

Review Article

Tobacco use in Pregnancy- Global evidence and Relevance to LMIC

Pratima Murthy* and Shree Mishra

Department of Psychiatry, National Institute of Mental Health and Neuro Sciences (NIMHANS), India

*Corresponding author

Pratima Murthy, Department of Psychiatry, National Institute of Mental Health and Neuro Sciences, Bangalore 560029, India, Tel: 919844094482; Email: pratimamurthy@gmail.com

Submitted: 02 November 2017

Accepted: 15 November 2017

Published: 18 November 2017

ISSN: 2373-9363

Copyright

© 2017 Murthy et al.

OPEN ACCESS

Keywords

- Smoking
- Pregnant women
- Tobacco
- E-cigarettes

Abstract

While smoking prevalence is showing a decline in high income countries (HIC), smoking among pregnant women has also reduced and current prevalence in certain HIC is between 8.4 to 11.4%. In low and middle-income countries (LMIC), exposure to second-hand smoke (SHS) and the use of smokeless tobacco (SLT) are significant problems. While pooled prevalence of smokeless tobacco use across 54 LMIC's was 2.6%, several countries particularly in the south Asian and West Pacific region show tobacco use prevalence higher than the pooled prevalence and rates of SLT use among pregnant women in Nepal, Bangladesh and India are 22%, 20% and 15% respectively. In many countries, pregnant women face high rates of exposure to SHS. Maternal smoking is associated with several adverse consequences for both mother and child. While a range of adverse fetal outcomes have been described, the strongest causal effects are for ectopic pregnancy and orofacial clefts. With SLT use, pre-term and small for gestation have been consistently demonstrated. Meta-analytical studies support the effectiveness of psychosocial interventions for smoking cessation. The same cannot be said of smokeless tobacco use among pregnant women in LMIC. Poverty, illiteracy, use of tobacco in the partner, poor motivation to quit, stigma are some of the common barriers to treatment in all settings, and decision not to breast-feed has been shown to be associated with a greater likelihood of relapse. There is no supporting evidence for pharmacotherapy for tobacco cessation in pregnancy and there is a growing concern of the use of E-cigarettes by pregnant women under the perceived notion that they are safer. Approaches to cessation, in addition to providing individual support, must also focus on evidence-based population strategies to reduce tobacco consumption. Asking for tobacco use and tobacco exposure, objective documentation and support to quit and to reduce SHS exposure must be offered in all maternity settings.

ABBREVIATIONS

LMIC: Low and Middle Income Countries; HIC: High Income Countries; SHS: Second Hand Smoking; SLT: Smokeless Tobacco; NRT- Nicotine Replacement Therapy

INTRODUCTION

Tobacco use in any form has been a growing concern worldwide. It is the 'only legal drug that kills many of its users, when used as it is intended'. The tobacco epidemic is one of the biggest public health threats the world has ever faced, killing more than 7 million people each year [1]. Nearly 80% of the world's more than 1 billion smokers live in low and middle-income countries. These countries, in addition to smoking, have a large burden of smokeless tobacco use, with nearly 90% of global smokeless tobacco users living in the South-East Asia region [2]. Second-hand smoking is attributable to 1% of deaths world-wide with 47% of these deaths occur in women and 28% in children [3].

Smoking in developed countries like the United States has shown an overall decline from 20.9% in 2005, to 15.1% in 2015 [4]. While smoking prevalence in younger age group females in the United States has been stabilizing, 17% of high school females report tobacco use [5]. However, smoking prevalence is of significant concern in developing countries like India [6]. While more men than women across the world are likely to be smokers, the prevalence of smoking among younger girls is high compared to adult females [7]. Smokeless tobacco use among women is most commonly reported from South-East Asia, with a relatively high prevalence in Bangladesh (27.9%) and India (18.2%) [8].

EPIDEMIOLOGY OF TOBACCO USE IN PREGNANCY

Tobacco in any form, either active or passively delivered brings has been associated with many adverse pregnancy-related outcomes. This selective review examines the prevalence of tobacco use (smoking and smokeless forms) during pregnancy, the risks from exposure to smoking (both through active smoking

and exposure to second-hand smoke) and smokeless tobacco use during pregnancy.

Although many of the high income countries have shown remarkable reductions in the prevalence of smoking among pregnant women, this continues to be a source of concern, with a prevalence of 8.4% in the United States [9], 11.4 % in the UK [10], and 11% in Australia [11]. From the Demographic and Health Surveys (DHS), done in 54 LMICs between 2001 and 2012, comprising 58922 pregnant women (aged 15-49), the pooled prevalence of any tobacco use in pregnant women in LMICs was calculated at 2.6%(95% CI 1.8-3.6). The South-East Asian region had the highest pooled prevalence at 5.1% (1.3-10.9) [12]. Countries which had prevalence higher than the pooled prevalence included Cambodia and Philippines in the West Pacific (6.7% and 2.5% respectively; four in South-East Asia [Nepal (8.4%), India (8.0%), Timor-Leste (3.7%), Maldives (3.4%)]. The 2008-10 Global Adult Tobacco Survey of 14 LMICs showed that in women of reproductive age, prevalence of current tobacco smoking ranged from 0.4% in Egypt to 30.8% in Russia [12].

SMOKELESS TOBACCO USE DURING PREGNANCY

While the pooled prevalence of current smokeless tobacco use was less than 1% in most countries, it is common in Bangladesh (20%), India (15%) [12,13], and in Nepal (22%) [14]. Studies in India have consistently found a high prevalence of smokeless tobacco use among pregnant women, with as many as 64% from an urban slum reporting SLT use [15].

SECOND-HAND SMOKING EXPOSURE

A study from Argentina interviewed women attending one of 21 clusters of publicly-funded prenatal care clinics regarding SHS exposure during pregnancy at the time of their hospitalization for delivery during 2011-2012. More than a third (35.9 %) of women were exposed to SHS at home or work [16]. Another study from Greece reported that while the prevalence of active smoking during pregnancy was 36%, 94% of the women studied were exposed to SHS, with 72% of the women exposed at home and 64% of them in a public place [17]. A review from China indicates that 38.9% to 75.1% pregnant women were exposed to second-hand smoking [18].

RISKS OF SMOKING AND SMOKELESS TOBACCO IN PREGNANCY

Since the first concern of the risks of tobacco use in pregnancy in 1935 [19], there has been growing evidence of the harms from tobacco use in pregnancy.

One of the effects attributed to tobacco use is its impact on the ability to become pregnant. Studies have indicated reduced fertility and fecundity in female smokers and lesser chances of ability to conceive during IVF. The reduction in fertility has been seen in grown up individuals who were exposed to tobacco smoke in utero reflecting an intricate and complex mechanism affecting conception [20].

Many studies have reported an association of maternal tobacco smoke exposure with a variety of adverse mother and child outcomes. These associations are summarized in Table 1.

ADVERSE MATERNAL OUTCOMES

Studies have demonstrated adverse cardio-vascular outcomes with smoking in women in general [62], and these effects are likely to get aggravated in pregnancy. In addition to hypertension and increased risk of cardiac disease, an increased risk for gestational diabetes has also been described in pregnant smokers [28].

Placental abnormalities

A range of placental abnormalities have been described [63]. Changes in placental blood flow and an altered balance between proliferation and differentiation of the cytotrophoblast has been observed, reflecting changes in gene and protein expression in the cytotrophoblast. Smoking in pregnancy has been linked with thickening of the trophoblastic basement membrane, increased collagen in the villous mesenchyme and decreased vascularization of the placenta. Cadmium in smoke has been found to cause complex enzymatic changes leading to IUGR.

Adverse fetal outcomes

Even in HMIC settings, it is suggested that maternal smoking could contribute to 20% of the still births [29]. In a large meta-analysis of 172 articles pooling 173687 children with congenital abnormalities compared with 11674332 unaffected controls, increased risk of congenital abnormalities was demonstrated for a variety of conditions [39]. A variety of health related adverse outcomes in both infants and older children have been described. These include neurobehavioral outcomes including attention deficit hyperactivity disorder, aggression and depression.

Second hand smoking is also linked with reduced birth weight (30-40gm, OR ranging from 1.2 to 1.25), SIDS, preterm birth as well as childhood cancers [64].

As tobacco smoke contains several carcinogens which cross the placental barrier, it is plausible that there would be an increased risk of cancer in the offspring. Both genotoxic effects and the creation of a tumor-supporting microenvironment by nicotine have been observed in vitro and in animal studies [65]. A meta-analysis examining the risk of leukemias and brain tumors among children exposed to ante-natal smoking found an increased risk for brain tumors but not for leukemias. Another recent review from the Danish national registers [66], did not find a positive association with maternal smoking and childhood cancers.

With increasing rates of obesity and diabetes and survival of preterm infants born at early gestational ages, the need to elucidate mechanisms responsible for programming of adult cardiovascular disease is essential for the treatment of upcoming generations [67].

While the above associations have been reported from many studies, according to the Surgeon-General's report from the USDHHS 2014, [68], a causal evidence between maternal smoking and adverse reproductive outcomes can be definitely established for the following risks- ectopic pregnancy and congenital malformations including orofacial clefts. Other adverse outcomes are surmised as being suggestive. This report also suggests that the evidence is insufficient to infer the presence or absence of

Table 1: Adverse maternal and fetal consequences of maternal smoking.

Risks associated with smoking for mother [17,21-27]
Pregnancy-induced hypertension
Ectopic pregnancy
Abortion
Pre-term delivery less than 37 weeks
Pre-eclampsia
Abruptio placenta
Placenta previa
Post-partum haemorrhage
Gestational diabetes [28]
Adverse fetal outcomes associated with exposure to tobacco smoke in utero
Stillbirth [29,30]
Premature birth [31,32]
Intrauterine growth retardation [26,33]
Small for gestational age (SGA) [26,33-37]
Increased perinatal mortality Sudden infant death syndrome (SIDS) [26,33,37,38]
Congenital Defects [39]
Cardiovascular/heart defects [OR 1.09, 95% confidence interval (CI) 1.02-1.17];
Musculoskeletal defects (OR 1.16, 95% CI 1.05-1.27);
Limb reduction defects (OR 1.26, 95% CI 1.15-1.39);
Missing/extra digits (OR 1.18, 95% CI 0.99-1.41);
Clubfoot (OR 1.28, 95% CI 1.10-1.47);
Craniosynostosis (OR 1.33, 95% CI 1.03-1.73);
Facial defects (OR 1.19, 95% CI 1.06-1.35);
Eye defects (OR 1.25, 95% CI 1.11-1.40);
Orofacial clefts (OR 1.28, 95% CI 1.20-1.36);
Gastrointestinal defects (OR 1.27, 95% CI 1.18-1.36);
Gastroschisis (OR 1.50, 95% CI 1.28-1.76);
Anal atresia (OR 1.20, 95% CI 1.06-1.36);
Hernia (OR 1.40, 95% CI 1.23-1.59); and
Undescended testes (OR 1.13, 95% CI 1.02-1.25).
Obesity in the infant [40]
Childhood Asthma [41,42]
Lung infections [31,43-45]
Dental caries [46]
Otitis media [47]
Chron's disease [48]
Older children (health effects) [49]
Depression and anxiety [50]
ADHD and other neurobehavioral symptoms [51-53]
Academic problems [54]
Adolescent bone health [55]
Early onset type-2 diabetes and non-diabetic obesity [28]
Childhood cancers [56]

a causal relationship between maternal prenatal smoking and the following disorders in the offspring- anxiety, depression, Tourette's syndrome, schizophrenia and intellectual disability.

SMOKELESS TOBACCO USE BY PREGNANT WOMEN- ADVERSE CONSEQUENCES

Smokeless tobacco causes a whole host of adverse consequences, which are outside the scope of this review. These consequences are also relevant to the pregnant woman, in addition to the specific associations mentioned in Table 2. With respect to adverse fetal outcomes, a systematic review of 9 studies with diverse methodology reported significant associations with SLT use in 5/7 studies for LBW, in 3/6 studies for preterm, in all 4 studies for stillbirth and in 1/2 studies assessing SGA [61]. Many

Indian studies have also consistently demonstrated adverse fetal outcomes [60] (Table 2).

ETIOLOGY OF TOBACCO RELATED ADVERSE HEALTH OUTCOMES

Nicotine itself is a neuroteratogen affecting many important milestones in brain development, often causing long term cognitive, behavioral, emotional sequelae and even addictive behavior in the offspring exposed to tobacco during pregnancy. It is also noted to affect development of many organs, especially the lungs [69].

Carbon monoxide in tobacco smoke is clearly fetotoxic and results in fetal hypoxia in chronic exposure and fetal death in acute exposure. There are many carcinogens in tobacco smoke which have been shown to be toxic in animal fetus, needs further research in humans [70].

AMOUNT OF EXPOSURE

Although no level of tobacco use is safe during pregnancy, greater smoking intensity has been shown to be associated with greater deleterious effects on the fetus [71].

OTHER CO-MORBIDITIES

While addressing issues related to tobacco use in pregnancy, it is important to be aware that pregnant mothers may also be exposed to alcohol, cannabis and other drugs which may also contribute to adverse fetal outcomes [72,73].

ADDRESSING TOBACCO USE IN PREGNANCY

Most tobacco intervention programs in pregnancy have focused on smoking tobacco.

All intervention starts with a comprehensive assessment. The 4A's- "ask, advice, assess, assist, and arrange" is recommended by the National Cancer Institute for counselling smokers in clinical practice and also by the Agency for Health Care Policy and Research (AHRP) [74].

Approaches have included behavioral support delivered in a variety of settings and formats, self-help interventions, and measures of effectiveness have included both validated measures like breath CO levels, as well as urinary cotinine measures, in

Table 2: Adverse maternal and fetal consequences of maternal smokeless tobacco use.

Risks associated with smokeless tobacco use for mother
Studies from LMIC [57-60]
Maternal anemia
Underweight mothers
Pregnancy induced hypertension
Ante-partum haemorrhage
Oligohydramnios
Polyhydramnios
Post-partum haemorrhage
Adverse fetal outcomes associated with smokeless tobacco use during pregnancy
Still birth (HRadj)= 2.6 [58]
Fetal distress (RR=1.8 (1.06-3.06)
Low birth weight [57,59]
Pre-term births
Small for gestational age (SGA) [61]

addition to self-report [75]. This is important as self-reporting of tobacco use can be biased on many occasions related to its potential of perceived stigma by the pregnant respondent. [76].

A study examining predictors of relapse found that non-intention to quit, lower quitting confidence, the presence of other household smokers and not planning to breast feed were short-term (1 month) predictors of relapse and low motivation to quit, a smoking partner were predictors of relapse at 12 months [76].

Pooled results of 72 trials, including 56 randomized control trials of more than 20,000 pregnant women (Cochrane databases) show that cessation interventions reduce smoking in late pregnancy [IR 0.94, 95% CI 0.93 to 0.96] and reduce incidence of low birth weight [RR 0.83, 95% CI 0.73 to 0.95] and pre-term births [RR 0.86, 95% CI 0.74 to 0.98] while increasing birth weight by a mean of 53.91g [95% CI 10.44g to 95.38g]. There were no statistically significant differences in neonatal intensive care unit admissions, very low birthweight, stillbirths, perinatal or neonatal mortality but these analyses had very limited power [77]. Some of the earlier reviews found no evidence that more intensive interventions work any better than brief interventions [75].

A recent review [78], included 102 randomised controlled trials with 120 intervention arms (studies) and data from 88 randomised controlled trials (involving over 28,000 women). The main intervention strategies were categorised as counselling (n = 54), health education (n = 12), feedback (n = 6), incentives (n = 13), social support (n = 7) and exercise (n = 1). This review provided moderate- to-high quality evidence that psychosocial interventions increased the proportion of women who had stopped smoking in late pregnancy by 35%, mean infant birthweight (by 56 g), reduced the number of babies born with low birthweight (by 17%) and admitted to neonatal intensive care immediately after birth (by 22%). A greater effect size was observed for incentive-based interventions. However, these studies were mostly from HICs. Counselling interventions had a clear effect on stopping smoking compared with providing usual care (from 30 studies), and a smaller effect when compared with less intensive interventions (18 studies), which was at variance with other reviews [78].

Programs in HIC addressing the issue of smoking during pregnancy have been present for more than two decades. Rates of smoking in pregnancy have significantly fallen in these countries, but smoking rates among indigenous women continue to be high because of socioeconomic disadvantage, social norms, and poor access to culturally appropriate tobacco cessation support [79].

More recently, a study from Australia which found a decline in the prevalence of smoking during pregnancy in NSW between 2003 and 2011 concludes that this decline was not a direct result of the antismoking activities evaluated, but to the wider tobacco control policies [80].

PHARMACOTHERAPY FOR TOBACCO CESSATION IN PREGNANCY

While the available evidence suggests no major benefit of nicotine replacement therapy. (NRT) in smoking cessation in pregnant populations, it has been suggested that NRT would

be less harmful as compared to the other chemicals in active smoking. However, there are also preliminary studies that suggest increased fetal malformation with NRT[70].

An observational study has suggested combination NRT may be more effective than single form NRT (patch or rapid acting form) in pregnant women [81]. This finding may be related to faster metabolism of nicotine in pregnancy. Other first line drugs like bupropion and varenicline are not recommended in pregnant populations due to the lack of RCTs and safety studies in this population [82,83].

USE OF E-CIGARETTES

A study in 2014 predicted that the perceived safety of e-cigarettes may lead to e-smoking during pregnancy [84]. A recent online survey of 445 pregnant women recruited online, found that 5.6% of the women reported smoking cigarettes, 6.5% used only e-cigarettes and 8.5% used both tobacco cigarettes and e-cigarettes [85]. In this study, a majority of participants (64.3%) viewed e-cigarettes as being safer than tobacco cigarettes, and this perception was greatly influenced by having seen advertisement for e-cigarettes [85]. However, e-cigarettes are not recommended as a substitute for cigarette smoking cessation during pregnancy [86].

CONCLUSION

Tobacco use in any form in pregnancy is associated with a plethora of adverse fetal effects as well as maternal risks. Existing effective interventions are primarily behavioral, but public health measures focused on tobacco control are also important in reducing risks from tobacco use during pregnancy. While there has been an encouraging reduction in the prevalence of smoking in HICs, exposure to SHS as well as smokeless tobacco use are serious problems globally, as well as in LMIC, particularly in South Asia. Identification of smoking and smokeless tobacco use, as well as exposure to second-hand smoking and interventions in such cases must become part of standard care in all maternity care settings.

REFERENCES

1. World Health Organization 2017. Tobacco Fact Sheet. 2017.
2. World Health Organization. 2013.
3. World Health Organization. Worldwide burden of disease from exposure to second-hand smoke. Global burden of disease from second-hand smoke. 2010.
4. Jamal A, King BA, Neff LJ, Whitmill J, Babb SD, Graffunder CM. Current cigarette smoking among adults- United States, 2005-2015. *MMWR Morb Mortal Wkly Rep.* 2016; 65: 1205-1211.
5. *Morbidity and Mortality Weekly Report.* CDC. 2017.
6. Goel S, Tripathy JP, Singh RJ, Lal P. Smoking trends among women in India: Analysis of nationally representative surveys (1993-2009). *South Asian J Cancer.* 2014; 3: 200-202.
7. Warren CW, Jones NR, Peruga A, Chauvin J, Baptiste JP, deSilva VC, et al. *Global Youth Tobacco Surveillance, 2000-2007.* CDC. 2008.
8. Sinha DN, Gupta PC, Ray CS, Singh PK. Prevalence of smokeless tobacco use among adults in WHO South-East Asia. *Indian J Community Med.* 2012; 49: 342-346.

9. Curtin SC, Mathews TJ. Smoking Prevalence and Cessation Before and During Pregnancy: Data from the Birth Certificate, 2014. National vital statistics report. 2016; 65: 1-13.
10. Health and Social Care Information Centre UK. Statistics on smoking UK. 2016.
11. Australian Institute of Health and Welfare (AIHW). Australia's mothers and babies 2014 - in brief. Perinatal statistics series no 32. Canberra: AIHW, 2016.
12. Caleyachetty R, Tait CA, Kengne AP, Corvalan C, Uauy R, Echouffo-Tcheugui JB. Tobacco use in pregnant women: analysis of data from demographic and health surveys from 54 low-income and middle-income countries. *The Lancet Global Health*. 2014; 2: e513-e520.
13. Centers for Disease Control and Prevention. Current tobacco use and secondhand smoke exposure among women of reproductive age-14 countries, 2008-2010. *MMWR Morb Mortal Wkly Rep*. 2012; 61: 877-882.
14. Ranjit A. Tobacco use among pregnant women in Nepal. Prevalence and Socio-demographic Determinants [Master's Thesis]. University of Tampere. 2013.
15. Nair S, Schensul JJ, Begum S, Pednekar MS, Oncken C, Bilgi SM, et al. Use of smokeless Tobacco by Indian Women aged 18-40 years during pregnancy and reproductive years. *PLoS One*. 2015; 10.
16. Tong VT, Morello P, Alemán A. Pregnant Women's Secondhand Smoke Exposure and Receipt of Screening and Brief Advice by Prenatal Care Providers in Argentina and Uruguay. *Maternal Child Health J*. 2015; 19: 1376-1383.
17. Vardavas Constantine I, Chatzi Leda, Patelarou Evridiki, Plana Estel, Sarri Katerina, Kafatos Anthony, et al. Smoking and smoking cessation during early pregnancy and its effect on adverse pregnancy outcomes and fetal growth. *Eur J Pediatr*. 2010; 169: 741-748.
18. Zhang L, Hsia J, Tu X, Xia Y, Zhang L, Bi Z, et al. Exposure to Secondhand Tobacco Smoke and Interventions Among Pregnant Women in China: A Systematic Review. *Prev Chronic Dis*. 2015; 12: 140377.
19. Sontag LW, Wallace RF. The effects of cigarette smoking during pregnancy upon the fetal heart rate. *Am J Obstet Gynecol*. 1935; 29: 77-83.
20. Jensen TK, Henriksen TB, Hjollund NH, Scheike T, Kolstad H, Giwercman A, et al. Adult and prenatal exposures to tobacco smoke as risk indicators of fertility among 430 Danish couples. *Am J Epidemiol*. 1998; 148: 992-997.
21. Handler A, Davis F, Ferre C, Yeko T. The relationship of smoking and ectopic pregnancy. *Am J Public Health*. 1989; 79: 1239-1242.
22. Zhang Jun, Zeisler Jonathan, Hatch Maureen C, Berkowitz Gertrud. Epidemiology of Pregnancy-induced Hypertension. *Epidemiologic Rev*. 1997; 19: 218-232.
23. Ananth CV, Smulian JC, Vintzileos AM. Incidence of placental abruption in relation to cigarette smoking and hypertensive disorders during pregnancy: a meta-analysis of observational studies. *Obstet Gynecol*. 1999; 93: 622-628.
24. England L, Zhang J. Smoking and risk of pre-eclampsia. A systematic review. *Front Biosci*. 2007; 12: 2471-2483.
25. Kaminsky LM, Ananth CV, Prasad V, Nath CA, Vintzileos AM. The influence of maternal cigarette smoking on placental pathology in pregnancies complicated by abruption. *Am J Obstet Gynecol*. 2007; 197: 275.e1-275.e5.
26. Reeves S, Bernstein I. Effects of maternal tobacco-smoke exposure on fetal growth and neonatal size. *Expert Rev Obstet Gynecol*. 2008; 3: 719-730.
27. Huxley RR, Woodward M. Cigarette smoking as a risk factor for coronary heart disease in women compared with men: a systematic review and meta-analysis of prospective cohort studies. *Lancet*. 2011; 378: 1297-1305.
28. Montgomery SM, Ekblom A. Smoking during pregnancy and diabetes mellitus in a British longitudinal birth cohort. *BMJ*. 2002; 324: 26-27.
29. Flenady V, Koopmans L, Middleton P, Froen JF, Smith GC, Gibbons K, et al. Major risk factors for still birth in high income countries: a systematic review and meta-analysis. *Lancet*. 2011; 377: 1331-1340.
30. Wisborg K, Kesmodel U, Henriksen TB, Olsen SF, Secher NJ. Exposure to tobacco smoke in utero and the risk of stillbirth and death in the first year of life. *Am J Epidemiol*. 2001; 154: 322-327.
31. Dybing E, Sanner T. Passive smoking, sudden infant death syndrome (SIDS) and childhood infections. *Human Experimental Toxicol*. 1999; 18: 202-205.
32. Anderka M, Romitti PA, Sun L, Druschel C, Carmichael S, Shaw G. Patterns of tobacco exposure before and during pregnancy. *Acta Obstetrica et Gynecologica Scandinavica*. 2010; 89: 505-514.
33. Miyake Y, Tanaka K, Arakawa M. Active and passive maternal smoking during pregnancy and birth outcomes: the Kyushu Okinawa Maternal and Child Health Study. *BMC Pregnancy Childbirth*. 2013; 13:157.
34. Milerad J, Vege A, Opal SH, Rognum TO. Objective measurements of nicotine exposure in victims of sudden infant death syndrome and in other unexpected child deaths. *J Pediatr*. 1998; 133: 232-236.
35. McMartin KI, Platt MS, Hackman R, Klein J, Smialek JE, Vigorito R, et al. Lung tissue concentrations of nicotine in sudden infant death syndrome (SIDS). *J Pediatr*. 2002; 140: 205-209.
36. Bajanowski T, Brinkmann B, Mitchell EA, Vennemann MM, Leukel, HW, Larsch KP, et al. Nicotine and cotinine in infants dying from sudden infant death syndrome. *Int J Legal Med*. 2008; 122: 23-28.
37. Kayemba-Kay S, Geary MPP, Pringle J, Rodeck CH, Kingdom JCP, Hindmarsh PC. Gender, smoking during pregnancy and gestational age influence cord leptin concentrations in newborn infants. *Eur J Endocrinol*. 2008; 159: 217-224.
38. Guntheroth WG, Spiers PS. The triple risk hypotheses in sudden infant death syndrome. *Pediatr*. 2002; 110: pe64.
39. Hackshaw A, Rodeck C, Boniface S. Maternal smoking in pregnancy and birth defects: a systematic review based on 173 687 malformed cases and 11.7 million controls. *Hum Reprod Update*. 2011; 17: 589-604.
40. Sowan NA, Stember ML. Effect of Maternal Prenatal Smoking on Infant Growth and Development of Obesity. *J Perinat Educ*. 2000; 9: 22-29.
41. Blaisdell RJ, Broadwin RL, Vork KL. Developing asthma in childhood from exposure to second-hand tobacco smoke- insights from a meta-regression. *Environ Health Perspect*. 2007; 115: 1394-1400.
42. Gilliland FD, Li YF, Peters JM. Effects of maternal smoking during pregnancy and environmental tobacco smoke on asthma and wheezing in children. *Am J Respir Crit Care Med*. 2001; 163: 429-436.
43. Leigh B, Ponsonby AL, Dwyer T, Venn A, Cochrane JA. Parental smoking and infant respiratory infection: How important is not smoking in the same room with the baby? *Am J Public Health*. 2003; 93: 482-488.
44. de Jongste JC, Shields MD. Cough 2. Chronic cough in children. *Thorax*. 2003; 58: 998-1003.
45. DiFranza, Joseph R, Aligne C, Andrew W, Michael. Prenatal and postnatal environmental tobacco smoke exposure and children's health. *Pediatr*. 2004; 113: 1007-1015.
46. Avşar A, Darka Ö, Topaloğlu B, Bek Y. Association of passive smoking

- with caries and related salivary biomarkers in young children. *Arch Oral Biol.* 2008; 53: 969-974.
47. Jacoby PA, Coates HL, Arumugaswamy A, Elsbury D, Stokes A, Monck R, et al. The effect of passive smoking on the risk of otitis media in aboriginal and non-aboriginal children in the Kalgoorlie-Boulder region of Western Australia. *Med J Aust.* 188: 599-603.
 48. Mahid SS, Minor KS, Stromberg AJ, Galandiuk S. Active and Passive Smoking in Childhood Is Related to the Development of Inflammatory Bowel Disease. *Inflammatory Bowel Diseases.* 2007; 13: 431-438.
 49. Richards GA, Terblanche AP, Theron AJ, Anderson R. Health effects of passive smoking in adolescent children. *South African Med J.* 1996; 86: 143-147.
 50. Moylan S, Gustavson K, Overland S, Karevold EB, Jacka NF, Pasco JA, et al. The impact of maternal smoking during pregnancy on depressive and anxiety symptoms in children: The Norwegian mother and child cohort study. *BMC Med.* 2015; 13: 24.
 51. Spencer N, Coe C. Parent reported longstanding health problems in early childhood: a cohort study. *Arch Dis Childhood.* 2003; 88: 570-573.
 52. Thapar A, Fowler T, Rice F, Scourfield J, van den Bree M, Thomas H, et al. Maternal smoking during pregnancy and attention deficit hyperactivity disorder symptoms in offspring. *Am J Psychiatry.* 2003; 160: 1985-1989.
 53. Brook DW, Zhang C, Rosenberg G, Brook JS. Maternal cigarette smoking during pregnancy and child aggressive behavior. *Am J Addict.* 2006; 15: 450-456.
 54. Batstra L, Hadders-Algra M, Neeleman J. Effect of antenatal exposure to maternal smoking on behavioral problems and academic achievement in childhood: prospective evidence from a Dutch birth cohort. *Early Hum Dev.* 2003; 75: 21-33.
 55. Martínez-Mesa J, Menezes AMB, Howe LD, Wehrmeister FC, Muniz LC, Chica DAG, et al. Lifecourse relationship between maternal smoking during pregnancy, birth weight, contemporaneous anthropometric measurements and bone mass at 18 years old. The 1993 Pelotas Birth Cohort. *Early Hum Dev.* 2014; 90: 901-906.
 56. Rumrich IK, Viluksela M, Vähäkangas K, Gissler M, Surcel H-M, Hänninen O. Maternal Smoking and the Risk of Cancer in Early Life – A Meta-Analysis. *PLoS One.* 2016; 11: e0165040.
 57. Gupta PC, Subramoney S. Smokeless tobacco use, birth weight and gestational age. Population based prospective cohort study of 1217 women in Mumbai, India. *BMJ.* 2004; 328: 1538.
 58. Gupta PC, Subramoney S. Smokeless tobacco use and risk of stillbirth: a cohort study in Mumbai, India. *Epidemiol.* 2006; 17: 47-51.
 59. Pratinidhi A, Gandham S, Shrotri A, Patil A, Pardeshi S. Use of 'mishri', a smokeless form of tobacco, during pregnancy and its perinatal outcome. *Indian J Community Med.* 2010; 35: 14-18.
 60. Subramoney S, Aghi MB. Women and smokeless tobacco. Special considerations. In *Smokeless tobacco and public health in India.* Gupta PC, Arora M, Sinha DN, Asma S, Parascandola M, editors. *Smokeless Tobacco and Public Health in India.* Ministry of Health & Family Welfare, Government of India; New Delhi. 2016.
 61. Inamdar AS, Croucher RE, Chokhandre MK, Mashyakhy MH, Marinho VC. Maternal smokeless tobacco use in pregnancy and adverse health outcomes in newborns: a systematic review. *Nicotine Tob Res.* 2015; 17: 1058-1066.
 62. Horta BL, Gigante DP, Nazmi A, Silveira VMF, Oliveira I, Victora CG. Maternal smoking during pregnancy and risk factors for cardiovascular disease in adulthood. *Atherosclerosis.* 2011; 219: 815-820.
 63. Kaminsky LM, Ananth CV, Prasad V, Nath CA, Vintzileos AM. The Influence of Maternal Cigarette Smoking on Placental Pathology in Pregnancies Complicated by Abruption. *Am J Obstet Gynecol.* 2007; 197: 271.e1-275.e5
 64. USDHHS. The health consequences of smoking: a report of the Arch Dis Child Fetal Neonatal Ed. 2008; 93: F351-361.
 65. Grando SA. Connections of nicotine to cancer. *Nat Rev Cancer.* 2014; 14: 419-429.
 66. Momen NC, Olsen J, Gissler M, Li J. Exposure to maternal smoking during pregnancy and risk of childhood cancer: a study using the Danish national registers. *Cancer Causes Control.* 2016; 27: 341-349.
 67. Rogers LK, Velten RM. Maternal inflammation, growth retardation, and preterm birth: Insights into adult cardiovascular disease. *Life Sci.* 2011; 89: 417.
 68. US Department of Health and Human Services. The health consequences of smoking- 50 years of progress. A report of the surgeon-general. 2014.
 69. Hellstrom-Lindahl E, Nordberg A. Smoking during pregnancy: a way to transfer the addiction to the next generation? *Respiration.* 2002; 69: 289-293.
 70. Reproductive Toxicology. 37th Annual Conference of the European Teratology Society Arles, France. 2009; 2: 117-284.
 71. Marufu TC, Ahankari A, Coleman T, Lewis S. Maternal smoking and the risk of still birth: Systematic review and meta-analysis. *BMC Public Health.* 2015; 15: 239.
 72. Bauer CR, Shankaran S, Bada HS, Lester B, Wright LL, Krause-Steinrauf H, et al. The Maternal Lifestyle Study: Drug exposure during pregnancy and short-term maternal outcomes. *Am J Obstet Gynecol.* 2002; 186: 487-495.
 73. Huizink AC, Mulder EJ. Maternal smoking, drinking or cannabis use during pregnancy and neurobehavioral and cognitive functioning in human offspring. *Neurosci Biobehav Rev.* 2006; 30: 24-41.
 74. Fiore MC, Wetter DW, Bailey WC, Bennett G, Cohen SJ, Dorfman SF, et al. The Agency for Health Care Policy and Research Smoking Cessation Clinical Practice Guideline. *JAMA.* 1996; 275: 1270-1280.
 75. Bauld L, Coleman T. The Effectiveness of Smoking Cessation Interventions during Pregnancy: A Briefing Paper. UK Centre for tobacco control studies. 2009.
 76. Simmons VN, Sutton SK, Quinn GP, Meade CD, Brandon TH. Prepartum and Postpartum Predictors of Smoking. *Nicotine Tob Res.* 2014; 4: 461-468.
 77. Lumley J, Chamberlain C, Downsell T, Oliver S, Oakley L, Watson L. Interventions for promoting smoking cessation during pregnancy. 2 *Cochrane Database Syst Rev.* 2009; CD001055.
 78. Chamberlain C, O'Mara-Eves A, Porter J, Coleman T, Perlen SM, Thomas J, et al. Psychosocial interventions for supporting women to stop smoking in pregnancy. *Cochrane Database Syst Rev.* 2013; CD001055.
 79. Gould GS, Lim LL and Mattes J. Prevention and treatment of smoking and tobacco use during pregnancy in selected indigenous communities in high-income countries of the United States, Canada, Australia and New Zealand. An evidence-based review. *Chest.* 2017; 152: 853-866.
 80. Havard A, Tran DT, Kemp-Casey A, Einarsdottir K, Preen DB, Jorm RJ. Tobacco policy reform and population-wide antismoking activities in Australia: the impact of smoking during pregnancy. *Tobacco Control.* 2017.
 81. Brose LS, McEwen A, West R. Association between nicotine replacement therapy use in pregnancy and smoking cessation. *Drug*

- Alcohol Depend. 2013; 132: 660-664.
82. Coleman T, Chamberlain C, Davey MA, Cooper SE, Leonardi-Bee J. Pharmacological interventions for promoting smoking cessation during pregnancy. *Cochrane Database Syst Rev.* 2012; 12: CD010078.
83. De Long NE, Barra NG, Hardy DB, Holloway AC. Is it safe to use smoking cessation therapeutics during pregnancy. *Expert Opin Drug Saf.* 2014; 12: 1721-1731.
84. Baeza-Loya S, Viswanath H, Carter A, Molfese DL, Velasquez KM, Baldwin PR, et al. Perceptions about e-cigarette safety may lead to e-smoking during pregnancy. *Bulletin of the Menninger Clinic.* 2014; 78: 243-252.
85. Wagner NJ, Camerota M, Propper C. Prevalence and Perceptions of Electronic Cigarette Use during Pregnancy. *Matern Child Health J.* 2017; 21: 1655.
86. Center for Diseases Control. Smoking and Tobacco use. 2017.

Cite this article

Murthy P, Mishra S (2017) Tobacco use in Pregnancy-Global evidence and Relevance to LMIC. *J Subst Abuse Alcohol* 5(4): 1069.