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PREVALENCE, PATTERNS AND PREDICTORS OF SECONDHAND TOBACCO SMOKE EXPOSURE AMONG ADULTS IN SOUTH EAST NIGERIA

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ABSTRACT

Evidences have shown that secondhand tobacco smoke (STS) exposure has remained a major threat to public health as well as a causal risk factor for a number of health problems for adults. This study assessed prevalence, patterns and predictors of secondhand tobacco smoke exposure in a sample of adults in South East Nigeria. A cross-sectional study was conducted between February and November, 2020 at the households/centres in South East Nigeria. Data on prevalence of STS exposure in different settings, tobacco smoking and health knowledge about STS were collected in the process using an 18-item structured questionnaire. Findings reveal that adults in lower age groups with no formal education and males were less exposed to STS. Adults with primary education and those with low and moderate knowledge of STS had higher likelihood of STS exposure at home, workplace and public places. In contrast to workplace, adults aged 42-55 years old and those with secondary education had higher likelihood of STS exposure at home and public places. Adults that smoke tobacco less than daily had lesser likelihood of STS exposure at home, workplace and public places than those that smoke daily. STS control should not be overlooked in public health policy. However, public sensitization and seminars should be organized by Non-Governmental Organizations and health stakeholders to enlighten adults on the adverse health outcomes of being exposed to STS at any setting particularly home and consequently take necessary precautions against the inherent dangers and their underlying predictors.

KEY WORDS : Prevalence, Patterns, Predictors, Tobacco consumption, Secondhand tobacco, Smoke, Adults

INTRODUCTION

Secondhand tobacco smoke (STS) is a major public health problem globally. About five million deaths occur annually due to tobacco use and this number of deaths is expected to reach more than eight million by 2030 (World Health Organization [WHO], 2009). The number of non-smokers exposed to secondhand tobacco smoke (STS) otherwise called passive/involuntary smoking or environmental tobacco smoke has been steadily increasing (WHO, 2016). It has remained a major

threat to public health due to its adverse health effects on both children and adults (Dinas *et al.*, 2011; Oberg *et al.*, 2011 and Metsios *et al.*, 2009). Secondhand tobacco smoke accounts for 42,000 non-smoker deaths annually in the U.S (Ng *et al.*, 2014), and at least 600,000 deaths per year globally, the majority of which are due to ischemic heart disease among adults (Oberg *et al.*, 2011). Even limited exposure could ensue to development of diseases (Fluoris *et al.*, 2012). Many non-smoking adults and children are regularly exposed to STS which can occur in a home, in a vehicle, at work, or in other public places such as bars or restaurants (Meeker and Benedict, 2013). The period following early and middle adults has particular developmental significance with regard to smoking behaviour (Arnett, 2007).

In recent decades, policies restricting smoking in worksite and public spaces have facilitated significant decreases in tobacco use and STS in the U.S. (Center for Disease Prevention and Control [CDC], 2018; Homa *et al.*, 2015 and McNabola and Gill, 2009). Nonsmokers or smokers who live or work with a smoker generally have the greatest exposure to STS.

Secondhand tobacco smoke has been established as a causal risk factor for a number of health problems for women, children and adults. In pregnant women, spontaneous abortion, adverse effects on fertility or fecundity, adverse perinatal outcomes, elevated risk of stroke, reduced foetal growth, low birth weight, pre-term delivery, respiratory diseases, increased infections and sudden infant death were linked to ETS exposure (California Environmental Protection Agency [CEPA], 2005; Homa *et al.*, 2015 and Lubick, 2011). Active tobacco smoking and exposure to STS are associated with cancer, respiratory diseases, and cardiovascular diseases (HHS Atlanta GA, 2014; Jamal *et al.*, 2018 and Ng *et al.*, 2014).

Smoking tobacco especially cigarette is the principal source of exposure of non-smokers or smokers to tobacco smoke. Secondhand smoking occurs when anyone (including the smoker) inhales tobacco smoke from the environment, as opposed to directly inhaling from a cigarette. This environmental or 'second-hand' smoke comprises two parts: smoke exhaled by a smoker (mainstream smoke) and smoke produced from the tip of a burning cigarette (side-stream smoke). The majority of STS is in the form of sidestream smoke generated from the burning end of a lighted cigarette, while the remainder is composed of mainstream smoke exhaled by individuals actively smoking (Meeker and Benedict, 2013). The burning cigarette produces smoke primarily in the form of mainstream smoke (MS), that is, the smoke inhaled by the smoker during puffing and side stream smoke (SS), that is, the smoke released by the smoldering cigarette while not being actively smoked (Eriksen *et al.*, 2012). Non-smokers are exposed to tobacco smoke from the burning cigarette and the exhaled smoke from smokers. This was confirmed by First (1985) that non-smokers or smokers are exposed to the combination of diluted SS that is released from the cigarette's burning end and the MS exhaled by the active smoker. This mixture of diluted SS and exhaled MS has been referred to as STS.

Both mainstream and sidestream smoke contain thousands of compounds, many of them are harmful to humans. Mainstream and sidestream smoke are produced at differing temperatures and oxygen conditions, and harmful constituents exist in varying proportions between the two types of smoke. For example, sidestream smoke contains more carbon monoxide (CO) and less carbon dioxide (CO_2), and higher levels of combustion products formed by nitrosation and amination, than mainstream smoke (Woodward and al-Delaimy, 1999). Smokers only inhale about 15 per cent of the smoke from a cigarette, and the rest enters the atmosphere (Khurana, 2018). In addition, there are other minor contributors to STS, such as the smoke that escapes while the smoker inhales, and some vapour-phase components that diffuse into the environment. These smoke constituents may also aggregate with other components in the air and pollute the air that non-smokers will be exposed to, that have detrimental health effect on them. Secondhand smoke contains all the same carcinogenic and toxic chemicals that the smoker inhales, but at even greater levels. The toxins in second hand smoke are not filtered as they are when inhaled directly from the cigarette. Also, because side-stream smoke is formed at lower temperatures, it gives off even larger amounts of some harmful substances. STS contains a number of known or suspected reproductive toxins, and human exposure to STS is prevalent worldwide (Meeker and Benedict, 2013). Over 3000 different chemicals, including irritant gases, carcinogens and fine particles (WHO, 2009), nicotine, CO, and CO_2 (Pogodina *et al.*, 2009), asbestos, arsenic, benzene, radon, and other carcinogens (Goel *et al.*, 2004) are

contained in tobacco smoke. Various products of tobacco smoke (benzopyrene, cadmium, and cotinine, a nicotine metabolite) reach the ovarian follicle and the presence of cotinine has been associated with reduced fertilizing ability of the oocyte. Cotinine has been found in the ovarian follicles of passive smoker (Khurana, 2018).

In addition to a large and growing health burden, STS exposure also imposes economic burdens on individuals and countries, both for the costs of direct health care as well as indirect costs from reduced productivity (WHO, 2009). Literature showed socio-economic and demographic factors, and knowledge, attitude and perception (KAP) towards STS to significantly influenced the exposure level (Abdullah *et al.,* 2011; Bolte *et al.,* 2009; Hyland *et al*., 2009; Sims *et al.,* 2010; Rachiotis *et al.,* 2010; Mei *et al.,* 2009; Oberg *et al.,* 2011; and Chen *et al.,* 2009). Like direct smoking, STS was linked to enormous health problems among adults (Eriksen *et al.,* 2012; Oberg *et al.,* 2011 and WHO, 2010). Evidence shows that the STS problem is also serious in Nigeria compared to developed countries and this is due to population density, lower level of knowledge and awareness, lack of strict public law enforcement (Oberg *et al.,* 2011 and WHO, 2010).

There are negative health consequences when adults are exposed to STS. However, comprehensive researches on developing countries including Nigeria where their consequences are serious are lacking. Research on STS exposure prevalence, patterns and their predictors in Nigeria are scarce. Thus, this study assessed the prevalence, patterns and predictors of STS exposure among adults at home, workplace and public places. This study's findings would help health professionals, researchers, government, health agencies, adults among others in providing an insight to the prevalence, patterns and predictors of STS exposure in a sample of adults as well as in the design and implementation of smoke free environments in South East Nigeria alongside other preventive strategies.

MATERIALS AND METHODS

Study design, setting and population

A cross-sectional study was conducted from February through November, 2020 at the households/centres in the five States that make up South East Nigeria. South East Nigeria is one of the six geopolitical zones in Nigeria, consisting of five States. The five States are: Abia, Anambra, Ebonyi, Enugu and Imo. Each of these States has three Senatorial Districts otherwise referred to as Geopolitical Zones, and the Senatorial Districts are made up of Local Government Areas (LGAs). In the various LGAs, there are autonomous communities and villages. It is located between latitudes 4 and 7 degrees North of the Equator and between longitudes 7 and 9 degrees East bordered by South South and North Central Nigeria. The area is one of the most populous regions in Nigeria.

The study population comprised young and middle-aged adults in the study area. Only young and middle-aged adults (18-55 years) were included in the study population. Older adults (over 55 years) were excluded from the study.

Sample size determination and procedure

The sample size was determined using Benneth *et al*. (1991) and Sarnda and Swensson (2003) sample size determination formular. Based on a previous study where 44.4 per cent of the population indicated having being exposed and had knowledge of ETS adverse health outcomes (Ezeah, 2016), we calculated a sample size of 1,550 that would be required to give a 95% probability measuring the prevalence of STS exposure with 50% accuracy, a none response rate of 5%.

Purposive and convenience sampling methods were adopted in selecting 1,550 participants for this study. Purposive in the sense that only young and middle-aged (18-55years) adults were used, and convenience in the sense that young and middle-aged adults in different places, who had time and expressed their consent in responding to our questionnaires, were used.

Data collection tools

Following the participants' consent, an 18-item self reported interviewer-administered structured questionnaire was administered for data collection. The questionnaire was developed based on a detailed literature review of previous studies that had assessed STS exposure (Johansson *et al.,* 2005 and Nondahl *et al.,* 2005), and Domains included within the standardized Global Adult Tobacco Survey (GATS) Bangladesh core and optional questions (WHO, 2010) and the Global Youth Tobacco Survey (GYTS) (Giovino *et al.,* 2012 and Kyrlesi *et al.,* 2007). The questionnaire consisted of two parts. Part I consisted of four socio-

demographic and economic variables (gender, age, place of residence and education level). Part II consisted of 14 questions with both dichotomous and non-dichotomous response options on prevalence of STS exposure in different settings (home, workplace and public places), tobacco consumption and duration of smoking and specific health knowledge about STS exposure.

Questions on prevalence of STS exposure and tobacco consumption were based on previous studies (Fazel *et al.,* 2020 and WHO, 2010). The questions included: (i) During the past 30 days, did anyone smoke inside your home? (ii) During the past 30 days, did anyone smoke in indoor areas where you work? (iii) Did anyone smoke inside of any of the public places (healthcare facilities, institutions, restaurant, public transport, meeting places etc) you visited in the past 30 days? (iv) How often do you currently smoke or used smokeless tobacco? (a) daily, (b) less than daily, (c) not at all.

Questions assessing knowledge of STS exposure was prepared by the researchers according to literature review and had dichotomous response options (yes and no): thus: Based on what you know or believe, does Second hand Tobacco Smoke cause or increase the chance of any of the following in non-smokers: heart disease in adults? lung cancer in adults and children? infertility in both men and women? premature birth and low birth weight? sudden infant death syndrome (SIDS)? upper and lower respiratory infections, chest pain, persistent cough? asthma and or shortness of breath? blood platelets to become stickier? complications and discomforts in pregnancy? and lowering one's high-density lipoprotein cholesterol (HDL)?

Content validity of the questionnaire was evaluated by a professional board of seven specialists in nursing and midwifery, health education and environmental health, and as well was tested for internal consistency. The internal consistency of the questionnaire was determined using alpha with an index of .917.

Ethical consideration and consent to participate

The ethical approval was obtained prior to commencing research. The Ethics Committee of the Faculty of Education, University of Nigeria, Nsukka approved the study. The researchers explained the objectives of research for the participants and the latter were assured about the privacy of their personal data. After their consent was gotten, adults were contacted in their homes, workplaces, banks, hospitals, institution, public transport stations and meeting venues around the towns across States in South East Nigeria for data collection.

Data collection procedure

A total number of 1,550 questionnaires were filled out in the process. Out of 1,550 questionnaires administered, 1,514 were returned, which gave a return rate of 97.7 per cent. Out of the returned questionnaires, 12 copies were not duly filled out, thus discarded. Only 1,502 copies of the questionnaire duly filled out were used for analyses.

Data analysis

The IBM Statistical Package for Social Sciences (SPSS) version 23.0 was used for all the statistical analyses. The standard descriptive statistics were applied to describe data pattern. Frequency counts and percentages were generated to compute the prevalence of STS at three settings. Bivariate analyses using cross tabulations were also performed to obtain the prevalence of STS for various categories of the selected variables and to identify significant predictors using Pearson's Chi-square (χ^2) test. Predictors that significantly explain STS at three settings were entered into the Logistic regressions for multivariate analyses. We utilized three binary Logistic regression models separately for three different settings (Model A: exposed at home, Model B: exposed at workplace and Model C: exposed at public places). In Logistic regressions, STS exposure at home, workplace and public places were used as response variables. Socio-demographic and economic variables (gender, age, place of residence and education level) as well as specific health knowledge about STS and Tobacco Consumption were considered as predictors. All the tests were 2-tailed, and the probability values less than 0.05 ($p<0.05$) were considered significant.

RESULTS

The final sample was 1,502 adults, comprising 792 males and 710 females. The mean age of participants was 36 years. The male-female ratio was (52.7 vs 47.3). The respondents were aged between 18 – 55 years, with most of them 563 (37.5%) falling in the category of 30-41 years. The respondents reside in both urban 734 (48.9%) and rural 768 (51.1%) settings. The vast majority of the respondents had attained at least secondary

education 1,010 (67.2%) as contained in Table 1.

Table 2 shows the prevalence of STS exposure in different settings (home, workplace, and public places) by various indicators including socio-demographic factors, health specific knowledge on STS and tobacco consumption. The gender differentials in exposure level were remarkedly higher among females than males in all the settings. However, in the home, workplace and public places, gaps in exposure level between males and females were relatively narrower in comparison to other settings. The adults aged 42-55 years old were more exposed to STS than other age groups in all the settings together. This age group was also exposed more in the public places (83.3%) than other groups. Adults aged 18-29 years old were less exposed than other groups in the home and public places except at workplace. The exposure level for adults living in rural areas was remarkedly higher than those residing in urban areas in all the settings. However, in the home, gaps in exposure level between rural and urban dwellers were relatively narrower in comparison to other settings.

The adults with secondary education were more exposed by STS than those that had attained other education levels in all the settings together. Those

Table 1. Socio-demographic characteristics of the participants

Variables	Frequency	Per cent
Gender		
Male	792	52.7
Female	710	47.3
Age (in years)		
18-29	537	35.8
30-41	563	37.5
42-55	402	26.8
Place of residence		
Urban	734	48.9
Rural	768	51.1
Education level		
No formal education	93	6.2
Primary education	320	21.3
Secondary education	690	45.9
Tertiary education	399	26.6

Table 2. STS exposure in different settings by selected variables

Variables	ETS exposure in different settings					
	Model A		Model B		Model C	
	% yes	χ^2 (p)	% yes	χ^2 (p)	% yes	χ^2 (p)
Gender						
Male	73.6	.503 (> .05)	75.5	.062 (> .05)	76.8	.000 (> .05)
Female	75.2		76.1		76.8	
Age (in years)						
18-29	71.5		75.4		73.0.	
30-41	72.8	10.85 (< .01)	75.1	.552 (> .05)	75.7	11.19 (< .01)
42-55	80.3		77.1		83.3	
Residence						
Urban	74.1	.048 (> .05)	74.7	.957 (> .05)	75.1	2.315 (> .05)
Rural	74.6		76.8		78.4	
Education						
No Formal Education	59.1		69.9		65.6	
Primary Education	77.2	24.40 (< .001)	80.3	11.91 (< .01)	80.0	26.67 (< .001)
Secondary Education	78.4		77.4		81.0	
Tertiary Education	68.7		70.7		69.4	
Knowledge of STS						
No knowledge	60.4		66.7		64.6	
Low knowledge	77.0		80.2		80.1	
Moderate knowledge	74.9	13.47 (< .01)	43.9	16.19 (< .01)	75.8	13.29 (< .01)
High knowledge	71.4		70.5		74.3	
Tobacco Smoking						
Daily	75.2		79.8		77.2	
Less than daily	66.8	16.15 (< .001)	66.0	26.11 (< .001)	68.6	20.47 (< .001)
Not at all	77.7		78.9		80.5	

*p < 0.05; **p < 0.01; ***p < 0.001

Model A: exposed at home: Model B: exposed at workplace; Model C: exposed at public place

with secondary education were also exposed more in the public places (81.0%) than other settings. Adults with no formal education were less exposed than those in other levels in all settings. The adults that had low knowledge of STS were more exposed than others in all the settings together. Those that had low knowledge of STS were exposed more in the workplace (80.2%) and public places (80.1%) than the others.

In bivariate analysis, education level was significantly ($p < 0.001 – p < 0.05$) associated with STS exposure in all the three settings. Age was a significant factor ($p < 0.05$) for STS exposure at home and public places but non-significant at workplace. Health specific knowledge on STS was statistically significant ($p < 0.01$) for STS exposure in all the three settings. Tobacco smoking was statistically significant ($p < 0.001$) for STS exposure in all the three settings.

Table 3 shows that adults aged 42-55 years old had approximately 42% and 60% higher likelihood of STS exposure at home (OR = 1.417, CI [1.028-1.954], $p = .033$) and public places (OR = 1.599, CI [1.142-2.239], $p = .006$) respectively than adults aged 18-29 years old. Adults with primary education had 2 times higher likelihood of STS exposure at home (OR = 2.301, CI [1.396-3.792], $p = .001$); approximately 74% and 96% higher likelihood at workplace (OR = 1.736, CI [1.016-2.965], $p = .044$) and public places (OR = 1.927, CI [1.186-3.129], $p = .008$) respectively; while those with secondary education had 2 times higher likelihood of STS exposure at home (OR = 2.330, CI [1.461-3.716] , $p < .001$) and approximately 93% at public places (OR = 1.927, CI [1.186-3.129], $p = .008$) than adults with no formal education. Specific health knowledge on STS and tobacco smoking had significant influence on exposure at all the setting (home, workplace and public places). For instance, adults with low knowledge of STS had approximately 84%, 84% and

Table 3. Logistic regression of covariates adjusted for STS exposure in different settings

Variables	ETS exposure in different settings		
	Model A OR (95% CI)	Model B OR (95% CI)	Model C OR (95% CI)
Gender			
Male	-	-	-
Female	1.108 (.873-1.406)	1.074 (.842-1.369)	1.005 (.785-1.286)
Age (in years)			
18-29	-	-	-
30-41	1.148 (.869-1.517)	1.145 (.856-1.531)	1.290 (.968-1.718)
42-55	1.417 (1.028-1.954)*	.974 (.708-1.340)	1.599 (1.142-2.239)**
Residence			
Urban	-	-	-
Rural	.951 (.749-1.207)	1.070 (.839-1.364)	1.134 (.885-1.452)
Education			
No Formal Education	-	-	-
Primary Education	2.301 (1.396-3.792)**	1.736 (1.016-2.965)*	1.958 (1.165-3.294)*
Secondary Education	2.330 (1.461-3.716)***	1.361 (.829-2.236)	1.927 (1.186-3.129)**
Tertiary Education	1.563 (.973-2.510)	1.041 (.628-1.725)	1.162 (.713-1.894)
Knowledge of STS			
No knowledge	-	-	-
Low knowledge	1.842 (1.163-2.918)**	1.837 (1.136-2.969)*	1.759 (1.094-2.826)*
Moderate knowledge	1.734 (1.084-2.775)*	1.317 (.811-2.139)	1.447 (.894-2.343)
High knowledge	1.418 (.853-2.358)	1.101 (.654-1.855)	1.350 (.799-2.278)
Tobacco Smoking			
Daily	-	-	-
Less than daily	-.591 (.417-.838)**	-.445 (.310-.639)***	-.569 (.398-.813)**
Not at all	.912 (.658-1.264)	.855 (.606-1.206)	.951 (.678-1.333)

*p < 0.05; **p < 0.01; ***p < 0.001

Model A: exposed at home: Model : exposed at workplaces; Model C: exposed at public places

Ref Groups: Gender = Male; Age = 15 – 24 years; Place of Residence = Urban; Education Level = No Formal Education ; Knowledge of STS = No Knowledge

76% higher likelihood of STS exposure at home (OR = 1.842, CI [1.163-2.918], p = .009), workplace (OR = 1.837, CI [1.136-2.969], p = .013) and public places (OR = 1.759, CI [1.094-2.826], p = .020) respectively; while those with moderate knowledge (OR = 1.734, CI [1.084-2.775], p = .022) of STS had 73.4% higher likelihood of STS exposure at home than adults that had no knowledge of STS. Adults that smoke tobacco less than daily had 40.9%, 55.5% and 43.1% lesser likelihood of STS exposure at home (OR = .591, CI [.417-.838], p = .003), workplace (OR = .445, CI [.310-.639], p < .001) and public places (OR = .569, CI [.398-.813], p < .002) respectively than those that smoke daily.

DISCUSSION

Research in recent years has shown that exposure to STS is a significant predictor of specific health problems among adults at a global scale. However, this study was undertaken to assess prevalence, patterns and predictors of secondhand tobacco smoke exposure in a sample of adults in South East Nigeria. Table 1 shows that 1,502 adults, comprising 792 males and 710 females participated in our research. The mean age of participants was 36 years. The male-female ratio was (52.7 vs 47.3). The respondents were aged between 18 – 55 years, with most of them 563 (37.5%) falling in the category of 30-41 years. The respondents reside in both urban 734 (48.9%) and rural 768 (51.1%) settings. The vast majority of the respondents had attained at least secondary education 1,010 (67.2%).

The findings revealed that greater than 50% of South Eastern Nigerian adults were exposed to STS at home comprising more males than females. Adults were also exposed at workplace with female dominance. Exposure to secondhand smoke in the home was more common among females (Jallow *et al.*, 2018 and Rudatsikira *et al.*, 2009). The findings were not in line with the finding of Bhatti *et al.* (2010) who found that the prevalence of tobacco use and exposure was significantly higher amongst males than females. The exposure level was higher in productive ages 42-55 years old. These are not consistent with other studies (Abdullah *et al.*, 2011 and International Tobacco Control [ITC], 2006). The STS exposure was also high at public places but females were reportedly more exposed than the males. This finding contradicted the findings that males had overwhelmingly higher exposure at public places than females (Abdullah *et al.*, 2011; Palipudi *et al.*, 2011 and Rachiotis *et al.*, 2010). These lower levels of exposure among men compared to women in workplace and all the public places suggest that males who are mainly unemployed were less likely to visit these public places. Besides, the adults aged 42-55 years old were more exposed to STS than other age groups in all the settings together. We found that respondents aged 18-29 years old had significantly lower risk of STS exposure at home. These findings were not consistent with the findings on adults aged 45+ years in other empirical studies (Abdullah *et al.*, 2011 and Palipudi *et al.*, 2011), where it was clear that age was significantly associated with STS exposure at home. Also, the results were not in line with the findings of Kabir and Farhana (2018) who found that adults in higher age groups and females were less exposed to STS. The higher the number of persons in a household, the higher the risk to be exposed to STS at home. Similar findings were also reported in some studies (Bolte *et al.*, 2009; Hyland *et al.*, 2009 and Sims *et al.*, 2010) and this may be due to having more smokers in the household. In line with other studies (Abdullah *et al.*, 2011 and Palipudi *et al.*, 2011), place of residence also showed significant associations. For instance, the exposure level for adults living in rural areas was remarkedly higher than those residing in urban areas in all the settings. The findings were in line with the findings that more than half of non-smoking employees were exposed to STS at work (Krakowiak *et al.*, 2020).

However, in the home, gaps in exposure level between rural and urban dwellers were relatively narrower in comparison to other settings, and this may be also related to knowledge gap. The findings that STS exposure occur in all the settings (home, workplace and public places) was consistent with the findings of Vardavas *et al.* (2017) and Alagiyawanna *et al.* (2018) who found that the most important sources of STS exposure were the home, the family, car, public places and the workplace. Smoking outside the home and away from the household reduces but does not completely protect a smoker's home from STS contamination and a smoker's household from STS exposure (Table 2). Mixed results were found in South East Nigeria's specific health knowledge about STS. For instance, people in the study area with moderate and high knowledge had higher likelihood to be exposed to STS at home, workplace and public places compared with people without any knowledge. This might be because people with good or high

knowledge about the adverse effects of STS are more responsive than their counterpart without any knowledge. In consistency with South East Nigerian adults, Indian adults with some knowledge and good knowledge had higher likelihood to be exposed to STS at home only. This may be due to socio-economic and cultural differences (Abdullah *et al.,* 2010; Chen *et al.,* 2009 and Oberg *et al.,* 2011). Like STS exposure at home, respondents were also exposed to STS at public places. Consistent with the findings of (Abdullah *et al.,* 2011; Bolte *et al.,* 2009; Hyland *et al.,* 2009; Palipudi *et al.,* 2011; and Sims *et al.,* 2010), South East Nigerian adults aged 42-55 years old were more likely to be exposed to STS at home and public places than younger adults aged 18-29 years old. This may be due to productive age groups and working status, and less time spent outside home.

Higher education was positively associated with support for smoke-free workplace (Chen *et al.,* 2009 and Oberg *et al.,* 2011). Consistent with other findings, this study showed taht adults with primary education had higher likelihood of STS exposure at home, workplace and public places while those with secondary education had higher likelihood of STS exposure at home and public places than adults with no formal education. This might be because educated people were more responsive about the exposure level than their non-educated counterpart. In contrast with one of other studies (Abdullah *et al.,* 2011), South East Nigerian adults have the higher likelihood to be exposed at all the settings, which may be attributed to their environment. Findings also revealed that adults that smoke tobacco less than daily had lesser likelihood of STS exposure at home, workplace and public places than those that smoke daily (Table 3). Enforcement of smoke free laws in Nigeria is weak but this is improving as stronger legislation is enacted, rigorous enforcement is demanded by people who have growing awareness on the harms of STS exposure. These policies contribute decisively to smoking reduction, and help with the approval and implementation of other policies that reduce tobacco demand, such as: a comprehensive ban of tobacco advertisement, promotion, and sponsorship. Making policies for 100% smoke free environment is the most effective way to protect the public, including children, women, and people at their homes, workplace, and public places from exposure to STS. There is sufficient evidence that implementation of smoke free policies substantially decrease STS exposure (Oberg *et al.,* 2011 and Pierce and Leon, 2008). Some special techniques, such as: unannounced inspections, surprise checks and raids by the empowered government agency can be very effective deterrents for erring public places. To this end, people must be made aware about their rights to demand clean, tobacco-free air in public places as well as in workplaces.

The implications are significant for public health. It is essential to inform healthcare providers, patients, and the general public about the adverse health effects of exposure to STS. The findings have implications for the ministry of environment in promoting legislative ban on the use of tobacco in various settings. The findings also have implications for ministries of health and environment in sensitizing adults about disorders and health challenges arising from STS exposure. The burden of disease increases considerably among non-smokers exposed to STS. Exposure to STS has previously been reported to cause increased mortality due to cardiovascular diseases, lung cancer, chronic obstructive pulmonary disease, respiratory symptoms of infectious and non-infectious nature and stroke.

Strengths and Limitations

Strengths of this study include using both male and female adults as participants. Our findings can be used to initiate an intervention programme for high risk groups of exposure to STS and consequently used for follow-up evaluations on the efficacy and effectiveness of the programme. However, there are some limitations in the study. First, self-directed data on STS and active tobacco smoking exposure could suffer recall bias and deliberate misreporting. This bias or misreporting could influence the prevalence, patterns and associated factors, that is, predictors of STS exposure. A participant's ability to recall STS exposure episodes, including frequency and duration may also be questionable. Recall accuracy was improved by reducing the time frame between the discrete event and the length of the recall period. For instance, this study employed recall in the exposure between 24 hours and 30 days. Second, the use of questionnaire alone to collect data may lack precision to quantify low levels of STS exposure, and are subject to recall and reporting bias, which may result to some degree of misclassification. False reporting or over/under reporting are potential limitations of using questionnaires and will vary depending on the

cultural context of smoking tobacco and STS exposure. We did not assess biomarkers of tobacco smoke exposure, such as cotinine levels in study participants who reported exposure to STS. Although many variables were analysed, exclusion of some other variables might limit the findings. Finally, the study was cross sectional in nature, limiting our ability to infer causality (cause-effect relationships), meaning we reported only associations throughout.

CONCLUSION

Our findings revealed that adults in lower age groups with no formal education and males were less exposed to STS in all the settings. Education level and health specific knowledge on STS, and tobacco smoking were significantly associated with STS exposure in all the three settings. It is crucial to immediately reduce STS exposure and tobacco consumption. STS control should not be overlooked in public health policy. Protection from STS at home is particularly important, given its impact on the attitude towards and knowledge of STS exposure at all places. Public interventions aimed at limiting STS exposure among adults should consider both the home and the out of home environment. Existing measures should be directed to interventions that may reduce STS exposure among adults. There is the need for modifying the policies related to tobacco use and ensure smoking bans in the homes, workplaces and public places as well as increasing tobacco use cessation. Awareness campaigns through effective public education, media advocacy and communication are the key to implement smoke-free policies. There is the need to implement comprehensive smoke-free legislation nationally across Nigeria to prevent the numerous effects of STS among individuals. This can be done by restriction of retail sales of tobacco products and promotion of their activities. Increased awareness of the considerable health risks posed by STS at home, workplace and public places and concerns for public safety have led to an active movement to impose a total ban on smoking at public places, workplaces and home, which can be achieved by collaboration between government and communities. The ministry of health in collaboration with the ministry of environment should make public sensitization on prevention and control of tobacco consumption and secondhand tobacco smoke an effective component of periodic health programmes across every State in Nigeria to help build up knowledge level of adults on their inherent dangers and adverse health effects. Future studies should consider within regions in Nigeria variation, and investigate the unidentified predictors, perhaps through qualitative enquiry.

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