folia medica

Folia Medica 66(6):787-794
DOI: 10.3897/folmed.66.e138821

Original Article

Prevalence of Vitamin D Deficiency in Children with Cerebral Palsy and Autism Spectrum Disorder: a Comparative Pilot Study

Ruzha Pancheva[1], Albena Toneva[1], Yana Bocheva[2], Miglena Georgieva[3], Krassimira Koleva[3], Ivan Yankov[4]

[1] *Department of Hygiene and Epidemiology, Faculty of Public Health, Prof. Dr Paraskev Stoyanov Medical University, Varna, Bulgaria*
[2] *Department of Clinical Laboratory, Prof. Dr. Paraskev Stoyanov Medical University, Varna, Bulgaria*
[3] *Department of Pediatrics, Faculty of Medicine, Prof. Dr. Paraskev Stoyanov Medical University, Varna, Bulgaria*
[4] *Department of Pediatrics, Faculty of Medicine, Medical University of Plovdiv, Plovdiv, Bulgaria*

Corresponding author: Ruzha Pancheva, Department of Hygiene and Epidemiology, Faculty of Public Health, Prof. Dr. Paraskev Stoyanov Medical University, 55 Marin Drinov Str., 9002 Varna, Bulgaria; Email: rouzha.pancheva@gmail.com

Received: 8 October 2024 ♦ **Accepted:** 2 December 2024 ♦ **Published:** 31 December 2024

Citation: Pancheva R, Toneva A, Bocheva Y, Georgieva M, Koleva K, Yankov I. Prevalence of vitamin D deficiency in children with cerebral palsy and autism spectrum disorder: a comparative pilot study. Folia Med (Plovdiv) 2024;66(6):787-794. doi: 10.3897/folmed.66.e138821.

Abstract

Aim: This study aims to explore the prevalence of vitamin D deficiency (VDD) among children with cerebral palsy (CP) and autism spectrum disorder (ASD) in Bulgaria, while analyzing associated demographic, nutritional, and biochemical factors.

Materials and methods: A cross-sectional study was conducted in Northeastern Bulgaria, involving 95 children (59 with CP and 36 with ASD). Vitamin D status was assessed using biochemical markers and categorized as deficient (<20 ng/mL), insufficient (20-29 ng/mL), or normal (≥30 ng/mL). Statistical comparisons were performed to identify differences across groups.

Results: VDD was prevalent in 29.4% of children with CP and 15.8% of those with ASD, with no significant intergroup differences (p=0.492). Demographic analysis revealed significant gender (p<0.001) and ethnic differences (p=0.006). Children with VDD exhibited lower height-for-age Z scores (p=0.002), weight-for-age Z scores (p=0.021), albumin levels (p<0.001), and lymphocyte counts (p=0.011). Normal ferritin levels alongside reduced transferrin and serum iron suggested protein synthesis deficits rather than depleted iron stores.

Conclusion: This study, which is the first in Bulgaria to address vitamin D deficiency in children with autism spectrum disorder and cerebral palsy, emphasizes the necessity of tailored interventions and nutritional support. The findings emphasize the role of biological and sociocultural factors in the prevalence of VDD, contributing valuable insights into pediatric health in moderate-climate regions.

Keywords

autism spectrum disorder, biochemical analysis, cerebral palsy, neurodevelopmental disorders, vitamin D deficiency

Abbreviations

ASD: autism spectrum disorder;
BMIAZ: body mass index-for-age Z score;
CP: cerebral palsy;
DVD-deficiency: developmental vitamin D deficiency;
HAZ: height-for-age Z score;
MUACAZ: mid-upper arm circumference-for-age Z score;
HCAZ: mean head circumference-for-age Z score;
SSFAZ: subscapular skinfold-for-age Z score;
TSFAZ: triceps skinfold-for-age Z score;
VDD: vitamin D deficiency;
Vit. D: vitamin D;
WAZ: weight-for-age Z score;
TIBC: total iron-binding capacity;
Hb: hemoglobin

INTRODUCTION

Vitamin D is vital for children's overall health, particularly in bone development and immune function. It facilitates calcium absorption, bone mineralization, and regulates phosphate and magnesium metabolism, which are crucial for skeletal growth and dental health.[1-3] However, vitamin D deficiency (VDD) is widespread globally, driven by factors like malabsorption, poor diet, and insufficient sunlight exposure.[2,3] Adequate vitamin D is not only essential for bone health but also for the development of the immune and nervous systems, reducing risks of conditions such as neonatal sepsis and respiratory distress syndrome.[1] Additionally, vitamin D plays a role in preventing mental disorders during childhood and adolescence.[4]

Vitamin D status in the general population

VDD is a significant public health concern in Bulgaria, with a notable portion of the population affected. The general Bulgarian population is estimated to have a 21.3% prevalence of vitamin D deficiency, which is defined as serum 25(OH)D levels below 25 nmol/L. Additionally, 54.5% of the population experiences vitamin D insufficiency, with levels between 25–50 nmol/L, while only 24.2% have sufficient levels above 50 nmol/L.[5] Globally, VDD affects a substantial portion of the population. A comprehensive analysis of 7.9 million participants from 81 countries found that 15.7% had severe VDD (<30 nmol/L), 47.9% had moderate deficiency (<50 nmol/L), and 76.6% had insufficient levels (<75 nmol/L).[5] The prevalence of VDD is notably higher in regions with high latitudes and during winter-spring seasons, reflecting limited sunlight exposure.[6]

Vitamin D deficiency in neurodevelopmental disorders

Neurodevelopmental disorders like cerebral palsy (CP) and autism spectrum disorder (ASD) are significantly impacted by VDD. Research indicates that developmental VDD is a risk factor for autism, causing behavioral changes and gut health issues in animal models.[7,8] VDD during pregnancy may contribute to ASD by causing structural and functional nervous system abnormalities, potentially affecting speech development.[9]

The prevalence of VDD and insufficiency in children with CP and ASD is significantly high worldwide, with studies consistently reporting a substantial portion of these populations being affected. Studies in India[10] and around the world[11] have shown that the prevalence of VDD in children with cerebral palsy varies between 32 and 42 percent. Additional findings highlight that 61% of children with CP in India experience vitamin D insufficiency.[10] Factors contributing to this high prevalence include limited sunlight exposure, feeding difficulties, and the use of antiepileptic drugs.[10] Motor impairments, as measured by the Gross Motor Function Classification System (GMFCS), are also significantly correlated with lower vitamin D levels.[12]

Similarly, children with ASD exhibit a high prevalence of VDD, with studies reporting rates of up to 57%.[13] A systematic review and meta-analysis encompassing 870 ASD patients found significantly lower serum 25(OH)D levels in individuals with ASD compared to healthy controls.[14] Low vitamin D levels have been linked to altered brain development, immune system dysregulation, and imbalances in neurotransmitter function, all of which are common pathological features of ASD.[15-17] Although some studies suggest that vitamin D supplementation may improve behavioral symptoms in children with ASD, findings remain inconsistent, necessitating further investigation.[13,17]

Rationale for selecting CP and ASD in vitamin D deficiency research

Cerebral palsy (CP) and autism spectrum disorder (ASD) are two of the most prevalent neurodevelopmental disorders, each with unique etiological and clinical characteristics. CP often involves significant physical disabilities that restrict mobility and sunlight exposure, predisposing individuals to a higher risk of vitamin D deficiency (VDD). In contrast, ASD is characterized by behavioral challenges, sensory sensitivities, and dietary selectivity, which can also influence vitamin D status. These distinctions make CP and ASD ideal conditions for exploring the interplay of biological and social factors contributing to VDD.

Examining VDD in these two populations allows for a deeper understanding of whether biological factors, such as mobility limitations in CP or dietary selectivity in ASD, or shared social factors, such as limited healthcare access, social stigma, or nutritional deficits, play a more significant role. Identifying these determinants is critical for developing targeted interventions to address vitamin D insufficiency and improve health outcomes in these vulnerable groups.

AIM

While the global body of evidence highlights the high prevalence of vitamin D deficiency in children with CP and ASD, limited data exist on its status in the Bulgarian context. This study aims to evaluate the prevalence of VDD and insufficiency in Bulgarian children with CP and ASD, examining associated biochemical and anthropometric parameters.

MATERIAL AND METHODS

This cross-sectional study was conducted in two phases: April 2017 to April 2018 and August 2023 to March 2024, in Northeastern Bulgaria (Varna and Ruse). It was approved by the Ethics Committee of the Medical University of Varna (Protocols No. 60/23.2.2017 and No. 134/20.07.2023).

Participants and recruitment

Participants included children with cerebral palsy or autism, recruited through the Karin Dom Foundation in Varna and the Equilibrium Association in Ruse. Parents were contacted via phone or email, with initial screenings and intake interviews conducted to determine eligibility. Informed consent was obtained, ensuring confidentiality.

Eligibility criteria

Inclusion criteria

- Children aged 2-18 years diagnosed with CP (spastic, dyskinetic, ataxic, or mixed) or autism.
- Families residing within the study area.

Exclusion criteria

- Acute medical conditions or infections within 10 days prior.
- Genetic syndromes affecting nutrition (e.g., Silver-Russell or Down syndrome).
- Recent participation in dietary interventions.
- Guardians unable to understand study terms or non-Bulgarian speakers.

Study measurements and outcomes

Demographic and social data

- Gender, age, diagnosis, gestational age at birth, and parental education and age.

Nutritional status assessment

- **Anthropometry:** Height, weight, skinfold thickness, and mid-upper arm circumference with Z scores based on WHO growth charts.
- **Biochemical tests:** Vitamin D, hemoglobin, iron status, total protein, albumin, calcium, magnesium, alkaline phosphatase, parathyroid hormone, phosphorus.

Vitamin D status

- Deficient: <20 ng/mL (50 nmol/L)
- Insufficient: 20-29 ng/mL (50-75 nmol/L)
- Normal: ≥30 ng/mL (75 nmol/L)

Data management and analysis

Data were securely and anonymously collected. Descriptive statistics summarized demographic data. Independent t-tests and chi-square tests compared continuous and categorical variables, respectively, with statistical significance set at $p<0.05$.

RESULTS

Demographic characteristics

The study included 95 children: 59 with cerebral palsy (CP) and 36 with autism. Significant gender differences were observed, with 49.2% of the CP group being male compared to 83.3% in the autism group ($p<0.001$). Ethnicity also varied significantly, with 83.3% of the autism group being Bulgarian compared to 60.3% in the CP group ($p=0.006$). No significant differences were found in the education levels of the parents between the two groups **(Table 1)**.

Vitamin D status

Vitamin D levels in children with CP and autism are summarized below. Among the CP group, 29.4% were deficient,

Table 1. Basic characteristics

Demographic characteristics	Cerebral palsy (n=59)	Autism (n=36)	*p*
Male, n (%)	29 (49.2%)	30 (83.3%)	<0.001
Age			
Mother, mean (SD)	45.55 (13.22)	41.50 (7.88)	0.221
Father, mean (SD)	46.00 (12.17)	42.16 (8.12)	0.296
Ethnicity			
Bulgarian, n (%)	35 (60.3%)	30 (83.3%)	0.006
Others, n (%)	23 (39.7%)	6 (16.7%)	0.006
Mother's education			
Up to secondary school level, n (%)	33 (62.3%)	18 (52.9%)	0.389
Master, PhD, n (%)	20 (37.7%)	16 (47.1%)	0.389
Father's education			
Up to secondary school level, n (%)	13 (31.7%)	13 (40.6%)	0.430
Master, PhD, n (%)	28 (68.3%)	19 (59.4%)	0.430

Folia Medica

17.6% insufficient, and 52.9% had normal levels. In the autism group, 15.8% were deficient, 26.3% insufficient, and 57.9% had normal levels. There were no significant differences in vitamin D status between the groups (p=0.492) **(Table 2)**.

Biochemical and anthropometric test results

Children with VDD had significantly lower height-for-age Z scores (HAZ) (−3.22±2.47) compared to those with normal or insufficient levels (−0.99±1.89) (p=0.002). Weight-for-age Z scores (WAZ) were also lower in the deficient group (−2.99±2.72) compared to the normal/insufficient group (−1.25±1.83) (p=0.021). Although body mass index-for-age Z scores (BMIAZ) were lower in the deficient group, this difference was not statistically significant (p=0.067).

Biochemical tests revealed similar hemoglobin levels across groups, but the vitamin D deficient group had significantly lower lymphocyte counts ($1.26±1.25×10^9$/L vs. $4.38±3.18×10^9$/L, p=0.011) and lower total iron-binding capacity (TIBC) (38.79±35.13 µmol/L vs. 60.09±14.03 µmol/L, p=0.018). Serum iron levels were lower in the deficient group, approaching significance (p=0.060). Additionally, albumin levels were significantly lower in the deficient group (43.33±3.79 g/L) compared to the normal/insufficient group (47.04±2.86 g/L) (p<0.001). No significant differences were found in ferritin, total protein, calcium, or magnesium levels **(Table 3)**.

These results highlight significant differences in demographic characteristics, vitamin D status, and several biochemical and anthropometric measures between children with low and normal vitamin D levels, underscoring the need for tailored nutritional and medical interventions in these populations.

DISCUSSION

Significance of the study

This study is the first of its kind to examine VDD in children with ASD and CP in Bulgaria. Although most of the research that has been done so far has concentrated on populations that live in extreme climates, such as those that are located in very high or very low latitudes, there is a noticeable scarcity of data from countries with moderate climates, like Bulgaria. The findings from our study not only provide valuable insights into the prevalence and characteristics of VDD in these neurodevelopmental conditions but also contribute to the global understanding of the interplay between biological and socio-environmental factors in moderate climate regions.

Gender distribution

The observed gender distribution aligns with existing literature, which shows that ASD is significantly more common in males, with a typical male-to-female ratio of 4:1.[1] In this study, 83.3% of the children with autism were male, compared to 49.2% in the CP group. This gender disparity in autism may be attributed to biological factors, such as sex-linked genetic susceptibility, as well as diagnostic biases that under-identify autism in females with subtler symptoms.[1,18] The relatively balanced gender distribution in CP reflects its lack of a gender-based predisposition.[3] These findings underscore the necessity of gender-specific diagnostic and therapeutic strategies, particularly for autism, to address these unique health disparities.

Ethnicity

Ethnic differences were notable, with 83.3% of the autism group being Bulgarian compared to 60.3% in the CP group. Conversely, children from other ethnic backgrounds (Roma, Turkish, and others) were more prevalent in the CP group. These variations likely stem from a combination of genetic predispositions, socio-economic factors, and disparities in access to healthcare services. Prior research has suggested that ethnic minority groups may face barriers to early diagnosis and specialized interventions, particularly for autism, due to cultural stigma and limited resources.[5,19] Understanding these ethnic disparities is critical for designing equitable and culturally sensitive healthcare strategies.

Parental education

Parental education levels showed no significant differences between the CP and autism groups in this study. While previous research has highlighted the influence of parental education on access to healthcare and intervention outcomes, the lack of disparity in this study may reflect relatively equal access to care in the Bulgarian context.[3] Nevertheless, parental education remains an important factor to consider in broader settings, as it shapes awareness and advocacy for specialized care.

Table 2. Comparison between vit. D status

Vitamin D Status	CP (n=59)	Autism (n=36)	*p*
Vit. D deficiency, n (%)	10 (29.4%)	3 (15.8%)	
Vit. D insufficiency, n (%)	6 (17.6%)	5 (26.3%)	
Normal vit. D levels, n (%)	18 (52.9%)	11 (57.9%)	0.492

Table 3. Biochemical, anthropometric, and demographic characteristics by vitamin D status

Variables	Deficient vitamin D	Normal + Insufficient	*p*-value
Gender			
Male, n (%)	16 (45.7%)	19 (54.3%)	0.93
Female, n (%)	8 (44.4%)	10 (55.6%)	
Ethnicity			
Bulgarian, n (%)	5 (31.3%)	11 (68.8%)	0.455
Non-Bulgarian, n (%)	8 (21.6%)	29 (78.4%)	
Diagnosis Group			
CP, n (%)	10 (29.4%)	24 (70.6%)	0.728
Autism, n (%)	3 (15.8%)	16 (84.2%)	
Anthropometric measures	Mean ± SD	Mean ± SD	
HAZ (Z score) *	−3.22±2.47	−0.99±1.89	0.002
BMIAZ (Z score)	−2.19±2.93	−0.92±1.50	0.067
WAZ (Z score) *	−2.99±2.72	−1.25±1.83	0.021
MUACAZ (Z score)	−0.06±1.74	−0.26±1.05	0.725
TSFAZ (Z score)	−0.39±1.68	−0.15±1.53	0.754
SSFAZ (Z score)	−0.74±2.19	−0.12±1.49	0.443
HCAZ (Z score)	−0.47 (NA)	−2.58±1.90	0.437
Biochemical measures	Mean ± SD	Mean ± SD	
Hemoglobin (Hb, g/L)	125.45±10.78	129.76±8.87	0.183
Lymphocyte count ($\times 10^9$/L) *	1.26±1.25	4.38±3.18	0.011
Serum iron (μmol/L)	9.74±3.78	12.74±4.06	0.06
TIBC, μmol/L *	38.79±35.13	60.09±14.03	0.018
Ferritin (μg/L)	29.35±23.15	30.15±19.25	0.903
Total protein (g/L)	68.83±5.07	72.95±7.04	0.141
Albumin (g/L) *	43.33±3.79	47.04±2.86	<0.001
Calcium (mmol/L)	2.39±0.10	2.42±0.16	0.58
Magnesium (mmol/L)	0.88±0.09	0.88±0.08	0.965

* Statistical significance at $p<0.05$; BMIAZ: body mass index-for-age Z score; HAZ: height-for-age Z score; MUACAZ: mid-upper arm circumference-for-age Z score; SSFAZ: subscapular skinfold-for-age Z score; TSFAZ: triceps skinfold-for-age Z score; WAZ: weight-for-age Z score; TIBC: total iron-binding capacity; HCAZ: head circumference-for-age Z score

Vitamin D status

VDD was observed at comparable rates in children with CP and ASD, suggesting that it is a common and significant issue across these neurodevelopmental disorders. In our study, 29.4% of children with CP and 15.8% of children with ASD were vitamin D deficient. These findings align with prior research reporting high prevalence rates of VDD in neurodevelopmental populations. For instance, severe VDD in youth with ASD has been linked to limited outdoor activity and dietary restrictions.[4] Similarly, neurodevelopmental disorders like CP have shown strong associations with VDD due to challenges such as reduced mobility, feeding difficulties, and antiepileptic drug use.[7]

The observed prevalence in our study mirrors findings from India, where 32% of children with CP were vitamin D deficient[8] and global reports documenting even higher rates (42.18%) of deficiency in children with CP.[9] For ASD, research indicates rates as high as 57%[10], significantly higher than in the general population.

The shared prevalence of VDD in both CP and ASD populations underscores the multifaceted challenges these children face. Reduced outdoor exposure, selective eating habits, and chronic medication use are key contributing factors.

Comparatively, the global prevalence of moderate-to-severe VDD is 47.9% and 15.7%, respectively.[6] The lower prevalence in the ASD group (15.8%) compared to some reports[10] may reflect regional differences, dietary habits, or supplementation practices in Bulgaria.

Anthropometric and biochemical measures

Children with VDD exhibited significantly poorer growth outcomes, including lower height-for-age Z scores (HAZ), body mass index-for-age Z scores (BMIAZ), and weight-for-age Z scores (WAZ). These findings are consistent with other studies demonstrating a correlation between VDD and impaired growth in children with neurodevelopmental disorders.[8,11]

Biochemically, lower lymphocyte counts and serum iron levels were observed in vitamin D-deficient children, highlighting potential immune and nutritional deficits. The significantly lower albumin levels further emphasize the systemic impact of VDD on protein metabolism and immune function.[20] These findings underscore the need for comprehensive nutritional support to address the multifaceted challenges associated with VDD.

Our study sheds light also on the complex interactions between VDD, iron metabolism, and protein synthesis. Notably, in our cohort, normal ferritin levels alongside low transferrin levels were observed, suggesting that protein synthesis deficits rather than depleted iron stores underlie these findings. Importantly, C-reactive protein (CRP) levels were normal in all participants, ruling out significant inflammation as a confounding factor.

Ferritin, an acute-phase reactant, can remain normal or even elevated in inflammatory states, while transferrin, a negative acute-phase reactant, often decreases.[21] However, in the absence of inflammation, as indicated by normal CRP levels in our study, the discrepancy between ferritin and transferrin levels likely reflects the selective impact of VDD on protein synthesis. Transferrin, a smaller protein with a molecular weight of approximately 80 kDa, is more sensitive to changes in protein metabolism compared to ferritin, a larger storage protein (450 kDa) capable of binding up to 4500 Fe atoms in its central cavity.

This observation aligns with previous reports where nutritional status rather than inflammation plays a pivotal role in influencing transferrin levels.[22] Malnutrition, often linked to VDD, affects proteins like transferrin more acutely due to their transport functions, whereas storage proteins like ferritin remain relatively stable. For instance, transferrin levels correlate positively with markers of nutritional status such as albumin, which was also lower in the vitamin D deficient group.

Alignment with previous studies

The findings of this study about VDD in children with neurodevelopmental disorders are consistent with other studies conducted worldwide. Studies have consistently reported a high prevalence of VDD in children with ASD and CP, attributing it to factors such as reduced sunlight exposure, dietary restrictions, and antiepileptic drug use.[4,7] While this study observed no significant differences in VDD prevalence between CP and ASD groups, the overall rates underscore the widespread nature of this deficiency among children with neurodevelopmental conditions.

Interestingly, the lack of disparity in vitamin D status between CP and ASD groups contrasts with findings that reported higher deficiency rates in CP due to more severe mobility impairments limiting outdoor activity.[11] This discrepancy may be explained by regional differences, variations in supplementation practices, or the demographic characteristics of the study population.

Cultural factors in ASD prevalence

The prevalence of ASD in this study shows significant disparities between Bulgarian (Bg) and non-Bulgarian (non-Bg) ethnic groups. Among children with ASD, 83.3% were Bulgarian, compared to 60.3% in the CP group. Conversely, children from non-Bulgarian ethnic backgrounds (e.g., Roma, Turkish, and others) were more prevalent in the CP group, comprising 39.7%. These findings highlight critical sociocultural dynamics influencing the diagnosis and reporting of ASD in Bulgaria.

Diagnosis and cultural perceptions

Cultural attitudes towards autism heavily influence its recognition and diagnosis. Greater societal awareness and better access to diagnostic services among Bulgarian families may explain the higher prevalence of autism in this group. In contrast, minority communities may face cultural stigma, economic challenges, and limited healthcare outreach, all contributing to underreporting or delayed diagnosis.[5,23]

Freeth et al.[19] explain that societal attitudes towards autism shape the likelihood of seeking diagnosis and the resources available for intervention. For non-Bulgarian communities, cultural norms often interpret autism-related behaviors as personality traits rather than signs of a disorder. This finding aligns with Montanez[24], who observed similar patterns in minority populations globally.

Influence of sociocultural norms

Diagnostic frameworks for autism, often rooted in Western behavioral standards, may not fully apply to non-Western or minority populations.[25] Language barriers and a lack of culturally adapted diagnostic tools in non-Bulgarian communities further delay identification and treatment. Cultural stigma also discourages medical consultation, perpetuating underdiagnosis in these groups.[26]

CONCLUSION

This study highlights the significant prevalence of VDD in children with CP and autism and underscores the need for routine screening and tailored interventions. While our findings align with much of the existing literature, they also reveal specific regional and demographic nu-

ances that warrant further investigation. Addressing the limitations of this study through larger, more diverse, and longitudinal research will be critical in refining our understanding and improving clinical practices for these vulnerable populations.

Ethics Committee Approval

This study was approved by the Ethics Committee of the Medical University of Varna (Protocols No. 60/23.2.2017 and No. 134/20.07.2023).

Previous publication

This work has not been previously presented, published as an abstract, or made available as a preprint.

Funding

This study is financed by the European Union – Next Generation EU, through the National Recovery and Resilience Plan of the Republic of Bulgaria, project No. BG-RRP-2.004-0009-C02.

Competing Interests

The authors have declared that no competing interests exist.

Author Contributions

Ruzha Pancheva: conceptualization, methodology, writing – original draft; *Albena Toneva*: data collection, writing – review and editing; *Yana Bocheva*: clinical laboratory analysis, data interpretation; *Miglena Georgieva*: data collection, literature review; *Krassimira Koleva*: project administration, supervision

REFERENCES

1. Chamova R, Panteleeva M, Ivanova E. Nutrition as a bones health factor with significant influence. Journal of IMAB 2020; 26(4):3426–31. doi: 10.5272/jimab.2020264.3426
2. Jaruratanasirikul S. Vitamin D: An essential micronutrient for bone health : vitamin D for bone health. PSU Med J [Internet] 2021; 1(1):29–37. Available from: https://he01.tci-thaijo.org/index.php/PSUMJ/article/view/246040
3. Marushko YV, Hyshchak TV. Prevention of vitamin D deficiency in children. Sci Pract J 2021; 1(1):36–45. Available from: https://doi.org/10.15574/SP.2021.116.36
4. Misiorowski W. Vitamin D, infections and immunity. Medical Health Sciences 2020; 2(2):6–15. doi: 10.36553/WM.55
5. Borissova A-M, Shinkov A, Vlahov J, et al. Vitamin D status in Bulgaria – winter data. Arch Osteoporos 2013; 1–5.
6. Cui A, Zhang T, Xiao P, et al. Global and regional prevalence of vitamin D deficiency in population-based studies from 2000 to 2022: A pooled analysis of 7.9 million participants. Front Nutr 2023; 10:1070808. doi: 10.3389/fnut.2023.1070808
7. Tamang MK, Ali A, Moreira RAN. Developmental vitamin D-deficiency produces autism-relevant phenotypes in rats. Transl Psychiatry 2023; 13:1. doi: 10.1038/s41398-023-02513-3
8. Kočovská E, Gaughran F, Krivoy A, et al. Vitamin-D deficiency as a potential environmental risk factor in multiple sclerosis, schizophrenia, and autism. Front Psychiatry 2017; 8:47. doi: 10.3389/fpsyt.2017.00047
9. Eyubova S, Hachmeriyan A, Toneva A. Unveiling connections: The impact of vitamin D on language development in pediatric neurodevelopmental contexts. Journal of IMAB 2023; 29(Suppl. 1).
10. Manohar S, Gangadaran RP. Vitamin D status in children with cerebral palsy. Int J Contemp Pediatr 2017; 4(2):615–9. doi: 10.18203/2349-3291.IJCP20170719
11. Alenazi KA, Alanezi A. Prevalence of vitamin D deficiency in children with cerebral palsy: A meta-analysis. Pediatr Neurol 2024; 159:56–61 doi: 10.1016/j.pediatrneurol.2024.03.021
12. Akpinar P. Vitamin D status of children with cerebral palsy: Should vitamin D levels be checked in children with cerebral palsy? Northern Clinics of Istanbul. 2018; 5(4):341–7. doi: 10.14744/NCI.2017.09581
13. Saad K, Abdelrahman AA, Elserogy YM, et al. Vitamin D status in autism spectrum disorders and the efficacy of vitamin D supplementation in autistic children. Nutritional Neuroscience. 2016; 19(8):346-351. doi: 10.1179/1476830515Y.0000000019
14. Wang T, Shan L, Du L, et al. Serum concentration of 25-hydroxyvitamin D in autism spectrum disorder: A systematic review and meta-analysis. Eur Child Adolesc Psychiatry 2016; 25(4):341–50. doi: 10.1007/S00787-015-0786-1
15. Siracusano M, Riccioni A, Abate R, et al. Vitamin D deficiency and autism spectrum disorder. Current Pharmaceutical Design 2020; 26(21):2460–74. doi: 10.2174/1381612826666200415174311
16. Alzghoul L. Vitamin D and autism spectrum disorder: A review of mechanisms and therapeutic potential. Neurodevelopmental Research Quarterly 2020; 10(3):89–102.
17. Jia J. The potential role of vitamin D in autism spectrum disorder: Evidence from preclinical and clinical studies. Journal of Pediatric Research 2014; 6(2):123–9.
18. Huang R. Influencing factors and intervention therapy of autism spectrum disorder. Sci Eng Technol 2022; 14:157–62. doi: 10.54097/hset.v14i.1605
19. Freeth M, Milne E, Sheppard E. Autism and ethnicity: Implications for diagnosis, research, and service provision. Autism Research 2014; 7(1):1–12. doi: 10.1002/aur.1348
20. Johnson CR, Thacher TD. Vitamin D: immune function, inflammation, infections and auto-immunity. Paediatr Int Child Health 2023; 43(4):29–39. doi: 10.1080/20469047.2023.2171759
21. Akkuş İ, Kaçmaz B. Acute phase reactants. Intercont J Int Med 2024; 2(3):74-76.
22. Rohner F, Namaste SM, Larson LM, et al. Adjusting soluble transferrin receptor concentrations for inflammation: Biomarkers Reflecting Inflammation and Nutritional Determinants of Anemia (BRINDA) project. Am J Clin Nutr 2017; 106:372S–382S.
23. Marinov D, Hristova D. Supplementation with vitamin D – cur-

rent recommendations. Journal of IMAB 2021: 27(4):3554–6. doi: 10.5272/jimab.2021271.3554
24. Montanez S. An Anthropological perspective on the prevalence of autism. Sociology and Anthropology 2016; 4(5):315–9. doi: 10.13189/SA.2016.040503
25. Norbury CF, Sparks A. Difference or disorder? Cultural issues in understanding neurodevelopmental disorders. Dev Psychol 2013; 49(1):45–58. doi: 10.1037/A0027446
26. Kim HU. Autism across cultures: Rethinking autism. Disability and Society 2012; 27(4):535–45. doi: 10.1080/09687599.2012.659463

Распространённость дефицита витамина D у детей с детским церебральным параличом и расстройствами аутистического спектра: сравнительное пилотное исследование

Ружа Панчева[1], Албена Тонева[1], Яна Бочева[2], Миглена Георгиева[3], Красимира Колева[3], Иван Янков[4]

[1] Кафедра гигиены и эпидемиологии, Факультет общественного здравоохранения, Медицинский университет „Проф. д-р Параскев Стоянов", Варна, Болгария

[2] Кафедра клинической лабораторной диагностики, Медицинский университет "Проф. д-р Параскев Стоянов", Варна, Болгария

[3] Кафедра педиатрии, Медицинский факультет, Медицинский университет «Проф. д-р Параскев Стоянов», Варна, Болгария

[4] Кафедра педиатрии, Факультет медицины, Медицинский университет - Пловдив, Пловдив, Болгария

Адрес для корреспонденции: Ружа Панчева, Кафедра гигиены и эпидемиологии, Факультет общественного здравоохранения, Медицинский университет „Проф. д-р Параскев Стоянов", ул. „Марин Дринов" № 55, 9002 Варна, Болгария ; Email: rouzha.pancheva@gmail.com

Дата получения: 8 октября 2024 г. ♦ **Дата приемки:** 2 декабря 2024 г. ♦ **Дата публикации:** 31 декабря 2024 г.

Образец цитирования: Pancheva R, Toneva A, Bocheva Y, Georgieva M, Koleva K, Yankov I. Prevalence of vitamin D deficiency in children with cerebral palsy and autism spectrum disorder: a comparative pilot study. Folia Med (Plovdiv) 2024;66(6):787-794 . doi: 10.3897/folmed.66.e138821.

Резюме

Цель: Целью данного исследования является изучение распространённости дефицита витамина D (ДВД) среди детей с церебральным параличом (ЦП) и расстройством аутистического спектра (РАС) в Болгарии, а также анализ связанных демографических, пищевых и биохимических факторов.

Материалы и методы: В северо-восточной Болгарии было проведено поперечное исследование с участием 95 детей (59 с ЦП и 36 с РАС). Статус витамина D оценивался с использованием биохимических маркеров и классифицировался как дефицитный (<20 ng/mL), недостаточный (20-29 ng/mL) или нормальный (≥30 ng/mL). Статистические сравнения проводились для выявления различий между группами.

Результаты: ДВД был распространён у 29.4% детей с ЦП и 15.8% детей с РАС, без существенных различий между группами (p = 0.492). Демографический анализ выявил существенные гендерные (p < 0.001) и этнические различия (p = 0.006). Дети с ДВД показали более низкие показатели Z-роста для возраста (p=0.002), Z-веса для возраста (p=0.021), уровни альбумина (p<0.001) и количество лимфоцитов (p=0.011). Нормальные уровни ферритина наряду со сниженным трансферрином и сывороточным железом предполагали дефицит синтеза белка, а не истощение запасов железа.

Заключение: Это исследование, которое является первым в Болгарии, посвящённым дефициту витамина D у детей с расстройством аутистического спектра и церебральным параличом, подчёркивает необходимость индивидуальных вмешательств и нутритивной поддержки. Результаты подчёркивают роль биологических и социокультурных факторов в распространённости ДВД, внося ценные сведения о здоровье детей в регионах с умеренным климатом.

Ключевые слова

расстройство аутистического спектра, биохимический анализ, детский церебральный паралич, нарушения нейроразвития, дефицит витамина D