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ORIGINAL ARTICLE

Age of smoking initiation among adolescents in Africa

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Abstract
Objectives To estimate prevalence and identify correlates of age of smoking initiation among adolescents in Africa.
Methods Data ($n = 16{,}519$) were obtained from nationally representative Global Youth Tobacco Surveys in nine West African countries. Study outcome was adolescents' age of smoking initiation categorized into six groups: ≤7, 8 or 9, 10 or 11, 12 or 13, 14 or 15 and never-smoker. Explanatory variables included sex, parental or peer smoking behavior, exposure to tobacco industry promotions, and knowledge about smoking harm. Weighted multinomial logit models were conducted to determine correlates associated with adolescents' age of smoking initiation.
Results Age of smoking initiation was as early as ≤7 years; prevalence estimates ranged from 0.7 % in Ghana at 10 or 11 years age to 9.6 % in Cote d'Ivoire at 12 or 13 years age. Males, exposures to parental or peer smoking, and industry promotions were identified as significant correlates.
Conclusions West African policymakers should adopt a preventive approach consistent with the World Health Organization Framework Convention on Tobacco Control to prevent an adolescent from initiating smoking and developing into future regular smokers.

Keywords Adolescent · Age of smoking initiation · Global Youth Tobacco Survey · Africa

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Introduction

Tobacco use rates in African countries are low (Thun et al. 2012) with wide gender gap (Calo and Krasny 2013; Mamudu et al. 2013a), and expected to increase rapidly by 37 % by 2025 (Reidpath et al. 2014). The socioeconomic transformation such as westernization, urbanization, and improving economic well-being, along with tobacco industry marketing and promotions (Yach and Bettcher 2000) contribute to this increasing trend. The World Health Organization (WHO) has projected that non-communicable diseases (NCDs)-related deaths will increase by 27 % over the next decade in Africa, the greatest among all the six WHO regions. Yet, research to support tobacco control in many African countries lags behind the rest of the world and the paucity of scientific evidence limits tobacco control policy development and implementation in these countries.

Thus, this study seeks to investigate tobacco use initiation in Africa to inform tobacco control initiatives and advocacy in Africa.

Behavioral theories indicate that tobacco learning behavior progresses through stages of never-smoking, initiation/experimentation, regular smoking, and addiction (Jackson 1997). The early phases of the behavior are very critical because research suggests that the likelihood of being a smoker in adulthood is two times greater among adolescents who started to smoke at age $\leq$13 years than those who started at age $\geq$17 years (Breslau and Peterson 1996; Townsend et al. 2006), and that the risks of nicotine dependence and adverse health outcomes are higher among those who initiated smoking at an early age (DeBry and Tiffany 2008). Indeed, studies conducted using populations in high-income countries (HICs) reported that up to 90 % of regular cigarette users initiate smoking before age 18 years (Hipple et al. 2011; Lando et al. 2010; United States Department of Health and Human Services 2012). In Africa, a few existing single-country studies involving smoking initiation among adolescents (Odukoya et al. 2013; Peltzer 2011b) and adults from Gambia (Maassen et al. 2004), Nigeria (Swart 1998), South Africa (Swart et al. 2006), and Zimbabwe (Gwede et al. 2001), and a comparative study of seven eastern and southern African countries (Peltzer 2011b) found that adolescent smokers initiated smoking before 14 years of age, although there was variation between the countries. These studies, however, did not determine the specific age of onset creating uncertainty that generated the need for further research. Moreover, no study has examined tobacco use initiation among youth in West Africa countries, a relatively homogenous populations in terms of socio-cultural and economic development with strong regional integration through the Economic Community of West African Countries (ECOWAS). This study aimed to assess the age of initiation of cigarette smoking among youth, and identify factors associated with it in countries of West Africa using the Global Youth Tobacco Surveys (GYTSs) (Warren et al. 2009). The GYTS provides nationally representative data about tobacco related perceptions, knowledge and behaviors among school-going adolescents.

Tobacco control in Africa is still in the early phase where most countries have ratified the Framework Convention on Tobacco Control (FCTC), but yet to fully implement the FCTC recommended policies due to scarce resources and inadequate scientific evidence. Therefore, it is important to investigate the age at which an adolescent starts smoking his/her first cigarette to provide the necessary scientific evidence to inform policies and programs targeting adolescents in West Africa, and Africa in general, and prevent the progression of tobacco epidemic in Africa.

Methods

Study population

The study data were obtained from the GYTSs conducted in nine West African countries (Cape Verde, Cote d'Ivoire, Ghana, Guinea, Mali, Mauritania, Niger, Senegal, and Togo) during 2006–2009. Only countries with surveys that collected nationally representative tobacco-related information on school-going adolescents were included. Similar to earlier studies (Mamudu et al. 2015; Veeranki et al. 2014, 2015a, c), only data from the most recent survey were included for countries that administered the survey more than once. Detailed description of the GYTS design, administration, data collection and processing has been published in previous studies (Warren et al. 2009). Briefly, GYTS uses a two-stage cluster sampling design, where clusters of schools representative of the adolescent population were selected during the first stage, and classes within the selected schools were randomly selected at the second stage. All students in the selected classrooms were eligible to participate in the survey. Despite the eligibility of all students, only those aged 13–15 years were included because the GYTS sampling frame includes adolescents' representative of those aged 13–15 years, and to ensure consistency and comparability with other GYTS studies. This resulted in a study sample of 16,519 adolescents. The Institutional Review Board at the corresponding author's institution provided approval for the study.

Study measures

The study outcome was age at which an adolescent smoked his/her first cigarette. Study participants were asked, "How old were you when you first tried or experimented with smoking?" The responses included "I have never smoked", "7 years old or younger", "8 or 9 years old", "10 or 11 years old", "12 or 13 years old", and "14 or 15 years old". Thus the outcome is a categorical variable categorized into six groups.

Based on the existing literature and plausible associations with age of smoking initiation (Jackson 1997; Leventhal and Cleary 1980), the following independent variables were included in the study- sex (male/female), parental (no/yes) or peer (no/yes) smoking, knowledge about smoking harm (no/yes), and exposure to tobacco industry promotions (no/yes). Additionally, country level dummy variables were included to capture any country-level effects on an adolescent's smoking initiation. The survey questions and related responses, and coding of these responses for analysis was illustrated in Table 1.

Table 1 Study questions, responses and recoded values, Global Youth Tobacco Survey, West African countries, 2006–2009

	GYTS study question	Response	Recoded value
Dependent variable			
Age of smoking initiation	How old were you when you smoked your first cigarette?	I never smoked cigarettes 7 years old or less 8 or 9 years old 10 or 11 years old 12 or 13 years old 14 or 15 years old	0 = I never smoked cigarettes 1 = Any other response
Independent variables			
Gender	What is your sex?	Male Female	0 = Female 1 = Male
Knowledge about smoking harm	Do you think that smoking is harmful to health? Do you think that smoke from other people's cigarette is harmful to you?	Definitely not Probably not Probably yes Definitely yes	0 = Definitely not 1 = Any other response
Exposure to tobacco industry promotions	Do you have something (t-shirt, pen, backpack, etc.) with a cigarette brand logo on it? Has a (cigarette representative) ever offered you a free cigarette?	No Yes	0 = No 1 = Yes
Parental or peer smoking	Do your parents smoke?	None Both Father only Mother only I don't know	0 = None 1 = Both, father only, mother only
	Do any of your closest friends smoke cigarette?	None of them Some of them Most of them All of them	0 = None of them 1 = Any other response

Statistical analysis

We computed the prevalence estimates of age of cigarette smoking initiation using survey-sampling weights so that the estimated sample proportions are representative of the population estimates of the respective countries. We performed bivariate analysis between the dependent and independent variables. To understand the determinants of age of smoking initiation among adolescents, we modeled the outcome variable using a multinomial logit model (MNLM). Indeed, whether to smoke or when to initiate smoking is a choice an adolescent makes and these choices are independent and mutually exclusive. MNLM is a straight forward extension of logistic models, in that it deals with outcome variables which has more than two outcomes. In other words, a MNLM with only two outcome is a logit model. It uses a maximum likelihood estimation method to estimate the parameters of interest. To describe the relationship between the dependent variable and independent variables, for an outcome variable with M categories, it requires the calculation of M-1 equations, one for each category relative to the reference category. "Never smoked cigarettes" was used as the reference category. Probability of the age of smoking initiation compared to never smoking was estimated using MNLM for each of the explanatory variables. By default the exponentiated values of the coefficients estimated from a MNLM gives the relative risk ratios for a one-unit change in the corresponding variable. Since the relative risks are difficult to interpret, we estimated the average marginal effects (AME) for each of the independent variables on each of the outcome categories relative to the base outcome. AMEs are presented after multiplying by 100 so that the results can be interpreted as percentages. For example, keeping all other characteristics same, the probability of an adolescent male initiating smoking at the age 7 or less compared to never-smoker is 0.026 (2.6 %) and that of a female is 0.015 (1.5 %). The AME would report the difference between these probabilities as 0.011 (1.1 % points). It means the probability for initiating smoking at the age 7 or less is

1.1 % points higher for the adolescent males than females compared to a never smoking adolescent. Standard tests such as likelihood ratio (LR) test and Wald tests for testing the independent variables, LR test for combining alternatives in the outcome variable, and Hausman test for testing the assumption of independence of irrelevant alternatives were conducted to test for model assumptions, and were reported in Table 4. All analyses were conducted using the Stata ver.12 (StataCorp, College Station, TX).

Results

A total of 16,519 adolescents aged 13–15 years were included in the study, with sample sizes ranging from 1155 in Cape Verde to 3946 in Ghana. Table 2 presents the descriptive characteristics of the study participants. Males constituted more than half of the participants in four of the nine countries, ranging from 43.45 % in Cape Verde to 59.57 % in Togo. While the proportion of adolescents exposed to parental smoking ranged from 7.71 % in Ghana to 22.01 % in Mauritania, those exposed to peer smoking ranged from 13.56 % in Togo to 37.51 % in Mauritania. More than 60 % of adolescents in all nine countries were knowledgeable about tobacco harm, and those exposed to tobacco industry promotions ranged from 4.95 % in Cote d'Ivoire to 25.08 % in Mauritania. Additionally, there is variation in age at which an adolescent initiated smoking ranging from 0.70 % of adolescents in Ghana initiated smoking at 10 or 11 years to 9.60 % of adolescents in Cote d'Ivoire initiated at ages 12 or 13 years. Table 3 presents the bivariate analysis of age at which an adolescent smoked his/her first cigarette with adolescent characteristics. Among adolescent males and females who initiated smoking in any of the six age categories, a higher proportion of them initiated smoking at ages 12 or 13 years (5.24 %), and at $\leq$7 years (1.17 %).

Table 4 presents the average marginal effects of each of the independent variables from the MNLM on age at which an adolescent initiated cigarette smoking. There were significant differences in probability at which an adolescent smoked his/her first cigarette by sex, exposure to parental or peer smoking or tobacco industry promotions, or knowledge about smoking harm (Fig. 1). Compared to adolescent females, the probability of smoking initiation was higher by at least one-percentage points for males at all age groups considered. The biggest difference was in the age group 12 or 13 years where the probability of initiation was 3.25 % points higher for males than females followed by 14 or 15 years age group where the excess probability of initiation was 2.5 % points among adolescent males. Compared to adolescents who were not exposed to peer

Table 2 Distribution of adolescents in nine West African countries by demographic characteristics, Global Youth Tobacco Survey, 2006–2009

Demographics	Cape Verde	Cote D'Ivoire	Ghana	Guinea	Mali	Mauritania	Niger	Senegal	Togo
Sample size	1155	1870	3946	1199	2002	1642	1249	1544	1912
Male (%)	43.45	52.92	49.63	51.52	55.51	48.22	47.63	46.92	59.57
Age of initiation (%)									
Never smoked	92.14	75.98	94.81	90.28	77.94	82.81	91.19	88.78	89.00
7 years or less	1.45	1.49	1.92	1.96	2.66	2.55	0.73	2.14	2.03
8 or 9 years	1.30	2.42	0.95	1.16	2.49	1.87	1.54	0.77	1.64
10 or 11 years	1.43	4.45	0.70	1.61	4.29	3.79	1.12	1.93	1.84
12 or 13 years	1.77	9.60	1.06	3.22	8.28	4.06	3.40	4.02	3.04
14 or 15 years	1.91	6.06	0.56	1.77	4.33	4.90	2.02	2.35	2.45
Exposure to parental smoking (%)									
Yes	14.84	15.58	7.71	19.31	20.14	22.01	8.59	21.67	12.00
Exposure to peer smoking (%)									
Yes	23.86	31.31	16.19	22.87	37.20	37.51	16.29	26.66	13.56
Knowledge about smoking harm (%)									
Yes	85.54	82.76	63.78	59.32	78.05	70.89	84.14	64.34	75.58
Exposure to tobacco industry promotions (%)									
Yes	5.67	4.95	10.57	23.13	10.18	25.08	5.85	8.53	6.94

Table 3 Age of smoking initiation among adolescents in West Africa by adolescent characteristics, Global Youth Tobacco Survey, 2006–2009

Characteristic	Age of smoking initiation (years)					
	Never smoked	7 or less	8 or 9	10 or 11	12 or 13	14 or 15
Gender (%)						
Female	95.45	1.17	0.67	0.60	1.15	0.94
Male	84.51	2.75	1.87	2.81	5.24	2.81
Exposure to parental smoking (%)						
No	91.87	1.39	1.07	1.38	2.70	1.60
Yes	79.11	4.77	2.25	3.81	6.30	3.76
Exposure to peer smoking (%)						
No	94.40	1.17	0.85	1.03	1.74	0.81
Yes	73.55	4.97	2.92	4.28	8.51	5.77
Knowledge about smoking harm (%)						
No	92.64	2.05	1.00	1.12	1.81	1.37
Yes	88.49	1.96	1.44	2.02	3.94	2.15
Exposure to tobacco industry promotions (%)						
No	91.03	1.49	1.20	1.61	2.96	1.71
Yes	80.39	5.83	2.06	2.58	5.47	3.67
Country (%)						
Cape Verde	92.14	1.45	1.30	1.43	1.77	1.91
Cote D'Ivoire	75.98	1.49	2.42	4.45	9.60	6.06
Ghana	94.81	1.92	0.95	0.70	1.06	0.56
Guinea	90.28	1.96	1.16	1.61	3.22	1.77
Mali	77.94	2.66	2.49	4.29	8.28	4.33
Mauritania	82.81	2.55	1.87	3.79	4.06	4.90
Niger	91.19	0.73	1.54	1.12	3.40	2.02
Senegal	88.78	2.14	0.77	1.93	4.02	2.35
Togo	89.00	2.03	1.64	1.84	3.04	2.45

smoking, the probability of smoking initiation was higher by at least 1 % point for those adolescents in all age groups who were exposed to peer smoking. The biggest difference was in the age group 14 or 15 years age group where the probability of initiation was 4.55 % points higher for those exposed to peer smoking than those who were not. The probability of smoking initiation in adolescents also increased with exposures to parental smoking or tobacco industry promotions. Compared to adolescents who were not exposed to parental smoking, the probability of smoking initiation was higher for those adolescents in all age groups who were exposed to parental smoking. The excess probability of smoking initiation among the adolescents exposed to parental smoking was highest (1.86 % points) in the age group $\leq$7 years than those who were not exposed. Similarly, compared to adolescents who were exposed to tobacco industry promotions, the probability of smoking initiation was higher in adolescents exposed to industry promotions in all age groups, although the difference was not statistically significant for 8 or 9 years age. The biggest difference was in the age group 14 or 15 years where the probability of smoking initiation was 2.82 % points higher for adolescents exposed to industry promotions than those who were not exposed. Knowledge about the harmful effects of smoking also had a significant effect on the probability of smoking initiation among adolescents of all age groups, although its effects were not significant for adolescents aged $\leq$9 years. Biggest difference in probabilities was in the age group 12 or 13 years where the probability of smoking initiation was 0.99 % point higher for those who were knowledgeable about tobacco harm than those who were not knowledgeable.

Compared to adolescents residing in Ghana, the probability of smoking initiation was higher for adolescents in all

Table 4 Average marginal effects of adolescent characteristics on age of smoking initiation among adolescents in West Africa, Global Youth Tobacco Survey, 2006–2009

Characteristic	Age of smoking initiation (years)				
	7 or less	8 or 9	10 or 11	12 or 13	14 or 15
Male (referent group: female)	1.19***	1.23***	2.07***	3.25***	2.67***
Exposure to parental smoking (referent group: no)	1.86***	0.94***	1.06***	1.52***	1.73***
Exposure to peer smoking (referent group: no)	2.13***	1.41***	2.04***	4.05***	4.55***
Knowledge about smoking harm (referent group: no)	0.01	0.16	0.69***	0.96***	0.77**
Exposure to tobacco industry promotions (referent group: no)	1.72***	0.21	1.11***	0.99**	2.82***
Cape Verde (referent group: Ghana)	−0.68	0.41	1.09**	1.88***	2.39***
Cote D'Ivoire (referent group: Ghana)	−1.18***	0.92**	3.32***	6.50***	7.56***
Guinea (referent group: Ghana)	−0.38	0.10	0.47	1.55***	1.86***
Mali (referent group: Ghana)	0.87*	1.12***	2.66***	4.68***	1.94***
Mauritania (referent group: Ghana)	−0.24	0.32	1.96***	2.76***	2.35***
Niger (referent group: Ghana)	−0.64	0.13	0.55	2.40***	3.17***
Senegal (referent group: Ghana)	−0.51	0.25	1.67***	3.02***	2.26***
Togo (referent group: Ghana)	0.40	0.53*	1.35***	2.15***	2.47***

Base outcome: never smoked. (converted to percentage)

Average marginal effects were estimated from the multinomial logit regression and multiplied by 100 to present the values as percentage point difference between the referent group and comparison group

Log likelihood = −14,531.8; LR $\chi^2(65) = 4256.42$; pseudo $R^2 = 0.1277$; AIC ($df = 70$) = 29,203.76; BIC ($df = 70$) = 29,782.08

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

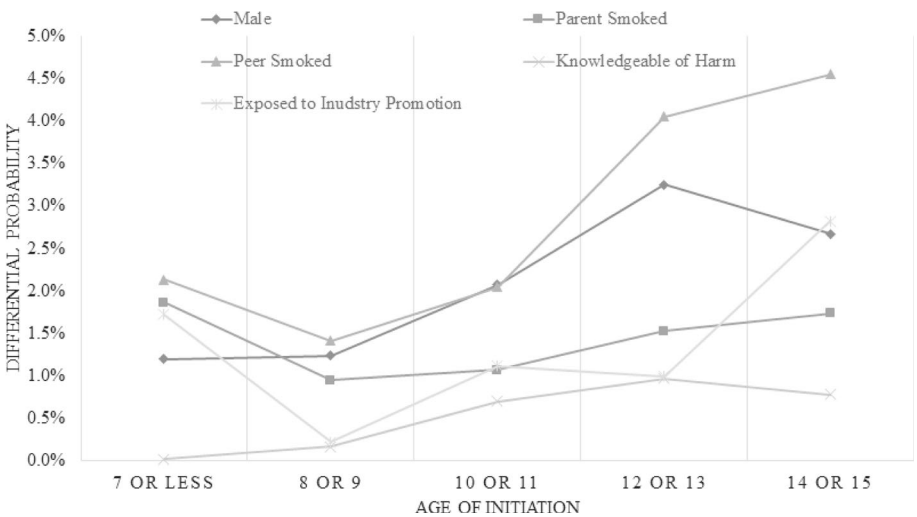

Fig. 1 Excess probability to initiate smoking among adolescents in West Africa at various ages by adolescent characteristics, Global Youth Tobacco Survey, 2006–2009. The referent group for male is 'female'. For all others referent group is 'no'

age groups ≥8 years in the other eight West African countries in the analysis (Cape Verde, Cote d'Ivoire, Guinea, Mali, Mauritania, Niger, Senegal and Togo). Interestingly, although the probability of smoking initiation at most age groups of adolescents were lower for Ghanaian adolescents compared to those in other West African countries, the reverse is the case (except in Mali and Togo) when it comes to adolescents with age ≤7 years. However, the differences were significant only for Cote d'Ivoire whose under 7 year olds had 1.18 % points lower probability of smoking initiation at ≤7 years compared to those ≤7 years in Ghana. For those ≤7 years olds in Mali; however, the probability of smoking initiation was significantly higher compared to their counterparts in Ghana.

Discussion

Tobacco use contributes to over 6 million annual deaths worldwide, which is expected to reach one billion by the

end of the 21st Century (WHO World Health Organization 2009). Much of the increase in tobacco use and the associated morbidity and mortality will occur in LMICs such as those in Africa. Although tobacco use is considered as a "pediatric disease" as up to 90 % of the users start before age 18 years (Hipple et al. 2011; Lando et al. 2010), very few studies on smoking initiation have been conducted in West Africa (Maassen et al. 2004; Peltzer 2011a; Swart et al. 2006). In light of this paucity of research despite the fact that local policymakers are amenable to locally generated data, we conducted a study on the age of smoking initiation in nine West African countries using nationally representative GYTS data to provide one of the first major comparative insights into the issue to inform policy and advocacy initiatives in the region. This study is particularly important because African countries have shown an inclination and the political-will to address tobacco use and non-communicable diseases (NCDs) by ratifying the WHO FCTC and adopting the WHO Global Action Plan for the Prevention and Control of NCDs (2013–2020) to reduce NCDs by 30 % by 2025 (Bonita et al. 2013; Kontis et al. 2014). This study found that in all the nine West African countries, the reported age of smoking initiation among adolescent smokers was $\leq$7 years. This early age of initiation of tobacco use in the region suggests the importance of adopting policies and programs targeting early childhood, including school-based ones (Murnaghan et al. 2008), which aggressively target youths and could stop the initiation of usage of tobacco in the region.

A myriad of factors for smoking initiation among youth have been identified in previous studies (Maassen et al. 2004; Odukoya et al. 2013; Peltzer 2011b). In this study we found sex, parental and peer smoking behavior, and exposure to tobacco industry promotions as factors significantly associated with higher probability of adolescents' smoking initiation across all ages in the West Africa region. We found that adolescent males were at higher risk of smoking initiation than female adolescents. This suggests the urgent need for policies and programs that target young males. Perhaps, investigating cultural and social mores that underpin this risky behavior in early childhood could help address the issue of early initiation of smoking among males in the region.

Earlier studies in Africa found that parental and peer smoking behaviors were associated with tobacco use (Mamudu et al. 2013b; Veeranki et al. 2015b), susceptibility to smoking (Veeranki et al. 2014), and secondhand smoking exposure (Mamudu et al. 2015; Veeranki et al. 2015c). Consistent with these studies, parental and peer smoking behaviors significantly increased probability of smoking initiation among adolescent smokers at all ages in the West African countries. Thus, having parents or peers who smoke have broader societal implications, including smoking in the early ages among nonsmoking adolescents. Indeed, studies in SSA countries suggest that students' perception of (anticipated) parental reaction/attitude affects the likelihood of smoking initiation (Munodawafa et al. 1992). These dynamics means that there is critical need for smoking cessation programs and policies to encourage adult smokers (parents and peers) to quit smoking as their behaviors likely affect the social acceptability of smoking, which translates into smoking initiation in younger populations. Furthermore, research suggests that perception of social acceptability of smoking in Africa may be related to changing social norms, which suggests the need for deeper investigations into the interrelationships between the ongoing socio-economic transformation in the region and youths engagement in risky behaviors, including smoking (Blum 2007).

Overall, >60 % of the adolescents in the study reported that they were knowledgeable about smoking harm. This knowledge was associated with increased smoking initiation among adolescents between the ages 10–15 years. While these results contravene conventional wisdom and intended purpose of enhancing students' knowledge about smoking harm, they are consistent with earlier studies that found that knowledge about smoking harm was associated with increased smoking (Mamudu et al. 2013b; Veeranki et al. 2015b), susceptibility to smoking (Veeranki et al. 2014), and exposure to SHS both inside and outside the home (Mamudu et al. 2015; Veeranki et al. 2015c). These consistent findings suggest the need for qualitative investigation into why enhancing the knowledge of smoking harm ironically contributes to increased probability of smoking initiation among youths in Africa, a contradiction to results from elsewhere, particularly in HICs (General USPHSOotS 2007; USDHHS United States Department of Health and Human Services 2012). Perhaps, one plausible explanation is that societal values of respect for elders and their actions and young people's desire to emulate such elders (especially those who smoke) in Africa dwarf efforts to enhance the knowledge of youths to prevent smoking initiation. Additionally, there is critical need to examine how messages about harmful effects of tobacco use are conveyed to youth in countries in SSA to take into consideration the unique pressures confronted by these adolescents.

Tobacco industry promotional activities in SSA are associated with tobacco use (Mamudu et al. 2013b; Veeranki et al. 2015b), susceptibility to smoking (Veeranki et al. 2014), and secondhand smoking exposure (Mamudu et al. 2015; Veeranki et al. 2015c). We found in this study that exposure to tobacco industry promotions was significantly associated with increased probability of smoking initiation at age $\leq$7 years, 10 or 11 years, 12 or 13 years, and 14 or 15 years. Tobacco companies engage in several activities, including promoting tobacco use and smuggling

to make tobacco available and easily accessible to both youths and adults (Legresley et al. 2008). Similar to other countries (USDHHS United States Department of Health and Human Services 2012), the tobacco industry targets youth in Africa (Maassen et al. 2004), which contributes to smoking initiation among adolescents in the region. This suggests the need for compliance with the WHO FCTC that obliges government to protect children from being targeted by the tobacco industry's activities, and the Convention on the Right of the Child.

Although the entire SSA region is in the Stage I of the tobacco epidemic model (Thun et al. 2012), there is a wide variation in the rates of tobacco use prevalence among youths (Mamudu et al. 2013b; Veeranki et al. 2015b) and adults in the region (Mamudu et al. 2013a; Pampel 2008). In a study of 17 African countries, the prevalence of adult smoking ranged from 8.1 % in Ghana to 48.9 % among males in Madagascar (Mamudu et al. 2013a). Despite all the systemic pressures on African countries, including globalization of tobacco industry influence (Yach and Bettcher 2000), the tobacco use rates have consistently been lower in Ghana (Mamudu et al. 2013a). Thus, not surprising, there was overall increase in the probabilities of smoking initiation in the other eight countries, compared to Ghana. This suggests the need for qualitative investigation into tobacco use in Ghana.

The study has limitations to consider. GYTS is a cross-sectional study that limits causal inferences. Additionally, it is a school-based survey and included only adolescents who attended schools on the day of the survey administration. We defined the outcome variable, age of smoking initiation, using a question that collected information before the time of surveys administration, and might be subject to recall bias. In addition, the independent variables included in the study were defined using survey questions that did not collect information in the past 30 days or 12 months; however, it is possible that the adolescents responded to the survey questions assuming that the questions asked about their tobacco-related knowledge or behavior at the time of survey administration. This could potentially lead to misclassification bias, and future longitudinal studies with subsequent follow-ups should be conducted to minimize this bias. Further, the study might be subject to unmeasured confounding, including exposure to smoking in movies, access to tobacco products, perceptions about social acceptability of tobacco use, low academic achievements, lack of self-efficacy, low self-esteem, engagement in health risk behaviors, and other community and political characteristics that have been identified in previous studies (Peltzer 2011b), but not accounted due to the unavailability of information. Nevertheless, this is the first major comparative study of age of smoking initiation in the West African region and provides the much-needed scientific evidence for policymaking and advocacy.

Although African countries are in Stage I of the tobacco epidemic (Thun et al. 2012), they are confronted with major public health problems with regards to rapid increase in tobacco use and NCDs (Unwin et al. 2004). Given that scientific evidence is required to inform tobacco policy and advocacy (Cairney and Mamudu 2014; Warner 2007; Widome et al. 2010), we conducted investigation into the age of smoking initiation among adolescents in nine West African countries. It was found that the early age at which an adolescent initiated smoking in these countries was at $\leq$7 years; and sex, smoking status of parents and peers, and exposure to tobacco industry promotions were associated with increased probability of smoking initiation. Thus, this study suggests that while there is the need for targeting tobacco control activities at children in general, it supports targeting such activities at male children and children with smoking parents and friends. Additionally, there is urgent need to enact and fully implement the WHO FCTC provisions that curtail youth exposure to industry marketing strategies and access to tobacco products. Overall, the study findings suggest that reversing the increasing trend of tobacco use will require the adoption of the prevention approach to halt early initiation of tobacco use.

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Compliance with ethical standards

Ethical approval This article includes secondary data analysis of publicly available data.
This article does not contain any studies with human participants or animals performed by any of the authors.

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References

Blum RW (2007) Youth in sub-Saharan Africa. J Adolesc Health 41:230–238. doi:10.1016/j.jadohealth.2007.04.005

Bonita R, Magnusson R, Bovet P, Zhao D, Malta DC, Geneau R, Suh I, Thankappan KR, McKee M, Hospedales J, de Courten M, Capewell S, Beaglehole R, Lancet NCDAG (2013) Country actions to meet UN commitments on non-communicable diseases: a stepwise approach. Lancet 381:575–584. doi:10.1016/S0140-6736(12)61993-X

Breslau N, Peterson EL (1996) Smoking cessation in young adults: age at initiation of cigarette smoking and other suspected influences. Am J Public Health 86:214–220

Cairney P, Mamudu H (2014) The global tobacco control 'endgame': change the policy environment to implement the FCTC. J Public Health Policy 35:506–517. doi:10.1057/jphp.2014.18

Calo WA, Krasny SE (2013) Environmental determinants of smoking behaviors: the role of policy and environmental interventions in preventing smoking initiation and supporting cessation. Curr Cardiovasc Risk Rep 7:446–452. doi:10.1007/s12170-013-0344-7

DeBry SC, Tiffany ST (2008) Tobacco-induced neurotoxicity of adolescent cognitive development (TINACD): a proposed model for the development of impulsivity in nicotine dependence. Nicotine Tob Res 10:11–25. doi:10.1080/14622200701767811

General USPHSOotS (2007) Children and secondhand smoke exposure excerpts from The health consequences of involuntary exposure to tobacco smoke: a report of the Surgeon General. US Department of Health and Human Services, Public Health Service, Office of the Surgeon General, Rockville

Gwede CK, McDermott RJ, Westhoff WW, Mushore M, Mushore T, Chitsika E, Majange CS, Chauke P (2001) Health risk behavior of rural secondary school students in Zimbabwe. Health Educ Behav 28:608–623

Hipple B, Lando H, Klein J, Winickoff J (2011) Global teens and tobacco: a review of the globalization of the tobacco epidemic. Curr Probl Pediatr Adolesc Health Care 41:216–230. doi:10.1016/j.cppeds.2011.02.010

Jackson C (1997) Initial and experimental stages of tobacco and alcohol use during late childhood: relation to peer, parent, and personal risk factors. Addict Behav 22:685–698

Kontis V, Mathers CD, Rehm J, Stevens GA, Shield KD, Bonita R, Riley LM, Poznyak V, Beaglehole R, Ezzati M (2014) Contribution of six risk factors to achieving the 25 × 25 non-communicable disease mortality reduction target: a modelling study. Lancet 384:427–437. doi:10.1016/S0140-6736(14)60616-4

Lando HA, Hipple BJ, Muramoto M, Klein JD, Prokhorov AV, Ossip DJ, Winickoff JP (2010) Tobacco is a global paediatric concern. Bull World Health Org 88:2. doi:10.2471/BLT.09.069583

Legresley E, Lee K, Muggli ME, Patel P, Collin J, Hurt RD (2008) British American Tobacco and the "insidious impact of illicit trade" in cigarettes across Africa. Tob Control 17:339–346. doi:10.1136/tc.2008.025999

Leventhal H, Cleary PD (1980) The smoking problem: a review of the research and theory in behavioral risk modification. Psychol Bull 88:370–405

Maassen IT, Kremers SP, Mudde AN, Joof BM (2004) Smoking initiation among Gambian adolescents: social cognitive influences and the effect of cigarette sampling. Health Educ Res 19:551–560. doi:10.1093/her/cyg077

Mamudu HM, John RM, Veeranki SP, Ouma AE (2013a) The odd man out in Sub-Saharan Africa: understanding the tobacco use prevalence in Madagascar. BMC Public Health 13:856. doi:10.1186/1471-2458-13-856

Mamudu HM, Veeranki SP, John RM (2013b) Tobacco use among school-going adolescents (11–17 years) in Ghana. Nicotine Tob Res 15:1355–1364. doi:10.1093/ntr/nts269

Mamudu HM, Veeranki SP, John RM, Kioko DM, Ogwell Ouma AE (2015) Secondhand smoke exposure among nonsmoking adolescents in West Africa. Am J Public Health 105:1823–1830. doi:10.2105/AJPH.2015.302661

Munodawafa D, Marty PJ, Gwede C (1992) Drug use and anticipated parental reaction among rural school pupils in Zimbabwe. J Sch Health 62:471–474

Murnaghan DA, Leatherdale ST, Sihvonen M, Kekki P (2008) A multilevel analysis examining the association between school-based smoking policies, prevention programs and youth smoking behavior: evaluating a provincial tobacco control strategy. Health Educ Res 23:1016–1028. doi:10.1093/her/cyn034

Odukoya OO, Odeyemi KA, Oyeyemi AS, Upadhyay RP (2013) Determinants of smoking initiation and susceptibility to future smoking among school-going adolescents in Lagos State, Nigeria. Asian Pac J Cancer Prev 14:1747–1753

Pampel F (2008) Tobacco use in sub-Sahara Africa: estimates from the demographic health surveys. Soc Sci Med 66:1772–1783. doi:10.1016/j.socscimed.2007.12.003

Peltzer K (2011a) Determinants of exposure to second-hand tobacco smoke (SHS) among current non-smoking in-school adolescents (aged 11–18 years) in South Africa: results from the 2008 GYTS study. Int J Environ Res Public Health 8:3553–3561. doi:10.3390/ijerph8093553

Peltzer K (2011b) Early smoking initiation and associated factors among in-school male and female adolescents in seven African countries. Afr Health Sci 11:320–328

Reidpath DD, Davey TM, Kadirvelu A, Soyiri IN, Allotey P (2014) Does one cigarette make an adolescent smoker, and is it influenced by age and age of smoking initiation? Evidence of association from the US Youth Risk Behavior Surveillance System (2011). Prev Med 59:37–41. doi:10.1016/j.ypmed.2013.11.011

Swart D (1998) Cigarette smoking initiation and maintenance. Int J Adolesc Med Health 10:51–63. doi:10.1515/IJAMH.1998.10.1.51

Swart D, Panday S, Reddy SP, Bergstrom E, de Vries H (2006) Access point analysis: what do adolescents in South Africa say about tobacco control programmes? Health Educ Res 21:393–406. doi:10.1093/her/cyl042

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

Townsend L, Flisher AJ, Gilreath T, King G (2006) A systematic literature review of tobacco use among adults 15 years and older in sub-Saharan Africa. Drug Alcohol Depend 84:14–27. doi:10.1016/j.drugalcdep.2005.12.008

Unwin N, Epping Jordan J, Bonita R (2004) Rethinking the terms non-communicable disease and chronic disease. J Epidemiol Community Health 58:801 **(author reply 801)**

USDHHS (United States Department of Health and Human Services) (2012) Preventing tobacco use among youth and young adults: a report of the Surgeon General. http://www.ncbi.nlm.nih.gov/pubmed/22876391

Veeranki SP, Mamudu HM, Anderson JL, Zheng S (2014) Worldwide never-smoking youth susceptibility to smoking. J Adolesc Health 54:144–150. doi:10.1016/j.jadohealth.2013.07.036

Veeranki SP, Alzyoud S, Kheirallah KA, Pbert L (2015a) Waterpipe use and susceptibility to cigarette smoking among never-smoking youth. Am J Prev Med. doi:10.1016/j.amepre.2015.03.035

Veeranki SP, Mamudu HM, John RM, Ouma AE (2015b) Prevalence and correlates of tobacco use among school-going adolescents in Madagascar. J Epidemiol Glob Health 5:239–247. doi:10.1016/j.jegh.2014.12.005

Veeranki SP, Mamudu HM, Zheng S, John RM, Cao Y, Kioko D, Anderson J, Ouma AE (2015c) Secondhand smoke exposure among never-smoking youth in 168 countries. J Adolesc Health 56:167–173. doi:10.1016/j.jadohealth.2014.09.014

Warner KE (2007) Charting the science of the future where tobacco-control research must go. Am J Prev Med 33:S314–S317. doi:10.1016/j.amepre.2007.09.010

Warren CW, Lee J, Lea V, Goding A, O'Hara B, Carlberg M, Asma S, McKenna M (2009) Evolution of the global tobacco surveillance system (GTSS) 1998–2008. Glob Health Promot 16:4–37. doi:10.1177/1757975909342181

WHO (World Health Organization) (2009) WHO report on the global tobacco epidemic, 2009: implementing smoke-free

environments. http://www.who.int/tobacco/mpower/2009/gtcr_download/en/index.html

Widome R, Samet JM, Hiatt RA, Luke DA, Orleans CT, Ponkshe P, Hyland A (2010) Science, prudence, and politics: the case of smoke-free indoor spaces. Ann Epidemiol 20:428–435. doi:10.1016/j.annepidem.2010.03.004

Yach D, Bettcher D (2000) Globalisation of tobacco industry influence and new global responses. Tob Control 9:206–216