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VITAMIN SUPLEMENTATION ON ODONTOGENESIS DURING PREGNANCY AND POSTNATAL PERIOD

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Abstract: Odontogenesis is a complex process that involves highly coordinated cellular and molecular events, which culminate in the formation of dental elements. The proper formation and development of the dentition are fundamental processes, and nutrition is of special relevance to the oral tissues. Knowing that dental formation and development begin in the gestational period, the influence of maternal health on possible oral pathologies subsequent to the child can be highlighted. The present study aimed to carry out a systematic review of the literature on the effects of vitamin supplementation on odontogenesis in the gestational and postnatal period. Articles published since 1965 on the relationship of vitamin supplementation on intra and extrauterine odontogenesis were searched through PubMed, Scopus and SciELO electronic databases, using the keywords "Vitamins in odontogenesis, vitamin supplementation in tooth eruption, nutrition and tooth eruption". Malnutrition in general is capable of affecting odontogenesis in all its phases, involving the pre and postnatal periods. Vitamin D is effective when its plasma concentration is not below the reference values in all phases of the individual. In this study, one can observe the functionality of more randomized studies related to the subject, where one can verify the need for vitamins in oral development.
Keywords: Tooth eruption, Nutrition, Odontogenesis, Vitamins.

INTRODUCTION

Odontogenesis consists of a complex process that involves highly coordinated cellular and molecular events, which culminate in the formation of dental elements [24]. This process begins in the 6th week of intrauterine life, period in which the preparations for the oral and nasal cavity are completed [14]. The initial stage of odontogenesis includes migration of ectodermal cells generated in the neural crests, forming vestibular and dental laminae, which are responsible for the formation of the bud. The bud stage gives rise to tooth germs, which follow the cap, bell, crown and root stages. The bell will be responsible for the constitution of the teeth and their supporting structures, forming dentin, enamel, cement and bone [18]. The proper formation and development of the dentition are fundamental processes, as the teeth perform important physiological functions, including mastication and speech [17]. Teeth influence facial appearance and may affect individual quality of life [8]. Nutrition is of special relevance to oral tissues, which is acquired primarily through mastication and ingestion, and later through digestion and absorption by cells [30]. The placenta is a metabolically active organ that increases in size during pregnancy in conjunction with fetal growth. The placenta has nutrient/substance transport mechanisms, synthesis of peptide and steroid hormones, and constitutes an immune barrier to prevent rejection of the semi-allogeneic fetus [28]. Any adversity presented in transport, such as nutrient deprivation, will affect placental function and consequently fetal development [29]. Maternal nutritional status during pregnancy can affect the development, formation and mineralization of fetal teeth, as well as susceptibility to dental caries in children [16]. The main nutrients involved in odontogenesis are: calcium, phosphate, vitamins and proteins [27]. In the in vitro study by Woo et al. (2015) [43] it was found that treatment of human dental pulp cells with vitamin D3 significantly increased the expression of genes related to odontoblast differentiation (such as dentin sialophosphoprotein and dentin matrix protein1) and mineralization of these cells via activation modulation kinase controlled by extracellular signaling (ERK).

Thus, nutritional deficiencies can contribute to dental malformation [35], which can affect both deciduous and permanent dentition, as these follow a well-defined chronological order [5,13]. In this context, Menaker and Navia (1973) verified that rats submitted to protein malnutrition during the perinatal period present delayed eruption of the first and second molars [26]. Studies have shown that vitamin deficiency during the prenatal period is associated with changes in dental enamel [42,7]. Vitamin A deficiency is known to alter amelogenesis and odontogenesis [39].

Knowing that dental formation and development begin in the gestational period, the influence of maternal health on possible oral pathologies subsequent to the child can be highlighted, therefore, the present study aimed to carry out a systematic review of the literature on the effects of Vitamin supplementation on odontogenesis in the gestational and postnatal period.

MATERIAL AND METHODS

This study carried out a systematic review in order to answer the following guiding question (based on the PECO strategy): "Do nutritional factors influence the processes of odontogenesis and tooth eruption?". The research was carried out by two eligibility reviewers independently, through the electronic databases PubMed, Scopus and SciELO, using the keywords "Vitamins in odontogenesis, vitamin supplementation in tooth eruption, nutrition and tooth eruption". Between February and April 2020, published data were collected on the relationship of vitamin supplementation on intra and extrauterine odontogenesis since 1965, when the first relevant article on the subject was published (Table 1).

Initially, duplicate articles were removed. After reading the title, the exclusion process continued, considering the criteria: low nutritional relationship; relationship with specific disease; drug treatment; without human relation; little relation to the subject; relationship with specific protein. The records excluded after reading the abstracts were separated into: general concept; literature review; animal studies; in vitro studies. The next step was the exclusion of non-randomized

Database	Search Strategies (April,2020)	Results
Pubmed http://pubmed.ncbi.nlm.nih.gov/	"Vitamins of odontogenesis" OR "vitamin supplementation in tooth" OR "nutrition and dental development".	258
Scopus https://www.scopus.com/home.uri	"Vitamins of odontogenesis" OR "vitamin supplementation in tooth" OR "nutrition and dental development".	69
SciELO https://scielo.org/	"Vitamins of odontogenesis" OR "vitamin supplementation in tooth" OR "nutrition and dental development".	0

Table 1 - Strategies for searching in databases

articles, bringing through the randomized articles a higher standard of excellence in this survey. Published articles were reviewed for changes in the pattern of dental development in children who were nutrient deprived during pregnancy and postnatally.

RESULTADS

The first phase of selection of studies resulted in a total of three hundred and twenty-seven records distributed in three electronic databases. After removing the duplicate records, three hundred and thirteen proceeded to analyze the titles. Thus, after reading the titles of the records, one hundred and thirteen articles proceeded to analyze the abstracts. After analyzing the abstracts, twenty-seven records were considered eligible, but sixteen were disregarded because they were non-randomized studies. Thus, eleven titles followed for the reading of the full text (Figure 1).

A summary of the objectives and main results of the selected articles can be found in Table 2. The studies presented were between the years 1990 and 2018, and two of the studies presented were related to vitamin D [34,2]; while the other nine made an association between general development and dental development of the child, raising circumstances such as malnutrition, premature birth, low birth weight and retarded growth as a pattern [3,2,23,4,37,12,15,9,19].

DISCUSSION

Changes in normal growth patterns may be closely linked to the development of other parts of the body, such as the teeth [20]. Among the nutritional causes are malnutrition, vitamin D deficiency and vitamin A deficiency [11]. Oral tissues are the first to develop and nutrient deficiency can impact the development of these tissues, as well as excess vitamins can lead to toxicity, impairing epithelial development [1,40]. In the results of the selected studies, a wide relationship between the authors and malnutrition can be observed, presenting harm to children's dental development. Of the nine articles related to children's nutritional factors, four were associated with impaired dental development [3,23,25,15]. The "critical period" of dental development operates both in the pre-eruptive and post-eruptive periods. Malnutrition is related to irreversible damage that can cause changes in the structure, composition, size and susceptibility of teeth to caries [41]. Children with low growth rate, low weight and retarded growth had delayed tooth eruption, delayed dentition [2,4,12], and untreated dental caries [9]. Enamel defects caused by poor nutrition can lead to caries when combined with cariogenic factors that, in some cases, can lead to the extraction of temporary teeth [41,22,6]. Bastos was able to observe a higher incidence of the multifactorial disease in malnourished children [4]. While maxillofacial development can be compromised from malnutrition, oral breathing can lead to dentomaxillary changes, due to the postural relationship between head and cervical spine, leading to dental crowding. [33,38]. Thomaz correlated parameters of malnutrition and mouth breathing and found the reliability of the occurrence of dental crowding [37]. The period from birth to two years of age makes the development of human body systems more vulnerable to malnutrition and more responsive to nutritional treatment [31]. The most active metabolite of vitamin D plays a central role in calcium and phosphorus homeostasis, where calcium is fundamental in the development of dental alveolar bone and its mineralization, and indirectly is able to regulate phosphorus levels [21,36]. Two authors addressed the primacy of vitamin D, Schroth administered vitamin D at a dose of 400 IU in children who already had enamel defects, and this supplementation did not

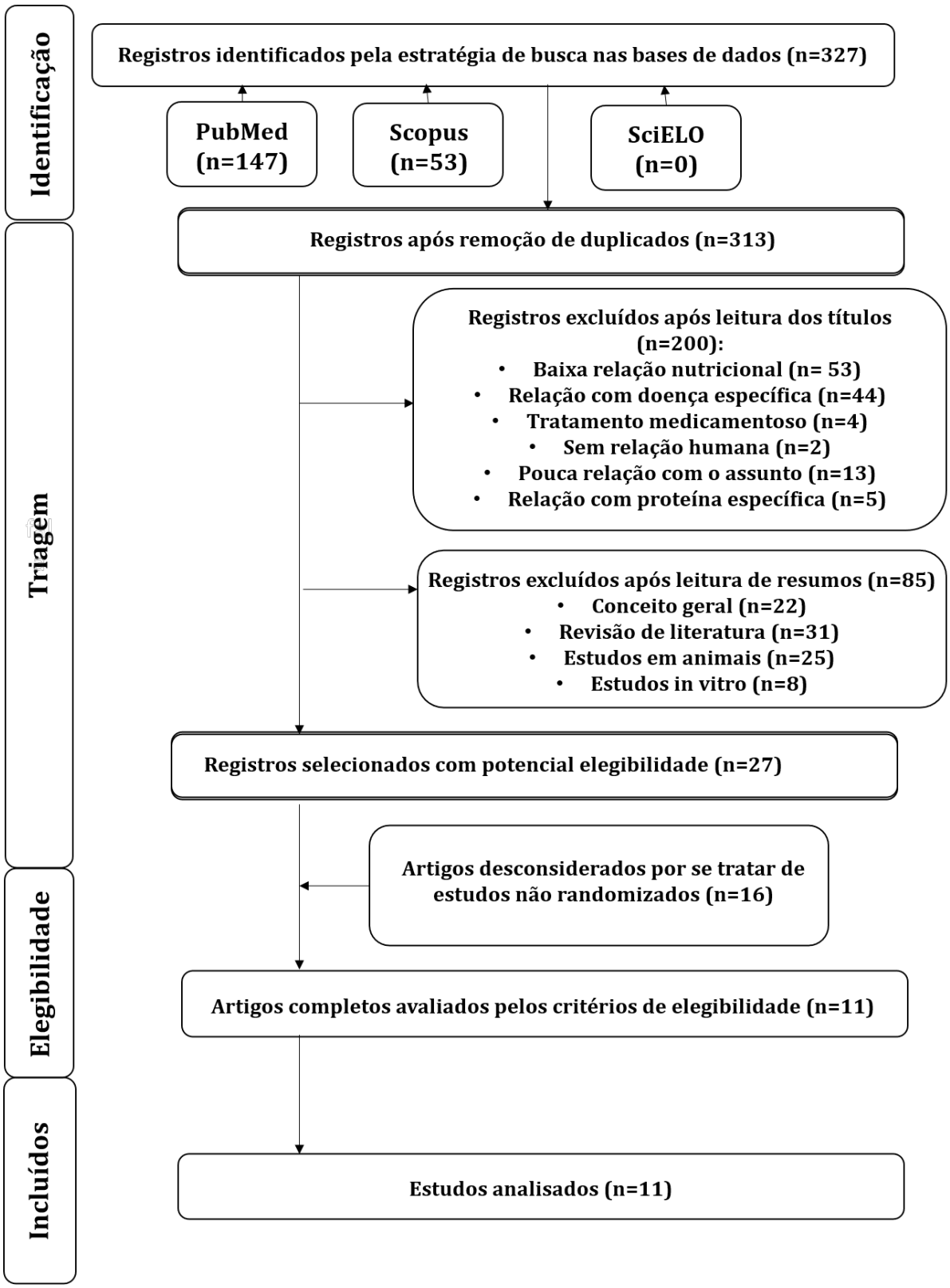

Figure 1 - Process of search, identification, inclusion and exclusion of articles.

Translation below

Identificação: Identification

Registro identificados pela estratégia de busca nas bases de dados: Records identified by the search strategy in the databases (n=327)

PubMed (n=147)

Scopus (n=53)

SciELO (n=0)

Triagem: Screening

Registros após remoção de duplicatos: Records after removing duplicates (n=313)

Registro excluídos após leitura de dados: Records excluded after reading the titles (n=200)

Baixa relação nutricional: Low nutritional relationship (n=53)

Relação com doença específica: Relationship with specific diseases (n=44)

Tratamento medicamentoso: Drug treatment (n=4)

Sem relação humana: No human relationship (n=2)

Pouca relação com o assunto: Little relationship with the subject (n=13)

Relação com proteína específica: Relationship with specific protein (n=5)

Registros excluídos após leitura de resumos: Records deleted after reading abstracts (n=85)

Conceito geral: General concepts (n=22)

Revisão de literatura: Literature Review (n=31)

Estudos com animais: Study in animals (n=25)

Estudos in vitro: In vitro studies (n=8)

Registros selecionados com potencial elegibilidade: Records we selected with potential eligibility (n=27)

Elegibilidade: Eligibility

Artigos desconsiderados por se tratar de estudos não randomizados: Articles disregarded because they were non-randomized studies (n=16)

Artigos completos avaliados pelos critérios de elegibilidade: Full articles evaluated by eligibility criteria (n=11)

Incluídos: Included

Estudos analisados: Studies analyzed (n=11)

Authors	Year	Goals	Results
[3]	1990	To investigate the effect of different types of malnutrition on the development of caries.	Malnutrition delayed dental development and increased the incidence of caries in children's primary teeth.
[2]	1993	To evaluate the effects of an episode of malnutrition before one year of age on the eruption of deciduous teeth.	Eruption of primary teeth was significantly delayed in all malnourished children.
[23]	1993	Anthropometric assessment of craniofacial growth and tooth development in 3-year-old children and the presence of structural changes in dental tissues.	Dental development is impaired in malnourished children, together with a marked dependence on tooth eruption, presence of caries and hypoplasia as a function of nutritional status.
[34]	2005	To assess the prevalence of caries, to determine potential risk factors for Early Childhood Caries and to study those of vitamin D treatment in the development of primary dentition.	About 50% of the children had enamel defects, a high prevalence for the community. Vitamin D supplementation at 400 IU was previously administered to participants in this study and did not result in reduced enamel defects or caries.
[4]	2007	Test the association of child growth/ development with socioeconomic status and tooth eruption patterns.	Children with a low growth rate up to six years of age had delayed tooth eruption.
[25]	2009	To assess the prevalence of enamel defects in babies from a socially and economically poor population. And the possible association of these defects with disorders that occur in the pre, peri and postnatal periods of human development.	The association between enamel defects and the etiological factors evidenced in this study suggests the existence of social influences on oral health and dental development..
[37]	2010	To investigate the relationship between anthropometry with failure and dental crowding in the permanent dentition.	Malnutrition is related to crowding in permanent dentition in mouth breathing adolescents.
[12]	2012	To assess the influence of malnutrition on the emergence of deciduous dentition.	Children with short stature are significantly more likely to have a late onset of deciduous dentition..
[15]	2013	To assess the relationship between the number of erupted permanent teeth and nutritional status in students aged 10 to 13 years old in rural Philippines, where malnutrition is still a major health concern.	Thin, stunted boys had one less tooth than normal boys at that age. Impaired physical growth and tooth development appear to have common risk factors.
[9]	2018	To assess the relationship between dental caries in primary and permanent dentition and the child's nutritional status, and whether nutritional status affects the eruption of permanent teeth.	Low weight and stunted growth are associated with untreated tooth decay and delayed eruption of permanent teeth in children.
[19]	2018	To identify the association between 25(OH) D levels and dental caries in Korean children.	Plasma vitamin D concentration below 50 nmol/L increases the chance of having first molar caries in children.

Table 2 - Summary of the objectives and main results of the articles

result in reduced enamel defects or caries [34], while Kim clarified that amounts of vitamin D below 50 mmol/L resulted in an increased chance of caries in the first molar in children [19]. Odontogenesis is shown to benefit in relation to nutritional supplementation of the B complex, accelerating tissue formation and increasing the size of the germ [32]. The prevalence rate of vitamin D deficiency is directly associated with the development of acute and severe complications among mothers and newborns [10].

CONCLUSION

From the factors studied, it was possible to elucidate the need for good nutritional conditions in dental disorders. Malnutrition in general is capable of affecting odontogenesis in all its phases, involving the pre and postnatal periods. In the literature, vitamin D is shown to be effective when its plasma concentration is not below the reference values in all phases of the individual. We can observe the functionality of more randomized studies related to the subject, where the need for each vitamin of the complexes in oral development can be verified.

REFERENCES

1. Alfano MC. Nutrição na cárie dentária. In: Avaliação das condições de saúde bucal de crianças com desnutrição intra-uterina. SP. **Tese [Doutorado em Odontopediatria]–Universidade de São Paulo**;2003.

2. Alvarez J, Caceda J, Woolley TW, Carley KW, Baiocchi N, Caravedo L, &Navia JM. A longitudinal study of dental caries in the primary teeth of children who suffered from infant malnutrition.**J. Dental Res.,**1993.72(12),1573-1576.

3. Alvarez J, Eguren JC, Caceda J,&Navia JM. The effect of nutritional status on the age distribution of dental caries in the primary teeth.**J. Dental Res.,**1990.69(9),1564-1566.

4. Bastos JL, Peres MA, Peres KG, & Barros AJ. Infant growth, development and tooth emergence patterns: a longitudinal study from birth to 6 years of age.**Arch. of oral biology,** 2007.52(6),598-606

5. Batista LRV, Moreira EAM, Corso ACT, Universidade Federal de Santa Catarina F, Brasil. Alimentação, estado nutricional e condição bucal da criança. **Rev Nutr.**2007;20(2):191-6.

6. Bello PA, Machado MM, Castillo HR, Barreto FE. Efecto de la malnutrición fetal sobre los tejidos dentarios. **Rev Cubana Estomatol** [Internet]. 1997 Dic [citado 2020 Nov 17] ; 34(2):57-61. Disponible en: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0034-75071997000200001&lng=es.

7. Bevilacqua FM, Sacramento T, Felício CM. Amelogênese imperfeita, hipoplasia de esmalte e fluorose dental-revisão de literatura. **REV.UNIARA**, 2010.v.13, n.2,p.136-148.

8. Delgado H, Habicht JP, Yarbrough C, Lechtig A, Martorell R, Malina RM,Klein, RE. Nutritional status and the timing of deciduous tooth eruption. **The American Journal of Clinical Nutrition.** 1995.28(3),216–224. doi:10.1093/ajcn/28.3.216

9. Dimaisip-Nabuab J, Duijster D, Benzian H, Heinrich-Weltzien R, Homsavath A, Monse B, &Kromeyer-Hauschild K. Nutritional status, dental caries and tooth eruption in children: a longitudinal study in Cambodia, Indonesia and Lao PDR. **BMC pediatrics**,2018.18(1),300.

10. Elsori DH, & Hammoud M. Vitamin D deficiency in mothers, neonates and children. **The Journal of Steroid Biochemistry and Molecular Biology**.2018.175,195–199. doi:10.1016/j.jsbmb.2017.01.023

11. Ferreira SLM. Avaliação das condições de saúde bucal de crianças com desnutrição intra-uterina. SP. **Tese [Doutorado em Odontopediatria]–Universidade de São Paulo;**2003.

12. Gaur R, & Kumar P. Effect of undernutrition on deciduous tooth emergence among Rajput children of Shimla District of Himachal Pradesh, India.**American journal of physical anthropology.**2012.148(1),54-61.

13. Gonçalves AF, Ferreira SLM. Defeitos hipoplásicos do esmalte dentário. **Rev Odonto Univ Santo Amaro.**2000;5(1):13-20.

14. Guedes-Pinto AC, Melo-Moura ACV. **Odontopediatria**, 9ª edição.RJ: Guanabara-Koogan,2017.

15. Heinrich-Weltzien, R., Zorn, C., Monse, B., &Kromeyer-Hauschild, K. Relationship between malnutrition and the number of permanent teeth in Filipino 10-to 13-year-olds.**BioMed research international**,2013.

16. Holt RD. Advances in Dental Public Health. **Primary Dental Care.**2001.8(3),99–102. doi:10.1308/135576101322561903

17. Hovorakova M, Lesot H, Peterka M, Peterkova R. Early development of the human dentition revisited. **J Anat.**2018;233(2):135-145. doi:10.1111/joa.12825

18. Katchburian E, Arana V. **Histologia e Embriologia Oral**, 4ª edição. RJ: Guanabara-Koogan,2017.

19. Kim IJ, Lee HS, Ju HJ, Na JY, Oh HW. A cross-sectional study on the association between vitamin D levels and caries in the permanent dentition of Korean children.**BMC Oral Health**.2018;18(1):43. Published 2018 Mar 13. doi:10.1186/s12903-018-0505-7

20. Lamons FF, &Gray SW. A study of the relationship between tooth eruption age, skeletal development age, and chronological age in sixty-one Atlanta children. **American Journal of Orthodontics**,1958;44(9),687–691.

21. Lezot F, Descroix V, Hotton D, Mauro N, Kato S, &Berdal A. Vitamin D and tissue non-specific alkaline phosphatase in dental cells. **European J. of Oral Sciences**,2006.114(s1),178–182. doi:10.1111/j.1600-

22. Li Y, Navia JM, Bian JY. Prevalence and distribution of developmental enamel defects in primary dentition of Chinese children 3–5 years old. **Community dentistry and oral epidemiology**23.21995:72-79.

23. Machado MM, &Caravia MF. Evaluación del crecimiento craneofacial y del desarrollo de la dentición en niños malnutridos fetales. **Rev. cuba. ortod**,1993.10-5.

24. Martyn T, Cobourne BDS. The Genetic control of early Odontogenesis. **British J. of Orthodontics**,v.26,n.1,p.21-28,1999.

25. Massoni AC, Chaves AM, Rosenblatt A, Sampaio FC, Oliveira AF. Prevalence of enamel defects related to pre-, peri-and postnatal factors in a Brazilian population. **Community Dent Health**.2009 Sep;26(3):143-9.PMID:19780354.

26. Menaker L,&Navia JM. Effect of Undernutrition During the Perinatal Period on Caries Development in the Rat: IV. Effects of Differential Tooth Eruption and Exposure to a Cariogenic Diet on Subsequent Dental Caries Incidence. **J. Dental Res**.,52(4),692–697.

27. Menoli APV, Fanchin PT, Duarte DA, Ferreira SL, Imparato JCP. Nutrition and tooth development. Publ. UEPG Ci. **Biol. Saúde**, Ponta Grossa,Junho 2003.9(2):33-40

28. Myatt L, & Thornburg KL. Effects of Prenatal Nutrition and the Role of the Placenta in Health and Disease. **Investigations of Early Nutrition Effects on Long-Term Health**.2018.19–46.

29. Myatt L.Placental adaptive responses and fetal programming. **J Physiol**. 2006.572(Pt 1):25–30

30. Navia JM. Nutrition in dental developmentand disease. In: Alfin-. Slater R, Dritchersky D, Winick M, eds. Nutrition: pre and postnatal development. **Human nutrition-A comprehensive treatise**, Vol 1. New York: Plenum Press,1979:333-62.

31. Ramakrishna T. Vitamins and brain development. **Physiological research** 48.1999:175-188.

32. Rosa RAC, Cabrera MA, Peralta CC, Bernabé PFE. Efeito da suplementação vitamínica intra e extra-uterinas sobre a odontogênese e erupção dentária. **Rev. Fac. Odontologia Lins/UNIMEP**.2002,v.14, n.2,p.41-52

33. Rosana JC, Pereira SRA, Mitri G, Motta JC, Pignatari SSN, Weckx LLM. Relação da oclusão dentária com a postura de cabeça e coluna cervical em crianças respiradoras orais. **Rev. Paulista de Pediatria**[Internet].2005;23(2):88-93.Recuperado de: https://www.redalyc.org/articulo.oa?id=406038911008

34. Schroth RJ, Smith PJ, Whalen JC, Lekic C, Moffatt ME. Prevalence of caries among preschool-aged children in a northern Manitoba community. **J Can Dent Assoc**.2005Jan;71(1):27.PMID: 15649337.

35. Sheetal A, Hiremath VK, Patil AG, Sajjansetty S, Kumar SR. Malnutrition and its oral outcome -a review. **J ClinDiagn Res**.2013;7(1):178-180. doi:10.7860/JCDR/2012/5104.2702

36. Sun W, Sun W, Liu J, Zhou X, Xiao Y, Karaplis A, Miao D. Alterations in phosphorus, calcium and PTHrP contribute to defects in dental and dental alveolar bone formation in calcium-sensing receptor-deficient mice. **Development**,2010.137(6),985–992.

37. Thomaz EB, Cangussu MCT, Silva AAMD, &Assis AMO. Is malnutrition associated with crowding in permanent dentition?. **Int. J. of environmental res. and public health**.2010.7(9),3531-3544.

38. Thomaz EBAF, Valença AMG. Associação entre déficit de peso e apinhamento na dentição decídua. **J. Pediatr.** (Rio J.) v.85 n.2 Porto Alegre 2009.

39. Toledo OA, Bezerra ACB, Bezerra VLVA, Dristig EB. Cárie e estado nutricional, prevalência da cárie dentária relacionada com o estado nutricional em população de baixa renda do Distrito Federal. **RGO**.1989;37(4):295-8.

40. Touger-Decker R, &Mobley C. Position of the Academy of Nutrition and Dietetics: Oral Health and Nutrition. **J. of the Academy of Nutrition and Dietetics**. 2013.113(5),693–701.

41. Wei SHY, Anderson TA. Nutrition and dental health. In: Avaliação das condições de saúde bucal de crianças com desnutrição intrauterina. SP. **Tese [Doutorado em Odontopediatria] –Universidade de São Paulo**; 2003.

42. Winter GB. Maternal nutritional requirements in relation to the subsequent development of teeth in children. **Int. J. of Food Sciences and Nutrition**,30(2),93–99.

43. Woo SM, Lim HS, Jeong KY, Kim SM, Kim WJ, Jung JY. Vitamin D Promotes Odontogenic Differentiation of Human Dental Pulp Cells via ERK Activation. **Mol Cells**. 2015.38(7):604-609. doi:10.14348/molcells.2015.2318