# Association of Secondhand Smoke Exposure During Pregnancy and Umbilical Cord Blood Vitamin D Levels with Newborn Weight

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**Track Record Article**

Accepted: 25 March 2023
Revised: 30 March 2023
Published: 22 June 2023

**How to cite :** Nasution, I. F., Sulastri, D., & Karmia, H. R. (2023). Association of Secondhand Smoke Exposure During Pregnancy and Umbilical Cord Blood Vitamin D Levels with Newborn Weight. *Contagion : Scientific Periodical of Public Health and Coastal Health*, *5*(2), 601-611

***Abstract***

*Newborn weight is an important predictor of the growth and survival of infants. Low birth weight affects newborns at risk of experiencing health problems and the risk of death Women in developing countries experience many pregnancies with malnutrition, and exposure to cigarette smoke can reduce micronutrient deficiencies. Exposure to cigarette smoke damages the health of pregnant women and their fetuses. Vitamin D is a micronutrient that supports every stage of pregnancy, the placenta, and the fetus to achieve a healthy pregnancy. This study aims to determine the association of secondhand smoke exposure during pregnancy and umbilical cord blood vitamin d levels with newborn weight. This research is a quantitative analytic observational study with a Cross-Sectional Study design. This research was conducted at Hermina Padang Hospital. The time of research was carried out from 14 December 2022 to 10 January 2023. The population in this study were all mothers who gave birth at Hermina Hospital. The sampling technique uses non-probability sampling. The number of samples in this study was 55 samples. Data analysis using the ANOVA test. The study results showed a significant mean difference between the level of exposure to cigarette smoke and birth weight. This can be seen from the p-value <0.05 (p=0.002) and no significant difference in the average blood vitamin D levels. Umbilical cord with birth weight, can be seen from the p-value>0.05 (p=0.484) at Hermina Padang Hospital. It is recommended that health workers provide counseling about exposure to cigarette smoke to pregnant women and mothers to pay attention to meeting the needs of vitamin D during pregnancy.*

***Keywords: Newborn Weight, Secondhand Smoke Exposure, Vitamin D***

## INTRODUCTION

The quality of the next generation is determined by optimal nutritional adequacy in the first 1000 days of life (window of opportunity) which greatly determines a child's ability to achieve optimal growth and development. Low birth weight burdens developing and developed countries' political, social, economic, and health systems (Lee et al., 2022). Low birth weight is a significant global problem where 20% of all births will be low by 2022 accounting for 20.5 million babies born with low birth weight (WHO, 2022). The incidence of LBW in Indonesia has increased from 6.2% in 2018 to 6.6% in 2021, and LBW is also the main cause of neonatal death in Indonesia, with a prevalence of 35.2% in 2020. West Sumatra is a province in Indonesia with a prevalence of anthropometric-size newborns at risk with a prevalence of birth weight <2,500 g (5.9%) (Kemenkes RI, 2021).

Based on research, babies born weighing <2500 grams are significantly 1.5 times more at risk of becoming stunted, 1.6 times more at risk of being very thin, and 2.0 times more at risk of becoming stunted and wasting compared to children with normal birth weight (Abbas et al., 2021). Low birth weight also affects newborns so that they experience health problems, such as hypoglycemia, hypothermia, mental retardation, and physical and neurodevelopmental problems resulting in a high risk of death in infants and also the risk of experiencing chronic disease in the future (Xi et al., 2020; Sun et al., 2020).

Fetal growth and development are caused by factors such as the mother's age during pregnancy, gestational age, prepregnancy weight, weight gain during pregnancy, anemia status, nutritional intake and exposure to cigarette smoke during pregnancy (Suzuki et al., 2019). Women in developing countries often experience malnourished pregnancies and exposure to secondhand smoke can exacerbate micronutrient deficiencies with health consequences for the fetus. The epidemic of tobacco smoking is one of the largest public health problems globally and the number of non-smokers exposed to secondhand smoke is steadily increasing (Kumar et al., 2020).

Exposure to cigarette smoke is the main preventable factor causing LBW. Cotinine in cigarette smoke can diffuse into the fetal blood and amniotic fluid and negatively affect neurological development. Exposure to cigarette smoke during pregnancy interferes with placental differentiation and proliferation (Amyx et al., 2021) . Cotinine is a vasoconstrictor that reduces uterine blood flow by 30%-40%, decreasing the supply of oxygen and nutrients needed for fetal growth. Cotinine also suppresses the production of amino acids and reduces the activation of enzymes associated with fetal growth (Ramadani et al., 2019). Even smoking has become a habit that is tolerated and not questioned by society (Nasution, 2020).

Research results show that mothers exposed to cigarette smoke are at risk of 1.16 times giving birth to babies with low birth weights (Andriani, 2021). Pregnant women exposed to secondhand smoke gave birth to babies who were an average of 282 g lighter than babies born to mothers who were not exposed. Exposure to secondhand smoke is also associated with adverse birth outcomes such as low birth weight, premature birth, spontaneous abortion, and congenital disabilities (Prince et al., 2021).

Optimal fetal growth is not only sufficient for macronutrients but must require micronutrients, even though micronutrients do not provide energy, they have an important role in the normal development of certain organs and the normal function of certain metabolic pathways. A micronutrient that plays an important role in the growth and development of the fetus is vitamin D. The fetus depends entirely on the mother's stores of vitamin D for its

development. Vitamin D maintains calcium homeostasis, bone integrity, and extraskeletal functions, namely it plays a role in glucose metabolism, angiogenesis, and immune function. Vitamin D also regulates transcription and gene expression during pregnancy (Mousa et al., 2019).

The impact of vitamin D deficiency on mothers is 1.72 times more risk of giving birth to babies with a birth weight <2500 grams (Mansur et al., 2022). Moreover, has the potential to interfere with epigenetic programming during the development of target organs/tissues such as the fetus's brain, liver and adipose tissue. It is also associated with low birth weight, poor bone health, impaired brain development, autoimmune diseases, obesity and insulin resistance (Ideraabdullah et al., 2019).

Low birth weight has become an important risk factor for increasing the disease burden. Based on this description, the researchers wanted to see if there was a relationship between exposure to cigarette smoke in pregnant women and levels of vitamin D in cord blood with the weight of newborns at Hermina Hospital, Padang City.

## METHODS

This research is a quantitative analytic observational study with a Cross-Sectional Study design. The study aimed to determine the relationship between exposure to cigarette smoke in pregnant women and vitamin D levels in umbilical cord blood with newborn baby weight.

Sampling and blood centrifugation were carried out at Hermina Padang Hospital, and vitamin D levels were examined at the Biomedical Laboratory, Faculty of Medicine, Andalas University, Padang. The time of research was carried out from 14 December 2022 to 10 January 2023.

The population in this study were all mothers who gave birth at Hermina Hospital. The sampling technique used Non-probability sampling with the Consecutive sampling method; all subjects who came sequentially and met the inclusion and exclusion criteria were included in the study until the required number of samples was met (Hardisman, 2021). The number of samples in this study was 55 samples.

Data collection in this study consisted of 1)The Secondhand Smoke Exposure Scale questionnaire on cigarette smoke exposure using interview techniques, 2)Enzyme-linked Immunosorbent Assays (ELISA) for measuring vitamin D levels using the DBC 25(OH)D ELISA Kit method.

Data analysis in this study used a one-way ANOVA test. The ANOVA test is a parametric test with the condition that the data is normally distributed and the ANOVA test requires a homogeneous data variant (homoscedasticity) category.

This research passed an ethical review by the research ethics committee of the Andalas University medical faculty with ethical number 1048/UN.16.2/KEP-FK/2022 on November 23 2022. All patients who were included in this study were given informed consent, an explanation of the research, objectives, benefits, risks, and research techniques that will be carried out in the research.

## RESULTS

**The characteristics of the research respondents in table 1 are as follows:**

**Table 1. Characteristics of Pregnant Women at Hermina Hospital, Padang City**

| Characteristic | Frequency | % |
|---|---|---|
| **Mother's Age (years)** | | |
| 21-35 Years | 49 | 89,1 |
| ≥36 Years | 6 | 10,9 |
| **Mother's Education** | | |
| Senior High School | 11 | 20 |
| College | 44 | 80 |
| **Parity** | | |
| Primigravida | 27 | 49,1 |
| Multigravida | 28 | 50,9 |
| **Mother's prepregnancy Body Mass Index (kg/m²)** | | |
| Normal | 43 | 78,2 |
| Over Weight | 12 | 21,8 |
| **Gestational Weight Gain of Pregnancy (kg)** | | |
| Not enough | 18 | 32,7 |
| Enough | 26 | 47,3 |
| Excess | 11 | 20 |

Based on Table 1, it is explained that almost all mothers' ages were in the range of 21-35 years (89.1%). Most of the mother's level of education (76.4%) was in college. Half of the total sample (50.9%) were mothers with multigravida. Most prepregnancy body mass index is in the normal range (78.2%). Nearly half of all samples of pregnant women experienced appropriate weight gain during pregnancy (47.3%).

The frequency distribution of sun exposure levels is in table 2 below:

**Table 2. Frequency Distribution of Sun Exposure Levels**

| Sun Exposure | Frequency | % |
|---|---|---|
| Low | 27 | 49,1 |
| Currently | 28 | 50,9 |
| Tall | 0 | 0 |

Based on the data in table 2. it shows that none of the samples got optimal sun exposure, half of the total samples were in the moderate category of 28 people (50.9%).

The distribution of the frequency of exposure to cigarette smoke in pregnant women is in table 3 below :

**Table 3. Frequency distribution of cigarette smoke exposure levels in pregnant women**

| Cigarette Smoke Exposure | Frequency | % |
|---|---|---|
| Not Exposed | 11 | 20,0 |
| Lightly exposed | 25 | 45,5 |
| Moderately exposed | 16 | 29,1 |
| Heavily exposed | 3 | 5,5 |

The data in table 3 shows that almost half of the sample of pregnant women was exposed to cigarette smoke in the light exposure category of 25 people (45.5%).

The frequency distribution of cord blood levels of vitamin D is shown in table 4 below:

**Table 4. Frequency distribution of cord blood vitamin D levels**

| Cord Blood Vitamin D Levels (ng/Ml) | Frequency | % |
|---|---|---|
| Optimal | 15 | 27,3 |
| Insufficiency | 18 | 32,7 |
| Deficiency | 22 | 40,0 |

Based on the data in table 4, almost half of the total samples are in the category of vitamin D deficiency as many as 22 samples (40%).

The average baby's birth weight is in table 5 below:

**Table 5. Average Baby Birth Weight**

| | ***Mean* ± SD** |
|---|---|
| Birth weight (grams) | 3016,45±432,38 |

Based on table 5. The mean value and standard deviation of birth weight of 55 samples is 3016.45 ± 432.38 grams.

Differences in Average Exposure to Cigarette Smoke in Pregnant Women and Newborn Weight in Table 6 below:

**Table. Differences in Mean Exposure to Cigarette Smoke in Pregnant Women and Newborn Weight**

| Cigarette Smoke Exposure | Birth Weight (grams) | | *p-value* |
|---|---|---|---|
| | ***Mean*** | **SD** | |
| Not Exposed | 3186,27 | 461,423 | 0,002 |
| Lightly exposed | 3165,68 | 366,935 | |
| Moderately exposed | 2745,56 | 373,16 | |
| Heavily exposed | 2594,67 | 179,626 | |

The research data in table 6 shows that the lowest mean birth weight was found in the pregnant women with a level of exposure with a mean and standard deviation of 2594.67 ± 179.626 grams. Based on the One-Way Anova parametric statistical test, showed that there was a significant average difference between the level of exposure to cigarette smoke and birth weight. This can be seen from the p-value <0.05, namely p=0.002.

Differences in Average Cord Blood Vitamin D and Newborn Weight in Table 7 below:

**Table 7. Differences in Mean Levels of Vitamin D in Cord Blood with Weight of Newborns**

| Cord Blood Vitamin D Levels (ng/mL) | Birth Weight | | *p-value* |
|---|---|---|---|
| | ***Mean*** | **SD** | |
| Optimal | 3028,60 | 366,779 | |
| Insufficiency | 3103,56 | 507,089 | 0,484 |
| Deficiency | 2936,91 | 87,820 | |

Based on the research data in table 7. The lowest average birth weight was in the pregnant women deficient in the vitamin D group with an average of 2936.91 ± 87.820 grams. One-Way Anova parametric statistical test showed no significant mean difference between umbilical cord blood vitamin D levels and birth weight with p-value> 0.05, p = 0.484.

## DISCUSSION

### Association between Secondhand Smoke Exposure During Pregnancy with newborn weight at Hermina Hospital, Padang City

Based on the One-Way Anova parametric statistical test, it shows that there is a significant relationship between the level of exposure to cigarette smoke and birth weight, this can be seen from the p-value <0.05, namely p = 0.002. This proves that the higher the exposure to cigarette smoke during pregnancy, the lower the average birth weight. In this study, researchers found that the exposure to secondhand smoke in pregnant women was related to the baby's birth weight, even at low levels of exposure.

This study's results align with the systematic literature review by Nadhiroh et al (2020) that exposure to cigarette smoke before or after birth is inversely related to body weight. Exposure to secondhand smoke is associated with adverse growth outcomes. Cigarette smoke contains more than 4000 chemicals that can cross the placenta and directly affect the hypothalamic center of the fetus, which can delay the body's growth. The hypothalamus is vital in weight control by balancing food intake, energy release, and body fat (Nadhiroh, 2020).

Cigarette smoke is harmful to pregnant women. Exposure to nicotine in pregnant women will cause stimulation of the catecholamine hormone (adrenaline), which stimulates the heart and blood pressure. The heart is not allowed to rest, and blood pressure will becomes higher, which results in hypertension (Gould et al., 2020). Exposure to secondhand smoke can alter heart rate and umbilical blood flow, and induce hypoxia in the fetus. Exposure to cigarette smoke in pregnant women will enter the lungs which are the main storage place for the body to be absorbed into the mother's circulation and reach peak concentrations in about 15-30 minutes. Minimal biotransformation occurs from the transition of nicotine into the placenta.

Nicotine is then recycled from the placenta back into the mother's circulation, but some are excreted into the amniotic fluid through fetal urine (Kuniyoshi et al., 2020).

According to recent studies, exposure to cigarette smoke in pregnancy can reduce blood flow to the placenta, possibly causing fetal growth disorders. Exposure to secondhand smoke in early pregnancy may affect placental development directly or indirectly by reducing blood flow, which creates a pathological hypoxic environment. Some of these studies' results indicate that mothers exposed to cigarette smoke are associated with decreased birth weight (Grandinata et al., 2019; Hanum et al., 2016; Wojtyla et al., 2021).

**Correlation between Cord Blood Vitamin D Levels and Newborn Weight at Hermina Hospital, Padang City**

Based on the One-Way Anova parametric statistical test, it showed that there was no significant difference in mean cord blood vitamin D levels with the mean birth weight with p-value> 0.05, p = 0.484. The results of this study are in conjunction with a prospective study conducted by Boychuk et al., (2020). This study conducted a food intake survey of pregnant women and assessed vitamin D levels in blood serum with an enzyme immunoassay. In the group of pregnant women with optimal vitamin D levels, the average child's weight at birth was slightly higher than the group of pregnant women with vitamin D deficiency or insufficiency. However, the difference was not significant (p>0.05), indicating no correlation between the nutritional status of maternal vitamin D and neonatal anthropometric measures (Boychuk et al., 2020).

This study showed no difference in mean birth weight between babies born to mothers with vitamin D deficiency and pregnant women with vitamin D deficiency. This is the same as the results of the Wierjeszka et al (2018) study, which showed no difference in birth weight between babies born from women with vitamin D deficiency and adequate levels. The investigators concluded that the currently recommended levels of vitamin D in pregnant women (>30 ng/ml) do not need to be achieved. Given the various reports, the consensus is that vitamin D levels should exceed 32 ng/ml for optimal pregnancy and pregnancy outcomes (Wierzejska et al., 2018).

The results of this study are different from the study of Adnan et al (2020) which stated that birth weight was positively correlated with levels of 25(OH)D (r = 0.23, p = 0.03) (Adnan et al., 2022) and research by Jose et al (2022) which stated levels of 25 (OH)D <20 ng/mL has an increased risk of LBW [OR 1.56 (95% CI 1.02–2.39)] (Mansur et al., 2022).

Vitamin D has an important function in calcium homeostasis and bone metabolism. Vitamin D has an extraskeletal role related to fetal growth, including cell proliferation, adipogenesis,

immunomodulation and glucose homeostasis, so its concentration during pregnancy should not only be seen through neonatal anthropometric measurements but also seen through long-term development and health conditions of infants and children (Lee, Ling, Loh, et al., 2022; Wierzejska et al., 2018).

The researcher's assumption that there are low levels of vitamins in cord blood is probably because the researchers did not assess the total amount of vitamin D (25(OH)D and (1,25(OH)D) in cord blood serum. In line with the theory of 25-hydroxyvitamin's and 1 , 25-dihydroxy vitamin must be transferred across the placenta. This transfer is important for the health of the fetal vitamin D and its transformation to 1,25(OH)2 vitamin D in determining the availability of vitamin D metabolites to the fetus in pregnancy. Transportation of 25(OH)D3 metabolites across the placenta can contribute to an increase in maternal 1,25(OH)2D3 concentrations during pregnancy, which contributes to maternal physiological adaptations that support pregnancy (Ashley et al., 2022).

They are based on research by Ashley et al (2020) using human placental perfusion using the isolated perfused placenta cotyledon methodology and villi explants. This study aimed to investigate the role of the placenta in regulating the relationship between maternal 25(OH)D and fetal physiology. The results of these studies indicate that the placenta plays an important role in determining the amount of 25(OH)D3 transferred to the fetus and storing and using 25(OH)D3 for its cellular needs. Placental metabolism and absorption of 13C-25(OH)D3 are key factors in determining the fetal 13C-25(OH)D3 supply. Active placental transport of 25(OH)D3 and synthesis of 1,25(OH)2D3 suggests that fetal supply depends on placental function rather than only maternal 25(OH)D availability (Ashley et al., 2022).

Oral vitamin D supplementation is not recommended for all pregnant women to improve pregnancy outcomes. This recommendation is in line with WHO recommendations regarding vitamin D supplementation during pregnancy found in WHO ANC guidelines (1) Pregnant women should be encouraged to receive adequate nutrition which is best achieved through consuming a healthy and balanced diet and referring to healthy eating guidelines (2) Pregnant women should be informed that sunlight is the most important source of vitamin D. For pregnant women who are suspected of having a vitamin D deficiency, the recommended vitamin D supplement is 200 IU (5 μg) per day (WHO, 2020).

## CONCLUSIONS

The results of this study indicate that there is a significant average difference between the level of exposure to cigarette smoke and birth weight, this can be seen from the p-value <0.05 (p=0.002) at Hermina Padang Hospital, and there is no significant difference in the average between vitamin levels D cord blood with birth weight, this can be seen from the p-value> 0.05 (p=0.484) at Hermina Padang Hospital.

It is recommended that health workers, especially midwives, provide not only physical care but also increase promotive, preventive, and even support efforts related to the problem of exposure to cigarette smoke during pregnancy and pay attention to meeting the needs of vitamin D during pregnancy for pregnant women or women in Indonesia to pay attention to the adequacy of vitamin D by pay attention to food intake and basking in the sun, if pregnant women are unable to meet the needs of Vitamin D, they need to be assisted with supplementation.

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