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LEVELS OF VITAMIN D IN THE BLOOD, THE FACTORS THAT AFFECT IT, AND ITS RELATIONSHIP TO REPEATED INFECTIONS IN PRE-SCHOOL-AGED CHILDREN

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Abstract

The influence of vitamin D on calcium and phosphorus metabolism in relation to bone and muscle metabolism has been known for a long time. Lately, it seems that the effect of vitamin D has expanded. Among other things, it influences the immune system, diabetes mellitus, obesity or neuropsychiatric development. The lack of vitamin D is associated with an increased incidence of infectious diseases in children and adults.

The goal of this article was to map the levels of vitamin D in the blood of pre-school-aged children, its supplementation, using creams with protective factors in winter, stays at sea, nutrition and recurrent respiratory tract infections.

The research was carried out in two phases (with two sample groups) from June 2018 to March 2019. Blood samples were taken from the children in the first sample group, and these were analyzed for vitamin D levels. At the same time, their parents filled in questionnaires (N = 31). The blood samples from the children in the second sample group (N = 61) were analyzed for the relationship between vitamin D levels and recurrent respiratory tract infections.

We proved the importance of supplementation on vitamin D levels. We discovered that 56.5% of children without supplementation suffered from severe or mild vitamin D deficiency, and 25% of children with supplementation had a slight deficiency. We also partly proved the positive influence of solar radiation and the use of creams with UV protective factors on vitamin D levels. We also proved a relationship between low levels of vitamin D and respiratory diseases in children. 23% of children with recurrent respiratory tract infections had a mild or severe deficiency of vitamin D. Our results are limited by a low number of examinations and also by the fact that this study is retrospective.

Keywords: *Airways; Nutrition; Pre-school-aged children; Supplementation; UV filter; Vitamin D levels*

INTRODUCTION

Vitamin D is a much-discussed topic, and levels of vitamin D, their influence on the immune system and repeated respiratory infections have been monitored. Vitamin D is produced in the skin by UV radiation, where cholecalciferol is formed from the endogenous precursor of 7-dehydrocholesterol, which is subsequently hydroxylated several times in the body. The first hydroxylation occurs in the liver and 25-hydroxycholecalciferol or calcidiol is formed (25-OHD). It is subsequently hydroxylated in the kidneys and 1.25-dihydroxycholecalciferol or calcitriol (1.25-

ORIGINAL ARTICLE

OHD) is produced (Broulík and Broulíková, 2013a).

We assess the organism saturation with vitamin D using the serum concentration 25-OHD, which takes a long time to break-up (2–3 weeks) in comparison to 1.25-$(OH)_2D$. Establishing the active form of vitamin D (1.25-$(OH)_2D$) as a marker of its intake is not recommended (except nephropathy) due to its short break-up time (4–7 hours), but also because its serum concentration is significantly influenced by other factors, such as PTH (Braegger et al., 2013).

The most significant vitamin D source for the organism is its endogenous production with the help of UV radiation. However, vitamin D organism supply depends on many factors. Zittermann and Pilz (2018) state the following factors that influence vitamin D levels: geographical latitude, season, time of day, weather, skin type, altitude, supplementation, nutrition, some illnesses, staying outside, clothing, or creams with protective factors.

Vitamin D intake from food is usually low (approximately 10% of the total vitamin D intake) (Zittermann and Pilz, 2018). The food sources of this vitamin include cod liver oil, fatty sea fish, egg yolk and fortified foods (Bischofová et al., 2018; Broulík and Broulíková, 2013b; Earthman et al., 2012; Ginde et al., 2009; Stránský and Ryšavá, 2014).

Vitamin D is particularly important due to its antirachitic effect (with calcium intake). It is an important factor for skeleton growth – not only in the infantile period (Bronský et al., 2019; Zittermann and Pilz, 2018). It ensures the right differentiation, mineralization and maturation of growing bones. It is also important for muscle toning (uprighting, diastasis of abdominal muscles, hernia), CNS development (nerve growth factor production, regulation of information neurotransmitters) (Eyles et al., 2013), or in the development of natural and adaptive immunity (Krejsek, 2018; Šterzl, 2012). Low vitamin D levels in the blood are accompanied by infections of the upper airways. Daňková (2015), Krejsek (2018) and Sundaram and Coleman (2012) deal with the relationship between vitamin D levels and the progress of influenza. Maratová et al. (2018) point out the connection between vitamin D and inflammatory intestine illnesses in children. McGrath (2001) mentions the importance of imprinting in the prenatal period. Baker et al. (2010) mention the relationship between vitamin D levels and pre-eclampsia. The issue of vitamin D levels in adolescence was dealt with by the study of the Society for Adolescent Health and Medicine (2013). The importance of vitamin D in paediatrics was dealt with by Tláskal (2013). The relationship between vitamin D and diabetes and obesity has also been mentioned (Eartman et al., 2012; Holick, 2007; Holick et al., 2011; Pelzyńska et al., 2016).

The calcidiol serum level (Table 1) is an important indicator regarding the condition of vitamin D in the organism. According to Referential Values for Nutrition Intake (Society for Nutrition, 2019), at least 50 nmol/l is internationally considered necessary for healthy bone tissue.

Table 1 – Serum concentrations of 25-OHD

Serum concentrations of 25-OHD	Assessment
<30 nmol/l	severe deficit
30–50 nmol/l	mild deficit
50–75 nmol/l	sufficient level
>75 nmol/l	increased level

Source: Bouillon (2017)

The goal of this article was to map the levels of vitamin D in the blood of pre-school-aged children, its supplementation, using creams with protective factors in winter, stays at sea, nutrition and recurrent respiratory tract infections.

MATERIALS AND METHODS

We used the quantitative research method. This research was intentional and the participation was voluntary. It was carried out in two phases between June 2018 and March 2019. The first sample group included 31 pre-school-aged children, who were included in the first phase. This group was divided by locality into two subgroups. The first subgroup included 21 children from the Waldorf kindergarten, located in Rudolfov. The second subgroup included 10 children, whose data were gained from a non-state medical institution (NSMI) in Třeboň. The children's blood samples were taken in March 2019. Their parents filled in a questionnaire with 17 questions that covered vitamin D supplementation, using creams with protective factors in winter, stays at sea and nutrition.

The second phase was focused on preschool-aged children who suffered from recurrent respiratory diseases (i.e. at least 3 times a year). The sample group included 61 children and it was based on examining vitamin D levels in blood in the NSMI. The research included children who suffered from recurrent respiratory tract infections (49 children). The control group included 12 healthy children, whose blood samples were also taken in March 2019.

The blood samples from both phases were sent to a biochemical laboratory for the analysis of vitamin D levels.

For the assessment of the gained data, we used descriptive statistics. The results in the tables show the responses to the questionnaires. The results are divided by smaller groups of children to discover the influence of individual factors on vitamin D levels. It is a retrospective assessment in the last year.

Parents or other legal representatives of each child included in the research signed informed consent to give approval for their child to be included in the research.

RESULTS AND DISCUSSION

Vitamin D levels in the blood that are associated with its supplementation (*N* = 31, without supplementation 23, with supplementation 8)

Sufficient pro-hormone vitamin D level (i.e. calcidiol –25-OHD) is important for maintaining physiological functions, i.e. immunity. The Endocrine Society recommends supplementing vitamin D when the concentration of 25-OHD is below 50 nmol/l (Paszkova, 2010). The same recommendation is presented by the Society for Nutrition in its publication Referential Values for Nutrient Intake (2019). When applying this form of vitamin D, we must consider risk groups that are inclined to have low vitamin D levels (especially seniors and children). In these development life phases, it is very important to monitor vitamin D levels and supplement if necessary (Krejsek, 2018). It is very difficult to gain precise information, especially if it anamnestic, if it is for a retrospective study. The interpretation of results is also very difficult, particularly if we consider the scale of possible influences on vitamin D levels (Zittermann and Pilz, 2018).

Table 2 shows the percentage of children by vitamin D sufficiency in the blood. We assessed 23 children who did not supplement vitamin D during blood sampling. A mild or severe vitamin D deficit in the blood occurred in 56.5% of children who did not supplement the vitamin.

The remaining 8 children from the sample group used vitamin D supplements. These supplements were Vigantol, omega 3 or Vibovit. Children taking supplementation did not show a severe deficit. A mild deficit occurred in 25% of children (Table 3).

The positive effect of supplementation on vitamin D levels in the blood was proven. Bischofová et al. (2018) achieved similar results.

The assessment of vitamin D levels and the use of protective factors in winter (*N* = 31)

The results in other monitored variables are not persuasive, largely due to the insufficient number of respondents (examinations). The

Table 2 – The assessment of vitamin D levels in children without supplementation (*n* = 23)

	Severe deficit	Mild deficit	Sufficient level	Increased level
Number of children	26.1% 6 children	30.4% 7 children	30.4% 7 children	13% 3 children

Table 3 – The assessment of vitamin D levels in children with supplementation (*n* = 8)

	Severe deficit	Mild deficit	Sufficient level	Increased level
Number of children	no children	25% 2 children	37.5% 3 children	37.5% 3 children

effect of creams with protective factors is also debatable. It is necessary to consider the prevention of skin malignancies, but these creams have a negative effect on vitamin D levels (Krejsek, 2018). It is necessary to be aware of the strength of protective factors, duration, season, etc. This issue has also been dealt with by Zittermann and Pilz (2018).

The mentioned results do not confirm an unequivocal assumption for the use of UV filters (Table 4). The exact application time or the strength of UV filters of the used cream was not always known. The respondents who used creams with protective factors had a mild and severe deficit. Not one child that used creams with protective factors had severe vitamin D deficit, but they did have increased vitamin D levels in the blood. The mentioned results are certainly influenced by the fact that the children mostly used creams with protective factors and some children did not.

Table 4 – The assessment of vitamin D levels and using protective factors (*n* = 31)

Application of creams with protective factors	Severe deficit	Mild deficit	Sufficient level	Increased level
Application of creams with protective factors (*n* = 29)	20.7% 6 children	27.6% 8 children	31% 9 children	20.7% 6 children
No application of creams with protective factors (*n* = 2)	n/a	50% 1 child	50% 1 child	n/a

The assessment of vitamin D levels in connection to a stay by the sea (*N* = 31)

Sufficient vitamin D levels were found in 43% of children who regularly spent time at the seaside. 14% of these children had a severe deficit. Children that did not spend regular time at the seaside more frequently had a vitamin D deficit (60%). Half of them had a severe deficit and half had a mild deficit. Only 10% of the children that did not spend regular time at the seaside had sufficient vitamin D levels in the blood (Table 5).

Table 5 – The assessment of vitamin D levels in connection to a stay by the sea

Stay at the sea	Severe deficit	Mild deficit	Sufficient level	Increased level
Go to the sea (*n* = 21)	14% 3 children	29% 6 children	43% 9 children	14% 3 children
Do not go to the sea (*n* = 10)	30% 3 children	30% 3 children	10% 1 child	30% 3 children

The assessment of vitamin D levels in connection with the consumption of fatty sea fish (*N* = 31)

Children with vitamin D deficit (mild or severe) did not show any connection to the frequency of consuming vitamin D rich fish. However, more children ate such fish more frequently (30.8%), i.e. more than twice a month. They had an increased vitamin D level (Table 6).

Table 6 – The assessment of vitamin D levels in connection with the consumption of fatty sea fish

The frequency of consuming fish that are rich in vitamin D	Severe deficit	Mild deficit	Sufficient level	Increased level
None/low (max. once a month) (*n* = 18)	22.2% 4 children	27.8% 5 children	38.9% 7 children	11.1% 2 children
Often (more than twice a month) (*n* = 13)	15.3% 2 children	30.8% 4 children	23.1% 3 children	30.8% 4 children

We proved that food quality does not significantly influence vitamin D levels in the blood. Zittermann and Pilz (2018) achieved the same results. However, Krejsek (2018) points out significant vitamin D sources, such as milk fat, egg yolks and mushrooms. Information that warns about insufficient vitamin D levels in people with increased BMI is important (Zittermann and Pilz, 2018).

Vitamin D levels in children with recurrent respiratory tract infections (*N* = 61)

Regarding infections, it was proven (Table 7) that children with recurrent respiratory infections (at least three times a year) have decreased vitamin D levels. Daňková (2015), Ginde et al. (2009) and Tláskal (2013) achieved the same results. There are also children with normal or increased vitamin D levels, although they repeatedly face infections.

Table 7 – Vitamin D levels in children with recurrent respiratory infections

Number of children (*N* = 61)	Deficit level
49 ill children	23% – mild and severe deficit, 77% – no deficit
12 healthy children	16% – mild deficit, 84% – no deficit

There were no children with severe vitamin D deficit in the group of healthy children, i.e. children without recurrent respiratory infections, but there was a deficit among the children with recurrent respiratory infections.

All findings point to the fact that vitamin D assessments in the blood are necessarily multifactorial. The values cannot be interpreted individually. Another significant problem is the high financial cost of this examination.

CONCLUSIONS

After the assessment of the gained data, we concluded that supplementing vitamin D is positive for its levels in the blood. The differences were obvious between the children that used supplements and those that did not. Children that regularly went to the seaside had higher vitamin D levels. Regular consumption of fish also had a positive effect, but this finding cannot be considered statistically significant due to the low number of respondents. We also discovered that children who did not use creams with protective factors did not have severely low levels of vitamin D. Severe vitamin D deficit was found among the children that used creams with protective factors. While searching for a connection between the frequency of respiratory system illnesses and vitamin D levels, we discovered that insufficient vitamin D levels influenced the frequency of the incidence of respiratory illnesses.

Conflict of interests

The authors have no conflict of interests to declare.

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