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Prevalence and correlates of tobacco use among school-going adolescents in Madagascar

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Abstract Approximately 90% of adults start smoking during adolescence, with limited studies conducted in low-and-middle-income countries where over 80% of global tobacco users reside. The study aims to estimate prevalence and identify predictors associated with adolescents' tobacco use in Madagascar. We utilized tobacco-related information of 1184 school-going adolescents aged 13–15 years, representing a total of 296,111 youth from the 2008 Madagascar Global Youth Tobacco Survey to determine the prevalence of tobacco use. Gender-wise multivariable logistic regression models were conducted to identify key predictors.

Approximately 19% (30.7% males; 10.2% females) of adolescents currently smoke cigarettes, and 7% (8.5% males and 5.8% females) currently use non-cigarette tobacco products. Regardless of sex, peer smoking behavior was significantly associated with increased tobacco use among adolescents. In addition, exposures to tobacco industry promotions, secondhand smoke (SHS) and anti-smoking media messages were associated with tobacco use. The strong gender gap in the use of non-cigarette tobacco products, and the role of peer smoking and industry promotions in

Abbreviations: CI; Confidence Interval; FCTC; Framework Convention on Tobacco Control; LMIC; Low- and Middle-Income Country; NCD; Non-Communicable Disease; OR; Odds Ratio; SHS; Secondhand Smoke; SSA; Sub-Saharan Africa; TTC; Transnational Tobacco Company; WHO; World Health Organization

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adolescent females' tobacco use should be of major advocacy and policy concern. A comprehensive tobacco control program integrating parental and peer education, creating social norms, and ban on promotions is necessary to reduce adolescents' tobacco use.

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1. Introduction

Tobacco use continues to be the leading cause of preventable death in the world and is a major risk factor for many illnesses in children and young adults, including short-term health consequences such as respiratory and atopic diseases and nicotine addiction, and long-term health consequences such as heart diseases, stroke, psychological disorders and cancer [1–3]. In addition, tobacco is an addictive product and is a gateway to other drug use among adolescents [2,4]. Over the past few decades, the tobacco epidemic has shifted to low- and middle-income countries (LMICs); yet, research investigations to address this public health issue are sparse. As approximately 90% of smokers start smoking during adolescence [2], it generates the need for investigations into tobacco use behaviors among adolescents to inform effective public health interventions, advocacy and policy efforts. Moreover, further research could help address the increasing trend of tobacco use in many LMICs, particularly those with high adult prevalence rates including Madagascar [2,5–7].

Tobacco use in Sub-Saharan African (SSA) countries is generally low, but progressively increasing, which provides potential market for transnational tobacco companies (TTCs) to explore. This is further augmented with increasing incomes, globalization, urbanization, demographic shifts in populations and low-levels of education in the region [8]. However, in few SSA countries such as the Madagascar, the prevalence of tobacco use among adults is exceptionally high [1,6]. In fact, recent studies demonstrated that approximately half of the adult population in Madagascar use some form of tobacco product [7,9], which creates a bleak public health future for Madagascar. The situation of public health in Madagascar is further exacerbated by the fact that approximately two-thirds of the populations lives below the poverty line, the Human Development Index is one of the lowest in the world and Non-communicable diseases (NCDs) have emerged as major causes of

mortality [10]. Similar to other LMICs, Madagascar ratified the World Health Organization (WHO) Framework Convention on Tobacco Control (FCTC) in 2004 to combat the tobacco epidemic. Thus, investigating tobacco use among adolescents in Madagascar will provide insight into the behavior and inform the effective implementation of the FCTC in the country, LMICs and worldwide.

The objective of this study was to estimate the prevalence and identify key factors associated with tobacco use among adolescents in Madagascar. Previously known as Malagasy Republic, Madagascar is the largest island in the Indian Ocean and located off the southeast coast of Africa. As of May 2014, the total population of Madagascar was approximately 23 million [11]. Although the tobacco industry has been in existence in Madagascar since the 1950s, the country has recently experienced aggressive penetration of its market by the TTCs [12]. In 2001, the Imperial Tobacco Limited (ITL) acquired the Tobacco Group and became a near monopoly in cigarette manufacturing. The primary goal of ITL in the acquisition of Tobacco Group is to increase tobacco use in Madagascar and distribute tobacco products in the Eastern and Southern Africa through common market agreements [6]. This situation provided potential venue for TTCs to target adolescents as these are the populations with increased susceptibility and more likely to become future tobacco users [13]. On the other hand, the government has taken aggressive steps to combat the increasing trend in tobacco use in the country since 1998 by implementing some of the underlying provisions of the FCTC, yet, tobacco use in the country is one of the highest among SSA nations [6]. Therefore, findings of this study will facilitate comprehensive understanding of the tobacco use in Madagascar with the potential to inform public health practices and policy to address the issue at an early stage. This could prevent Madagascan adolescents from tobacco use initiation and transition into future and established smokers.

2. Methods

2.1. Study setting and Madagascar Global Youth Tobacco Survey

The study data were obtained from the Madagascar Global Youth Tobacco Survey (GYTS) conducted in 2008 to obtain tobacco-related information from 1184 school-going adolescents aged 13–15 years and representing 296,111 youth. The Madagascar GYTS is a standard school-based survey designed to collect information on cigarette and non-cigarette tobacco products and on five determinants of tobacco use – access/availability and price, secondhand smoke (SHS) exposure, cessation, media messages and advertising, and school curriculum from students who attend schools in the 3rd, 4th and 5th standards. The survey design and methodology have been described in earlier studies [13,14]. Briefly, it is a 2-stage cluster sampling design to obtain representative data for Madagascar adolescents. The schools proportional to their enrollment size were selected during the first stage, followed by random selection of classes within these schools in the second stage. All students in selected classes were eligible to participate in the survey. The overall survey response rate was 83.3%, with school, class and students' response rates being 100%, 100%, and 83.3%, respectively. The analysis of the GYTS dataset was approved by Institutional Review Board of the authors' institution.

2.2. Study measures

The status of tobacco use among Madagascan adolescents was examined using two outcome measures – *current cigarette smoking* and *current use of non-cigarette tobacco products*. The *current cigarette smoking* status of an adolescent was determined by his/her self-reported response of one or more days to the question, "During the past 30 days (one month), on how many days did you smoke cigarettes?", and the *current use of non-cigarette tobacco products* status was determined by his/her positive response to any of the following two questions – "During the past 30 days (one month), did you use any form of smoked tobacco products other than cigarettes (e.g. cigars, water pipes, cigarillos, little cigars, pipes)?" and "During the past 30 days (one month), did you use any form of smokeless tobacco products (e.g. chewing tobacco, snuff, dip)?", respectively. Using existing literature [2,13,15,16], 13 predictors were constructed from 27 questions that could potentially

be associated with status of tobacco use among adolescents in Madagascar, including parental or peer smoking, perception about smoking, exposure to secondhand smoke inside or outside home, exposure to smoking or anti-smoking media messages, exposure to tobacco industry promotions, attitudes toward smoking ban, knowledge about harmful effects of smoking and SHS, age and sex. The responses to study questions were dichotomized based on the existing literature [13,15].

2.3. Statistical analysis

To estimate the status of tobacco use among adolescents in Madagascar, the sample data were weighted to adjust for sampling design effect, non-responses at school, class and student levels, and post-stratification of the sample relative to sex and grade distribution in the population similar to earlier studies [13,15]. Analyses were conducted in SAS v9.3 using *proc survey* commands to account for complex sampling design and for incorporating weights as indicated above (SAS Institute Inc., Cary, NC, USA). Because of the established gender gradient in the Sub-Saharan Africa, separate analyses were conducted for male and female adolescents [1]. Bivariate analyses were conducted to assess the crude relationship between outcome and predictors using χ^2 contingency statistics. Finally, multivariable logistic regression analyses were conducted to delineate the predictors associated with *current cigarette smoking* and *current use of non-cigarette tobacco products*, separately for males and female adolescents, respectively. All models were checked for possible multicollinearity but did not result in dropping any variable. However, the following predictors were dropped from the models because of lack of variability-knowledge about harmful effects of smoking and SHS exposure (for all four models), perception about smoking and exposure to anti-smoking media messages (for current cigarette smoking among females model), perception about smoking and exposure to smoking media messages (for current use of non-cigarette tobacco products among males model), and peer smoking, perception about smoking, exposure to smoking and anti-smoking media messages, exposure to tobacco industry promotion and receptivity of school anti-smoking education (for current use of non-cigarette tobacco products among females model), respectively. The adjusted odds ratios (AOR) along with respective 95% confidence intervals (CIs) were reported. A 2-sided 5% significance level was used for all statistical inferences.

3. Results

3.1. Study population

The study population included 1184 school-going adolescents aged 13–15 years. Majority of them were females (54.8%) and aged 14 years (36.7%). Approximately one-third and half of the adolescents were exposed to parental and peer smoking behavior, respectively. About 90% of the adolescents perceived that there were differences in appeal, social skills or attractiveness between smokers and non-smokers, were exposed to smoking or anti-smoking media messages, and were knowledgeable about harmful effects of smoking and SHS exposure. Approximately 50% were exposed to SHS inside home and 63% outside home, and 84% supported smoking ban in public places (data not shown).

3.2. Current cigarette smoking

Overall, the prevalence of current cigarette smoking among adolescents in Madagascar was 19.3%. The prevalence among adolescent males and females was 30.7% and 10.2% with a significant difference in cigarette smoking status between them ($p < 0.0001$). Among males, the prevalence of cigarette smoking was highest among those who self-reported exposure to tobacco industry promotion, while among females it was highest among those who reported having smoking peers. Approximately 87% of adolescents received anti-smoking education in schools and they reported a smoking prevalence of 21% (30.9% among males and 11.5% among females). About 7% of adolescents were exposed to tobacco industry promotions and reported a smoking prevalence of 28% (48.5% among males and 16.2% among females). All predictors except for exposure to anti-smoking media messages ($p = 0.06$), exposure to tobacco industry promotion ($p = 0.09$), knowledge about harmful effects of smoking and SHS exposure ($p = 0.97$), and attitudes toward smoking ban ($p = 0.48$) were significantly associated with cigarette smoking status among Madagascan adolescents (Table 1).

Table 2 identifies the predictors associated with Madagascan male and female adolescent cigarette smokers. Among males, those who had smoking peers were almost 7 times more likely to smoke cigarettes compared to those without such peers (AOR 7.38, 95% CI 3.68, 14.82). Similarly, those who were exposed to anti-smoking media messages were almost 3 times more likely to smoke cigarettes (AOR 2.92, 95% CI 1.47,

7.48) compared to those who were not. Among females, those who were exposed to peer smoking, SHS outside home, and tobacco industry promotion were almost 17 (AOR 16.92 95% CI 5.79, 49.45), three (AOR 3.32, 95% CI 1.18, 9.36) and three (AOR 2.60, 95% CI 1.02, 6.63) times more likely to smoke cigarettes compared to referent groups, respectively. In contrast, female adolescents aged 13 years were 78% less likely to smoke cigarettes than 15 year olds (AOR 0.22, 95% CI 0.07, 0.65).

3.3. Current use of non-cigarette tobacco products

Overall, the prevalence of current use of non-cigarette tobacco products among adolescents in Madagascar was 7.0%. The prevalence among male and female adolescents was 8.5% and 5.8% respectively with no significant difference in the use of non-cigarette tobacco products ($p = 0.34$). Similar to cigarette smoking status, the prevalence of non-cigarette tobacco products use in males was highest among those who self-reported exposure to tobacco industry promotions, and in females it was highest among those who reported having smoking peers. All predictors, except for parental smoking ($p = 0.56$), perception about smoking ($p = 0.21$), exposure to tobacco industry promotions ($p = 0.23$), attitudes toward smoking ban ($p = 0.53$) and receptivity of school anti-smoking education ($p = 0.44$) were significantly associated with use of non-cigarette tobacco products among Madagascan adolescents (Table 1).

Table 2 delineates the predictors associated with the use of non-cigarette tobacco product among male and female adolescents in Madagascar. Among males those who had smoking peers were approximately 7 times (AOR 7.36, 95% CI 2.20, 24.66) more likely to use non-cigarette tobacco products compared to those who had no smoking peers. In contrast, those who were exposed to SHS outside the home were 63% less likely to use non-cigarette tobacco products (AOR 0.37, 95% CI 0.16, 0.86) compared to those who were not. Among females, exposures to SHS inside or outside the home were significantly associated with increased use of non-cigarette tobacco products by almost 12 (AOR 12.40, 95% CI 3.92, 39.23) and 6 (AOR 5.71, 95% CI 1.52, 21.40) times, respectively. Compared to 15 year old females, those aged 14 years were 80% (AOR 0.20, 95% CI 0.06, 0.60) less likely to use non-cigarette tobacco products.

Table 1 Prevalence of current cigarette smoking and non-cigarette tobacco products use among male and female adolescents in Madagascar, Global Youth Tobacco Survey, 2008 ($n = 1184$; $N = 296,111$).

Characteristic	Current cigarette smoker			Current user of non-cigarette tobacco products		
	Total; 19.3%	Males; 30.7%	Females; 10.2%	Total; 7.0%	Males; 8.5%	Females; 5.8%
%	a					
Age						
13 years	11.7	22.0	4.7	6.2	6.9	5.0
14 years	19.2	32.2	7.9	4.2	8.9	1.9
15 years	25.2	33.5	17.7	10.6	19.6	10.7
Parental smoking	24.3	37.9	13.8	8.6	17.5	7.9
Peer smoking	34.7	43.5	23.0	12.9	17.1	14.4
Perception about cigarette smoking	18.7	29.2	10.3	6.8	12.8	5.6
Exposure to smoking media messages	21.0	32.2	11.3	7.7	13.0	6.8
Exposure to anti-smoking media messages	20.1	32.0	10.6	7.4	13.3	6.5
Exposure to tobacco industry promotion	27.6	48.5	16.2	12.1	29.4	6.6
SHS ^b exposure inside home	27.9	39.5	16.5	10.9	16.5	11.7
SHS ^b exposure outside home	26.3	36.5	16.1	9.1	16.2	9.3
Knowledge about harmful effects of smoking and SHS	19.1	30.2	10.1	7.0	12.4	5.8
Attitudes toward smoking ban	17.8	27.9	10.1	7.2	13.0	5.9
Receptivity of school anti-smoking education	20.6	30.9	11.5	7.4	12.7	7.2

^a % means weighted percentage.

^b SHS means Secondhand Smoke.

4. Discussion

Tobacco use is the leading preventable cause of morbidity and mortality, accounting for over 6 million global deaths each year [1]. Non-communicable diseases (NCDs), including those attributed to tobacco use such as cardiovascular diseases, cancer and respiratory diseases have emerged as the second leading cause of death in SSA [17,18]. However, the implementation of the FCTC to address the problem in SSA countries has been lagging due to several factors including the tobacco industry interference and inadequate domestic-generated data and surveillance [19,20]. The low, but increasing prevalence of tobacco use and NCDs poses a major public health threat in SSA. This demands investigations, particularly in countries such as Madagascar where it is evident that adult tobacco use is exceptionally high but research to inform public policy and advocacy activities is sparse [6,7]. Tobacco use is considered as a pediatric disease because most adult users begin using tobacco products during their adolescence [5]. Therefore, we used the GYTS, a national representative survey of Madagascan youth to estimate the prevalence of tobacco use (cigarette smoking and use of non-cigarette tobacco products) among school-going adolescents and identify factors associated with such behavior. We found that 19.3% of adolescents in Madagascar were cigarette smokers,

and 7% were users of non-cigarette tobacco products. These rates of tobacco use prevalence were greater than those in most SSA countries including Ghana [21], the Republic of Congo [22], Cote d'Ivoire, Eritrea, Ethiopia, Mozambique, Niger and Zimbabwe [23]. Similar to adults in the country [6], we found significant gender differences in cigarette smoking (30.7% males versus 10.2% females), but not for non-cigarette tobacco products use (8.5% males versus 5.8% females). Although the usage rate for non-cigarette tobacco products is low, the absence of gender gap generates the importance of incorporating gender while developing and implementing tobacco control policies. Moreover, the use of non-cigarette tobacco products, including smokeless tobacco products is as equally dangerous to health as cigarette smoking and public health education and advocacy campaigns in the country should include such information [24].

The results of gender-wise regression analyses showed that irrespective of sex, peer smoking behavior was most significantly associated with cigarette smoking, which is consistent with studies involving adolescents in other SSA countries, LMICs and High-Income Countries (HICs) [21,25]. However, unlike them, peer influence on female cigarette smoking is exceptionally strong. While the study findings suggest the need for policies that restrict youth access to and demand for tobacco products such as age verification and ban on sale

Table 2 Key determinants of current cigarette smoking and non-cigarette tobacco product use among male and female adolescents in Madagascar, Global Youth Tobacco Survey, 2008.

Determinant	Current cigarette smoker		Current user of non-cigarette tobacco products	
	Males	Females	Males	Females
	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Age				
13 years	1.05(0.56, 1.96)	0.22 [*] (0.07, 0.65)	0.84(0.34, 2.12)	0.58(0.25, 1.34)
14 years	1.12(0.65, 1.94)	0.58(0.28, 1.20)	0.47(0.19, 1.18)	0.20 [*] (0.06, 0.60)
(ref: 15 years)				
Parental smoking	0.93(0.53, 1.63)	1.73(0.74, 4.03)	0.54(0.24, 1.22)	0.62(0.28, 1.37)
(ref: no parental smoking)				
Peer smoking	7.38 ^{***} (3.68, 14.82)	16.92 ^{***} (5.79, 49.45)	7.36 ^{***} (2.20, 24.66)	^
(ref: no peer smoking)				
Perception about cigarette smoking	0.29 ^{**} (0.13, 0.66)	^	^	^
(ref: no perception about cigarette smoking)				
Exposure to smoking media messages	2.44 (0.73, 8.17)	1.69(0.43, 6.62)	^	^
(ref: no exposure to smoking media messages)				
Exposure to anti-smoking media messages	2.92 [*] (1.14, 7.48)	^	1.01 (0.29, 3.42)	^
(ref: no exposure to anti-smoking media messages)				
Exposure to tobacco industry promotion	2.40(0.84, 6.88)	2.60 [*] (1.02, 6.63)	3.23(1.01, 10.29)	^
(ref: no exposure to tobacco industry promotion)				
SHS ^a exposure inside home	1.57(0.86, 2.86)	0.85(0.36, 2.03)	1.69(0.80, 3.59)	12.40 ^{***} (3.92, 39.23)
(ref: no SHS exposure inside home)				
SHS exposure outside home	1.41(0.72, 2.76)	3.32 [*] (1.18, 9.36)	0.37 [*] (0.16, 0.86)	5.71 ^{***} (1.52, 21.40)
(ref: no SHS exposure outside home)				
Attitudes toward smoking ban	0.57(0.30, 1.07)	0.67(0.26, 1.76)	2.21(0.68, 7.16)	1.43(0.40, 5.03)
(ref: no attitude toward smoking ban)				
Receptivity of school anti-smoking education	1.04(0.39, 2.74)	1.16(0.33, 4.01)	0.36(0.12, 1.06)	^
(ref: no receptivity of school anti-smoking education)				

AOR means adjusted Odds Ratio.

CI means Confidence Interval.

^{*} $p < 0.05$.^{**} $p < 0.01$.^{***} $p < 0.001$.^a SHS means Secondhand Smoke.

^ Predictors not included in the multivariable logistic regression models because of lack of variability.

to minors, they also emphasize the necessity to educate peers, especially female cigarette smokers, and create social norms against the use of tobacco products in social gatherings or among peers.

Although the results were not consistent among males and females, SHS exposure inside and outside home provides insight into adolescents' use of tobacco products in Madagascar. Indeed 1 out of 2 adolescent tobacco users reported being exposed to tobacco use inside or outside home, which signifies a high level of exposure to SHS among adolescents in Madagascar [3]. In this respect, while exposure to SHS inside home increased the likelihood of the use of non-cigarette tobacco products among females by over 12 times, exposure to SHS outside home increased cigarette smoking and use of non-cigarette tobacco products by approximately 3 and 6 times, respectively. In contrast, exposure to SHS outside home significantly reduced the use of non-cigarette tobacco products among adolescent males by 63%. These results suggest that the use of non-cigarette tobacco products such as chewing tobacco among female adolescents in Madagascar might be strongly influenced by the home environment. This situation needs urgent attention given the high use of non-cigarette tobacco products among adult females in the country [6]. With adolescent females highly influenced by their adult counterparts, it is particularly important that policies and programs are developed to reach and inform adult tobacco users about the ramifications of their behaviors on their youth. Moreover, the use of non-cigarette tobacco products in the country is mostly culturally related; therefore it is important for the public health community, policymakers and school administrators to create social norms against the use of such products through education and media campaigns.

Exposure to tobacco industry promotions was associated with increased tobacco use, but significant only for female cigarette smokers, which affirms earlier studies [26]. This is likely due to the targeting of female smokers by TTCs with images of success, sociability, beauty and feminine liberation that might have stronger impact on adolescent females [27]. While large cohort studies are needed to evaluate these associations in detail, it is important to develop tobacco youth control programs that resembles the "Truth Campaign" in the United States that focused on tobacco industry's deceptive practices aimed at youth and delivery of anti-smoking messages through media appropriately [28].

Moreover, exposure to anti-smoking messages in media was found to be significantly associated with increased cigarette smoking among adolescent males. Although this finding both confirms and contradicts earlier studies, it provided important evidence about the nature of anti-smoking messages that these adolescents were exposed through media [13,29]. Although there was no significant association between parental smoking and use of tobacco products among adolescents in the study, it needs emphasis because studies from SSA, other LMICs and HICs have shown the positive effect of parental smoking on an adolescent's tobacco use behavior [21,30]. For this reason, future studies should be conducted to evaluate the association in Madagascar. Similarly, we could not study the role of school personnel's smoking behavior in adolescents' tobacco use as suggested by earlier studies [31], and future studies should be warranted in this direction, as it provides important evidence about the need for smoke- or tobacco-free school campuses in Madagascar.

We acknowledge that this study has certain important limitations. The Madagascar GYTS was a school-based survey and did not include adolescents who did not either attend schools or were absent on the day that this survey was administered, however the school response rate was 100%. In addition, the survey was a cross-sectional study design limiting establishment of causal relationship, with the responses being self-reported and subjected to recall bias. Moreover, 27 questions were pooled to construct 13 predictors based on the existing literature, which limits identifying differences in tobacco use status when exposed to individual components. Only measures at individual level were used, and no information on national tobacco control programs or policies was taken into account; future studies should be conducted with inclusion of such country-level measures. Due to minimal variability, many covariates were not included in the regression models, and due to small sample sizes some predictors demonstrated wider confidence intervals; however, all models showed significant goodness-of-fit. Moreover, the Madagascar GYTS survey has been conducted in 2008 (5 years ago) but we defined it as "current" as it provides information about the latest situation of adolescent tobacco use and warrants administering future GYTS survey to understand the trends in tobacco use and determine the impact of tobacco control efforts on adolescent behaviors in the country. Nevertheless, this study is the first investigation to estimate prevalence and identify factors associated with tobacco

use among Madagascan adolescents using a nationally representative sample, and the study findings have the potential to inform policy and public health practice about tobacco control efforts targeting adolescents in Madagascar.

5. Conclusion

Approximately 1 out of 5 adolescents in Madagascar currently smoke cigarettes, and 1 out of 15 currently use non-cigarette tobacco products. A significant gender gap exists among cigarette smokers, but not among the users of non-cigarette tobacco products. Regardless of sex, peer smoking behavior was significantly associated with increased use of tobacco products, especially among female cigarette smokers. With tobacco use among adults being alarmingly high and scarce tobacco-related information among adolescents in Madagascar, the study addresses a major gap in the scientific literature by providing evidence about the need to reduce or prevent tobacco use among adolescents at an early stage so as to help prevent establishment of future adult smokers in Madagascar.

Conflict of interests

The authors have no competing interests to declare.

Contributions

SPV identified the importance of understanding tobacco use among adolescents in Madagascar. SPV collected and analyzed the data, and wrote the first draft of the manuscript. HMM, RMJ and AOE provided critical input into the data analyses; and assisted SPV in interpretation of the results. All authors were involved in several revisions of the final manuscript.

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