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Cigarette prices and smoking among adults in eight sub-Saharan African countries: evidence from the Global Adult Tobacco Survey

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ABSTRACT

Background Despite growing concern over tobacco use in sub-Saharan Africa, evidence on the association between cigarette prices and adult smoking behaviour in the region is limited.

Objectives To provide new evidence on the association between cigarette prices and adult smoking in eight sub-Saharan African countries.

Methods The analysis uses data from 51 270 individuals taken from the Global Adult Tobacco Survey, which was conducted in eight African countries during 2012–2018. The relationship between prices and smoking is estimated using probit models for smoking participation and generalised linear models for conditional cigarette demand.

Results Higher prices are significantly associated with lower cigarette demand across African countries. The estimated price elasticity of participation is –0.362 (95% CI –0.547 to –0.177). The price elasticity of conditional cigarette demand is –0.133 (95% CI –0.194 to –0.072) for people who have just started smoking. The estimated total price elasticity of cigarette demand by new adult smokers is –0.495. The absolute value of the conditional demand elasticity becomes smaller by 0.004 units for each additional year that a person smokes. For the average smoker in the sample, with a smoking duration of 18.07 years, the total elasticity estimate is –0.422.

Conclusions Higher cigarette prices significantly decrease the likelihood of smoking and decrease the intensity of cigarette consumption among African adults. Increases in the excise tax that increase the retail price of cigarettes will play an important role in reducing adult tobacco use on the continent. Governments are encouraged to increase excise taxes to improve public health.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Countries on the African continent have some of the lowest tobacco tax rates in the world.
⇒ Policymakers demand local evidence before implementing policy changes.
⇒ Evidence on the association between cigarette prices and adult smoking in sub-Saharan African countries is limited.

WHAT THIS STUDY ADDS

⇒ The unconditional cigarette price elasticity of demand for those people who have just started smoking in the eight African countries in the sample is –0.495.
⇒ Approximately three-quarters of this reduction in consumption is attributed to a reduction in smoking prevalence and the other quarter is attributed to a reduction in smoking intensity among continuing smokers.
⇒ The absolute value of the price elasticity of conditional demand becomes smaller (less elastic) for each additional year that a smoker has smoked.
⇒ For the average smoker in the sample, with a smoking duration of 18.07 years, the total elasticity estimate is –0.422. Around 86% of this reduction in consumption is attributed to a reduction in smoking prevalence, while the other 14% is attributed to a reduction in smoking intensity among continuing smokers.

INTRODUCTION

Despite declining global tobacco use, Africa is positioned to experience a tobacco epidemic due to the fast economic and population growth, coupled with intensive marketing efforts by the tobacco industry.[1] Increasing the excise tax on tobacco products is a powerful tool for reducing the demand for tobacco products,[2–4] and the Article 6 Guidelines of the WHO Framework Convention on Tobacco Control encourage Parties to consistently raise taxes on tobacco products to render them less affordable over time.[5] Yet countries on the African continent have some of the lowest tobacco tax rates in the world.[6]

Although comprehensive international literature reviews show that tax-induced cigarette price increases reduce cigarette consumption and increase government revenues,[3 7] policymakers still demand local evidence before implementing policy changes.[8] Table 1 summarises the existing research on the relationship between cigarette prices and adult cigarette demand in sub-Saharan Africa.

This body of literature has three limitations. First, it is dominated by evidence from South Africa. Second, many of these studies use aggregate data, which have several shortcomings that can be addressed by using survey data.[9 10] For example, aggregate data cannot be used to determine whether a price-induced decline in consumption comes from a decrease in prevalence, or a decrease in intensity among users, whereas individual-level data permit this distinction to be made.[9] Also, in an aggregate demand model, aggregate cigarette demand is modelled as a function of country cigarette prices, which often leads to a simultaneity bias.[10] This bias

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HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The estimated price elasticities for a previously unexplored sample of eight African countries are in line with those of most other low and middle-income countries. This study thus supports the idea that the range in which estimates of adults' price elasticity demand fall are truly global.

⇒ This study shows that the biggest impact of a price-led decrease in the demand for cigarettes is on smoking prevalence, rather than the intensity of smoking. The epidemiological literature clearly indicates that a smoker will realise much greater health benefits if they quit smoking, rather than simply reducing consumption. Results of this research thus suggest that excise tax increases could be a potent tool to improve public health in the countries sampled.

⇒ This study provides Africa-specific evidence for governments on the continent to increase excise tax rates on tobacco products.

is typically reduced by using individual-level data since no one person can affect country prices through their own consumption.[10] Aggregate data analysis also does not allow one to investigate individual effects.[9] Typically, aggregate studies look only at price and income as determinants of cigarette demand, whereas individual data are much more fine grained, allowing one to study the impact of sociodemographic characteristics on cigarette demand and price responsiveness.[9] While four studies that investigate the relationship between cigarette prices and adult cigarette demand outside of South Africa do use survey data, three of these studies rely on data collected in, or before, the year 2010 (table 1).

Given that timely, locally relevant evidence on the likely impact of a tax increase is often required to convince policymakers to raise tobacco excise taxes,[8] there is a clear need to update and expand the evidence base concerning the relationship between cigarette prices and adult cigarette demand in sub-Saharan African countries.

A data source that can be used to examine the relationship between cigarette prices and demand that has yet to be explored for adults in sub-Saharan Africa is the Global Adult Tobacco Survey (GATS).[10–12] GATS is a nationally representative, standardised household survey of non-institutionalised adults aged 15 and older that collects data on tobacco use and tobacco control indicators globally.[13] To date, eight sub-Saharan African countries have implemented a single wave of GATS. Surveys have been conducted in Botswana (2017), Cameroon (2013), Ethiopia (2016), Kenya (2014), Nigeria (2012), Senegal (2015), Tanzania (2018) and Uganda (2013).

This study uses individual-level data from GATS to provide new evidence on the association between cigarette prices, smoking participation and conditional cigarette demand (ie, intensity) among adults from eight sub-Saharan African countries. To the best of my knowledge, there are no published estimates of the relationship between cigarette prices and demand that have taken advantage of the publicly available sub-Saharan African GATS data. In conducting this analysis, this paper adds to the literature on the association between cigarette prices and adult smoking in sub-Saharan Africa.

Table 1 Studies that estimate adult's price elasticity of demand for cigarettes in sub-Saharan Africa

Study	Country	Data type	Elasticity estimate (range)
Aggregate data			
Reekie[30]	South Africa	Annual time series data from 1970 to 1989	−0.88
van Walbeek[31]	South Africa	Annual time series data from 1960 to 1990	Short run: −0.32 to −0.99 Long run: −0.53 to −1.52
Economics of Tobacco Control in South Africa Project[32]	South Africa	Annual time series data from 1970 to 1994	Short run: −0.57 to −0.59 Long run: −0.69
Maravanyika[33]	Zimbabwe	Annual time series data from 1970 to 1996	Short run: −0.52 Long run: −0.85
van Walbeek, 2005[34]	South Africa	Annual time series data from 1970 to 2003	Long run: −0.78
Boshoff[35]	South Africa	Quarterly time series data from 1996 to 2006	Long run: −0.16 to −0.66
Tsighe *et al*[36]	Eritrea	Annual time series data from 1998 to 2012	Long run: −0.82 to −2.81
Ho *et al*[37]	36 African countries	Cross-country panel data from 1999 to 2013	−0.486 to −0.562
Survey data			
Kidane *et al*[38]	Tanzania	2008 Tanzanian household budget survey	Participation elasticity: −0.88 Conditional price elasticity: −0.85 Total elasticity: −1.73
Adeniji[24]	Nigeria	Cross-sectional data from the Harmonized Nigerian Living Standard Survey (HNLSS, 2009–2010)	Conditional price elasticity: −0.62
Chelwa and van Walbeek[25]	Uganda	Stacked cross sections for 2007 and 2009 from the Uganda National Panel Survey	Conditional price elasticity: −0.26 to −0.33
Stoklosa *et al*[26]	Zambia	Panel for 2012 and 2014 from the International Tobacco Control (ITC) Zambia Survey	Participation elasticity: −0.20
Dare *et al*[27]	South Africa	Single cross section (2017) from the National Income Dynamics Study	Unconditional price elasticity: −0.86
Boachie and Ross[39]	South Africa	Pooled data from two cross-sectional surveys of adult smokers living in selected South African townships	Conditional price elasticity: −0.295
Mukong and Tingum[28]	South Africa	Panel for 2008, 2010, 2012 and 2014 from the National Income Dynamics Study	Participation elasticity: −0.175 to −0.291 Conditional price elasticity: −0.43 to −0.69

Table 2 Sample sizes of GATS implementing sub-Saharan African countries

Country	Survey year	GATS sample (n)	Population aged 15 and older in millions (N)
Botswana	2017	4643	1.45
Cameroon	2013	5271	12.48
Ethiopia	2016	10 150	60.38
Kenya	2014	4408	27.12
Nigeria	2012	9765	93.33
Senegal	2015	4347	8.24
Tanzania	2018	4797	31.48
Uganda	2013	8508	18.38

GATS, Global Adult Tobacco Survey.

DATA AND METHODS

Data

GATS includes various modules that gather individual-level information on topics such as the respondents' background characteristics, tobacco use and cessation, expenditure on cigarettes, and quantities purchased, exposure to tobacco-related messages in the media, as well as attitudes towards tobacco use.[13] GATS samples are randomly selected through stratified multistage cluster sampling methods. Survey sample weights were created accounting for non-response and poststratification adjustments to provide nationally representative estimates.[13] Total sample sizes for completed individual interviews in each of the countries included in the analysis are presented in table 2.

While GATS is the only source of data on both smoking participation and conditional demand available for any of the countries in our sample, a drawback of these data is that they only represent a single year, rather than multiple cross sections over time. The analysis thus cannot control for country fixed effects that could influence the relationship between prices and smoking. Sub-Saharan African GATS data therefore cannot be used to establish causality between price and smoking behaviour for the sampled countries.

In an analysis of cigarette prices and adult smoking using GATS data from 13 non-African, low and middle-income countries (LMICs), Kostova *et al* demonstrate that in a pooled country cross-sectional framework, one can use between-country price variation to estimate the direction of the relationship between prices and smoking outcomes.[10] To do this, the authors employ the two-part model developed by Cragg.[14] The first part of this model estimates the probability of smoking participation (smoking prevalence) using a probit or logit regression.[15] The second part of the model estimates the amount of cigarettes consumed by smokers (conditional cigarette demand) using ordinary least squares.[15]

To address the presence of unobserved country differences that could affect the relationship between smoking and prices, Kostova *et al* control for gross domestic product (GDP) per capita in both of their regressions.[10] Furthermore, the authors control for average local rates of exposure to cigarette advertising and average local rates of exposure to antismoking messaging in each of the countries.

In the current paper, where each country is also represented by a single year of data, the difference in cigarette prices across countries is used to study the association between cigarette prices, smoking participation and smoking intensity using Cragg's two-part model of cigarette demand.[14]

To account for the fact that the GATS sample size 'oversamples' some countries relative to the actual size of their adult populations, and 'under-samples' others (table 2), the empirical specification, elaborated on in the section 'Empirical Specification', uses weighted data, where a weight for each country is calculated as:

$$weight_i = \frac{\sum_{i=1}^{i=8} n_i}{n_i} \times \frac{N_i}{\sum_{i=1}^{i=8} N_i} \quad [1]$$

where n_i is the sample size of country i, and N_i is the size of the adult population in country i, as derived from the World Bank Development Indicators.[16]

Dependent variables

The first regression in the two-part model estimates an individual's decision to smoke.[17] The dependent variable, which is taken from GATS, takes a value of 1 if an individual indicated that they smoked cigarettes daily or less than daily, and 0 if they indicated that they do not smoke cigarettes at all. Respondents not reporting their smoking status (n=619, 1.19% of observations) are excluded from the model. The highest smoking prevalence is observed in Botswana (11.7%) and the lowest in Ethiopia (2.8%) (table 3).

The second part of the two-part model examines the number of cigarettes consumed by smokers (conditional cigarette demand).[17] The dependent variable—smoking intensity—is measured as the average number of cigarettes smoked per day by current smokers. Weighted average cigarette consumption among smokers in the sample is 8.1 cigarettes per day. Average cigarette consumption among smokers is highest in Ethiopia (10.2 cigarettes per day) and lowest in Uganda (5.8 cigarettes per day) (table 3). The following subsection discusses each of the control variables included in the models.

Independent variables

Three types of independent variables are employed in this analysis: individual-level variables, primary sampling unit (PSU)-level variables and country-level variables.

Individual-level variables

Both models control for age (and age^2 to account for potential non-linearity between age and smoking outcomes), gender, residence location, education, personal wealth, employment status, marital status and whether the respondent believes that smoking tobacco causes illness. Smoking duration is also added as a control in the second part of the two-part model. Sample means of these individual-level variables are presented in table 3. Construction of each of these variables is discussed in online supplemental appendix 1.

The average respondent in the sample is 33.1 years old, while the average age of smokers is 39.1 years old (table 3). There are slightly more females (50.7%) than males (49.3%) in the sample. Thirty-three per cent of the sample live in urban areas, while 67% live in rural areas. Cameroon has the largest proportion of people living in urban areas (50.1%), and Ethiopia has the lowest proportion (24.1%). In terms of education, 42% of people in the sample have no formal education. Senegal has the highest proportion of people with no formal education (69.6%), while Botswana has the lowest proportion (16.7%).

Botswana has the largest proportion of people in the highest wealth quintile (52.2% of its population), while Uganda has the lowest (3.7% of its population). In terms of employment,

Table 3 Sample means

	Botswana	Cameroon	Ethiopia	Kenya	Nigeria	Senegal	Tanzania	Uganda
Survey year	2017	2013	2016	2014	2012	2015	2018	2013
Individual-level variables: cigarette smokers only								
% current smokers	11.7	5.75	2.79	7.06	3.69	4.17	5.58	4.23
Average number of cigarettes smoked per day	6.33	8.29	10.21	8.67	7.12	9.23	7.42	5.84
Average age of smokers	36.4	38.13	37.6	40.35	39.18	35.52	39.63	41.56
Smoking duration* (number of years)	15.1	17.87	16.71	20.21	19.14	16.92	17.4	21.2
Individual-level variables: smokers and non-smokers								
Average age	36.59	33.58	31.23	33.64	33.65	34.55	34.53	33.98
% male	48.05	48.31	49.94	48.78	50.04	48.53	47.86	47.2
% urban	46.2	50.05	24.14	34.96	36.95	49.95	33.21	25.83
% with no formal education	16.68	40.37	50.63	38.33	36.21	69.55	29.58	55.63
% of population in the highest wealth quintile of all eight countries combined	52.21	18.66	6.45	9.13	24.63	25.54	15.22	3.74
% employed	44.28	48.69	50.39	47.32	60.15	48.48	69.61	64.33
% single	77.16	34.93	35.71	32.71	33.68	34.54	28.93	29.92
% misinformed about the harms of tobacco use	4.73	4.63	12.02	7.22	17.65	6.13	7.71	5.42
PSU-level variables: smokers and non-smokers								
Average PSU-level price paid per pack, PPP-adjusted constant 2019 dollars	9.02	2.26	2.59	2.79	3.18	2.67	3.24	2.62
Average PSU-level advertising exposure rate	0.21	0.8	0.04	0.19	0.21	0.4	0.35	0.25
Average PSU-level exposure rate to antitobacco messaging	0.78	0.78	0.24	0.64	0.43	0.58	0.55	0.69
Number of PSUs	364	210	370	189	1058	244	204	400
Country-level variables								
% living below the poverty line	14.5	26	30.8	37.1	56.4	38.5	49.4	41.3
'POWE' composite score (out of possible 25 points)	14	17	16	17	13	19	14	11

*Only included in model of conditional demand.
PPP, purchasing power parity; PSU, primary sampling unit.

Tanzania has the highest employment rate among our sample of countries (69.6%), while Botswana has the lowest (44.3%). Around 12% of respondents do not know or believe that smoking tobacco causes serious illness. The proportion of those who are misinformed about the harms of tobacco use is highest in Nigeria (17.7%) and lowest in Botswana (4.7%).

Average smoking duration in the sample is 18.07 years, while this average age of smokers is 39.1 years (table 3). This indicates that the average smoker in the sample started smoking at around the age of 20. Average smoking duration is highest in Uganda at 21.2 years and lowest in Botswana at 15.1 years.

PSU-level variables

Three PSU-level variables are included in the analysis: two that control for the local tobacco-related environment (the local prevalence of cigarette advertising exposure and the local prevalence of antitobacco media messages) and cigarette prices. Variable construction is described in online supplemental appendix 1. Sample means are presented in table 3.

Cigarette prices are highest in Botswana and lowest in Cameroon. Because density plots reveal that prices are skewed before logging, but normal after, these prices enter the regressions in logarithmic form. The average prevalence of cigarette advertising is 0.21, indicating that approximately 21% of respondents had been exposed to cigarette advertising. The range of the PSU-level rate of advertising between countries varies greatly, with Cameroon exhibiting the highest prevalence of cigarette advertising exposure (0.80) and Ethiopia the lowest (0.04). The average prevalence of antitobacco media messages in the sample is 0.45, with Botswana and Cameroon exhibiting the highest prevalence of exposure to antismoking messages (0.78), and Ethiopia the lowest (0.24).

For both the participation and intensity models, I conduct a sensitivity analysis of the results obtained under the specification that uses the local prevalence of cigarette advertising exposure and the local prevalence of antitobacco media messages to proxy for the local tobacco control environment. To do this, these PSU-level variables are replaced with each country's 'POWE' composite score, where 'POWE' represents four of the six components of the WHO's MPOWER policy package (see online supplemental appendix 1 for details).[18]

Country-level variables

In their analysis of the association between cigarette prices and smoking outcomes using pooled cross sections of GATS data from 13 non-African LMICs, Kostova *et al* used per-capita GDP as a catch-all proxy for unobserved country differences.[10] This variable gave them a statistically significant coefficient. Provisional specifications with per-capita GDP for the current sample of countries did not yield a significant coefficient. Given the high degree of inequality in the countries included in the present sample,[19] and the fact that per-capita GDP is an average measure of well-being, the percentage of people living below the poverty line in each country may be a better measure of standard of living than per-capita GDP for the countries under study.

Following Filby and van Walbeek,[20] to control for the impact of poverty levels on tobacco use, the percentage of the population living on less than $1.90 a day (at 2011 international prices) is added to the regressions. This poverty line is set by the World Bank to classify those people living in extreme poverty.[21] At the time that they implemented GATS, Botswana (2017) had the lowest proportion of people living below the poverty line (15.5%), while Nigeria (2012) had the highest (56.4%) (table 3).

In terms of their implementation of key tobacco control policies, reflected in their composite 'POWE' scores, Senegal has the most comprehensive tobacco control policies, while those in Uganda are the least comprehensive.

Empirical specification

As indicated earlier, the analysis employs Cragg's two-part model of cigarette demand. In part 1, models of smoking participation are estimated with a probit regression and the average marginal effects are reported.[17] Average marginal effects and the price elasticity of smoking participation are estimated using Stata's 'margins' command.[22]

In part 2, based on the most favourable Akaike information criterion statistic between competing models, a generalised linear model with a normal distribution and log link is employed to estimate the covariates of smoking intensity. As is standard practice, the number of cigarettes smoked by smokers enters the model in logarithmic form.[15] This allows one to interpret the coefficient on the logarithm of price as an intensity (or conditional) elasticity.[23]

Missing data on the independent variables make up less than 0.3% of observations. Individuals with non-responses on any of the analysis variables are therefore excluded from the analysis. The final sample consists of 51 270 respondents from eight countries.

The regressions employ a pooled country cross-sectional framework. Price elasticities are reported at the mean characteristics of the sample. The total (or unconditional) price elasticity of demand is calculated by adding the price elasticities of demand from the first and second parts of the two-part model.

RESULTS

Results from the smoking participation and conditional demand models are presented in part 1 and part 2 of table 4, respectively.

Smoking participation

Higher cigarette prices are significantly (at the 1% level) associated with lower smoking prevalence. The estimated price elasticity of participation is –0.362 (95% CI –0.55 to –0.18) indicating that a 10% increase in cigarette price is associated with a 3.62% decrease in prevalence. Exposure to cigarette advertising and exposure to antismoking messages are not statistically significant determinants of smoking participation. The coefficient on the 'POWE' composite score is also statistically insignificant (online supplemental appendix 2).

Table 4 Average marginal effects from two-part model of cigarette demand

	Part 1	Part 2
	Smoking participation (logit: smoking=1)	Conditional demand (dependent variable=ln(consumption))
	n=51 122	n=2284
ln(Cigarette price)	–0.014*** (0.004)	–0.133*** (0.031)
Smoking duration	–	0.003 (0.002)
ln(Cigarette price)×smoking duration	–	0.004** (0.001)
Local rate of exposure to cigarette advertising	0.013 (0.015)	0.028 (0.067)
Local rate of exposure to antismoking messages	0.009 (0.017)	–0.166 (0.120)
Age	0.007*** (0.001)	0.007 (0.005)
Age squared	–0.00007*** (0.000)	–0.0002** (0.000)
Male	0.127*** (0.012)	0.149*** (0.041)
Urban	0.001 (0.008)	0.035 (0.035)
Education (base=no formal education)		
Primary schooling completed	0.007 (0.004)	0.016 (0.030)
Secondary schooling completed	0.002 (0.006)	0.022 (0.040)
Any form of tertiary education	–0.012** (0.005)	0.036 (0.047)
Wealth (base=lowest wealth quintile)		
Low	–0.006 (0.004)	0.116* (0.061)
Mid	–0.011 (0.008)	0.158** (0.078)
High	–0.020 (0.013)	0.162** (0.080)
Highest	–0.025* (0.014)	0.134* (0.071)
Employment (base=employed)		
Unemployed	0.008 (0.006)	0.084* (0.045)
Not in the workforce	–0.026*** (0.0058)	–0.020 (0.039)
Marital status (base=single/never married)		
Married/cohabiting	–0.022*** (0.007)	0.033 (0.033)
Divorced/separated/widowed	0.016*** (0.005)	0.000 (0.043)
Misinformed about the harms of tobacco smoking	0.027*** (0.009)	0.023 (0.0706)
% of the population living below the PPP $1.90 poverty line	–0.001*** (0.000)	–0.004** (0.002)
Price elasticity	**–0.362*** **	**–0.133***† **

SEs are clustered by country and indicated in parentheses.
*p<0.1; **p<0.05; ***p<0.01.
†Indicates that this is the price elasticity of demand for people who have just started smoking. As indicated by the coefficient on the interaction between cigarette price and smoking duration, the price elasticity of demand becomes less elastic as smoking duration increases.
PPP, purchasing power parity.

In terms of individual-level characteristics, being male is associated with a substantially higher probability of smoking. Smoking participation increases as age increases, though the marginal effect is diminishing as age increases. For ages greater than 50, the likelihood of smoking decreases as age increases. Education and income effects are only statistically significant at the highest levels of these socioeconomic indicators. The probability of smoking is 1.2 percentage points lower among individuals with any form of tertiary education compared with those with no formal schooling, and it is 2.5 percentage points lower among those in the highest wealth index relative to those in the lowest.

Relative to singletons, those who are married/cohabitating are less likely to smoke while those who are divorced/separated/widowed are more likely to smoke. Those who do not know/believe that smoking tobacco causes serious illness are significantly more likely to smoke than those who believe/know that it does. At the country level, people in countries with higher poverty rates are less likely to smoke.

The sensitivity analysis does not alter the statistical significance of any of these results, with one exception. The coefficient on 'primary schooling completed' changes from being statistically insignificant in the original specification to being statistically significant at the 5% level in the sensitivity analysis.

Conditional cigarette demand

Cigarette price is negatively and significantly (at the 1% level) associated with lower cigarette consumption among smokers. The coefficient on cigarette price must be interpreted alongside the coefficient on the interacted term 'cigarette price x smoking duration'. These two coefficients suggest that someone who has just started smoking cigarettes has a conditional price elasticity of demand of –0.133. However, the absolute value of the conditional demand elasticity becomes smaller (less elastic) by 0.004 units for each additional year that a person smokes. Given that average smoking duration in the sample is 18.07 years (table 3), the conditional price elasticity of the average smoker is −0.06 (=−0.133+(18.07*0.004)).

Among smokers, the number of cigarettes smoked increases as age increases, though at a decreasing rate. Being male, wealthier and living in a country with a lower proportion of people living below the poverty line are associated with heavier smoking. The sensitivity analysis does not alter the statistical significance of any of these results (online supplemental appendix 2).

DISCUSSION

This paper has shown that several factors, both demographic and policy related, influence adult smoking prevalence and intensity in eight sub-Saharan African countries. In terms of the factors that can be directly influenced by tobacco control policy, the models incorporated the effects of exposure to antismoking messaging and cigarette advertising, cigarette prices and whether the individual knew/believed that tobacco smoking is harmful to one's health. A sensitivity analysis that replaces local rates of exposure to antismoking messaging and cigarette advertising with 'POWE' composite scores was also conducted.

Exposure to antismoking messaging and exposure to cigarette advertising are not statistically significant predictors of smoking prevalence or intensity. In the sensitivity analyses, the coefficient on the 'POWE' composite score was also not statistically significant. Knowing or believing that tobacco use is harmful is associated with a decreased likelihood of smoking cigarettes, but does not impact the number of cigarettes smoked. This suggests that once the decision to smoke is made, health messaging does not have a clear impact on smoking behaviour for countries in the sample.

Of all the factors that can be influenced by tobacco control policy included in the models, cigarette price is the only statistically significant predictor of both smoking participation and intensity. Results show that higher cigarette prices are associated with reductions in smoking prevalence and cigarette consumption among adults in the sampled countries. This result is robust to the aforementioned sensitivity analysis.

The estimated total price elasticity of cigarette demand for by new adult smokers is –0.495. For the average smoker in the sample, with a smoking duration of 18.07 years, the elasticity estimate is –0.422. These estimates fall within the range found for other African countries,[24–28] and LMICs more broadly.[3 7] Since governments can influence the retail price of cigarettes through increased excise taxation, this study shows that increases in the excise tax would be an effective tobacco control intervention.

The epidemiological literature indicates that a smoker will realise much greater health benefits if they quit smoking, rather than simply reducing consumption.[29] Thus, the proportion of the total price elasticity that is accounted for by elasticity of smoking prevalence is particularly relevant from a public health perspective. For new smokers in the sampled countries, approximately three-quarters of the reduction in consumption is attributed to a reduction in smoking prevalence and the other quarter is attributed to a reduction in smoking intensity among continuing smokers. Results further show that the impact of price on smoking intensity decreases as one's smoking duration increases. For the average smoker in the sample, the proportion of the reduction in consumption driven by a reduction in smoking prevalence is even higher (–0.362/–0.422=86%) than that attributable to a reduction in smoking intensity among continuing smokers (–0.06/–0.422=14%). The policy implication of this is that key priority should be placed on preventing smoking participation by significantly increasing cigarette prices.

This study has limitations. First, the strength of the results is limited by the lack of survey data over time and the corresponding inability to control for country fixed effects. They therefore point only to the direction and strength of the relationship between price and smoking outcomes for this sample of eight sub-Saharan African countries. Scholars will be able to more quantify the relationship between price and smoking outcomes more precisely if new waves of GATS are repeated over time. Second, because the models rely on self-reported prices, the prices used in the analysis may be subject to reporting errors. The direction of the reporting errors is unknown. Third, GATS was not conducted in the same year in all countries. There is therefore a risk of bias created by the different periods of time. Fourth, the models only control for average prices, which makes no allowance for the fact that the distribution of cigarette prices may vary between countries. To the extent that a wider range of prices may encourage existing smokers to down trade rather than quit, or encourage smoking initiation, the results presented in this paper may be biased.

CONCLUSION

This paper adds to a substantial literature that estimates the price elasticity of demand using cross-sectional survey data. The contribution of this paper is that it focuses on an under-researched region, sub-Saharan Africa. The estimated price elasticities align with those of most other LMICs. This paper supports the idea that some principles in the economics of tobacco control (like

the range in which the price elasticity of demand falls) are truly global.

It is fortuitous that the biggest impact of a price-led decrease in the demand for cigarettes is on prevalence, rather than smoking intensity. The public health impact of people quitting smoking is much greater than continuing smokers cutting back their consumption. This finding for these eight African countries makes an increase in the excise tax a more potent tool than in countries where the primary impact of a price increase is on reducing smoking intensity. Governments of African countries would do well to make more use of this powerful tool to reduce the demand for tobacco products.

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