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## Association between secondhand smoke exposure and quality of life in pregnant women and postpartum women and the consequences on the newborns

Rasmon Kalayasiri<sup>1,2,\*</sup>, Waranya Supcharoen<sup>1</sup>, and Pichanan Ouiyanukoon<sup>1</sup>

<sup>1</sup>Department of Psychiatry, Faculty of Medicine, Chulalongkorn University, Pathumwan, Bangkok 10330, Thailand <sup>2</sup>Department of Psychiatry, King Chulalongkorn Memorial Hospital, Pathumwan, Bangkok 10330, Thailand

### Abstract

**Purpose**—Secondhand smoke (SHS) exposure is prevalent and could damage the health of nonsmokers, especially that of pregnant women (PW) and postpartum women (PPW). Nevertheless, there is no study on the impact of SHS during pregnancy on the quality of life (QOL) of PW and PPW. The study's purpose is to study the effects of exposure to SHS on the QOL of pregnant and postpartum women and health of the newborns.

**Methods**—Self-reports and urine tests for cotinine were used to obtain data on SHS exposure in 296 women in the second trimester of pregnancy and 106 women in the postpartum period at the Obstetrics & Gynecology Clinic located in a university hospital. The WHOQOL-BREF-THAI and the Edinburgh Postnatal Depression Scale (EPDS) were used to assess QOL and postpartum depression, respectively.

**Results**—Of the participants, 88.2% of PW and 62.3% of PPW reported exposure to SHS during pregnancy. Of the PPW, 5.7% had postpartum depression. PW with good QOL were less likely to have family member who smoked ( $p = 0.007$ ) or to be exposed to SHS in public parks ( $p = 0.037$ ) or in the household or workplace ( $p = 0.011$ ). Likewise, PPW with good QOL in the psychological domain were less likely to be exposed to SHS during pregnancy, as shown in both verbal report ( $p = 0.010$ ) and objective measure of urine cotinine test ( $p = 0.034$ ). In addition, maternal exposure to SHS during pregnancy is associated with low birth weight and other health problems in the newborns ( $p < 0.05$ ).

\*Correspondence to Rasmon Kalayasiri, Department of Psychiatry, Faculty of Medicine, Chulalongkorn University 1873 Rama 4 Road, Pathumwan, Bangkok 10330, Thailand. Rasmon.k@chula.ac.th, Tel/Fax. +66 2256 4298.

#### Declaration of interests

The authors declare that they have no conflict of interest.

#### Compliance with ethical standards

Conflict of Interest:

The authors declare that they have no conflict of interest regarding the publication of this article.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the Institutional Review Board of the Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand (Med Chula IRB #646/2016) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual participants included in the study.

**Conclusions**—Exposure to SHS during pregnancy is associated with a lower QOL and a poorer health condition in the newborns.

### Keywords

quality of life; secondhand smoke; cigarette; pregnant women; postpartum women; prenatal exposure

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## Introduction

Tobacco smoking is a health problem around the world. The World Health Organization estimated that around six million people die yearly because of tobacco, including about 890,000 people who die from exposure to smoke from smokers [1]. Most smokers—around 80%—live in developing countries [2,1]. Thailand, a middle-income, developing country situated in Southeast Asia, has conducted the latest national household survey on tobacco and alcohol use with an estimation that 11.4 million, or 20.7% of the Thai population age 15 or older, smoked tobacco in 2014 [3]. However, the remaining people, including children and adolescents, may be at risk despite being nonsmokers, by receiving smoke from lighted cigarettes or from exhaled air. The inhalation of smoke from others' lighted cigarettes has been called involuntary smoke, passive smoke, environmental tobacco smoke, or secondhand smoke (SHS) [4].

Although Thailand issued a Health Protection Act for nonsmokers in 1992 [5], the national household survey in 2014 estimated that 39.5% of the house-representative respondents reported in-house smoking, and 27.8% received daily SHS at home [3]. About 250 chemicals in SHS have been declared harmful to human health, including as a carcinogen and as affecting the fetuses of pregnant women and newborn babies [4,6]. The complications during pregnancy of inhaling SHS included but was not limited to toxic pregnancy, preterm birth, sudden death syndrome in the newborn, low birth weight and short body length, abnormality in the neurodevelopmental system of the newborn, respiratory tract infection, otitis media, and poor lung development [6,3].

Not only would the health of newborns be directly affected by SHS, but the health of the mothers, physical and mental, may be affected by SHS. In general, postpartum depression, or depression with peripartum onset [7], in which the major depressive episode lasts for 2 weeks or more during pregnancy or occurs within 4–6 weeks after delivery, is found commonly in 10%–25% of mothers around the world, especially in migrant populations [8–12]; however, it is usually underdiagnosed. The cause of postpartum depression is unknown but could be multifactorial, including from hormonal changes and significant psychosocial change after giving birth, which is one of the critical periods in women's lives [8,9,11,13]. Women may experience labile postpartum moods that lead to depression and affect their ability to care for their child. These depressive symptoms can also be a factor that affects the general well-being of the mothers. Quality of life (QOL), the well-being of physical health and mind, involves being in a good environment and society [14], and exposure to SHS may be a significant risk factor that indicates overall risk to the QOL of the mothers because it is

a harmful environment to the general population but in particular to the health of the fetus and newborn.

In this study at a university hospital in Bangkok, Thailand, we study the effects of exposure to SHS in pregnant and postpartum women cohorts, and the outcome or impact of SHS on the health of newborns and the mental health and QOL of these mothers, as well as the risk of SHS causing or contributing to depression. The results may show the need to protect family members and others from cigarette smoke and to support serious measures to protect the health of nonsmokers, especially those in vulnerable groups.

## Methods

### Samples and populations

Two-hundred and ninety-six pregnant women (PW) in the second trimester (13–24 weeks pregnancy) who attended the prenatal care clinic at King Chulalongkorn Memorial Hospital between September 2015 and December 2015 were recruited. In an independent cohort, 106 postpartum women (PPW) receiving postpartum care at around 6 weeks at the Department of Obstetrics and Gynecology, King Chulalongkorn Memorial Hospital between October 2016 and May 2017 were interviewed to collect data on the mothers' mental health and SHS exposure. Data on the newborns' health, including birth weight, crown–heel length, head circumference, and complications at birth, was collected from the hospital inpatient records during labor and delivery. Women younger than 18 years, who had a diagnosis of depression before giving birth, smoked during or after pregnancy, or used alcohol or other substances during pregnancy were excluded from the study. Informed consent was obtained from all individual participants included in the study. The study was approved by the Institutional Review Board of the Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand (Med Chula IRB #646/2016).

### Measurement

WHOQOL-BREF-THAI [15], the World Health Organization brief instrument to indicate quality of life (QOL) in the Thai version, is a five-choice (0–5), self-rated scale, ranging from none to most, on 26 items. The items are grouped into four domains, including physical, psychological, social relationships, and environmental domains. There are 23 positive-meaning items and 3 negative-meaning items. The instrument had a high Cronbach's alpha coefficient = 0.8406 and concurrent validity compared to the longer version, WHOQOL-100 = 0.6515. A score of 96 or more indicates good QOL. The Edinburgh Postnatal Depression Scale (EPDS) - Thai version is a 10-item Likert scale with a total score = 30. A score of 11 or more indicates postpartum depression with a sensitivity = 100% and specificity = 88 [16]. The data on the exposure to SHS was obtained by verbal report of exposure at the workplace, home, or public spaces by using a yes/no question; "Have you ever received cigarette smoke during this pregnancy?", followed by a multiple choice question asking "Where did you receive cigarette smoke during this pregnancy?". The methods of obtaining objective SHS in PW were reported in details elsewhere [17]. In brief, objective data on exposure to SHS was obtained by using the direct barbituric acid (DBA) method, which is a measure that detects cotinine, the metabolite of nicotine, in the

urine as measured by comparing color change of the sample to the standard cotinine level at 10, 25, 50, and 100 micromole/liter [18].

### Data analysis

All continuous data was checked for normal distribution. If non-normally distributed, the continuous data was transformed to categorical variables. Descriptive statistics for demographics, exposure to SHS, and mental health were analyzed in PW and PPW groups. Demographics, SHS exposure status, and postpartum depression were compared between women with high and low to moderate levels of QOL in the two cohorts by using chi-square or Fisher's exact test. Logistic regression analysis was used to investigate the predictors of QOL in pregnant and postpartum women by using verbal report of SHS as an independent variable. Exposure to SHS and variables that were tested to be associated or nearly associated with QOL in the initial analysis ( $p < 0.1$ ) were subjected to inclusion in the logistic regression on QOL using enter method. Last, exposure to SHS during pregnancy was analyzed for association with the health of the newborn at birth by chi-square or Fisher's exact test.

## Results

### Pregnant women (PW) cohort

The mean age of the studied PW cohort was 30 years. Out of 296 subjects, 288 (97.3%) lived with their husbands, and 134 (45.3%) were carrying their first child. Interestingly, a poor level of overall QOL was not observed in the cohort, but 60.5% and 39.5% of the cohort had moderate and good QOL, respectively. Exposure to SHS during pregnancy was reported by 88.2%, and urine tests for cotinine were positive in 93.9% of the PW cohort. PW were exposed to SHS everyday or almost everyday by 16.9%. The most frequent location of exposure to SHS was in public places (58.8%), including street walkways and bus stops, whereas the household area was the second most common place (47.6%) that PW were exposed to SHS during pregnancy (Table 1).

Table 2 shows demographics and data on exposure to SHS in individuals with good and moderate levels of QOL. PW with good QOL were more likely than those with a moderate level of QOL to have higher income ( $\chi^2 = 10.037$ ,  $p = 0.007$ ) and higher levels of education ( $\chi^2 = 12.2$ ,  $p = 0.001$ ). However, other demographics, including age and employment, were not associated with QOL in the cohort. Although the regression analysis did not show that exposure to SHS was a predictor for QOL ( $p > 0.05$ ), PW with good QOL were less likely to have a family member who smoked ( $\chi^2 = 10.037$ ,  $p = 0.007$ ) and to be exposed to SHS in public parks ( $\chi^2 = 4.369$ ,  $p = 0.037$ ) and the household or workplace ( $\chi^2 = 6.504$ ,  $p = 0.011$ ) in the univariate analysis.

### Postpartum women (PPW) cohort

The mean age of the studied PPW cohort was 31 years. Other demographics are shown in Table 1. Out of 106 PPW, 99 (93.4%) completed the prenatal care program, and 57 (53.8%) had normal delivery. Postpartum depression was observed in 6 out of the 106 (5.7%) PPW. Like the PW cohort, a poor level of QOL was not observed in the PPW cohort, whereas a

high rate of good QOL (68.9%) was observed. Exposure to SHS during pregnancy was reported by 62.3%, and urine tests for cotinine were positive in 86.8% of the PPW cohort. Like reported by the PW cohort, the most frequent location of exposure to SHS was reported to be in public places (38.7%), including street walkways and bus stops. PPW were exposed to SHS everyday or almost everyday by 9.4% (Table 1).

PPW with good QOL were more likely than those with moderate QOL to have adequate income (Table 2). However, other demographics, including age, employment, and level of education were not associated with QOL. Having family planning, but not the total number of children, was associated with good QOL. PPW with good QOL in the physical and environmental domains were less likely to have depression (Fisher's exact test;  $p = 0.002$  and  $0.027$ , respectively) and those with good QOL in the psychological domain were less likely to be exposed to SHS during pregnancy, as shown by both verbal report ( $\chi^2 = 6.578$ ,  $p = 0.010$ ) and the urine cotinine test ( $\chi^2 = 4.501$ ,  $p = 0.034$ ). SHS was not associated with postpartum depression in our cohort. In the regression analysis, having depression was a predictor for lower QOL. It could predict 55.3% of the QOL. If the score on depression increased 1 unit, the QOL score may drop 1.251 ( $R^2 = 0.553$ ,  $b = -1.251$ , S.E. (b) = 0.185,  $t = -6.750$ ,  $p < 0.001$ ).

### Newborns of the PW and PPW cohorts

Data on 121 newborns in the PW cohort and data on 58 newborns in the PPW cohort was available from the hospital records to study the outcome of exposure to SHS during pregnancy on newborn health. Mother's exposure to SHS was associated with low birth weight, specifically, and overall newborn health problems, including jaundice, diabetes, and low birth weight (Fisher's exact test;  $p = 0.041$  and  $0.006$ , respectively) in the newborns of the PW cohort (Table 3), although those results were not observed in the PPW cohort. However, the combined data of the newborns from the two cohorts ( $n = 179$ ) showed that mothers' exposure to SHS was associated with overall newborn health problems ( $p < 0.001$ ) (Table 3).

### Discussion

Exposure to SHS is found commonly in the general population; our study shows that such exposure is still very common in vulnerable groups such as pregnant women and those with newborns. The high rates of SHS exposure in PW and PPW shown in this study are consistent with previous studies on SHS exposure during pregnancy [19,20], although they are much higher than a survey by the public health service in Thailand, partly due to a less strict definition of SHS in our study [21]. However, a urine test for cotinine, a metabolite of nicotine, was used, and the results could be used to confirm a high rate of SHS in our cohorts. The reports of exposure to SHS during pregnancy in PPW were lower than those in the PW cohort, which may be due to the recall bias of SHS exposure during pregnancy in the PPW. However, the frequencies of SHS as measured by urine tests were more comparable between the two cohorts, suggesting the consistency of the rate of SHS exposure in pregnant and postpartum women. Our study shows that exposure to SHS during pregnancy is associated with a lower QOL among pregnant and postpartum women and more health

problems in the infants. Exposure to QOL was not associated with depressive disorder in the PPW cohort.

The higher rate of good QOL in PPW (~70%) than in PW (~40%) in our study may be due to the relief of the PPW from the burden of carrying the child from factors such as weight gain and limited activity during pregnancy [22,23]. Postpartum depression in our cohort (~5.7%) was less than in those reported in previous studies [9,8,10–12], confirming that our postpartum-women cohort might have quite good mental health consistent with the high QOL found in the study (i.e., poor QOL was not observed). As discussed, the rate of SHS exposure in PPW was lower than that in pregnant women and may partly be the reason for having a higher rate of good QOL in the PPW. Likewise, SHS exposure, especially from having smokers in the house, was a significant factor affecting QOL, confirming the negative effects of SHS exposure on the nonsmokers' QOL in general and some health-related specific populations [24–29]. Nevertheless, this study is the first to show that SHS exposure is associated with lower QOL in the special population of pregnant and postpartum women.

SHS exposure is known to increase the risk of cardiovascular disease, lung cancer, and other respiratory diseases [30,31] in adult nonsmokers, and the effects of direct smoking by pregnant women have also been well documented [32]; our study shows that SHS exposure during pregnancy is associated with low birth weight and health problems in newborns consistent with the previous findings [33,34]. The effect of maternal SHS exposure prior to birth may carry forward to effects on adolescents' body weight such as obesity [35]. Low birth weight is a significant health risk for the newborn and is associated with a host of other risks, including infection, slow development, and mortality at birth that are associated with exposure to smoke during pregnancy [36]. Further study of the effects of tobacco smoke exposure during pregnancy on the newborn's other psychological or neurodevelopmental conditions are needed because some may take time to manifest. For example, exposure to tobacco smoke during pregnancy may increase the risk for obsessive-compulsive disorder (OCD) [37] and/or attention-deficit hyperactivity disorder (ADHD) [38,39]. Therefore, public communication is needed to warn people of the harmful effects of exposure to tobacco smoke very early in life, such as prior to birth, that may manifest later in life.

Other variables associated with QOL deserve mention. Level of education and income and/or perception of adequate income are associated with QOL consistent with reports from previous studies in the national survey and in various populations in Thailand [40–42]. Social determinants of health are likely to play a significant role in explaining QOL in these populations of pregnant and postpartum women. People with low socioeconomic status and low level of education may have higher prevalence of cigarette smoking that may increase rate of exposure to SHS in others who they live with including pregnant and postpartum women. In addition, depression is a predictor of QOL in our result, consistent with previous reports both in PW and in PPW [43–45]. This finding is not surprising because depressive disorder is increasingly the leading cause of the burden of disease as measured by disability-adjusted life years worldwide [46]. Although we did not find the association between postpartum depression and exposure to SHS during pregnancy, previous studies reported the linkage between SHS and depression in the general population [47] and in specific populations such as adolescents [48] and PPW [49].

Our study has several limitations that need to be addressed. Although we screened for cotinine, a metabolite of nicotine in urine, it is a cross-sectional result rather than of the overall exposure during the entire period of pregnancy. This limitation is highlighted especially in the postpartum women cohort, given that screening for cotinine is cross-sectional and not longitudinal. The prevalence of SHS during pregnancy may be underreported due to the recall bias of exposure to SHS that may influence overall outcomes. Nevertheless, the very high rate of cross-sectional positive cotinine in urine (85–90%) could exclude the probability of wrong categorization because most of the participants already tested positive for cotinine. In addition, a significant percentage of hospital record data used to assess newborn health are missing because some mothers who attended the pre and post-natal care clinic of the hospital may prefer to have delivery elsewhere including other private hospitals. Difference between clinical settings for antenatal care and delivery may cause a selection bias on the newborn health data and influence the newborn health outcome in the study. For example the current setting is a large university hospital providing tertiary care that pregnant women with pregnancy complications may be densely populated for delivery.

Women in general usually are more concerned about health than men are, and pregnancy is one of the motivations in female smokers to quit smoking [50,51], reflecting the concern for their child's health. However, the high rate of SHS found in pregnant and postpartum women in this study could reflect that although this vulnerable group might be very careful about health risks and protective of their child, SHS in their daily environment is very difficult for them to avoid. This fact should encourage people, especially those living with pregnant women or children in the house, to quit smoking no matter what, due to the unintentional risk they cause to pregnant women and their children. Smoking and exposure to SHS are harmful not only to mothers' health but also to the fetus and the newborn. At the minimum, our results suggest that smoking cessation by the family members of the house with pregnant women or children is a must, just as pregnant smokers needed to quit smoking when they know they are expecting.

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**Table 1**

Demographics, exposure to secondhand smoke, and quality of life of pregnant and postpartum women

	Pregnant women (N = 296)		Postpartum women (N = 106)	
	n	%	n	%
<b>Demographics</b>				
Age (years)				
<24	73	24.7	16	15.1
24–35	167	56.4	61	57.5
>35	56	18.9	29	27.4
(Pregnant women; mean = 29.68 ± 6.14, Min = 18, Max = 42) (Postpartum women; mean = 31.16 ± 5.99, Min = 18, Max = 42)				
Level of education more than high school	150	50.7	55	51.9
Employment	243	82.1	90	84.9
Income more than 10,000–13,000 Thai baht	141	47.6	68	64.2
Perception that income is sufficient	266	76.4	86	81.1
Living with husband	288	97.3	101	95.3
Expecting/having the first child	134	45.3	49	46.2
<b>Secondhand smoke</b>				
Secondhand smoke exposure during pregnancy	261	88.2	66	62.3
at street and bus stop	174	58.8	41	38.7
in household area	141	47.6	33	31.1
at commercial shops/restaurants	113	38.2	26	24.5
at public park	61	20.6	10	9.4
at work	34	11.5	3	3.7
Frequency of secondhand smoke exposure during pregnancy				
Less than once a week	131	44.2	71	67.0
1–2 days per week	81	27.4	16	15.1
3–4 days per week	34	11.5	9	8.5
5–7 days per week	50	16.9	10	9.4
Family member(s) smoked in the house	93	31.4	28	26.4
Urine test positive for cotinine at the interview	278	93.9	91	86.8
<b>Mental health</b>				
Quality of life				
Good	117	39.5	73	68.9
Moderate	179	60.5	33	31.1
Poor	0	0	0	0
Postpartum depression	N/A	N/A	6	5.7

**Table 2**  
Association between demographics and secondhand smoke and the quality of life of pregnant and postpartum women

	Pregnant women's QOL (N = 296)				$\chi^2$	P Values	Postpartum women's QOL (N = 106)				$\chi^2$	P Values
	Good (n = 117)		Moderate (n = 179)				Good (n = 73)		Moderate (n = 33)			
	n	%	n	%			n	%	n	%		
<b>Demographics</b>												
Age more than 30-35 years	70	59.8	88	49.2	3.2	0.072	18	24.7	11	33.3	0.9	0.354
Level of education more than high school	74	65.2	76	42.5	12.2	0.001**	38	52.1	17	51.5	0.0	0.959
Employment	99	84.6	144	80.4	0.8	0.360	63	86.3	27	81.8	FET	0.567
Income more than 10,000-13,000 Thai baht	68	58.1	73	40.8	10.0	0.007**	49	67.1	19	57.6	0.9	0.343
Perception that income is sufficient	96	82.1	130	72.6	3.4	0.070	64	87.7	22	66.7	6.6	0.016*
Living with husband	114	97.4	174	97.2	FET	1.000	70	95.9	31	93.9	FET	0.646
Expecting/having the first child	58	49.6	76	42.5	1.4	0.235	35	47.9	14	42.4	0.3	0.598
<b>Secondhand smoke</b>												
Secondhand smoke during pregnancy	101	86.3	160	89.4	0.6	0.425	43	58.9	23	69.7	1.1	0.288
at street and bus stop	69	59.0	105	58.7	0.0	0.957	25	34.2	16	48.5	1.9	0.163
in household area	51	43.6	90	50.3	1.3	0.260	22	30.1	11	33.3	0.1	0.742
at commercial shops/restaurants	47	40.2	66	36.9	0.3	0.568	18	24.7	8	24.2	0.0	0.963
at public park	17	14.5	44	24.6	4.4	0.037*	5	6.8	5	15.2	FET	0.279
at work	10	8.5	24	13.4	1.6	0.263	3	4.1	0	0.0	FET	0.549
Frequency of secondhand smoke at least one day per week	59	50.4	106	59.2	2.2	0.137	23	31.5	12	36.4	0.2	0.622
Family member(s) smoked in the house	28	23.9	65	36.3	5.0	0.025*	20	27.4	8	24.2	0.1	0.733
Urine positive for cotinine at the interview	107	91.5	171	95.5	2.1	0.151	67	91.8	29	87.9	FET	0.674
<b>Mental health</b>												
Postpartum depression	N/A	N/A	N/A	N/A	N/A	N/A	2	2.7	4	12.1	FET	0.074

QOL = quality of life, FET = Fisher's exact test.

\* p < 0.05.

two-tailed chi-square test.

;<sup>\*</sup>  
p > 0.01;

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**Table 3**

Effect of exposure to secondhand smoke during pregnancy on newborn health

	Mothers' exposure to secondhand smoke				$\chi^2$	P Values
	Yes		No			
	n	%	n	%		
<i>Newborn of the pregnant women cohort (n = 121)</i>						
Low birth weight	19	18.6	0	0.0	FET	0.041 *
Short head circumference (n = 108)	46	48.4	4	30.8	1.4	0.231
Preterm at birth	13	12.7	0	0.0	FET	0.218
Low Apgar score (n = 119)	16	15.8	1	5.6	FET	0.464
Having health problem(s)	95	93.1	13	68.4	FET	0.006 **
<i>Newborn of the postpartum women cohort (n = 58)</i>						
Low birth weight	6	16.2	4	19.0	FET	1.000
Short head circumference (n = 33)	11	50.0	5	45.5	0.1	0.805
Preterm at birth (n = 36)	6	30.0	4	25.0	FET	1.000
Low Apgar score (n = 35)	2	8.3	1	9.1	FET	1.000
Having health problem(s)	22	59.5	10	47.6	0.8	0.384
<b>Total (n = 179)</b>						
Low birth weight	25	18.0	4	10.0	1.5	0.227
Short head circumference (n = 141)	57	48.7	9	37.5	1.0	0.316
Preterm at birth (n = 157)	19	15.6	4	11.4	0.4	0.541
Low Apgar score (n = 154)	18	14.4	2	6.9	1.2	0.279
Having health problem(s)	117	84.2	23	57.5	13.0	<0.001 ***

\* p <0.05,

\*\* p <0.01;

Fisher's exact test.

\*\*\* p <0.001;

two-tailed, chi-square test.