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HEALTH EFFECTS OF SECONDHANDSMOKE DURING PREGNANCY ON MATERNAL AND PERINATAL OUTCOMES IN TOMOHON CITY, NORTH SULAWESI, INDONESIA

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ABSTRACT

Introduction: A study conducted in 31 countries described that over 60% of women and children are exposed to SHS outside. **Aims:** was to explore the association of secondhand smoke (SHS) exposure on maternal and perinatal outcomes in highland settings in Indonesia. **Methods:** The retrospective cross-sectional survey was used a random sampling method with 52-items of the questionnaire included information of women and infants. This study conducted with the community health center and all seven public health centers in Tomohon city, North Sulawesi, Indonesia, from May to October 2017. The participants were women who had given birth and were exposed to SHS during pregnancy. Their health condition was measured before and after pregnancy, the gestational week at birth, birth weight and height, and perinatal health conditions of the infants. **Result:** Among 234 women who completed the questionnaire and were included in the analysis. The 97% of household active smokers had a chance to smoke outside the house. Also, approximately 70% of women (162/234) reported exposure to SHS from active household smokers during pregnancy. Maternal secondhand smoke (SHS) exposure during pregnancy was significantly associated with the risk of reduction of birth weight ($p = 0.02$). Moreover, infants' birth weight of mothers exposed to SHS outside the house was significantly less than those exposed to SHS only inside ($p = 0.03$). **Conclusion:** Further research is required to focus on public smoke-free strategies to protect women and children's health from SHS in Indonesia.

Keywords: Birth Weight, Breastfeeding, Secondhand Smoke, Postpartum Depression, Indonesia

INTRODUCTION

Over one billion people smoke worldwide, and around six million people die annually from the effects of tobacco use and exposure to tobacco smoke (World Health Organization, 2016). Tobacco smoking is the most preventable main risk factor or cause of death, and it relates to six of the eight leading causes of death globally. Tobacco smoking is a problem which has attracted worldwide attention in recent years and has become a global health target within the sustainable development goals. In Indonesia, the prevalence of current tobacco usage among males over 15 years or more is over 70%, and it's considered as active tobacco smokers by any means (World Health Organization, 2015). In addition, the global adult tobacco survey reported that all non-smokers are exposed to secondhand smoke (SHS) which is defined as smoke formed from the burning end of cigarettes and other tobacco products emitted into the environment and between puffs and from the mainstream smoke exhaled by the smoker (Öberg et al., 2011; Stanković et al., 2012). SHS is found

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throughout Indonesia, particularly at home, restaurants, and public transportations (World Health Organization, 2012).

SHS exposure brings many health problems. Exposure to SHS increases the risk of cardiovascular diseases, cancers, and respiratory symptoms like cough, wheezing, chest tightness, breathing difficulty for adults, and respiratory diseases, middle ear disease, lower respiratory illness, sudden infant death syndrome for children (Jacobs et al., 2013), contributes to preterm birth (Jaddoe et al., 2008; Khader et al., 2011; Jacobs et al., 2013), and stillbirths (OR = 1.23, 95% [CI = 1.09 to 1.38] in four studies in Sweden, the US, India, and Turkey) (Leonardi-Bee et al., 2011). Maternal SHS exposure is also associated with adverse birth outcomes (i.e., low birth weight (LBW), small gestational age, maternal mental health problems) (Jaddoe et al., 2008; Khader et al., 2011;Wahabi et al., 2013; Zhou et al., 2014; Hawsawi et al., 2015; Niu et al., 2015; Vila Candel et al., 2015; Alibekova et al., 2016; Weng et al., 2016; Suzuki et al., 2019b). Also, exposure to SHS during pregnancy was associated with a reduction in exclusive breastfeeding duration (Baheiraei et al., 2014) and discontinuing any breastfeeding types before six months (Suzuki et al., 2019a).

However, almost all the effects reported in developed countries were from the United States and Europe. Studies from the Asian countries are few. Most studies done in Asian countries were conducted in Taiwan, China, and Korea. It is already known that women and children exposed to SHS are associated with health problems. Moreover, Indonesia's prevalence of current tobacco usage is 36.2% male youth and 4.3% female youth: 56.7% adult male and 1.9% adult female. Only a few male youths and adult male smokers use smokeless tobacco, and over 70% of males age 15 years or more in Indonesia are considered active tobacco smokers by any means (World Health Organization, 2015). In addition, the global adult tobacco survey reported that all non-smokers are exposed to SHS throughout Indonesia, particularly at home, restaurants, and public transportations (World Health Organization 2012). A study conducted in 31 countries described that over 60% of women and children are exposed to SHS outside (Wipfli et al., 2008).

Women, especially pregnant women and their fetus are also exposed to SHS in many places in Indonesia. Thus, the purpose of this study was to explore the association of SHS exposure from a partner or other family members on the maternal and perinatal outcomes of pregnant women and their infants in Tomohon, North Sulawesi Indonesia.

METHODS

Design and setting

In this retrospective cross-sectional survey, participants were drawn from a population sample frame, and who brought their baby for a health check or immunization at community health centers (*posyandu*) of the seven public health centers (*puskesmas*) in Tomohon which is one of the cities of North Sulawesi Province in central Indonesia.

Participants and procedure

Participants' selection included random sampling at two hospitals, seven puskesmas, and posyandu in each selected village in Tomohon. Postpartum women who were 20 years old or older and had a singleton birth within January to August 2017 and live in Tomohon were included. However, women who already moved out of Tomohon and women who did not consent to participate in this study were excluded. The questionnaires were distributed to participants by community health volunteers (kader) in each posyandu or each participant's house directly visited. Before collecting data, kaders were given an explanation of the study. Also, they were educated to collect the data from the research team. The participants first read

the consent form, and they agreed to participate. They then answered the questionnaire. The data were collected from May to October 2017.

Sample size

The sample size was calculated with a simplified formula for proportions (Yamane, 1967). The number of 1513 deliveries in Tomohon during 2015 was used to calculate the sample size. A confidence level of 95% and a p-value of 0.05 were assumed. The minimum sample size is 316, and an increase of 10% adjusted the target sample size to compensate for participants who might be excluded from the research. Therefore, the total number of participants needed is 348.

Measurements

The questionnaire was written in Indonesian, and it was created based on the Global Adult Tobacco Survey (GATS) questionnaire (Global Adult Tobacco Survey Collaborative, 2010),which was first designed in English and then translated into Indonesian. Also, independently back translated to English to check the quality of translation before being used for field implementation. The 52-item questionnaire included characteristics of mothers (mothers' age, parity, marital status, educational status, smoking status, occupation and working place, pre-existing condition), infants (gender, birth weight, and birth height), secondhand smoke exposure status (frequency of smoking status at home and office, smokers' information around women and infants), and health condition information for women and infants. The 20 postpartum women were recruited to validate the questionnaire from the same inclusion and exclusion criteria from the Minahasa regency, similar to the research setting before the primary research in Tomohon. After collecting the questionnaires, we only needed to make slight modifications for some items to increase clarity.

Statistical analysis

The dichotomous data were analyzed as odds ratio (ORs) and used single and multiple logistic regression models. Continuous data were analyzed using single and multiple linear regression models. The statistical significance is determined as p values less than 0.05, and results will be shown with 95% confidential intervals (CI). Statistical analyses were performed using IBM SPSS Statistics version 25 for Mac OS.

Ethical consideration

This researcher collaborated with Sam Ratulangi University, North Sulawesi, Indonesia, after ethical approval from St. Luke's International University, Tokyo, Japan (17-A007) and Sam Ratulangi University, North Sulawesi, Indonesia (2404/UN12/LL/2017). Participation in this research was completely voluntary after agreeing to the consent form. Also, we were informed of withdrawal by discontinuing the answers, and no disadvantage occurred to participants.

RESULTS

Demographics and characteristics of participants and SHS exposure status

Of the 991 eligible women enrolled at two hospitals and seven *puskesmas* in Tomohon, 348 eligible women were randomly picked to use the computer-based random number list. A total of 95 women were excluded because they were registered in the pregnancy information in *puskesmas*, but they had already moved out. Therefore, *kaders* could not locate some participants. Also, 19 women were excluded for analysis because their age was less than 20 years old or smoked during pregnancy. Finally, 234 (67.2%) women completed the questionnaire and were included in the analysis (Table 1). As many as 162 women (69.2%) reported exposure to SHS and 66 (28.2%) women were not exposed to SHS from someone in the household who was an active smoker. Also, 2.9% of smokers were

smoking only inside the home, 38.8% smoking only outside the home, and 58.3% smoking inside and outside the home. The relationship between smokers and pregnant women mainly was husbands (3.5% inside, 43.1% outside, and 53.5% of both). Other smokers were fathers (4.8% inside, 33.3% outside, and 61.9% of both).

Association between SHS and birth weight

The prevalence of LBW where the mother was exposed to SHS was higher than non-SHS exposure mothers (12.3% of SHS exposed vs. 6.6% of non-SHS exposure). There was no statistically significant difference in the risk ratio of LBW when exposed to SHS during pregnancy compared to the non-SHS group. However, the direction of 95% CI was a higher risk of LBW for SHS exposure. (Risk ratio = 2.0, 95% CI: 0.7 to 6.2).

The existence of SHS exposure was associated with birth weight using multiple linear regression analysis. Babies born from non-exposure mothers had heavier birth weight (g) than SHS exposures (Adjusted Estimate (β) = 488.23, 95% confidence interval [CI]: 86.78 to 892.67, p = 0.02).

Table 1. Characteristics of Participants by Secondhand Smoke Exposure Status

			Exposure status (n=228)		
		Total	**Non-SHS exposure**	**SHS exposure**	***p* value**
(%)		**n=234 (%)**	**n=66 (%)**	**n=162 (%)**	
Maternal age (n=212)	Median [IQR] Range	27 [24, 31] 20 - 46	27 [24, 31] 20 - 45	27 [24, 31] 20 - 46	0.38
	20 to 34	190 (89.6)	58 (92.1)	132 (88.6)	0.62
	Over 35	22 (10.4)	5 (7.9)	17 (11.4)	
Maternal education level	Primary school	3 (1.3)	0	3 (1.9)	<0.001
	Secondary school	34 (15.1)	6 (9.4)	28 (17.9)	
	High school	130 (57.8)	29 (45.3)	98 (62.8)	
	University/ College	58 (25.8)	29 (45.3)	27 (17.3)	
Marital status	Married	197 (88.3)	61 (96.8)	133 (85.8)	0.02
	Single (Divorced/Bereaved)	26 (30.8)	2 (3.2)	22(14.2)	
Maternal occupation	Housewife	155 (69.2)	38 (59.4)	116 (74.8)	0.03
	Working mother	69 (30.8)	26 (40.6)	39 (25.2)	
Maternal smoking status before pregnancy	Yes	10 (4.6)	3 (4.6)	7 (4.7)	1
	No	209 (95.4)	62 (95.4)	143 (95.3)	
Parity	1	81 (36.2)	25 (39.1)	52 (33.5)	0.44
	Over 2	143 (63.8)	39 (60.9)	103 (66.5)	
Pre-pregnancy	Median [IQR]	22 [19.7, 25.6] 12.7 - 37.8	22.1 [19.7, 25.5] 14.6 - 37.0	22.0 [19.9, 25.8]	0.94

BMI (n=186)	Range			12.7 - 37.8	
	Under weight	20 (10.8)	6 (10.9)	13 (10.3)	0.97
	Normal	89 (47.8)	27 (49.1)	60 (47.6)	
	Overweigh t	77 (41.4)	22 (40.0)	53 (42.1)	
Breastfeedi ng status	Exclusive breastfeedi ng	119 (52.9)	32 (49.2)	85 (54.8)	0.46
	Any breastfeedi ng	106 (47.1)	33 (50.8)	70 (45.2)	
EPDS [a] (n=218)	Median [IQR] Range	9 [7.0, 12.0] 1 - 23	9 [7.0, 12.3] 1 - 19	10 [7.0, 12.0] 1 - 23	0.71
	Less than score 9	87 (39.9)	28 (43.8)	57 (38.0)	0.45
	Over score 10	131 (60.1)	36 (56.2)	93 (62.0)	

			Exposure status (n=228)		
		Total	**Non-SHS exposure**	**SHS exposure**	***p* value**
(%)		**n=234 (%)**	**n=66 (%)**	**n=162 (%)**	
Paternal age (n=209)	Median [IQR] Range	30 [26, 35] 17 - 50	30 [27, 35] 21 - 50	30 [25, 34] 17 - 50	0.30
	20 to 35	155 (74.1)	45 (29.0)	110 (71.0)	0.61
	Over 35	54 (25.8)	18 (33.3)	36 (66.7)	
Paternal education level	Primary school	12 (5.4)	2 (3.1)	10 (6.5)	0.02
	Secondary school	43 (19.3)	7 (10.8)	36 (23.2)	
	High school	121 (54.3)	35 (53.8)	84 (54.2)	
	University/C ollege	47 (21.1)	21 (32.3)	25 (16.1)	
Paternal occupation	Private employee	49 (21.7)	14 (21.5)	34 (21.4)	0.05
	Government employee	22 (9.7)	12 (18.5)	10 (6.3)	
	Entrepreneur	45 (19.9)	15 (23.1)	29 (18.2)	
	Farmer	32 (14.2)	9 (13.8)	23 (14.5)	
	Laborer	28 (12.4)	4 (6.2)	24 (15.1)	
	Others	50 (22.1)	11 (16.9)	39 (24.5)	
Types of delivery	Vaginal birth	160 (71.4)	42 (64.6)	114 (74.0)	0.19
	Cesarean section	64 (28.6)	23 (35.4)	40 (26.0)	
Household earning [b]	Rp. 2.600.000 or less	111 (52.6)	27 (43.5)	84 (57.1)	0.10

	Over Rp. 2.600.000	100 (47.4)	35 (56.5)	63 (42.9)	
Types of households	Nuclear family	67 (29.9)	30 (46.9)	37 (23.9)	0.001
	Joint family	157 (70.1)	34 (53.1)	118 (76.1)	
Socioeconomic status [c]	High	62 (29.1)	44 (68.8)	18 (12.1)	<0.001
	Middle	82 (38.5)	10 (15.6)	72 (48.3)	
	Low	69 (32.4)	10 (15.6)	59 (39.6)	
Gender of baby	Boys	111 (47.8)	28 (42.2)	79 (49.7)	0.38
	Girls	121 (52.2)	38 (57.6)	81 (50.3)	
Birth week	Median [IQR]	36.2 [36.0, 38.0]	36.6 [36.0, 38.0]	36.0 [36.0, 38.0]	0.37
Birth weight (n=221)	Median [IQR] Range	3100 [2800, 3400] 1600 - 4500	3000 [2900, 3300] 1800 -4000	3100 [2800, 3400] 1600 - 4500	0.93
	Less than 2500 g	23 (10.2)	4 (6.3)	19 (12.1)	0.54
	Normal	192 (85.3)	57 (90.5)	135 (85.4)	
	Over 4000 g	6 (2.7)	2 (3.2)	4 (2.5)	
Birth height	Median [IQR]	48 [46.0, 50.0]	48 [45.0, 49.1]	48 [46.0, 50.0]	0.34

a Cut-off point is 9/10 based on using the Edinburgh Postnatal Depression Scale (EPDS) translated into languages other than English

b Cut-off point based on regional standard salary of North Sulawesi, Indonesia in 2017 (sourced by Badan Pusat Statistik)

c Based on score of nine items of economic indicator used for principal component analysis

Moreover, the birth weight of babies whose mothers were exposed to SHS outside the house was less than those exposed to SHS inside (Adjusted β = -272.39, 95% CI: -511.84 - -32.95, p = 0.03). However, on the one hand univariate regression analysis showed there was no significant association between the existence of SHS and SHS exposure place (β = -17.51, 95% CI: -159.16 - -124.13, p = 0.81 for existence of SHS, β = -67.99, 95% CI: -154.98 - -19.01, p = 0.12 for SHS exposed place). On the other hand, the univariate regression analysis reported pre-pregnancy BMI was associated with birth weight (β = 116.38, 95% CI: 12.99 to 219.77, p = 0.03). Also, multiple regression analysis showed no significant association, but there were weak trends between pre-pregnancy BMI and birth weight (Adjusted β = 125.02, 95% CI = -15.15 to 265.2, p = 0.08). All results are shown in Table 2 and 3.

Table 4 shows the effects of SHS exposure for LBW infants. Birth weights of continuous data were categorized into two categories LBW of less than 2500 g and normal weight baby that excluded the baby weight of 4000 g or more. There was a weak trend between exposure place of SHS and LBW (AOR = 2.53, 95% CI = 0.87 to 7.43, p = 0.06). However, there was no significant association between the existence of SHS and the place of SHS and LBW.

Association between SHS and breastfeeding

SHS exposure and breastfeeding condition had no significant association

(AOR = 1.06, 95% CI: 0.15 to 7.65, p = 0.95). Women who were married had significantly higher odds for the exclusive breastfed at two to four months than single mothers (AOR = 0.28, 95% CI: 0.09 to 0.89, p = 0.03). Moreover, the number of older mothers who exclusively breastfed at two to four months was significantly higher compared to younger mothers (AOR = 1.04, 95% CI: 1.01 to 1.29, p = 0.04) (Table 5).

Table 2. Effects of Secondhand Smoke Exposure for Birth Weight (Univariate regression)

	(β)	**(95% CI)**	**SD**	**t value**	***p* value**
SHS exposure	-17.51	(-159.16 to 124.13)	71.9	-0.24	0.81
SHS exposed place	-67.99	(-154.98 to 19.01)	44.1	-1.54	0.12
SHS exposed dose	-31.67	(-188.78 to 125.44)	79.5	-0.4	0.69
Smoked before pregnancy	-87.16	(-386.03 to 211.7)	151.6	-0.57	0.57
Maternal age [a]	-3.37	(-14.74 to 8.00)	5.77	-0.58	0.56
Maternal education [b]	-58.16	(-226.15 to 108.94)	85.0	-0.69	0.49
Pre-pregnancy BMI [c]	116.38	(12.99 to 219.77)	52.4	2.22	0.03
Parity [a]	29.34	(-45.63 to 104.31)	38.0	0.77	0.44
Gender of baby	-39.52	(-165.94 to 86.91)	64.2	-0.62	0.54
Paternal age [a]	-3.12	(-13.57 to 7.33)	5.3	-0.59	0.56
Paternal education [b]	-49.81	(-198.49 to 98.87)	75.4	-0.66	0.51
Household earning [d]	-22.97	(-151.06 to 105.12)	65.0	-0.35	0.72

a Continuous data were used for analysis

b Category was adjusted to combine the primary with secondary and above high school as dichotomous data

c Categorized data were used for analysis

d Cut-off point based on regional standard salary of North Sulawesi, Indonesia in 2017 (sourced by Badan Pusat Statistik)

SHS exposure	1: Exposed	2: Non-exposed	
SHS exposed place	1: Inside of house	2: Outside of house	
SHS exposed dose	1: 1 to 6 cigarettes/day	2: 7 to over 10 cigarettes/day	
Smoked before pregnancy	1: Yes	2: No	
Maternal education	1: Completed until Secondary	2: Completed until High School or more	
Pre-pregnancy BMI	1: Under weight	2: Normal	3: Overweight
Gender of baby	1: Boys	2: Girls	
Paternal education	1: Completed until Secondary	2: Completed until High School or more	
Household earning	1: Rupia 2.600.000/month or less	2: Over Rupia 2.600.000/month	

Table 3. Effects of Secondhand Smoke Exposure for Birth Weight (Multiple regression) _

	Adjusted (β)	**(95% CI)**	**SD**	**t value**	***p* value**
SHS exposure	488.23	(83.78 to 892.67)	203.4	2.4	0.02
SHS exposed place	-272.39	(-511.84 to -32.95)	120.4	-2.26	0.03
SHS exposed dose	-92.59	(-281.39 to 96.21)	94.9	-0.98	0.33
Smoked before pregnancy	-137.57	(-659.77 to 384.62)	262.6	-0.52	0.60
Maternal age [a]	-6.15	(-34.97 to 22.68)	14.5	-0.42	0.67
Maternal education [b]	90.2	(-277.48 to 457.88)	184.9	0.49	0.63
Pre-pregnancy BMI [c]	125.02	(-15.15 to 265.2)	70.5	1.77	0.08
Parity [a]	96.81	(-53 to 246.61)	75.3	1.29	0.20
Gender of baby	132.27	(-50.65 to 315.19)	92.0	1.44	0.15

	Adjusted (β)	(95% CI)	SD	t value	*p* value
Paternal age [a]	17.43	(-5.88 to 40.74)	11.7	1.49	0.14
Paternal education [b]	76.6	(-150.11 to 303.32)	114.0	0.67	0.50
Household earning [d]	-40.07	(-223.5 to 143.36)	92.2	-0.43	0.67

a Continuous data were used for analysis

b Category was adjusted to combine the primary with secondary and above high school as dichotomous data

c Categorized data were s used for analysis

d Cut-off point based on regional standard salary of North Sulawesi, Indonesia in 2017 (sourced by Badan Pusat Statistik)

SHS exposure	1: Exposed	2: Non-exposed	
SHS exposed place	1: Inside of house	2: Outside of house	
SHS exposed dose	1: 1 to 6 cigarettes/day	2: 7 to over 10 cigarettes/day	
Smoked before pregnancy	1: Yes	2: No	
Maternal education	1: Completed until Secondary	2: Completed until High School or more	
Pre-pregnancy BMI	1: Under weight	2: Normal	3: Overweight
Gender of baby	1: Boys	2: Girls	
Paternal education	1: Completed until Secondary	2: Completed until High School or more	
Household earning	1: Rupia 2.600.000/month or less	2: Over Rupia 2.600.000/month	

Table 4. Effects of Secondhand Smoke Exposure for Low Birth Weight by Exposure and Location

	OR (95% CI)	*p* value	Adjusted OR (95% CI)	*p* value
SHS exposure	2.02 (0.66 to 6.20)	0.22	0.46 (0.06 to 3.64)	0.56
SHS exposed place	1.83 (0.97 to 3.44)	0.06	2.53 (0.87 to 7.43)	0.06

Principal component analysis was used to construct and adjust the maternal age, maternal education, socioeconomic status, and parity.

LBW	1: 2500 to 3999 g	2: Less than 2500 g
SHS exposure	1: Exposed	2: Non-exposed
SHS exposed place	1: Inside of house	2: Outside of house

Table 5. Effects of Secondhand Smoke Exposure for Exclusive Breastfeeding Condition

	OR	(95 % CI)	*p* value	Adjusted OR	(95 % CI)	*p* value
SHS exposure	0.80	(0.45 to 1.43)	0.45	1.06	(0.15 to 7.65)	0.95
SHS exposed place	0.96	(0.67 to 1.37)	0.81	0.83	(0.24 to 2.83)	0.76
SHS exposed dose	0.87	(0.45 to 1.66)	0.67	0.74	(0.31 to 1.81)	0.51
Smoked before pregnancy	1.24	(0.34 to 4.53)	0.74	0.36	(0.03 to 5.06)	0.45
Maternal age [a]	1.03	(0.99 to 1.09)	0.17	1.14	(1.01 to 1.29)	0.04
Maternal occupation	1.02	(0.89 to 1.17)	0.77	0.95	(0.76 to 1.18)	0.63
Maternal education [b]	1.43	(0.68 to 3.03)	0.35	0.65	(0.13 to 3.18)	0.59
Socioeconomic status	0.90	(0.64 to 1.28)	0.56	1.04	(0.56 to 1.93)	0.89
Household earning	1.02	(0.59 to 1.78)	0.94	0.91	(0.36 to 2.30)	0.84
Types of household	1.17	(0.65 to 2.11)	0.59	1.73	(0.60 to 4.96)	0.31
Types of delivery	1.24	(0.69 to 2.23)	0.48	0.69	(0.26 to 1.81)	0.45
Parity [c]	0.88	(0.64 to 1.22)	0.44	0.59	(0.26 to 1.32)	0.20

	OR	(95 % CI)	*p* value	Adjusted OR	(95 % CI)	*p* value
Marital status	0.69	(0.45 to 1.07)	0.10	0.28	(0.09 to 0.89)	0.03

a Continuous data were used for analysis

b Category was adjusted to combine the primary with secondary and above high schools dichotomous data

c Categorized data were used for analysis

Breastfeeding condition	1: Exclusive	2: Any or only formula	
SHS exposure	1: Exposure	2: Non-exposure	
SHS exposed place	1: Inside of house	2: Outside of house	
SHS exposed dose	1: 1to6 cigarettes/day	2: Over 7 cigarettes/day	
Smoked before pregnancy	1: Yes	2: No	
Maternal education	1: Completed until Secondary	2: Completed more than High School	
Maternal occupation	1: Housewife	2: Working	
Socioeconomic status	1: Low	2: Middle	3: High
Household earning	1: Rp. 260000/month or less	2: Over Rp. 2600000/month	
Types of household	1: Nuclear family	2: Joint family	
Types of delivery	1: Virginal delivery	2: Cesarean section	
Parity	1: 1st time	2: 2nd time or more	
Marital status	1: Married	2: Single (divorced/bereaved)	

Association between SHS and maternal mental health

There was also no significant association between SHS exposure and depressive symptoms. However, both results of univariate and logistic regression analysis showed social economic status were associated with postpartum depressive symptoms (AOR = 0.29, 95% CI = 0.14 to 0.62, p < 0.01). For the univariate analysis, there was no significant association between postpartum depressive symptoms and household. However, multiple logistic regression results indicated that mothers who did not live with their parents were at higher risk of postpartum depressive symptoms. The EPDS total score showed a similar trend (AOR = 0.23, 95% CI = 0.07 to 0.76, p = 0.02) (Table 6).

Table 6. Effects of Secondhand Smoke Exposure for Postpartum Depressive Symptoms

	OR	(95 % CI)	*p* value	Adjusted OR	(95 % CI)	*p* value
SHS exposure	1.29	(0.71 to 2.34)	0.40	5.18	(0.57 to 46.60)	0.14
SHS exposed place	1.07	(0.73 to 1.55)	0.74	0.68	(0.19 to 2.47)	0.56
SHS exposed dose	1.53	(0.77 to 3.05)	0.22	0.82	(0.32 to 2.08)	0.67
Smoked before pregnancy	2.06	(0.54 to 7.92)	0.29	0.28	(0.02 to 4.89)	0.39
Maternal age [a]	0.97	(0.92 to 1.02)	0.29	1.03	(0.91 to 1.16)	0.64
Maternal education [b]	0.53	(0.23 to 1.21)	0.13	0.41	(0.08 to 2.03)	0.27
Socioeconomic status	0.51	(0.35 to 0.74)	<0.01	0.29	(0.14 to 0.62)	<0.01
Household earning	1.46	(0.82 to 2.58)	0.20	1.93	(0.71 to 5.28)	0.20
Types of household	0.77	(0.43 to 1.41)	0.40	0.23	(0.07 to 0.76)	0.02
Types of delivery	1.02	(0.55 to 1.87)	0.96	1.78	(0.61 to 5.19)	0.29
Parity [c]	0.90	(0.51 to 1.58)	0.70	0.58	(0.18 to 1.88)	0.36
Marital status	1.27	(0.81 to 1.98)	0.29	2.51	(0.95 to 6.65)	0.06

†Cut-off point is 9/10 based on using the Edinburgh Postpartum Depression Scale translated into languages other than English

a Continuous data were used for analysis

b Category was adjusted to combine the primary with secondary and above high schools as dichotomous data

c Categorized data were used for analysis

Score of EPDS	1: Less than score 9	2: Over score 10	
SHS exposure	1: Exposure	2: Non-exposure	
SHS exposed place	1: Inside of house	2: Outside of house	
SHS exposed dose	1: 1to6 cigarettes/day	2: Over 7 cigarettes/day	
Smoked before pregnancy	1: Yes	2: No	
Maternal education	1: Completed until Secondary	2: Completed more than High School	
Socioeconomic status	1: Low	2: Middle	3: High
Household earning	1: Rp. 260000/month or less	2: Over Rp. 2600000/month	
Types of household	1: Nuclear family	2: Joint family	
Types of delivery	1: Virginal delivery	2: Cesarean section	
Parity	1: 1st time	2: 2nd time or more	
Marital status	1: Married	2:Single divorced/bereaved)	

DISCUSSION

Main findings of this study

This research found that 97% household active smokers had a chance to smoke outside the house in Tomohon. In other words, it might define that non-smokers, mostly women and children, easily get SHS exposure outside the house. Moreover, maternal SHS exposure and SHS exposure outside the home during pregnancy were significantly associated with the risk of reduced birth weight in Tomohon. Also, there was a weak trend between SHS exposure outside the home and LBW.

Naeye (1987) found there was a weak trend for small placentas associated with LBW and that exposure to SHS during pregnancy negatively affected the placenta, increasing the risk for LBW. The possibility of older age mothers being well-educated about breastfeeding conditions, marital status, and maternal mechanism was associated with the cytokine's potential pathway. Exposure increased the risk for LBW. The mechanism was associated with the cytokine's potential pathway. Exposure to SHS increased cytokines, and it was related to lower placental weight (Niu et al., 2016). Generally, mothers exposed to inside SHS had the possibility of longer exposure times and a higher dose than mothers with outside exposure. Besides, mothers exposed to inside SHS might have inhaled more concentrated smoke compared to outside SHS exposure. Also, our research showed that over 85% of mothers are housewives in SHS exposure groups. It might be shown that exposure of women to SHS from active household smokers is more accessible inside the house.

However, Indonesian houses typically have good cross-ventilation—, where the average temperature is around 30 degrees Celsius throughout the year. Therefore, almost every house has ventilation holes other than windows. Therefore, the smoke might easily pass out from the house and be diluted by natural ventilation systems even if someone smoked inside the house. Thus, we created a hypothesis that women might have a longer and more chance to be exposed to SHS outside in Indonesia. This hypothesis is based on the public transportation systems in Indonesia. The Indonesians use small buses called micro for public transportation, and everyone can catch and ride it easily everywhere, and some passengers and drivers are often smoking inside the micro. Also, many men are smoking in masses at community meetings and parties. Thus, pregnant women are

easily exposed to SHS throughout public places, and pregnant women might be exposed to SHS even longer than inside their homes.

Our findings showed no direct statistical significance between SHS exposure and breastfeeding conditions or postpartum depressive symptoms. The findings in this study were different from the findings in our systematic review (Suzuki et al., 2019a; 2019b). However, we found that lower socioeconomic status increases the odds of depressive symptoms. The association between socioeconomic status and smoking was found in a previous study in Finland (Laaksonen et al., 2005). Also, other reviews showed that lower socioeconomic status countries, especially developing countries, had a higher prevalence of smoking (Hiscock et al., 2012). According to existing knowledge of these associations, lower socioeconomic status mothers might be exposed to higher tobacco smoking concentrations than higher socioeconomic status mothers. Moreover, there were associations of postpartum depressive symptoms with single marital status and the nuclear family. We hypothesized that single mothers and mothers in a nuclear family might have had no one to help and support them in the early demanding postpartum period. Also, for depressive symptoms and mothers' education level, there was an association between higher educated mothers and the risk of depressive symptoms. Well-educated mothers have more knowledge but also higher expectations of themselves compared to lower educated mothers. Perhaps, well-educated mothers feel a considerable challenge for baby's care, or some events happen that mothers never experienced nor expected. Then, they do not know how to cope, and it might be very stressful for them. Therefore, well-educated mothers possibly felt more nervous compared to lower educated mothers. A published study documents the association between current smoking and suicidal ideation (Hughes, 2008); smoking increases the risk of depression, anxiety, stress, and other mental health problems compared to those who quit smoking (Taylor et al., 2014). Another study reported that nicotine is the factor of depressive symptoms. However, the direct association between smoking and depressive symptoms was not clarified (Markou et al., 1998). There was an age factor. If mothers knew the benefit of breastfeeding for babies, mothers were more motivated to breastfeed (Hillenbrand and Larsen, 2002). Therefore, maternal age and breastfeeding conditions might be associated.

Of course, it would be possible to prevent adverse outcomes from SHS exposure if active smokers quit smoking in public places. According to the WHO's framework on tobacco control, it helps manage and implement tobacco control in each country. Furthermore, relatively new tobacco control packages include measures and resources. It includes six components and forms the acronym MPOWER (World Health Organization, 2008). Under the MPOWER implementation, many people will be saved from tobacco-related problems (Dubray et al., 2015; Ngo et al., 2017; Levy et al., 2018). However, Indonesia did not embrace the WHO Framework Convention on Tobacco Control (World Health Organization, 2012). They implemented their national tobacco program and several MPOWER components; however, some components have not yet been achieved, especially a smoke-free law and anti-tobacco mass media campaigns.

The one suggestion from these results is for the public health centers to promote a "stop smoking in public places" campaign. This campaign should include several aspects, such as promoting prevention education at pregnant women's checkups. Targeting teenagers at primary and secondary schools is crucial for preventing SHS exposure because teenagers already start smoking in Indonesia (World Health Organization, 2012). Furthermore, the smoker has some

social benefits, especially for men (Kaufman et al., 2015); additionally, smoking is known to show men's masculinity as one of the cultures in Indonesia (Nichter et al., 2009). Therefore, education must also address this and provide alternatives for socializing and self-image. In Indonesia, public health centers function as primary healthcare institutions; everyone has sickness or health problems. Also, public health centers serve as community health centers. The community health centers are connected to the community by the public health center's staff. Thus, everyone has more accessible access to the community health center than the public health center, which might be too far away and not accessible. Thus, a 'stop smoking' campaign might have more impact if promoted locally by the community health centers.

Limitations

There were several limitations to this study. First, it used under the minimum sample size for analysis. Then, we calculated the target sample size as 348. Unfortunately, we could not fulfill it, and there was only approximately 67% of the data for analysis. However, we used regression analysis to reduce some biases and confounding factors as much as possible and showed some of the effect of SHS exposure in Tomohon. While the results are general, perhaps if we had achieved the target sample the results might be different.

Second, the data about SHS exposure situations during pregnancy were collected from self-reports from postpartum women and the questionnaire distributed at two to four months postpartum; therefore, it may include recall bias and performance bias. Performance bias might be minimized because the results of this study had no direct benefit to participants; therefore, they had nothing to gain by obscuring the truth. We considered both recall bias and performance bias.

Third, cotinine levels in the body indicating SHS exposure were not verified. The SHS exposure status measured was only from the self-report questionnaire. Also, the number of non-SHS-exposure women was approximately half compared to SHS exposures. Therefore, more participants and reliable data by testing urinary, blood, or hair cotinine levels are required for future research.

CONCLUSION

In conclusion, maternal SHS exposure during pregnancy was associated with reducing infants' birth weight compared to non-maternal SHS exposure in Tomohon. However, there were no statistically significant associations between maternal SHS exposure and breastfeeding condition at two to four months and postpartum depressive symptoms. Further research is required in other areas in North Sulawesi province and should focus on interventions to prevent SHS exposure at home and in public places.

Also, one of our suggestions is to accept and follow WHO tobacco frameworks or smoke-free policy, especially in a public place, which may decrease the chance of SHS exposure of women, children, and other non-smokers. Besides, it is most important to educate fathers as to how SHS is harmful to women and children. Therefore, some promotion will be needed to hold and inform them in puskesmas about adverse effects of SHS and to consider the smoking place. Moreover, parent perinatal education classes will be held led by puskesmas and then educating both women and their partners might be helpful to reduce smokers inside the house.

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