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EXPLORING INDOOR AIR POLLUTION EXPOSURE DURING PREGNANCY AND RISK OF LOW BIRTH WEIGHT IN SEBERANG ULU 1, PALEMBANG

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ABSTRACT

Adverse birth outcomes are determined by a complex combination of genetic, social, and environmental factors. Numerous studies have concluded an association exists between air pollution and low birth weight (LBW). This case-controlled study aimed to analyze the association by using 38 cases (mothers of LBW infants) and 40 controls (mothers of normal birth weight infants) in Seberang Ulu 1, Palembang City. Primary data related to indoor air pollution exposure during pregnancy was collected via structured interviews. The data was analyzed by performing chi-square and multiple logistic regressions within a risk factor model. Exposure to indoor air pollution during pregnancy was associated with the occurrence of LBW (chi-square test, p-value: 0.012, OR 3611 [95% CI 1.415 to 9.215]). No variables were found to have an interaction with the effects of indoor air pollution exposure during pregnancy and the occurrence of LBW. Exposure to indoor air pollution during pregnancy had the most significant impact on LBW occurrences after controlling for maternal age during pregnancy (multiple logistic regression, p-value: 0.019, OR 3.19 [95% CI 1, 21-8.406]). Air pollution has associated with the occurrence of LBW

Keywords: *Indoor air pollution, low birth weight, pregnancy,*

EKSPLORASI PAJANAN POLUSI UDARA DALAM RUANG SELAMA KEHAMILAN TERHADAP RISIKO KEJADIAN BBLR DI KECAMATA SEBERANG ULU 1 KOTA PALEMBANG

ABSTRAK

Hasil suatu kelahiran ditentukan oleh kombinasi faktor yang kompleks meliputi faktor genetic, social dan lingkungan. Sejumlah studi menemukan bukti yang mendukung hipotesis bahwa polusi udara dalam ruang dapat meningkatkan risikokejadian Berat Bayi Lahir Rendah (BBLR). Penelitian ini bertujuan untuk menganalisis hubungan pajanan polusi udara dalam ruang dengan kejadian Berat Bayi Lahir Rendah (BBLR). **P**enelitian ini merupakan penelitian dengan disain studi case control dengan jumlah sampel sebanyak 38 kasus (ibu bayi dengan BBLR) dan 40 kontrol (ibu bayi dengan BB lahir normal) di Kecamatan Seberang Ulu 1 Palembang. Data riwayat pajanan polusi udara diambil secara primer dengan cara wawancara kondisi saat ibu hamil menggunakan kuesioner terstruktur. Data yang didapat selanjutnya dianalisis secara univariate, bivariate dengan uji cho-square, dan multivariate dengan uji regresi logistic ganda model faktor risiko. Terdapat hubungan yang signifikan antara pajanan polusi udara dalam ruang selama kehamilan terhadap kejadian Berat Bayi Lahir Rendah (BBLR) (p-value: 0.012, OR 3,611 (CI 95% 1,415-9,215)). Tidak terdapat variabel yang berinteraksi dengan pajanan polusi udara dalam ruang selama kehamilan dalam mempengaruhi kejadian BBLR. Variabel yang paling berhubungan dengan kejadian Berat Bayi Lahir Rendah (BBLR) adalah pajanan polusi udara dalam ruang selama kehamilan setelah dikontrol oleh variabel umur ibu saat hamil (p-value: 0.019, OR 3,19 (CI 95% 1.21-8.406)).

Kata kunci: Polusi udara dalam ruang, berat bayi lahir rendah, kehamilan

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INTRODUCTION

Increased levels of air pollution are associated with increased rates of acute and chronic diseases. Some of the 10 most common causes of death globally in 2011 were diseases and conditions caused by exposure to air pollution, such as respiratory tract infections (3.2 million cases); chronic obstructive pulmonary disease (COPD) (3 million cases); tracheal, bronchial, and lung cancer (1.5 million cases); and preterm delivery (1.2 million cases).[1] In 2013, UNICEF reported 2.9 million babies worldwide die in the first month of life; one of the causes is low birth weight and lack of timely and adequate medical treatment.[2] The term low birth weight (LBW) describes an infant born weighing less than 2500 grams, regardless of gestational age.[3] The global prevalence of LBW was about 20.6 million (15.5%) in 2011 and 15.2% in 2012. Of the total cases of LBW, 95.6% occur in developing countries.[3] In Indonesia, according to Riskesdas's results, the prevalence of low birth weight babies (LBW) has decreased: 11.5% in 2007, 11.1% in 2010, and 10.2% in 2013.[4,5]

LBW prevalence in South Sumatera Province is 9.3%.[5] In Palembang City, based on child program reports, the number of infant deaths in 2012 included as many as 97 infant deaths out of 29,451 live births from causes such as asphyxia, LBW, congenital abnormalities, pneumonia, and other causes.[6] Of the 29,235 live births, there were 319 (1.13%) cases of LBW.[7] Many studies have found evidence supporting the hypothesis that air pollution may increase the risk of impaired fetal growth.[8,9] Indoor air pollution is one of the variables of interest in several studies on adverse birth outcomes.[10,11,12,13,14,15] This study is a reconfirmation study of a previous study.[16] On a similar topic, but with some refinement of the research variables. The relationship between indoor air pollution exposure and the occurrence of LBW observed in this study is analyzed at the individual level. The conclusion of causality, especially the temporal relationship, can be further explained in this study because it uses a case control design. This research can be basic of protection of the impact of indoor air pollution and is expected to provide recommendations for related parties to conduct environmental health management as a form of preventive effort against environmental health-related events or illnesses. This study aimed to analyze the association between exposure to indoor air pollution and the occurrence of LBW infants.

METHOD

Study Design and Sampling Procedure

This case control research study used the quantitative method. The sample was grouped based on the infants' birth weight; infants weighing <2500 grams at birth (LBW) were included as the cases, and infants weighing ≥2500 grams (normal) at birth were used as controls. The selection of cases was based on records or live birth reports from 5 health centers ('puskesmas') in the district of Seberang Ulu 1 in the city of Palembang. With a confidence interval of 95% ($\alpha = 0.05$), the power of the test was 90% ($\beta = 0.10$), and the value of P1 (the proportion exposed in the case group) was 73%.[17] The sample was selected using a simple random sampling method; the sample size was multiplied by the design effect (2): 10 x 2 = 20 live births.[18] Drop out was prevented by adding 10% of the sample so that 20 + 10% of 20 = 22 births. To prevent any expected values less than 5 by more than 25%, the researcher adds the number of samples doubles the number of births to 44. The births to be used as case and control samples were chosen using justified sampling via the cluster sampling technique for the determination of the location of the study after the selection process was performed based on the inclusion criteria. The determination of the number of sample units in each cluster was made using proportional sampling, and the selection of sample units to be visited for information was performed by means of justified sampling.

Sample Analysis

In the data analysis phase, the analyzed research samples included 78 respondents consisting of 38 case group and 40 control group respondents. Meeting the goal of obtaining an initial sample of 44 respondents for each group was not possible because some of the selected respondents no longer lived in the research location.

Instrument Development and Data Collection Procedures

Primary data in this study include respondent characteristics, nutritional status during pregnancy, maternal smoking habits, history of comorbidities during pregnancy, number of children and birth spacing (parity), and history of indoor air pollution exposure as measured by the presence of indoor pollutant sources. Data collection was conducted by interviewers using a structured questionnaire instrument which contained several questions aimed at exploring exposure history information and LBW-related risk factors. Secondary data covering the case data of LBW and normal birth weight infants obtained from 5 health centers (‘puskesmas’) in districts which became the research location. The collection of LBW incident data was performed by following these steps:

1. Determining the number of samples used in this study for both case and control groups using the Lemeshow formula and establishing the sample size of each health center (‘puskesmas') by using the proportional sampling technique.
2. Asking the community health centers’ permission to obtain live birth data from 2015 to determine the birth weight status and the infants’ home addresses.
3. Establishing a sample that meets the inclusion criteria to be visited using the justified sampling method and conducting structured interviews using a questionnaire.

Data Processing and Analysis

The process of data management involved several stages:

1. Data coding
   Verbal information was converted into data in the form of numbers or numbers that were adjusted to the operational definitions that have been made. Questions with open answer options were then recoded in accordance with predefined categories.
2. Editing data (data editing)
   Checks were performed on the thoroughness of information collected on the questionnaires. The answers given should be complete, clear, relevant and consistent so that data quality can be maintained properly.
3. Create the data structure and data file
   The data structure and data files were created before data was entered. This activity can also be described as creating a template or worksheet on the application software that will be used to assist in data analysis.
4. Entering data (data entry)
   The data was prepared for analysis by entering information from the questionnaire into the software on a computer system and statistical data analysis applications that existed in the faculty’s computer laboratory at the Public Health University of Indonesia in 2015.
5. Cleaning data (data cleaning)
   The entered data was checked again for accuracy.

The methods of data analysis in this study were univariate, bivariate, stratification, and multivariate. A univariate analysis was used to determine the frequency distribution of respondents' characteristics, LBW occurrence in study population, history of indoor air pollution exposure during pregnancy, and other risk factors such as maternal age during pregnancy, maternal nutrition during pregnancy, maternal smoking, maternal disease during pregnancy, and parity. The bivariate analysis aimed to identify the relationships between independent and dependent variables. In this study, a bivariate analysis was used to determine the correlation between indoor air pollution exposure during pregnancy and the occurrence of LBW, as well as LBW and other risk factors such as maternal age, maternal nutritional status during pregnancy, maternal smoking habits, comorbidities during pregnancy, and parity. The statistical test used for this purpose was chi-square with a significance level of 95% (α = 0,05). The chi-square test was used because the data to be processed was categorized or discrete case data (LBW and not LBW) as well as historical data related to exposure to indoor air pollution (high exposure versus low exposure).

In this study, a stratification analysis was performed to determine whether an interaction occurred between indoor air pollution exposure during pregnancy and LBW, as well as between other variables and analyze the type of interactions that occurred. Variables that had no further interaction were tested using a confounding stratified method. The multivariate analysis aimed to connect several independent variables with one dependent variable. To test the multivariate relationships, this research used an analysis of multiple logistic regression.

RESULTS

Prevalence of LBW Occurrence

Based on the results of the analyses, the average birth weight of infants born to respondents in this study was 2670.51 grams, with a standard deviation of 699.742 grams. In this study, the lowest birth weight reported was 1100 grams and the highest was 4800 grams. Furthermore, the birth weight of infants included in the study was categorized as either LBW or non-LBW. The distribution of the proportion of infants with low birth weight (LBW) did not differ significantly from non-LBW infants (Table 1).

Table 1.
Proportion of Newborn Weight Born in District Seberang Ulu 1City of Palembang 2016

Variable	n	%
LBW	38	48.7
Normal	40	51.3
Σ	**78**	**100.0**

Proportion of Pregnant Women Exposed to Indoor Air Pollution

Respondents' exposure to indoor air pollution during pregnancy status was determined by considering the presence of other household members who smoked in the home, the frequency of smoking near pregnant women, the presence and frequency of coworkers who smoke close to working mothers, the use of cooking fuels such as wood, oil, and gas, and the use of mosquito repellent and spray during pregnancy. Furthermore, compilations related to these conditions were categorized as either high exposure to indoor air pollution or low exposure (Table 2).

Table 2.
Proportion of Status of Exposure to Indoor Air Pollutionon Case Groups and Control Groups

Exposure Status	LBW		Normal	
	N	%	n	%
High Exposure	26	68.4	15	37.5
Low Exposure	12	31.6	25	62.5
Σ	**38**	**100.0**	**40**	**100**

The Relationship between Indoor Air Pollution and LBW

There was a significant relationship between pregnant women's exposure to indoor air pollution and the occurrence of LBW. There was also a risk score of 3.611 (95% CI 1.415-9.215) which means that respondents who were exposed to high levels of indoor air pollution during pregnancy had a 3.6 times greater risk of delivering LBW infants when compared to those with low exposure. At a 95% confidence level, it can be stated that in this population, pregnant women who are exposed to high levels of indoor air pollution during pregnancy are 1.4 to 9.2 times more likely to deliver LBW infants (Table 3).

Table 3.
Cross tab Between Exposure to Indoor Air Pollution during Pregnancy to LBW Occurrences

Exposure Status	LBW	Normal	Total	OR (95% CI)	p Value
High Exposure	26 (68.4%)	15 (37.5%)	41 (52.6%)	3,611 (1.415-9.215)	0.012
Low Exposure	12 (31.6%)	25 (62.5%)	37 (47.4%)		
Total	38 (100%)	40 (100%)	78 (100%)		

Dominant Variables Affect BBLR Events

The first step taken in the multivariate analysis using the risk factor model was testing the interaction with a stratification analysis. After the interaction test was performed, it was concluded that there were no variables that interacted in influencing the relationship between exposure to indoor air pollution during pregnancy and the occurrence of LBW. A multivariate analysis was conducted on the previous multivariate analysis for the OR adjusted to the low birth weight event (Table 4).

Table 4.
Preliminary Modeling Multivariate Analysis Multiple Logistic Regression Model Risk Factors In Individual Air Pollution Exposure During Pregnancy Against LBD

Variable	B	Exp (B)	95% Confidence Interval		p Value
			Lower	Upper	
Exposure of indoor air pollution	1.245	3.472	1.284	9.391	0.014
Maternal Age during pregnancy	1.216	3.373	1.129	10.077	0,029
Nutrition during Pregnancy	0.008	1.008	0.337	3.021	0,988
Disease during pregnant	0.109	1.115	0.412	3.023	0,830
Parity	-0.979	0.376	0.048	2.964	0,353
Constant	-2.127	0,119			0,389

In the confounding test, the candidate confounders were tested 3 times by removing the suspected confounder variables and re-entering the proven confounder variable in the exposure to indoor air pollution during pregnancy and the occurrence of LBW. The variables with p> α (0.05) and statistically proven as candidate confounders were maternal nutritional status during pregnancy, comorbidity, and parity. If excluding these variables did not cause an OR change of more than 10%, then the variable was excluded from modeling because it was not a confounder in the relationship between exposure to indoor air pollution during pregnancy and the occurrence of LBW. In the final model (full model) (Table 5), it is known that exposure to indoor air pollution during pregnancy is the variable most closely related to the occurrence of LBW, with a p value of 0.019 <α (0.05). It was also found that respondents exposed to high levels of indoor air pollution during pregnancy were 3.19 times more likely to deliver low birth weight infants after controlling for maternal age during pregnancy.

Table 5.
Final Model (Full Model) Multivariate Analysis Multiple Logistic Regression Model Risk Factor Exposure Air Pollution In The Room During Pregnancy Against LBD

Variable	B	Exp (B)	95% Confidence Interval		p Value
			Lower	Upper	
Exposure of Indoor air pollution	1.160	3.190	1.210	8.406	0.019
Maternal age during pregnancy	1.197	3.309	1.129	9.696	0,029
Constant	-3.688	0,025			0,002

DISCUSSION

Fundamentally, birth outcomes depend on the fetus' ability to develop normally, and generally, this developmental ability or process is affected by complex interactions between genetic, social, and environmental factors. Based on this knowledge, in this study, the researchers included variables other than just those related to environment in relation to the occurrence of LBW. It is intended to be able to more validly estimate the relationship between indoor air pollution exposure in pregnancy and the occurrence of LBW after controlling for other variables. The levels of some air pollutants are sometimes higher in closed-in spaces such as buildings than in ambient air.[19] Increased levels of indoor pollutants other than from pollutant penetration from outside the structure can also come from sources such as cigarette smoke, smoke produced during cooking and meal preparation, and the use of anti-mosquito repellent. Environmental or outdoor air pollution can also affect birth outcomes. Components of outdoor air pollution include gases (CO, SO2, CO2, NO2), propellant aerosols, and live particles (i.e. viable particulate pollutants).[20]

The WHO reported that the odds ratio of increased exposure to indoor air pollution impacting the occurrence of LBW was 1.74 (95% CI 1.2-2.5).[21] The impact of indoor air pollution in the home on health can occur either directly or indirectly. Direct health problems can occur immediately after exposure, while indirect health problems can occur several years after exposure.[22] Indoor air pollution has been proven to affect birth outcomes.[23,24,25,26,27] Sources of indoor air pollution include combustion processes such as using firewood for cooking, the use of anti-mosquito repellent, and people smoking tobacco indoors, among others.

CONCLUSION

There is a significant relationship between indoor air pollution exposure during pregnancy and LBW occurrence, and the variable most closely related to LBW occurrence is exposure to indoor air pollution during pregnancy after controlling for maternal age. Recommendations to reduce the concentration of indoor air pollutants and reduce the risk of LBW occurrence include avoiding or minimizing the use of indoor air pollutant emission sources, avoiding exposure to secondhand smoke during pregnancy, consuming foods and beverages that have antioxidant benefits such as fruit and products that contain high levels of vitamin C (oranges, pineapples, lemons, red wine), berries, legumes that contain lots of vitamin E (walnuts, hazelnuts, soybeans, sunflower seeds), dates, raisins, carbohydrate sources (maize and potatoes), vegetables (cabbage, spinach, beetroot, carrots, broccoli), green tea drinks, and low-fat milk.

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REFERENCES

1. WHO. The Top 10 Causes of Death: The 10 Leading Causes of Death in the World, 2000 and 2011. Geneva, Switzerland: World Health Organization; 2013.
2. IGME, U. I.-A. G. o. C. M. E. U. Levels and Trends in Child Mortality; Report 2013 New York: UNICEF; 2014.
3. WHO. WHO Guidelines on Preventing Early Pregnancy and Poor Reproductive Outcomes Among Adolescents in Developing Countries. Geneva, Switzerland: World Health Organization; 2011.
4. Litbangkes. Riset Nasional Kesehatan Dasar (Riskesdas) 2007. Jakarta: Kementerian Kesehatan Republik Indonesia; 2007.
5. Litbangkes. Riset Nasional Kesehatan Dasar (Riskesdas) 2013. Jakarta: Kementerian Kesehatan Republik Indonesia; 2013.
6. Dinkes. Profil Kesehatan Kota Palembang 2014. Palembang: Dinas Kesehatan Kota Palembang; 2014.
7. Dinkes. Profil Kesehatan Kota Palembang 2014. Palembang: Dinas Kesehatan Kota Palembang; 2015.
8. Bell, e. a. Ambient Air Pollution and Low Birth Weight in Connecticut and Massachuset. Environmental Health Perspectives, 2007; (115):1118-1124.
9. Brauer, e. a. A Cohort Study of Traffic Related Air Pollution Impacts on Birth Outcomes. Environmental Health Perspectives, 2008; (116): 680-686.
10. Abusalah A, Gavana M, Haidich A.-B, Smyrnakis E, Papadakis N, Papanikolaou A, & Benos A. Low Birth Weight and Prenatal Exposure to Indoor Pollution from Tobacco Smoke and Wood Fuel Smoke: A Matched Case–Control Study in Gaza Strip. Maternal Children Health Journal, 2011; (16): 1718–1727.
11. Ballester FEM, Iniguez C, Llop S, Ramon R, Esplugues A. Air Pollution Exposure during Pregnancy and Reduced Birth Size: A Prospective Birth Cohort Study in Valencia, Spain. Environmental Health Perspective, 2010; 9(6): 1-11
12. Fitria L, Wulandari RA, Hermawati E, & Susanna D. Kualitas Udara Dalam Ruang Perpustakaan Universitas ”X” ditinjau dari Kualitas Biologi, Fisik, dan Kimiawi. Makara, Kesehatan, 2008; 12(2): 76-82.
13. Llop S, e. a. Preterm Birth and Exposure to Air Pollutants during Pregnancy. Environ Research, 2010; 110 (8): 778-785
14. Salam MT, e. a. Birth Outcomes and Prenatal Exposure to Ozone, Carbon Monoxide, and Particulate Matter: Results from the Children's Health Study. Environmental Health Perspective, 2010; (113): 1638–1644.
15. Siddiqui AR, Gold EB, Yang X, Lee K, Brown KH, & Bhutta ZA. Prenatal Exposure to Wood Fuel Smoke and Low Birth Weight. Environmental Health Perspectives, 2008; 4(116): 543-549
16. Septiawati D, e. a. Pengaruh Pajanan Nitrogen Dioksida (NO_2) Terhadap Berat Bayi Lahir Rendah (BBLR) di Kota Palembang, Provinsi Sumatera Selatan. Jurnal Ekologi Kesehatan, 2017; 16 (1): 36-45
17. Lemeshow. Adequacy of Sample Size in Health Studies (D. Pramono, Trans.). Genewa: John Wiley & Sons; 1990.
18. Ariawan, IdB. Sampel dan Cara Penarikan [Modul Kuliah Rancangan Sampel]. Depok Fakultas Kesehatan Masyarakat Universitas Indonesia; 2012.
19. Baird, Colin & Cann, Michael. Environmental Chemistry (Fourth Ed). New York: W.H Freeman and Company.2008.
20. Mukono, H.J.Pencemaran Udara dan Pengaruhnya Terhadap Gangguan Saluran Pernapasan. Surabaya; Airlangga Universitas Press; 2008.
21. World Health Organization (WHO). Air Quality Guideline Global [online]. 2005. Cited: 2014, April 1, Available from http://whqlibdoc.who.int/hq/2006/WHO_SDE_PHE_OEH_06.02_eng.pdf?ua=1
22. Kementerian Kesehatan RI.Peraturan Menteri Kesehatan RI No 1077/Menkes/Per/V/2011 Tentang Pedoman Penyehatan Udara Dalam

Ruang Rumah. Indonesia: Kemenkes; 2011.

23. Mishra, Retherford, and Smith.Cooking Smoke and Tobacco Smoke as Risk Factors for Stillbirth. International Journal od Environmental Health Research, 2006;15(6):397-410.
24. Smith, Metha and Feuz.Indoor Air Pollution from Houshold Sloane. 2004. Anatomi dan Fisiologi. Jakarta: Penerbit Buku Kedokteran EGC; 2004.
25. Mishra V, Dai X, Smith KR, Mika . Maternal Exposure to Biomass Smoke and Reduced Birth Weight in Zimbabwe. Ann Epidemiol, 2004; (14): 740-747.
26. Tauseef and Zaidi.Indoor Air Pollution and Child Health in Pakistan. Addiction, 2001; 96(12): 1847-1854.
27. US Department of Health and Human Services. The Health Consequences of Smoking for Women: a Report of the Surgeon General. US: Department of Health and Human Services; 2006.