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*By* Julian Dewantiningrum

# Brain-derived neurotrophic factor (BDNF) and the capute scales in offspring of mothers with normal and deficient vitamin D levels



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## ABSTRACT

**Background:** Vitamin D deficiency during pregnancy is associated with a child's neurocognitive development. During the COVID-19 pandemic, the Capute Scales have become ineffective because requiring face-to-face interaction to examine children's neurocognitive development. Brain-Derived Neurotrophic Factor (BDNF) is an alternative method to determine children's neurocognitive development through blood sampling. This study aims to evaluate the relationships between BDNF and the Capute Scales in the offspring of mothers with vitamin D levels.

**Methods:** A diagnostic study from 14 community health centers in Semarang City, Central Java, Indonesia, was conducted. The study was performed from August 2017 until August 2018 and included vitamin D level records at 20–24 weeks of normal gestation in 2017 from all single births at these community health centers. The cases were divided into two groups: 30 children born to mothers with normal vitamin D levels (25(OH)D > 20 ng/mL) and 30 children born to mothers with vitamin D deficiency (25(OH)D < 20 ng/mL). This study aimed to assess the relationship between BDNF levels and the Capute Scales of children aged 2 years and to determine the cut-off value based on each group's examination of BDNF levels.

**Results:** The mean age of pregnant women whose vitamin D levels were checked was 29.32 years. The cut-off value of BDNF among the two groups was 7968 pg/mL. Of the 55 samples that met the Capute Scales criteria, 44 had a BDNF value less than the cut-off value, and 11 samples had a BDNF value more than the cut-off value. Meanwhile, of the five samples that met the Capute Scales criteria and were suspected of mental retardation, three had a BDNF value less than the cut-off value, and two had a BDNF value more than the cut-off value. The sensitivity, specificity, positive, and negative predictive values were 80%, 60%, 0.93, and 0.15, respectively.

**Conclusions:** BDNF levels can be an alternative neurocognitive examination in children born to mothers with normal and deficient vitamin D levels. BDNF is a growth factor that plays an important role in neurons' differentiation, growth, and survival in the postnatal phase.

**Keywords:** Brain-Derived Neurotrophic Factor, Capute Scales, Vitamin D.

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## BACKGROUND

Vitamin D is a micronutrient that contributes to bone growth and calcium homeostasis regulation. Vitamin D has several effects on neurodevelopment, and it plays a role in the growth of bone.<sup>1</sup> However, vitamin D deficiency remains a major public health issue worldwide because it can affect people of various ages and socioeconomic backgrounds. Pregnant women are the most at risk for vitamin D deficiency. Based on the Endocrine Society, vitamin D deficiency is defined as <20 ng/mL (<50 nmol/L). In a study conducted in West Sumatra, Indonesia,

vitamin D deficiency is prevalent in the first and third trimesters, accounting for 82.8% and 61.2%, respectively. Another study in West Java, Indonesia, found that 86.5% of pregnant women had vitamin D deficiency in the first trimester.<sup>2-4</sup> Vitamin D deficiency during pregnancy is due to lack of a vitamin D-rich diet, lack of mobility and exposure to sunlight, lack of vitamin D supplementation, and darker skin tones in some populations.

Fetuses are utterly dependent on their mother's vitamin D status.<sup>2-12</sup> Low levels of vitamin D during pregnancy have been correlated with a child's neurocognitive development, including

signaling roles in cell differentiation and synaptogenesis, gene expression, neurotrophic and neurotoxic factor metabolic control, and a protective role during brain inflammation.<sup>13-16</sup> The Capute Scales assessment determines a child's neurocognitive status. The Capute Scales is a tool for assessing cognitive, verbal, and physical development in children under three years old. This evaluation takes only 6–15 min to complete.<sup>17</sup> However, this measure has some limitations because the COVID-19 epidemic limits regular doctor-patient meetings. This limitation has resulted in a search for other neurocognitive tests that

can be performed.

Neurotrophin, which is a growth factor, has been demonstrated to play a role in the differentiation, synthesis, and protection of neuronal cells in several recent studies.<sup>18</sup> It also leads to brain-derived neurotrophic factor (BDNF), which is involved in both prenatal and postnatal brain development.<sup>19,20</sup> BDNF has been linked to a variety of neurocognitive issues, including neurological and mental diseases, in multiple studies.<sup>21</sup> Therefore, this study aimed to determine the cut-off value of BDNF levels based on the Capute Scales examination in children aged 2 years who were born to mothers with normal pregnancies and vitamin D deficiency.

## METHODS

### Data collection

The design was cohort retrospective. This study collected data from 14 community health centers in Semarang City, Central Java, Indonesia. This study was performed from August 2017 until August 2018. In addition, this study included vitamin D levels recorded at 20–24 weeks of normal singleton gestation in 2017 at these community health centers. The inclusion criteria were singleton and normal pregnancy. The subjects will be excluded if they have congenital anomalies and refuse to join this research. It also included the BDNF of children from birth through blood sampling and the Capute Scales examination in children aged 2 years. During the first 1000 days of life, the research team extracted data using piloted data extraction forms. In total, 353 cases were collected, but only 60 were recruited for the pilot study because of the COVID-19 pandemic. All of the subjects used consecutive sampling.

### Study design

The cases were divided into two groups: children born to mothers with normal vitamin D levels (25 (OH) D > 20 ng/mL) and children born to mothers with vitamin D deficiency (25 (OH) D < 20 ng/mL). A total of 30 cases were included in the normal vitamin D group and another 30 cases in the vitamin D deficiency group. Information about pregnant women was collected, including age, education, body

mass index (BMI) before pregnancy, and social-economic status. In addition, information about children, including sex, Z score, BDNF level, and the Capute Scales scores, was collected.

### Plasma BDNF evaluation

Plasma BDNF contents were measured using a commercially available ELISA kit (Elabscience Biotech). Plasma was collected using EDTA or heparin as an anticoagulant. The samples were centrifuged for 15 minutes at 10000 × g and 2°C–8°C within 30 minutes of collection. Afterward, 100 µL of supernatant was added to the appropriate well and pre-coated with an antibody specific to BDNF, followed by incubation for 90 min at 37°C. Then, a biotinylated detection antibody specific to BDNF and HRP conjugate was added to each well and incubated for 1.5 h. The substrate solution was added to each well, and the enzyme-substrate reaction was terminated by adding sulfuric acid solution. The final absorbance was read at 450 nm using a microplate reader (Victor X5, Perkin Elmer).

### Capute Scales examination

The Capute Scales consist of two types of examinations: the cognitive adaptive test (CAT) and the clinical linguistic and auditory milestone scale (CLAMS). A midwife in community health centers performed the Capute Scales examination. After the examination, the midwife, accompanied by a pediatrician, made a home visit and performed neurocognitive monitoring of the children. The CAT measurement also consists of 19 levels of testing age with 57 visual-motor milestones. The child should perform all of the milestones of the visual-motor scale (some spontaneous and some after being exemplified by the examiner). Each test should start at two age groups below the child's functional level and continue until the highest age group, where the child can complete the task. The CLAMS measures receptive and expressive language milestones. It has 26 expressive language milestones that cover 19 age levels of testing, namely, 1–12 months (1-month interval); 14, 16, and 18 months (2-month interval); 21 and 24 months (3-month interval); and 30 and 36 months (6-month

interval). The Capute Scales were cumulative scores of CAT and CLAMS.

### Statistical analysis

Statistical analysis was performed using SPSS version 25.0 (SPSS Inc., Chicago, IL, USA) for Windows. Normally distributed data were expressed as mean ± standard deviation. We analyzed the Independent-T Test to compare the parametric scale characteristics and the Chi-square test to compare the continuous and categorical data between the two groups. Pearson's correlation analysis was used to explore relationships. The cut-off value of BDNF in children born to mothers with normal vitamin D levels and children born to mothers with vitamin D deficiency was calculated using the Youden index of the receiver operating characteristic (ROC) curve. A p-value less than 0.05 was considered significant.

## RESULTS

Sixty pregnant mothers and their children were included in this study. The characteristics of the samples are listed in Table 1. No significant difference in maternal age, weight, height, BMI, educational status, or socioeconomic level was observed between the two groups. The average vitamin D level in the normal group was 23.83 ± 4.39 ng/mL, whereas the average vitamin D level in the deficiency group was 15.57 ± 2.50 ng/mL. On the contrary, a mean difference in BDNF levels was observed in children of pregnant women with normal vitamin D levels and the offspring of pregnant women with vitamin D deficiency, but this difference was not statistically significant. In addition, no differences were found between the two groups.

The optimal cut-off value was obtained using the Youden index J formula, the largest value (sensitivity + specificity – 1) of any one cut-off value. The ROC curve in Figure 1 shows an optimal cut-off value of 9,769.50 pg/mL. The cut-off sensitivity value was 80%, with a specificity of 60%. In addition, the positive predictive value was 0.93, and the negative predictive value was 0.15. The accuracy of the cut-off value was 76.67%, with a 95 % Area Under Curve (AUC) of 0.585.



**Table 1. Characteristics of Samples.**

Characteristics	All (N = 60)	Normal vitamin D level (n = 30)	Vitamin D deficiency (n = 30)	p
<b>Pregnant Women</b>				
Age (Year) (mean±SD)	29.32 ± 5.71	30 ± 5.93	28.63 ± 5.49	0.631
Weight (kg) (mean±SD)	53.72 ± 10.11	52.73 ± 9.69	54.70 ± 10.58	0.452
Height (m) (mean±SD)	1.52 ± 0.05	1.51 ± 0.05	1.52 ± 0.05	0.571
Body Mass Index before pregnancy (kg/m <sup>2</sup> ), n (%)				0.530
Underweight	6 (10.0)	3 (10.0)	3 (10.0)	
Normal	34 (56.7)	19 (63.3)	15 (50.0)	
Overweight	20 (33.3)	8 (26.7)	12 (40.0)	
Education Status, n (%)				0.136
Elementary School	4 (6.7)	3 (10.0)	1 (3.3)	
Junior High School	14 (23.3)	7 (23.3)	7 (23.3)	
Senior High School	36 (60.0)	18 (60.0)	18 (60.0)	
Diploma degree	4 (6.7)	0 (0.0)	4 (13.3)	
Bachelor degree	2 (3.3)	2 (6.7)	0 (0.0)	
Socioeconomic status (income), n (%)				0.500
Middle income	23 (38.3)	11 (36.7)	12 (40.0)	
Low income	37 (61.7)	19 (63.3)	18 (60.0)	
Vitamin D levels (ng/mL) (mean±SD)	19.70 ± 5.46	23.83 ± 4.39	15.57 ± 2.50	0.452
<b>Offspring</b>				
Sex, n (%)				0.060
Male	29 (48.3)	11 (36.7)	18 (60.0)	
Female	31 (51.7)	19 (63.3)	12 (38.7)	
Weight (kg) (mean±SD)	12.37 ± 1.56	12.25 ± 1.61	12.49 ± 1.53	0.869
Height (cm) (mean±SD)	89.41 ± 10.25	98.75 ± 14.12	91.08 ± 2.95	0.064
Head circumference (cm) (mean±SD)	47.68 ± 1.15	47.57 ± 1.17	41.74 ± 76.18	0.984
Upper arm circumference (cm) (mean±SD)	14.94 ± 1.07	14.94 ± 1.16	14.95 ± 1.14	0.111
BDNF level (pg/mL) (mean±SD)	7,605.55 ± 4,202.23	7,329.37 ± 3,791.60	7,881.73 ± 6,991.50	0.346

\*p-values were provided by independent *t* test to compare the parametric scale characteristics and Chi-square and Fischer exact test to compare the continuous and categorical data between the two groups.

Table 2 shows the sample distribution with a comparison between the BDNF cut-off value and the Capute Scales criteria. Of the 55 samples that met the normal Capute Scales criteria, 44 had a BDNF value less than the cut-off value, and 11 samples had a BDNF value more than the cut-off value. Meanwhile, of the five samples that met the Capute Scales criteria and were suspected of mental retardation, three had a BDNF value less than the cut-off value, and two had a BDNF value more than the cut-off value. The Kappa value from the BDNF and Capute Scales was 0.116 (slight agreement) with a *p*-value of 0.299.

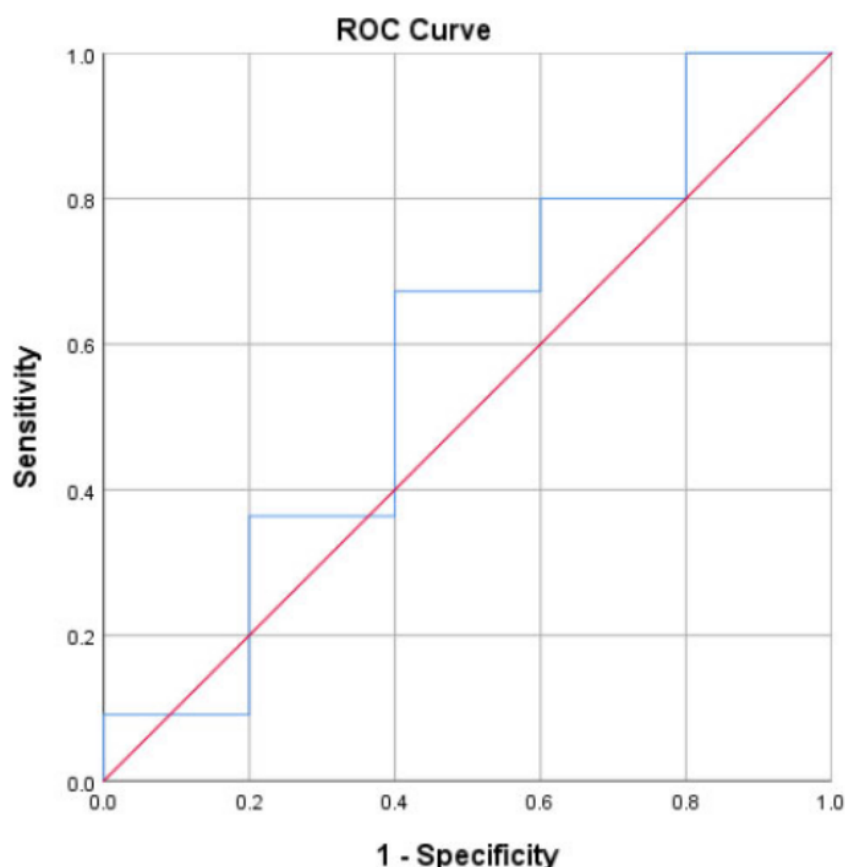
## DISCUSSION

Vitamin D deficiency in pregnant women is a health issue faced by each country. Vitamin D can be obtained endogenously and exogenously and can

be passed through placenta to the fetus.<sup>13-16</sup> In general, vitamin D deficiency during pregnancy is due to a lack of a vitamin D-rich diet, lack of mobility and exposure to sunlight, lack of vitamin D supplementation, and darker skin tones in most Indonesians. Congenital rickets, osteopenia, asthma, rhinitis, and poor neurocognitive development are potential consequences in children born to mothers who are vitamin D deficient.<sup>13-16</sup> The effect of vitamin D levels in pregnant women and predictors of BDNF on the Capute scales, which measures the neurocognitive development of children of pregnant women with normal vitamin D levels and vitamin D deficiency, was the subject of this study.

To our knowledge, this study was the first to investigate plasma BDNF levels in children of pregnant women with normal vitamin D levels and vitamin D deficiency.

Our retrospective cohort study included 60 women with singleton pregnancies: 30 had normal vitamin D levels, and another 30 women had vitamin D deficiency. The samples were collected from 14 public health centers in Semarang, Indonesia. Vitamin D levels were derived from data collected between 20 and 24 weeks of pregnancy and each child was tested for BDNF at the age of 2 years. Based on the findings of our study, the cut-off value for BDNF levels in children born to mothers with normal vitamin D levels was 9653.50 pg/mL. Meanwhile, the cut-off value for BDNF levels among children born to mothers with vitamin D deficiency was 3611.00 pg/mL. A BDNF level greater than the appropriate cut-off value indicates a lower Capute Scales score. Our results are consistent with those of Subedi et al. They assessed the BDNF cut-off value in infants with neonatal abstinence syndrome (NAS)



**Figure 1.** ROC curve assessing the association between BDNF levels and Capute Scales scores in offspring born to mothers with normal vitamin D levels and vitamin D deficiency. ROC, receiver operating characteristic.

**Table 2.** Comparisons between the BDNF and Capute Scales.

Variables	Normal	Suspected of mental retardation	Total
BDNF $\geq$ Cut-off	11	2	13
BDNF $<$ Cut-off	44	3	47
Total	55	5	60

Sensitivity 80%; Specificity 60%; PPV 0.93; NPV 0.15; Cut-Off: 9,769.50 pg/ml  
BDNF: Brain-derived neurotrophic factor, PPV: Positive predictive value, NPV: Negative predictive value

and found that in the early withdrawal phase, BDNF levels were high in infants with NAS.<sup>22</sup>

Several studies have associated Vitamin D deficiency with low levels of BDNF.<sup>23,24</sup> Previous studies have found an association between BDNF levels and acetylcholinesterase activity in those who were given D3 supplementation.<sup>23,24</sup> Therefore, vitamin D might indirectly affect the cholinergic system by enhancing BDNF levels. In addition, cholinergic

neuronal maturation and survival were dependent on neurotrophins, including BDNF.<sup>24,25</sup>

In the present research, BDNF levels were found to be below the optimal cut-off value in 25 of 30 children of pregnant mothers with normal vitamin D levels. Meanwhile, BDNF levels were above the optimal cut-off value in 26 out of 30 pregnant women with vitamin D deficiency children. This finding

demonstrates a significant difference in BDNF levels between children born to mothers with normal vitamin D levels and children born to mothers with vitamin D deficiency.

This study also has limitations. Many study participants refused to conduct home visits because of the COVID-19 pandemic; thus, the number of samples used in this study was limited. The effect of vitamin D levels in pregnant women on children's BDNF levels and their correlation with the Capute Scales score will be better described if the number of participants in this study is sufficient.

## CONCLUSION

BDNF levels can be an alternative neurocognitive examination in children to mothers with vitamin D deficiency. BDNF is a growth factor that plays an important role in neurons' differentiation, growth, and survival in the postnatal phase.

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## CONFLICT OF INTEREST

The authors declared that they have no competing interests.

## ETHICS APPROVAL

The study was approved by the Research Ethics Committee, Faculty of Medicine, Diponegoro University. All the study methods were conducted in accordance with the seven WHO 2011 standards. Written consent was obtained from participants of the study.

## CONSENT TO PUBLICATION

The participants had oral consent that their data would be published in a journal article without mentioning their names.

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## AUTHOR'S CONTRIBUTION

JD contributed to conceiving the study idea, writing the protocol, leading data collection and data analysis, interpreting data, and writing and reviewing the manuscript. FH contributed to writing a protocol and analyzing the result of the Capute Scales. MM contributed to developing a protocol, interpreting data, and revising the manuscript. AS contributed to creating a protocol and revising the manuscript. AE contributed to developing a protocol, interpreting data, and revising the manuscript. SH contributed to creating a design and revising the manuscript. DP contributed to writing a protocol, interpreting data, and reviewing the manuscript.

## REFERENCES

- Holick MF. The vitamin D deficiency pandemic: Approaches for diagnosis, treatment and prevention. *Rev Endocr Metab Disord* 2017;18(2):153–65.
- Whitehouse AJ, Holt BJ, Serralha M, Holt PG, Kusel MM, Hart PH HP. Maternal serum vitamin D levels during pregnancy and offspring neurocognitive development. *Pediatrics* 2012;129(3):485–93.
- Morales E, Guxens M, Llop S, Rodríguez-Bernal CL, Tardón A, Ríao I et al. Circulating 25-hydroxyvitamin D3 in pregnancy and infant neuropsychological development. *Pediatrics* 2012;130(4):e913–20.
- Hanieh S, Ha TT, Simpson JA, Thuy TT, Khuong NC, Thoang DD, et al. Maternal vitamin D status and infant outcomes in rural vietnam: A prospective cohort study. *PLOS ONE* 2014;9(6):e99005.
- Laird E, Thurston SW, van Wijngaarden E, Shamlaye CF, Myers GJ, Davidson PW, et al. Maternal vitamin D status and the relationship with neonatal anthropometric and childhood neurodevelopmental outcomes: Results from the Seychelles child development nutrition study. *Nutrients* 2017;9(11).
- McCarthy EK, Murray DM, Malvisi L, Kenny LC, O'B Hourihane J, Irvine AD, Kiely ME. Antenatal vitamin D status is not associated with standard neurodevelopmental assessments at age 5 years in a well-characterized prospective maternal-infant cohort. *J Nutr* 2018;148(10):1580–6.
- Gale CR, Robinson SM, Harvey NC, Javaid MK, Jiang B, Martyn CN et al. Maternal vitamin D status during pregnancy and child outcomes. *Eur J Clin Nutr* 2008;62(1):68–77.
- Veena SR, Krishnaveni GV, Srinivasan K, Thajna KP, Hegde BG, Gale CR, Fall CH. Association between maternal vitamin D status during pregnancy and offspring cognitive function during childhood and adolescence. *Asia Pac J Clin Nutr* 2017;26(3):438–49.
- Melough MM, Murphy LE, Graff JC, Derefinko KJ, Lewinn KZ, Bush NR, et al. Maternal Plasma 25-hydroxyvitamin D during gestation is positively associated with neurocognitive development in offspring at age 4–6 years. *J Nutr* 2021;151(1):132–9.
- Tylavsky FA, Kocak M, Murphy LE, Graff JC, Palmer FB, Völgyi E, et al. Gestational vitamin 25(OH)D status as a risk factor for receptive language development: A 24-month, longitudinal, observational study. *Nutrients* 2015;7(12):9918–30.
- Chawla D, Fuemmeler B, Benjamin-Neelon SE, Hoyo C, Murphy S, Daniels JL. Early prenatal vitamin D concentrations and social-emotional development in infants. *J Matern Fetal Neonatal Med* 2019;32(9):1441–8.
- Brouwer-Brolsma EM, Vrijkotte TGM, Feskens EJM. Maternal vitamin D concentrations are associated with faster childhood reaction time and response speed, but not with motor fluency and flexibility, at the age of 5–6 years: The Amsterdam Born Children and their Development (ABCD) Study. *Br J Nutr* 2018;120(3):345–52.
- Kesby JP, Eyles DW, Burne THJ, McGrath JJ. The effects of vitamin D on brain development and adult brain function. *Mol Cell Endocrinol* 2011;347(1–2):121–7.
- Cui X, Gooch H, Petty A, McGrath JJ, Eyles D. Vitamin D and the brain: Genomic and non-genomic actions. *Mol Cell Endocrinol* 2017;453:131–43.
- Harms LR, Burne THJ, Eyles DW, McGrath JJ. Vitamin D and the brain. *Best Pract Res Clin Endocrinol Metab* 2011;25(4):657–69.
- Eyles D, Burne T, McGrath J. Vitamin D in fetal brain development. *Semin Cell Dev Biol* 2011;22(6):629–36.
- Semrud-Clikeman M. The Capute scales. *Pediatr Neurol* 2006;34(1):79–80.
- Bekinschtein P, von Bohlen Und Halbach O. Editorial. Editorial: Cellular and molecular mechanisms of neurotrophin function in the nervous system. *Front Cell Neurosci* 2020;14:101.
- Mitchellmore C, Gede L. Brain derived neurotrophic factor: Epigenetic regulation in psychiatric disorders. *Brain Res* 2014;1586:162–72.
- Chen HJ, Lee YJ, Huang CC, Lin YF, Li ST. Serum brain-derived neurotrophic factor and neurocognitive function in children with type 1 diabetes. *J Formos Med Assoc* 2021;120(1 Pt 1):157–64.
- As S, Hadju V, Tammasse J. The correlation between brain derived neurotrophic factor (BDNF) level and motor development of children aged under 2 years in Timor Tengah selatan Nusa Tenggara Timur. *Ijsbar* 2015;23(1):164–72.
- Subedi L, Huang H, Pant A, Westgate PM, Bada HS, Bauer JA, et al. Plasma brain-derived neurotrophic factor levels in newborn infants with neonatal abstinence syndrome. *Front Pediatr* 2017;5:238.
- Khairy EY, Attia MM. Protective effects of vitamin D on neurophysiologic alterations in brain aging: Role of brain-derived neurotrophic factor (BDNF). *Nutr Neurosci* 2021;24(8):650–9. <https://doi.org/10.1080/1028415X.2019.1665854>.
- Sakata K, Overacre AE. Promoter IV-BDNF deficiency disturbs cholinergic gene expression of CHRNA5, CHRM2, and CHRM5: Effects of drug and environmental treatments. *J Neurochem* 2017;143(1):49–64.
- Silakarma D, Sudewi AAR. The role of brain-derived neurotrophic factor (BDNF) in cognitive functions. *Bali Medical Journal*. 2019;8(2):427–434.



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### PRIMARY SOURCES

1 Ratnasari D. Cahyanti, Widyawati Widyawati, Mohammad Hakimi. "'Sharp downward, blunt upward': district maternal death audits' challenges to formulate evidence-based recommendations in Indonesia - a qualitative study", BMC Pregnancy and Childbirth, 2021 109 words — 3%

[Crossref](#)

2 Mohd Aizuddin Mohd Lazaldin, Igor Iezhitsa, Renu Agarwal, Nor Salmah Bakar, Puneet Agarwal, Nafeeza Mohd Ismail. "Neuroprotective effects of brain - derived neurotrophic factor against amyloid beta 1 - 40 - induced retinal and optic nerve damage", European Journal of Neuroscience, 2020 56 words — 2%

[Crossref](#)

3 "2011 Annual Meeting of the American Society for Bone and Mineral Research San Diego, CA September 16-20, 2011", Journal of Bone and Mineral Research, 2011 41 words — 1%

[Crossref](#)

4 Mohd Aizuddin Mohd Lazaldin, Igor Iezhitsa, Renu Agarwal, Nor Salmah Bakar, Puneet Agarwal, Nafeeza Mohd Ismail. "Time- and dose-related effects of amyloid beta1-40 on retina and optic nerve morphology in rats", International Journal of Neuroscience, 2018 34 words — 1%

[Crossref](#)



---

5 C. V. Harinarayan. "Prevalence of vitamin D insufficiency in postmenopausal south Indian women", Osteoporosis International, 2004

27 words — 1%

Crossref

---

6 Eman Y. Khairy, Maha M. Attia. "Protective effects of vitamin D on neurophysiologic alterations in brain aging: role of brain-derived neurotrophic factor (BDNF)", Nutritional Neuroscience, 2019

25 words — 1%

Crossref

---

7 Wen-Guang Yu, Wei Liu, Yi-He Jin, Xiao-Hui Liu, Fa-Qi Wang, Li Liu, Shoji F. Nakayama. "Prenatal and Postnatal Impact of Perfluorooctane Sulfonate (PFOS) on Rat Development: A Cross-Foster Study on Chemical Burden and Thyroid Hormone System", Environmental Science & Technology, 2009

22 words — 1%

Crossref

---

8 "Meeting Abstracts of the 12th World Congress on the Menopause", Climacteric, 2009

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Crossref

---

9 Kristin Holvik, Ahmed A. Madar, Haakon E. Meyer, Cathrine M. Lofthus, Lars C. Stene. "A randomised comparison of increase in serum 25-hydroxyvitamin D concentration after 4 weeks of daily oral intake of 10µg cholecalciferol from multivitamin tablets or fish oil capsules in healthy young adults", British Journal of Nutrition, 2007

15 words — < 1%

Crossref

---

10 Pardis Keshavarz, Parisa Jandaghi, Mojtaba Shafiee, Naorin Islam, Hassan Vatanparast. "Chapter 3 Maternal Vitamin D Status among Different Ethnic Groups and Its Potential Contribution to Adverse Pregnancy and Child Outcomes", IntechOpen, 2020

15 words — < 1%



11 Ron D. Hays, Phyllis L. Ellickson. "COMPARISON OF THE ROST AND THE CAGE ALCOHOL SCREENING INSTRUMENTS IN YOUNG ADULTS", Substance Use & Misuse, 2001

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Crossref

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12 words — < 1%

Crossref

13 Adelgrit Trisia, Nurul Hidayah, Meitria Syahadatina Noor, Edi Hartoyo, Indra Widjaja Himawan. "Role of Neurogenesis and Oxidative Stress in Epilepsy (Study on Plasma Brain Derived Neurotrophic Factor and Malondialdehyde Level)", Open Access Macedonian Journal of Medical Sciences, 2023

12 words — < 1%

Crossref

14 Keadrea Wilson, Tebeb Gebretsadik, Margaret A. Adgent, Christine Loftus et al. "The association between duration of breastfeeding and childhood asthma outcomes", Annals of Allergy, Asthma & Immunology, 2022

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15 Mario Flores. "A role of vitamin D in low-intensity chronic inflammation and insulin resistance in type 2 diabetes mellitus?", Nutrition Research Reviews, 2007

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Crossref

16 Elizabeth Ann Szalay, Elyce B. Tryon, Michael D. Pleacher, Sandra L. Whisler. "Pediatric Vitamin D Deficiency in a Southwestern Luminous Climate", Journal of Pediatric Orthopaedics, 2011

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- 17 "Biomarkers in Diabetes", Springer Science and Business Media LLC, 2023 9 words — < 1%  
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- 18 G. V. Krishnaveni. "Maternal vitamin D status during pregnancy and body composition and cardiovascular risk markers in Indian children: the Mysore Parthenon Study", American Journal of Clinical Nutrition, 03/01/2011 9 words — < 1%  
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- 19 Jason M. Johnson. "The Long-term Effects of Gastric Bypass on Vitamin D Metabolism", Annals of Surgery, 05/2006 9 words — < 1%  
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- 
- 22 V. Udaya kumar, Garapati Pavan, Krishna Murti, Rahul kumar, Sameer Dhingra, Mainul Haque, V. Ravichandiran. "Rays of immunity: Role of sunshine Vitamin in management of COVID-19 infection and associated comorbidities", Clinical Nutrition ESPEN, 2021 9 words — < 1%  
Crossref

23 Yi Lin Ong, Phaik Ling Quah, Mya Thway Tint, Izzuddin M. Aris et al. "The association of maternal vitamin D status with infant birth outcomes, postnatal growth and adiposity in the first 2 years of life in a multi-ethnic Asian population: the Growing Up in Singapore Towards healthy Outcomes (GUSTO) cohort study", British Journal of Nutrition, 2016 9 words — < 1%  
Crossref

24 Bistra I. Veleva, Rutger L. van Bezooijen, Victor G.M. Chel, Mattijs E. Numans, Monique A.A. Caljouw. "Effect of Ultraviolet Light on Mood, Depressive Disorders and Wellbeing", Photodermatology, Photoimmunology & Photomedicine, 2018 8 words — < 1%  
Crossref

25 Francisco J Schneuer, Christine L Roberts, Cyrille Guilbert, Judy M Simpson et al. "Effects of maternal serum 25-hydroxyvitamin D concentrations in the first trimester on subsequent pregnancy outcomes in an Australian population,,", The American Journal of Clinical Nutrition, 2014 8 words — < 1%  
Crossref

26 Hafsa Tahir, Naveed Munir, Syeda Saira Iqbal, Umar Bacha et al. "Maternal vitamin D status and attention deficit hyperactivity disorder (ADHD), an under diagnosed risk factor; A review", European Journal of Inflammation, 2023 8 words — < 1%  
Crossref

27 Melissa M Melough, Laura E Murphy, J Carolyn Graff, Karen J Derefinko et al. "Maternal Plasma 25-Hydroxyvitamin D during Gestation Is Positively Associated with Neurocognitive Development in Offspring at Age 4–6 Years", The Journal of Nutrition, 2020 8 words — < 1%  
Crossref

28 Monica Tous, Marcela Villalobos, Lucia Iglesias, Sílvia Fernández-Barrés, Victoria Arija. "Vitamin D status during pregnancy and offspring outcomes: a systematic review and meta-analysis of observational studies", European Journal of Clinical Nutrition, 2019

8 words — < 1%

[Crossref](#)

29 S. M. Chatfield. "Vitamin D deficiency in general medical inpatients in summer and winter", Internal Medicine Journal, 6/2007

8 words — < 1%

[Crossref](#)

30 Sanae Makhout, Eline Vermeiren, Karolien Van De Maele, Luc Bruyndonckx et al. "The Role of Brain-Derived Neurotrophic Factor in Obstructive Sleep Apnea and Endothelial Function in a Pediatric Population With Obesity", Frontiers in Medicine, 2022

8 words — < 1%

[Crossref](#)

31 Vasiliki Daraki, Theano Roumeliotaki, Katerina Koutra, Georgia Chalkiadaki et al. "High maternal vitamin D levels in early pregnancy may protect against behavioral difficulties at preschool age: the Rhea mother-child cohort, Crete, Greece", European Child & Adolescent Psychiatry, 2017

8 words — < 1%

[Crossref](#)

32 Elvira Larqué, Eva Morales, Rosaura Leis, JoséE. Blanco-Carnero. "Maternal and Foetal Health Implications of Vitamin D Status during Pregnancy", Annals of Nutrition and Metabolism, 2018

7 words — < 1%

[Crossref](#)

33 "Ninth European Congress on Clinical and Economic Aspects of Osteoporosis and Osteoarthritis – ECCEO 9 – IOF", Osteoporosis International, 2009

6 words — < 1%



34 A. R Goldstone. "Should surgeons take a break after an intraoperative death? Attitude survey and outcome evaluation", BMJ, 2/14/2004 6 words — < 1%

Crossref

35 Michael K. Turner, W. Michael Hooten, John E. Schmidt, Jennifer L. Kerkvliet, Cynthia O. Townsend, Barbara K. Bruce. "Prevalence and Clinical Correlates of Vitamin D Inadequacy among Patients with Chronic Pain", Pain Medicine, 2008 6 words — < 1%

Crossref

36 Yue Zhang, Chun-Yan Zhou, Xi-Rui Wang, Xian-Ting Jiao, Jun Zhang, Ying Tian, Luan-Luan Li, Chen Chen, Xiao-Dan Yu. "Maternal and neonatal blood vitamin D status and neurodevelopment at 24months of age: a prospective birth cohort study", World Journal of Pediatrics, 2023 6 words — < 1%

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