

*Original article*

The Association Between Exposure to Cigarette Smoke in Pregnant Women and Estimated Foetal Weight in Kepahiang Regency

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Abstract

Introduction: Infant mortality rate serves as a critical indicator in assessing population health, reflecting the overall well-being of a community. Foetal development is influenced by multiple determinants, including maternal health, foetal factors, and environmental conditions. When pregnant women are exposed to cigarette smoke as passive smokers, the toxic chemical constituents present in tobacco smoke can disrupt pregnancy outcomes. An early detection method to evaluate foetal growth involves estimating foetal weight through clinical examination.

Method: This study aims to analyse the characteristics of pregnant women exposed to secondhand smoke in relation to estimated foetal weight in Kepahiang Regency. This research employs an observational analytic design with a cross-sectional approach. Data were collected through structured questionnaires and uterine fundal height measurements, with a total sample size of 72 pregnant women.

Results: The analysis revealed no statistically significant association between household cigarette smoke exposure ($p = 0.722$), duration of secondhand smoke exposure ($p = 0.497$), or urinary cotinine levels ($p = 1.000$) and estimated foetal weight.

Conclusion: These findings suggest that maternal exposure to secondhand smoke may not necessarily influence estimated foetal weight, as other confounding factors could play a more dominant role in foetal growth.

Keywords: Pregnant Women, Cigarette Smoke Exposure, Estimated Fetal Weight.

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INTRODUCTION

The Infant Mortality Rate (IMR) serves as a vital indicator of a population's health, reflecting the broader well-being of a society. According to the 2020 UNICEF-WHO global, regional, and national report on low birth weight (LBW), approximately 1 in 7 infants worldwide—equating to over 20 million newborns—were born with LBW. The 2017 Indonesian Demographic and Health Survey (IDHS) recorded an IMR of 24 per 1,000 live births, with LBW and sepsis identified as the primary contributors to infant and neonatal mortality. Data from the National Socioeconomic Survey (Susenas) spanning 2018–2020 indicated fluctuating LBW rates in Bengkulu Province: 8.64% in 2018, increasing to 10.17% in 2019, before declining to 9.09% in 2020. Geographically, the highest proportions of LBW deliveries in Bengkulu were observed in Mukomuko Regency (15.63%), North Bengkulu Regency (12.40%), and Kepahiang Regency (10.95%).

Tobacco smoke exposure represents a significant environmental risk factor for foetal development. Smoking prevalence remains a major public health concern, particularly in developing nations such as Indonesia. The World Health Organization (WHO) projects a 45% increase in Indonesia's smoking population by 2025 (WHO, 2020). Longitudinal data from the Indonesian Basic Health Research (Riskesdas) demonstrate fluctuating smoking prevalence among adults aged ≥ 15 years: 34.2% (2007), 34.3% (2010), 36.3% (2013), 32.8% (2016 National Health Survey), and 33.8% (2018) (Riskesdas, 2018). Notably, Bengkulu Province exhibits the second highest smoking prevalence among Indonesian provinces (32.31% of adults ≥ 15 years), with an average daily consumption of 13 cigarettes per smoker (BPS, 2020), surpassed only by Lampung Province.

Maternal exposure to secondhand tobacco smoke during pregnancy has been associated with adverse gestational outcomes. Prolonged cohabitation with individuals who are active smokers significantly increases the likelihood of delivering an infant with low birth weight (Prince et al, 2021). During the critical period of organogenesis, specifically between the third and eighth weeks of gestation, inhalation of

tobacco smoke allows hazardous chemical constituents to enter the maternal circulatory system and subsequently reach the developing foetus. This exposure has the potential to disrupt normal organ formation, leading to genetic mutations and increasing the risk of congenital anomalies due to teratogenic mechanisms (Norsa'adah et al, 2014).

One approach to predicting whether a newborn will present with low birth weight (LBW) is through the estimation of foetal weight (Puspita et al, 2019). Foetal weight estimation is considered essential during pregnancy, as intrauterine growth does not occur at a constant rate—it accelerates during the early stages and gradually decelerates as gestational age advances. This variability is associated with an increased risk of perinatal complications, including both low and excessive birth weight (Hidayah et al, 2015). Foetal weight can be estimated antenatally, with maternal fundal height serving as a practical indicator for approximating both gestational age and foetal weight. Accurate prediction of birth weight during the early stages of labour is critical for guiding timely clinical interventions, thereby minimising potential complications for both mother and infant (Kurdanti et al, 2020). Based on the aforementioned considerations, the present study aims to examine the association between maternal exposure to secondhand tobacco smoke and estimated foetal weight in Kepahiang Regency.

METHOD

This study employed a quantitative approach with a cross-sectional design. The research was conducted at the Ujan Mas, Keban Agung, Tebat Karai, Kabawetan, and Pasar Kepahiang Health Centres in October 2021. The study population consisted of all pregnant women attending health check-ups at these health facilities, while the sample comprised 72 pregnant women with gestational ages ranging from 22 to 40 weeks. Sampling was conducted using a purposive sampling method. The sample size was determined using the formula developed by Lwanga and Lemeshow (1997), which calculates the sample size based on hypothesis testing for differences between two proportions.

Data collection was divided into two categories: primary data, which were obtained from questionnaires assessing household consumption and the duration of tobacco smoke exposure, and secondary data, which were sourced from the Maternal and Child Health (MCH) book. Urinary cotinine levels in pregnant women were measured using the Cotinine Test Card (DA-110c), while foetal weight estimation was carried out by measuring the Fundal Height (FH) with a measuring tape. Data processing was performed using a computerised system, including editing, coding, input processing, and validation. The data were analysed using univariate analysis to examine the frequency distribution of each research variable, and bivariate analysis was conducted using the chi-square test with SPSS statistical software version 20. Data were presented in the form of univariate and bivariate tables.

RESULTS

Univariate Analysis

The study was conducted on 72 pregnant women who met the inclusion criteria and were free from the exclusion criteria. The univariate analysis results for each variable are presented in the following table:

Table 1. Frequency Distribution of Household Tobacco Consumption

No.	Tobacco Consumption	Frequency	Percentage (%)
1.	Heavy (> 24 cigarettes/day)	2	2,8
2.	Moderate (11-24 cigarettes/day)	10	13,9
3.	Light (\leq 10 cigarettes/day)	60	83,3
Total		72	100

Table 1 presents the frequency distribution of subjects based on household tobacco consumption. Among the 72 subjects, the majority consumed tobacco at a light level, with 60 individuals (83.3%) in this category. The remaining subjects were classified as moderate smokers, with 10 individuals (13.9%), while only 2 individuals (2.8%) fell into the heavy consumption category.

Table 2. Frequency Distribution of Duration of Tobacco Smoke Exposure

No.	Duration of Exposure	Frequency	Percentage (%)
1.	Heavy Exposure (> 3 hours/day)	4	5,6
2.	Moderate Exposure (1-3 hours/day)	10	13,9
3.	Light Exposure (< 1 hour/day)	58	80,6
Total		72	100

Table 2 presents the frequency distribution of subjects based on the duration of tobacco smoke exposure. Among the 72 subjects, the majority had a history of light tobacco smoke exposure, with 58 individuals (80.6%) in this category. The remaining subjects had a history of moderate tobacco smoke exposure, with 10 individuals (13.9%), while 4 individuals (5.6%) had a history of heavy tobacco smoke exposure.

Table 3. Frequency Distribution of Urinary Cotinine Levels in Pregnant Women

No.	Cotinine Level	Frequency	Percentage (%)
1.	Positive (above cut-off 100 ng/ml)	6	8,3
2.	Negative (below cut-off 100 ng/ml)	66	91,7
Total		72	100

Table 3 shows the urinary cotinine levels among the 72 subjects. The majority, comprising 66 individuals (91.7%), tested negative for cotinine, while 6 individuals (8.3%) had positive cotinine levels.

Table 4. Frequency Distribution of Estimated Foetal Weight in Pregnant Women

No.	Estimated Foetal Weight	Frequency	Percentage (%)
1.	Not Appropriate	56	77,8
2.	Appropriate	16	22,2
Total		72	100

Table 4 indicates that, among the 72 subjects, the majority—56 individuals (77.8%)—had an estimated foetal weight that was not appropriate for their gestational age. In contrast, only 16 individuals (22.2%) had an estimated foetal weight that was appropriate for their gestational age.

Bivariate analysis

Table 5. Bivariate Analysis of Research Variables

Variable	p-value	Prevalence Ratio (95% CI)
Household Tobacco Consumption	0,722	0,957 (0,673-1,362)
Duration of Smoke Exposure	0,497	0,901 (0,631-1,286)
Urinary Cotinine Level	1,000	1,078 (0,737-1,579)

The results of the bivariate analysis indicate that there is no statistically significant association between household tobacco consumption and estimated foetal weight in pregnant women (p -value = 0.722; $p > 0.05$). Similarly, no significant association was found between the duration of tobacco smoke exposure and estimated foetal weight (p -value = 0.497; $p > 0.05$). Furthermore, there was no statistically significant relationship between maternal urinary cotinine levels and estimated foetal weight (p -value = 1.000; $p > 0.05$).

DISCUSSION

Household Tobacco Consumption among Families of Pregnant Women

Household tobacco consumption refers to the number of cigarettes smoked per day by the husband and other family members who are active smokers in the presence of the pregnant woman during her most recent pregnancy. In this study, it was found that the majority of pregnant women were exposed to light household tobacco consumption, yet their estimated foetal weights were not appropriate for gestational age. Most family members who smoked consumed fewer than 10 cigarettes per day. This may be attributed to the fact that these individuals spent a significant amount of time working and refrained from smoking during working hours.

Moreover, household economic status appeared to play a role in the level of tobacco consumption; families with lower socioeconomic conditions tended to consume fewer cigarettes. This is supported by the findings of Nizamie and Kautsar (2021), who stated that household income is directly related to consumption patterns, with decreased income leading to reduced demand for goods, including tobacco. Excessive spending on cigarettes reduces the household's capacity to meet other essential needs such as food, children's education, healthcare, and nutrition.

In addition, this study suggests that, beyond tobacco smoke exposure, other factors may influence estimated foetal weight, including maternal age, employment status, nutritional status, and level of

education.

Duration of Tobacco Smoke Exposure

The duration of tobacco smoke exposure refers to the average number of hours per day a pregnant woman is exposed to cigarette smoke from her husband or other household members during her most recent pregnancy. In this study, it was found that the majority of pregnant women (58 individuals, 80.6%) experienced low levels of exposure, in comparison to moderate and high exposure durations. This may be attributed to the fact that exposure, measured in hours, does not necessarily occur consistently on a daily basis. The intensity of smoking among household members is likely to fluctuate, making it difficult to classify the exposure as continuous.

Furthermore, many pregnant women reported consciously avoiding situations or environments they perceive as harmful to their own health and that of the developing foetus. Additional insights from brief interviews revealed that several active smokers within the household preferred to smoke outdoors, such as on the front porch, thus reducing the accumulation of second-hand smoke indoors. Consequently, the risk of sustained exposure within the home environment may be mitigated in such cases.

The length of second-hand smoke exposure largely depends on the smoking habits of cohabiting family members. The longer a person lives with active smokers, the greater the risk of exposure and the more significant the potential adverse health effects. Health impacts on passive smokers are influenced by both the duration and type of smoke exposure in their environment (Janah & Martini, 2017). In this study, six subjects tested positive for urinary cotinine, of whom five were aged over 35 years and one was under 20 years. This may indicate that tobacco smoke exposure began early—either after marriage to an active smoker or even earlier, during childhood, particularly for those raised in households with smoking family members.

A study conducted by Mostafa (2011) on indoor air pollution caused by tobacco smoke reported that cigarette smoke can linger indoors for weeks or even months. Toxins from tobacco smoke adhere to clothing and household surfaces and may re-enter the air when disturbed by airflow. As a result, women who live with smokers are at continued risk of exposure and may become passive smokers unintentionally. Tobacco smoke poses serious risks to the foetus, as it may impair blood flow and the delivery of essential nutrients, thereby increasing the risk of low birth weight (Damarawati et al, 2020). Moreover, prenatal exposure to tobacco smoke can lead to structural changes in the infant's DNA, potentially compromising the child's immune system in the long term (Amstrong, 2010).

Urinary Cotinine Levels

Tobacco smoke exposure adversely affects the health of both pregnant women and their unborn children. Nicotine, a major component of tobacco smoke, may impair nutrient transfer from the mother to the foetus, leading to disrupted foetal development and increased risks of adverse pregnancy outcomes such as low birth weight, miscarriage, placental abruption, placenta previa, placental insufficiency, preterm birth, congenital anomalies, and foetal growth restriction (Prawirohardjo, 2010).

Urinary cotinine testing is widely recognised as an ideal biomarker for assessing environmental tobacco smoke exposure in passive smokers. Cotinine is highly specific to tobacco exposure, possesses a relatively long half-life in the body (15–19 hours), demonstrates high sensitivity and specificity, and can be measured through a non-invasive and practical procedure (Florescu et al, 2009). Furthermore, urinary cotinine levels are approximately 4–6 times higher than cotinine levels in blood or saliva, making urine a more sensitive medium for detecting environmental tobacco smoke exposure (Suryatama et al, 2019).

In this study, no statistically significant association was found between urinary cotinine levels and estimated foetal weight. Several factors may explain this outcome. It is possible that active smokers within the household did not consistently smoke indoors or in the direct presence of the pregnant women, thereby reducing continuous exposure. Smoking may have taken place outdoors, such as on the veranda, or at workplaces rather than inside the home. Another potential explanation is the relatively high cut-off point (100 ng/ml) used in the Cotinine Test Card (DA-110c) employed in this study. Cotinine levels below or near this threshold may have gone undetected, leading to negative results even in cases of meaningful exposure.

These findings are consistent with a study by Asmirin (2020), which also found no significant association between urinary cotinine levels and stunting in children (p -value = 1.000). In that study, which used the same Cotinine Test Card (DA-110c) method, only 2 out of 115 children tested positive for urinary cotinine levels above the 100 ng/ml cut-off point, while 113 tested negative (15). The presence of cotinine levels approaching the cut-off point in both studies may indicate that environmental exposure was still

considerable but insufficient to be classified as “positive” under the current testing threshold.

Future research should consider using alternative methods capable of providing precise quantitative measurements of cotinine levels in urine, saliva, or blood. This would allow for more accurate detection and analysis of low-level or intermittent tobacco smoke exposure, especially in sensitive populations such as pregnant women.

CONCLUSION

The findings of this study on the determinants of estimated foetal weight among pregnant women exposed to tobacco smoke in Kepahiang Regency suggest that household tobacco consumption, duration of exposure, and urinary cotinine levels are not necessarily the primary factors influencing inappropriate estimated foetal weight for gestational age. Other contributing factors—such as maternal health status and level of knowledge—also play a significant role in foetal development during pregnancy. It is therefore recommended that local health centres (*Puskesmas*) enhance educational outreach to pregnant women, their husbands, and other family members. This could be achieved by disseminating information on the “*Isi Piringku*” (My Plate) campaign to promote balanced nutritional intake among pregnant women. Educational materials such as leaflets, posters, and digital media platforms commonly used by the community should be utilized to maximize reach and engagement. Additionally, healthcare workers—particularly midwife coordinators—should provide counselling and support, especially for women who have not yet experienced pregnancy. Special attention should be given to adolescents entering early marriage, to better prepare them for future pregnancies.

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