

## RESEARCH ARTICLE

## Comparison of Vitamin D<sub>3</sub> Serum and Method of Deliveries among Pregnant Women Who Did and Did not Performe Regular Outdoor Aerobic Activities

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### Abstract

The maternal mortality rate in Indonesia is still very high. One of the main factors is postpartum hemorrhage and an increase in cesarean section rate (CSR). The American College of Obstetrics and Gynecology has recommended aerobic exercise. We assumed that outdoor aerobic exercise could be useful for the advancement of labor and the reduction of CSR. This study aimed to assess whether regular exercise can have a good impact on reducing labor and CSR, which is likely to be affected by an increase in vitamin D<sub>3</sub> levels. It was an experimental study involving 40 patients at Al Islam Awibitung Hospital and Ibrahim Adjie Healthcare Center in Bandung in February–April 2018, who met the inclusion criteria and divided into two groups, who performed regular outdoor aerobic activity and those who did not. Patient characteristics, work progress, and vitamin D<sub>3</sub> levels recorded. The data collected was then tested and compared between pre-and post-treatment, a paired t test was done. There was a relationship between the increase in-vitamin D<sub>3</sub> and the ease of childbirth in the treatment group ( $p < 0.05$ ). The comparison of vitamin D<sub>3</sub> levels among the two groups was  $-18.8\%$  vs  $-26.8\%$ , respectively ( $p < 0.05$ ). Method of delivery were spontaneous delivery  $80\%$  vs  $25\%$ , vacuum extraction  $15\%$  vs  $55\%$ , and cesarean section  $5\%$  vs  $20\%$  respectively ( $p < 0.05$ ). In conclusion that regular outdoor aerobic exercise in a pregnant woman could increase vitamin D<sub>3</sub> levels, ease labor, and reduce CSR.

**Key words:** Method of deliveries, regular aerobic activity, vitamin D<sub>3</sub> level

## Perbandingan Kadar Vitamin D<sub>3</sub> Serum dan Metode Persalinan antara Ibu Hamil yang Menjalankan dan tidak Menjalankan Aktivitas Aerobik di Ruang Terbuka secara Rutin

### Abstrak

Saat ini angka kematian maternal di Indonesia masih sangat tinggi. Salah satu faktor penyebab utama adalah perdarahan pasca salin dan meningkatnya insidensi seksio sesarea. Aktivitas aerobik telah direkomendasikan oleh American College of Obstetrics and Gynecology (ACOG). Kami mempunyai hipotesis bahwa aktivitas aerobik rutin di udara terbuka dapat memengaruhi kadar vitamin D<sub>3</sub> serum ibu yang dapat meningkatkan kelancaran persalinan dan menurunkan risiko seksio sesarea. Penelitian ini bertujuan membuktikan hipotesis di atas. Metode penelitian adalah studi eksperimental terhadap 40 ibu hamil di RS Al Islam Awibitung dan Puskesmas Ibrahim Adjie Bandung pada bulan Februari–April 2018 yang memenuhi kriteria inklusi, serta dibagi dalam 2 grup, yaitu grup perlakuan yang melaksanakan aktivitas aerobik di udara terbuka secara rutin dan grup kontrol yang tidak melaksanakan aktivitas aerobik. Dilakukan pencatatan karakteristik pasien, kemajuan persalinan, metode persalinan, dan kadar vitamin D<sub>3</sub> sebelum dan setelah perlakuan, serta dilakukan analisis statistik dengan paired t test. Terdapat hubungan bermakna antara perubahan kadar vitamin D<sub>3</sub> dan metode persalinan ( $p < 0,05$ ). Perbandingan perubahan kadar vitamin D<sub>3</sub> antara kedua kelompok adalah  $-18,8\%$  vs  $-26,8\%$  ( $p < 0,05$ ). Metode persalinan adalah persalinan spontan  $80\%$  vs  $25\%$ , ekstraksi vakum  $15\%$  vs  $55\%$ , dan seksio sesarea  $5\%$  vs  $20\%$  ( $p < 0,05$ ). Simpulan, aktivitas aerobik rutin di udara terbuka pada ibu hamil berdampak terhadap kadar vitamin D<sub>3</sub> serum ibu dan dapat memperlancar proses persalinan serta menurunkan risiko seksio sesarea.

**Kata kunci:** Aktivitas aerobik rutin, kadar vitamin D<sub>3</sub>, metode persalinan

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## Introduction

Labor progress is an essential requirement to reduce the occurrence of cesarean sections and artificial vaginal parturition. The uterus undergoes contractions that become stronger and more coordinated during childbirth. Calcium is an essential aspect of uterine contractions, and an increase in the concentration of calcium in the cells is essential for the contraction of the myometrium. Calcium enters the myometrium cells through calcium channels. It binds with calmodulin in the cytoplasm, which activates myosin light chain kinase until ATPase activity increases, and myosin binds with actin, resulting in the muscles' contraction. The 25-(OH)-vitamin D<sub>3</sub> molecule is an essential aspect in the absorption of calcium by the body and in maintaining calcium homeostasis.<sup>1,2</sup>

The most recent research indicates there is a correlation between 25-(OH)-vitamin D<sub>3</sub> deficiency and labor problems, including preeclampsia, gestational diabetes, decreased fetal size, and increased risk of cesarean section surgery.<sup>3,4</sup> Increased risk for cesarean section surgery is associated with the negative effect of 25-(OH)-vitamin D<sub>3</sub> deficiency on uterine muscle contraction.<sup>5,6</sup> This vitamin plays a role in maintaining calcium homeostasis, bone mineralization, and muscle strength. Maintaining normal calcium levels is essential for muscle contraction, growth, and function.

As recommended by ACOG, regular aerobic activities offer many benefits during childbirth and may reduce the occurrence of cesarean sections and artificial vaginal parturition. It may be due to the association between increased levels of 25-(OH)-vitamin D<sub>3</sub> in the blood serum and aerobic activity during pregnancy.<sup>7,8</sup>

## Methods

This study is a randomized, non-randomized controlled sample of repeated observation at Al Islam Awibitung Hospital and Ibrahim Adjie Healthcare Center in Bandung in February–April 2018. Initial measurements of 25-(OH)-vitamin D<sub>3</sub> levels in the blood serum were taken before diagnosis, and final measurements were taken when pregnancy came to term. Such data were then subjected to statistical analysis.

Samples were collected from subjects that fulfilled the inclusion criteria. The amount collected was based on statistical calculations

with a confidence interval of 95% ( $z\alpha=1.65$ , one-sided test) and a power of 80% ( $z\beta=0.84$ ). The following sample size determination formula used to test the difference between the two averages,

$$n = \frac{2\sigma^2 (Z_{\alpha} + Z_{\beta})^2}{d^2}$$

Description: n=sample size,  $\sigma$ =standard deviation, d=difference in average vitamin D levels between physically active women at a term and a control group

Based on the standard deviation obtained from Mihalache,<sup>9</sup> vitamin D<sub>3</sub>'s standard deviation was 18.7 nmol/L and was determined to be 15 nmol/L. Based on the above formula, n=20, the sample size was 20 subjects per group.

Aerobic activities carried out were physical activities, including walking at 4 km/hour from 9:00 am to 11:00 am. The duration recommended by ACOG is 30–60 minutes for 3–5 days per week.

Vitamin D (25-(OH)-vitamin D<sub>3</sub>) levels, measured in ng/mL, were collected from the patient's blood serum and sent to the laboratory for examination. Levels of 25-(OH)-vitamin D<sub>3</sub> were assessed before treatment (34 weeks of pregnancy) and after treatment (37 weeks of pregnancy).

The ease of childbirth is assessed by the period from the opening of the active labor process in the first stage of labor before the cervix is completely dilated. It was anticipated that the subjects would come and stay in the hospital from the first stage of labor before delivery. The distribution method was recorded.

Ethical approval for this study has been obtained from the Health Research Ethics Committee of Dr. Hasan Sadikin General Hospital Bandung with the letter number: LB.04.01/A05/EC/349/XII/2017.

## Results

At least 40 subjects who met the inclusion criteria were recruited as a study, 20 subjects in the control group and 20 subjects in the treatment group who conducted routine aerobic activity. Subjects were patients from the Al Islam Awibitung Hospital and Ibrahim Adjie Healthcare Center in Bandung.

Table 1 shows the subjects' characteristics, including age and body mass index (BMI). Based on the resulting p value ( $p=0.900$ ,  $p>0.05$ ), there was no significant difference in age between the

**Table 1 Physical Characteristics of the Subjects**

Characteristics	Groups		p Value
	Treatment (n=20)	Control (n=20)	
Age (years)			0.900*
Average (SD)	25.8 (3.8)	26.0 (6.0)	
Range	18–32	17–37	
BMI			0.461**
Average (SD)	23.4 (4.2)	22.1 (3.3)	
Median	23.1	21.4	
Range	18.5–35.1	16.3–27.5	

Note: \*unpaired t test; \*\*Mann-Whitney test; treatment group: engaged in regular aerobic activities; control group: did not engage in aerobic activities

**Table 2 Comparison of 25-(OH)-vitamin D<sub>3</sub> Levels before and after Treatment**

25-(OH)-vitamin D <sub>3</sub> (ng/mL)	Groups		p Value
	Treatment (n=20)	Control (n=20)	
Data before treatment			
Average (SD)	25.8 (3.8)	33.7 (11.9)	0.035*
Median	22.9	33	
Range	12.2–63.7	17.8–64.3	
Insufficient	7	2	0.127**
Sufficient	13	18	
Data after treatment			
Average (SD)	31.8 (15.1)	24.3 (8.5)	0.108*
Median	28.3	22.1	
Range	13.4–69.0	11.6–37.1	
Deficient	0	1	0.303**
Insufficient	4	7	
Sufficient	16	12	
Difference in vitamin D <sub>3</sub>			<0.001***
Average (SD)	4.4 (3.6)	-9.4 (7.0)	
Median	4.6	-8.4	
Range	-2.2–10.2	-29.4–(-0.7)	
Percent increase in vitamin D <sub>3</sub> (average)	18.8%	-26.8%	<0.001***

Note: \*Mann-Whitney test; \*\*chi-square test; \*\*\*unpaired t test; significant if p<0.05

control group and the treatment group with an age range between 18–32 years old for the treatment group and 17–37 years old for the control group. There was also no significant difference in BMI ( $p=0.461$ ,  $p>0.05$ ) with a range of 18.5–35.1 for the treatment group and 16.3–27.5 for the control group.

Table 2 shows the level of 25-(OH)-vitamin D<sub>3</sub> before and after treatment. Based on the data, the 25-(OH)-vitamin D<sub>3</sub> level of the treatment group increased 4.4 ng/mL (18.8%) while the 25-(OH)-vitamin D<sub>3</sub> level of the control group decreased 9.4 ng/mL (26.8%). Based on an unpaired t test, the difference in 25-(OH)-vitamin D<sub>3</sub> levels

is significant, with a p value of 0.001 ( $p<0.05$ ). Based on the criteria for adequate 25-(OH)-vitamin D<sub>3</sub> levels, the treatment had 13 subjects with sufficient 25-(OH)-vitamin D<sub>3</sub> levels, which increased to 16 after treatment. Compare this to the control group, where 18 subjects had adequate 25-(OH)-vitamin D<sub>3</sub> levels, which decreased to 12 at the end of pregnancy.

The delivery methods can be seen in Table 3, which indicates that 16 of 20 subjects in the treatment group had spontaneous vaginal delivery compared to only 5 of 20 in the control group. Based on statistical analysis, there was a significant difference in the delivery method

**Table 3 Comparison of Delivery Method between Two Groups**

Delivery Method	Groups		p Value*
	Treatment (n=20)	Control (n=20)	
Spontaneous delivery	16	5	0.002
Cesarean section	1	4	
Vacuum extraction	3	11	

Note: \*chi-square test, significant if  $p < 0.05$

**Table 4 Ease of Labor based on the Duration of the Active Labor Phase in the First Stage of Labor**

Duration of Active Labor Phase (Hours)	Groups		p Value*
	Treatment (n=20)	Control (n=20)	
x (SD)	6.9 (1.4)	8.2 (1.6)	0.012
Median	7	9	
Range	5-9	6-10	

Note: \*Mann-Whitney test

**Table 5 Relationship between 25-(OH)-vitamin D<sub>3</sub> Levels and Ease of Labor**

Vitamin D <sub>3</sub> Levels(ng/mL)	Delivery Method			p Value*
	Spontaneous Delivery	Cesarean Section	Vacuum Extraction	
Treatment group	(n=16)	(n=1)	(n=3)	
Before treatment				
Average (SD)	29.4 (15.1)	22.4	18.4 (3.0)	0.138
Median	24.5		17.1	
Range	12.2-63.7		16.3-21.8	
After treatment				
Average (SD)	34.8 (15.4)	20.6	19.5 (1.6)	0.112
Median	31.2		19.6	
Range	13.4-69.0		17.8-21.1	
Increase in vitamin D <sub>3</sub>				
Average (SD)	5.4 (3.0)	-1.8	1.1 (3.5)	0.039
Percent increase (average)	22.5%	-8.0%	7.8%	0.174
Control group	(n=5)	(n=4)	(n=11)	
Before treatment	43.3 (16.6)	24.6 (8.0)	32.6 (7.7)	0.049
Average (SD)	47.7	22.6	35.6	
Median	22.8-64.3	17.8-35.4	20.6-44.8	
Range				
After treatment	2.6 (8.2)	16.0 (2.5)	24.9 (8.2)	0.046
Average (SD)	34.3	16.6	24.5	
Median	19.1-37.1	12.5-18.2	11.6-36.0	
Range				
Increase in vitamin D <sub>3</sub>				
Average (SD)	-13.7 (9.9)	-8.6 (9.2)	-7.8 (3.8)	0.289
Percent increase (average)	-28.7%	-29.0%	-25.1%	0.872

Note: \*F-test (variance analysis), significant if  $p < 0.05$

( $p=0.002$ ,  $p<0.05$ ). Besides, the ease of delivery measured by the length of the active labor period was in Table 4.

Based on the data, the length of the active labor period for the treatment group was, on average, 7 hours, with a standard deviation of 1.4 hours and a mean of 7 hours. The control group experienced an active labor period of 8 hours on average, with a standard deviation of 1.6 hours and a mean of 9 hours. Subsequent statistical analysis showed a significant difference between the length of time of the two groups ( $p=0.012$ ,  $p<0.05$ ). The subsequent statistical study revealed a substantial difference in length of time.

The data analyzed to determine the relationship between an increase in 25-(OH)-vitamin D<sub>3</sub> levels and the delivery process between the two groups. The analysis was in Table 5.

Based on the results, there was a significant relationship between the increase in 25-(OH)-vitamin D<sub>3</sub> levels and the ease of childbirth in the treatment group ( $p=0.039$ ,  $p<0.05$ ). It can be seen in the increase in 25-(OH)-vitamin D<sub>3</sub> levels compared to the relatively low occurrence of cesarean sections and vacuum extractions seen in the treatment group. However, the 25-(OH)-vitamin D<sub>3</sub> levels in the control group decreased, and there was no significant relationship between it and the ease of childbirth ( $p=0.289$ ,  $p>0.05$ ).

### Discussion

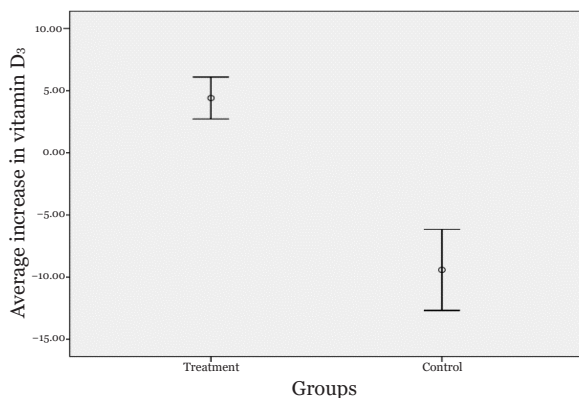
To observe the effects of regular aerobic activities for this study, a level of uniformity has to be maintained among the subjects chosen. It includes matching subjects with similar age,

BMI, and gestational age at the start of the study. It must be proven that there were no significant differences between the subjects given the treatment and subjects in the control group.

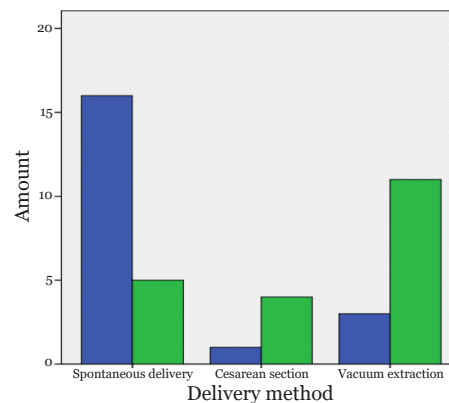
The average age of the subjects from the treatment group and the control group was 25.8 (3.8) years old and 25.6 (3.6) years old. Analysis from a subsequent t-test showed no significant difference in age between the two groups ( $p=0.900$ ,  $p>0.05$ ). The average BMI of the subjects from the treatment and control groups was 23.3 (4.2) and 22.1 (3.3). Subsequent Mann-Whitney test also showed no significant difference in BMI between the two groups ( $p=0.461$ ,  $p>0.05$ ). The similarity in age and BMI between the two groups showed that the subjects could be used to compare childbirth and differences in 25-(OH)-vitamin D<sub>3</sub> levels.

Low levels of 25-(OH)-vitamin D<sub>3</sub> levels during pregnancy have been associated with poor health conditions in mothers, such as preeclampsia, gestational diabetes, intrahepatic cholestasis during pregnancy, periodontal diseases, cesarean sections, and the development and mortality from HIV.<sup>9,10</sup>

Low 25-(OH)-vitamin D<sub>3</sub> levels during the first trimester were associated with poor pregnancy outcomes and neonates.<sup>9,11</sup> Article 2019 states that the results support the role played by 25-(OH)-vitamin D<sub>3</sub> in regulating the risk of complications during pregnancy and in maintaining fetal and bone development and immune maturation, particularly early in pregnancy.<sup>12,13</sup> Even though there is little and often contradictory evidence for the role maternal 25-(OH)-vitamin D<sub>3</sub> plays in pregnancy outcomes, neonate, and the health



**Figure 1 Increase in 25-(OH)-vitamin D<sub>3</sub> Levels of the Two Groups**



**Figure 2 Delivery Method of the Two Groups**



of the child, it does show that maternal vitamin D supplements are needed to prevent poor health outcomes for the mother, baby, and child.<sup>14,15</sup>

Previous studies have shown that there is a 25-(OH)-vitamin D<sub>3</sub> deficiency in pregnant women during the first trimester.<sup>16</sup> However, in normal pregnancy, 25-(OH)-vitamin D<sub>3</sub> rates will double after the third trimester.<sup>17–20</sup> This improves bone metabolism, immunomodulation, blood pressure control, and maintenance of insulin secretion by pancreatic beta cells.<sup>21,22</sup>

Initial examination of the subject's blood samples showed normal levels of 25-(OH)-vitamin D<sub>3</sub> in both the treatment and control groups. The average 25-(OH)-vitamin D<sub>3</sub> levels in the treatment and control groups were 27.4 ng/mL and 33.7 ng/mL. Table 2 shows the treatment group increase in 25-(OH)-vitamin D<sub>3</sub> by 4.4 ng/mL on average, which was an increase of 18.8%. However, the control group had a decrease in 25-(OH)-vitamin D<sub>3</sub> by as much as 9.4 ng/mL, which was a decrease of 26.8%. According to subsequent unpaired t test, the changes in 25-(OH)-vitamin D<sub>3</sub> levels were significant ( $p=0.001$ ,  $p<0.05$ ).

Labor begins with the first stage until the cervix is fully dilated. For primiparae, this first stage lasts for 8–12 hours on average and lasts 6–8 hours for multiparae. During the active labor phase, the rate of cervical dilation is 1.2 cm/hour for primiparae and 1.5 cm/hour for multiparae.<sup>23</sup> A rate of 1 cm/hour is usually used as an indicator of normal and abnormal labor.<sup>24</sup>

Dystocia is usually diagnosed if the rate of cervical dilation is lower than 0.5 cm/hour after 2 hours. Friedman stated that prolonged cervical dilation defined by a rate lower than 1.2 cm/hour for primiparae and 1.5 cm/hour for multiparae. Dystocia defines if there was no change in cervical dilation after 2 hours or if there was no fetal descent after 1 hour of observation.<sup>25,26</sup>

The ease of labor is determined by the method of childbirth undergone and the length of the first stage of labor. The onset of dystocia during labor typically involves more intervention, such as increased oxytocin, artificial vaginal parturition, and cesarean section.<sup>27,28</sup>

Researches showed a significant relationship between regular physical activities during the third trimester of pregnancy and an increase in spontaneous vaginal delivery and a decrease in the occurrence of cesarean sections.<sup>8,29</sup> Among pregnant women who underwent regular aerobic activities, there was a decrease in obstetric

operations and an increase in spontaneous vaginal delivery compared to women who did not undergo regular aerobic activities.<sup>30–32</sup> That research further supported by research done by Domenjoz et al.<sup>33</sup> concluded that there was a decrease in the occurrence of cesarean sections among pregnant women who performed regular aerobic activities.

Table 3 shows that of the 20 subjects in the treatment group who performed regular aerobic activities, 16 had a spontaneous vaginal delivery, 3 had vacuum extractions, and 1 had a cesarean section. It was significantly better compared to 20 subjects in the control group, where only 5 had a spontaneous vaginal delivery, 11 vacuum extractions, and 4 cesarean sections. Furthermore, statistical analysis showed a significant difference between the two groups ( $p=0.002$ ,  $p<0.05$ ).

The results showed a general positive effect of regular aerobic activities on childbirth in pregnant women. The higher percentage of spontaneous vaginal delivery was significant in suppressing the incidence of operative vaginal or abdominal delivery.

Research conducted in the Dr. Hasan Sadikin General Hospital showed that the highest indicator for cesarean section was oxytocin drip failure, which had a 53.6% rate. Table 3 shows that among pregnant women who did not perform regular physical activities, 4 of 20 subjects had cesarean sections because of oxytocin drip failure. Oxytocin augmentation was given to these four subjects due to an indication of hypotonic uterine inertia. The data illustrated the poor condition of this group that oxytocin required as a uterotonic. Of those given the uterotonic, some failed and had to undergo cesarean sections. However, subjects who performed regular aerobic activities had a normal vaginal delivery without surgery. The benefits of aerobic activities could be used by health agencies in an applicative program to promote spontaneous vaginal delivery.

Table 4 showed that the treatment group experienced an active labor phase of 7 hours on average with a standard deviation of 1.4 hours and a median of 7 hours. However, the control group experienced an active labor phase of 8 hours on average, with a standard deviation of 1.6 hours and a median of 9 hours. Statistical analysis showed that the difference between the two groups was significant ( $p=0.012$ ,  $p<0.05$ ).

Table 4 showed that the group who performed regular aerobic activities endured a faster active labor phase than the control group. This study

indicated that regular physical activities had a positive effect on pregnant women. It was similar to previous studies which also showed that pregnant women who engaged in regular physical activities experienced a faster active labor phase compared to a control sample.<sup>34</sup>

Table 5 showed that in the treatment group, there was a significant relationship between the increase in 25-(OH)-vitamin D<sub>3</sub> levels and the ease of labor ( $p=0.039$ ,  $p<0.05$ ). Subjects who underwent normal labor had a percentage increase in 25-(OH)-vitamin D<sub>3</sub> levels higher than subjects who underwent vacuum extractions or cesarean sections. In the control group, there was a decrease in 25-(OH)-vitamin D<sub>3</sub> levels and no significant relationship with the ease of labor ( $p=0.289$ ;  $p>0.05$ ).

This study showed that increased 25-(OH)-vitamin D<sub>3</sub> levels positively affected the ease of labor among pregnant women through regular aerobic activities. The increase in spontaneous vaginal delivery was significant and suppressed the occurrence of operative vaginal and abdominal delivery.

## Conclusion

In conclusion, there was an increase in 25-(OH)-vitamin D<sub>3</sub> levels in pregnant women who performed regular aerobic activities and had a better progression of labor than pregnant women who did not. Also, there was a positive relationship between increased levels of 25-(OH)-vitamin D<sub>3</sub> and the progress of labor.

## Conflict of Interest

There is no conflict of interest at all authors.

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