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Association Between Exposure to Secondhand Smoke During Pregnancy and Low Birthweight: A Narrative Review

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Exposure to secondhand smoke (SHS) during pregnancy may have adverse effects on the mother and infant. This study investigates the association of maternal exposure to SHS with low birthweight (LBW) in infants. Smoking during pregnancy has been linked to multiple complications for both mother and infant. To examine association of LBW and environmental tobacco smoke exposure during pregnancy, we reviewed 20 articles. Articles were accessed using the following electronic databases: CINAHL Plus with full text (EBSCO), PubMed, Embase, and MEDLINE. The findings of this review revealed that maternal exposure to environmental smoke is correlated with LBW in infants as well as numerous other adverse effects. The majority of the studies found negative consequences of SHS on the birthweight of infants born to nonsmoking women. Thus, this review helps to confirm the association between maternal exposure to SHS and LBW in infants. *Key words: secondhand smoke; environmental tobacco smoke; low birthweight; perinatal; passive smoking; infant low birthweight.* [Respir Care 2014;59(11):1–•. © 2014 Daedalus Enterprises]

Introduction

Exposure to cigarette smoke of nonsmokers, long referred to as secondhand smoke (SHS), is formed from the burning of cigarettes, other tobacco products, and smoke exhaled by smokers.[1-4] SHS includes chemicals such as nicotine, carbon monoxide, and carbon dioxide.[5] SHS includes asbestos, arsenic, benzene, radon, and other carcinogens.[6]

The United States Centers for Disease Control and Prevention estimated that 90% of nonsmokers in the United States are exposed to SHS.[5] SHS, also called environmental tobacco smoke, passive smoke, and involuntary smoke, has been linked to many adverse health outcomes. For

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example, several reports indicated that SHS causes lung cancer in nonsmokers and has other adverse effects both on adults and on children.[7,8] According to the World Health Organization, exposure to SHS caused an estimated 603,000 premature deaths around the world during 2004.[9]

Exposure to SHS during pregnancy has been associated with many complications on mother, fetus, and infant, including fetal growth restriction,[10] intrauterine growth restriction, spontaneous abortion,[10] miscarriage,[10] stillbirth,[11] preterm birth, low birthweight (LBW),[10,12,13] and sudden infant death syndrome.[10,12,13]

Exposure to SHS during pregnancy 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.[14] In addition, these two chemicals have been found to be extremely hazardous to the fetus. They may inhibit fetal growth because they cross the placental barrier.[15-17] Exposure to SHS during pregnancy may also cause higher rates of attention deficit hyperactivity disorder, asthma, and childhood cancers.[8,11]

LBW is a worldwide problem both in developed countries and in developing countries. The World Health Organization defines LBW as any birthweight $< 2{,}500$ g.[13,18-20] The more than 20 million LBW infants born annually worldwide, 96% of whom are born in developing countries, represent 16% of all births.[13] LBW newborns are considered to be at high risk for health issues such as growth retardation, infectious diseases, and developmental delay, and LBW is the single most important risk factor for neonatal death.[5]

We report on a narrative review of the literature published from the years 2000 through 2012 to determine whether exposure to SHS during pregnancy is associated with LBW.

Criteria for Selecting Studies

A literature search was conducted to identify articles that assessed an association between exposure to SHS during pregnancy and LBW. Articles were accessed using the following electronic databases: CINAHL Plus with full text (EBSCO), PubMed, Embase, and MEDLINE. The database searches were confined to publication years 2000–2012 and were limited to full-text, peer-reviewed articles published in English. The search phrases that were used were secondhand smoke, environmental tobacco smoke, second hand smoke, perinatal outcomes, passive smoking, and infant birthweight, which were used separately with Boolean operators OR and AND combined separately with search phrases low birthweight infant and low birthweight.

Titles and abstracts were reviewed to find out whether they noted inclusion criteria, which were maternal exposure to environmental tobacco smoke, prenatal exposure to tobacco smoke, effects of environmental tobacco smoke

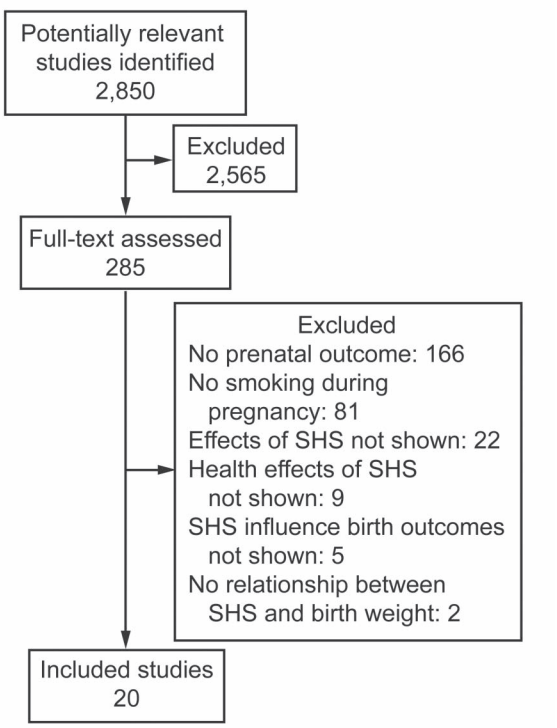

Fig. 1. Flow diagram of literature search. SHS = secondhand smoke.

on perinatal outcomes, and relationship between LBW and maternal exposure to SHS. Studies in which titles and abstracts did not note reports of examining associations between exposure to SHS during pregnancy and perinatal outcomes were excluded.

Remaining full-text articles that were assessed for eligibility were excluded from further analysis if the text did not report on examining associations between exposure to SHS during pregnancy and perinatal outcomes in titles and abstracts, on associations between exposure to SHS during pregnancy and birthweight, on active smoking or of exposure to SHS during pregnancy, or on associations between exposure to SHS during pregnancy and health of mothers. The remaining studies were analyzed. Computer searching and article selection was done by AM Hawsawi.

Exposure to Secondhand Smoke During Pregnancy and LBW

Of the 20 studies included for the analysis (Fig. 1), 18 relied solely on self-report to assess exposure to SHS during pregnancy. Some studies used medical records[21] or biomarkers such as nicotine and cotinine concentrations to confirm exposure to SHS (Table 1).[14,22,23]

Some reported strong evidence for an association between exposure to SHS and pregnancy through use of relating the extent of LBW to the dose of exposure during

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Table 1. Cross-Sectional Studies on the Effect of Exposure to SHS by Nonsmoking Women During Pregnancy on LBW

Study	Year	Assessment of Exposure to SHS During Pregnancy	Nonsmoking Pregnant Women			Association Between Exposure to SHS During Pregnancy and LBW
			Total (*N*)	Exposed to SHS (*n*)	Unexposed to SHS (*n*)	
Matsubara et al[20]	2000	Self-report	7,411	3,586	2,693	Mean birth weight of babies born to exposed mothers was 19 g less than that of babies born to unexposed mothers. No significant difference in risk of having LBW baby between exposed and unexposed (relative risk, 0.99).
Amasha and Jaradeh[27]	2012	Self-report	223	NR	NR	High risk of preterm birth associated with passive and active smoking.
Dejmek et al[21]	2002	Self-report; medical records	5,507	1,797	3,710	Mean birth weight of babies born to exposed mothers was 53 g less than that of babies born to unexposed mothers.
Goel et al[6]	2004	Self-report	576	141	435	31.9% small-for-gestation babies born to exposed mothers vs 17.2% born to unexposed mothers. Higher risk (odds ratio, 2.10) of small-for-gestation age babies with increasing cumulative exposure of mother to SHS. Mean birth weight of babies born to exposed mothers was 138 g less than that of babies born to unexposed mothers.
Kharrazi et al[14]	2004	Assay of blood cotinine concentration	2,777	NR	NR	Dose-dependent effect of cotinine concentration and birth weight; mean birth weight of babies born to exposed mothers was 109 g less than that of babies born to unexposed mothers.
Hanke et al[22]	2004	Assay of serum cotinine concentration	183	77	81	Serum cotinine levels at 20–24 wk of gestation was inversely associated with infant birth weight. Mean birth weight of babies born to exposed mothers was 100 g less than that of babies born to unexposed mothers.
Ward et al[32]	2007	Self-report	10,359	2,259	8,100	Mean birth weight of babies born to exposed mothers was 36 g less than that of babies born to unexposed mothers.
Jaddoe et al[34]	2008	Self-report	8,880	5,349	5,502	Mean birth weight of babies born to exposed mothers was 25–75 g less than that of babies born to unexposed mothers; exposure to SHS during late pregnancy was more strongly associated with LBW than exposure earlier.
Pogodina et al[5]	2009	Self-report	2,206	NR	NR	Odds ratio of having LBW babies born to exposed mothers relative to unexposed mothers was 1.29.
Abu-Baker et al[12]	2010	Self-report	300	NR	NR	Mean birth weight of babies born to exposed mothers was 33 g less than that of babies born to unexposed mothers, a significant difference.
Ashford et al[23]	2010	Self-report; assay of maternal hair nicotine	157	66	91	Mean birth weight of babies born to exposed mothers was 305 g less than that of babies born to unexposed mothers.
Anderka et al[31]	2010	Self-report	3,706	NR	NR	LBW was highest in neonates born to exposed mother when compared with the unexposed mothers.
Varvarigou et al[33]	2010	Self-report	3227	649	1,581	Mean birth weight of babies born to exposed mothers was 48 g less than that of babies born to unexposed mothers.
Khader et al[25]	2011	Self-report	8,490	NR	NR	Odds ratio of having LBW babies born to exposed mothers relative to unexposed mothers was 1.56.
Crane et al[11]	2011	Self-report	11,852	1,202	10,650	Mean birth weight of babies born to exposed mothers was 53.7 g less than that of babies born to unexposed mothers.
Wadi and Al-Sharbatti[15]	2011	Self-report	300	150	150	Mean birth weight of babies born to exposed mothers was 198.4 g less than that of babies born to unexposed mothers.
Krstev et al[24]	2012	Self-report	2,721	816	833	Mean birth weight of babies born to exposed mothers was 173 g less than that of babies born to unexposed mothers. Odds ratio of having LBW babies born to exposed mothers relative to unexposed mothers was 2.73.

SHS = second hand smoke
LBW = low birthweight
NR = not reported

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Table 2. Case-Control Studies and Systematic Reviews and Meta-Analyses of the Effect of Exposure to SHS by Nonsmoking Women During Pregnancy on LBW

Authors	Study		Assessment of Exposure to SHS During Pregnancy	Nonsmoking Pregnant Women* (*N*)	Association Between Exposure to SHS During Pregnancy and LBW
	Year	Design			
Fantuzzi et al[28]	2008	Case control	Self-report	942	SHS exposure during pregnancy was significantly associated with higher risk of severe small-for-gestational-age at term.
Leonardi-Bee et al[30]	2011	Systematic review and meta-analysis	Self-report	NR	SHS was associated with several adverse effects.
Salmasi et al[37]	2010	Systematic review and meta-analysis	Self-report	48,439	Maternal exposure to ETS significantly increased risk of LBW, lower longer neonate with an increased risk of congenital anomaly.

* Numbers of pregnant women exposed or not exposed to SHS during pregnancy were not reported.
SHS = secondhand smoke
LBW = low birthweight
NR = not reported
ETS = environmental tobacco smoke

pregnancy,[5,6] to quantity of exposure to SHS,[11,13,24-33,35,36] and to cotinine level (Tables 1 and 2).[12,14,17,22,37]

One study[10] confirmed that exposure to SHS during pregnancy was a cause of LBW and not merely an association. This study is consistent with previous studies indicating that exposure to SHS during pregnancy significantly reduced birthweight. Other studies[5,11,28,34] showed an association between LBW and SHS.

Two studies stood out as particularly noteworthy because they showed dose-dependent relationships between exposure to SHS during pregnancy and LBW.

The cross-sectional study by Goel et al,[6] which examined exposure to SHS by 576 nonsmoking pregnant women, reported a dose-dependent association in which increasing cumulative exposure to SHS during pregnancy was associated with a higher risk of small-for-gestational-age babies. The cross-sectional study by Kharrazi et al,[14] showed a dose-dependent effect of serum cotinine concentration on mean birthweight (−109 g) over the range of cotinine values.

In a case-control study of pregnant women in Los Angeles County, California, Ghosh et al[35] investigated the effects of residential indoor air quality and household ventilation on LBW in babies born to mothers exposed to SHS during pregnancy. The risks of having LBW babies born to two groups of pregnant mothers who were exposed to SHS during pregnancy were considered: those reporting no or low window ventilation at home, and those reporting moderate or high window ventilation at home. Exposed mothers living in unventilated homes had increased risk of having LBW babies, whereas exposed mothers living ventilated homes did not have increased risk. Thus, residential window ventilation might mitigate the risk of bearing LBW babies to mothers exposed to SHS during pregnancy.

Inasmuch as most of the studies used self-reporting to assess exposure to SHS during pregnancy, recall bias might have affected the findings of these studies and therefore of ours. In addition, the type of exposure to smoke during pregnancy, either by active smoking or by exposure by nonsmokers to SHS, was also self-reported. This might have led to misclassification as an active smoker or as a nonsmoker. This sort of misclassification was reported by Hanke et al,[22] who assessed exposure to SHS during pregnancy by assay of serum cotinine concentration. They found that 11 (6%) of the 183 study subjects who classified themselves as nonsmokers had serum cotinine concentrations indicative of active smoking. Nevertheless, our review identified several studies using different designs, such as case-control and systematic review and meta-analysis, besides the cross-sectional design, which reported strong association between exposure to SHS during pregnancy and LBW (see Tables 1 and 2).

Findings From Previous Studies of Exposure to Secondhand Smoke During Pregnancy and LBW

The findings of this review help to confirm previously observed associations between maternal exposure to SHS and LBW. Two studies published before 2000, which was the earliest year searched, reported that the risk of having LBW babies is increased for mothers who were exposed to SHS during pregnancy (Luck et al[17] and Hanke et al[38]). In addition, Hanke et al[38] showed a relationship between level of exposure to SHS and mean birthweight. A review[6] agreed that babies born to mothers exposed to SHS during pregnancy weighed less than babies born to unexposed mothers. In contrast to findings from other studies, the cross-sectional study by Windham et al[39] reported that, after

adjusting for confounders, the mean birthweight of infants of mothers exposed to SHS during pregnancy was 34.2 g greater than infants born to unexposed mother.

Findings From More Recent Studies of Exposure to Secondhand Smoke During Pregnancy and LBW

Two studies published more recently than 2012, the latest year of the literature searched in this review, reported on exposure to SHS during pregnancy and LBW. A cross-sectional study,[36] based on self-reports from 3,424 nonsmoking pregnant women (including 1,085 exposed to SHS during pregnancy and 2,341 unexposed), found that mean birthweight of babies born to exposed mothers was 35 g less than that of babies born to unexposed mothers. A case-control study[35] based on self-reports from 1,761 nonsmoking women who delivered a baby reported that, compared with unexposed mothers, mothers exposed to SHS in homes without a window had higher risk (odds ratio, 1.36; although 95% CI values included the null) of having LBW babies, whereas exposed mothers living in homes with window ventilation had no increased risk.

Conclusions

In conclusion, SHS has been long known to cause numerous adverse effects in mothers and infants. The literature indicates that maternal exposure to SHS is linked to LBW. This review supports previously observed associations between maternal exposure to SHS and LBW.

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 SHS. In addition, it is essential to make women, especially pregnant women, aware of the catastrophic consequences of SHS exposure.

Educational programs about the effects of SHS exposure should be targeted to pregnant women to increase their awareness and understanding of the harmful effects of SHS. Preventive measures should be implemented to decrease pregnant women's exposure to SHS. A needs assessment and environmental analysis could be conducted to gather data on common places of SHS exposure for pregnant women. In addition, studies should investigate the role of smoke-free policies in decreasing the number of LBW infants, identify the strengths and weaknesses of established ordinances used to reduce exposure to SHS, and provide feasible solutions to minimize pregnant women's exposure to secondhand smoke.

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