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INTEGRATED STUDY MASTER'S THESIS

Dentistry Students' Knowledge in Vitamin D Deficiency Importance to Early Childhood Caries

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1 ABBREVIATIONS

25-(OH)D	25-hydroxyvitamin D
25-(OH)D2	25-hydroxyvitamin D2
25-(OH)D3	25-hydroxyvitamin D3
AAP	American Academy of Paediatrics
ADI	Adequate Daily Intake
DNA	Deoxyribonucleic acid
dmft	Decay-missing-filled teeth (for primary teeth)
dmfs	Decay-Missing-Filled surfaces (for permanent teeth)
DV	Daily Value
ECC	Early Childhood Caries
EFSA	European Food Safety Authority
IU	International Units
NDA	Novel Foods and Food Allergens
PUFA	Polyunsaturated fatty acid
RDA	Recommended Dietary Allowances
QR-Code	Quick Response Code
S-ECC	severe Early Childhood Caries
UV	Ultraviolet
UVA	Ultraviolet A
UVB	Ultraviolet B
VDR	Vitamin D Receptor
$\chi 2$	Chi-square

2 ABSTRACT

Background: Research has shown that there is a potential association between vitamin D and early childhood caries (ECC). Low levels of vitamin D have been linked to an increased risk of dental caries in children. The students' understanding on this subject is critical in addressing the problem. Vitamin D is essential for oral health, and a lack of it has been related to weakening tooth enamel and an increased risk of dental caries. Interdisciplinary relationships and continual surveys are required to advance knowledge. Effective preventive strategies against ECC can be done by increasing students' understanding and mediate.

Aim: The aim of this research is to investigate dentistry students' knowledge about vitamin D deficiency importance to ECC at Vilnius University based on a primary quantitative survey research.

Methods: A cross-sectional questionnaire was conducted among 90 from a total 162 international and Lithuanian dentistry students in study years from 2 to 5 at the Vilnius University in Vilnius from 17th October 2023 until 30th of October 2023. A structured questionnaire containing 29 close-ended questions, divided into two parts, was used. The knowledge and assessment of vitamin D deficiency related to ECC in dentistry students was tested.

Result: The sample size was 86 students. The overall understanding of the importance and physiological role of vitamin D was good, with some gaps in knowledge on issues. 60% believed vitamin D3 is the most important form, and 15% chose vitamin D2. 81% answered correctly about measuring vitamin D levels in the body. 33% knew the recommended minimum daily intake of vitamin D for infants (400 IU per day). Only 16% identified vitamin D supplements as the most effective source for children. Over 60% chose 'Fortified food' and 'Fatty fish' as the best sources of vitamin D. 97% of students were certain about vitamin D deficiency being more common in certain geographical regions. 70% of respondents communicated about vitamin D with family, however 80% had not discussed it with their dentists. 65% students in the second year of study and 80% in the third year had not discussed vitamin D with their dentists. 70% of females and 62% of males had differing views on the importance of giving vitamin D to children. 78% believed in knowledge about vitamin D in ECC is important for their future work as dentists. National students rate their self-confidence lower than international students (20-25%). The knowledge of the second-year students of the minimum daily intake for children aged 1 to 18 was better than in other study years (p = 0,036). The national study group has performed better than the international study group (p = 0,034) by giving more correct answers to questionnaire. Third year students have almost never talked to their lecturer at Vilnius University about the importance of vitamin D and this differed in comparison to the second, fourth and fifth years (p = 0,009). More female than male students found it extremely important that children would intake vitamin D (p = < 0,001). Almost all second-year students are not confident in talking to the patients' parents about the importance of vitamin D.

Conclusion: The survey highlights the significance of dentistry students' knowledge of vitamin D deficiency concerning ECC. Although the participants showed a good understanding of the importance of vitamin D, there were also some misconceptions that require further education and awareness in effective vitamin D sources and vitamin D supplementation in children, consultation in pregnant parents and low confidence level in communication with patients about that topic. Comprehensive vitamin D education must be integrated into dentistry curriculum.

Key Words: vitamin d deficiency, early childhood caries (ECC), dentistry student knowledge, Vilnius university

3 INTRODUCTION

Early childhood caries (ECC) is a significant public health concern affecting millions of young children worldwide, and its prevalence remains high despite preventive efforts such as fluoride supplementation and dental check-ups. Recent research has highlighted the potential role of vitamin D in the prevention of ECC, as it plays a significant role not only in bone health but also in immune system health and has been linked to oral health (1). Vitamin D deficiency is common among children and adults, particularly in areas with limited sunlight exposure or dietary sources of vitamin D (2). It has been associated with an increased risk of several health problems, including dental caries. The exact mechanisms by which vitamin D affects oral health are still being investigated, but it is thought to play a role in promoting enamel mineralization and supporting the immune response in the oral cavity (3). Given the potential impact of vitamin D deficiency on children's oral health, healthcare professionals and researchers are exploring strategies to address this issue. These efforts include encouraging the consumption of vitamin D-rich foods, and considering vitamin D supplementation when necessary (3).

Aim

The aim of this research is to investigate dentistry students' knowledge in vitamin D deficiency importance to EEC at Vilnius University.

Tasks

The main tasks in this research include 1) to review the results of the most recent literature, 2) to investigate dentistry students' knowledge and attitude about vitamin D deficiency importance to ECC at Vilnius University and 3) to evaluate the depth of knowledge and understanding among dentistry students regarding the correlation between vitamin D deficiency and the prevalence of ECC.

Hypothesis

It is hypothesised that dentistry students have a profound understanding of the correlation between vitamin D deficiency and the prevalence of ECC in order to demonstrate ability to implement preventive measures and treatment strategies in paediatric dentistry.

4 LITERATURE REVIEW

4.1 VITAMIN D PRODUCTION AND STORAGE

The term “vitamin D” refers to a group of physiologically active calciferols. The two most important forms are ergocalciferol (vitamin D2) derived from plants and cholecalciferol (vitamin D3, colecalciferol, calciol) found in animal sources and produced by humans. Endogenous cholecalciferol is produced in the skin from 7-dehydrocholesterol, a precursor in the production of cholesterol. Ergocalciferol and cholecalciferol are converted in the liver to the storage form calcidiol (25-hydroxyvitamin D, 25-(OH)D), which is then carefully converted in the kidney to the active form calcitriol (1,25-dihydroxyvitamin D) (4). Besides the liver, vitamin D in its inactive form of calcidiol can also be stored in the adipose tissues for prolonged periods after it circulated in the blood for 24 hours. It can be released when the body requires it. Therefore, the stored calcidiol is converted into its active form calcitriol (4).

Like steroid hormones, calcitriol acts through an intracellular receptor called the vitamin D receptor (VDR) (5). Ergocalciferol and cholecalciferol should therefore be considered prohormones. Calcium absorption in the intestine and calcium reabsorption in the kidneys are two physiological functions of vitamin D. As a result, vitamin D plays a role in maintaining the physiological serum calcium levels and thus bone health. However, the VDR, through which vitamin D acts, is not only found in bone cells, but also in cells of many internal organs (pancreas, brain etc.), cells of the immune and cardiovascular system, and muscle cells. The VDR binds to DNA and works as a transcription factor, activating many genes. Vitamin D is not a genuine vitamin because it is generated endogenously in the skin from 7-dehydrocholesterol under the influence of UV radiation. Even in summer, a healthy adult who regularly spends time outdoors (latitudes 37° N and 60° N) can meet up to 100% of his or her vitamin D needs by endogenous synthesis (as indicated by 25-(OH)D serum levels) (6). Vilnius is also one of the cities in the middle latitudes (54°54’ N, 25°19’ S).

Research on whether the UV radiation in Lithuania can be categorised as ‘Very high’, ‘Moderate’, ‘Low’ or ‘Almost’ absent could not be found. The Rugsteliskes monitoring station in Kaunas presents during the years 2002-2003 a preliminary analysis of data on ultraviolet (UV) radiation and ground-level ozone concentration measurements (7). The observations showed variations in the average UV radiation levels throughout the year. The average UV radiation value in January differed significantly from that in July, with a difference of about 10 times. The maximum intensity of ultraviolet A (UVA) radiation was observed in July, while the minimum intensity was recorded in December. Similarly, the highest intensity of ultraviolet B (UVB) radiation was observed in May, while the minimum intensity for both UVA and UVB radiation was recorded in December. Skin pigmentation, ageing, and the use of sunscreens all inhibit the synthesis of cholecalciferol in the skin. Supplementation of

vitamin D therefore plays a significant function, particularly in those with low sun exposure, the elderly, and in young children and infants. Because treatment for vitamin D deficiency depends on age it is treated differently in infants than in older children and adolescents.

With implications for autoimmune and infectious diseases, vitamin D plays a crucial role in modulating the immune system (8). Vitamin D has important functions beyond calcium and bone homeostasis, including the modulation of both innate and adaptive immune responses. This modulation extends to cells of the immune system that can synthesise and respond to vitamin D. The vitamin D receptor is expressed on various immune cells, such as B cells, T cells and antigen-presenting cells, allowing autocrine action within the local immunological milieu. This ability enables vitamin D to modulate both innate and adaptive immune responses (8). Evidence linking vitamin D to autoimmune diseases such as Crohn's disease, juvenile diabetes mellitus, multiple sclerosis, asthma and rheumatoid arthritis is accumulating for its role in regulating T and B cells, macrophages, dendritic cells and keratinocytes (9). Increased autoimmunity and susceptibility to infection are associated with vitamin D deficiency (10). This suggests that the benefits of vitamin D supplementation in people with autoimmune disorders might extend beyond effects on bone and calcium homeostasis. To summarise, the effects of vitamin D on the immune system go beyond its classical effects on calcium and bone homeostasis, with potential implications for autoimmune diseases as well as infectious diseases.

4.2 VITAMIN D DEFICIENCY

Vitamin D deficiency is associated with insufficient antimicrobial peptide activity, for example cathelicidins and defensins, decreased salivary secretion and low salivary calcium levels (11,12). The deficiency can be diagnosed by a healthcare practitioner via a serum or plasma test. Children, like adults, are considered deficient when their levels fall below 20 ng/mL (equivalent to 50 nmol/L) (13),(14),(15). Levels of 21-29 ng/mL (equivalent to 52-72 nmol/L) are considered insufficient. Although there is some controversy on what constitutes an appropriate amount of vitamin D in the blood, values above 30 ng/ml (equivalent to 75 nmol/L) are typically considered sufficient (16). Vitamin D insufficiency and deficiency can go unrecognised since visible symptoms do not usually appear until a severe shortage develops. Furthermore, symptoms can be ambiguous, making it difficult for parents or caregivers to identify a deficiency. Vitamin D deficiency affects infants globally, with prevalence rates ranging from 2,7% to 45% (17). Babies under 2 years old are more likely to develop this deficit due to their lower exposure to sunshine compared to adults. Babies who are exclusively breastfed or chest fed may not obtain enough vitamin D without supplementation. The requirements are the same for babies who are fed on formula (18).

Osteomalacia and rickets in children and osteomalacia in adults can result from vitamin D deficiency. The fortification of milk with vitamin D in the 1930s proved successful in eradicating rickets worldwide (19). However, subclinical vitamin D deficiency is widespread in both industrialised and developing nations, with a global prevalence of up to 1 billion (17). This subclinical vitamin D deficit is linked to osteoporosis (20), an increased risk of falls, and fragility fractures. Many contradicting recent research have found a link between maternal vitamin D deficiency and severe ECC (12,21,22). This is why it is critical for the child's doctor to test their vitamin D levels frequently, especially if they are at risk of developing a deficiency.

4.3 ROLE OF VITAMIN D IN DEVELOPING EARLY CHILDHOOD CARIES (ECC)

As mentioned already above vitamin D deficiency is indeed linked to an increased risk of ECC. Multiple studies have indicated that insufficient levels of vitamin D can contribute to enamel hypoplasia and an increased likelihood of ECC in children (23,24). ECC is influenced by both biomedical and environmental factors. One proposed explanation for ECC is enamel hypoplasia resulting from defective amelogenesis: Vitamin D plays a crucial role in the calcification of hard tissues, and a deficiency during pregnancy is believed to be associated with enamel hypoplasia (24). Enamel hypoplasia increases the risk of caries as these defects are difficult to clean and become easily colonised with cariogenic bacteria (12). A probable association has been found between vitamin D concentrations and dental caries in children (1). Early vitamin D deficiency has been linked to a greater risk of bone fracture and dental enamel degradation in later childhood (25). Additionally, vitamin D deficiency is associated with poor periodontal health and may be involved in the immune mechanism of periodontal infection (26). Higher doses of vitamin D and vitamin D-rich enhanced dairy product consumption have been associated with better dental health outcomes and decreased caries incidence (27–29).

In trials in Poland of 1 638 children aged 3, 99,1% of children received vitamin D supplementation, but only 55,2% continued to receive seasonal vitamin D after 12 months of age (11). These studies also found that the incidence of ECC/S-ECC (severe early childhood caries) and the mean dmft (Decay-missing-filled teeth (for primary teeth)) or dmfs (Decay-Missing-Filled Surfaces (for permanent teeth)) indices were lower in children who received vitamin D supplementation compared with their equals who did not receive supplementation. However, it was noted that the addition of confounding factors to the statistical model, such as maternal education level, nullified their significance (11).

Additional studies have reported an association between vitamin D and caries in children, and maternal prenatal vitamin D levels may influence the development of ECC in their offspring (12,30). The Maternal Organics Monitoring study (MOMS) conducted in Alaska found that a significant

percentage of maternal and cord blood samples had insufficient vitamin D levels. The study aimed to evaluate the association between prenatal and birth vitamin D concentrations in mothers and the development of ECC in their children (31). The available evidence suggests a link between maternal prenatal serum vitamin D concentrations and the development of ECC in infants. Some studies indicate that insufficient levels of maternal vitamin D during pregnancy may impact tooth calcification, leading to enamel hypoplasia and an increased risk of ECC (24,30). However, it is important to note that the relationship between maternal prenatal vitamin D concentrations and ECC is still being investigated, and the exact biological mechanism behind this association is not fully understood. Some studies have found a weak connection between serum vitamin D concentrations and the risk of tooth decay in primary teeth, but the evidence is not strong enough to recommend vitamin D supplementation for preventing dental caries in children for pregnant women (32).

4.4 VITAMIN D RECOMMENDATIONS FOR DIFFERENT AGE GROUPS

The preferred form of vitamin D for supplementation is vitamin D3, also known as cholecalciferol. The Recommended Dietary Allowances (RDAs) for vitamin D are listed in both micrograms (μg) and International Units (IU). It also mentions that 1 μg of vitamin D is equivalent to 40 IU, while 0,025 μg of vitamin D equals 1 IU (6).

According to the NDA Panel (Novel Foods and Food Allergens) of the European Food Safety Authority (EFSA) the Adequate Daily Intake (ADI) for adults, including pregnant and lactating women, and children aged 1 to 18 years, was set at 600 IU (15 μg) for vitamin D. For infants aged 0 to 12 months, was set for vitamin D at 400 IU (10 μg), which was based on four trials that assessed the effect of vitamin D supplementation on serum 25(OH)D concentrations in (mostly) breastfed infants (33,34).

4.5 SUPPLEMENTATION

There are liquid preparations available that provide the recommended daily allowance of 400 IU in 0,5 or 1 ml of liquid. There are also liquid drops which provide the recommended daily allowance of 400 IU in a single drop. An example of liquid preparation is Enfamil® D-Vi-Sol® which is a highly concentrated infant vitamin D liquid preparation that consistently provides 400 IU of vitamin D per ml (35). This ensures that infants receive the appropriate amount of vitamin D for their growth and development. It is important to be aware that the concentration of vitamin D can vary significantly between different preparations, which may not provide the same level of consistency and accuracy as Enfamil® D-Vi-Sol® (36). Chewable vitamin D supplements are a great alternative to traditional capsules or tablets. They are meant to be chewed completely before swallowing. The chewing of

vitamin-enriched gum has been shown to increase plasma vitamin D concentrations for retinol, pyridoxine, ascorbic acid and tocopherol (37). They are regarded as safe for children over the age of three who can chew hard foods and candy. Particularly for those who have difficulty swallowing traditional tablets or capsules, this method can ensure adequate intake. The Department of Health and Social Care confidently recommends a daily supplement containing 8,5 to 10 μg of vitamin D for infants aged between birth and 1 year who are breastfed or formula-fed with less than 500 ml of infant formula a day (38). A daily vitamin D supplement of 10 μg should be given to children aged 0 to 4 years old throughout the year.

4.6 SOURCES OF VITAMIN D

Several foods contain vitamin D naturally, but it is important to note that the list is limited. Fatty fish like trout, salmon, tuna, and mackerel, as well as fish liver oils, are considered the best sources. According to the United States Department of Agriculture (Agricultural Research Service) (6) one tablespoon of cod liver oil contains with 1360 IU (= 34 μg) the highest amounts of vitamin D source. Followed by trout (645 IU = 16,2 μg) and salmon (570 IU = 14,2 μg) per 3 ounces[a]. The amount of vitamin D in an animal's tissues depends on its diet. Beef liver (42 IU = 1,0 μg per 33 g), egg yolks (44 IU = 1,1 μg per egg), and cheese contain small amounts of vitamin D, mainly in the form of vitamin D3 and its metabolite 25-(OH)D. The amount of vitamin D2 in mushrooms varies. Some commercially available mushrooms have been treated with UV light to increase their levels of vitamin D2. UV-treated mushroom powder has been approved by the FDA as a food additive to provide vitamin D2 in food products (366 IU = 9,2 μg per 44 g). Plant-based milk alternatives, including soy, almond, or oat beverages, are commonly fortified with comparable levels of vitamin D as found in fortified cow's milk, which is approximately 3 μg (120 IU) per cup[b] (39). Limited evidence suggests that there are no significant differences in the bioavailability of vitamin D from different food sources (6).

According to the research results, the most effective and safest way for children to obtain vitamin D is through the use of vitamin D supplements or multivitamins that contain vitamin D because it can be challenging for children to obtain enough vitamin D through diet alone and due to limited sun exposure (2). These supplements are often labelled as vitamin D3 and can help ensure that children are reaching their vitamin D requirements in their diet. While sunlight exposure can also contribute to the production of vitamin D in the body, it is important to balance sun exposure with the potential risks of skin damage and the use of sunscreen. The amount of sun exposure needed for adequate

[a] 1 once (US) = 28,3495 g
[b] 1 cup (US) = 150 g

vitamin D production can vary depending on factors like location and time of year. As a preventive measure for vitamin D deficiency, the American Academy of Paediatrics (40) advises that children who do not consume 600 IU of vitamin D through their diet or from a formula with a volume greater than 1 litre per day, and those who do not have regular sun exposure, should receive prophylactic vitamin D supplementation. With the notable rise in the prescription of prophylactic vitamin D supplementation, it is important to be cautious of the potential risks of overdose that can lead to toxicity. Prolonged sun exposure does not cause intoxication (17) but excessive supplementation of vitamin D can, although rare, result in clinical symptoms associated with hypercalcemia and hypercalciuria. These symptoms may include nausea, vomiting, abdominal pain, kidney stones (nephrolithiasis), and central nervous system depression (41).

4.7 DENTISTRY STUDENTS' ASSESSMENT

Because healthcare professionals are frequently seen as the primary source of health-related knowledge for the public, the purpose of this survey was to assess their knowledge and attitudes regarding their awareness of the clinical and epidemiological aspects of vitamin D deficiency. Dentistry students play a critical role in promoting healthy behaviours and educating patients and their parents about oral health, but there is limited research on their knowledge and awareness of the potential role of vitamin D in prevention of ECC.

While there is no specific information on dentistry students' knowledge of vitamin D and its relation to oral health, it is crucial for dentistry professionals, including students, to be aware of the potential impact of vitamin D deficiency on oral health. Understanding the role of vitamin D in tooth mineralization, tooth decay, and gum health can help dentistry professionals provide comprehensive care to their patients. Dentistry students should be aware of the potential impact of vitamin D deficiency on oral health and incorporate this knowledge into their future practice.

5 METHODS

A total of 90 responses were collected from Vilnius University from students studying Dentistry in years 2 to 5. The survey period ran from October 17th until October 30th in 2023. Later, 4 responses were removed due to invalid information about age and study year. Finally, 86 responses were eligible for further analysis. Among these, all 86 were students from the Faculty of Dentistry.

The dataset contains survey responses from students about their knowledge of vitamin D deficiency and its importance in ECC as well as their self-assessment in relation to the importance and knowledge of vitamin D. It includes information about the students' age, gender, year of study, and study group (4 questions), their knowledge of vitamin D (18 questions), and about the students'

assessment in how confident they feel about that topic (7 questions). The question and answers to number 11 (What is the recommended daily intake of vitamin D in adults in the Baltic states?) were deleted due to lack of evidence and research data for a correct answer.

The main objective of this research is to investigate dentistry students' knowledge about vitamin D deficiency importance to EEC at Vilnius University based on a primary quantitative survey research. By using a quantitative research approach, this paper aims to collect and analyse data from a diverse sample of students to draw correlations and conclusions. The research design involves collecting data from international and national dentistry students from the faculty of Dentistry at Vilnius University via a structured questionnaire, focusing on their knowledge in the role of vitamin D deficiency importance to ECC. The questionnaire included multiple-choice and open-ended questions, which allowed for both quantitative and qualitative analysis of the data. Data collection for this survey was carried out via QR-code live in classrooms from 17th October 2023 until 30th of October 2023.

This review establishes a theoretical foundation for the research and identifies gaps in current understanding. The survey findings offer valuable insights for healthcare professionals, educators and researchers seeking evidence-based strategies to improve student learning outcomes. Educational institutions can develop strategies to improve students' knowledge and understanding of the importance of preventing ECC due to vitamin D deficiency. By incorporating insights gained from surveys and research studies, educators can tailor their teaching methods and curriculum to address the specific needs of students.

5.1 SURVEY SETTING

A total number of 163 national and international students are studying in the Faculty of Dentistry at Vilnius University in 2024 study year. For this research analysis all 163 students were asked to fill the questionnaire. 90 dentistry students (55% of Faculty of Dentistry at Vilnius University in 2024) from both national and international backgrounds in Vilnius agreed to participate. The sample size was determined based on the feasibility of data collection and the desire to obtain a representative sample of the number of dentistry students at Vilnius University. Each year, an average of 20 students from each national and international group graduate with their master's degrees graduate at Vilnius University.

A cross-sectional descriptive survey was conducted among all national and international dentistry students at Vilnius University in the Faculty of Dentistry. Data were collected from students in years 2 to 5. First year students (not included in the total number) were excluded due to the lack of clinical relevance of the topic due to the curriculum.

In the second year of the dentistry programme, students study topics from the preclinical part, where they work without patients but do clinical work on dummies in the subjects of therapeutic dentistry

and orthopaedic dentistry. Other pre-clinical subjects include pathological physiology, psychiatry, pathological anatomy, professional communication, and psychosomatics, which are compulsory (Annex 2).

From the third year, students have practiced with patients. They must take the following clinical dentistry courses: orthopaedic dentistry, oral surgery, therapeutic dentistry, periodontology, basics of paediatric diseases. The focus of the course in the Fundamentals of Diagnosis and Treatment of Children's Diseases is on communication with healthy and sick children, learning the fundamentals of children's diseases and their relation to jaw and dental pathology and vice versa, as well as learning the principles of infant nutrition and the principles of diagnosis and treatment of emergency conditions (42).

From the fourth to the fifth year, paediatric dentistry focuses on the dentistry students' practical work with children. This includes taking and recording medical and dental histories, assessing oral and dental conditions, administering anaesthesia, assessing caries risk, providing preventive measures, managing caries, restoring teeth, and using behavioural management techniques for co-operative children (42).

5.2 STATISTICAL ANALYSIS

Descriptive statistical analysis (percentage and frequency) was conducted using Microsoft Excel 2023 to ensure accurate and reliable data interpretation. The analysis included calculating percentages and frequencies to provide a comprehensive understanding of the data. Narrative quantitative analysis was also employed to explore interconnections and correlations within the data. The combination of Microsoft Excel 2023 for descriptive statistical analysis and narrative quantitative analysis was a powerful approach in this study. It uncovered meaningful patterns, correlations, and interconnections within the data, enriching the understanding of the research topic. DATAtab (43) was used for inferential statistical procedures to find out chi-square ($\chi 2$) and p-value. In addition, p-value < 0,05 considered as significant.

5.3 RESULTS

5.3.1 DESCRIPTION OF PARTICIPANTS

The study analysed a total of 86 responses, revealing that most genders were female (65%; n = 56), followed by males (34%; n = 29), while a small percentage chose not to disclose their gender (1%; n = 1) (Figure 1a). Distribution of years of study is n = 29 (34%) in the fourth year, n = 27 (31%) in the fifth year, n = 20 (23%) in the second year, and n = 20 (12%) in the third year (Figure 1b). Out

of the total responses analysed (n = 86), *n* = 63 (73%) were from the international group and *n* = 23 (27%) were from the national group (Figure 1a).

The limited number of Lithuanian responses poses a challenge for making significant comparisons between national and international courses. However, with careful analysis and consideration, meaningful insights can still be drawn. Due to time limitations faced by both professors and students, it was impossible to distribute the questionnaire to every individual student enrolled in the Faculty of Dentistry at the University of Vilnius.

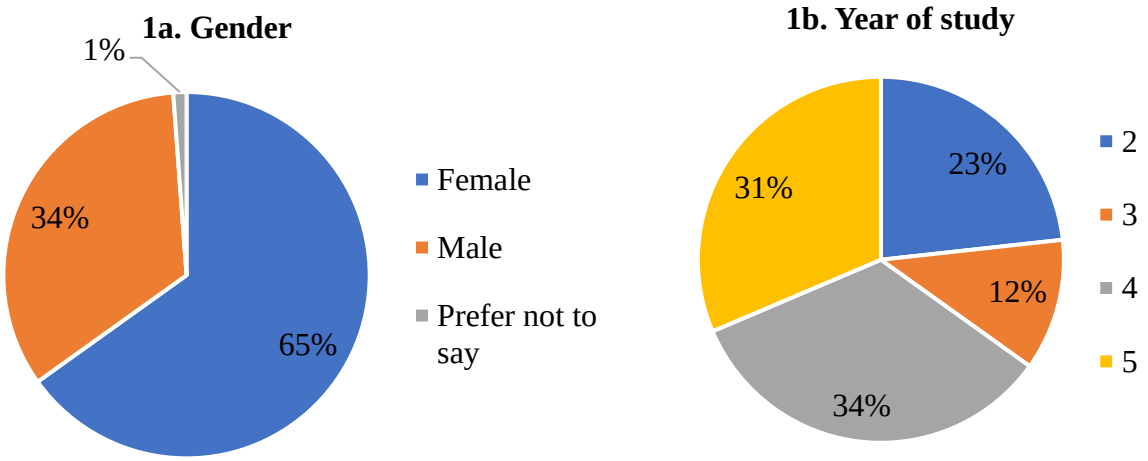


***Figure 1a-b**: Distribution of respondents from Vilnius University by their gender (1a) and students' academic year (1b) (n = 86).*

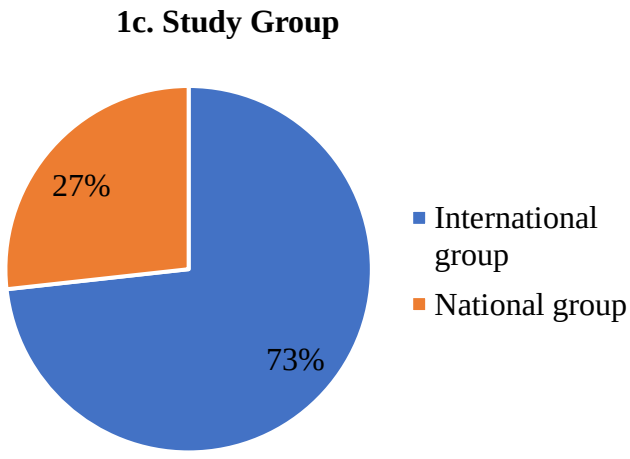


***Figure 1c:** Distribution of respondents by study group (n = 86).*

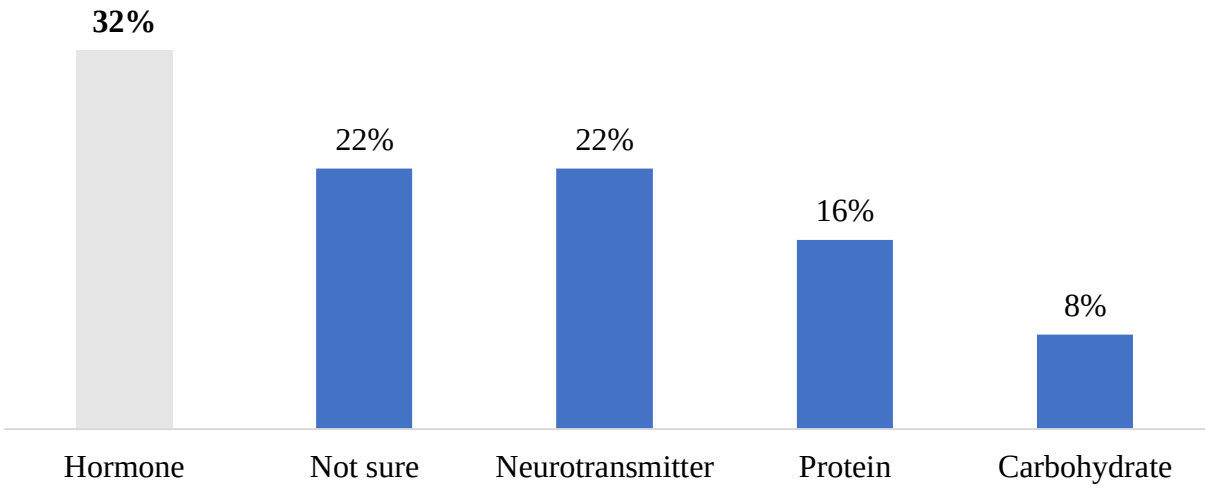
5.3.2 PARTICIPANTS SUSTAINABLE KNOWLEDGE OF VITAMIN D

When the participants were asked about what type of molecule vitamin D is, 32% (*n* = 27) of all the respondents thought it would be a hormone, while 22% (*n* = 14) believed it would be a

neurotransmitter. On the other side, 16% (*n* = 14) of the total respondents believed vitamin D would be a protein, while 8% (*n* = 7) of the respondents thought it would be a Carbohydrate. Furthermore, 22% (*n* = 19) of the students were not sure what type of molecule vitamin D is (Figure 2a).

Among the list of the most important form of vitamin D (where multiple answers could be chosen), the highest number of respondents chose vitamin D3 (60%; *n* = 71), followed vitamin D2 (15%; *n* = 18), vitamin D1 (13%; *n* = 15) and vitamin D4 (3%; *n* = 4). 'Not sure' were 9% (*n* = 10) of the participants (Figure 2b).

2a. Students' knowlage in vitamin D chemical structure.



2b. Students' knowledge in most important forms of vitamin D.

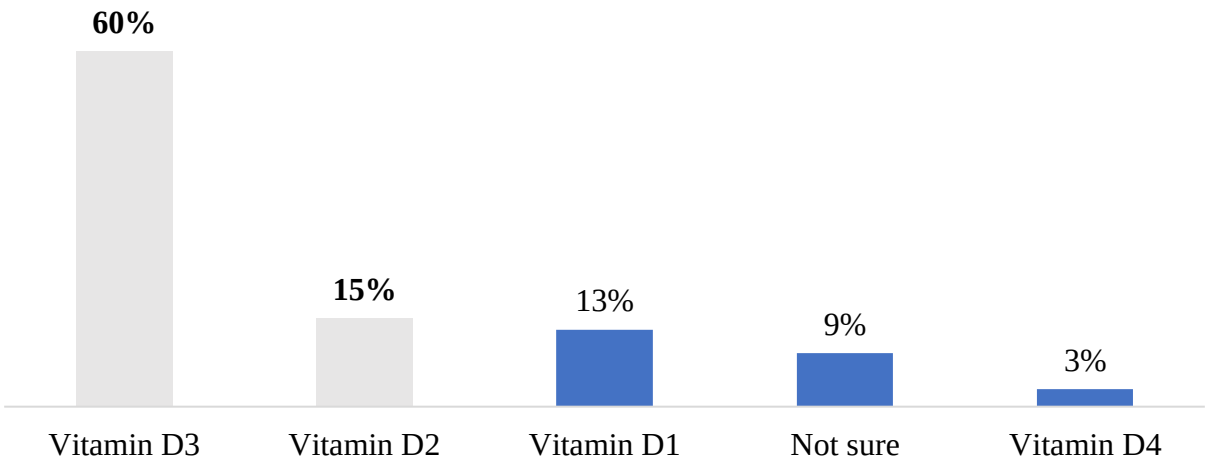


Figure 2a-b: *Distribution of students' answers to questions regarding what type of molecule is vitamin D (2a) and what is the most important form of vitamin D (2b). Students could choose more than 1 answer to question 2b. Correct answers marked in grey.*

When asked about the measurement of the vitamin D level in the human body, 'blood test' was the most preferred method among the respondents (chosen by 81%; *n* = 70), followed by 'urine test' (by 12%; *n* = 10), and 7% (*n* = 6) were not sure what to answer (Figure 3a).

Two third (62%; *n* = 53) of the respondents thought that vitamin D can be stored in the body but almost one fifth (24%; *n*= 21) replied that it cannot be stored in the human body (Figure 3b).

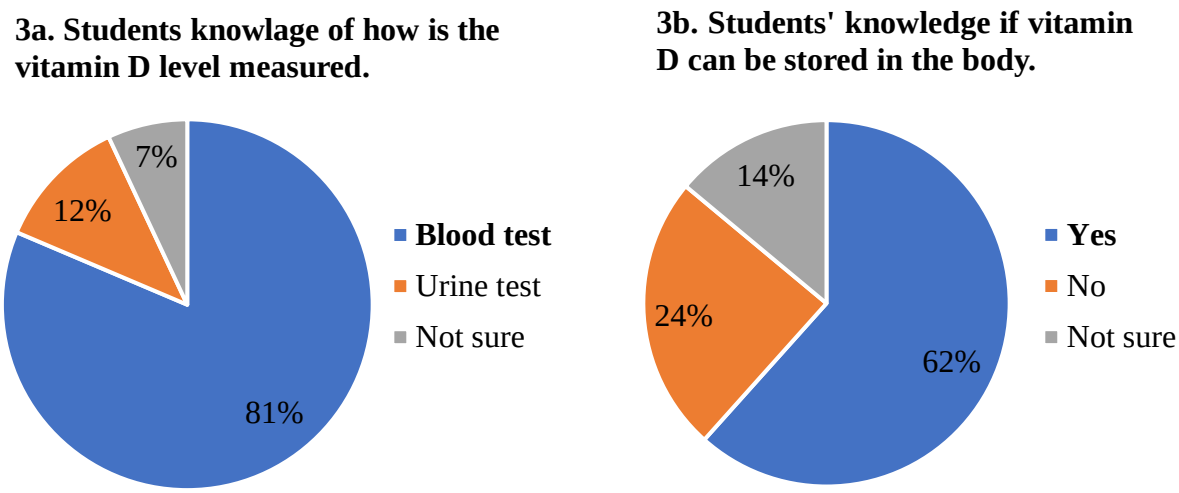


Figure 3a-b: *Distribution of students' answers to questions regarding how to measure vitamin D levels (3a) and whether vitamin D can be stored in the body (3b). Correct answer marked in bold.*

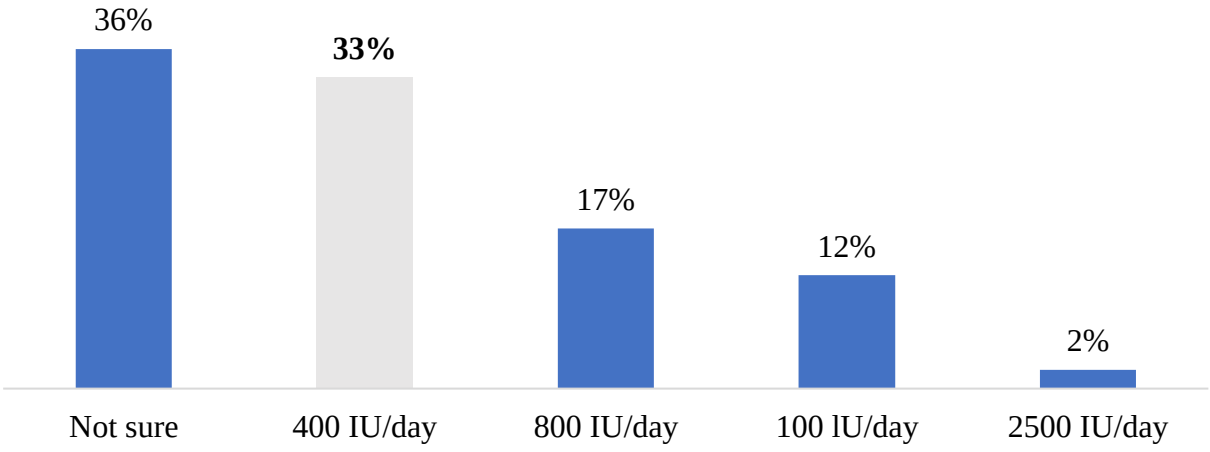
Regarding students' knowledge of the recommended minimum daily intake (diet or supplements) of vitamin D for infants up to the 12 months of age, 33% (*n* = 28) with 400 IU/day, 17% (*n* = 15) with 800 IU/day, 12% (*n* = 10) with 100 IU/day, and 2% (*n* = 2) with 2500 IU/day. The majority with 36% (*n* = 31) answered 'not sure' (Figure 4a).

Among all the respondents, 26% (*n* = 22) believed that 600 IU/day is the recommended minimum daily intake (diet or supplements) of vitamin D for children until the age of 1 to 18 years, while 23 % (*n* = 20) thought it was 1000 IU/day, 14% (*n* = 12) 400 IU/day, and 9% (*n* = 8)1500 IU/day. 28% (*n* = 24) were 'not sure' about the correct amount (Figure 4b).[c]

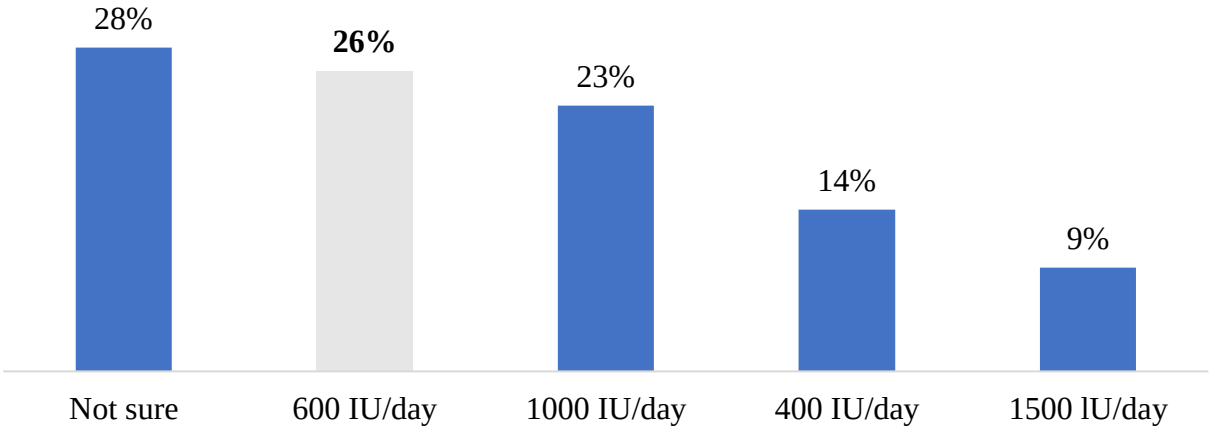
When the participants were asked about which food or drink has the highest concentration of vitamin D, half of all the respondents with 53% (*n* = 46) said it would be a fish such as salmon, mackerel, tuna, and sardines, while 13% (*n* = 11) believed it would be fortified food such as milk, orange juice, or fortified cereals. 12% (*n* = 10) of the total respondents thought vitamin D would be a cod liver oil, while 7% (*n* = 6) of the respondents thought it would be in beef liver as well as 7% (*n* = 6) egg yolks. Lesser percentages thought the highest concentration of vitamin D would be in soy products, mushrooms, or cheese (Figure 4c).

[c] 1 µg of vitamin D is equivalent to 40 IU, while 0,025 µg of vitamin D equals 1 IU

4a. Students' knowledge of the recommended minimum daily intake (diet or supplements) of vitamin D for infants up to the 12 months of age.



4b. Students' knowledge of the recommended minimum daily intake (diet or supplements) of vitamin D for children until age of 1 to 18 years.



4c. Students' knowledge in highest vitamin D concentrations in food/drink.

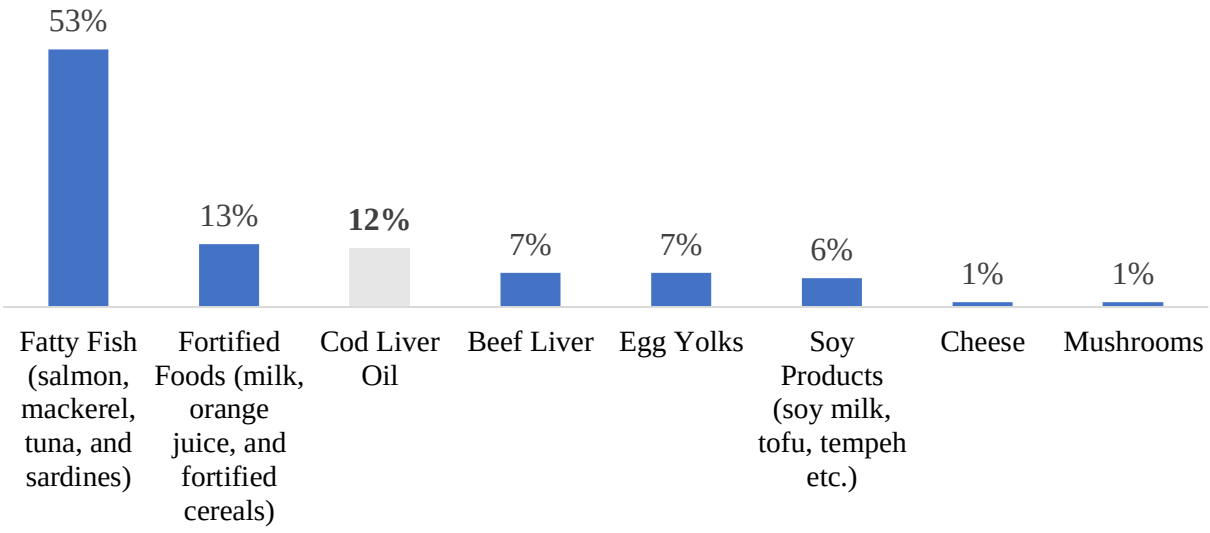


Figure 4a-c: *Distribution of students' answers to questions regarding the recommended daily dose of vitamin D for children up to 12 months (4a), children aged 1-18 years (4b) and drinks or food with the highest vitamin D content (4c). Correct answers marked in grey.*

More than half of the students (54%; *n* = 46) thought that regular exposure to sunlight is the most effective source of vitamin D for children, while 28% (*n* = 24) thought that eating foods rich in vitamin D is the main source and 16% (*n* = 14) thought that vitamin D supplements are the most effective source (Figure 5a).

When asked whether vitamin D supplementation is recommended for all infants and young children, 46% (*n* = 40) said 'no', 40% (*n* = 34) said 'yes', and 14% (*n* = 12) were 'not sure' (Figure 5b).

The data unequivocally demonstrates that 59% (*n* = 51) of participants answered 'yes', 16% (*n* = 21) answered 'no', and 25% (*n* = 14) were 'not sure' about the link between vitamin D deficiency and increased risk of early childhood caries (Figure 5c).

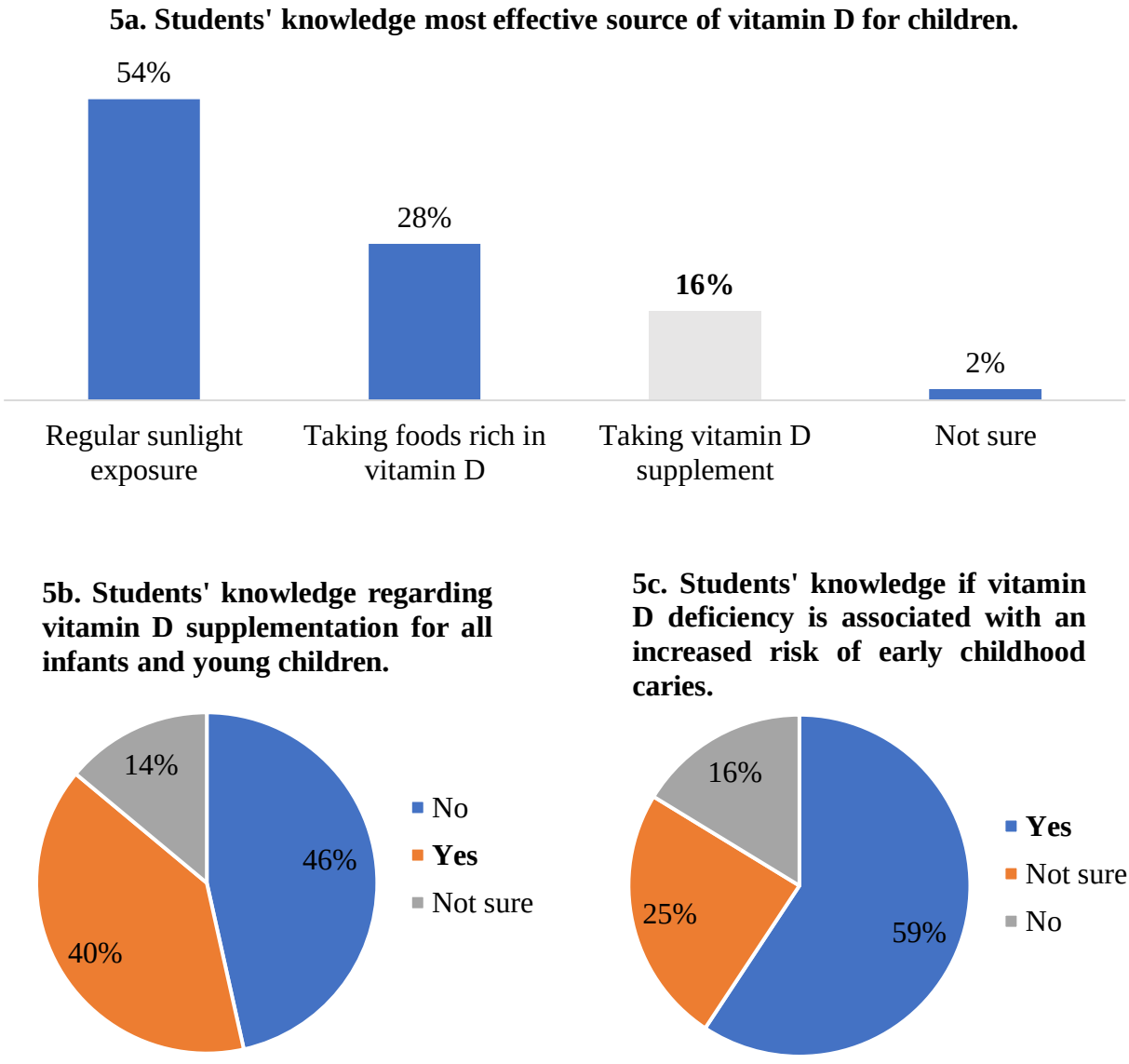


Figure 5a-c: *Distribution of students' answers to questions regarding knowledge of the most effective source of vitamin D (5a), recommendation of vitamin D supplementation for young children (5b) and the relationship between vitamin D deficiency and ECC (5c). Correct answers marked in grey and bold.*

76% (*n* = 65) of all the participants replied with 'yes' that vitamin D deficiency can affect the tooth enamel health (Figure 7a). If vitamin D deficiency can affect the gum health, as well 69% (*n* = 59) answered with 'yes' (Figure 7b). Almost all the 86 students (82 = 96%) thought that it can also affect the bone health (Figure 7c).

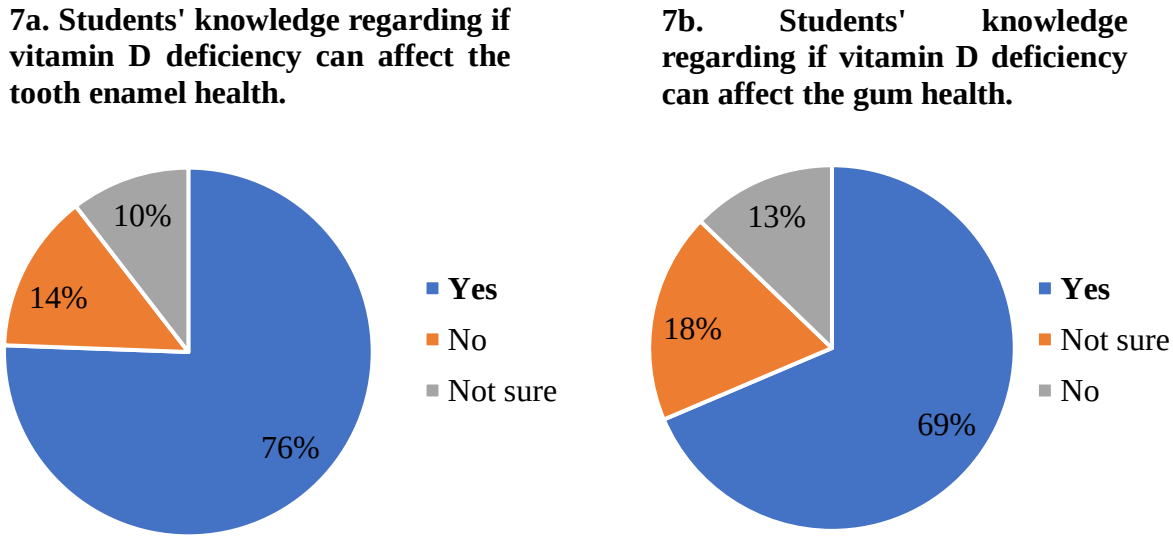


Figure 1a-b: *Distribution of students' answers to questions regarding knowledge of the influence of vitamin D to tooth enamel health (7a) and gingiva health (7b). Correct answers marked in bold.*

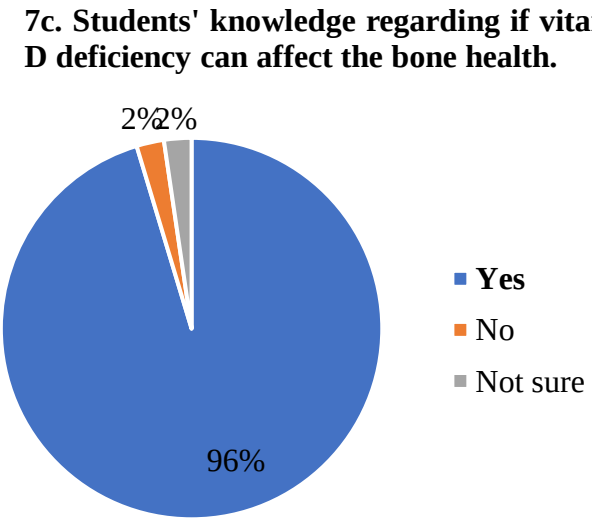
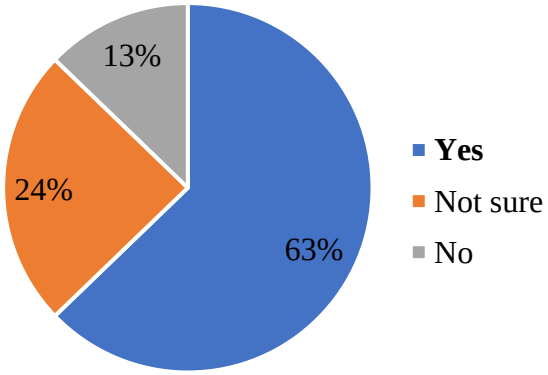


Figure 7c: *Distribution of students' answers to questions regarding knowledge of the influence of vitamin D to bone health. Correct answer marked in bold.*

Participants were positive that vitamin D supplementation could help prevent EEC, with 63% (*n* = 54) answering 'yes', 13% (*n* = 11) answering 'no' and almost a quarter (24%; *n* = 21) being 'not sure' (Figure 8a).

More than a third (34%; *n* = 27) were 'not sure' whether serum vitamin D concentrations in childbearing women (maternal prenatal) influence the development of EEC. However, more than half of the participants (51%; *n* = 43) thought that pregnant women's serum vitamin D levels influence ECC (Figure 8b). According to the survey results, 97% (*n* = 83) of respondents believed that vitamin D deficiency is more prevalent in certain geographic regions, while none of the respondents believed that it is not more prevalent. The remaining 3% (*n* = 3) were unsure about the prevalence of vitamin D deficiency in certain geographic regions (Figure 8c).

8a. Students' knowledge if vitamin D supplementation helps to prevent ECC.



8b. Students' knowledge regarding the influence of ECC development and the serum vitamin D concentrations of childbearing women (maternal prenatal).

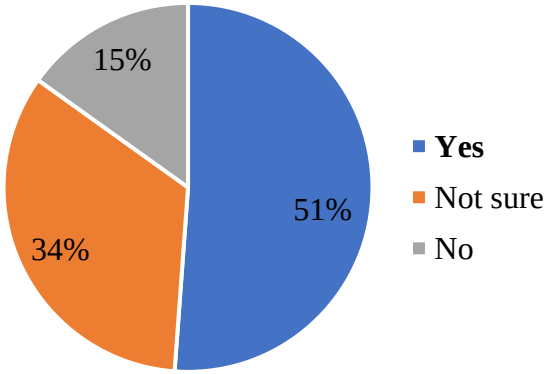


Figure 2a-b *Distribution of students' answers to questions regarding knowledge in preventing vitamin D deficiency with supplementations (8a) and child development in pregnant women (8b). Correct answers marked in bold.*

8c. Students' knowledge if vitamin D deficiency is more prevalent in certain geographic regions.

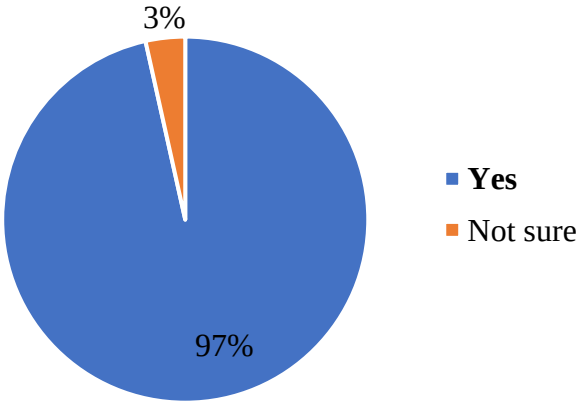


Figure 3c: *Distribution of students' answers to questions regarding knowledge in prevalence of vitamin D deficiency in certain geographic regions. Correct answer marked in bold.*

Most respondents (59%; *n* = 51) perceived the intensity of UV radiation in sunlight in Lithuania as 'low', while 20% (*n* = 17) considered it 'moderate' and 14% (*n* = 12) 'almost absent'. Only 1% (*n* = 1) of respondents perceived the level to be 'very high'. Additionally, 6% (*n* = 6) of participants reported not knowing about the level of UV radiation in Lithuania (Figure 9).

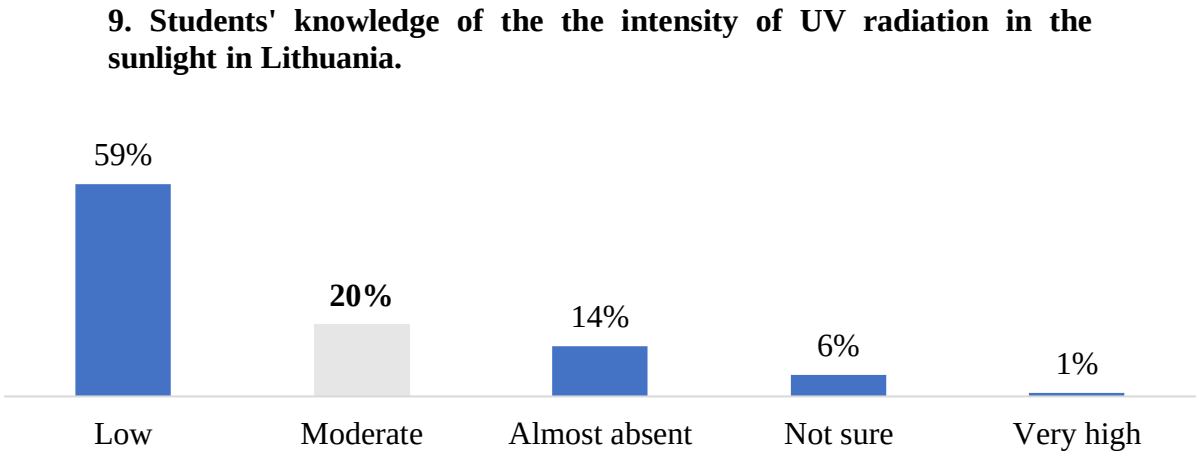


Figure 4: *Distribution of students' answers to questions regarding knowledge of the intensity of UV radiation in Lithuania. Correct answer marked in grey.*

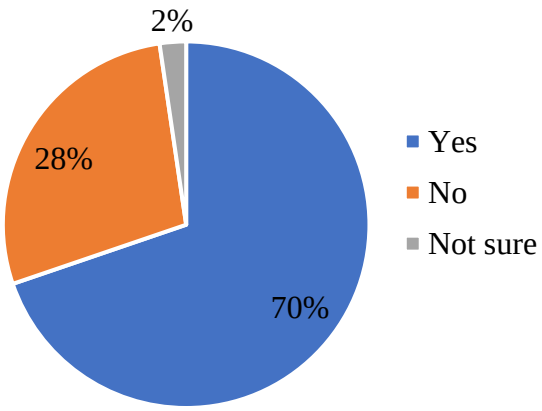
5.3.3 PARTICIPANTS ASSESSMENT

Three-fifths (70%; *n* = 60) had talked to their family about the importance of vitamin D. However, a quarter (28%; *n* = 24) said they had not. The remaining students (2%; *n* = 2) were 'not sure' if they had ever discussed the issue with their family (Figure 10a).

A majority, 80% (*n* = 69), had never talked to their dentist about the importance of vitamin D. Only 18% (*n* = 15) answered with 'yes' to this question. The remaining 2% (*n* = 2) were 'not sure' (Figure 10b).

When asked if they had ever spoken to their lecturer at Vilnius University about the importance of vitamin D, more than half of the students (53%; *n* = 46) answered 'no' and 33% (*n* = 28) answered 'yes' (Figure 10a).

10a. Students' assesment regarding their consultation with fmaily about the importance of vitamin D.



10b. Students' assesment regarding their consultation with dentists about the importance of vitamin D.

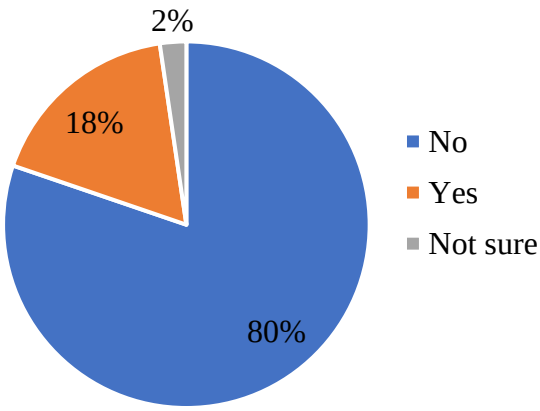


Figure 5a-b: *Distribution of students' answers to questions if they have ever consulted their family (10a) and their dentists (10b) about the importance of vitamin D.*

10c. Students' assesment regarding their consultation with lecturer about the importance of vitamin D.

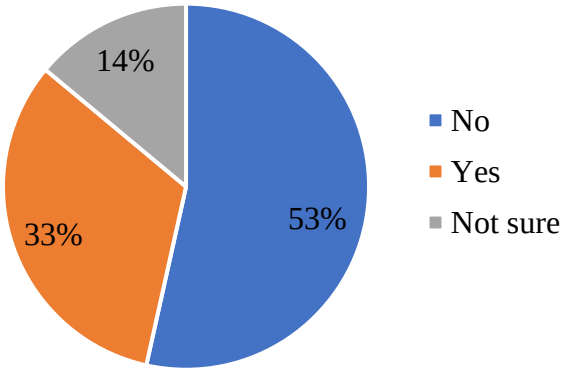


Figure 6c: *Distribution of students' answers to questions if they have ever consulted their lecturer about the importance of vitamin D.*

When participants were asked about the importance of vitamin D intake in children, 51% (*n* = 44) of respondents thought it was 'extremely important' (1% thought it was 'extremely not important'), while 40% (*n* = 34) thought it was 'somewhat important'. 8% remained neutral (Figure 11a). Furthermore, the students were asked about their future work life. When asked if it was important to know about the importance of vitamin D in early childhood 78% (*n* = 67) replied with 'yes' and 13% (*n* = 11) with 'no'. 'Not sure' responses made up less than 9% (*n* = 8) of the total answers (Figure 11b). 70% (*n* = 60) of the participants do not feel that they have enough knowledge about this topic is enough. 14% (*n* = 12) answered that they had enough knowledge (Figure 11c). In feeling confident

talking to patients about the importance of vitamin D 56% (*n* = 48) answered with ‘no’ and 28% (*n* = 24) with ‘yes’ (Figure 11d).

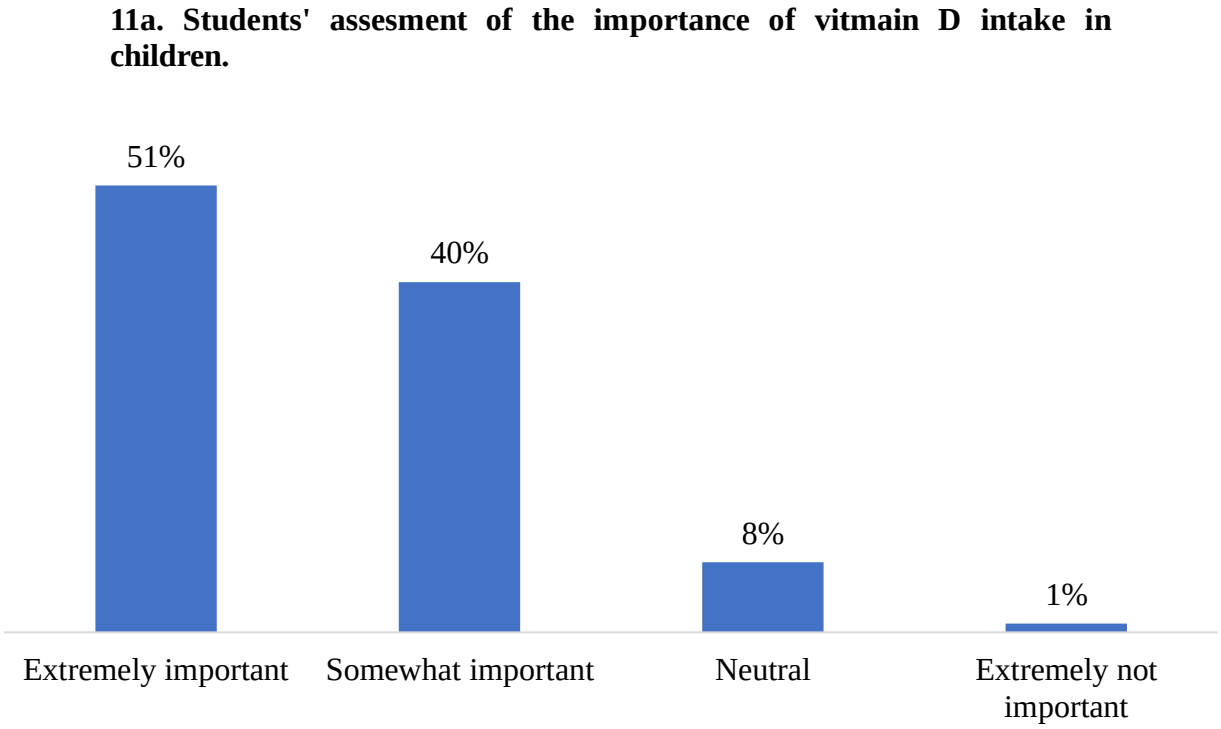


Figure 7a: *Distribution of students’ answers to questions how important the vitamin D intake in children is as perceived by the participants.*

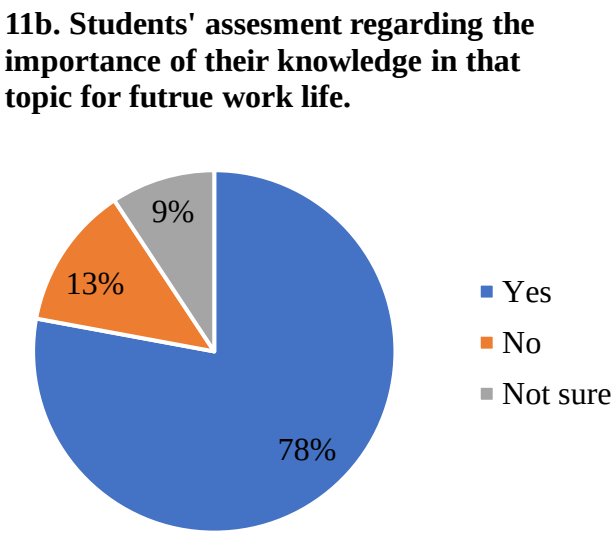
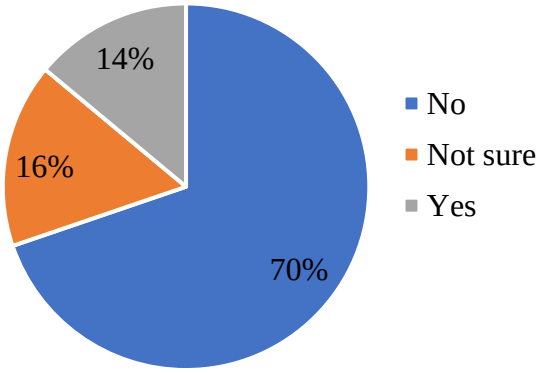


Figure 8b: *Distribution of students’ answers to question how important their knowledge in that topic of their knowledge in that topic for future work life is.*

11c. Students' assesment regarding having enough knowledge in that topic.



11d. Students' assesment regarding their confidence in talking about the topic vitamin D.

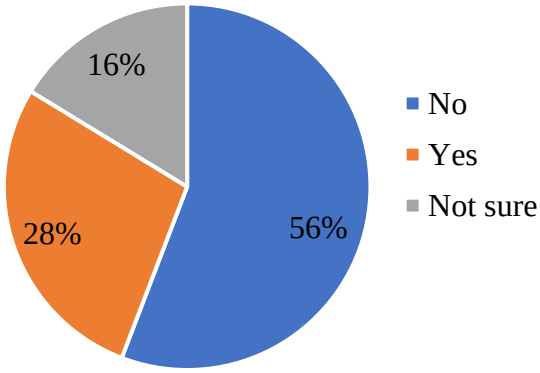


Figure 9c-d *Distribution of students' answers to questions regarding participants' assessment regarding, and self-assessment about the knowledge in that topic (Figure 11c) and confidence in talking about that topic (Figure 11d).*

5.3.4 RESULTS COMPARISON BETWEEN GROUPS (ANNEX 1)

Participants answers across different years of study, gender, and study group has been compared. In response to the questions, here are presented the number of participants (n) alongside frequency percentage (%). A statistically significant difference was set at *p*-value less than 0,05 (Annex 1).

5.3.4.1 PARTICIPANTS KNOWLEDGE ABOUT VITAMIN D

The first part of the results analyses the students' existing knowledge. The results of the students who answered the questions correctly are presented below.

The percentages for correct answers were 40% (*n* = 4) of third-year students, 28% (*n* = 8) of fourth-year students, and 41% (*n* = 11) for fifth-year students. The results show that only 20% (*n* = 4) of second-year students correctly identified vitamin D as a hormone. Additionally, the question was answered correctly by 24% (*n* = 7) of male students and 36% (*n* =20) of female students. International and national students demonstrated almost equal proportions of correct answers, with 30% (*n* = 19) and 35% (*n* = 8) respectively.

Most students in years two to five correctly identified the most important form of vitamin D as vitamin D3. The question had two possible answers, with a higher percentage of students in third, fourth, and fifth year correctly selecting vitamin D3. Although vitamin D2 was also a correct answer, it was chosen by a lower percentage of students across all years. Both cases saw 60% (*n* = 24) of men and 59% (*n* = 45) of women provide the correct answer 'Vitamin D3'. However, only 18% (*n* = 7) of men and 14% (*n* = 11) of women correctly identified the second possible answer 'Vitamin D2'.

The majority of second-year students (70%; *n* = 14), third and fourth-year students (90%; *n* = 26), and fifth-year students (78%; *n* = 21) correctly identified 'blood test' as the appropriate method for measuring vitamin D levels. Both male and female students were equally confident in their responses, with 82% of each group (male: *n* = 24; female: *n* = 46) selecting the correct answer. Although there was a slight discrepancy between international students (83%; *n* = 52) and national students (78%; *n* = 18) in their accuracy, the results demonstrate a high level of competence and expertise among the student body.

When asked whether vitamin D can be stored in the body, second-year students (55%; *n* = 11), third-year students (40%; *n* = 4), fourth-year students (66%; *n* = 19) and fifth-year students (70%; *n* =19) answered 'yes'. More than half of male and female students answered correctly with 72% (*n* = 21) and 55% (*n* = 31) respectively. 67% (*n* = 42) of international students and 48% (*n* = 11) of national students answered 'yes'.

The recommended minimum daily intake of vitamin D for infants up to 12 months of age is 400 IU/day, whether from food or supplements. Second-year students answered this correctly at a rate of 40% (*n* = 7), while third-year, fourth-year, and fifth-year students answered correctly at rates of 30% (*n* = 6), 28% (*n* = 10), and 33% (*n* = 8), respectively. Less than half of male students (41%; *n* = 12) and less than a third of female students (27%; *n* = 15) gave the correct answer. Approximately one third of both international and national study groups stated the recommended daily intake as 400 IU/day.

For children aged 1 to 18, the recommended daily amount is 600 IU. The correct answer was given by 35% (*n* = 7) of second-year students, 60% (*n* = 6) of third-year students, 21% (*n* = 6) of fourth-year students, and 11% (*n* = 3) of fifth-year students *(p* = 0,036). Less than 30% of male (*n* = 8) and female (*n* = 13) students answered correctly. The same applies to the group of international and national students (24%; *n* = 15) and 30%; *n* = 7) (*p* = 0,034).

When asked which food or drink had the highest vitamin D content, none of the second- and fourth-year students correctly answered with 'cod liver oil' (0% in each case). However, 20% (*n* = 2) of third-year and 30% (*n* = 8) of fifth-year students answered the question correctly. In terms of gender, only 3% (*n* = 1) of male students had the correct answer compared to 16% (*n* = 4) of female students (*p* = < 0,001). Approximately one tenth of both international and national students answered the question correctly.

Only around 20% of third (*n* = 3) fourth (*n* = 4), and fifth-year (*n* = 4) students correctly identified the most effective source of vitamin D for children ('intake vitamin D supplement'). Specifically, 30% (*n* = 3) of third-year students answered correctly. Men and international students had the lowest percentage of correct answers at 7% (*n* = 2) and 13% (*n* = 8), respectively, while women and national students had higher percentages at 21% (*n* = 12) and 26% (*n* = 6), respectively.

30% of second (*n* = 6) and fifth (*n* = 8) year students answered whether vitamin D supplements are recommended for all infants and children, while half of third- and fourth-year students answered 'yes'. Additionally, just under half of male students (*n* = 14) and a third of female students (*n* = 19) answered this question correctly. The correct answer was given by 38% (*n* = 24) of national and 43% (*n* = 10) of international students.

Regarding the association between vitamin D deficiency and increased risk of ECC, the results were consistent across all years of study. Approximately 70% (*n* = 14) of second-year students, 50% (*n* = 5) of third-year students, 52% (*n* = 15) of fourth-year students, and 63% (*n* = 17) of fifth-year students answered this question correctly with a 'yes'. The response rate for 'yes' was also similar between female and male students, at 75% (*n* = 33) and 79% (*n* = 18), respectively. This similarity also applied to international and national students.

80% (*n* = 16) of second and third-year students believed that vitamin D deficiency affects tooth enamel health. The same answer was chosen by 66% (*n* = 19) of fourth-year and 81% (*n* = 22) of fifth-year students. There is little difference in the correct answer between genders, with 79% (*n* = 23) of men and 75% (*n* = 42) of women answering correctly. The results are similar for both international and national students, with 75% (*n* = 47) and 78% (*n* = 18) respectively.

90% (n = 9) of third-year students answered correctly with 'yes' when asked whether vitamin D deficiency affects gum health. The correct answer was also given by approximately 70% of second- (*n* = 14) and fourth-year (*n* = 21) students and 25% (*n* = 15) of fifth-year students, as well as by 66%-79% of students in different gender and study groups.

All study groups, regardless of gender or study year, agreed that vitamin D deficiency affects bone health with a distribution between 90% and 100%.

When asked whether vitamin D supplementation helps prevent ECC, 75% (*n* = 15) of second-year students, 60% (*n* = 6) of third-year students, 55% (*n* = 16) of fourth year students and 63% (*n* = 17) of fifth year students answered 'yes'. Around 60% of both male (*n* = 18) and female (*n* =36) students, 67% (*n* = 42) of international students and 52% (*n* = 12) of national students also answered 'yes'.

In response to the question of whether maternal prenatal serum vitamin D levels affect the development of ECC, 65% (*n* = 13) of second-year students, 30% (*n* = 3) of third-year students, 52% (*n* = 15) of fourth-year students, and 48% (*n* = 13) of fifth-year students answered affirmatively with 'yes'. Additionally, half of the gender and study group also provided the correct response.

All study groups, regardless of gender or study year, agreed that vitamin D deficiency is more prevalent in certain geographic regions, with a distribution between 90% and 100%.

Only less than a third of the three groups who answered 'moderate' were correct when asked about the intensity of UV radiation in sunlight in Lithuania (10%-26%).

5.3.4.2 PARTICIPANTS ASSESSMENT

The second part of the questionnaire (Annex 2) was about the students' own assessment in attitude and confidence to the topic of vitamin D. Here, the results of the questionnaire are shown, where you can see most of the responses. The responses to these questions were not evaluated as either correct or incorrect.

When asked if they had ever discussed the importance of vitamin D with their families, 55% (n = 11) of second-year students, 100% (n = 10) of third-year students, 66% (n = 19) of fourth-year students and 74% (n = 20) of fifth-year students said yes.

90% (n = 9) of third-year students have not discussed the importance of vitamin D with their dentist. The majority of years two (n = 15), four (n = 24), and five (n = 21) also answered 'no' to this question, ranging from 75% to 83%. Similarly, between 79% (n = 50) and 83% (n = 19) of both genders and study groups answered negatively.

80% (n = 8) of third-year students did not talk about vitamin D with their lecturer at Vilnius University, discussions about vitamin D with lecturers are uncommon among students. Specifically, 65% (n = 13) of second-year students, 28% (n = 8) of fourth-year students, and 63% (n = 17) of fifth-year students have never had such discussions. Additionally, 41% (n = 12) of fourth-year students answered affirmatively when asked if they had discussed vitamin D with their lecturer (p = 0,009). 38% (n = 11) of male students and 61% (n = 34) of female students answered 'no' to the question. Additionally, 79% (n = 50) of international and 83% (n = 19) of national students admitted to never discussing the importance of vitamin D with their lecturer.

63% (n = 17) of fifth-year students and 50% of second (n = 11) and third-year (n = 5) students believe that vitamin D intake in children is extremely important. Among female students, 70% found it extremely important, while 62% (n = 18) of male students found it somewhat important (p = 0,001). In terms of the type of course, 46% (n = 29) of international students and 65% (n = 15) of national students found it extremely important.

60% to 91% of students from various academic levels, genders, and nationalities considered the subject of vitamin D in early childhood to be significant for their future professions.

The majority of students in all study groups reported feeling inadequately prepared in their knowledge of vitamin D. Specifically, 79% (n = 23) of fourth-year students, 83% (n = 19) of national students and 75% (n = 42) of female students reported feeling unsafe.

Most students, regardless of their group, felt uncomfortable discussing the importance of vitamin D with patients' parents. Specifically, 90% (n = 9) of third-year students, 60% (n = 33) of female students, and 74% (n = 17) of national students reported discomfort.

6 DISCUSSION

The responses recorded in this survey provide a comprehensive insight into the knowledge and assessment of the importance of vitamin D in ECC and its physiological role among dentistry students at Vilnius University. To the best of our knowledge, this survey is one of the few studies on this topic that includes international and foreign students and has a moderate sample size (n = 86).

6.1 SUSTAINABLE KNOWLEDGE

Results of this survey highlights an overall good knowledge towards the general physiological and chemical facts of vitamin D in the human body. Evident from 60% of all respondents believing that the most important form of vitamin D is vitamin D3 and 15% answered with vitamin D2 (Figure 2b). Recent research suggests that vitamin D3 is more effective is than vitamin D2 at raising blood levels of vitamin D (44). Vitamin D3 administrated orally raises the total serum 25-hydroxyvitamin D (25D) more durable than D2. Vitamin D3 promotes calcium absorption, regulates bone growth, and plays a role in immune function. While both vitamin D2 and D3 help meet vitamin D requirements, they differ in some important ways. Vitamin D2, also known as ergocalciferol, is derived from plants. Vitamin D3 is synthesised in the human skin from 7-dehydocholesterol after sun exposure (45).

From all the responses a high percentage of the votes for the method of measuring the level of vitamin D in the body were also answered correctly (81%) (Figure 3). The levels of vitamin D in the human body are measured in by the biomarker 25-hydroxyvitamin D (25-(OH)D). It can be measured in serum, plasma, whole blood, or blood spots. The total 25-(OH)D concentration is the sum of levels of the metabolites 25-hydroxyvitamin D2 (25-(OH)D2) and 25-hydroxyvitamin D3 (25-(OH)D3) (46). Concurrently the indication of the serum level concentration of 25-(OH)D indicates a possible storage of vitamin D in the human body which the participants answered correctly as well. It is notable that almost a third (26%) of second-year students answered that vitamin D2 was just as important as D3. In contrast, only 6% of fifth-year students responded with the vitamin D2 option (Annex 1). This group also gave some answers about vitamin D4. There was no research on the importance of vitamin D4, nor was it mentioned. This event can be explained by the fact that the fifth-year courses in public health, biochemistry and human physiology are already further back. On the other hand, the second year has a great advantage as the above-mentioned subjects were only about half a year ago. According to the curriculum of the Faculty of Dentistry in Vilnius University (42), first-year students have already studied the chemistry and function of vitamins in the human body. Further subjects such as ‘Biochemistry’ or ‘Human physiology’ provided a more in-depth understanding of the metabolism of various vitamins. It is postulated that this group of students may have exhibited a greater level of

interest in the functionality of vitamin D, thus resulting in a higher level of knowledge on the subject matter.

On a similar note, regarding the recommended minimum daily intake of vitamin D in infants (until 12 months) more than one third of the respondents were not sure how to answer that question whereby 33% answered correctly with 400 IU per day (Figure 4a). As well as with the following question the majority of the respondents were not sure how the amount of the minimum daily intake of vitamin D in children and adolescents (1-18 years) is (Figure 4b). According to the EFSA ANS Panel (EFSA Panel on Food Additives and Nutrient Sources added to Food) (33) all children need vitamin D beginning shortly after birth. A daily intake of 400 IU of vitamin D is required for children under 12 months. Children 1 to 18 years old need 600 IU of vitamin D each day.

However, when the answers to the questions on students' knowledge are compared between the genders, the figures do not show a large gap in knowledge (Annex 1). Both groups gave similar answers. The question 'What is the recommended minimum daily intake (diet or supplements) of vitamin D for children and adolescents aged 1 to 18 years?' shows a discrepancy in the answers. The Daily Value (DV) for vitamin D is 20 μg (800 IU) for adults and children 4 years and older, according to the US Department of Agriculture's FoodData Central (38). It is important to note that the recommended daily amounts of vitamin D for children and adolescents aged 1 to 18 years are not explicitly mentioned in the provided fragments. However, the U.S. government provides average daily recommended amounts of vitamin D for different age groups in μg and International Units (IU). For children aged 1 to 18 years, the recommended daily intake is 15 μg (600 IU) (47). It is important to consult with healthcare professionals to determine the most appropriate protocol for ensuring adequate vitamin D intake in children and adolescents, but with guidance from healthcare professionals, parents can make informed decisions about their child's vitamin D intake. The varying recommendations from different sources have led to discrepancies in the recommended minimum daily intake of vitamin D for children and adolescents.

Anomalies exist between the international and national courses in the questions mentioned above (Annex 1). It is evident that the percentage of 'not sure' responses is notably higher among national students. National and international students may have different levels of knowledge or understanding, as suggested by this finding. The distribution of answers is more spread out among international students. There is a significant greater distribution of correct answers among national students. Nevertheless, there is also more uncertainty when answering the question (p = 0,034).

There is significant evidence to suggest a significant association between the study groups and the years from 2 to 5 (p = 0,036) and their answers to the question (Annex 1). The higher respond of 'not sure' could reflect respondents' uncertainty or lack of knowledge about the question being asked. A recent article (48) analyses the 'not sure' response as a typically answer of people who like to avoid

thinking thoroughly or do not have a clear position to that topic. The analysis presented in the article suggests that individuals who respond with 'not sure' may lack a well-defined position on the topic or have insufficient knowledge or exposure, among other factors. It is important to note that a 'not sure' response does not indicate a lack of intelligence or capability. The statement indicates the individual's honesty in acknowledging their uncertainty or the need for further information and discussion.

Only 16% of the participants of this survey identified the intake of vitamin D supplements as the most effective source of vitamin D for children, whereas 54% of the respondents believed 'regular sunlight exposure' as the best source (Figure 5). Presumably the question was not clear enough for the participants or they did not read the question to the end. The question refers to children and not to adults. Published literature suggest that reducing the potential risk of skin cancer in the future, the American Academy of Paediatrics (AAP) recommends that infants under 6 months of age should avoid direct exposure to the sun. Instead, they suggest providing natural foods or vitamin D supplements. Both the AAP and the Lawson Wilkins Paediatric Endocrine Society recommend that infants who are exclusively or partially breastfed should receive 400 IU of vitamin D daily from the first days of life (2). As such, the hypothesis that regular sunlight exposure is the most effective source of vitamin D particularly in the context of children, is most likely not correct. Insufficient exposure to sunlight is the primary cause of vitamin D deficiency, as highlighted in the study 'Vitamin D: The Sunshine Vitamin'(49). Wearing sunscreen with a sun protection factor of 30 reduces vitamin D synthesis in the skin by over 95%. It is important to note that individuals with naturally dark skin tones require longer exposure to produce the same amount of vitamin D as those with lighter skin tones. Sunlight exposure is not the most effective or reliable source for vitamin D synthesis (49). Several factors impact how much vitamin D is produced from sun exposure, including season, time of day, latitude, skin pigmentation, sunscreen use, and cloud coverage. Only small amounts of UVB radiation can penetrate the skin and trigger vitamin D production. Addressing potential misconceptions regarding the sole reliance on sunlight exposure as the primary source of vitamin D is crucial, particularly in the context of children's health. This highlights a knowledge gap, the majority of the dentistry students identifying the wrong source also needs to be addressed.

Comparably, about which drink, or food contains the most vitamin D the first two answers 'Fortified food' and 'Fatty fish' result together in over 60% (Figure 4c). It is striking that almost one third of the fifth-year students and more female participants answered that 'cod liver oil' contains the highest amount of vitamin D (Annex 1). Cod liver oil is an excellent source of vitamin D, with one teaspoon (5 ml) of the most commonly used Norwegian brand containing 10 g (400 IU) of vitamin D3, as well as other essential nutrients such as vitamin A, vitamin E, and omega-3 fatty acids EPA and DHA (50). Its unique combination of vitamin D and omega-3 PUFAs (Polyunsaturated fatty acid) makes it

an especially valuable supplement for individuals at higher risk of vitamin D deficiency and, may exert synergistic anti-inflammatory and immunomodulatory actions to a greater extent than when they are administered alone (51). A significant connection between the female and male students' answers and the question is shown (Annex 1). 'Fatty fish' was more common answer from both female and male students (p = < 0,001). As mentioned above, according to the United States Department of Agriculture (Agricultural Research Service) (6) cod liver oil is the leader in the highest amount of vitamin D. Nevertheless, 'fatty fish's' answer is not wrong. Cod liver oil is an oily substance extracted from the livers of fish. There may have been problems with the content and understanding of this question, which led to the more obvious answer.

According to the research results it is clear now that vitamin D supplementation is certainly recommended for all infants and young children to support their health development (17). Almost half of the students surveyed were misinformed about the need to give children vitamin D supplements (46%) (Figure 5b). One abnormality was observed in the fourth year of the survey. Over half of the participants (55%) confidently believed that children should receive additional vitamin D supplements (Annex 1). The increase in confidence following initial lack of awareness can be attributed to various factors, such as gaining new information or receiving education about the importance of vitamin D supplementation during the survey. The assumption that a majority would vote in favour because the questionnaire addressed the issue of vitamin D intake in both children and adults was incorrect. The questionnaire only asked about the total amount of vitamin D obtained from diet or supplementation, not just supplementation alone.

The survey results confirm that vitamin D deficiency has a unfavourable effect on enamel, gum, and bone health (Figure 7a, Figure 7b). The highest level of agreement was found for bone health (Figure 7c, Annex 1), with unanimous agreement among all participants, regardless of study years, gender, or study groups. This finding is consistent with the well-established understanding that vitamin D deficiency can lead to increased bone metabolism, impaired bone mineralisation, and an enhanced risk of fractures (20). Vitamin D deficiency causes decreased intestinal calcium absorption, secondary hyperparathyroidism, hypophosphatemia, and increased bone turnover (49). This leads to lower bone mineral density and an increased risk of bone loss or fracture in both men and women (52). Vitamin D deficiency has a negative impact on enamel, gum, and bone health. A comprehensive review published in PMC links vitamin D deficiency to a wide range of oral health disorders. Severe vitamin D deficiency in children can cause defective tooth mineralization, resulting in enamel and dentin defects, which may increase the risk of dental caries (26). Furthermore, vitamin D deficiency has been linked to a higher prevalence of periodontitis and gingival inflammation. Sufficient vitamin D intake is crucial for maintaining good health. The well-established detrimental effects of vitamin D deficiency on bone health include increased bone metabolism and increased risk of fractures.

Maintaining sufficient levels of vitamin D is crucial for preserving bone health and reducing the risk of fractures, especially in younger and older individuals (25).

Regarding the influence on ECC of serum vitamin D concentration in childbearing women more than one third of the participants do not have enough knowledge (Figure 8b). It is interesting to note that in percentage terms the equal number of men and women gave the same answer. Half of both genders think that it is important for women to have an adequate concentration of vitamin D in their blood during pregnancy (Annex 1). Nevertheless, more men (41%) than women (30%) are unsure about this question (Annex 1). Based on the research results, there is evidence of an association between maternal prenatal vitamin D levels and maternal prenatal vitamin D concentrations and the development of ECC in children. Several studies have investigated this association and found that mothers with lower prenatal vitamin D levels may have an increased risk of their children developing ECC (12,53). It is thought that maternal vitamin D status during pregnancy may influence dental calcification and enamel hypoplasia, which are factors associated with ECC. However, it is important to note that not all studies have found a significant association between maternal prenatal vitamin D levels and ECC (12). Further research in this area is ongoing and further studies are needed to studies are needed to fully understand the relationship between maternal vitamin D levels and the development of and ECC development in infants. It is worth noting that vitamin D deficiency is a common problem in children and adults, especially in areas with limited sunlight exposure or dietary sources of vitamin D during pregnancy and early childhood is important for overall health, including oral health.

Almost all participants (97%) were sure that vitamin D deficiency was more common in certain geographical regions (Figure 8c). This high percentage is striking and may be due to the general nature of the question. The survey did not ask for specific regions or provide specific data or research. The general nature of the question may have led participants to assume that vitamin D deficiency was more common in certain regions, based on their own experiences, observations, or general understanding of factors contributing to vitamin D deficiency, such as limited sunlight exposure or cultural practices that may affect vitamin D synthesis. Participants' answers may have been influenced by their general knowledge or perception of vitamin D deficiency. However, it is important to note that their beliefs may not match the actual prevalence rates in certain geographical areas. For example, the prevalence of vitamin D deficiency has been found to be high in South Asian adults. This may be due to the relatively low levels of sunlight available in subtropical regions (54). Also in Iran, prevalence is higher in women than in men. This suggests that factors involved in vitamin D deficiency may differ by gender in some populations (55). Several factors such as age, ethnicity, geographical location, and dietary habits play a certain role. Vitamin D deficiency is a significant global public health issue, particularly in the Middle East and other geographic regions (56). It is

important to note that regional differences in vitamin D status exist within Europe, with better vitamin D status observed in Northern Europe compared to Southern and Eastern European countries. It is a well-known fact that infants in countries such as India, Iran, Turkey, and China have reported high percentages of severe vitamin D deficiency (57). Furthermore, people living in tropical regions, including Bangladesh, India, and Sri Lanka, have a higher prevalence of vitamin D deficiency compared to those in subtropical regions (54). It is essential to take necessary measures to ensure adequate vitamin D levels in affected populations. Vitamin D deficiency is a complex issue that affects infants, children, and adolescents worldwide, as well as in most countries of South America and Africa. However, with proper education and awareness, it is possible to work towards addressing this issue and promoting better health for all. It is caused by various factors, including limited sunlight exposure, dark skin, older age, and obesity.

6.2 PARTICIPIANT ASSESSMENT

In general, the communication between students at Vilnius University and their family members talking about the importance of vitamin D is remarkably high, with a percentage of 70% (Figure 10a). This high level of communication may be attributed to personal experiences or influences from family or friends. It is possible that individuals have become more aware of the importance of vitamin D due to various factors. It is quite likely that before coming to Lithuania to study, some students have informed about how dark the days can be in winter. In 2018 a study was conducted about the vitamin D levels of out-patients in Lithuania. Lithuania is a country in the middle latitudes. In such areas, the intensity of sunlight decreases significantly in the cold season, and the synthesis of vitamin D3 in the skin is reduced or almost absent in the period from October to March, which seems to be the most important natural risk factor for vitamin D deficiency, at least in the cold season (58). Further extensive studies on the subject in Lithuania are necessary. Still, it is important to approach this matter with a balanced and informed perspective, considering all relevant factors and perspectives.

The survey results indicate that there is room for improvement in the communication between students and their dentists, particularly regarding the significance of vitamin D. It is concerning that 80% of the participants could not recall ever discussing this topic with their dentists (Figure 10b). However, by implementing more effective communication strategies, there can be work done towards improving this situation and the Vilnius University curriculum. It is important to note that 65% of respondents answered ‘no’ to the question in their second year of study and 80% of respondents answered ‘no’ to the question in their third year of study (Annex 1) despite the recent development of subjects such as ‘Public Health’, ‘Biochemistry’, and ‘Human Physiology’ by professors and lecturers in the first year, according to the Vilnius University curriculum (42). However, this response rate was expected to be relatively low for this year group. Due to the *p*-value of 0,009 it is even more

important to address this issue, it is recommended that more effective communication strategies are implemented. By improving communication between students and their dentists, valuable information about the role of vitamin D in oral health can be shared. To achieve this, it is recommended to implement strategies such as providing educational materials, initiating discussions during dental visits, and incorporating vitamin D-related topics into the Vilnius University curriculum. By doing so, the level of awareness and understanding among students can be significantly enhanced.

The survey results indicate that nearly half of the respondents consider it highly important for children to consume vitamin D (Figure 11a). According to the survey results, 51% of respondents rated it as extremely important, while 40% considered it somewhat important. It is worth noting that only a small percentage of respondents (1%) rated it as extremely unimportant. There was a significant difference in the answers between genders. 70% of females think it is extremely important that children are given vitamin D. Of the males, 62% thought it was only somewhat important ($p = < 0{,}001$). This is consistent with research showing differences in health behaviours and attitudes between men and women and highlights a marked gender difference in the perceived importance of vitamin D supplementation for children. For example, a study show that older women are more likely to live alone, which may affect access to support and healthcare (59). In addition, social and cultural factors have been shown to influence differences in cognitive performance between men and women. The term also reflects the wider social influence on how men and women role and behave. Gender roles are known to be shaped by socialization, which occurs through various agents including family, education, age groups and mass media (60). Stratification and differences in attitudes and behaviour between men and women can result from these prescribed gender roles. It is possible that the order of the questions influenced this result. Nevertheless, this study did not investigate the effectiveness of vitamin D intake in children. It is important to consider the wording and order of survey questions to minimise bias and maximise the reliability and validity of respondents' responses. Using simpler and more concrete language, avoiding double negatives or unfamiliar jargon, and considering potential biases or emotional reactions to certain emotional reactions to certain words are some important considerations when constructing survey questions (61).

A similar outcome could have occurred with the following question. However, 78% of respondents confidently answered 'yes' when asked if knowledge about vitamin D in ECC is important for their future work as a dentist (Figure 11b). Dentistry professionals have a crucial role in the promotion of oral health and the prevention of dental caries in young children. Their knowledge of the effects of vitamin D on oral health will enable them to provide comprehensive care and to educate parents and caregivers on the significance of sufficient vitamin D intake for their children's oral health. Recent data indicates a rise in the incidence of tooth decay amongst young children. This increase is

particularly prevalent amongst minority groups and those from lower socioeconomic backgrounds. This highlights the necessity for the establishment of dental homes and the implementation of simple, effective infant oral care preventive programmes for all children as part of a comprehensive medical disease prevention programme (62). To provide optimal oral health throughout their adult lives, it is important to have a suitable mix of dentistry professionals, effective prevention and treatment, with the goal of providing children with comfortable and functional primary dentitions, and healthy young permanent dentitions (63).

Participants evaluated their own confidence of the topic at the end of the questionnaire. The responses indicate that most respondents lack knowledge in the topic. The high percentage of 'no' responses (70%) suggest a lack of confidence or awareness among the respondents regarding their knowledge in the given topic (Figure 11c). As well as in the last question, if the participants feeling confident in talking to the patients' parents about the importance of vitamin D over the half of the students replied with 'no'. After all, almost one third (28%) confidently discussed the significance of vitamin D and provided information to parents and children (Figure 11d). The relationship between confidence in the topic and different years is statistically significant (p = 0,036), which is a noteworthy observation. As all students progress through their studies, they feel increasingly confident discussing the importance of vitamin D with the patient's parents (Annex 1). 90% of second-year students think are not confident talking to children's parents in the importance of vitamin D and less than the half of the fifth-year students are not confident. This is a natural outcome, as qualified dentists are responsible for their own practice and must convey a sense of security to their patients (64). As students advance through their dental education, their knowledge, experience, and confidence in communicating with them and their parents about various aspects of oral health, including its importance, increases. The results also highlight the importance of considering the developmental stages of dentistry students and the impact of their educational experiences on their confidence in communicating with patients. In conclusion, it highlights a notable disparity in the confidence levels of second-year and fifth-year students when it comes to discussing the importance of vitamin D with children's parents, with a statistically significant difference supported by the reported p-value of 0,036.

Nevertheless, over half of the students in all years of study do not feel confident in their understanding of the subject and correlates with the previous answers. This highlights the need for further support and resources to improve their knowledge, confidence, and skills. National students rate their self-confidence lower than international students (20-25%) for these questions. Still, it is important to note that this may be due to their discomfort in discussing the topic with parents and patients, rather than a lack of knowledge or preparation (Annex 1). As per one source, knowledge surveys measure students' confidence in their ability to answer questions rather than their actual knowledge. But, there is a debate about whether confidence is a reliable measure of knowledge (65). This indicates that

students' self-perceived confidence may not always align with their actual understanding of the subject. Additionally, the Hawthorne effect (66) is mentioned as a phenomenon where participants' performance or productivity initially increases due to increased interest or innovation but wears off over time. The individuals modify their behaviour in response to awareness of being observed or studied (66). This effect may explain why students initially feel more confident in their understanding but lose confidence as they continue their studies. The students' understanding of the subject can be influenced by their ability to apply their knowledge in real-world situations. It is important to note that self-esteem and perceived competence also affect students' confidence levels. Students who lack confidence may doubt their ability to succeed, causing hesitation when engaging with the subject matter. Research shows self-esteem relates to students' emotional and behavioural engagement in school. Those with lower self-esteem experience more disengagement through feelings like boredom, frustration and anxiety (67). Factors such as the measurement of confidence, the Hawthorne effect and students' self-perception of their skills and knowledge can influence their understanding of the subject. Further research and support are needed to address the complex interplay between confidence and actual understanding highlighted by these factors.

The survey focused on researching dentistry students from Vilnius University perception of the health implications of vitamin D deficiency to the health of children and its impact on ECC. Specifically, it aimed to understand the importance of knowledge and attitude as a dentistry student when interacting with patients and parents. Findings on the knowledge of metabolism and pathological aspects of vitamin D are consistent with several other studies conducted in China, Saudi Arabia, and Pakistan. A study conducted among general physicians in Saudi Arabia found that there is a need to improve knowledge and practice regarding vitamin D (68). A study conducted among medical students in China unequivocally demonstrated their inadequate knowledge and behaviours regarding vitamin D (69). The study, which was conducted amongst medical students in Pakistan, highlights the need for an enhanced understanding of vitamin D and its metabolism amongst the participants (70).

This study is unique in its comprehensive approach to addressing knowledge and self-assessments regarding the importance of vitamin D in ECC in children. Furthermore, it boasts a diverse range of national and international students and was conducted on a notably moderate number of participants.

7 LIMMITATIONS

The limitations of this survey should be acknowledged and considered when interpreting the results. The primary focus of the survey was to assess knowledge and attitudes about the importance of vitamin D in ECC. As a result, many of the questions were specifically designed for this study, making it difficult to directly compare participants' responses with those from other studies. This

uniqueness of the questions limits the ability to make broad comparisons or to establish a comprehensive standard.

Furthermore, due to the time constraints of both professors and students, it was not possible to administer the questionnaire to every single student in the Faculty of Dentistry at the University of Vilnius. As a result, the sample size of this survey may not fully represent the entire student population of the dentistry programme. The limited number of Lithuanian responses is also an obstacle to robust comparisons between national and international courses.

Therefore, generalizing the findings to all students in the dentistry programme at Vilnius University should be done with caution. The results should be seen as an indication of the sustainable knowledge and attitudes within the sample surveyed, rather than as being universally applicable to the student body as a whole. The unique focus and moderate sample size of this survey require careful consideration when applying the findings to a broader context, although it provides valuable insights into the specific group of participants.

8 CONCLUSION

The review have shown that vitamin D plays a significant role in paediatric dentistry, particularly in the treatment of enamel caries in children and immune diseases, maintaining with supplementation normal levels of vitamin D with in the blood is crucial, and prevention of maternal vitamin D deficiency.

Dentistry students exhibit a strong understanding of the biochemistry, clinical aspects of vitamin D and awareness of regional disparities in vitamin D deficiency. The survey results clearly indicate that there are misconceptions among the participants regarding effective vitamin D sources and vitamin D supplementation in children, their attitude towards consultation in pregnant parents and low confidence level in communication with patients about that topic.

The study on students' understanding of the correlation between vitamin D deficiency and ECC prevalence has generated valuable insights that can inform educational strategies, contribute to the literature on oral health, and potentially influence policy decisions aimed at enhancing oral health education and practice, specifically among dentistry students.

The hypothesis that dentistry students have a profound understanding of the correlation, enabling them to implement preventive measures and treatment strategies in paediatric dentistry, cannot be confirmed by the current body of evidence.

9 RECOMMENDATIONS

It is recommended that the Faculty of Dentistry at Vilnius University integrate wide-ranging education on the importance of vitamin D supplementation, dietary habits, and communication skills with patients' parents into its curriculum. This will address knowledge gaps and misconceptions among students, and will also encompass the significance of vitamin D deficiency in relation to ECC and its impact on oral health outcomes in paediatric dentistry practice.

Furthermore, the collaboration be promoted among dentistry professionals, healthcare providers, and public health agencies with the aim of developing and implementing awareness programmes aimed at dentistry students about the importance of vitamin D and strategies for ensuring optimal levels for overall health.

It is recommended that further research be conducted in this area in order to expand the existing body of literature on oral health and the impact of vitamin D deficiency on the prevalence of ECC.

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11 ANNEXES

ANNEX 1: *Table 1: Participants answers across different years of study, gender, and study group has been compared. The number of participants (n) and the frequency percentage (%) of the answers to the questions are shown here. A significant difference was observed (p-value <0,05).*

		Academic year (international and national)						**Gender**				**Study group**			
		n=20	**n=10**	**n=29**	**n=27**			**n=29**	**n=56**			**n=63**	**n=23**		
		(%)	(%)	(%)	(%)			(%)	(%)			(%)	(%)		***p*-**
Questions	**Answer options**	**2**	**3**	**4**	**5**	X^2	***p*-value**	**m**	**f**	X^2	***p*-value**	**International**	**National**	X^2	**value**
What type of molecule is vitamin D?	**Hormone**	20%	40%	28%	41%	15,93	0,195	24%	36%	10,58	0,227	30%	35%	2,54	0,638
	Protein	15%	0%	21%	19%			31%	9%			19%	9%		
	Neurotransmitter	35%	10%	14%	26%			21%	23%			19%	30%		
	Carbohydrate	15%	0%	10%	4%			7%	9%			8%	9%		
	Not sure	15%	50%	28%	11%			17%	23%			24%	17%		
*What is the most important form of vitamin D? * (multiple answers were possible)*	Vitamin D1	10%	7%	13%	17%	41,53	0,361	13%	13%	9,35	0,999	16%	22%	7.59	0,869
	Vitamin D2	26%	13%	15%	6%			18%	14%			24%	13%		
	Vitamin D3	55%	67%	64%	60%			60%	59%			81%	87%		
	Vitamin D4	0%	0%	0%	11%			5%	3%			6%	0%		
	Not sure	10%	13%	8%	6%			5%	11%			11%	13%		
How is the vitamin D level measured?	Urine test	15%	10%	7%	15%	4,78	0,573	10%	11%	7,69	0,103	13%	9%	1,93	0,382
	Blood test	70%	90%	90%	78%			83%	82%			83%	78%		
	Not sure	15%	0%	3%	7%			7%	7%			5%	13%		
Can vitamin D be stored in the body?	**Yes**	55%	40%	66%	70%	5,8	0,533	55%	72%	2,99	0,56	67%	48%	2,62	0,27
	No	35%	40%	17%	19%			29%	17%			21%	35%		
	Not sure	10%	20%	17%	11%			16%	10%			13%	17%		
What is the recommended minimum daily intake (diet or supplements) of vitamin D in infants until the age of 12 months?	100 IU/day	20%	0%	10%	11%	12,23	0,428	7%	14%	4,46	0,813	13%	9%	4,65	0,325
	400 IU/day	40%	30%	28%	33%			41%	27%			33%	30%		
	800 IU/day	0%	10%	24%	26%			17%	18%			21%	9%		
	2500 IU/day	5%	0%	3%	0%			0%	4%			3%	0%		
	Not sure	35%	60%	34%	30%			34%	38%			30%	52%		
What is the recommended minimum daily intake (diet or supplements) of vitamin D in children and adolescents until the age of 1 to 18 years?	400 IU/day	15%	10%	17%	11%	22,18	0,036	14%	14%	3,66	0,886	19%	0%	10,43	0,034
	600 IU/day	35%	60%	21%	11%			28%	23%			24%	30%		
	1000 IU/day	20%	0%	21%	37%			21%	25%			22%	26%		
	1500 IU/day	0%	0%	7%	22%			7%	11%			13%	0%		
	Not sure	30%	30%	34%	19%			31%	27%			22%	43%		

Questions	Answer options	Academic year (international and national) n=20 (%) 2	n=10 (%) 3	n=29 (%) 4	n=27 (%) 5	X^2	*p*-value	Gender n=29 (%) m	n=56 (%) f	X^2	*p*-value	Study groups n=63 (%) International	n=23 (%) National	X^2	*p*-value
Which food/drink has the biggest concentration of vitamin D?	Fortified Foods (milk, orange juice, and fortified cereals)	20%	20%	17%	4%	27,9	0,143	24%	7%	100,66	<0,001	16%	4%	0,061	0,66
	Fatty Fish (salmon, mackerel, tuna, and sardines)	50%	60%	55%	52%			38%	63%			52%	57%		
	Egg Yolks	10%	10%	10%	0%			14%	4%			8%	4%		
	Cheese	0%	0%	0%	4%			0%	0%			2%	0%		
	Mushrooms	5%	0%	0%	0%			0%	2%			2%	0%		
	Cod Liver Oil	0%	20%	0%	30%			3%	16%			11%	13%		
	Beef Liver	10%	0%	10%	4%			10%	5%			5%	13%		
	Soy Products (soy milk, tofu, tempeh etc.)	5%	0%	7%	7%			10%	4%			5%	9%		
What do you think is the most effective source of vitamin D for children?	Taking foods rich in vitamin D	40%	10%	28%	26%	6,13	0,726	28%	29%	7,54	0,274	25%	35%	4,33	0,228
	Taking vitamin D supplement	15%	30%	14%	15%			7%	21%			13%	26%		
	Regular sunlight exposure	40%	60%	55%	59%			59%	50%			59%	39%		
	Not sure	5%	0%	3%	0%			7%	0%			3%	0%		
Is Vitamin D supplementation recommended for all infants and young children?	**Yes**	30%	40%	55%	30%	6,2	0,402	48%	34%	3,3	0,509	38%	43%	0,2	0,903
	No	55%	40%	31%	59%			41%	50%			48%	43%		
	Not sure	15%	20%	14%	11%			10%	16%			14%	13%		
Is vitamin D deficiency associated with an increased risk of early childhood caries?	**Yes**	70%	50%	52%	63%	2,46	0,873	62%	59%	5,63	0,229	62%	52%	0,76	0,684
	No	15%	20%	17%	15%			17%	14%			16%	17%		
	Not sure	15%	30%	31%	22%			21%	27%			22%	30%		
Do you think that Vitamin D deficiency can affect the tooth enamel health?	**Yes**	80%	80%	66%	81%	4,2	0,674	79%	75%	6,5	0,165	75%	78%	1,42	0,492
	No	10%	10%	17%	11%			10%	14%			13%	17%		
	Not sure	10%	10%	17%	7%			10%	11%			13%	4%		
Do you think that Vitamin D deficiency can affect the gum health?	**Yes**	70%	90%	72%	25%	7,45	0,281	76%	66%	9,01	0,061	68%	70%	0,03	0,985
	No	5%	0%	17%	19%			14%	11%			13%	13%		
	Not sure	25%	10%	10%	26%			10%	23%			19%	17%		

Questions	Answer options	Academic Year (national and international) n=20 (%) 2	n=10 (%) 3	n=29 (%) 4	n=27 (%) 5	X^2	*p*-value	Gender n=29 (%) m	n=56 (%) f	X^2	*p*-value	Study group n=63 (%) International	n=23 (%) National	X^2	*p*-value
Do you think that Vitamin D deficiency can affect the bone health?	**Yes**	100%	90%	93%	96%	7,92	0,244	90%	98%	4,33	0,363	94%	100%	1,53	0,465
	No	0%	10%	0%	4%			3%	2%			3%	0%		
	Not sure	0%	0%	7%	0%			7%	0%			3%	0%		
Can Vitamin D supplementation help to prevent early childhood caries?	**Yes**	75%	60%	55%	63%	4,21	0,649	62%	64%	7,06	0,133	67%	52%	1,95	0,378
	No	10%	10%	10%	19%			24%	11%			13%	13%		
	Not sure	15%	30%	34%	19%			14%	25%			21%	35%		
Do you think the serum Vitamin D concentrations of childbearing women (maternal prenatal) influence the developing of early childhood caries (ECC)?	**Yes**	65%	30%	52%	48%	12,35	0,055	52%	52%	7,89	0,096	52%	48%	0,43	0,807
	No	10%	50%	10%	11%			7%	18%			16%	13%		
	Not sure	25%	20%	38%	41%			41%	30%			32%	39%		
Is Vitamin D deficiency more prevalent in certain geographic regions?	**Yes**	95%	100%	100%	93%	2,78	0,427	97%	96%	0,04	0,981	95%	100%	1,13	0,287
	No	0%	0%	0%	0%			0%	0%			0%	0%		
	Not sure	5%	0%	0%	7%			3%	4%			5%	0%		
How high is the intensity of UV radiation in the sunlight in Lithuania?	Low	55%	50%	62%	63%	13,94	0,305	66%	57%	7,66	0,467	60%	57%	1,18	0,882
	Moderate	25%	10%	28%	11%			21%	20%			17%	26%		
	Almost absent	5%	30%	10%	19%			10%	14%			14%	13%		
	Not sure	15%	10%	0%	4%			3%	7%			6%	4%		
Have you ever talked about the importance of vitamin D to your family?	Yes	55%	100%	66%	74%	8,43	0,209	59%	75%	4,95	0,293	70%	70%	0,59	0,745
	No	40%	0%	34%	22%			41%	21%			29%	26%		
	Not sure	5%	0%	0%	4%			0%	4%			2%	4%		

		Academic Year (international and national)						Gender				Study Group			
		n=20 (%)	n=10 (%)	n=29 (%)	n=27 (%)			n=29 (%)	n=56 (%)			n=63 (%)	n=23 (%)		*p*-
Questions	**Answer options**	**2**	**3**	**4**	**5**	X^2	***p*-value**	**m**	**f**	X^2	***p*-value**	**International**	**National**	X^2	**value**
Have you ever talked about the importance of vitamin D to your dentist?	Yes	20%	10%	14%	22%	2,83	0,83	21%	16%	0,8	0,938	19%	13%	0,92	0,631
	No	75%	90%	83%	78%			76%	82%			79%	83%		
	Not sure	5%	0%	3%	0%			3%	2%			2%	4%		
Have you ever talked about the importance of vitamin D to your lecturer at VU university?	Yes	25%	20%	41%	33%	17,15	0,009	38%	9%	6,24	0,182	19%	13%	2,44	0,295
	No	65%	80%	28%	63%			38%	61%			79%	83%		
	Not sure	10%	0%	31%	4%			24%	9%			2%	4%		
What do you think how important the intake of vitamin D in children is?	Extremely important	55%	50%	38%	63%	13,8	0,13	17%	70%	34,66	<0,001	46%	65%	4,31	0,23
	Somewhat important	45%	50%	41%	30%			62%	29%			41%	35%		
	Neutral	0%	0%	21%	4%			17%	2%			11%	0%		
	Somewhat not important	0%	0%	0%	0%			0%	0%			0%	0%		
	Extremely not important	0%	0%	0%	4%			3%	0%			2%	0%		
Do you think that the knowledge of the importance of vitamin D in early childhood is important for your future work life?	Yes	85%	60%	76%	81%	6,58	0,361	69%	84%	10,64	0,1	73%	91%	4,75	0,093
	No	10%	0%	17%	11%			21%	7%			17%	0%		
	Not sure	5%	0%	7%	7%			10%	9%			10%	9%		
Do you have the feeling that you do have enough knowledge in that topic?	Yes	15%	10%	14%	15%	5,15	0,525	28%	7%	7,09	0,131	17%	4%	3,2	0,221
	No	55%	70%	79%	70%			59%	75%			65%	83%		
	Not sure	30%	20%	7%	15%			14%	18%			17%	13%		
Are you confident in talking to the patients' parents about the importance of Vitamin D?	Yes	15%	10%	31%	41%	13,52	0,036	38%	23%	2,87	0,58	30%	22%	5,2	0,081
	No	15%	90%	59%	44%			48%	59%			49%	74%		
	Not sure	35%	0%	10%	15%			14%	18%			21%	4%		

ANNEX 2: *Questionnaire format with correct answers (grey).*

QUESTIONNAIRE

Survey: Students knowledge in Vitamin D deficiency and its importance in ECC

Hello everyone,

Together with Assist. Lina Džiaugytė I am conducting a survey in dentistry student knowledge in vitamin D deficiency and its importance in early childhood caries. It would be great if take a bit of your time and answer the following questions. It does not take longer than 5 minutes. All responses are recorded anonymously, thus full confidentiality is ensured. Thank you in advance for your help!

Rebecca Steiger
(rebecca.steiger@mf.stud.vu.lt)

Questions	**Answer options***
Your age	
Gender	Female Male Prefer not to say
Year of study	2 3 4 5
Study group:	International group National group
What type of molecule is vitamin D?	**Hormone** Protein Neurotransmitter Carbohydrate Not sure
*What is the most important form of vitamin D? * (multiple answers were possible)*	Vitamin D1 **Vitamin D2** **Vitamin D3** Vitamin D4 Not sure
How is the vitamin D level measured?	Urine test **Blood test** Not sure
Can vitamin D be stored in the body?	**Yes** No Not sure

What is the recommended minimum daily intake (diet or supplements) of vitamin D in infants until the age of 12 months?	100 IU/day
	400 IU/day
	800 IU/day
	2500 IU/day
	Not sure
What is the recommended minimum daily intake (diet or supplements) of vitamin D in children and adolescents until the age of 1 to 18 years?	400 IU/day
	600 IU/day
	1000 IU/day
	1500 IU/day
	Not sure
Which food/drink has the biggest concentration of vitamin D?	Fortified Foods (milk, orange juice, and fortified cereals)
	Fatty Fish (salmon, mackerel, tuna, and sardines)
	Egg Yolks
	Cheese
	Mushrooms
	Cod Liver Oil
	Beef Liver
	Soy Products (soy milk, tofu, tempeh etc.)
What do you think is the most effective source of vitamin D for children?	Taking foods rich in vitamin D
	Taking vitamin D supplement
	Regular sunlight exposure
	Not sure
Is Vitamin D supplementation recommended for all infants and young children?	**Yes**
	No
	Not sure
Is vitamin D deficiency associated with an increased risk of early childhood caries?	**Yes**
	No
	Not sure
Do you think that Vitamin D deficiency can affect the tooth enamel health?	**Yes**
	No
	Not sure
Do you think that Vitamin D deficiency can affect the gum health?	**Yes**
	No
	Not sure
Do you think that Vitamin D deficiency can affect the bone health?	**Yes**

	No
	Not sure
Can Vitamin D supplementation help to prevent early childhood caries?	**Yes**
	No
	Not sure
Do you think the serum Vitamin D concentrations of childbearing women (maternal prenatal) influence the developing of early childhood caries (ECC)?	**Yes**
	No
	Not sure
Is Vitamin D deficiency more prevalent in certain geographic regions?	**Yes**
	No
	Not sure
How high is the intensity of UV radiation in the sunlight in Lithuania?	Low
	Moderate
	Almost absent
	Not sure
Have you ever talked about the importance of vitamin D to your family?	Yes
	No
	Not sure
Have you ever talked about the importance of vitamin D to your dentist?	Yes
	No
	Not sure
Have you ever talked about the importance of vitamin D to your lecturer at VU university?	Yes
	No
	Not sure
What do you think how important the intake of vitamin D in children is?	Extremely important
	Somewhat important
	Neutral
	Somewhat not important
	Extremely not important
Do you think that the knowledge of the importance of vitamin D in early childhood is important for your future work life?	Yes
	No
	Not sure
Do you have the feeling that you do have enough knowledge in that topic?	Yes
	No
	Not sure
Are you confident in talking to the patients' parents about the importance of Vitamin D?	Yes
	No
	Not sure

* Correct answers marked in grey