ORIGINAL INVESTIGATION

Market Structures, Socioeconomics, and Tobacco Usage Patterns in Madagascar

Evan Blecher PhD[1], **Alex C. Liber** MSPH[1], **Martine Chaussard** MPH[2], **Stacey Fedewa** MPH[3]

[1]*International Tobacco Control Research Program, American Cancer Society, Atlanta, GA;* [2]*Global Health Department, American Cancer Society, Atlanta, GA;* [3]*Health Services Research, American Cancer Society, Atlanta, GA*

Corresponding Author: Evan Blecher, Ph.D., International Tobacco Control Research Program, American Cancer Society, 250 Williams St NW, Atlanta, GA 30303, USA. Telephone: 404-329-4339; Fax: 404-321-4669; E-mail: evan.blecher@cancer.org

ABSTRACT

Introduction: The isolated island nation of Madagascar has substantial prevalence of both smoking and smokeless tobacco use, although not of dual use. Madagascar's tobacco market, much like its historical and cultural underpinnings, appears to have both Asian and African influences. Additionally, it has a unique market structure that plays an important role in influencing patterns of tobacco use. This study analyzes the determinants of smoking and smokeless tobacco use in Madagascar.

Methods: This study uses the 2008 Madagascar Demographic and Health Survey to analyze both smoking tobacco and smokeless tobacco use, stratified by gender. Multivariate log binomial models were used to evaluate the relationship between tobacco use and age, residence (urban/rural), province, marital status, and education.

Results: Our analysis indicates that two distinctly different groups of people use two distinctly different tobacco products. Smoking is almost exclusively used by men and does not appear to be related to socioeconomic status. Conversely, smokeless tobacco is consumed by large proportions of both men and women, who are less educated and live in rural areas of the country. This disparate pattern in consumption is a reflection of the different market structures for smokeless tobacco (a cottage industry) and smoking tobacco (a near monopoly).

Conclusions: Distinct market-based, geographic, and socioeconomic disparities in tobacco use are explored in order to begin the classification of Madagascar's tobacco epidemic as more African, more Asian, or as a distinctly different environment.

INTRODUCTION

Of the 1.3 billion tobacco users worldwide, the majority are found in low- and middle-income countries (LMICs) and are intensely targeted by the tobacco industry's marketing strategies (Glynn, Seffrin, Brawley, Grey, & Ross, 2010). Adequate monitoring activities are critical to follow the progression and deepen our understanding of this epidemic in LMICs, and should strive to provide accurate data on both smoking and smokeless tobacco (WHO, 2011). Tobacco use in sub-Saharan Africa (SSA) is growing rapidly. Between 1970 and 2000, the World Health Organization (WHO) estimated that cigarette consumption in the WHO African region increased by 133% (Guindon & Boisclair, 2003). ERC data suggest that it increased by an additional 39% between 2000 and 2010 in 18 countries in the region for which data exist, and this reaches 60% if South Africa is excluded from the analysis (ERC Group, 2010). Tobacco use is expected to grow further in SSA in the next 20 years. Méndez, Alshanqeety, and Warner (2012) forecast adult smoking prevalence in the WHO African region to rise from 15.8% currently to a worst-case scenario of 26.5% by 2030 and to 18.2% in a best-case scenario. Although smoking prevalence is currently lower in Africa than in all other regions, Méndez et al. (2012) forecast that by 2030, smoking prevalence in Africa could be higher than the world average and higher than in the Americas, Eastern Mediterranean, and Southeast Asian regions.

Country-level prevalence data on tobacco use in SSA are sparse, mostly as a result of data paucity, limited capacity to conduct research, and limited funding (John, Mamudu, & Liber, 2012). Few tobacco-specific surveillance instruments exist in SSA although a growing number of instruments for general population health are including tobacco-related questions. Consistent cross-country data on tobacco use are found within the Demographic and Health Surveys (DHS) and WHO STEPwise approach to surveillance platforms, whereas the Global Youth Tobacco Survey (GYTS) provides a tobacco-specific platform for youth. In addition, new tobacco-specific instruments such as the Global Adult Tobacco Survey and the International Tobacco Control Policy Survey are being rolled out in a small number of SSA countries. Available data allow us to conclude that prevalence of tobacco use in SSA is generally low but increasing at a rapid pace (FAO, 2003; WHO, 2011).

Cigarette consumption in Madagascar is consistent with the overall SSA trend. Aggregate cigarette consumption increased by 180% between 1990 and 2010 and by 52% in per capita terms (ERC Group, 2010; World Bank, 2012). The prevalence of smoking in Madagascar is the highest among SSA countries with DHS data (Pampel, 2008) and is particularly high among men. The 2005 Madagascar DHS indicates a male and female cigarette smoking prevalence of 27.3% and 1.8%, respectively. In comparison, a simple average of the 16 DHS in 14 SSA countries between 2000 and 2006 reveals that 16.7% of men and 1.0% of women smoke cigarettes. The 2008 Madagascar DHS shows that the prevalence of tobacco use, including both smoking and smokeless tobacco, is 48.9% among men and 10.3% among women. Although smoking prevalence is 28.5% and 0.8% among men and women, respectively, smokeless tobacco use is 24.6% and 9.6% among men and women, respectively. Very little dual use is reported.

The Madagascar GYTS was conducted in 2008 among school students who were 13–15 years of age. A total of 42.3% of boys and 15.6% of girls had ever smoked cigarettes, whereas current tobacco use, including smoking and smokeless, was 33.2% and 14.3% among boys and girls, respectively. These data indicate that the smoking prevalence among youth in Madagascar is higher than the average for the WHO African region of 10.4% and 4.5% among boys and girls, respectively, and higher than the global average of 14.2% and 8.7% among boys and girls, respectively (Eriksen, MacKay, & Ross, 2012) (age 13–15 years).

Consumption patterns of smoking and smokeless tobacco may differ from one region to another and within a country between population subgroups as a function of gender, area of residence, education level, and other factors (Boffetta, Hecht, Gray, Gupta, & Straif, 2008; Gajalakshmi, Asma, & Warren, 2004). An emerging literature suggests that variations in market structures and regulations may affect consumption patterns of different tobacco products. For instance, Wen et al. (2005) demonstrated that after Taiwan liberalized its economy in the 1990s, a more competitive cigarette market drove up both smoked and smokeless tobacco use prevalence. In India, the relative protection of bidis from taxation and the market structure of producers and manufacturers in "cottage" industries skew consumption of these products toward a lower socioeconomic group of customers compared with manufactured cigarettes (Sunley, 2009a, 2009b).

In many LMICs, very little is known of the relative importance of smoking and smokeless tobacco consumption among different population groups (Glynn et al., 2010; Pampel, 2008). This paucity of data makes it particularly challenging to accurately describe consumption trends, but also to understand the role of socioeconomic characteristics and market structures, in influencing how people choose to use tobacco products. Madagascar presents an opportunity to study tobacco use since its prevalence of both smoking and smokeless tobacco use is higher than the regional average. Moreover, given its distinct tobacco market structure, characterized by a highly centralized, urban cigarette production industry, which exists opposite of a mostly rural, cottage smokeless tobacco market, Madagascar offers a chance to explore the possible ways in which market structure may affect tobacco consumption trends.

The purpose of this study is to analyze the socioeconomic and demographic determinants of tobacco use, focusing on the differences in determinants of smoking and smokeless tobacco use, using a nationally representative household survey. Furthermore, we examine Malagasy tobacco market structures and other economic and social characteristics that contextualize these differences and the implications for tobacco control policy.

DATA AND METHODS

A qualitative analysis of the market structure of tobacco production and manufacture in Madagascar is conducted through a review of secondary sources and primary interviews with country experts. This is followed by a quantitative analysis of tobacco use patterns using the 2008–2009 Madagascar DHS (Institut National de la Statistique & ICF Macro, 2010), which collected information from a nationally representative cross-sectional sample of Malagasy households. The DHS mostly contained questions on maternal and child health issues, but it also collected information on tobacco use. The survey used a stratified, two-stage cluster design, where 19,200 households were selected (4,768 in urban areas and 14,432 in rural areas) to be given a general household questionnaire. In every household surveyed, a woman of age 15–49 years was interviewed using the women's questionnaire. In half of the households surveyed, a man of age 15–59 years was interviewed using the men's questionnaire. The capital city of Madagascar "Antananarivo" was oversampled in order to better capture the complex social and economic characteristics of the country's most populous region. The respondents answered questions on their tobacco use by identifying if they currently consumed cigarettes, pipe tobacco, chewing tobacco, and/or snuff. Respondents were classified as current smokers (cigarettes or pipe tobacco), users of smokeless tobacco (chewing tobacco or snuff), or nonusers of tobacco. A current dual user is both a smoker and a smokeless tobacco user. The survey did not collect information on the frequency or intensity of tobacco use. The overall response rate for the household survey was 98.8%, with 17,857 households being successfully interviewed. Of the eligible women and men identified for interview, 17,375 women (response rate 95.6%) and 8,586 men (response rate 92.9%) were successfully interviewed (author's calculations were based on the published rural and urban response rates).

We examine the socioeconomic, demographic, and geographic determinants of smoking (Model 1) and smokeless tobacco use (Model 2) in Madagascar. The dependent variables used in the regression models were binary indicators of current smoking (value of 1 in Model 1) and current smokeless tobacco use (value of 1 in Model 2). Nonsmoking users served as the comparison group (value of 0) in Model 1, and nonsmokeless tobacco users served as the comparison group (value of 0) in Model 2.

We specify a model in which the independent variables captured important demographic, socioeconomic, and geographic characteristics of the Malagasy population similar to John et al (2012) in Ghana. The variables included gender, age group (5-year categories from 15 to 59 years), place of residence (rural or urban), marital status (never married, living together, married, and widowed/divorced/separated), province (Antananarivo, Fianarantsoa, Mahajanga, Toliara, Antsiranana, and Toamasina), and highest level of education (no education or preschool, primary school, secondary school, and higher

education). Occupation (unemployed, agriculture, service manual, nonmanual) and wealth (based on an asset index calculated by DHS and divided into poorest, poorer, middle, richer, and richest quintiles) were considered for inclusion but were excluded due to multicollinearity with education (R^2 for wealth on education = 37%; occupation on education = 23%). All variables are categorical and discrete. Education is treated as an ordinal variable, whereas gender and place of residence are binary variables. Unlike John et al (2012), alcohol was not included since it was not collected by the DHS in Madagascar. The variables of occupation and wealth are included in the descriptive statistics in Table 1 but are excluded from the regression models in Table 2.

Additionally, due to the low overall prevalence of tobacco use (both smoking and smokeless tobacco use; $p < .001$) among young adults and their disparate occupational groups relative to older adults, we ran additional regression models restricted to older adults only (Table 3). Furthermore, there were many statistically significant interactions between age and covariates (marital status and urban/rural status) when interaction terms were entered in the model, thus indicating the need for stratified analyses by age. A substantial proportion of young adults (younger than 22 years, which is the traditional end of tertiary education in Madagascar; Ministry of National Education, 2009) was unemployed (32.8%), was relatively wealthy and well educated, and few used tobacco products (12.6% any, 6.5% smokeless, 6.9% smoking). Older adults were defined as ages 22–59 for males and 22–49 for females.

Analyses were performed using STATA (StataCorp, 2011) and SAS software (SAS Institute, 2008). Chi-square tests were employed to analyze the relationship between smoking and smokeless tobacco use and all other covariates ($p < .01$). Due to high prevalence (>10%) of tobacco use, multivariate log binomial models were employed to estimate prevalence ratios (PR) and 95% *CI*, which were used to measure statistical significance (Deddens & Petersen, 2008). Per the DHS manual, multivariate models do not contain weights, but the univariate results do (Institut National de la Statistique & ICF Macro, 2010). Separate models were constructed to describe the determinants of smoking and smokeless tobacco use and both were stratified by gender due to the significantly different patterns of use by gender. Additionally sensitivity analyses were conducted to account for clustering at the province level and household level using generalized estimating equations (GEE).

RESULTS

Descriptive Statistics

Our study included 8,586 men and 17,375 women. The large majority of respondents resided in rural areas (83%), and approximately 49% and 55% of male and female respondents, respectively, were under the age of 30. The majority of men (63%) and women (58%) in the study were employed in agriculture. The unemployment rate was 11% for men and 18% for women. Educational attainment was relatively similar for men and women; approximately 20% respondents had no formal education or only a preschool education, whereas 46%–47% had primary, 30% had secondary, and less than 5% had higher education.

Tobacco Use Prevalence

Among male DHS respondents, 28.5% and 24.6% reported smoking and smokeless tobacco use, respectively (Table 1). The patterns of tobacco smoking among men were very different from smokeless tobacco use. Although smoking prevalence was low in men of age 15–19 (14.9%), it was greatest in men of age 20–29 (35.8%) and subsequently decreased with age. Little variance was seen in male smoking by educational attainment ($p = .0498$). Smoking prevalence was lowest in unemployed men (11.0%) and highest in service manual workers (35.4%). Smoking prevalence is seen to be similar in rural and urban areas among men, although prevalence in urban areas was slightly higher than rural areas.

Smokeless tobacco use increased with age from 8.4% in 15–19 year olds to 41.9% in 55–59 year olds. Smokeless tobacco use also varied greatly by education, declining as educational attainment increased (from 33.5% in men without education or preschool only to 2.7% in men with higher education, see Figure 1) and by occupation (ranging from 12.5% in unemployed to 56% in agriculture workers). Rural areas had higher smokeless tobacco prevalence (27.8%) relative to urban areas (8%).

Among female DHS respondents, the prevalence of smoking and smokeless tobacco use was 0.8% and 9.6%, respectively (Table 1). Although the overall prevalence of smokeless tobacco use in females was much lower than that in males, similar patterns by demographic characteristics were observed. Female smokeless tobacco prevalence increased with age and was more common in respondents who were employed in agriculture, lived in rural areas, and were less educated. There were slight differences in smoking patterns among women; however, due to the low prevalence of female smoking (<1%), it is difficult to discern emerging patterns in this population.

Although dual use of smoking and smokeless tobacco among men (4.3%) is considerably lower than smoking or smokeless tobacco use, it follows a similar age pattern with prevalence rising with age and peaking at 6.5% among 40–44 year olds and then declining. Higher dual use occurs in rural areas and declines with higher educational attainment, similar to smokeless tobacco use. Dual use among women is 0.1% and thus not statistically different from zero.

Determinants of Tobacco Use

Table 2 displays multivariable results for smoking and smokeless tobacco use stratified by gender. As observed in the bivariate analysis, prevalence of smokeless tobacco use among men increased significantly with age; men ≥ 25 years were over two times as likely to use smokeless tobacco and men ≥ 40 years were over three times as likely to use smokeless tobacco. Male smokeless prevalence in rural areas was almost twice than that in urban areas. Smokeless tobacco prevalence among men with less than secondary or higher education was 2.66–2.97 times that of men with no or only preschool education (Table 2). Compared with never married men, men living with a partner or married had higher smokeless tobacco prevalence. Similar to males' smokeless tobacco patterns, the impact of age on smokeless tobacco use in females was robust; women ≥ 25 years were over two times as likely to use smokeless tobacco and men ≥ 40 years were over 3.5 times as likely to use smokeless tobacco. Women residing in rural areas

Table 1. Male and Female Smoking or Smokeless Tobacco Use in Madagascar

Characteristics	Men				Women		
	N	Smoking prevalence	Smokeless prevalence	Dual use	N	Smoking prevalence	Smokeless prevalence
Total	8,586	28.5%	24.6%	4.3%	17,375	0.8%	9.6%
Age group							
15–19	1,743	14.9%	8.4%	1.1%	4,034	0.6%	3.4%
20–24	1,290	35.8%	17.1%	4.6%	2,901	0.4%	7.4%
25–29	1,201	33.6%	24.4%	5.3%	2,721	0.6%	9.7%
30–34	1,076	31.4%	27.9%	4.4%	2,498	0.7%	12.0%
35–39	916	32.4%	30.6%	5.1%	2,077	0.9%	13.8%
40–44	754	29.9%	32.2%	6.5%	1,720	1.2%	14.2%
45–49	674	32.9%	35.8%	6.3%	1,424	1.5%	15.1%
50–59	525	25.7%	40.5%	3.7%	n/a	—	—
55–59	407	24.4%	41.9%	4.3%	n/a	—	—
Marital status							
Never married	2,348	20.4%	10.9%	1.9%	3,208	0.6%	3.6%
Living together	838	30.8%	23.2%	4.4%	1,541	1.0%	9.8%
Married	4,863	31.0%	31.0%	5.4%	10,362	0.8%	10.8%
Widowed/divorced/separated	537	36.7%	28.7%	4.1%	2,264	0.8%	12.6%
Province							
Antananarivo	2,287	24.9%	27.6%	3.9%	4,711	1.2%	11.6%
Fianarantsoa	1,833	29.0%	35.1%	5.5%	3,717	0.2%	15.6%
Mahajanga	1,455	32.1%	23.8%	3.5%	2,880	0.4%	5.6%
Toliara	1,267	37.1%	19.5%	6.2%	2,685	1.3%	10.5%
Antsiranana	634	32.8%	12.8%	3.6%	1,220	0.8%	2.3%
Toamasina	1,110	24.7%	16.4%	3.1%	2,162	0.5%	4.2%
Residence							
Urban	2,158	33.8%	8.0%	2.7%	4,770	1.7%	4.4%
Rural	6,428	27.5%	27.8%	4.6%	12,605	0.6%	10.7%
Highest level of education							
No education, preschool	1,590	32.4%	33.5%	5.2%	3,588	0.8%	15.2%
Primary	4,026	27.3%	31.7%	4.8%	7,981	0.4%	11.7%
Secondary	2,596	28.4%	10.5%	3.2%	5,280	1.3%	3.6%
Higher	374	29.6%	2.7%	1.4%	526	2.1%	0.0%
Wealth quintiles							
Poorest	1,675	30.1%	34.4%	4.7%	3,555	0.4%	12.9%
Poorer	1,514	27.0%	31.2%	4.0%	2,987	0.6%	13.5%
Middle	1,464	25.2%	32.8%	5.0%	2,880	0.4%	11.6%
Richer	1,650	29.0%	22.6%	5.8%	3,056	0.4%	8.7%
Richest	2,283	30.7%	8.1%	2.2%	4,897	1.7%	3.7%
Occupation type[a]							
Unemployed	966	11.0%	1.9%	0.4%	3,042	1.1%	2.5%
Agriculture	5,464	29.0%	32.2%	5.2%	10,125	0.3%	12.5%
Service manual	1,631	35.4%	15.1%	3.2%	3,505	1.7%	7.9%
Nonmanual	502	32.5%	8.8%	3.7%	665	1.8%	1.4%

Note. [a]Three men were missing occupation type, and 38 women were missing occupation type. Dual use among women is not reported since all dual use among women is 0.1% and the highest reported subcategory is less than 0.4%.

and with lower educational attainment were more apt to use smokeless tobacco.

Due to the lower prevalence of tobacco use and wide variations in sociodemographic variables (particularly occupation) among younger subjects, we conducted multivariate analysis among adults only (defined as age > 22; Table 3). Occupational status was included in the adult-only models. When occupation was not included in the adult-only models, the PR for smokeless tobacco use among men with no education was 2.74 (95% *CI* 2.37–3.18) and among men with primary education was 2.51 (95% *CI* 2.19–2.87). When occupation was

included, the relationship between smokeless tobacco use and education (preschool only/no education: PR = 2.23, 95% *CI* 1.92–2.61; primary education only: PR = 2.05, 95% CI 1.78–2.36) was attenuated although occupation was not significantly linked to smokeless tobacco use in models restricted to adult males. The PRs for smokeless tobacco still varied by geographic region, increased with age and residence in rural areas (PR = 1.49, 95% *CI* 1.25–1.76), whereas marital status was no longer significant. In the female adult-only model, occupation attenuated the effect of education, and the only statistically significant employment category was agriculture, which

Table 2. Adjusted Prevalence Ratios and 95% Confidence Intervals of Smoking and Smokeless Tobacco Use, Male and Female DHS Respondents

	Men				Women			
	Smoking		Smokeless		Smoking		Smokeless	
Parameter	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI
Age group								
15–19	1.00		1.00		1.00		1.00	
20–24	2.15	1.86–2.49	1.98	1.60–2.44	1.03	0.49–2.18	1.90	1.51–2.38
25–29	2.10	1.79–2.46	2.46	1.97–3.06	1.42	0.66–3.04	2.40	1.91–3.01
30–34	1.88	1.59–2.23	2.68	2.14–3.35	2.32	1.13–4.75	2.96	2.37–3.71
35–39	1.91	1.60–2.27	2.98	2.38–3.73	2.52	1.21–5.27	3.86	3.09–4.82
40–44	1.81	1.51–2.17	3.41	2.72–4.28	3.19	1.55–6.58	3.72	2.96–4.68
45–49	1.82	1.52–2.19	3.49	2.78–4.38	3.24	1.52–6.89	3.51	2.78–4.45
50–59	1.52	1.27–1.83	3.79	3.04–4.72	n/a		n/a	
Marital status								
Single	1.00		1.00		1.00		1.00	
Living together	1.12	0.98–1.29	1.29	1.07–1.56	2.64	1.26–5.52	1.55	1.20–2.00
Married	1.18	1.05–1.33	1.19	1.02–1.40	1.19	0.58–2.45	1.12	0.90–1.39
Widowed/divorced/separated	1.48	1.28–1.71	1.16	0.95–1.40	1.39	0.62–3.15	1.26	0.99–1.60
Region								
Antsiranana	1.00		1.00		1.00		1.00	
Antananarivo	0.72	0.64–0.82	2.48	2.00–3.08	1.16	0.62–2.20	4.33	3.10–6.04
Fianarantsoa	0.91	0.80–1.04	2.43	1.96–3.00	0.36	0.16–0.84	4.42	3.18–6.15
Mahajanga	0.83	0.73–0.96	2.02	1.62–2.51	0.47	0.20–1.08	2.29	1.62–3.24
Toamasina	0.76	0.66–0.88	1.31	1.03–1.67	0.63	0.28–1.43	1.56	1.07–2.27
Toliara	1.11	0.97–1.26	1.24	0.98–1.58	1.72	0.89–3.32	2.89	2.06–4.07
Urban/rural status								
Urban	1.00		1.00		1.00		1.00	
Rural	0.75	0.70–0.82	1.93	1.67–2.22	0.41	0.28–0.62	1.57	1.35–1.82
Highest educational attainment								
Secondary or higher	1.00		1.00		1.00		1.00	
No preschool	1.10	0.99–1.21	2.97	2.58–3.42	0.91	0.54–1.52	3.89	3.25–4.65
Primary	1.03	0.95–1.12	2.66	2.33–2.66	0.46	0.29–0.72	3.02	2.56–3.56
Observations	8,586		8,586		17,375		17,375	

Note. PR = prevalence ratio.

was only modestly related to smokeless tobacco use in females (PR = 1.32, 95% CI 1.02–1.71). Age and residing in rural areas remained positively associated with smokeless tobacco use, and marital status was no longer significant.

Bivariate associations between smoking and sociodemographic variables were confirmed in multivariate analyses (Table 2). Men of age 20–24 years were over two times as likely to smoke as men of age 15–19 years, whereas men in the oldest age category (50–59 years) were only 1.5 times as likely to smoke relative to men of age 15–19 years. Men in rural areas were 25% less likely to smoke than men in urban areas. Men who were widowed/divorced/separated had higher smoking rates, and there was no association between education and smoking rates in multivariable analysis. In sensitivity analyses adjusting for province-level clustering using GEE models, results were generally attenuated but remained statistically significant (data available upon request). Smoking among women was difficult to assess in multivariable analysis given the wide confidence intervals (due to the small number of women reporting current smoking), although similarly to men, age was positively associated with smoking. Unlike men,

women with primary education were significantly less likely to smoke (PR = 0.46, 95% CI 0.29–0.72).

In a model restricted to adult males (Table 3) where occupation was included as a covariate, smoking was elevated among men employed in the service and manual (PR = 1.55, 95% CI 1.11–2.16) sectors, but there was no relationship observed for men in agriculture or nonmanual industries. In the adult-only model where men of age 23–29 years were the referent, men of 50–59 years were less likely to smoke (PR = 0.75, 95% CI 0.66–0.85). Smoking was still more common in rural areas while educational status and marital status were not related to smoking prevalence.

DISCUSSION

The results show some important differences in tobacco use in Madagascar. Smokeless tobacco use among men shows a similar magnitude to smoking; however, smokeless tobacco use among women is considerably more prevalent than smoking among women although less prevalent than smokeless tobacco use

Table 3. Adjusted Prevalence Ratios and 95% Confidence Intervals of Smoking and Smokeless Tobacco Use, Adult (Age 23–59) Male and Female DHS Respondents

| | Men | | | | Women | | | |
| | Smoking | | Smokeless | | Smoking | | Smokeless | |
Parameter	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI
Age group								
23–29	1.00		1.00		1.00		1.00	
30–39	0.90	0.82–0.98	1.18	1.06–1.31	1.72	1.04–2.85	1.48	1.31–1.68
40–49	0.87	0.79–0.96	1.45	1.30–1.62	2.42	1.45–4.05	1.62	1.41–1.85
50–59	0.75	0.66–0.85	1.62	1.45–1.81	n/a		n/a	
Marital status								
Single	1.00		1.00		1.00		1.00	
Living together	0.91	0.76–1.08	1.35	1.08–1.68	2.09	0.71–6.18	1.16	0.84–1.59
Married	0.96	0.83–1.10	1.16	0.95–1.41	0.92	0.33–2.53	0.78	0.59–1.03
Widowed/divorced/separated	1.22	(1.03–1.45)	1.11	0.88–1.40	1.02	0.34–3.05	0.90	0.67–1.20
Region								
Antsiranana	1.00		1.00		1.00		1.00	
Antananarivo	0.71	0.61–0.82	2.50	2.01–3.11	0.90	0.46–1.77	3.90	2.78–5.46
Fianarantsoa	0.87	0.75–1.00	2.39	1.92–2.97	0.36	0.15–0.86	3.94	2.82–5.50
Mahajanga	0.92	0.79–1.06	1.99	1.59–2.4	0.40	0.16–1.01	2.09	1.47–2.98
Toamasina	0.74	0.63–0.87	1.31	1.02–1.68	0.52	0.22–1.26	1.40	0.95–2.07
Toliara	1.15	1.00–1.32	1.23	0.96–1.57	1.43	0.71–2.88	2.70	1.90–3.83
Urban/rural status								
Urban	1.00		1.00		1.00		1.00	
Rural	0.76	0.68–0.84	1.49	1.25–1.76	0.70	0.44–1.11	1.37	1.14–1.63
Highest educational attainment								
Secondary or higher	1.00		1.00		1.00		1.00	
No preschool	0.98	0.87–1.10	2.23	1.92–2.61	0.96	0.52–1.76	2.62	2.15–3.19
Primary	0.95	0.86–1.05	2.05	1.78–2.36	0.52	0.31–0.85	2.27	1.90–2.72
Occupation								
Unemployed	1.00		1.00		1.00		1.00	
Agriculture	1.41	1.00–1.99	1.86	0.97–3.58	0.33	0.17–0.65	1.32	1.02–1.71
Nonmanual	1.23	0.87–1.76	0.72	0.35–1.49	0.78	0.37–1.67	0.26	0.13–0.55
Service manual	1.55	1.11–2.16	1.28	0.67–2.47	1.14	0.67–1.95	1.12	0.86–1.46
Observations	6,034		6,034		11,447		11,447	

Note. PR = prevalence ratio.

among men. Smokeless tobacco use increases with age among men and women, but smoking does not. Smokeless tobacco use is significantly higher in rural areas than in urban areas, whereas smoking is higher in urban areas than rural areas (although by a smaller magnitude). Finally, the prevalence of smoking remains relatively unchanged as education rises, whereas smokeless tobacco use declines with higher education. These results are broadly consistent with expectations of a country at the early stages of the tobacco epidemic, especially differences in tobacco use by gender (Thun, Peto, Boreham, & Lopez, 2012).

These consumption patterns may be interpreted as a logical outcome of the tobacco market characteristics in Madagascar. A low-income economy, this isolated SSA country of 20.7 million inhabitants has undergone significant political and economic change since the early 1990s, characterized by the progressive, yet uncertain liberalization of its institutions (Marcus, 2010; World Bank, 2012). These trends are reflected in the context of tobacco production, which for the most part remains highly centralized at the government level, despite the existence of tight relationships with private stakeholders. The tobacco industry in Madagascar is almost entirely managed by the OFMATA (Malagasy Tobacco Board), a state-owned

entity created in an effort to circumscribe commercial activities surrounding the growing, regulation, and sale of tobacco leaves in the country. The OFMATA also sets a floor price for tobacco before each harvest season (Madagascar Ministry of Agriculture, 2004; WTO, 2008). Since the late 1980s, the OFMATA primarily collaborates with Imperial Tobacco, which is the main private sector actor in Malagasy tobacco, along with its four subsidiaries SOCTAM, SITAM, SACIMEM, and PROMODIM controlling planting, leaf transformation, cigarette manufacture, and wholesale distribution, respectively.

Tobacco growing in Madagascar is dominated by family-owned businesses, and counts close to 30,000 registered planters (WTO, 2008). Tobacco growers can be distinguished in three broad types of production: large-scale farms employing daily laborers; small, family-owned crops; and informal, unauthorized—and therefore unregistered—farmers. The former two groups work directly with the OFMATA, whereas informal growers sell their tobacco in a parallel market thought to represent a sizable portion of the total market and potentially escaping taxation and regulation, including recent packaging and labeling restrictions (Madagascar Ministry of Agriculture, 2004). Both informal and small-family farmers tend to grow
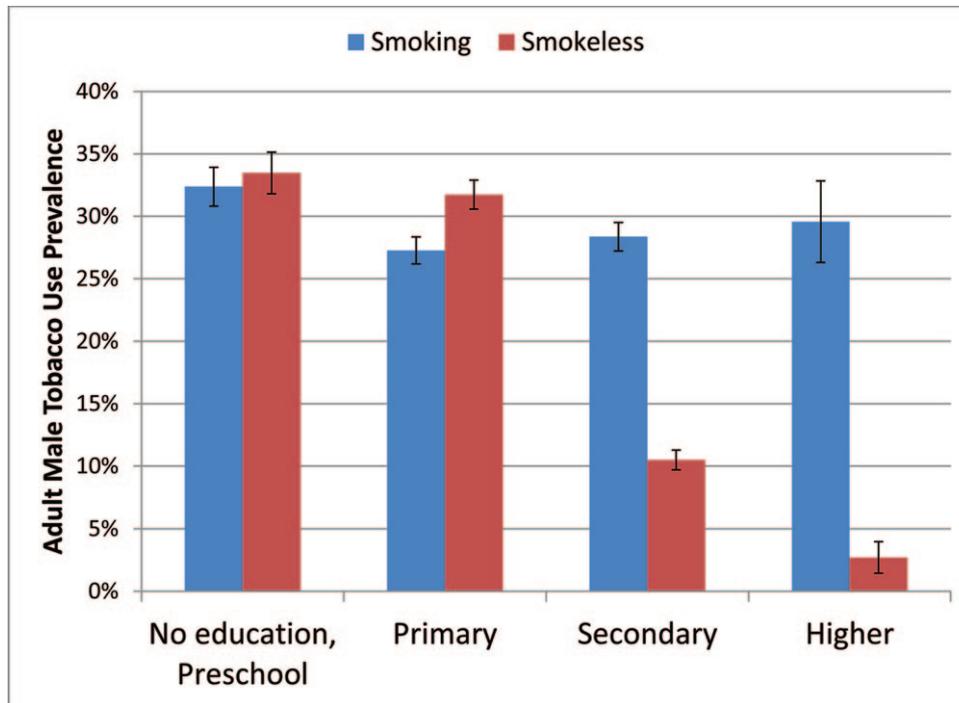
Figure 1. Adult male tobacco use by education level.

tobacco along with other food and industrial crops such as manioc, rice, bananas, and sugarcane, which could explain the higher prevalence of smokeless tobacco use among agricultural sector workers. Tobacco for chewing is particularly likely to be sold in the parallel market, because many growers look for alternative buyers, faced with OFMATA's inability to pay on time for this type of tobacco, or attracted by the higher prices found in the informal market (Madagascar Ministry of Agriculture, 2004; Razafiarisoa, 2005).

Commonly referred to as *paraky* in Malagasy, chewing tobacco appears to be found mainly in rural areas, where nearly 80% of the population lives. It is largely be the product of a cottage, artisanal industry, although small paraky manufactures exist and buy tobacco from OFMATA (Madagascar Ministry of Agriculture, 2004). Contrary to cigarettes, most paraky is generally not available in supermarkets but is rather sold by the packet in grocery stores, bars, local markets, at kiosks on the streets, and even in the bush country. The chewing of tobacco is a highly traditional practice and is believed to cure tooth and stomach aches, dental cavities, as well as to give strength and relieve pain (Razafiarisoa, 2005). A distinction is perceived by chewers between stronger artisanal preparations and the more expensive yet possibly lighter manufactured products (Razafiarisoa, 2005). As an illustration of the relative importance of chewing as a form of tobacco use, it is anecdotally said in Madagascar that "you don't bum a cigarette; you extend your hand for a sprig of tobacco" (Razafiarisoa, 2005). Men and women reportedly chew tobacco indiscriminately, starting at a young age, and this habit is deeply entrenched in family traditions, transmitted from generation to generation (familial tobacco use patterns, Madagascar Health Advocacy NGO, personal communication, 2012). Cigarette smoking, on the other hand, is ordinarily perceived as a more urban, male phenomenon, and as a statement of one's status and education

or the effect of peer pressure (social meaning of tobacco use, Madagascar Health Advocacy NGO, personal communication, 2012). This perception is confirmed in our results, except as they relate to the relationship between educational attainment and cigarette smoking among men.

Madagascar ratified the Framework Convention on Tobacco Control in 2004 (FCA, 2012). A permanent structure within the Ministry of Health exists to tackle tobacco control, the OFNALAT (National Tobacco Control Office), and an interministerial decree from 2003 regulates tobacco industrialization, importation, commercialization, and consumption, covering all forms of tobacco, including chewing. This piece of legislation includes clauses on taxation; tobacco cessation; smoke-free spaces; prohibition of sale to minors of age; a ban on tobacco advertisement, promotion, and sponsorship; as well as a vague reference to education and public awareness (content of legislation, OFNALAT, personal communication, 2012). The regulation of the contents of tobacco products is not addressed (content of legislation, OFNALAT, personal communication, 2012). The level of implementation of this legislation is unclear. As of March 2012, Madagascar became the third African country to require graphic health warnings, in addition to text warnings in Malagasy, on tobacco product packages, covering 65% of the front and back of packages (FCA, 2012). However, given the characteristics of the smokeless tobacco market, there is a risk that a significant proportion of tobacco users in the country will not be exposed to this health messaging.

As a result of the market structure characteristics and cultural norms and traditions, we note the existence of two distinct parallel tobacco markets: a regulated, urban cigarette market; and an unregulated, mostly informal and rural market for smokeless paraky. In light of our results, it is apparent that the market structure of tobacco production and manufacture in

Madagascar influences the pattern of tobacco use. The higher rates of smokeless tobacco use in rural areas are most certainly influenced by the large informal sector that also leads to less regulation and lower cost, due to lower or no taxation of smokeless tobacco products in these areas. A point of concern from a tobacco control policy perspective is therefore how smokeless tobacco products escape much of the relatively progressive tobacco control policy measures implemented in Madagascar including smoke-free spaces and graphic health warnings. The issue of taxation in these respective two market structures is of particular interest. The retail price of tobacco products in Madagascar includes a high tax rate, with cigarettes being charged both a 250% ad valorem excise tax on the ex-factory price and a specific excise tax of 6 MGA (less than one U.S. cent) per pack termed, a "special tax for youth and sport "(Andrianomenjanaharinarina, 2012). Smokeless tobacco produced in the formal sector is assessed both a 50% ad valorem tax on its ex-factory price and a specific excise tax of 1 MGA per package for "youth and sport" (Andrianomenjanaharinarina, 2012). However, a substantial proportion of the smokeless tobacco consumed in Madagascar evades excise taxation altogether, diminishing the opportunity for sound policies to effectively reduce consumption. Given the relatively high rates of smokeless tobacco use, tobacco control policies in Madagascar should pay greater attention to smokeless tobacco products in addition to cigarettes and smoked tobacco, and actively search for innovative strategies to mitigate the risk of substitution of taxed tobacco products by informal smokeless tobacco.

The patterns of smokeless tobacco use among men are of a similar magnitude to smoking prevalence, and this is unusual, especially outside South Asia. Additionally, the magnitude of smokeless tobacco use is similar to that found in the Asian nations of Bangladesh (27.2%), Bhutan (19.4%), India (25.9%), Myanmar (29.6%), Nepal (18.6%), Sri Lanka (15.8%), as well as in other high smokeless tobacco prevalence countries such as Sudan (12.2%) and Sweden (17.0%) (Eriksen et al., 2012). However, the dual use of smoking and smokeless tobacco in Madagascar is low, which is not the case in Bangladesh and India. Smokeless tobacco use among women in Madagascar is more prevalent than smoking among women, a result consistent with other African and Asia countries that have high rates of smokeless tobacco use including South Africa and Bangladesh. This study is one of the first to describe patterns of use in a nation with high smokeless tobacco prevalence outside of South Asia and elevates smokeless tobacco use as an increasingly important topic in tobacco control in SSA.

Limitations

Although this study has provided important insight into the determinants of tobacco use in Madagascar, it is limited by only using cross-sectional data. This limits our ability to make judgments about the changes in tobacco use over time. Additionally, this limits the causal links between socioeconomics, demographics, and tobacco use. Furthermore, individual-level price data were not available and could not be included as a determinant of tobacco use even though price is one of the most important determinants of tobacco use. Methodologically, the sampling frame used in the Madagascar DHS is based on a 1993 census and may not reflect real changes in the population distribution that occurred since that census. Additionally, the DHS excludes women over age 49 and men over age 59, which

may bias our estimates of the true prevalence of tobacco use in Madagascar downwards, given life expectancy of women and men of 66 and 62 years, respectively (CIA, 2012).

FUNDING

DECLARATION OF INTERESTS

ACKNOWLEDGMENT

REFERENCES

Andrianomenjanaharinarina, J. M. (2012). Madagascar: Third implementation report. Framework Convention on Tobacco Control. World Health Organization. Retrieved from http://www.who.int/fctc/reporting/party_reports/madagascar_2012_report_final.pdf

Boffetta, P., Hecht, S., Gray, N., Gupta, P., & Straif, K. (2008). Smokeless tobacco and cancer. *The Lancet Oncology*, *9*(7), 667–675. doi:10.1016/S1470-2045(08)70173–6

CIA. (2012). Madagascar. United States Central Intelligence Agency—The World Factbook. Government Reference. Retrieved from https://www.cia.gov/library/publications/the-world-factbook/geos/ma.html

Deddens, J. A., & Petersen, M. R. (2008). Approaches for estimating prevalence ratios. *Occupational and Environmental Medicine*, *65*(7), 501–506. doi:10.1136/oem.2007.034777

ERC Group. (2010). *World cigarette reports 2010*. Suffolk, UK: ERC Group Ltd.

Eriksen, M., MacKay, J., & Ross, H. (2012). *The tobacco atlas*. Atlanta, GA: American Cancer Society.

FAO. (2003). *Projections of tobacco production, consumption and trade to the year 2010*. Rome: Food and Agriculture Organization of the United Nations. Retrieved from ftp://ftp.fao.org/docrep/fao/006/y4956e/y4956e00.pdf

FCA. (2012). Madagascar gets graphic warning labels. Framework Convention Alliance. Retrieved from http://www.fctc.org/index.php?option=com_content&view=article&id=666:madagascar-gets-graphic-warning-labels&catid=239:packaging-and-labelling&Itemid=243

Gajalakshmi, V., Asma, S., & Warren, C. W. (2004). Tobacco survey among youth in South India. *Asian Pacific Journal of Cancer Prevention*, *5*, 273–278.

Glynn, T., Seffrin, J. R., Brawley, O. W., Grey, N., & Ross, H. (2010). The globalization of tobacco use: 21 challenges for the 21st century. *CA: A Cancer Journal for Clinicians*, *60*(1), 50–61. doi:10.3322/caac.20052

Guindon, G. E., & Boisclair, D. (2003). *Past, current and future trends in tobacco use*. Washington, DC: World Bank.

Institut National de la Statistique, & ICF Macro. (2010). Enquête Démographique et de Santé de Madagascar 2008–2009. Demographic and Health Surveys (p. 474). Antananarivo, Madagascar: INSTAT and ICF Macro. Retrieved from http://legacy.measuredhs.com/aboutsurveys/search/metadata.cfm?surv_id=296&ctry_id=23&SrvyTp=download

John, R. M., Mamudu, H. M., & Liber, A. C. (2012). Socioeconomic implications of tobacco use in Ghana.

Nicotine & Tobacco Research, 14(10), 1205–1212. doi:10.1093/ntr/nts013

Madagascar Ministry of Agriculture. (2004). Politique De La Filiere Tabac A Madagascar. Antananarivo: Madagascar Ministry of Agriculture. Retrieved from www.maep.gov.mg/filpolitabac.htm

Marcus, R. R. (2010). Marc the Medici? The failure of a new form of Neopatrimonial Rule in Madagascar. *Political Science Quarterly*, *125*(1), 111–131.

Méndez, D., Alshanqeety, O., & Warner, K. E. (2012). The potential impact of smoking control policies on future global smoking trends. *Tobacco Control*, *22*, 46–51. doi:10.1136/tobaccocontrol-2011–050147

Ministry of National Education. (2009). Higher education reform strategy in Madagascar. Presented at the General Management of Higher Education and Research, Ouagadougou, Madagascar. Retrieved from http://info.worldbank.org/etools/docs/library/252058/Madagascar%20STPTE_Ralijaona_EN.pdf

Pampel, F. (2008). Tobacco use in sub-Sahara Africa: Estimates from the demographic health surveys. *Social Science & Medicine*, *66*(8), 1772–1783. doi:10.1016/j.socscimed.2007.12.003

Razafiarisoa, H. (2005). Madagascar: Chewing tobacco, tar of the poor. *Promotion & Education*, *12*(Suppl 4), 38. doi:10.1177/1025382305120040116

SAS Institute. (2008). SAS. Cary, NC: SAS Institute.

StataCorp. (2011). STATA. College Station, TX: StataCorp.

Sunley, E. M. (2009a). *India: The tax treatment of bidis*. Paris: International Union Against Tuberculosis and Lung Disease.

Sunley, E. M. (2009b). Taxation of cigarettes in the Bloomberg Initiative countries: Overview of policy issues and proposals for reform (White Paper). International Union Against Tuberculosis and Lung Disease. Retrieved from http://tobaccofreeunion.org/assets/Technical%20Resources/Economic%20Reports/Sunley%20White%20paper%2012%2009%2009.pdf

Thun, M., Peto, R., Boreham, J., & Lopez, A. D. (2012). Stages of the cigarette epidemic on entering its second century. *Tobacco Control*, *21*(2), 96–101. doi:10.1136/tobaccocontrol-2011–050294

Wen, C. P., Cheng, T. Y., & Eriksen, M. P. (2005). How opening the cigarette market led to an increase in betel quid use in Taiwan. *Public Health*, *119*(10), 940–944. doi:10.1016/j.puhe.2005.02.007

WHO. (2011). WHO report on the global tobacco epidemic 2011: Warning about the dangers of tobacco. Retrieved from http://whqlibdoc.who.int/publications/2011/9789240687813_eng.pdf

World Bank. (2012). World development indicators. Washington, DC: World Bank. Retrieved from http://data.worldbank.org/indicator

WTO. (2008). Trade policy review: Madagascar. Geneva: World Trade Organization. Retrieved from http://www.wto.org/english/tratop_e/tpr_e/tp297_e.htm