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KNOWLEDGE OF ADVERSE HEALTH OUTCOMES OF MATERNAL EXPOSURE TO PASSIVE AND ACTIVE SMOKING IN NIGERIA

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ABSTRACT

Studies have shown that maternal passive and active smoking is associated with an increased risk of obstetric complications (OC) and adverse perinatal outcomes (APO). This study assessed knowledge of impact of maternal passive and active smoking on obstetric complications, impaired fecundity (IF) and adverse perinatal outcomes. A cross-sectional study was conducted between February and November 2020 at the public health facilities providing antenatal and postpartum care. Data on passive smoking, knowledge of its adverse impacts, and active tobacco smoking were collected in the process using a 28-item structured questionnaire. The final sample was 1,463 participants, of which 80.2% reported passive smoking. The women aged 30-39 years (OR = 1.390, CI [1.067-1.810], $p < .05$) and those reporting passive smoking (OR = 21.393, CI [11.374-40.237], $p < .001$) had higher likelihood of being knowledgeable about the impact of passive smoking on OC and IF. Non-smoking women had higher likelihood of being knowledgeable about the impact of passive smoking on IF (OR = 32.039, CI [19.934-51.493], $p < .001$); and APO (OR = 1.784, CI [1.335-2.384], $p < .001$) than smoking mothers. More women reported passive smoking, and had higher likelihood of being knowledgeable about the impact of passive smoking on OC, IF and APO than smoking mothers. Still sensitization of childbearing mothers about adverse effects of passive and active smoking should consider complications, impaired fecundity and delivery abnormalities as additional reasons to avoid STS, and thus prompt them to adopt prevention strategies.

KEY WORDS : Knowledge, Passive smoking, Active smoking, Impaired fecundity, Impact, Obstetric complications, Adverse perinatal outcomes, Childbearing mothers

INTRODUCTION

Tobacco smoking has remained a major public health challenge despite numerous strategies devised by international communities to control it. The number of non-smokers exposed to passive smoking otherwise called secondhand tobacco smoke (STS), involuntary smoke or environmental tobacco smoke has been steadily increasing (World Health Organization [WHO], 2016). It is well known that STS exposure brings about almost the same adverse health outcomes as active smoking (Chen *et* *al.,* 2013). The impact of smoking is not limited on the smokers, but it can spread to affect the non-smokers as well. Bearinger and Linda (2007) disclosed that disease risks due to inhalation of tobacco smoke are not limited to smokers, but extend to non-smokers who inhale STS at home, at workplace or in public places. Inhalation of STS can be more dangerous than active smoking. Apart from the annoying discomfort of coughs, headache, nasal discomfort, irritation of the eyes and breathlessness; it can give rise to many diseases as direct smoking (Iwuagwu and Ekenedo, 2015).

Exposure of non-smoking childbearing mothers to STS is a public health challenge to maternal-foetal health (ACOG Committee on Health Care for Underdeserved Women, 2005). Studies have shown that about 40% of children, 35% of women, and 33% of men are exposed to STS in their daily lives (Myers *et al.,* 2020 and Oberg *et al.,* 2011). Around 40 per cent of children are exposed to tobacco smoke, increasing their risk of poor health (Myers *et al.,* 2020). Harmful exposure to these environmental risks could begin in the mother's womb and affect foetal development. Therefore, more attention should be paid to pregnant women who are susceptible to STS exposure. Negative effects of maternal smoking are well documented, yet globally, 53% of women who smoke daily continue to smoke daily during pregnancy (Kumar and Gould, 2019).

Secondhand tobacco smoke (STS) contains a number of known or suspected reproductive toxins, and human exposure to it is prevalent worldwide (Meeker and Benedict, 2013). Tobacco smoke contains over 7000 chemicals including nicotine, polycyclic aromatic hydrocarbons (PAHs), aromatic amines, and carbon monoxide (CO) (Lee *et al*., 2019). In addition to CO, STS contains other chemicals that are known or suspected reproductive toxicants— for example, benzene, cadmium, ethylbenzene, formaldehyde, hydrazine, lead, limonene, methylamine, methylene chloride, nicotine, pyridine, toluene, and radioactive polonium-210 (Lindbohm *et al.,* 2002). Maternal passive smoking has also been associated with increased concentrations of nicotine and cotinine (the primary metabolite of nicotine) in the amniotic fluid and in the serum or urine of the mother and newborn (Kharrazi *et al.,* 2004). This is because nicotine diffuses into foetal blood, amniotic fluid, and breast milk and negatively affects neurological development. Therefore, the foetuses and infants of mothers who smoke are at high risk of ill health because of exposure to nicotine (National Institute on Drug Abuse, 2018). In addition, these two chemicals have been found to be extremely hazardous to the foetus, and may inhibit foetal growth because they cross the placental barrier (Wadi and Al-Sharbatti, 2011).

Robust evidence exists for the adverse outcomes of active and passive smoking on fertility, birth defects and pregnancy, but studies of secondhand tobacco smoke exposure are much more limited in number (Meeker and Benedict, 2013). Exposure to smoke or tobacco in other forms during pregnancy is associated with an increased risk of obstetric complications and adverse health outcomes for children in-utero (Gould *et al.,* 2020). Obstetric complications associated with maternal use of opiods include: a higher incidence of spontaneous abortion, premature delivery, preterm labour, placental abruption, chorioamnionitis, impaired foetal growth and foetal distress (Wallen and Gleason, 2018). Exposure to STS increases the risk of acute lower respiratory infection in children (Suryadhi *et al.,* 2019) and impaired fecundity; which is the physical difficulty in either getting pregnant or carrying a pregnancy to live birth (Chandra *et al.,* 2013). Maternal smoking is a well-known risk factor for spontaneous abortion, ectopic pregnancy, premature of rupture of membranes, small for gestational age (Leonardi-Bee *et al.,* 2011 and WHO, 2014), low birth weight (Abu-Baker *et al.,* 2010), intrauterine growth retardation (Hawsawi *et al.,* 2016), restricted foetal growth, asthma or wheeze, lower respiratory tract illness (Zairina, 2016), and preterm birth (Miyake *et al.,* 2013) that, in turn might affect children's development. Meeker *et al.* (2007) disclosed that female exposure to STS as a child or in utero may be associated with an increased risk of spontaneous abortion in adulthood. Exposure to STS during pregnancy may also cause higher rates of attention deficit hyperactivity disorder, asthma, and childhood cancers (Crane *et al.,* 2011), and early pregnancy discomfort symptoms, such as: thirst, heartburn, lower abdominal pain, frequent urination and depression (Hung *et al.,* 2017).

Studies have shown that active and passive smoking is associated with female subfertility. Studies of impaired fecundity in relation to STS exposure are quite limited (Norwitz *et al.,* 2001 and Peppone *et al.,* 2009). Only 50 to 60% of all conceptions advance beyond 20 weeks of gestation (Norwitz *et al.,* 2001), and up to 75% of the lost pregnancies are a result of blastocyst implantation failure and are never clinically recognized as pregnancies. Thus, these early losses may manifest clinically as female infertility. A retrospective study of fertile women found that the risk of experiencing delayed conception for at least six months was significantly elevated among women that reported STS exposure, and the risk estimate was similar in magnitude to that for women who actively smoked (Hull *et al.,* 2000). In a more recent study, women self-reporting STS exposure had greater difficulty becoming pregnant and experienced increased foetal loss compared to those reporting no exposure (Peppone *et al.*, 2009).

Results from the studies investigating associations between STS exposure and birth defects appear to have been inconsistent. Both active and passive smoking have been found to alter expression of key mediators of placental development which may describe a potential mechanism for the decreased birth weights and increased risk of low birth weight (<2500 grams), cause preterm birth, still birth, foetal growth retardation and congenital anomalies, such as cleft lip and palate, and the risk for sudden infant death syndrome (SIDS) (Benkaddour *et al.,* 2016; Hawsawi *et al.,* 2016; Khader *et al.*, 2011; Merritt *et al.,* 2012; National Institute on Drug Abuse, 2018 and WHO, 2014), delayed immune development (Vila Candel *et al.,* 2015), and reduction in all phases of an infant's sleep cycle (Mennella *et al.,* 2007).

There is a substantial body of evidence supporting the association between maternal active smoking during pregnancy and complications of pregnancy, but the association and knowledge level of pregnant and postpartum women on adverse health outcomes of passive smoking and OC, IF and APO have not been well documented in Nigeria, particularly South East geopolitical region. 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; WHO, 2010). Many childbearing mothers seemed not to have good knowledge of adverse health outcomes of STS exposure and tobacco consumption. Very little is known about the impact of STS exposure on obstetric complications, as well as impaired fecundity and adverse perinatal outcomes. Studies on maternal knowledge of passive and active smoking in relation with obstetric complications, impaired fecundity and adverse perinatal outcomes across Nigeria are scarce, which makes this study to become necessary. This study finding would help health policy makers and programme planners, researchers, environmental health professionals, health care providers, childbearing mothers, among others to reinforce the continued need for education on prevention of exposure to STS. The outcome would also enable the society and childbearing mothers and their families to be better informed on the underlying obstetric complications, impaired fecundity and adverse perinatal outcomes associated with knowledge of impact of active and passive smoking by childbearing mothers and the best ways to mitigate and possibly prevent them.

MATERIALS AND METHODS

Study design, setting and population

A cross-sectional study was conducted between February and November, 2020 at the public health facilities 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.

The study population comprised childbearing mothers (CBMs); both pregnant and postpartum women aged 20-49 years in the study area. Only childbearing mothers who are in good health and had no multiple deliveries were included in the study population. Younger than 20 and older than 49 years old were excluded to eliminate age-related complications of pregnancy. Also, women who had a multiple pregnancy and those with chronic health conditions 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 34.4 per cent of the population indicated having being exposed and had knowledge of Environmental Tobacco Smoke (ETS) adverse health outcomes (Ezeah, 2016), we calculated a sample size of 1,500 that would be required to give a 95% probability measuring the knowledge of STS adverse health outcomes with 50% accuracy, a none response rate of 5%.

Purposive and convenience sampling methods were adopted in selecting 1,500 participants for this study. Purposive in the sense that only childbearing mothers (20-49 years) were used and convenience in the sense that women in different public health facilities, who had time and expressed their consent in responding to our questionnaires, were used.

Data collection tools

A self reported interviewer-administered structured questionnaire was used for data collection. The structured interview form consists of two parts: Part I consisted of three socio-demographic variables (age, place of residence and education level). Part II consisted of 25 questions with dichotomous response options covering information on active and passive smoking, and knowledge of impact of passive and active smoking on obstetric complications, impaired fecundity and adverse perinatal outcomes.

Questions on maternal active and passive smoking were based on previous studies (Fazel *et al.,* 2020). The questions included: (i) Are you currently smoking? (ii) During the past 30 days, did anyone smoke where you were or besides you? Passive smoking (STS) was defined as occurring when a woman was living with someone who smokes at home or working together with someone who smokes at worlplace (Grarup *et al.,* 2014 and Ward *et al.,* 2007). An "active smoker" was defined as a childbearing mother that smoked recently. A "passive smoker" was defined as a childbearing mother that was closely exposed to tobacco smoke by people, such as her husband, family members and co-workers. A "non-smoker" was defined as a childbearing mother who stated that she did not smoke during pregnancy or postpartum.

Questions assessing maternal knowledge of STS and active smoking in relation with OS, IF and APO 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 smoking or being exposed to tobacco smoke cause or increase the chances of any of the following in non-smoking childbearing mothers: Obstetric Complications (vaginal, bleeding, urinary tract infection, vomiting/emesis, upper and lower respiratory infections, problems with the placenta (covering the cervix: placenta previa and separating too early from the uterus; placental abruption), premature rupture of membranes (PROM), developing high blood pressure and swelling (pre-eclampsia), gestational diabetes mellitus (GDM)/ectopic pregnancy, spontaneous abortion (pregnancy loss), early pregnancy discomfort symptoms (thirst, heartburn, lower abdominal pain, frequent urination, persistent cough, depression)?; Impaired Fecundity (delayed conception, altered menstrual cycling and advancing the time of menopause by 1-4 years, failed implantation/reduced In-Vitro-Fertilization [IVF] success/accelerating loss of reproductive function)?; Adverse Perinatal Outcomes (being born too early [premature delivery]), being born underweight, dying from (sudden infant death syndrome [SIDS], long term damage to the lungs, brain and blood resulting in asthma or pneumonia, foetal growth restriction, having birth defects, such as: smaller head circumference, cleft lip or cleft palate, having neurodevelopmental problem, having middle ear infections or permanent hearing impairment, being vulnerable to type 2 diabetes, obesity, heart and kidney diseases, stillbirth)? Knowledge on OC and APO have 10 questions in which answering no question implies no knowledge; answering 1-5 questions correctly implies some knowledge, and answering 6-10 questions correctly implies good knowledge. Knowledge on IF has 3 questions in which answering no question implies no knowledge; answering 1-2 questions correctly implies some knowledge, and answering 3 questions correctly implies good knowledge.

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 split half (Spearman's Brown Coefficient) with an index of .731.

Data collection procedure

The ethical approval was obtained prior to commencing research. The Ethics Committee of the Faculty of Education, University of Nigeria, Nsukka approved the study. After obtaining the health facilities' permission for data collection, women who gave consent for participation were interviewed by the researchers as soon as possible before leaving the selected public health facilities. The researchers explained the objectives of research for the participants and they were reassured that their smoking status is confidential and no personal identifiers will be disclosed. After their consent was gotten, childbearing mothers were contacted in various public health facilities where they seek antenatal and postpartum care across States in South East Nigeria for data collection. The questionnaire was administered with the aid of well-trained interviewers. A total number of 1,500 questionnaires were filled out in the process. Out of 1,500 questionnaires administered to CBMs who gave their informed consent, 1,486 were returned, which gave a return rate of 99.1 per cent. Out of the returned questionnaires, 23 copies were not duly filled out, thus discarded. Only 1,463 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 knowledge of women and their exposure to STS. Bivariate analyses using cross tabulations were also performed to obtain the proportion of women exposed and not exposed to STS for various categories of the selected variables and to identify significant associated variables using Fisher's Exact Probability test. We utilized three binary Logistic regression models separately for each of the key variables of interest (Model A: STS exposure in relation to obstetric complications; Model B: STS exposure in relation to impaired fecundity; Model C: STS exposure in relation to adverse perinatal outcomes). In Logistic regressions, STS Impact on Obstetric Complications Knowledge, STS Impact on Impaired Fecundity Knowledge and STS Impact on Adverse Perinatal Outcomes Knowledge were used as response variables. Socio-demographic and economic variables as well as STS exposure (Exposed to Secondhand Tobacco Smoke [E-STS] & Not Exposed to Secondhand Tobacco Smoke [NE-STS]) and smoking status (smoker & non-smoker) 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 1,463 participants in our research. Among the 1,463 participants that duly filled out the questionnaires, 1,174 (80.2%) reported exposure to STS while 289 (19.8%) did not report STS exposure. Differences in demographic characteristics were found between groups of women with and without STS exposure. Educational status above primary school level was significantly greater for women who reported STS exposure compared to those who did not report STS exposure. Women reporting STS had higher educational status ($p<.001$) and were also more likely to reside in urban setting ($p<.01$) than those not reporting exposure. Also, women reporting STS were likely to be active smokers as there was statistically significant difference found between

Table 1. Participant demographics by whole sample and STS exposure, p-values from Fisher's Exact probability test

Variable	STS ExposureNE-STS (*n* = 289)	E-STS (*n* = 1,174)	p-value
Age (in years)			
20-29	120 (41.5)	406 (34.6)	
30-39	114 (39.4)	437 (37.2)	.004
40-49	55 (19.0)	331 (28.2)	
Residence			
Urban	166 (57.4)	561 (47.8)	.004
Rural	123 (42.6)	613 (52.2)	
Education			
No formal education	33 (11.4)	58 (4.9)	
Primary education	56 (19.4)	256 (21.8)	
Secondary education	112 (38.8)	550 (46.8)	<.001
Tertiary education	88 (30.4)	310 (26.4)	
Active tobacco smoking			
Non-smoker	262 (90.7)	924 (78.7)	<.001
Smoker	27 (9.3)	250 (21.3)	

Key: NE-STS = Not Exposed to Secondhand Tobacco Smoke; E-STS = Exposed to Secondhand Tobacco Smoke those exposed to STS and those not exposed, together with their age category (Table 1).

Table 2 shows that overall, 54.3%, 62.2% and 49.0% of women in the study had some knowledge about the negative effects of STS exposure and obstetric complications, impaired fecundity and adverse perinatal outcomes respectively. The findings were not in line with the finding of Jallow *et al.* (2018) who found that about 35% of young females were unaware of the harmful effects of exposure to secondhand smoke.

Table 2. Knowledge of women, overall by STS exposure in relation with obstetric complications, infertility and adverse birth outcomes

Variable n(%)	Overall 1,463
STS Impact on Obstetric Complications Knowledge	
No knowledge (0)	159 (10.9)
Some knowledge (1-5)	794 (54.3)
Good knowledge (6-10)	510 (34.9)
STS Impact on Infertility Knowledge	
No knowledge (0)	407 (27.8)
Some knowledge (1-2)	910 (62.2)
Good knowledge (3)	146 (10.0)
STS Impact on Adverse Birth Outcomes Knowledge	
No knowledge (0)	180 (12.3)
Some knowledge (1-3)	717 (49.0)
Good knowledge (4-7)	566 (38.7)

Table 3 shows that the women aged 30-39 years had 1.39 times (39%) higher likelihood of being knowledgeable about the adverse relationship between STS exposure and obstetric complications (OR = 1.390, CI [1.067-1.810], $p < .05$) than those aged 20-29 years. Women living in rural area had 22.1% lesser likelihood of being knowledgeable about the adverse relationship between STS exposure and obstetric complications (OR = .779, CI [.619-981], $p < .05$) than those living in urban area. The women exposed to STS had 21 times (39%) higher likelihood of being knowledgeable about the adverse relationship between STS exposure and impaired fecundity (OR = 21.393, CI [11.374-40.237], $p = < .001$) than those not exposed to STS. Non-smoking women had 32 times higher likelihood of being knowledgeable about the adverse relationship between STS exposure and impaired fecundity (OR = 32.039, CI [19.934-51.493], $p = < .001$); and 1.78

Table 3. Logistic regression of covariates adjusted for knowledge of STS exposure in relation to obstetric complications, infertility and adverse birth outcomes

Variables	STS exposure in different settings		
	Model A OR (95% CI)	Model B OR (95% CI)	Model C OR (95% CI)
Age (in years)			
20-29	-	-	-
30-39	1.390 (1.067-1.810)*	.780 (.572-1.064)	1.036 (.782-1.373)
40-49	1.032 (.762-1.397)	1.085 (.779-1.510)	1.015 (.741-1.389)
Residence			
Urban	-	-	-
Rural	.779 (.619-981)*	.807 (.620-1.050)	.866 (.679-1.105)
Education			
No Formal Education	-	-	-
Primary Education	.942 (.563-1.577)	1.435 (.731-2.815)	.894 (.515-1.549)
Secondary Education	.817 (.502-1.329)	1.444 (.758-2.750)	.919 (.548-1.540)
Tertiary Education	1.207 (.735-1.983)	1.430 (.736-2.779)	1.130 (.666-1.918)
Exposure to STS			
NE-STS	-	-	-
E-STS	.980 (.734-1.309)	-21.393 (11.374-40.237)***	898 (.661-1.220)
Tobacco Smoking			
Smoker			
Non-Smoker	1.048 (.782-1.404)	-32.039 (19.934-51.493)***	-1.784 (1.335-2.384)***

*p < 0.05; **p < 0.01; ***p < 0.001 NE-STS = Not Exposed to STS; E-STS = Exposed to STS
Model A: STS exposure in relation to obstetric complications; Model B : STS exposure in relation to infertility; Model C: ETS exposure in relation to adverse perinatal outcomes
Ref Groups: Age = 15 – 24 years; Residence = Urban; Education = No Formal Education; Exposure to STS = NE-STS ; Active Tobacco Smoking = Non-Smoker

times (78.4%) higher likelihood of being knowledgeable about the adverse relationship between STS exposure and adverse perinatal outcomes (OR = 1.784, CI [1.335-2.384], p = < .001) than smoking mothers.

DISCUSSION

Research in recent years has shown that exposure to STS is a significant risk factor for a plethora of diseases and adverse health-related outcomes at a global scale. However, this study was undertaken to investigate maternal knowledge of active and passive smoking in relation with obstetric complications, impaired fecundity and adverse perinatal outcomes. Table 1 shows that 1,463 childbearing mothers participated in our research. About 1,174 (80.2%) reported exposure to STS while 289 (19.8%) did not report STS exposure. Differences in demographic characteristics were found between groups of women with and without STS exposure. Educational status above primary school level was significantly greater for women who reported STS exposure compared to those who did not report STS exposure. Women reporting STS had higher educational status and were also more likely to reside in urban setting than those not reporting exposure. Also, women reporting STS were likely to be active smokers as there was statistically significant difference found between those exposed to ETS and those not exposed, together with their age category (Table 1). The finding on education level was consistent with the finding of Flora and Chassin (2005) who found that adults who have acquired tertiary education will know more about the dangers of STS than those who have acquired secondary education. Experience show that adults with tertiary education are more exposed in terms of academic exposure and should possess more knowledge of the effects of STS exposure and smoking. Moreover, the finding on education was not in line with the findings of Fazel *et al.* (2020) who found that women reporting STS had lower educational status ($p < .001$) and were also more likely to be active smokers ($p < .001$). Table 2 shows that overall, 54.3%, 62.2% and 49.0% of women in the study had some knowledge about the negative effects of STS exposure and obstetric complications, impaired fecundity and adverse perinatal outcomes respectively. The findings were not in line with the finding of Jallow *et al.* (2018) who found that about 35% of young females were unaware of the harmful effects of exposure to secondhand smoke. Based on self-reported maternal exposure to STS and engaging in active smoking, previous studies have shown a negative impact of such exposure on complications of pregnancy and child birth and impaired fecundity. The finding on obstetric complications was consistent with the finding that exposure to smoke or tobacco use in other forms during pregnancy is associated with an increased risk of obstetric complications and adverse health outcomes for children exposed in-utero (Gould *et al.*, 2020). The study finding also agree with a study in Indonesia which reveal that exposure to STS increased the risk of acute lower respiratory infection (Suryadhi *et al.*, 2019).

The finding on adverse perinatal outcomes was not in line with the findings from a recent cross-sectional study of 33 Malaysian women who also found no association between preterm birth and STS exposure which was estimated *via* cotinine in maternal saliva (Arffin *et al.*, 2012). The chemicals in cigarette damage eggs and sperm, and can affect a baby's health. Even if a woman does not smoke, just being around a spouse, friend or co-worker who does could significantly lower her chances of being able to get pregnant. Smoking or being exposed to smoking lowers a woman's fertility by about 20% and even potentially. If she spends time breathing the smoke of others, it may take her much longer than she expected to get pregnant. Smoking appears to accelerate the loss of reproductive function and may advance the time of menopause by 1-4 years. Also, there is good evidence that smoking in the female is associated with impaired fecundity and increased risks of spontaneous abortion and ectopic pregnancy (Khurana, 2018).

Numerous studies have repeatedly shown that those women who smoke experience problems establishing and maintaining pregnancies (Talbot and Lin, 2011). There is evidence that there is impaired fecundity if a woman is exposed to passive smoking at home or the workplace. It affects not only the ovaries, but also the endometrial lining in women thereby bringing down the fertility potential. Previous studies have shown that chemicals in tobacco smoke can damage a man's sperm and can actually lodge in a woman's ovaries and interfere with her reproductive functions (Christopher and Ford, 2000). The finding on impaired fecundity was consistent with the finding that delayed conception was statistically significantly associated with both active smoking by the women and their exposure to passive smoking compared with women not exposed to tobacco smoke (Hull *et al.,* 2000). A retrospective study of fertile women revealed that the risk of experiencing delayed conception or impaired fecundity for at least six months was significantly elevated among women that reported STS exposure, and the risk estimate was similar in magnitude to that for women who actively smoked (Meeker and Benedict, 2013). Smoking during pregnancy can cause tissue change in the unborn baby, particularly in the lung and brain. It is worth noting that cigarette smoke contains toxic reactive oxygen species, which can damage the delicate egg; when the egg is damaged, and can increase the risk of miscarriage. Carbon monoxide in tobacco smoke can keep the developing foetus from getting enough oxygen. Tobacco smoke toxin cross the placenta and restrict placental blood flow; thereby reducing available oxygen and impairing foetal growth. STS exposure affects the development of a baby girl's ovaries and increases the risk of miscarriage and having ectopic pregnancy. Passive smoking has detrimental effects on women's ability to conceive. Smoking affects the DNA (genetic materials) in eggs and sperm; men's and women's hormone production, the fertilized eggs' ability to reach the uterus and the environment inside the uterus, where the foetus develops. Men and women who smoke are more likely to have fertility problems and take longer to conceive than non-smokers. Women who smoke have some difficulty becoming pregnant and have a higher risk of never becoming pregnant or experiencing impaired fecundity. Women living in rural area had lesser likelihood of being knowledgeable about the adverse relationship between STS exposure and obstetric complications than those living in urban area. This finding is consistent with the finding of Pederson *et al.* (2007) who found that young adults (youths) who live in the urban area tend to have more knowledge of the effects of STS than the rural dwellers. Non-smoking women had higher likelihood of being knowledgeable about the impact of passive smoking on impaired fecundity and adverse perinatal outcomes than smoking mothers. The finding on adverse perinatal outcomes is consistent with the finding of Crane *et al.* (2011) who found an association between exposure of non-smoking pregnant women to environmental tobacco smoke with several adverse perinatal outcomes, including reduced birth weight, smaller head conference, still birth, and shorter birth length. The findings were also in line with the finding of Bhatti *et al.* (2010) who found that tobacco use was reported by 20.2% of all respondents and 11% reported daily use of tobacco product, and those who have never used tobacco are significantly more likely to have knowledge about tobacco-related issues. The conception rates in women non-smokers and former smokers appear to be similar, while pregnancy rates are lower in women smokers than non-smokers, and higher infertility risk in women smokers was reported by de Mouzon and Belaisch-Allart (2005). There is good evidence that non-smokers with excessive exposure to tobacco smoke may have reproductive consequence as great as those observed in smokers (Khurana, 2018). The need to improve maternal smoking and child STS-reduction interventions in vulnerable populations remains a significant public health priority (Mbulo *et al.,* 2016 and Stiby *et al.,* 2013). Interventions targeting these populations require more-intensive behaviour change strategies. 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, and improvement in the level of knowledge possessed by adults on the effects of STS. The findings have implications for ministries of health and environment in sensitizing programmes on adults about disorders and health challenges arising from STS exposure.

Strengths, limitations and future directions

Strengths of this study include using both pregnant and postpartum women as participants. Also, the study has strengths in the pooled analysis of the included studies that showed the relationship between passive and active smoking and the risk of adverse perinatal outcomes, obstetric complications and impaired fecundity. Self-directed data on exposure to STS and active smoking could suffer recall bias and deliberate misreporting. 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. Again, 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. The self-reported questionnaires that were most commonly used in antenatal and postpartum clinics are often less accurate in identifying smokers among pregnant women. With the majority of pregnant women not revealing their smoking status, the numbers of those who smoked during pregnancy could be underrated. Since the data sets were cross-sectional, cause-effect relationships could not be interfered, which would require clinical trials and longitudinal studies.. However, passive smoking (STS exposure) among the women in the study was measured only by self-report. In addition, the statistical analyses were somewhat limited in that they did not account for potential confounding variables in multivariate analyses. However, a majority of the studies used self-reported STS exposure categories and are susceptible to exposure misclassification and/or bias, underscoring the need for further study using biomarkers of exposure.

CONCLUSION

Our study showed that more women reported exposure to secondhand tobacco smoke/passive smoking, and provided empirical evidence of some knowledge on its impact on obstetric complications, impaired fecundity and adverse perinatal outcomes. Since the exposure to STS is moderately high, public health education programme targeting this population should enhance their self-awareness and consequently increase their knowledge to the complications, discomforts, infertility and adverse perinatal outcomes related to STS exposure and prompt them to adopt prevention strategies. Also, the government in collaboration with ministries of environment and health should increase public awareness and knowledge about the adverse effects of active tobacco use and STS exposure, with emphasis on protection of women and their children in order to carry thorough and comprehensive smoke-free laws in rural and urban areas, while also increase tobacco taxation. Sensitization programmes bordering on obstetric complications, adverse perinatal outcomes and impaired fecundity should be organized for CBMs, which should also include smoking cessation strategies targeted towards smokers inhabiting in the homes of smoking and non-smoking CBMs. Also, there is the need to plan population health policies aimed at implementing educational programmes to minimize tobacco smoke exposure during pregnancy and lactation. The disparities in active and passive tobacco smoking among CBMs underscore the importance of factors that should be considered in interventions and surveillance in order to advance progress towards the goal of reducing tobacco's harm. A needs assessment and environmental analysis could be conducted to gather data on common places of STS exposure for pregnant women. A well-established public health campaign could be effective in increasing the knowledge level to reduce tobacco exposure in homes, workplace and public areas. Less costly public campaigns, such as: smoking cessation posters or pictures about the harmful effects of passive and active tobacco exposure during pregnancy and postpartum should be placed in the public areas, such as: antenatal clinics. Stakeholders of health should provide education, monitoring and support that will facilitate smoking cessation. Future research should also aim to determine the relative contributions of paternal and maternal factors to reduced fecundity and adverse pregnancy outcomes in relation to smoking and STS exposure, and strive to identify specific STS constituents associated with both male and female infertility and other complications of pregnancy and birth defects. In addition, a number of other environmental agents have been implicated in reduced fecundity and/or adverse pregnancy outcomes (e.g. pesticides), and studies to date have not considered potential confounding or modification (e.g. environment-environment interactions) of effect estimates by hazardous co-exposures or other environmental factors.

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