnel, the dependent variable “perception of seriousness of tobacco use among youth” might inevitably have been affected by personal characteristics of the respondents. It was thus necessary to control a variety of personal characteristics, including sex and the extent of responsibility for teaching about health. More details about variables are shown in Table 1.

## Statistical Analysis

### Potential Endogeneity Problem of Ordinary Least Square Estimation

Although a variety of personal characteristics of respondents were controlled, there might still have been unobservable determinants omitted on the regression analysis. It was thus inevitable that an endogeneity problem would occur when using ordinary least square (OLS) estimation. When an endogeneity problem occurs, the estimated effect of the explanatory variable on the outcome variable can be upward- or downward-biased (the direction of bias depends on the positive or negative correlation between the explanatory variable and the disturbance term).

In this study, tobacco-products accessibility apart from purchase was also an important potential determinant of the perceived seriousness of tobacco use among youth. However, this has rarely been controlled in previous research for a lack of relevant data. Studies have reported that there are a variety of ways for young smokers to obtain tobacco products, including from family members, borrowing, marketing personnel of tobacco companies, and stealing.<sup>10,21,22</sup> Only a relatively small proportion of school students (26%) get cigarettes from stores.<sup>23</sup>

**Table 1** Description of Variables

	Definition and Value Assignment	Mean	SD	Nonmissing Observations
<b>Dependent variable</b>				
Seriousness of tobacco use among Youth	Respondent (school personnel) feels not at all (1)/somewhat (2)/very much (3) concerned/anxious about tobacco use among youth in community	2.6798	0.5759	18,767
<b>Independent variables (components of interaction term)</b>				
Tobacco-prohibition policy (campus level)	Number of the following tobacco-prohibition policies carried out by schools the respondents work for: <ul style="list-style-type: none"> <li>• The school has a policy or rule specifically prohibiting tobacco use among students inside school buildings.</li> <li>• The school has a policy or rule specifically prohibiting tobacco use among students outside school buildings and on school premises/property.</li> <li>• The school has a policy or rule specifically prohibiting tobacco use among students at school-sponsored activities, wherever they occur.</li> <li>• The school has a policy or rule specifically prohibiting tobacco use among school personnel inside school buildings.</li> <li>• The school has a policy or rule specifically prohibiting tobacco use among school personnel outside school buildings and on school premises/property.</li> <li>• The school has a policy or rule specifically prohibiting tobacco use among school personnel at school-sponsored activities, wherever they occur.</li> </ul> Not answering question or simply replying "I don't know" included in missing values.	2.8947	2.0435	10,237
Policy-enforcement strength	Sum of scores of (1) and (2): <ol style="list-style-type: none"> <li>1. How well does your school enforce any of its policies (or rules) on tobacco use among students? No policy or rules on tobacco use among students (0), not at all (1), partially (2), completely (3).</li> <li>2. How well does your school enforce any of its policies (or rules) on tobacco use among school personnel? No policy or rules on tobacco use among school personnel (0), not at all (1), partially (2), completely (3).</li> </ol>	3.4485	2.0231	17,296
<b>Control variables</b>				
Tobacco accessibility on campus through purchase	0: Cigarettes/tobacco products can neither be purchased inside your school building nor within 100 m of school buildings. 1: Cigarettes/tobacco products can be purchased either inside your school buildings or within 100 m of school buildings. 2: Cigarettes/tobacco products can be purchased both inside your school buildings and within 100 m of school buildings. Respondents not sure about whether they could purchase tobacco regarded as having no access to tobacco inside/within 100 m of buildings.	0.6111	0.6068	18,690
Personal characteristics of respondents	Sex: 1 = male, 2 = female.	1.5387	0.4985	15,430
	Extent of being responsible for teaching about health: one of primary responsibilities, and teach about health a lot (1); not one of primary responsibilities, but teach about health sometimes (2); do not teach about health (3).	1.8399	0.6961	16,414

(Continued)

**Table 1** (Continued).

	Definition and Value Assignment	Mean	SD	Nonmissing Observations
<b>Instrumental variables</b>				
Access to tobacco-prevention teaching and learning materials	Do you have access to teaching and learning materials about tobacco use and how to prevent its use among youth? Yes (1), no/do not know (0)	0.4502	0.4975	18,584
Tobacco-prevention nonclassroom programs	Are nonclassroom programs or activities (such as an assembly) used to teach tobacco-use prevention to students in your school? Yes (1), no/do not know (0)	0.2655	0.4416	17,955

Because of the lack of relevant data, this study controlled for the influence of tobacco-products purchase on campus and left other ways of obtaining tobacco products uncontrolled. As such, the influence of tobacco-products accessibility apart from purchase was omitted in the regression analysis. If normal OLS estimation were still applied to this variable, its influence would have become part of the disturbance term. The explanatory variable should not be correlated with the disturbance term in the normal OLS estimation. Otherwise, the identical and independent distribution condition of the disturbance term will be violated, making the effect estimation of explanatory variables biased. In this study, since tobacco-prohibition policy instituted by schools may have to some extent considered (and thus to some extent correlated with) the ease of students' access to tobacco products (purchasing or other ways), there may have been correlation between the explanatory variable and the disturbance term. It was thus inappropriate to use normal OLS to estimate the effect of explanatory variables. Therefore, the endogeneity problem resulting from omitted variables makes the results of OLS estimation appear unreliable.

### Instrumental Variable Estimation

To overcome the potential endogeneity problem in estimation, we needed to perform IV estimation. The choice of IVs should meet several requirements. First, IVs should be correlated with potentially endogenous explanatory variables. Second, IVs should be uncorrelated with the disturbance term. Third, the number of IVs should be no fewer than the number of potentially endogenous explanatory variables to meet the order condition. Fourth, the correlation between potentially endogenous explanatory variables and IVs should not be too weak to meet the rank condition.

In this study, access to tobacco-prevention teaching and learning materials and tobacco-prevention nonclassroom

programs were used as IVs for several reasons. First, schools that put more emphasis on tobacco-prohibition policies were expected to devote more financial resources with permission to enhance health education, and in doing so maximize the policy effect. Therefore, there may have existed correlations between the selected IVs and the explanatory variable tobacco-prohibition policy  $\times$  policy-enforcement strength. Second, the setting of tobacco-prevention curriculums and tobacco-prevention nonclassroom programs by schools in underdeveloped areas is mainly subject to school finances, and thus may not have an explicit and direct relationship with tobacco-products accessibility apart from purchase. Accordingly, it was expected that the IVs selected in this study would have no significant correlations with the disturbance terms.

Further, it was not appropriate to use access to tobacco-prevention teaching and learning materials and tobacco-prevention nonclassroom programs as control variables in the regression. The inclusion of these two variables as controls can result in an estimation problem. First, the existing research lacks sufficient and direct evidence to show a close relationship between access to tobacco-prevention materials/non-classroom programs and seriousness of tobacco use. This might due to the fact that access to tobacco-prevention materials/nonclassroom program is a soft rather than hard constraint of tobacco use, and its effect probably slow in the long term and thus difficult to be observed immediately. Second, as mentioned, these two variables were correlated with the explanatory variable tobacco prohibition policy  $\times$  policy enforcement strength, the inclusion of these two variables as controls would thus bring into play the multicollinearity problem and estimation bias. Stata 13.0 was used to conduct IV estimation.

## Results

### Descriptive Statistics Dependent Variable

Among 18,767 nonmissing observations, 1,069 (5.70%) respondents reported that they felt not at all concerned/



anxious about tobacco use among youth in the community (score 1), 3,872 (20.63%) reported “somewhat concerned/anxious about the situation” (score 2), and 13,826 (73.67%) reported “very much concern” (score 3). For each of the 20 sub-Saharan countries, the dependent-variable scores reported by school personnel are presented in [Table 2](#).

### Independent Variables

Among 10,237 nonmissing observations for tobacco-prohibition policies at campus level, 1933 (18.88%) respondents reported no prohibition (score 0), 1,157 (11.30%) one regulation (score 1), 1,339 (13.08%) two (score 2), 1,576 (15.40%) three (score 3), 1,509 (14.74%) four (score 4), 1,304 (12.74%) five (score 5), and 1,419 (13.86%) six (score 6). Among the 17,296 nonmissing observations for policy enforcement strength, 3,867 (22.36%) respondents reported the strictest enforcement strength (score 6), 2,122 (12.27%) a score of 5, 2,832 (16.37%) 4, 3,407 (19.70%) 3, 1,977 (11.43%) 2, 331 (1.91%) 1, and 2,760 (15.96%) 0 (ie, no effort devoted to enforce any tobacco-prohibition policy). Scores for these variables reported by school personnel for each of the 20 sub-Saharan countries, are also displayed in [Table 2](#).

### Control Variables

Among 18,690 nonmissing observations, 8,488 (45.41%) respondents reported that students could not purchase tobacco products inside school buildings or within 100 m of school buildings, 1,220 (6.53%) that they could purchase tobacco products both inside school buildings and within 100 m of school buildings, and 8,982 (48.06%) that they could purchase tobacco products at one of these places. Among 15,430 nonmissing observations, 7,118 (46.13%) were male and 8,312 (53.87%) female. Among 16,414 nonmissing observations on responsibility for teaching about health, 5,501 (33.51%) respondents replied “It is one of my primary responsibilities, and I teach about health a lot”, 8,040 (48.98%) “It is not one of my primary responsibilities, but I do teach about health sometimes”, 2,873 (17.50%) “I do not teach about health”.

## Regression Results and Identification Tests

[Figure 1](#) provides an intuitive visual presentation of the extent of perceived seriousness of tobacco use among

youth, tobacco-prohibition policies, policy-enforcement strength, and tobacco accessibility on campus through purchase across the 20 countries. As shown in [Figure 1](#), there were no obvious relationships between tobacco-prohibition policies and perceived seriousness of tobacco use among youth or between policy-enforcement strength and perceived seriousness of tobacco use among youth.

[Table 3](#) shows the effect of the interaction of tobacco-prohibition policy (at campus level) and policy-enforcement strength on perceived seriousness of tobacco use among youth in the countries covered. Results indicated that tobacco-prohibition policy  $\times$  policy-enforcement strength significantly and negatively affected perceived seriousness of tobacco use among youth ( $-0.0053$ , 95% CI  $[-0.0101, -0.0005]$ ;  $p < 0.05$ ), ie, when the campus tobacco-prohibition policy and its enforcement strength were both very strict (high level), the perceived seriousness of tobacco use among youth in the countries was lowest.

[Table 3](#) also shows the results of a series of identification tests to examine the reliability of regression results when using IV estimation. Results indicated that all the identification tests and the endogeneity test were passed. The regression results were thus confirmed to be reliable. To be specific: 1) the statistical significance of the underidentification test (435.805,  $p < 0.01$ ) showed a significant correlation between the endogenous explanatory variable and the IVs, which implies that the endogenous explanatory variable was identified by the IVs; 2) the significant results of the weak-identification test (231.261  $>$  19.93) showed that the correlation between the endogenous explanatory variable and the IVs was strong enough; 3) the statistical insignificance of the overidentification test (0.088,  $p = 0.7661$ ) implied that the IVs met the exogenous condition that the correlation between the IVs and the disturbance term was statistically insignificant; and 4) the insignificant results of the endogeneity test showed that the estimation no longer suffered from the endogeneity problem (3.595,  $p = 0.0579$ ). Taking these results together, it is concluded that the regression results were reliable when using IV estimation. A robustness check including country-level policies in analysis was also conducted in this study. More details are provided in [Appendix A](#).

## Discussion

### Main Research Findings

There is controversy over the effectiveness of campus policies on tobacco control. The findings of previous studies appear highly context-specific, and results found in

Table 2 Variables by country

Cameroon	Central African Republic	Congo	Eritrea	Ghana	Guinea-Bissau	Malawi	Mauritania	Mauritius	Namibia
<b>Seriousness of tobacco use among youth</b>									
Not at all (1)	9 (1.83%)	5 (1.12%)	316 (22.22%)	12 (1.53%)	90 (16.27%)	4 (0.37%)	70 (5.85%)	38 (4.44%)	48 (6.47%)
Somewhat (2)	49 (9.94%)	32 (7.14%)	419 (29.47%)	174 (22.25%)	234 (42.31%)	367 (35.92%)	142 (11.86%)	284 (33.22%)	99 (13.34%)
Very much (3)	1228 (71.94%)	411 (91.74%)	687 (48.31%)	596 (76.21%)	229 (41.41%)	711 (65.71%)	985 (82.29%)	533 (62.34%)	595 (80.19%)
<b>Tobacco-prohibition policy (campus level)</b>									
0	63 (7.68%)	73 (28.40%)	198 (21.64%)	93 (15.50%)	319 (64.06%)	58 (7.29%)	237 (38.92%)	42 (8.75%)	72 (15.58%)
1	50 (6.10%)	45 (17.51%)	133 (14.54%)	68 (11.33%)	17 (3.41%)	73 (9.17%)	202 (33.17%)	37 (7.71%)	61 (13.20%)
2	163 (19.88%)	43 (16.73%)	138 (15.08%)	62 (10.33%)	11 (2.21%)	102 (12.81%)	77 (12.64%)	57 (11.88%)	75 (16.23%)
3	181 (22.07%)	28 (10.89%)	136 (14.86%)	71 (11.83%)	29 (5.82%)	146 (18.34%)	27 (4.43%)	47 (9.79%)	75 (16.23%)
4	103 (12.56%)	18 (7.00%)	124 (13.55%)	101 (16.83%)	39 (7.83%)	170 (21.36%)	38 (6.24%)	81 (16.88%)	58 (12.55%)
5	89 (10.85%)	13 (5.06%)	74 (8.09%)	113 (18.83%)	62 (12.45%)	152 (19.10%)	12 (1.97%)	92 (19.17%)	54 (11.69%)
6	171 (20.85%)	37 (14.40%)	112 (12.24%)	92 (15.33%)	21 (4.22%)	95 (11.93%)	16 (2.63%)	124 (25.83%)	67 (14.50%)
<b>Policy-enforcement strength</b>									
0	189 (11.28%)	136 (28.51%)	320 (22.50%)	97 (12.45%)	No data	122 (11.55%)	316 (26.99%)	88 (10.48%)	130 (17.76%)
1	32 (1.91%)	17 (3.56%)	52 (3.66%)	12 (1.54%)	No data	13 (1.23%)	15 (1.28%)	13 (1.55%)	19 (2.60%)
2	282 (16.83%)	107 (22.43%)	180 (12.66%)	63 (8.09%)	No data	124 (11.74%)	131 (11.19%)	77 (9.17%)	71 (9.70%)
3	349 (20.82%)	46 (9.64%)	234 (16.46%)	237 (30.42%)	No data	301 (28.50%)	315 (26.90%)	103 (12.26%)	82 (11.20%)
4	385 (22.97%)	102 (21.38%)	221 (15.54%)	59 (7.57%)	No data	99 (9.38%)	227 (19.39%)	142 (16.90%)	155 (21.17%)
5	204 (12.17%)	25 (5.24%)	153 (10.76%)	85 (10.91%)	No data	165 (15.63%)	71 (6.06%)	126 (15.00%)	79 (10.79%)
6	235 (14.02%)	44 (9.22%)	262 (18.42%)	226 (29.01%)	No data	232 (21.97%)	96 (8.20%)	291 (34.64%)	196 (26.78%)
<b>Seriousness of tobacco use among youth</b>									
Not at all (1)	46 (7.37%)	10 (5.08%)	15 (2.43%)	14 (2.73%)	136 (3.65%)	13 (1.16%)	0 (0.00%)	49 (4.12%)	15 (14.71%)
Somewhat (2)	83 (13.30%)	26 (13.20%)	87 (14.10%)	132 (25.73%)	540 (14.50%)	354 (31.49%)	36 (7.41%)	327 (27.53%)	5 (4.90%)
Very much (3)	495 (79.33%)	161 (81.73%)	515 (83.47%)	367 (71.54%)	3048 (81.85%)	757 (67.35%)	450 (92.59%)	812 (68.35%)	82 (80.39%)
<b>Tobacco-prohibition policy</b>									
0	103 (33.33%)	8 (6.67%)	194 (59.51%)	14 (7.11%)	155 (15.77%)	59 (8.64%)	63 (19.81%)	35 (4.01%)	14 (21.54%)
1	36 (11.65%)	8 (6.67%)	61 (18.71%)	20 (10.15%)	127 (12.92%)	58 (8.49%)	47 (14.78%)	32 (3.67%)	4 (6.15%)
2	59 (19.09%)	10 (8.33%)	29 (8.90%)	22 (11.17%)	190 (19.33%)	82 (12.01%)	42 (13.21%)	76 (8.71%)	6 (9.23%)

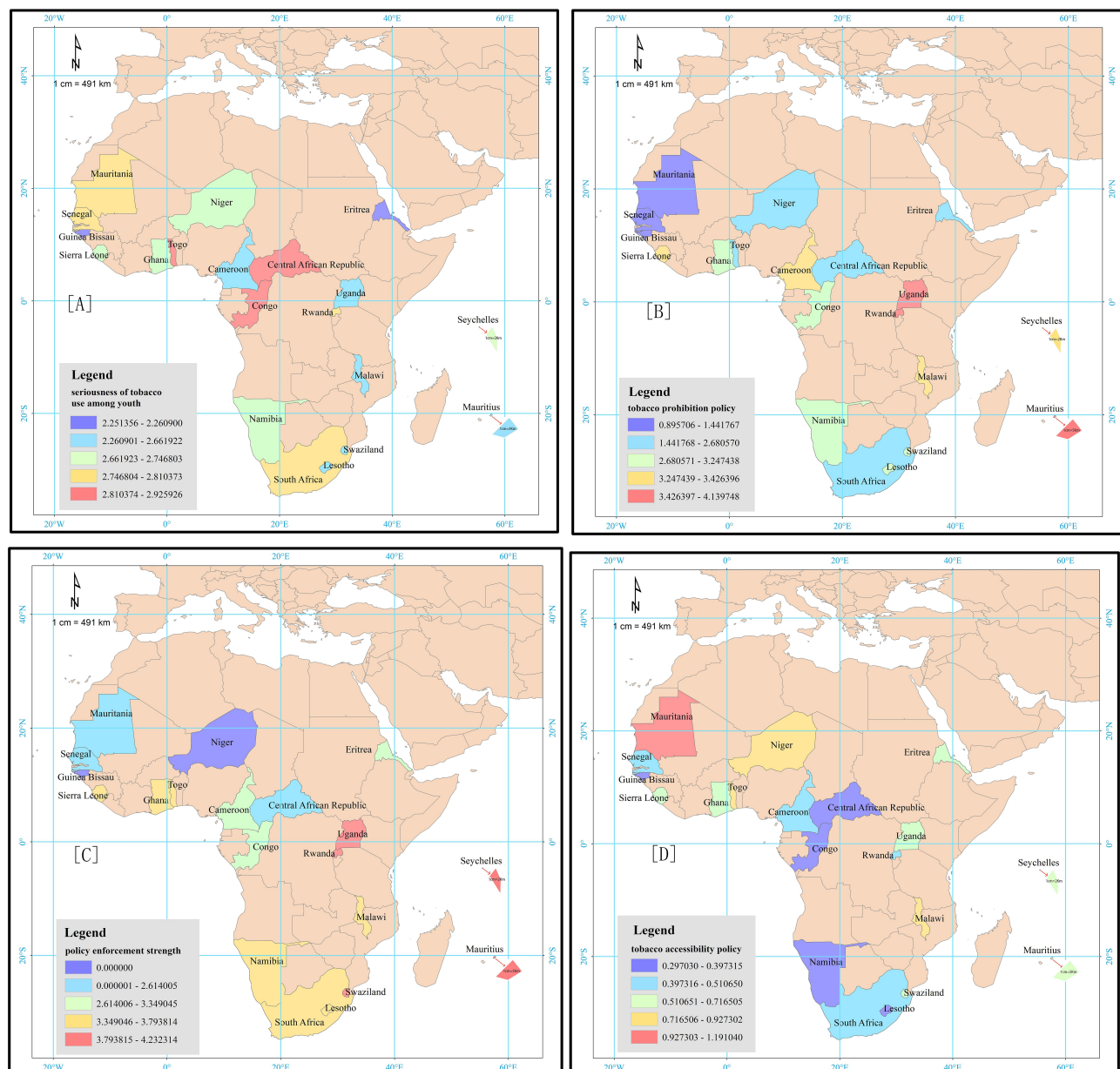
	Niger	Rwanda	Senegal	Seychelles	Sierra Leone	South Africa	Swaziland	Togo	Uganda	Lesotho
3	29 (9.39%)	18 (15.00%)	17 (5.21%)	49 (24.87%)	128 (19.63%)	182 (18.51%)	191 (27.96%)	61 (19.18%)	135 (15.46%)	8 (12.31%)
4	37 (11.97%)	26 (21.67%)	9 (2.76%)	36 (18.27%)	126 (19.33%)	156 (15.87%)	115 (16.84%)	49 (15.41%)	173 (19.82%)	10 (15.38%)
5	18 (5.83%)	14 (11.67%)	10 (3.07%)	16 (8.12%)	94 (14.42%)	80 (8.14%)	105 (15.37%)	50 (15.72%)	199 (22.79%)	7 (10.77%)
6	27 (8.74%)	36 (30.00%)	6 (1.84%)	40 (20.30%)	113 (17.33%)	93 (9.46%)	73 (10.69%)	6 (1.89%)	223 (25.54%)	16 (24.62%)
<b>Policyenforcement strength</b>										
0	No data	27 (13.85%)	286 (47.51%)	29 (5.75%)	124 (13.75%)	582 (15.82%)	81 (7.30%)	23 (4.88%)	73 (6.38%)	18 (4.88%)
1	No data	0 (0.00%)	17 (2.82%)	6 (1.19%)	29 (3.22%)	83 (2.26%)	3 (0.27%)	3 (0.64%)	6 (0.52%)	0 (0.00%)
2	No data	13 (6.67%)	50 (8.31%)	61 (12.10%)	81 (8.98%)	454 (12.34%)	91 (8.20%)	54 (11.46%)	79 (6.90%)	8 (0.64%)
3	No data	26 (13.33%)	93 (15.45%)	105 (20.83%)	124 (13.75%)	608 (16.53%)	280 (25.23%)	168 (35.67%)	268 (23.41%)	12 (11.46%)
4	No data	31 (15.90%)	56 (9.30%)	99 (19.64%)	155 (17.18%)	722 (19.63%)	127 (11.44%)	43 (9.13%)	120 (10.48%)	16 (35.67%)
5	No data	23 (11.79%)	24 (3.99%)	55 (10.91%)	111 (12.31%)	443 (12.04%)	230 (20.72%)	104 (22.08%)	196 (17.12%)	6 (9.13%)
6	No data	75 (38.46%)	76 (12.62%)	149 (29.56%)	278 (30.82%)	786 (21.37%)	298 (26.85%)	76 (16.14%)	403 (35.20%)	37 (22.08%)

developed countries may not apply well to underdeveloped countries. Using a multicountry data set across several years, this study clarified the effectiveness of campus policies on tobacco control in sub-Saharan African countries. We considered the interaction effect of tobacco-prohibition policies and policy-enforcement strength on policy outcomes. As suggested by prior studies, insignificance of a tobacco-control policy might not demonstrate the failure of policy per se, but reflect the result of ignoring the strength of policy enforcement in the analysis. Our practice can partially remedy the problem of solely investigating the influence of policy institution and provide a more comprehensive examination of policies. The study shows that the interaction between campus tobacco-prohibition policy and policy-enforcement strength has a significant and negative impact on the perceived seriousness of tobacco use among youth in the 20 sub-Saharan countries. When campus tobacco-prohibition policies and enforcement strength were both very strict (high level), perceived seriousness of tobacco use among youth in the 20 countries was lowest.

### Research Contributions

This study could advance the existing literature in several aspects. First, it explored campus tobacco-prohibition policies over a larger area instead of in a single country, and thus provides more robust and general results. Second, this study enriches existing research by exploring the effectiveness of the campus tobacco-control policy in an underdeveloped setting, which is becoming an important area of marketing for the tobacco industry. Third, it considered the potential endogeneity problem of omitted variables by using IV estimation. In the practice of estimation, it is almost impossible to control every potential determinant due to data availability. The omission of relevant variables seems inevitable and common. In prior research on tobacco-control policies and tobacco use, the endogeneity problem has been rarely mentioned or taken seriously. Since underdeveloped areas show low improvement national health-monitoring systems, relevant data in the field of tobacco access/use/control are not always available. The intrinsic difficulty in dealing with the endogeneity problem dampened relevant discussions in prior studies concerning the effectiveness of tobacco-control policies. Therefore, the IV approach was used in this study to solve the endogeneity problem in estimation to give reliable research findings.





**Figure 1** The extent of perceived seriousness of tobacco use among youth (A), tobacco-prohibition policy (B), policy-enforcement strength (C), and tobacco accessibility on campus through purchase (D) across the 20 sub-Saharan African countries.

Finally, this study used perceived seriousness of tobacco use among youth scored by school personnel as the dependent variable. This measure may have some advantages over prior studies that used self-scored questionnaires of school-aged students. As suggested by previous research, students/youth (as respondents) have the motivation to rate their own smoking behavior as less serious to meet social desirability.<sup>24</sup> The social desirability bias is likely to occur in research into the youth-smoking problem and adults' intentions to quit smoking.<sup>25</sup> The self-scored bias caused by respondents' intentions to

meetsocial desirability and thus avoid criticism is called social desirability bias.<sup>26</sup> Such bias could lessen the validity of data and regression results. In this study, the alternative measure of scoring by school personnel rather than youths themselves to some extent avoided the influence of social desirability bias.

## Policy Implications

This study has some important policy implications. First, it could to some extent clarify the debate on the effectiveness of campus tobacco-control policies in the context of

**Table 3** Influence of Tobacco-Prohibition Policy (Campus Level) and Policy-Enforcement Strength on the Seriousness of Tobacco use Among Youth

	Dependent Variable: Seriousness of Tobacco Use among Youth		
	Coefficient	Robust SE	95% CI
<b>Independent variables</b>			
Tobacco-prohibition policy (campus level) × policy-enforcement strength	-0.0053*	0.0024	[-0.0101, -0.0005]
Tobacco accessibility on campus through purchase	0.0400**	0.0113	[0.0178, 0.0622]
Sex	-0.0037	0.0141	[-0.0313, 0.0239]
Extent of responsibility for teaching about health	-0.0722**	0.0100	[-0.0919, -0.0525]
<b>Time effect</b>			
2005	Reference		
2006	-0.0657*	0.0254	[-0.1154, -0.0159]
2007	0.2130**	0.0263	[0.1616, 0.2645]
2008	0.2175**	0.0242	[0.1700, 0.2649]
2009	0.2943**	0.0260	[0.2433, 0.3453]
2011	0.2129**	0.0241	[0.1657, 0.2601]
Intercept term	2.7106**	0.0435	[2.6253, 2.7959]
Number of nonmissing observations			7365
F-statistic			44.65
p-value			0.00
<b>Underidentification test</b>			
Kleibergen–Paap rank LM statistic			435.805
p-value			0.00
<b>Weak identification test</b>			
Cragg–Donald Wald F statistic			231.261
Stock–Yogo weak ID test: critical value of 10% significance level maximal IV size			19.93
<b>Overidentification test</b>			
Sargan statistic			0.088
p-value			0.7661
<b>Endogeneity test</b>			
Statistics			3.595
p-value			0.0579

**Notes:** Data for 2010 were absent for all countries, and thus the time effect for 2010 was not included in the regression analysis. The variables “access to tobacco-prevention teaching and learning materials” and “tobacco-prevention nonclassroom program” were used as instrumental variables for the endogenous independent variable. Two-stage generalized moment method used for instrumental variable (IV) estimation. \* $p < 0.05$ ; \*\* $p < 0.01$ .

underdeveloped areas. Stricter tobacco-control policies should be considered a deterrent to school-aged students from using tobacco products. Second, this study shows campus tobacco-control policies that are strictly enforced can be effective in lowering tobacco use among youth. As such, schools in underdeveloped countries should also raise levels of enforcement of regulations in accompaniment with stricter tobacco-control policies. Third, the regression results also demonstrated the significant time effect in the perceived seriousness of tobacco use among youth. With 2005 as the reference year, except for 2006, when a significant negative time effect

was observed, all other years displayed a significant positive time effect. This implies that during most of 2005–2011, the seriousness of tobacco use among youth was intensifying. As such, countries in sub-Saharan Africa should be alerted to the deteriorating tobacco-control situation among youth. Prompter actions are needed to prevent rapid development of tobacco use among youth in this area.

## Limitations

This study has also some limitations. It only confirms the effectiveness of tobacco-prohibition policy on campus in the

context of underdeveloped areas. Therefore, the findings of this study may not be automatically applied to other contexts. For example, stricter policy enforcement manifesting in higher penalty impositions on young smokers who violate tobacco-prohibition policy might be more effective in alleviating the tobacco-use problem in underdeveloped rather than in developed areas. Such differences in policy effects may be generated by the difference between richer and poorer areas in smokers' sensitivity to loss of money.<sup>27</sup> Future research needs to use additional samples to investigate the validity and wider applicability of our findings and recognize differences in effects of campus tobacco-prohibition policies in different contexts.

Moreover, due to the availability of data, this study could not differentiate which kind of schools the students attended (eg, public versus private, primary, secondary, or higher education) or which tobacco products (traditional cigarettes or e-cigarettes) the students used. Future research can conduct a fine-grained exploration of the effectiveness of campus policies on tobacco control for different tobacco-product use among students in different kinds of schools. Since the good flavor or good use experience of e-cigarettes may make people less aware of their hazards to health and thus the higher risk of smoking them, campus tobacco-control policies need to consider a wide variety of tobacco products beyond traditional ones, whereby targeting different students for controlling traditional tobacco smoking and e-cigarette use can be achieved.

## Conclusion

This study investigated the association between the interaction of tobacco-prohibition policies and policy-enforcement strength on campuses and tobacco use among youth across 20 sub-Saharan countries during 2005–2011. The results confirmed the effectiveness of tobacco-prohibition policies and policy-enforcement strength in alleviating perceived seriousness of tobacco use among youth in underdeveloped areas.

## Ethics

This study did not involve human/animal subjects or require any ethical approval.

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## Disclosure

The authors declare no conflicts of interest for this work.

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