Status of Environmental Tobacco Smoke Exposure During Pregnancy to Risk Enhancement of Low Birth Weight in Palembang City

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Abstract - A number of studies have found evidence to support the hypothesis that exposure to environmental tobacco smoke in pregnant women can increase the risk of impaired fetal growth. This study aims to analyze the relationship of environmental tobacco smoke exposure with the incidence of Low Birth Weight (LBW). The conclusion of causality, especially time relationship can be further explained in this study because it uses a case control study design with a sample of 145 maternal cases and 145 maternal control samples in 16 sub-districts in Palembang. Historical data on environmental tobacco smoke exposure were taken primarily by interviewing conditions while pregnant women using a structured questionnaire. The data obtained were then analyzed using univariate, bivariate with *chi-square* test, and multivariate with *multiple logistic regression* tests with risk factor models. There was a significant relationship between exposure to environmental tobacco smoke during pregnancy to the incidence of Low Birth Weight (LBW) (p-value: 0.018, OR 4.1 (95% CI 2.53-8.27)). There are no variables that interact with environmental tobacco smoke exposure during pregnancy in influencing LBW events. The variable most associated with the incidence of Low Birth Weight (LBW) is environmental tobacco smoke exposure during pregnancy after being controlled by maternal nutritional status variables during pregnancy (p-value: 0.014, OR 3.49 (95% CI 1.6-9.3)). Air pollution is proven to have an impact on birth outcomes. Environmental tobacco smoke is one of the air pollutants that can increase the risk of LBW when exposing the mother during pregnancy

Keywords: *environmental tobacco smoke exposure, low birth weight, pregnancy*

I. INTRODUCTION

Indoor air pollution is very dangerous to human health, because people spend more time doing activities in the house so that the house becomes very important as a microenvironment related to the risk of air pollution [1]. WHO reports that in 2012 around 7 million people died as a result of exposure to air pollution [2]. Every day, animals, air humidity, household products and other environmental factors such as smoking, contribute to indoor air pollution in public buildings and private homes [3].

Smoking and a damaged heating system can introduce harmful gases into the air in the room. Tobacco smoke contains more than 4,000 chemicals, including 43 species that have been known to cause cancer in humans and animals. Smokers and non-smokers inhale these chemicals when people smoke indoors. Carbon monoxide- a colorless and odorless gas that interferes with the absorption of oxygen in the blood [4]. The increasing presence of cigarette smoke in the air is in line with the increase in acute and chronic diseases. Based on 10 causes of death in the world in 2011, diseases caused by exposure to air pollution into several of them, such as lower respiratory tract infections (3.2 million cases), COPD / COPD (3 million cases), Trachea bronchus & lung cancer (1.5 million cases), and premature birth (1.2 million cases) [2].

In addition to the aforementioned diseases, chronic bronchitis, chronic obstructive pulmonary disease (COPD), lung cancer, Low Birth Weight (LBW) deaths,

infant deaths less than one week old, otitis media and ARI, tuberculosis are often found in environments with air quality in a bad room [1]. In 2013 UNICEF reported 2.9 million babies worldwide died in the first month of life. One reason is a history of low birth weight that does not immediately get serious treatment. Low Birth Weight (LBW) is a baby born weighing less than 2500 grams regardless of gestational age [5]. The mortality rate of babies with low birth weight is 35 times higher than babies with birth weight of more than 2500 grams [6]. More than 80% of deaths in newborns occur in babies with low birth weight (LBW) whether caused by premature, small for gestational age (SGA) or a combination of both [7]. The prevalence of LBW in the world was around 20.6 million (15.5%) in 2011 and 15.2% in 2012. Of the total LBW cases, 95.6% of cases were in developing countries [5].

In Indonesia, according to the results of Riskesdas, the prevalence of babies with low birth weight (LBW) decreased from 11.5% in 2007 to 11.1% in 2010 and to 10.2% in 2013 [8,9]. The prevalence of LBW in South Sumatra Province is 9.3% [9]. Palembang City, based on children's program reports, the number of infant deaths in 2012 was 97 infant deaths from 29,451 live births with causes of death including asphyxia, LBW, congenital abnormalities, pneumonia, and other causes (Profile of Basic Health Services Section (2011 in the Department Palembang City Health) [10]. Of the 29,235 live births there were 319 (1.13%) cases of LBW [11].

A number of studies have found evidence to support the hypothesis that exposure to cigarette smoke in pregnant women can increase the risk of impaired fetal growth [4,12,13,14,15]. This research is a reconfirmation study from previous studies [14] with a similar topic, but with the development of research variables. The relationship of exposure to cigarette smoke exposure with LBW events observed in this study is an analysis of the relationship up to the individual level. The conclusion of causality, especially time relationship can be further explained in this study because it uses a case control study design. This research is a research as a form of protection based on academic evidence about the impact of air pollution in space and is expected to later be able to provide recommendations for related parties to carry out environmental health management as a form of preventive measures against events or environmental based health disorders.

II. METHOD

This research was conducted in 16 districts in the city of Palembang. This study uses quantitative methods with a type of Case Control Study design. Case control study design is a study comparing cases (subjects with certain characteristics) with subjects who do not have these characteristics as controls. Comparison is done by comparing the output (exposure) of the variables that are suspected to be the cause of the cases under study. Case-control studies are also referred to as retrospective studies because they focus on past circumstances that might cause subjects to be cases and not controls.

The case control research design was chosen because this study was conducted to trace back the factors that caused BBLR in Palembang. This design is also suitable for use because in South Sumatra, especially in the city of Palembang, the prevalence of LBW is below 10%, namely 319 cases of 29,235 live births (1.13%) 10. However, this research is considered important to be done considering the impact arising from LBW events for children's health and health investment in adulthood. Case selection is based on records or reports of live births from 39 health care centre in 16 sub-districts in Palembang City. Because of these considerations, the case control study design is considered the right study design for this research.

In this study, samples were grouped based on the condition of infants with low birth weight, namely <2500gram (LBW) as cases and infants weighing ≥2500gram (Not LBW) as controls. Then samples from both groups were observed for past conditions to compare the history of exposure to cigarette smoke in the environment during pregnancy in the two groups.

The study population in this study is the total number of infants born alive in the city of Palembang, South Sumatra who was born throughout 2018. The sample of this study is a portion of infants represented by toddler households as a population unit with adult household members (age 17 years) as research respondents. Because this study collects primary data on characteristics, cigarette smoke exposure variables, and LBW risk factors, it must be known in advance the large proportion of LBW status variables from the results of previous studies to then calculate the minimum sample size.

By case: control ratio is 1: 1 so the required sample of research is 145 households with low birth weight babies (LBW) and 145 households with normal baby weight. The baby households to be sampled were selected using the justified sampling method with cluster sampling techniques to determine the location of the study after a selection process was previously based on inclusion criteria. Determination of the number of sample units in each cluster will be selected by proportional sampling and the selection of sample units to be visited for information extraction is selected by justified sampling.

Data is processed in tabular form. Data analysis that was carried out was quantitative and descriptive. This study conducted a univariate data analysis to determine

the frequency distribution. Bivariate analysis aims to see the relationship between the independent variables and the dependent variable. In this study, bivariate analysis was used to see the relationship between cigarette smoke status variables with LBW events. In addition, other risk factors such as internal factors under five (age, history of breastfeeding, history of infectious diseases) and external factors under five (genetics, maternal anaemia status during pregnancy, type of cooking fuel used, second hand smoker status, physical condition of the home) also bivariate analysis was carried out on the physical growth of infants.

The statistical test used in this study was chi-square with a significance level of 95% ($\alpha = 0.05$). The reason for using chi-square is because the data to be processed is categorical or discrete data, that is, birth weight data (LBW and normal) and data on the status of exposure to cigarette smoke in the environment (environmental tobacco smoke) (high exposure and low exposure). To determine the degree of relationship between exposure of environmental tobacco smoke to LBW events seen through the Odds Ratio (OR). Odds ratio is a comparison of the odds value of mothers with high exposure status to cigarette smoke in the environment during pregnancy in the LBW group compared to the odds value of mothers with high exposure status to cigarette smoke in the environment during pregnancy in the control group. In this study stratification analysis was conducted to see whether there was an interaction that occurred between cigarette smoke exposure variables during pregnancy to LBW events with other variables and analyzed the type of interaction that occurred. Variables that do not have interactions will then be tested stratified by confounding.

Multivariate analysis aims to link several independent variables with one dependent variable. To conduct a multivariate relationship test, this study uses a multiple logistic regression test.

III. Results

The sample of this study consisted of 285 respondents consisting of 140 respondents who had babies with low birth weight ie less than 2500 grams (LBW) as a case group and 145 respondents who had babies with normal birth weight that is above the same as 2500 grams as a control group. The initial minimum sample set of 145 respondents for each group could not be fulfilled because there were selected respondents who were no longer residing at the study site and there were several respondents who were not at home when the researchers conducted the study. Public health data related to the research objectives that have been collected are then coded and then analyzed according to the objectives of the study.

Based on Table 1 it is known that the average weight of newborn babies of respondents in this study was 2670.51 grams with a standard deviation of 699,742 grams. This can still be said to be good because the weight of the newborn is still above 2500 grams and does not include the category of Low Birth Weight (LBW). In this study, the lowest birth weight of babies was 1100 grams and the highest was 4800 grams.

Table 1. Frequency Distribution of Newborn Weight in Palembang in 2019

Statistical	Value (gram)
Mean	2670.51
Median	2550
Modus	2000
Std. Deviation	699.742
Minimum	1100
Maximum	4800

Table 2. Proportion of Newborn Weight in Palembang in 2019

Variables	Value (n)	Percentage (%)
LBW	140	49.1
Normal	145	51.9
Total	285	100.0

Furthermore, infant weight at birth is categorized into two namely LBW and Not LBW. The cut-off point used is the standard in determining LBW status in newborns, where if a baby is born weighing less than 2500 grams, it is included in the LBW category and if born with a body weight of more than 2500 grams is included in the non-LBW category.

Proportion of Pregnant Women Exposed to Cigarette Smoke during Pregnancy

In determining the status of respondents 'exposure to cigarette smoke during pregnancy, a compilation of respondents' exposure to cigarette smoke comes from sources of cigarette smoke during pregnancy (active smokers; passive smokers). The conditions in question include the status of the smoker of the mother, the presence of other household members who smoke in the house, the frequency of smoking near pregnant women, the presence and frequency of co-workers who smoke close to working mothers, neighbours who smoke near pregnant women, the mother's environment during pregnancy which is polluted by cigarette smoke. Furthermore, the compilation of these conditions is categorized into two categories, namely high exposure

with cigarette smoke and low exposure. The proportions for respondent's exposure status data to indoor air pollution are shown in table 3

Table 3. Proportion of Respondent Exposure Status During Pregnancy Against Cigarette Smoke

Exposure Status	Value (n)	Percentage (%)
High Exposure	241	84.56
Low Exposure	44	15.44
Total	**285**	**100.0**

Based on Table 3 it is known that the majority of respondents have a history of high exposure to cigarette smoke during pregnancy (84.56%). Next, the status of exposure will be seen in the two sample groups namely the case group (LBW) and the control group (not LBW) shown in Table 4. Based on Table 4 it is known that the proportion of history of cigarette smoke exposure during pregnancy is higher in the case group compared to the control group.

Table 4. Proportion of Exposure Status to Cigarette Smoke During Pregnancy in the Case and Control Groups

Exposure Status	LBW		Normal	
	n	%	n	%
High Exposure	146	60.6	95	39.4
Low Exposure	12	27.3	32	72.7
Total	**158**	**100.0**	**127**	**100**

Relationship between Cigarette Smoke Exposure During Pregnancy with LBW Events

To see the relationship between exposures to cigarette smoke during pregnancy with LBW events, a bivariate statistical analysis was performed using a chi-square test with a 95% confidence level. The results of the analysis are shown in Table 5. Based on Table 5 it is known that there is a significant relationship between exposures to cigarette smoke (environmental tobacco smoke) in pregnant women to LBW events. Also obtained a risk value of 4.1 (95% CI 2.53-8.27) which means that respondents who were exposed to high levels of cigarette smoke during pregnancy had a 4.1 times greater risk of giving birth to babies with low birth weight (LBW) compared to respondents who were low exposed. At a 95% confidence level the researchers believe that in the population, pregnant women who are exposed to high levels of cigarette smoke during pregnancy can increase the risk of giving birth to a low birth weight baby (LBW) by 2.5 times to 8.7 times.

Table 5. Cross Tabulation Between Cigarette SmokeExposure During Pregnancy to LBW Events

Exposure Status	BBLR	Normal	Total	OR (95% CI)	P Value
1.High Exposure	1 46 (60.6%)	95 (39.4%)	241 (84.5%)	4,1 (2,53-8,27)	0.018
2.Low Exposure	12 (27.3%)	32 (72.7%)	44 (15.4%)		
Total	158 (100%)	127 (100%)	285 (100%)		

Dominant Variables Affect LBW Events

In the confounding test of this study, three confounder candidate tests were performed by removing the alleged confounder variables and re-entering the variables that were proven to be confounders in the relationship of cigarette smoke exposure during pregnancy to LBW events. Variables that have a value of p> α (0.05) and are statistically proven as confounder candidates are variables of maternal age during pregnancy, co morbidities, and parity. Expenditures of these variables did not cause changes in OR by more than 10%, so these variables were excluded from modelling because they were not confounding for the relationship of cigarette smoke exposure during pregnancy to LBW events.

Table 6. Final Model (Full Model) Multivariate Analysis of Multiple Logistic Regression Risk Factors Models of Cigarette Smoke Exposure During Pregnancy Against LBW Events

Variable	B	Exp (B)	95% Confidence Interval		Nilai p
			Lower	Upper	
1. ETS Exposure	1.286	3.497	1.619	9.376	0.014
2. Maternal Nutrition	1.721	3.263	1.457	8.432	0,021
Constant	-2.892	0,047			0,001

In the final model (full model) (Table 6) it is known that exposure to cigarette smoke during pregnancy is the variable most associated with the incidence of LBW with a p value of 0.014 <α (0.05). It is also known that respondents who are exposed to high levels of cigarette smoke during pregnancy will be 3.49 times more likely to give birth to babies with low birth weight (LBW) after being controlled by variables of maternal nutritional status during pregnancy.

VI. Discussion

Based on Table 2 it is known, the distribution of contributions for babies with low birth weight (LBW) is not significantly different from babies born with normal weight. Basically, the birth results from the ability of the fetus to develop and the genital ability of this development process due to genetic, social and

environmental factors. Based on this, in this study the researchers also included other variables besides the environmental variables associated with LBW events. This can be used to estimate the relationship of air exposure in the future space to LBW events after being controlled by other variables.

Smoking and a damaged heating system can introduce harmful gases into the air in the room. Tobacco smoke contains more than 4,000 chemicals, including 43 species that have been known to cause cancer in humans and animals. Smokers and non-smokers inhale these chemicals when people smoke indoors. Carbon monoxide - a colorless and odorless gas that interferes with the absorption of oxygen in the blood. Materials such as the use of energy that is not environmentally friendly, the use of energy sources such as coal and biomass (wood, dried animal waste, agricultural residues), smoking behavior in the home, the use of pesticides, the use of cleaning chemicals can remove pollutants that can survive in space for a sufficiently long period of time.

Pregnant women who are exposed to second hand smoke (Tobacco Smoke) 5 have the same risks as pregnant women who smoke. Based on research, there are 3 toxic compounds that are carcinogens and can poison the mother and baby, namely benzo (a) pyrene, 4-aminobhipelin and acrylonitrile. Cigarette smoke contains 400 chemicals and 200 of them are poisonous. Carbon monoxide (CO) is one of the toxic substances that can cause blood vessels to clamp so that blood pressure rises, blood vessel walls can be torn. Co gas can also cause *desaturation* of hemoglobin, directly reducing the circulation of oxygen to tissues throughout the body, causing myocardial pressure, and CO can replace the place of O2 to bind with hemoglobin [7].

Passive smoking is someone who does not have the habit of smoking but is forced to smoke cigarette smoke exhaled by other people who happen to be nearby. Cigarette smoke can be divided into two, namely the main smoke (mainstream smoke) or smoke that is smoked by the smoker and side smoke (side steam smoke) which is smoke that is constantly coming out of the end of the cigarette. Side smoke from cigarettes has a very big effect on the health of people who are in an environment polluted by cigarette smoke, because a cigarette that burns will produce 2 times more side smoke than the main smoke and side smoke 3 times more dangerous than the main smoke [23].

Basically, all air pollutants have a detrimental impact on health. The effects of cigarette smoke exposure can be mediated by several mechanisms (for example, exposure to cigarette smoke can have a direct effect on fetal growth by crossing the placenta or indirectly through interference to maternal health). Potential toxicological effects of cigarette smoke exposure on birth outcomes include the effects of oxidative stress and inflammation, variability in heart rate leading to changes in heart function, and changes in blood clotting, endothelial function, and hemodynamic responses.

As explained earlier that one mechanism of cigarette smoke exposure affects fetal health is due to oxidative stress. Oxidative stress occurs due to excessive free radicals (for example, NO2 or CO contained in cigarette smoke) and decreased anti-oxidant defences. Oxidative stress can have a direct effect on placental function. Oxidative stress can cause DNA damage which will eventually cause DNA transcription disorders and result in an increase in the number of DNA adducts. There is no direct association between increased DNA adducts and adverse pregnancy outcomes, but there is evidence of research results that increase DNA adducts in the environment with heavy cigarette smoke and its relationship with stunted fetal growth. This study found no association between exposure to cigarette smoke and premature. Although there is no strong evidence to date showing a relationship between premature and cigarette smoke exposure, several research results have reported this relationship through various possible mechanisms of effect.

Cigarette smoke inhaled can penetrate up to the alveoli and will flow along with the blood and is distributed in the body and can be stored in various organs or tissues. If this pollutant is able to reach the placenta will cause inflammation of the placenta that can interfere with the exchange of trans-placental nutrition which can ultimately inhibit fetal growth. Inflammation can also increase the susceptibility of the mother to infection, which is closely related to the incidence of premature (25-45% of premature due to factors of maternal susceptibility to infection.

A number of studies have suggested that exposure to cigarette smoke (especially NO2, CO, and PM10) is associated with haematological effects such as changes in viscosity, blood *coagulability*, and vasoconstriction of the arterial canal which have an impact on heart health. If this effect occurs in pregnant women, it is likely to cause reduced blood flow to the placenta, preventing adequate oxygen transfer to the placenta and the weight of other *lypophilic* molecules. This results in stunted fetal growth and SGA. This is a mechanism of possible effects where cigarette smoke might limit growth but does not necessarily increase the risk of spontaneous preterm.

Exposure to cigarette smoke can also cause a hemodynamic response in the body such as changes in blood pressure, heart rate and rhythm, as well as autonomic heartbeats which have an impact on increasing systolic and diastolic blood pressure. Hemodynamic changes are a risk factor for hypertension and other cardiovascular diseases. Hypertension and cardiovascular

disease are risk factors for LBW.

The impact of air pollution caused by cigarette smoke on health can occur both directly and indirectly. Direct health problems can occur after exposure while indirect health effects can occur several years later after exposure (USEPA, 2007 in the Ministry of Health, 2011). In addition to these diseases, chronic bronchitis, chronic obstructive pulmonary disease (COPD), lung cancer, death, low birth weight (LBW), infant deaths less than one week old, otitis media and ARI, tuberculosis are often found in environments with deep air quality bad space (Ministry of Health, 2011). Exposure to cigarette smoke has been shown to affect birth outcomes (Mishra, et. Al (2006), Smith, et. Al (2004), Mishra, et. Al (2004), Tauseef and Zaidi (2006), and US Dept. Of Health and Human Service (2006)).

VII. CONCLUSION

There is a significant relationship between exposure to cigarette smoke during pregnancy and the incidence of LBW, and the variable most associated with the incidence of LBW is cigarette smoke exposure during pregnancy after being controlled for by the variable nutritional status of the mother during pregnancy. Recommendations for reducing the risk of LBW include avoiding or minimizing cigarette smoke exposure during pregnancy by consuming foods and drinks that have antioxidant benefits such as fruits and products containing high levels of vitamin C (oranges, pineapples, lemons, red grapes), berries, nuts beans containing lots of vitamin E (walnuts, hazelnuts, soybeans, sunflower seeds), dates, raisins, carbohydrate sources (corn and potatoes), vegetables (cabbage, spinach, beets, carrots, broccoli), green tea drinks, and milk low fat and use a mask when outside the home or around the environment with air pollution.

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