2ND QUARTER 2024 • VOLUME 25 NO. 2 • ISSN 1018-1466

OHASA JOURNAL

OFFICIAL MOUTHPIECE OF THE ORAL HYGIENISTS' ASSOCIATION OF SOUTH AFRICA

CONTENTS

EDITORIAL COMMITTEE

Managing Editor
Dr Aneesa Moolla | Tel: (010) 060 0046 | Cell: 084 587 0277 | E-mail: ohasajournal@gmail.com

Co-Editors
Anri Bernardo, E-mail: anribernardo@gmail.com | Lesley Vorster, E-mail: ry.lesley@gmail.com
Stella Lamprecht, E-mail: stella1805@gmail.com

OHASA OFFICE

PO Box 830, Newlands, 0049 | Fax: 086 696 7313 | E-mail: admin@ohasa.co.za | ohasanational@gmail.com | Website: https://www.ohasa.co.za

PUBLISHER

Kashan Advertising (Pty) Ltd | Reg. 2020/131924/07 | E-mail: advertising@kashan.co.za

PRODUCTION OFFICE

Kashan Advertising (Pty) Ltd | Tel: (012) 342 8163 | Fax: 086 645 0474 | E-mail: advertising@kashan.co.za | Website: www.kashan.co.za
Sub-editor: Caro Heard | **Layout and Design:** Kashan Advertising (Pty) Ltd

Published by
kashan advertising (Pty) Ltd

On behalf of
OHASA

Member of
IFDH INTERNATIONAL FEDERATION OF DENTAL HYGIENISTS

EDITORIAL

FROM THE EDITOR'S DESK

Dr Aneesa Moolla
Editor

Dear Colleagues

Welcome to the second edition of our OHASA Journal for 2024. Since the publication of our first edition, it has been a busy few months with multiple seminars organised by the OHASA team. Thank you for your attendance and making these events a success. This edition contains highlights from all the OHASA seminars to date. It shows how enjoyable and enlightening each of these sessions was, the pictures of each seminar are worth a thousand words!

On to current news... In terms of the knowledge I would like to impart through the carefully chosen manuscripts within this journal edition, you will find yourself wanting to brush up on your own knowledge about paediatric dentistry.

Firstly, we cover the ethico-legal dilemma of child abuse and where we stand when faced with such cases. Most importantly, is it something we even notice? How can we improve our critical inquiry strategies when we suspect that something is just not right – and in these cases, the added complexity is that it is a minor in our chair that we are treating? We, as clinicians need to start broadening our knowledge of the field of child abuse and neglect and start to not just report but speak out against such forms of abuse. This starts with documenting all that you take note of in each case to build up a portfolio of evidence to report to Child Welfare.

Secondly, in terms of medical conditions, there are instances when you can make a big difference by advising parents who note that they have a child who does not swallow 'normally'. This is referred to as atypical swallowing which is defined as a myofunctional problem characterised by a postural change in the tongue during the swallowing process. There are numerous devices that are currently available that you can discuss with your patient before having to refer them. It is imperative that we all create a resource list of the necessary healthcare practitioners so that we can easily refer patients to professionals within their vicinity.

Finally, we do not always detail the impact of vitamin deficiencies to our patients. We are in a unique position to assist parents or caregivers to counteract long-term problems by learning how the different vitamin deficiencies present within the oral cavity. Take the time to read this article thoroughly so that you can help your patient address nutritional deficiencies while setting up a proper referral system.

With that said, I continue to reach out to all of you for opinion pieces or even case studies from your work in practice. Until the next edition, keep reading and building up your knowledge as it equips you to help others. Please share your thoughts with me on ohasajournal@gmail.com

Stay well

Aneesa Moolla

OHASA'S VISION OHASA is a dedicated, dynamic, professional association representing hygienists as invaluable members of the health profession team.
OHASA'S MISSION OHASA aims to promote quality oral healthcare by representing, protecting and advancing the profession in partnership with stakeholders.

Anri Bernardo
OHASA President

FROM THE PRESIDENT'S DESK

Dear OHASAJ Reader

We are already in the second quarter of the year; I am filled with immense gratitude about the strides our association continues to make. It is an honor to connect with you through this journal and share updates on our progress, initiatives, and upcoming opportunities.

In the past few months, all our branches have successfully held their full day seminars . We gave all members the opportunity to attend all branch seminars in person or virtually. Our loyal traders have stepped up again to attend each full day seminar providing our members with the latest updates on products etc. We want to extend our gratitude to each company that supports OHASA and its members.

Although all the in-person full-day seminars are done for the year we have a list of free webinars coming up between June and October this year. I encourage members to keep an eye open for emails regarding free webinars from OHASA, some of which will be in collaboration with our supportive traders. I am excited about our National Conference and AGM which will be held in Cape Town on the 25th to 26th of October 2024. The two-day programme promises to be filled with top speakers and a lot of opportunities to gain knowledge. All relevant information for the AGM and National Conference will be communicated soon.

International Symposium on Dental Hygiene 2024

For all our new members, The International Federation of Dental Hygienists (IFDH) is an organisation that unites dental hygiene associations from around the world in their common cause of promoting dental health.

OHASA is privileged to be a member of the IFDH and every second year they have an international symposium with House of Delegates (HOD) business meetings. This year the HOD business meeting and symposium will be held in Seoul, South Korea on the 8th to 13th of July 2024. Each member country has two HOD representatives who will attend the business meetings and represent their country at these meetings and the symposium. South Africa (OHASA) will be represented this year by myself as president and Elaine Johnson as OHASA IFDH representative. We are busy preparing for the meetings and ask all members support us during this time of preparation as well as when we are in Seoul.

We will be communicating to all members via social media posts and the website while we are there and I ask that members participate in the google form questions that were sent out regarding a motion that needs to be voted on at the HOD meetings. Visit the IFDH website for all information at www.ifdh.org

The next few months of the year will again be busy for OHASA with a few collaborative meetings with different stakeholders planned. I can assure you that after each stakeholders meeting all members will receive feedback and if certain decisions need to be made we would like to hear your opinion.

I urge all members to make use of the website www.ohasa.co.za to get all the latest information under the 'News' section. All events will be booked via the website under the 'Events' section. For all OHASA members, you must log in first as a member to use the different sections on the website. Encourage your patients to visit the OHASA website as there are 'Blogs' for them to read regarding different oral health issues.

As always, we value your feedback and suggestions. Please do not hesitate to reach out with any ideas or concerns. Your voice is important to us. Stay connected with us through our website, social media channels, and upcoming events.

Thank you for your continued support of your profession and the association.

Be Blessed

Anri Bernardo

EVENT DATES FOR 2024*:

All webinars for the rest of the year will be communicated in advance.
OHASA AGM and National Conference (Cape Town): 25–26 October 2024

OHASA contact details:
ohasanational@gmail.com – General enquiries
ohasamembership@gmail.com – Membership enquires
president@ohasa.co.za – Important enquiries/suggestions/concerns

THE BEHAVIOURAL INFLUENCE ON A PATIENT

OF A CLINICIAN'S CHOICE OF TOPIC SPECIFIC WORDS

Hafeez Ahmed

INTRODUCTION

It has been recognised that not only does the patient interview need to be empathetic but the discussion content needs to be topic specific.[1] In recent years, clinicians have been encouraged by the General Dental Council to move towards patient-centred care.[2] In addition to this, it has been described that simply 'being nice' and maintaining a good relationship with the patient are not sufficient for patient-centred care. Patient-centred care requires detailed topic-based discussions.[3] However, there appear to be no studies on topic-specific words and their influence on patient understanding.

Beyond that, it is accepted that 'effective communication' is essential to behaviour change and was comprehensively covered and discussed in detail in a series of articles by Ruth Freeman in 1999.[4] The importance of effective communication and behaviour change is further underlined by the fact that the majority of dental care requires patients to adhere to advice, otherwise the care is undermined.[5]

It is intriguing that despite the dental profession believing they are actively engaging in effective patient communication the prevalence of periodontal diseases remains largely unchanged. Chronic periodontitis occurs in 45% of the UK population[6] and in 11.2% of the global population[7].

Experience suggests that, when patients find it difficult to make the necessary behavioural changes, it is generally for a variety of reasons, including: they do not fully understand periodontal diseases, they do not appreciate the long-term implications and legacy of the disease, they do not entirely recognise the pivotal role of homecare, or they are individuals who understand all the advice but do not want to change.

A POSSIBLE SOLUTION

In my practice I created a table with a list of 20 topic-specific words and phrases (Table 1). The words and phrases were selected from those I heard being used most commonly by patients and dental professionals. On the right-hand side of the list I placed a Likert-type scale numbered from 1 to 5. My plan was to ask potential participants to rate the words/phrases by circling one number on the scale for each of them to indicate the degree of perceived encouragement or motivation each word/phrase offered them.

Starting in June 2022, every new patient referred was invited to take part with the aim of compiling 100 lists. By virtue of the referral, all patients had received at least one course of periodontal therapy from the referring dentist. Potential participants were recruited by discussing the purpose of the study with them in the waiting room, following the completion of their initial consultation. The following statements were made as an invitation to take part:

"I am conducting a small study in an attempt to identify if some of the words we use when we discuss gum disease with our patients affect their enthusiasm more than other words. Essentially, I want to see if some words create more of a feeling of seriousness and also if some words create a greater feeling of enthusiasm or motivation to act on the advice than other words."

'Motivation' was defined as: "It makes you feel like taking the matter seriously" and "It makes you want to do your part in resolving the matter". Potential participants were also advised: "What I really want to see is if any of the words or phrases make you feel more like sitting down for 8 to 10 minutes each evening to use floss or inter-dental brushes or wood sticks to clean in-between your teeth and the margins of your gums."

During the discussion, and before the patients agreed to participate, they were given the list so they could see what was being described. They were also given guidance for the Likert-type scale (Table 2). To maintain anonymity, patients were advised that they were not required to put their name on the list—only their age and gender.

Those patients who agreed to take part were then shown to a seat and asked to read the list and rating scale carefully and to confirm their understanding. Reassuringly, a few of them smiled and said: "It's pretty straight forward," others laughed and said: "It's not rocket science."

Table 1: The list, with the words and phrases and the Likert-type scale

	Word/Phrase					
1	Inflammation	1	2	3	4	5
2	Irritated gums	1	2	3	4	5
3	Irreversible	1	2	3	4	5
4	Results from food packing	1	2	3	4	5
5	Causes swelling	1	2	3	4	5
6	Affects supporting structures of teeth	1	2	3	4	5
7	Causes bleeding	1	2	3	4	5
8	May cause bone loss	1	2	3	4	5
9	Infection	1	2	3	4	5
10	Causes bad breath	1	2	3	4	5
11	Reversible	1	2	3	4	5
12	Gingivitis	1	2	3	4	5
13	Avoid dentures	1	2	3	4	5
14	Periodontitis	1	2	3	4	5
15	Will result in tooth loss	1	2	3	4	5
16	Halitosis	1	2	3	4	5
17	Will cause bone loss	1	2	3	4	5
18	Caused by bacteria	1	2	3	4	5
19	Result in food packing	1	2	3	4	5
20	May result in tooth loss	1	2	3	4	5

Table 2: Guidance explaining the grading scale

Grade	
1	Least likely to encourage/motivate me to take action
2	
3	
4	
5	Most likely to encourage/motivate me to take action

FINDINGS

One hundred lists were rated between June 2022 and January 2023; a record was kept of the participants, although at no point were their names written on the list. Fifteen patients declined the invitation to take part in the study. Of the reasons given , the two main ones were: "It's not something that I'm interested in" and, "I don't have time."

On the 100 lists that were completed, responses were received for all 20 words/phrases. The gender demographic was split, 61 females and 39 males. The average age was 57years; the youngest patient was 18 and the oldest was 77.

A mean score for each word/phrase was calculated. The maximum score was 5, the word/phrase was most likely to encourage/motivate the patient; the lowest score was 1, the word/phrase was least likely to encourage/motivate the patient. Although it was not the original intention, the mean score became known as the 'Encouragement Value'.

Table 3: Results present the actual number of patients who circled each score. The mean is represented on the right-hand side and the words/phrases have been listed in descending order of Encouragement Value.

Word/Phrase	Score Given					Mean Score
	1	2	3	4	5	
Will result in tooth loss	0	0	0	13	87	4.87
Causes bad breath	0	0	0	15	85	4.85
Irreversible	0	0	9	13	78	4.69
Infection	0	0	5	22	73	4.68
May result in tooth loss	0	7	3	25	65	4.48
Will cause bone loss	7	3	4	16	70	4.27
Causes swelling	0	4	16	38	42	4.18
Avoid dentures	0	4	8	55	33	4.17
Causes bleeding	0	8	32	21	39	3.91
May cause bone loss	0	11	18	49	22	3.82
Result in food packing	0	9	31	41	19	3.70
Results from food packing	22	16	22	19	21	3.01
Caused by bacteria	5	44	33	15	3	2.67
Halitosis	18	31	28	15	8	2.64
Irritated gums	18	69	1	10	2	2.09
Affects supporting structures of teeth	57	9	11	18	5	2.05
Periodontitis	53	23	4	11	9	2.00
Gingivitis	55	21	12	7	5	1.86
Inflammation	67	09	13	5	6	1.74
Reversible	69	24	7	0	0	1.38

For example, the mean score for 'Will result in tooth loss' was calculated as follows: 13x4 + 87x5 divided by 100 (52+435 divided by 100 = 4.87)

DISCUSSION

The findings suggest that, in the opinion of susceptible patients with experience of periodontal diseases, certain words when used to describe the disease can, somehow, generate different feelings, with some being more motivational than others. This indicates that patients form different meanings from different words. It also suggests that words can change the way a patient thinks. These points align well with research carried out by Andrew Newberg and Mark Waldman in their book *Words Can Change Your Brain*.[8] The authors also proposed that the mechanism behind how we process a communication is directly related to the number of words that are used. They claim that 30 seconds of language is all the brain can understand and, accordingly, they encourage fewer words for greater impact.

The findings also revealed a trend: the more severe sounding words scored higher mean values. This finding aligns with the consensus that the more immediate and severe the threat, the greater the chance of positive behaviour changes.[9] DeMatteo and DiNicola also found that patients with mildly threatening problems tend not to comply with their therapists' advice. Worryingly, this suggests that some of our patients, irrespective of how we communicate with them, will fail to comply until a stage when tooth loss is inevitable.

In a more recent study, which investigated the collaboration between medicine and dentistry in relation to diabetes management[10] patients reported inconsistency in the information and advice they were given by different healthcare providers. It was suggested that consistency would be beneficial to communication. Diabetes and periodontitis are inextricably linked as chronic inflammatory diseases that adversely influence one another. The creation and use of universal statements as scripts, using the topic-specific words reported by patients as more encouraging, make sense. The scripts would increase consistency in information sharing and thus increase the potential for a positive impact on a patient's periodontal health.

The short and long term aim of periodontal therapy is to keep the inflammatory response below the threshold of bone loss or further bone loss. This is entirely dependent upon us, as clinicians, persuading our patients to take our advice and follow it.

Compliance is defined as: "the extent to which a person's behaviour coincides with medical and dental advice".[11] Compliance requires that a patient is more than just a passive receiver of information. The estimates of compliance range from 20% to over 80%.[12] Generally, the rates of compliance for long term therapy tend to converge at 50%, regardless of setting or illness.[13] Although we know that patients do not follow oral hygiene recommendations consistently, we do not know specifically why they do not. One reason it is not understood could be that compliance research has been dominated by the perspective of the healthcare professional. These findings offer an insight into these patients' perspectives.

The degree to which a patient complies with oral hygiene instruction is of more importance than the choice of any particular treatment method.[14] The literature shows that compliance in general decreases as treatment time or the complexity of the required behavioural change increases.[14] It is often the case that by the time some susceptible patients appreciate what their type of periodontal disease is and what self-care is necessary to treat, stabilise and maintain it, insufficient bone remains to retain some of their teeth. Therefore, if we are to succeed with a preventative approach, we need to empower patients and achieve compliance at the early stages of bone loss.

▶▶

Around 2006, I had carefully devised the following statements to explain gum disease to my patients in a way I thought would be most effective:

1. Gum disease is an infection that irreversibly destroys the bone that holds your teeth in place.
2. When a significant amount of bone has been destroyed, your teeth will feel loose or wobbly.
3. When insufficient bone remains to support your teeth, they will start to drift or fall out.

A few of the words and phrases I put in the list in this study closely resemble some of the ones in these statements. In fact, it is my use of the above statements with my patients that inspired me to conduct this study. To avoid bias I deliberately avoided using the above statements in the initial consultations during the period of this study.

The above statements might not be to everyone's liking but they are simple, short, topic-specific and to the point. They accurately reflect the seriousness of the condition. I devised them to increase the likelihood of patients fully understanding what is being said, as amongst other things, understanding helps allay anxiety.[15] I appreciate that the statements have a negative tone; however, once patients appreciate the seriousness of their condition positive tones can be introduced by discussing the benefits of resolving the condition. Since using these statements, I have found my patients clearly understand the seriousness of their condition and, almost always, express their gratitude for the unambiguous nature of my communication. The message contains bad news but I deliver it gently with a measured polite firmness aimed at ensuring patients understand the potential seriousness of periodontal infection. [16,17,18]

CONCLUSION

In respect to the patient discussion, these findings suggest that the information which is conveyed by a single word or phrase does have the potential to affect the communication. Each word has a meaning but more importantly each word creates a mood.

CONTEXT

The author is a clinician operating a private referral practice restricted to periodontal care, with some minor oral surgery and implant dentistry. On a day-to-day basis, most treatments involve helping patients resolve their periodontal problems. The author is not a researcher, and has no experience of statistical analysis. This opinion paper was prompted by the fact that a poor understanding of 'gum disease' was relatively common amongst patients, despite the fact that they had regularly seen a dentist and/or a dental hygienist. Some of them had received multiple courses of periodontal therapy but still could not demonstrate a good understanding of gum disease. It is hoped that this article stimulates wide-spread debate as to how we communicate with our patients. It is also hoped that researchers will be inspired to utilise their resources to produce a more robust and in-depth study so that we can all learn from best practice.

Author:
Dr Hafeez Ahmed, Specialist Periodontist BDS(Wales)1991, FDS, MRD, MSc, MClinDent, DGDP. Binswood House Dental Practice, Royal Leamington Spa, WarwickshireCV32 5SE.

Contact:
binswoodhousedentalpractice@btinternet.com

REFERENCES

1. Suchman AL, Markakis K, Beckman HB, Frankel R. A model of empathetic communication in the medical interview. *JAMA. 1997*, **277(8)**, 678–682.
2. General Dental Council. Standards for the dental team. 2013.
3. Asimakopoulou K. A good relationship and good communication are not sufficient for patient-centred care; *Brit Dent J*. 2015, **219(3)**, 105–106. Published online: 14 August 2015, doi:10.1038/sj.bdj.2015.589.
4. Freeman R. The psychology of dental patient care: The common-sense approach, *Brit Dent J*. 1999, **186(9)**, 450–452.
5. Brown JC. Patient non-compliance – a neglected topic in dentistry. *JAmDent Assoc*. 1981, **103(4)**, 567–569.
6. Adult dental health survey 2009: Summary report and thematic series 2011.
7. Kassebaum N J, Bernabe E, Dahiya M, Bhandari B, Murray C J L, Marcenes W. Global burden of severe periodontitis in 1990–2010: A systematic review and metaregression. *J Dent Res*. 2014, **93(11)**, 1045–1053.
8. Newberg, A., Waldman, M. R Words can change your brain. Hudson Street Press (2012).
9. DeMatteo, M.R., DiNicola, D. D. Achieving patient compliance. New York: Pergamon Press Inc. (1982).
10. Bissett SM, Stone KM, Rapley T, PreshawPM. An exploratory qualitative interview study about collaboration between medicine and dentistry in relation to diabetes management. *BMJ Open* 2013, **3(2)**, e002192, doi:10.1136/bmjopen-2012-002192.
11. Haynes RB. Introduction. In: Compliance in health care. Baltimore: John Hopkins Univ. Pr. (1979).
12. Buckalew LW, Sallis RE. Patient compliance and medication perception. *J Clin Psychol*. 1986, **42(1)**, 49–53.
13. Morris LS, Schulz RM. Patient compliance- an overview. *JClinPharmTher*. 1992, **17(5)**, 283–295.
14. Ramjford SP, Morrison EC, Burgett FG, Nissle RR, Shick RA, Zann GJ et al. Oral hygiene and maintenance of periodontal support. *JPeriodontol*. 1982, **53(1)**, 26–30.
15. Freeman R. Communication, body language and dental anxiety. *Dental Update*, 1992, **19(7)**, 307–309.
16. Ptacek JT, Eberhardt TL. Breaking bad news. A review of the literature. *JAMA*, 1996, **276(6)**, 296–502.
17. Davis, K. Power words in periodontal communication. *Reg Dent Hyg*, 2011, **31(9)**, 74.
18. Davis K. The Art & Science of Effective Communication for Non-surgical Periodontal Treatment. *Contin Educ*. 2007, 58–68.

This article was first published in Dental Health 2024;63(2):34-37.

THE DARK SIDE OF PAEDIATRIC DENTISTRY

CHILD ABUSE

Authors: Alejandro Carlos de la Parte-Serna[a],*, Gonzalo Oliván-Gonzalvo[b], Cosmina Raluca Fratila[a], Mariona Hermoso-Vallespí[a], Andrea Peiró-Aubalat[a], Ricardo Ortega-Soria[c]

[a] Faculty of Health and Sports Sciences, University of Zaragoza, Huesca, Spain
[b] Social Services Institute of Aragón, Government of Aragón, Zaragoza, Spain
[c] Pediatrics Emergency Service, HLA Montpellier Hospital, Zaragoza, Spain

Correspondence: E-mail address: alejandro.delaparte@gmail.com

ABSTRACT

Background

Children who have been abused could exhibit lesions and diseases in their oral cavity and develop psychological consequences towards the dentist-patient relationship.

Objectives

Analyse the oral lesions and diseases, the psychological consequences and understand the role of the dentist in the detection and notification of child abuse.

Methods

Systematic review, according to PRISMA statement, with two search strategies in the MEDLINE/PubMed database. 19 publications were included after the application of selection and eligibility criteria.

Results

Physical-abuse-related lesions and Münchausen syndrome are not pathognomonic; this requires the detection of indicators of suspicion. Physical-neglect diseases usually have associated other chronic health problems. Specifically, diseases related to sexual abuse are the oral infection caused by Treponema pallidum and Neisseria gonorrhoeae; while other lesions and diseases might only suggest abuse. The most frequent psychological sign of child abuse in the dentist-patient relationship is dental phobia. Typically, when detecting and notifying, dentist face the following barriers: insufficient information; fear of wrong suspicion; impact in the professional practice; fear of consequences on the minor; fear of violence against the dentist; lack of knowledge of necessary documents/procedures; fear of judicial statement.

Conclusions

Child-abuse-related lesions and diseases often appear in the oral region. Dentists play a fundamental role in the detection and notification of those. It is essential to establish training and action protocols as well as reliance strategies in the patient-dentist relationship.

Keywords: Child abuse, Oral and dental lesions, Paediatric dentistry, Primary care dentistry, Legal dentistry

1. INTRODUCTION

Nowadays, child abuse is a prominent problem in the worldwide public health sector that is present in all socioeconomic and educational backgrounds. It persists despite the numerous information and awareness-raising programs in place to educate both professionals and the general public. Such programs focus on the occurrence, the indicators of suspicion, the complaint mechanisms and the possible sequels [1]. More concretely, the OMS estimates that, each year, 22.9% of the children under the age of 18 in the European region suffer from physical abuse and 9.6% from sexual abuse. Despite the alarming numbers, many of those cases of child abuse are not reported [2].

Children can be exposed to multiple forms of abuse with different consequences in the oral cavity and teeth. That is why dentists might be the first ones to detect them. Thus, dentists should be provided with the relevant training to identify those lesions and manage the situation adequately. Dentists, similar to other healthcare professionals, are obligated to notify signs of child abuse suspicion. As a result, a well-prepared and aware oral healthcare professional is a basic pillar in the protection of the minor [3].

The objective of this work is to revise the oral aspects derived from child abuse so as the psychological consequences in the dentist-patient relationship and the role of dentists in the detection and notification of such circumstances.

2. METHODS

Systematic review study according to PRISMA statement [4]. Two search strategies [Search 1 and 2] from the MEDLINE/PubMed database were carried out until July 2019. Search 1 used the following equation: "Child abuse"[MeSH Terms] AND "Dentists"[MeSH Terms], without year limit. The filters applied were *Full text* and *English* language, with the equation: "Child abuse"[MeSH Terms] AND "Dentists"[MeSH Terms] AND ["loattrfull text"[sb] AND English[lang]]. Search 2 was based on the following equation: “Dentist-Patient Relations”[Mesh] AND Dental abuse, without year limit, with filters *Full text* and *English* language, and so the equation is given by: "Dentist-Patient Relations"[Mesh] AND [["dental health services"[MeSH Terms] OR ["dental"[All Fields] AND "health"[All Fields] AND "services"[All Fields]] OR "dental health services"[All Fields] OR "dental"[All Fields]] AND

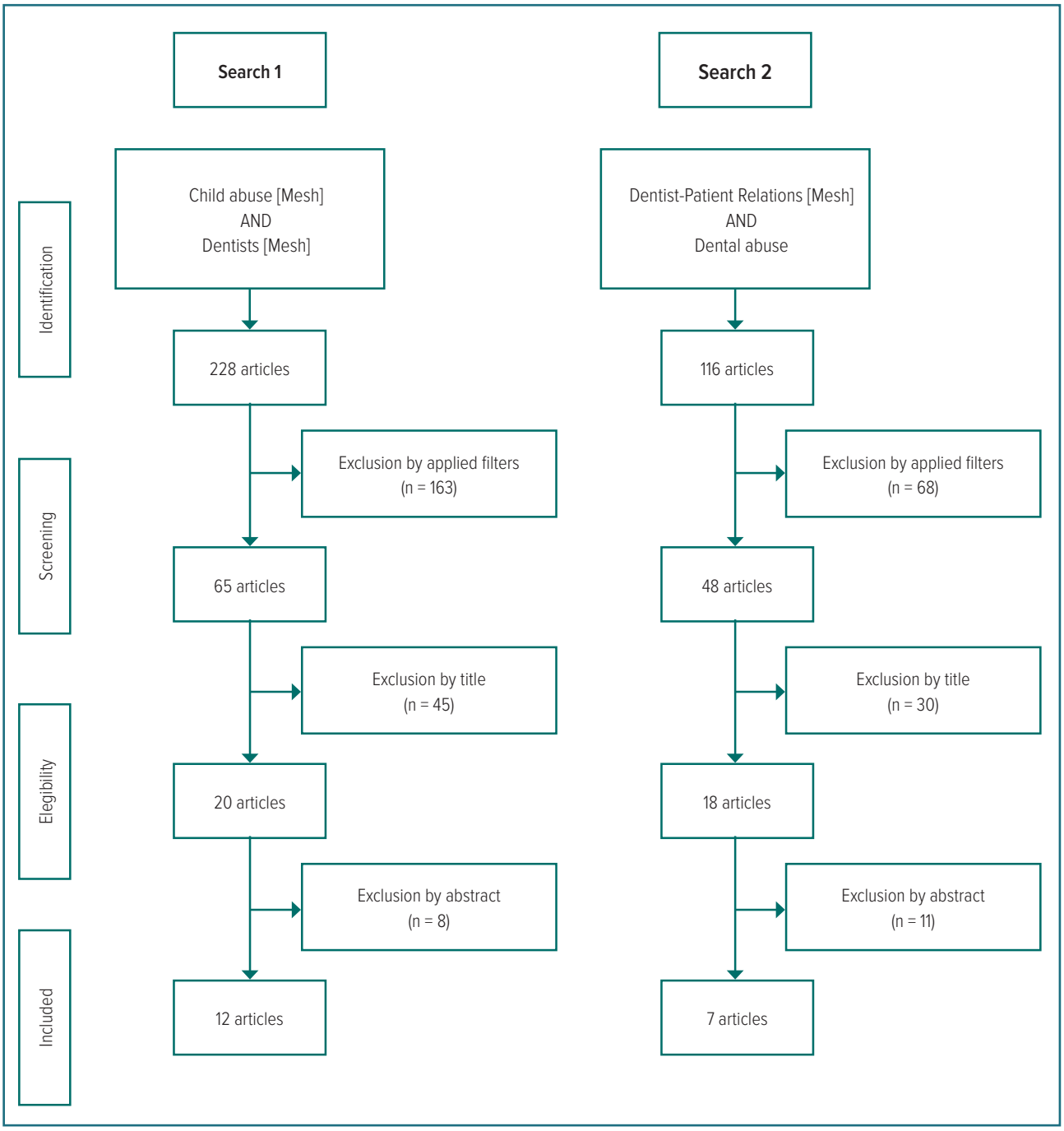


Figure 1: Flowchart of the process of study selection

["substance-related disorders"[MeSH Terms] OR ["substance-related"[All Fields] AND "disorders"[All Fields]] OR "substance-related disorders"[All Fields] OR "abuse"[All Fields]]] AND ["loattrfull text"[sb] AND English[lang]].

Figure 1 shows the flux diagram of both bibliographic search strategies and the study selection process. In Search 1, without filters applied, 228 publications were identified. After the application of the selection criteria 65 publications remained. After this, 45 publications were excluded as their titles were not related to the current study. Additionally, 8 more publication were discarded as the abstract did not relate to the objectives of our revision. Consequently, 12 publications were included in the final selection. On the other hand, in Search 2, without filter application, 116 articles were identified, that were reduced to 48 after the search filters were applied. 30 of these publications were then discarded after identifying that the title was not related to the revision, with 18 articles remaining. Similarly, after the analysis of the abstracts, 11 publications were excluded from the selection as their objectives did not meet the ones of our study. Finally, 7 publications were selected for our revision.

The combination of both bibliographic searches resulted in 19 publications that were selected for revision and whose results are described in the discussion section.

3. RESULTS AND DISCUSSION

3.1. ORAL LESIONS AND DISEASES OF CHILD ABUSE

Most frequent forms of child abuse include physical abuse, neglect and sexual abuse. Lesions and diseases related to those abuses often appear in the craneofacial region and more concretely in the oral region [up to 55% of physical abuse and up to 15% of sexual abuse cases]. As a result, a dentist might be the first healthcare professional that examines the victim of child abuse. Unfortunately, a high percentage of dentists [between 60-80%] state that they possess limited information on the topic and appear to lack the appropriate training to detect it [5-11]. Consequently, it is essential for dentist to acquire the knowledge to detect lesions and diseases that could be a consequence of abuse.

In Table 1 we list the oral and dental lesions and diseases which constitute indicators of suspicion of physical abuse and neglect [5-14].

Regarding physical-abuse-related lesions, it is important to consider that as none of them are pathognomonic it is essential to focus on indicators of high suspicion. This indicators are: lesions incompatible in either extension, depth, location, distribution or pattern-type with the child age or their development level; lesions incompatible with the provided story; lesions in different stages of healing; frequent and reiterated lesions in children under 6 years old; lesions in children under 9 months old or children that do not yet move autonomously.

Despite it being infrequent, the Münchausen syndrome by proxy or factitious disorder imposed on another should be taken into account due to the severe physical and emotional damage that could manifest in the minor. The syndrome generally occurs in children under 5 years old and lesions are typically intentional, conscious and planned as the mother reiteratively injures the child. After this, the mother usually seeks for healthcare assistance with the objective of obtaining some diagnosis and treatment. Nevertheless, her conscious behaviour does not produce any economic or social benefit but only the 'psychological benefit' from being in contact with health professionals and gaining their sympathy, solidarity and compassion for being the carer of a 'poor sick child'. Her psychological motivation is in assuming the role of the ill through her own child.

Table 1: Oral and dental lesions and diseases suspected of physical abuse and neglect

Patient
Physical abuse • Hematomas or scars in the commissural region, caused by jaws placed in the mouth during attempts to force it to shut up. • Bruises and lacerations on lips, upper labial frenulum, gums, tongue, palate, sublingual and oral mucosa, caused by direct trauma and / or eating utensils during forced feeding. • Burns or blebs in the perioral and intraoral region, caused by boiling liquids. • Fractures, displacements or dental avulsions. • Pulp necrosis [gray or pink discoloration of the tooth], caused by repeated old trauma. • Bite marks inside the mouth caused by your own teeth, produced during physical abuse. • Bite marks that reproduce the ovoid or elliptical shape of the human dental arch, have an inter-canine distance greater than 3 cm, and often have a central ecchymosis.
Münchausen syndrome by proxy • Persistent, recurrent, motley and unusual mouth ulcers that can hardly be pigeonholed in a specific clinical condition or disease and are intentionally inflicted to require health care. • Pharyngeal lesions intentionally inflicted to cause the child to cough or vomit blood or to create other symptoms that require health care.
Neglect • Caries in abundant and untreated numbers. • Missing teeth. • Repeated phlegmons. • Granulomas and other periodontal diseases. • Loss of normal tooth color.

Diseases related to neglect in the oral care and attention are usually linked to other health problems derived from chronic physical neglect in diet, hygiene, home safety and basic healthcare. As a result, these lesions are often examined by dentists after the children have entered the child protection system and, from there, are derived to oral healthcare services for their treatment.

In Table 2, we list the oral lesions and diseases that suggest or indicate sexual abuse [12-16].

Table 2. Suggestive or specific oral lesions and diseases of sexual abuse

- Petechiae, erythema and / or erosions in the intraoral region, particularly in the area of union between the hard and soft palate, caused by forced oral sex.
- Bite marks inside the mouth caused by your own teeth, produced during sexual abuse.
- Infection by *Treponema pallidum* [syphilitic chancre].
- Infection by *Neisseria gonorrhoeae*.
- Infection by human papilloma virus [HPV], especially types 6 and 11.
- Infection by *Chlamydia trachomatis* [venereal lymphogranuloma], types L1, L2 and L3.
- Infection by herpes simplex virus [HSV], type 1 and especially type 2.

Beyond the finding of sperm or seminal fluid in the perioral are and/or the oral cavity, only infections of *Treponema pallidum* and *Neisseria gonorrhoeae* can be considered as clear indicators of sexual abuse. The rest of the lesions and diseases might suggest sexual abuse but are not pathognomonic.

Treponema pallidum infection manifests as a painless and indurated necrotic ulcer with raised edges, which lasts between 3 to 6 weeks, typically present in the amygdalae with associated ipsilateral adenopathy and less often in the pharynx and other zones of the perioral and oral cavity.

Neisseria gonorrhoeae infection appears as multiple ulcers with a white pseudomembrane accompanied by bright red oral mucous. It often appears as pharyngitis, but can sometimes appear as tonsillitis, gingivitis, stomatitis or glossitis. Despite it being most commonly asymptomatic, it can cause itch or burn feeling or even become painful.

Human papillomavirus infection manifests in the perioral level as condyloma acuminatum, verruca vulgaris or squamous papillomas, typically not painful, and in any surface of the pharyngeal or oral mucosa.

Chlamydia trachomatis infection appears as an ulcer in the oral cavity or the pharynx, which can be painful and that disappears without treatment. Additionally, painful inflammation of the lymph nodes near the initial lesion appears after 2 to 6 weeks. Herpes simplex virus infection manifests as gingival enanthema, oral mucosa haemorrhage and clustering of small blisters, which evolve into pustules, in all regions of the oral mucosa including tongue, palate and perilabial skin. These blisters and pustules often burst giving rise to highly painful ulcers with dimensions around 1-5 mm. These ulcers, with corrugated edges and surrounding erythema, tend to coalesce.

3.2. PSYCHOLOGICAL ASPECTS OF CHILD ABUSE IN THE DENTIST-PATIENT RELATIONSHIP

The psychological patterns as a consequence of child abuse are numerous and many can persist even during adulthood. One of these is the fear of dentists. Dental phobia is an indicator of oral health. Patients suffering dental phobia do not typically get regular checks, suffer from more oral health problems and would only meet their dentists when they require treatment. Some signs of dental phobia are easily detected. Patients usually voluntarily say they feel nervous. Dentists can observe physiological reactions during treatment. Other factors are harder to detect, such as lack of trust or negative reactions to physical intimacy. Several studies have linked the fear of dentists or dental phobia with victims of physical or sexual abuse and not just individuals with negative dentist experiences in the past. In particular, 34% of women with a strong fear of dentists reported histories of sexual abuse as children; this includes 15% who reported rape attempts and 13% reporting rape or incest. Thus, there is a significant link between the fear of the dentist and child abuse arising from the similarity between situations of abuse and dental treatment [12, 15-18].

As a result, it is essential to differentiate between two types of fear of dentists: the one linked to negative previous dental experiences and the one associated to child trauma or abuse. Victims of sexual abuse can associate certain situations during dental treatments with traumatic memories. In both situations, the minor is left alone with a more powerful individual that then positions them horizontally, anticipating or experiencing pain. Abusers often start with some activity that seems harmless and frequently link their sexual behaviour with positive motivations, such as love or the need for education. Similarly, in the dental clinic, patients are expected to rely on the dentist and their ability to provide the best possible treatment for them. Dentists usually assure the patient that, similarly to the abusers, despite the experience potentially being painful or unpleasant, the result would be positive. In addition, sexual activity often involves both mouth and genitalia of the minor which links with the dental treatment that requires accessing the mouth of the patient. Over 90% of the victims of forced oral sex report deep dental phobia, fear of being trapped in the dental chair, fear of drowning and nausea when dental instruments are introduced in their oral cavity. As a result, dentist struggle to build a trust relationship with those patients. Therefore, it is essential for the dental care of victims of sexual child abuse that dentists adapt their treatment planning to the specific needs of those patients [12, 17].

3.3. THE ROLE OF DENTISTS IN THE DETECTION AND REPORT OF CHILD ABUSE

Reporting a suspected case of child abuse can become a clinical, ethical and legal dilemma that arises from the different professional roles, difficulties to confirm the suspicion of abuse and perceived deficiencies in the child protection system. Compared to other healthcare professionals, dentists report a lower number of cases than doctors or nurses, with 18%, 38% and 44% respectively. The most common cause of report by dentists is from repeatedly missing dental appointments and the lack of dental care while other forms of abuse are rarely reported. It is important to consider that missing dental appointments arises from complex family problems and it is more common in families with poor dental care. This is also linked to dental phobia. Additional studies have proven that between 21-38% of the suspected cases of child abuse are not reported. In order to successfully confirm cases of suspicion it is essential to establish adequate clinical records. In potential cases of abuse, lesions and diseases in the oral cavity should be recorded together with other significant psychological signs, such as the way that the minor interacts with their parent or guardian. It is essential to obtain photographic evidence of the lesions and, in the event of suspicion of sexual abuse, samples of the oral mucous and tongue with an air-dried sterile cotton swab which is then conserved adequately for laboratory analysis.

These records would them become essential for both assessing the treatment evolution and supporting the legal procedure for the child protection [6, 8, 9, 17, 19, 20].

The apparent difficulties that dentist experience when reporting cases of child abuse stand out. For example, in the USA, between the years 1995-2012, approximately only 1% of child abuse reports received were created by dentists. A surprisingly low percentage specially taking into account that dentist has an advantageous position to detect and report suspected child abuse cases with oral signs. One of the main reasons that affect the dentist ability to report abuse is that between 20-67% of dentists ignore the contact people in the report process. In addition to this, dentists detecting signs of suspicion outside their professional competence, typically focus on guaranteeing the general wellbeing of the child rather than suspecting abuse. In many of the cases of sexual or physical abuse, the signs were often too vague to create a report with a proper description of the abuse suspicion. Cases where parents were making their child miss the treatment despite an untreated cavity would confirm their abuse suspicions. However, in cases were the parents would acceptably fulfil the dental treatment requirements, dentists expressed their dilemma in whether to inform or not. As a result, it is complex to establish well-defined thresholds for the obligation to notify abuse with varying opinions in the evaluation among the child abuse experts [8, 11, 16, 21].

The hesitation to report can also arise from the uncertainty of the notification actually improving the child situation and the fear that an unnecessary report could damage the family relationship. Furthermore, dentists often seem to prioritise providing the dental treatment over reporting to social services. This might be caused by the possibility of a report interrupting the dental treatment and damage the family relationship or by the concern whether enough evidence exists for a report. It is important to highlight that in cases of hesitation in the informant, the social services comments played an essential role in the decision to report. On the other hand, in cases of confirmed dental negligence, reports were created despite this lack of communication. Other possible barriers for the report and notification are related to the fear of violence against the professional and the fear of a court case. Nowadays, the number of child abuse reports has increased, but a significant mismatch exists in the number of suspected and reported cases [8, 22, 23].

Now, we will discuss several indicators that might confirm the sexual abuse suspicions. This includes irrational or incompressible fear to the visit to the dental office, potential nausea arising from either the latex-glove smell or the oral exploration and the dental carelessness. Common fears reported by the victims include the need to lay down to receive treatment, the presence of objects in their mouths, the feel of the dentists hand over their mouths and/or noses, the inability to breathe or swallow, the perceived loss of control and the concern of upsetting the dentist. Moreover, patients who were sexual abuse victims might experience anxiety or powerlessness as they are unable to close their mouths or communicate during the dental care. Dental phobia can become more complex than just fear of pain or needles as the supine position being unable to speak, the lack of control and the fear to be touched can appear in the patients without the dentist being aware [7,13,17].

After a potential child abuse case is detected, it should be notified to social services, the child protective services and/or the juvenile prosecution service. This is a mandatory step in order to ensure the intervention and guarantee the legal and professional obligation. In the case of Spain, the notification is through a specific document, "Notification form of risk and child abuse", that all autonomous regions currently use [24]. The use of these notification forms promotes the systematic information gathering and the inter-institutional coordination, increasing the efficiency in the decision-making process. Each form consist of three copies: one addressed to the child record in the specific area [in this case, the health sector]; another for the social intervention, addressed to the primary care social services relevant to the ordinary action protocol or the corresponding entity for the minor protection in the case that the procedure requires urgent action; the last copy is addressed to the child abuse center in the autonomous region for statistical purposes. Once the necessary forms have been completed, there are two notification procedures, as we mentioned, ordinary and urgent protocol. In the ordinary protocol the information available about the case is reported to social services. Then, social services can evaluate initially if the intervention is made by them or if the case required to be derived to child protection services. On the other hand, the urgent protocol is activated in the event of reasonable indicators of the health and/or safety of the minor being at risk or being threatened and in the lack of a family or attachment figure that could take care of the minor. In these cases, regardless of the area where this situation is detected, child protection services are contacted directly. Dentists possessing suspicion or evidence of a child abuse case have then the duty to complete these notification forms and send them to the corresponding authorities. The professional would then also send the prescriptive lesion or medical report to the duty court or the prosecutor's office. Furthermore, in the event of risk for the child integrity, the minor should be kept in the health center until, either social services or the corresponding police force, transfer the victim to a child protection center.

4. CONCLUSIONS

Lesions and diseases resulting from child abuse often appear in the oral region and, consequently, the dentist can play an essential role in their detection and notification. The most common psychological sign of child abuse in the dentist-patient relationship is the fear of the dentist or dental phobia. Dentists face important barriers in the detection and notification of child abuse including: the lack of training in the subject, the fear of a wrong suspicion, the professional impact in the professional practice, the fear of negative consequences in the minor, the fear of violence against the professional, the unawareness of the required documents and processes and the fear of a court case. There is a high discrepancy in the figures of suspected child abuse cases and the reports created by dentists. Consequently, it is necessary to train the professionals and establish protocols of action. The dentist is legally obligated to notify social services, the child protective services and/or the judicial system.

5. REFERENCES

1. World Health Organization. Child Maltreatment. Geneva: World Health Organization, 2017. Available from: http://apps.who.int/violence-info/child-maltreatment [accessed Dec 2019].
2. World Health Organization. Violence against children: tackling hidden abuse. Copenhagen: WHO Regional Office for Europe. 13/1/2020. Available from: http://www.euro.who.int/en/health-topics/disease-prevention/violence-and-injuries/news/news/2020/01/violence-against-children-tackling-hidden-abuse [accessed Feb 2020].
3. Fisher-Owens SA, Lukefahr JL, Tate AR. Oral and dental aspects of child abuse and neglect. Pediatr Dent. 2017;39:278-83.
4. Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. J Clin Epidemiol. 2009;62:1006-12. doi: 10.1016/j.jclinepi.2009.06.005.
5. Mathur S, Chopra R. Combating child abuse: the role of a dentist. Oral Health Prev Dent. 2013;11:243-50. doi: 10.3290/j.ohpd.a29357.
6. Kvist T, Cocozza M, Annerbäck EM, Dahllöf G. Child maltreatment - prevalence and characteristics of mandatory reports from dental professionals to the social services. Int J Paediatr Dent. 2017;27:3-10. doi: 10.1111/ipd.12230.
7. Raja S, Rajagopalan CF, Kruthoff M, Kuperschmidt A, Chang P, Hoersch M. Teaching dental students to interact with survivors of traumatic events: development of a two-day module. J Dent Educ. 2015;79:47-55.
8. Kvist T, Wickström A, Miglis I, Dahllöf G. The dilemma of reporting suspicions of child maltreatment in pediatric dentistry. Eur J Oral Sci. 2014;122:332-8. doi: 10.1111/eos.12143.
9. Cairns AM, Mok JY, Welbury RR. The dental practitioner and child protection in Scotland. Br Dent J. 2005;199:517-20; discussion 512; quiz 530-1. doi: 10.1038/sj.bdj.4812809.
10. Park CM, Welbury R, Herbison J, Cairns A. Establishing comprehensive oral assessments for children with safeguarding concerns. Br Dent J. 2015;219:231-6. doi: 10.1038/sj.bdj.2015.689.
11. Katner DR, Brown CE. Mandatory reporting of oral injuries indicating possible child abuse. J Am Dent Assoc. 2012;143:1087-92. doi: 10.14219/jada.archive.2012.0038.
12. Leeners B, Stiller R, Block E, Görres G, Imthurn B, Rath W. Consequences of childhood sexual abuse experiences on dental care. J Psychosom Res. 2007;62:581-8. doi: 10.1016/j.jpsychores.2006.11.009.
13. Stalker CA, Russell BD, Teram E, Schachter CL. Providing dental care to survivors of childhood sexual abuse: treatment considerations for the practitioner. J Am Dent Assoc. 2005;136:1277-81. doi: 10.14219/jada.archive.2005.0344.
14. Uldum B, Christensen HN, Welbury R, Poulsen S. Danish dentists' and dental hygienists' knowledge of and experience with suspicion of child abuse or neglect. Int J Paediatr Dent. 2010;20:361-5. doi: 10.1111/j.1365-263X.2010.01070.x.
15. Lazenbatt A, Freeman R. Recognizing and reporting child physical abuse: a survey of primary healthcare professionals. J Adv Nurs. 2006;56:227-36. doi: 10.1111/j.1365-2648.2006.04030.x.
16. McDowell JD, Kassebaum DK, Fryer GE Jr. Recognizing and reporting dental violence: a survey of dental practitioners. Spec Care Dentist. 1994;14:49-53. doi: 10.1111/j.1754-4505.1994.tb01099.x.
17. Dougall A, Fiske J. Surviving child sexual abuse: the relevance to dental practice. Dent Update. 2009;36:294-6, 298-300, 303-4. doi: 10.12968/denu.2009.36.5.294.
18. Willumsen T. The impact of childhood sexual abuse on dental fear. Community Dent Oral Epidemiol. 2004;32:73-9. doi: 10.1111/j.1600-0528.2004.00120.x.
19. Uldum B, Christensen HN, Welbury R, Haubek D. How Danish dentists and dental hygienists handle their role in child abuse and neglect matters. Acta Odontol Scand. 2017;75:332-7. doi: 10.1080/00016357.2017.1307448.

20. Brattabø IV, Iversen AC, Åstrøm AN, Bjørknes R. Experience with suspecting child maltreatment in the Norwegian public dental health services, a national survey. Acta Odontol Scand. 2016;74:626-32. doi: 10.1080/00016357.2016.1230228.
21. Mouden LD, Bross DC. Legal issues affecting dentistry's role in preventing child abuse and neglect. J Am Dent Assoc. 1995;126:1173-80. doi: 10.14219/jada.archive.1995.0339.
22. Rodrigues JLSA, Lima APB, Nagata JY, Rigo L, Cericato GO, Franco A, Paranhos LR. Domestic violence against children detected and managed in the routine of dentistry - A systematic review. J Forensic Leg Med. 2016;43:34-41. doi: 10.1016/j.jflm.2016.07.006.
23. Harris JC, Bradbury J, Porritt J, Nilchian F, Franklin CD. NHS dental professionals' evaluation of a child protection learning resource. Br Dent J. 2011;210:75-9. doi: 10.1038/sj.bdj.2011.3.
24. Ministerio de Sanidad, Servicios Sociales e Igualdad. Protocolo básico de intervención contra el maltrato infantil en el ámbito familiar. Madrid: Secretaría de Estado de Servicios Sociales e Igualdad; 2014. Available from: http://www.observatoriodelainfancia.mscbs.gob.es/productos/pdf/MaltratoInfantil_accesible.pdf

CONTINUING PROFESSIONAL DEVELOPMENT QUESTIONNAIRE – ARTICLE 1

ETHICS ARTICLE: THE DARK SIDE OF PAEDIATRIC DENTISTRY: CHILD ABUSE

1. Reporting a suspected case of child abuse can become a clinical, ethical and legal dilemma that arises from which of the factors below:
   a. Different professional roles, difficulties to confirm the suspicion of abuse and perceived deficiencies in the child protection system.
   b. Different professional roles, difficulties to confirm the pathological oral lesions origins and perceived deficiencies in the child protection system.
   c. Differences in legal opinion, difficulties to confirm the suspicion of abuse and perceived deficiencies in the child protection system.
   d. Different professional roles, difficulties to confirm the suspicion of abuse and no Child Protections Acts in place.

2. Why do victims of sexual abuse often associate certain situations during dental treatments with traumatic memories?
   a. In both situations, the abuser is present as a dominant presence in the room.
   b. In both situations, the minor is unable to articulate how they feel in a vocal manner.
   c. In both situations, the minor is left alone with a more powerful individual that then positions them horizontally, anticipating or experiencing pain.
   d. In the dental setting, the minor is not given appropriate opportunities to talk about their previous dental experiences which forces them to be silent about all other experiences.

3. What percentage of victims of forced oral sex report deep dental phobia, fear of being trapped in the dental chair, fear of drowning and nausea when dental instruments are introduced in their oral cavity.
   a. >60%
   b. >90%
   c. >70%
   d. 50%

4. Which of the following are suggestive or specific oral lesions and diseases of sexual abuse?
   a. Petechiae, erythema and / or erosions in the intraoral region, particularly in the area of union between the hard and soft palate, caused by forced oral sex.
   b. Infection by Treponema pallidum or Infection by Neisseria gonorrhoeae.
   c. Infection by human papilloma virus (HPV), especially types 6 and 11 or Infection by Chlamydia trachomatis.
   d. A, B and C
   e. B and C

5. Which of the following dental manifestations are signs of child neglect?
   a. Caries in abundant and untreated numbers, missing teeth and repeated phlegmons.
   b. Granulomas and other periodontal diseases and loss of normal tooth colour.
   c. Gingiva that looks light pink and is firm and stippled.
   d. A and B
   e. B and C
   f. None of the above

EFFECTS OF FROGGY MOUTH APPLIANCE IN PEDIATIC PATIENTS WITH ATYPICAL SWALLOWING: A PROSPECTIVE STUDY

Authors: Andrea Scribante[1,*], Maurizio Pascadopoli[1,*], Simone Gallo[1], Paola Gandini[1], Pietro Manzini[2], Giulia Fadani[1] and Maria Francesca Sfondrini[1]

[1] Unit of Orthodontics and Pediatric Dentistry, Section of Dentistry, Department of Clinical, Surgical, Diagnostic and Pediatric Sciences, University of Pavia, 27100 Pavia, Italy; simone.gallo02@universitadipavia.it (S.G.); francesca.sfondrini@unipv.it (M.F.S.)
[2] Independent Researcher, 46100 Mantua, Italy
* Correspondence: andrea.scribante@unipv.it (A.S.); maurizio.pascadopoli01@universitadipavia.it (M.P.)

Source: Dent. J. 2024, 12(4), 96; https://doi.org/10.3390/dj12040096

ABSTRACT

Atypical swallowing has a high incidence in growing subjects. Orthopedic treatment with orthodontic appliances and speech therapy are the main approaches to this problem. The aim of this prospective study was to evaluate the changes in the dental arches induced by one year of treatment with the Froggy Mouth myofunctional appliance designed to correct atypical swallowing. In total, 16 patients with atypical swallowing were instructed to use the Froggy Mouth appliance. A digital intraoral impression was taken at baseline (T0). The Froggy Mouth appliance had to be used for 15 min/day throughout the treatment period. At the end of the first year of treatment (T1), another impression was taken with the same intraoral scanner. Digital casts of the T0 and T1 impressions were obtained using software and the two casts were superimposed to record the following measurements: upper intercanine distance, upper arch diameter, upper arch width, overbite and overjet. The data were statistically analyzed (significance threshold: $p < 0.05$). Student's t-test was used to compare pre- and post-treatment measurements. Linear regressions were performed to assess the influence of arch width on anterior and posterior diameters. A significant increase was found for the upper arch diameters ($p < 0.05$), whereas no statistically significant difference was found for the incisor relationship (overjet/overbite) ($p > 0.05$). To date, the efficacy of this appliance has not been extensively studied. According to the present prospective study, the Froggy Mouth protocol could be a valuable method as a myofunctional therapy for atypical swallowing, but further studies are needed to confirm these preliminary results.

Keywords: open bite; growing patients; orthopedic treatment; orofacial growth; dentistry; orthodontics; froggy

1. INTRODUCTION

The normal process of swallowing in adults is represented by the positioning of the tip of the tongue on the incisive papilla with contact of the dental arches. A different pattern of swallowing is atypical swallowing, in which the tongue is positioned between the dental arches during this process, or sometimes there is an improper vestibular thrust against the upper frontal teeth [1,2]. When this condition occurs, treatment should be aimed at eliminating the tongue interference that prevents the proper eruption of teeth and bone growth [3].

During the first few years of life, rudimentary swallowing is considered physiological. Subsequently, the transition between mixed and final dentition, neuromuscular development and novel feeding methods lead to a progressive adaptation of the swallowing pattern [2,4,5]. Between 3 and 7 years of age is the period of transition from infantile to adult swallowing. Atypical (infantile) swallowing may be diagnosed if infantile swallowing persists beyond the previous upper limit [6]. Poor oral habits, incorrect eating habits or pathological problems are generally considered to be the main causes of this condition [6,7].

In terms of clinical signs, lingual interposition, mental muscle contraction and lower lip interposition between the dental arches are all signs of atypical swallowing [4]. This condition can affect several functions including chewing, breathing, speech and posture [8–10]. It can also affect the facial profile and mimicry, resulting in the hypertonia of the orbicularis oris muscle and the chin [5,8]. Lip strength is associated with altered jaw movements, such as mandibular protrusion [9] and labial incompetence, while it is also critical for maintaining balance in the anterior teeth [10].

The association between atypical swallowing patterns and other physiological functions can be explicated by considering the engagement of muscles in the lips, face, tongue, pharynx, larynx, and esophagus in both respiratory and swallowing processes. These muscular components serve critical roles in maintaining airway patency, ensuring airway protection, and facilitating the propulsion of food boluses. Dysphagia, characterized by swallowing disorders, and its multifaceted etiologies primarily impact these muscular structures and the surrounding connective tissues, resulting in functional impairments such as compromised bolus propulsion and potential airway compromise. Behavioral therapeutic modalities frequently incorporate compensatory strategies, including postural adjustments, maneuvers aimed at enhancing airway protection and bolus clearance, and regimens comprising strengthening exercises [11].

It is also believed that a significant deficit in daily function and facial growth may be caused by deficits in lip strength [11]. Therefore, the treatment of atypical swallowing is necessary to eliminate the harmful interference of tongue thrusting and to achieve the harmonious growth of the maxillofacial region [5,9,12].

Several devices have been proposed to treat atypical swallowing, including functional devices such as the Bionator [13], Fraenkel [14], eruption guidance appliances, lingual spurs [15], fixed appliances [16], as well as speech therapy treatment [17] and myofunctional therapy (MFT) [10,18–20]. One of the latest devices, the Froggy Mouth (FM), proposed in 2016 [18], consists of a small removable device made of thermoplastic material that is placed between the lips and inhibits both sucking and swallowing, and stimulates lip contraction to keep the device stable

▶▶

[16]. The use of the device for 10–15 min per day is justified by the use of the subcortical pathway to build new neural circuits [1]. The device is, therefore, considered to be a myofunctional appliance as it prevents bilabial contact, forces the tongue into a correct position, stimulates muscular training and, ultimately, induces a new swallowing pattern. An advantage of the Froggy Mouth is that it can be prescribed to young children and does not require analogue impressions or digital scans for its manufacture.

The aim of the present study was to evaluate the effects of Froggy Mouth therapy in growing children on orthodontic measures, specifically the upper intercanine distance, upper arch diameter, overbite, overjet and upper arch width after one year of treatment. The null hypothesis of the study was that there was no statistically significant difference when comparing the above outcomes before and after the Froggy Mouth therapy.

2. Materials and Methods

2.1. Study Design

This was a single-arm, prospective study conducted in accordance with the Declaration of Helsinki on experimentations involving human subjects and received approval by the Unit Internal Review Board (registration n: 2021-0512). The parents of the patients signed informed consent prior to the start of the study. The study started in June 2021 and ended in January 2023.

2.2. Participants

Pediatric patients attending the private practice of Dr. Pietro Manzini, 46100 Mantua, Italy, for oral care requiring orthodontic evaluation were enrolled in the study. The inclusion criteria were as follows:

- Age 5–12 years;
- No previous orthopedic and/or orthodontic treatment;
- No current orthodopedic and/or orthodontic treatment;
- Atypical swallowing diagnosed with lingual interposition between the dental arches during swallowing with contraction of the perioral muscles.

The following exclusion criteria were applied:

- Patients receiving speech therapy for atypical swallowing;
- Previous speech therapy for atypical swallowing.

2.3. Interventions and Outcomes

Patients were visited and parents were proposed to study the orthodontic case. Intraoral and extraoral photographs, digital impressions, orthopantomography and lateral cephalometric radiograph were performed for each patient. The case was discussed with parents and acceptance of the treatment plan was provided. At the beginning of the study (baseline, T0), patients were instructed to use the commercially available Froggy Mouth appliance (ATFC srl, Alpago, BL, Italy) (Figure 1), a small removable appliance created by a thermoplastic elastomer. The appliance is available in different sizes, and the clinician chose the right size for the patients. Children were subdued again to an impression taken with an intraoral scanner (3Shape TRIOS 3, 3Shape, Copenhagen, Denmark). The Froggy Mouth appliance had to be used for 15 min/day throughout the treatment period (Figure 2). No specific exercises or modifications were recommended while wearing the appliance.

Patients were visited every two months to evaluate their comfort and compliance with the treatment that was monitored by asking both the patients and the parents if the appliance was worn.

At the end of the first year of treatment (T1), the patient was re-evaluated, and another impression was taken with the same intraoral scanner. The digital casts of T0 and T1 impressions were elaborated

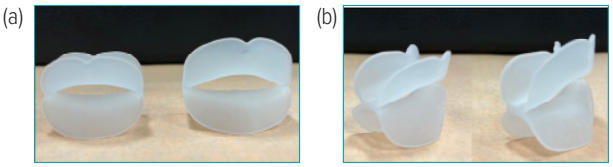


Figure 1. Froggy Mouth appliance (S size on the left and M size on the right): (a) frontal vision; (b) lateral vision

Figure 2. Patient wearing Froggy Mouth appliance

with 3Shape OrthoAnalyzer software (version 1.9.3.2, 3Shape) and the superimposition (Figure 3) of the two casts was performed with the aim of obtaining the following measures:

- Upper intercanine distance: distance between the edge of the cusps of the deciduous canines;
- Upper arch diameter (Figure 4a): distance between the mesio-palatal cusps of upper second deciduous molars;
- Upper arch width: distance between upper interincisal point and the point of intersection between the straight line passing from the furthest point from the crown of the second deciduous molars and the perpendicular line passing from the interincisal point;
- Overbite: distance between the uppermost vertically erupted middle incisor and the corresponding incisal edge of the opposite mandibular tooth;
- Overjet (Figure 4b): distance between the most palatal point of the maxillary central incisors and the corresponding reference point on the vestibular surface of the mandibular incisor. 2.4. Sample Size

2.4. Sample Size

Type I error (alpha) = 0.05 and type II error (power) = 80% were set to calculate the sample size of the study for the chosen primary outcome "intercanine distance". The calculation was based on the results of Garg and colleagues [19], hypothesizing an expected value of 51.4, an expected mean of 1.27 and a standard deviation of 1.28, requiring 16 patients for the enrollment.

2.5. Statistical Analysis

Data were statistically analyzed using R software (R version 3.1.3, R Development Core Team, R Foundation for Statistical Computing, Wien, Austria). The Shapiro–Wilk test was performed, and it revealed the normal distribution of data for all the variables. For each group and variable, descriptive statistics, including mean, standard deviation, median, minimum, maximum, and Cohen's d standardized effect size, were measured for each group. The Student's t test was performed for all the variables tested. Pearson's correlation coefficients were calculated

to assess the mutual influence of the variation in the upper arch width, upper intercanine distance, and upper arch diameter.

Statistical significance was set at $p < 0.05$ for all statistical tests.

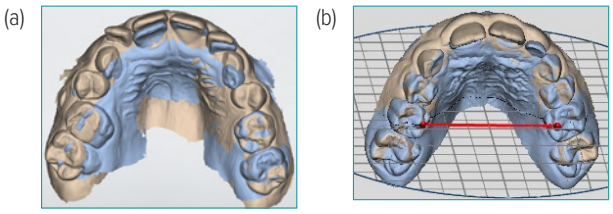


Figure 3. Digital models from intraoral impressions: (a) superimpositions of pretreatment models (blue) and post-treatment models (brown), (b) section of upper arch at the level of second deciduous molars.

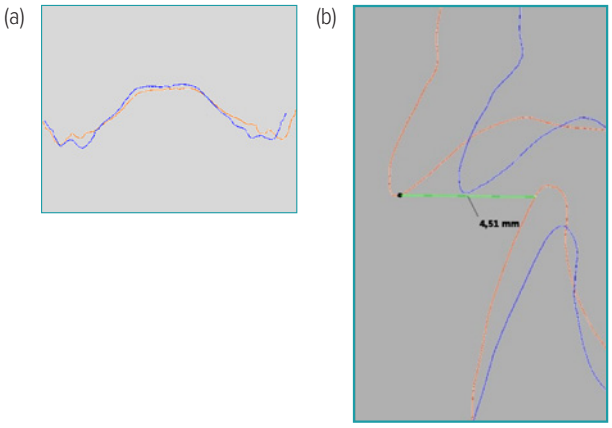


Figure 4. Measures performed on the digital casts: (a) results of the section at the level of second deciduous molars, (b) section at the incisor level for OJ measurement. Legend: blue line, pretreatment cast; red line, post-treatment cast.

3. Results

3.1. Demographic Data

A flowchart of the randomized clinical trials from enrollment to data analysis is shown in Figure 5. Initially, 19 patients were included in the study. During the conduct of the study conduction, 3 patients had to be excluded because they were scheduled for a second phase of treatment with different orthotic devices. Enrolment continued until the sample size was reached. Finally, 16 patients were analyzed at the end of the study. Their mean age was 9.06 ± 1.29 years, 8 males (8.96 ± 1.46 years) and 8 females (9.15 ± 1.21).

3.2. Statistical Analysis Results

In terms of the variables tested (Table 1), statistical significance was achieved after one year of treatment for upper intercanine distance ($p = 0.04$), upper arch diameter ($p = 0.02$) and upper arch width ($p = 0.01$). However, the T0-T1 difference was not significant for overbite ($p = 0.43$) and overjet ($p = 0.77$) measurements.

Pearson's correlation coefficients (Table 2) used to assess the mutual influence of the variation in the upper arch width, upper intercanine distance, and upper arch diameter resulted in weak correlations.

4. Discussion

Orthopedic treatment in growing patients is desirable to correct skeletal discrepancies before aligning teeth. Various research has been performed to assess the best timing for intervention, considering the influence of factors like sex, age and compliance of the patients [20]. Generally, the first problem that should be corrected is maxillary transverse discrepancy [21], while secondary interventions should involve sagittal discrepancies' correction, with an approach involving functional appliances [22].

Atypical swallowing is an alteration in the correct pattern of deglutition that usually occurs in the early stages of growth and evolves towards correct swallowing with tooth eruption [23]. In fact, infantile swallowing consists of moving the tip of the tongue forward. This type of swallowing can persist beyond the fourth year of life and can be considered an atypical mechanism, often associated with other anomalies such as anterior open bite (AOB) and increased overjet [6]. Tongue thrust can, therefore, be considered in two types of patients; namely, younger children, as a physiological stage of swallowing maturation, and patients of any age, due to predisposing factors such as increased overjet and anterior open bite, which facilitate the forward position of the tongue. Intercepting tongue thrust in the early years of life is surely easier than approaching the problem in later stages [24].

The null hypothesis of the study was partially rejected. In fact, the present study showed that after one year of treatment, the Froggy Mouth device caused a significant increase in the upper intercanine distance, the upper arch diameter and the upper arch width, whereas no effect was found on the parameters reflecting the relationship between the central upper and lower incisors (i.e., overjet and overbite). To date, no comprehensive studies have been conducted on the Froggy Mouth device and, to the best of our knowledge, only three studies have been published in the literature examining the effects of this device on orthodontic outcomes: two prospective studies and a case series. Di Vecchio and colleagues [18] tested the Froggy Mouth device on 370 patients to evaluate its influence after 9–12 years of treatment. The study consisted of the collection of intraoral and extraoral photographs of the patients, impressions, orthopantomographies and lateral cephalograms, as well as clinical records and other information obtained through a questionnaire. According to the results obtained, the authors found that the appliance showed positive clinical results in resolving malocclusions in growing patients, including open bite, transverse palatal constriction, cross bite and deep bite. Froggy Mouth also helped to resolve other problems such as snoring, drooling, sleep apnoea and difficulty breathing through the nose. Extraoral photographs showed the change in the face, neck and shoulder position immediately after wearing the device, suggesting a direct correlation between the altered contraction of the perioral and masticatory musculature and the asymmetrical contraction of the cervical musculature, with implications for TMJ and posture. Manzini et al. [25] reported the clinical use of the Froggy Mouth appliance in a case series; however, no measurements or comparisons of clinical studies were performed.

A prospective study was also carried out by Quinzi and colleagues [26], who evaluated the effect of the functional device on atypical swallowing, assessing lip force and altered facial mimicry. The benefits of the appliance were evaluated in 40 children with atypical swallowing before and during 6 months of treatment. The study showed that after 6 months of treatment, 82.5% of the subjects showed good compliance and all achieved a corrected swallowing pattern. Of these, 2 children (5% of the total sample) achieved early correction after only 3 months, 5 children (12.5% of the total sample) after 4 months, 11 children (27.5% of the total sample) after 5 months and 15 children (37.5% of the total sample) after 6 months. In total, 17.5% of the total sample (7 children out of 40) did not adequately follow the recommended protocol and refused the device; thus, not achieving the expected result. In patients exhibiting

▶▶

Table 1: Descriptive statistics of the variables assessed in the study. * Statistical significance was set for $p < 0.05$.

Group	Time	Mean	SD	Min	Median	Max	SES	Significance
Upper intercanine distance	T0 T1 T1-T0	31.86 32.78	2.54 2.19	27.60 27.70	32.25 32.83	36.18 35.66	0.388	0.042 *
Upper arch diameter	T0 T1 T1-T0	35.02 36.07	2.35 2.05	28.90 31.75	35.11 36.22	38.53 39.33	0.476	0.016 *
Upper arch width	T0 T1 T1-T0	30.25 31.96	3.62 3.35	24.62 28.04	29.27 31.58	40.00 42.00	0.490	0.012 *
Overbite	T0 T1 T1-T0	1.08 1.26	1.49 1.61	−1.66 −2.70	1.09 1.59	3.38 3.66	0.116	0.433
Overjet	T0 T1 T1-T0	3.57 3.69	2.46 1.49	−2.16 0.42	4.05 3.42	7.43 7.40	0.048	0.769

Table 2. Pearson's correlation coefficients (r) of the variations in the upper intercanine distance, upper arch diameter, and upper arch width.

Variables	r
Δ Upper intercanine distance~Δ Upper arch diameter	−0.0783
Δ Upper intercanine distance~Δ Upper arch width	0.2382
Δ Upper arch diameter~Δ Upper arch width	−0.1578

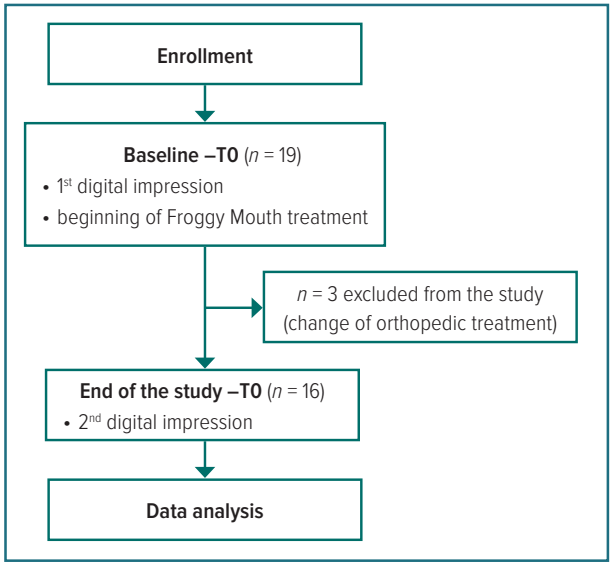


Figure 5. Flowchart of the study. Legend: *n*, number of patient

high compliance, treatment success was achieved in all cases. Clinical observations showed that most patients progressed in a steady manner throughout the observation period and eventually achieved the result. Therefore, the authors concluded by highlighting the short-term efficacy of this myofunctional appliance in the treatment of atypical swallowing, achieving the correction of facial mimics and labial incompetence with a significant improvement in lip strength.

The current research has mainly focused on the effectiveness of the Froggy Mouth device on the diameter of the maxillary arch and on the relationship between the incisors (overjet/overbite), whereas no direct evaluation was performed to test the effect on atypical swallowing. On the basis of these considerations, the results of the present study can be partially compared with those of the authors mentioned above. However, even Di Vecchio et al. [18] concluded that Froggy Mouth showed positive clinical results in resolving malocclusions in growing patients, such as transverse palatal constriction, but they also found an improvement in deep bite, whereas no effect on overbite and overjet was assessed in the present study. Conversely, Quinzi et al. [26] evaluated parameters directly related to atypical swallowing, but not to upper arch diameter and incisor ratio; thus, not allowing comparison with the current research. Certainly, atypical swallowing and tongue thrust can be adopted as criteria for using this orthopedic appliance, considering the fact that patient compliance is fundamental. The first phase of treatment can be faced with this appliance and then it can be continued with other compliance-related appliances [27]. However, the biggest disadvantage of the Froggy Mouth appliance is probably the fact that it is a removable appliance; therefore, the results of the treatment depend on patients' compliance. In the present study, a mean improvement in arch parameters was noted, but, surely, other variables should be considered for further research. The main limitation of this study is that it was a prospective protocol without a control group to compare with the experimental group. The lack of a control group with no treatment is justified by ethical reasons; however, it could be considered worthwhile to add an active comparison with other functional appliances. Additionally, it could be considered beneficial to add patients that only attend the dental setting without undergoing orthopedic treatment due to parental choice, to assess in an ethical way the natural growth versus orthopedic treatment results. Furthermore, only orthodontic parameters were assessed, without including the results of atypical swallowing and perioral muscle activity. The one-year follow-up could not be enough to evaluate long-term dental changes and potential relapse. Therefore, future randomized controlled trials should be performed to better clarify the effect of the Froggy Mouth device on both orthodontic malocclusion and atypical swallowing for longer durations of the studies and with active controls. Specifically, other populations and other clinical variables should be considered and comparisons of this treatment protocol with other devices and with

logopedic therapy, alone or in combination, should be considered [4,28]. Additionally, the correlation between sleeping disorders and anterior open bite, together with myofunctional treatments, should be furtherly explored [29]. Patients' perceptions dur ing therapy and the feasibility of use of the appliance could be further evaluated. Considerations on adult patients should be performed, suggesting the use of the Froggy Mouth appliance in light of the fact that tongue thrust can cause severe open bite even in patients with post-orthodontic retention appliances like fixed multibraided retainers [30].

5. Conclusions

The clinical protocol based on the use of the Froggy Mouth appears to be effective in atypical swallowing patients for improving upper arch diameters, including upper intercanine distance, upper arch diameter and upper arch width, while no significant changes were found for overbite and overjet measurements. Further scientific studies with the addition of control groups are needed to support these early results and explore other clinical variables.

Author Contributions:

Conceptualization, M.F.S. and A.S.; methodology, M.F.S., G.F. and A.S.; software, A.S.; validation, M.F.S. and A.S.; formal analysis, A.S.; investigation, G.F. and P.M.; resources, M.F.S. and P.G.; data curation, G.F., P.M. and A.S.; writing—original draft preparation, S.G. and M.P.; writing—review and editing, S.G., M.P. and A.S.; visualization, M.F.S. and A.S.; supervision, P.G.; project administration, P.G.; funding acquisition, M.F.S. All authors have read and agreed to the published version of the manuscript.

Funding:

This research received no external funding.

Institutional Review Board Statement:

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Unit Internal Review Board of the Unit of Orthodontics and Paediatric Dentistry, Section of Dentistry, Department of Clinical, University of Pavia (registration number: 2021-0512 Approval Date: 12 May 2021).

Informed Consent Statement:

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement:

Data are available upon motivated request to the corresponding authors.

Conflicts of Interest:

The authors declare no conflicts of interest.

References

1. Fellus, P. From digit-sucking-cum-deglutition to deglutition in dentate subjects. *Orthod*. Fr. **2016**, 87, 89–90. [CrossRef] [PubMed]
2. Fellus, P. Tongue disfunction and abnormal development. *Orthod*. Fr. **2006**, 77, 105–112. [CrossRef]
3. Begnoni, G.; Cadenas de Llano-Pérula, M.; Dellavia, C.;Willems, G. Cephalometric traits in children and adolescents with and without atypical swallowing: A retrospective study. *Eur. J. Paediatr. Dent*. **2020**, 21, 46–52. [PubMed]
4. Condò, R.; Costacurta, M.; Perugia, C.; Docimo, R. Atypical deglutition: Diagnosis and interceptive treatment. A clinical study. *Eur. J. Paediatr. Dent*. **2012**, 13, 209–214. [PubMed]
5. Maspero, C.; Prevedello, C.; Giannini, L.; Galbiati, G.; Farronato, G. Atypical swallowing: A review. *Minerva Stomatol*. **2014**, 63, 217–227. [PubMed]
6. Schmid, K.M.; Kugler, R.; Nalabothu, P.; Bosch, C.; Verna, C. The effect of pacifier sucking on orofacial structures: A systematic literature review. *Prog. Orthod*. **2018**, 19, 8. [CrossRef] [PubMed]
7. Caruso, S.; Nota, A.; Darvizeh, A.; Severino, M.; Gatto, R.; Tecco, S. Poor oral habits and malocclusions after usage of orthodontic pacifiers: An observational study on 3–5 years old children. *BMC Pediatr.* **2019**, 19, 294. [CrossRef] [PubMed]
8. Begnoni, G.; Dellavia, C.; Pellegrini, G.; Scarponi, L.; Schindler, A.; Pizzorni, N. The efficacy of myofunctional therapy in patients with atypical swallowing. *Eur. Arch. Otorhinolaryngol*. **2020**, 277, 2501–2511. [CrossRef] [PubMed]
9. Tecco, S.; Baldini, A.; Mummolo, S.; Marchetti, E.; Giuca, M.R.; Marzo, G.; Gherlone, E.F. Frenulectomy of the tongue and the influence of rehabilitation exercises on the sEMG activity of masticatory muscles. *J. Electromyogr. Kinesiol*. **2015**, 25, 619–628. [CrossRef]
10. Machado, A.J.; Crespo, A.N. Cephalometric evaluation of the airway space and hyoid bone in children with normal and atypical deglutition: Correlation study. *Sao Paulo Med. J*. **2012**, 130, 236–241. [CrossRef]
11. Martin-Harris, B. Clinical implications of respiratory-swallowing interactions. *Curr. Opin. Otolaryngol. Head Neck Surg*. **2008**, 16, 194–199. [CrossRef]
12. Hur, M.-S. Anatomical connections between the buccinator and the tendons of the temporalis. *Ann. Anat. Anat. Anzeiger.* **2017**, 214, 63–66. [CrossRef] [PubMed]
13. Jungbauer, R.; Koretsi, V.; Proff, P.; Rudzki, I.; Kirschneck, C. Twenty-year follow-up of functional treatment with a bionator appliance: A retrospective dental cast analysis. *Angle Orthod*. **2020**, 90, 209–215. [CrossRef]
14. Tecco, S.; Farronato, G.; Salini, V.; Di Meo, S.; Filippi, M.R.; Festa, F.; D'Attilio, M. Evaluation of cervical spine posture after functional therapy with FR-2: A longitudinal study. *Cranio* **2005**, 23, 53–66. [CrossRef]
15. Leite, J.S.; Matiussi, L.B.; Salem, A.C.; Provenzano, M.G.A.; Ramos, A.L. Effects of palatal crib and bonded spurs in early treatment of anterior open bite: A prospective randomized clinical study. *Angle Orthod*. **2016**, 86, 734–739. [CrossRef] [PubMed]
16. Giuca, M.R.; Pasini, M.; Pagano, A.; Mummolo, S.; Vanni, A. Longitudinal study on a rehabilitative model for correction of atypical swallowing. Eur. J. Paediatr. Dent. **2008**, 9, 170–174.
17. Bigenzahn, W.; Fischman, L.; Mayrhofer-Krammel, U. Myofunctional Therapy in Patients with Orofacial Dysfunctions Affecting Speech. *Folia Phoniatr. Logop*. **1992**, 44, 238–244. [CrossRef] [PubMed]
18. Di Vecchio, S.; Manzini, P.; Candida, E.; Gargari, M. Froggy mouth: A new myofunctional approach to atypical swallowing. *Eur. J. Paediatr. Dent.* **2019**, 20, 33–37.
19. Garg, H.; Khatria, H.; Kaldhari, K.; Singh, K.; Purwar, P.; Rukshana, R. Intermolar and Intercanine width Changes among Class I and Class II Malocclusions Following Orthodontic Treatment. *Int. J. Clin. Pediatr. Dent*. **2021**, 14, S4–S9.
20. Huo, B.; Che, X.; Li, X. Timing of early correction of mandibular hypoplasia in skeletal class II malocclusion: A review. J. *Clin. Pediatr. Dent*. **2023**, 47, 11–20.
21. Malmvind, D.; Golež, A.; Magnuson, A.; Ovsenik, M.; Bazargani, F. Three-dimensional assessment of palatal area changes after posterior crossbite correction with tooth-borne and tooth bone-borne rapid maxillary expansion. *Angle Orthod*. **2022**, 92, 589–597. [CrossRef] [PubMed]
22. Guinot, F.; Ferrer, M.; Díaz-González, L.; García, C.; Maura, I. Effects of Orthodontic Functional Appliances in Relation to Skeletal Maturation of Cervical Vertebrae In Class II Malocclusion. *J. Clin. Pediatr. Dent*. **2022**, 46, 62–69. [CrossRef] [PubMed]
23. Teixeira, E.C.; das Neves, B.M.; Castilho, T.; Silva Ramos, T.; Flaviana, A.; Carelli, J.; Kuchler, E.C.; Germano, F.N.; Alves Antunes, L.A.; Antunes, L.S. Evidence of Association between MTRR and TNF-α Gene Polymorphisms and Oral Health-Related Quality of Life in Children with Anterior Open Bite. *J. Clin. Pediatr. Dent*. **2022**, 46, 249–258. [CrossRef] [PubMed]

24. Proffit, W.R.; Fields, H.W., Jr.; Larson, B.E.; Sarver, D.M. *Contemporary Orthodontics*; Elsevier: Philadelphia, PA, USA, **2019**; p. 130.
25. Manzini, P.; Rosmarini, M.; Frati, E.; Severino, M.; Caruso, S. Tongue rehabilitation through the froggy mouth device: Case series. *J. Biol. Regul. Homeost. Agents* **2020**, 34, 142–150. [PubMed]
26. Quinzi, V.; Nota, A.; Caggiati, E.; Saccomanno, S.; Marzo, G.; Tecco, S. Short-Term Effects of a Myofunctional Appliance on Atypical Swallowing and Lip Strength: A Prospective Study. *J. Clin. Med*. **2020**, 9, 2652. [CrossRef] [PubMed]
27. Chen, J.; Xu, Y.; Guo, W. Combined orthopedic-orthodontic treatments of adolescent skeletal open-bite with severe molar-incisor hypomineralization: A case report and literature review. *J. Clin. Pediatr. Dent*. **2023**, 47, 91–99.
28. Cenzato, N.; Iannotti, L.; Maspero, C. Open bite and atypical swallowing: Orthodontic treatment, speech therapy or both? A literature review. *Eur. J. Paediatr. Dent*. **2021**, 22, 286–290. [PubMed]
29. Hoang, D.A.; Le, V.N.T.; Nguyen, T.M.; Jagomägi, T. Orofacial dysfunction screening examinations in children with sleepdisordered breathing symptoms. *J. Clin. Pediatr. Dent*. **2023**, 47, 25–34.
30. Sfondrini, M.F.; Pascadopoli, M.; Beccari, S.; Beccari, G.; Rizzi, C.; Gandini, P.; Scribante, A. Orthodontic Fixed Retainer and Unwanted Movements of Lower Anterior Teeth: A Case Report. *Case Rep. Dent*. **2022**, 2022, 3100360.

CONTINUING PROFESSIONAL DEVELOPMENT QUESTIONNAIRE – ARTICLE 2

EFFECTS OF FROGGY MOUTH APPLIANCE IN PEDIATRIC PATIENTS WITH ATYPICAL SWALLOWING: A PROSPECTIVE STUDY

6. What is atypical swallowing?
   a. A different pattern of swallowing in which the tongue is positioned between the dental arches during this process, or sometimes there is an improper vestibular thrust against the upper frontal teeth.
   b. A normal pattern of swallowing in which the tongue is positioned between the dental arches during this process.
   c. Process of swallowing which is represented by the positioning of the tip of the tongue on the incisive papilla with contact of the dental arches.
   d. A different pattern of swallowing in which the cheeks are pulled inwards during this process, or sometimes there is a normal vestibular thrust against the upper frontal teeth.

7. One of the latest devices, the Froggy Mouth (FM) designed to treat atypical swallowing, consists of which of the following?
   a. a. A medium-sized removable device made of durable elastic that is placed between the lips and inhibits both sucking and swallowing, and stimulates lip contraction to keep the device stable.
   b. A small removable device made of thermoplastic material that is placed between the lips and inhibits both sucking and swallowing, and stimulates lip contraction to keep the device stable.
   c. A small fixed device made of thermoplastic material that is placed between the lips and inhibits both sucking and swallowing, and stimulates lip contraction to keep the device stable.
   d. A small removable device made of thermoplastic material that is placed on the insides of each cheek and inhibits both sucking and swallowing, and stimulates tongue contraction to keep the device stable.

8. In terms of general orthopaedic treatment to treat skeletal discrepancies, which interventions take precedence?
   a. The first problem that should be corrected is maxillary transverse discrepancy, while secondary interventions should involve sagittal discrepancies' correction, with an approach involving functional appliances.
   b. The first problem that should involve sagittal discrepancies' correction while secondary interventions should be to correct maxillary transverse discrepancy
   c. The first problem that should involve sagittal discrepancies' correction while secondary interventions should be to correct mandibular transverse discrepancy.
   d. The first problem that should involve orbital discrepancies' correction while secondary interventions should be to correct maxillary transverse discrepancy

9. What did the evaluation of the Froggy Mouth appliance find?
   a. After 3 months of treatment, 82.5% of the subjects showed good compliance and all achieved a corrected swallowing pattern.
   b. After 6 months of treatment, 82.5% of the subjects showed good compliance and all achieved a corrected swallowing pattern.
   c. After 6 months of treatment, 59.5% of the subjects showed good compliance and all achieved a corrected swallowing pattern Patient smoking habits, patient dexterity or brushing duration.
   d. After 6 months of treatment, all subjects showed good compliance and all achieved a corrected swallowing pattern.

10. What is the biggest disadvantage of the Froggy Mouth appliance?
    a. It is a non-removable appliance; therefore, the results of the treatment depend on patients' frequency of visits to the clinician.
    b. It is a removable appliance; therefore, the device can break easily.
    c. It is a removable appliance; therefore, the results of the treatment depend on patients' compliance.
    d. It is a fixed appliance; therefore, the chances of decay are high.

THE IMPACT OF VITAMIN DEFICIENCIES

ON ORAL MANIFESTATIONS IN CHILDREN

Authors: Stjepanka Leši´c[1,†], Zrinka Ivaniševi´c[1,†], Bruno Špiljak[2,*], Matej Tomas[1,*], Magdalena Šoštari´c[3] and Aleksandar V˘cev[4]

[1] Department of Dental Medicine, Faculty of Dental Medicine and Health Osijek, J. J. Strossmayer University of Osijek, 31000 Osijek, Croatia; slesic@fdmz.hr (S.L.); zivanisevic@fdmz.hr (Z.I.)
[2] School of Dental Medicine, University of Zagreb, 10000 Zagreb, Croatia
[3] Faculty of Dental Medicine and Health Osijek, J. J. Strossmayer University of Osijek, 31000 Osijek, Croatia; sostaricmagdalena@gmail.com
[4] Department of Pathophysiology, Physiology and Immunology, Faculty of Dental Medicine and Health Osijek, J. J. Strossmayer University of Osijek, 31000 Osijek, Croatia; avcev@fdmz.hr
* Correspondence: bruno.spiljak@gmail.com (B.Š.); mtomas@fdmz.hr (M.T.)
† These authors contributed equally to this work.

Source: Dent. J. 2024, 12, 109. https://doi.org/10.3390/dj12040109

ABSTRACT:
Vitamins play a vital role in human health, particularly in the development and maintenance of oral health in children. These nutrients are broadly categorized into fat-soluble and water-soluble types, crucial for children's well-being. The objective of this study is to investigate the impact of vitamin deficiencies on the oral health of children, focusing on how these deficiencies contribute to various oral health issues and determining the relationship between specific vitamin shortages and oral diseases. Findings indicate that shortages in vitamins A and D lead to enamel issues and a higher susceptibility to dental diseases, vitamin E assists in treating oral mucositis, and vitamin K is essential for blood clotting in dental surgeries. Deficits in B-complex and vitamin C result in enamel hypomineralization and soft tissue ailments, including aphthous stomatitis and gingival petechiae. Additionally, a lack of vitamin B7 compromises the immune response, increasing oral candidiasis risk. Therefore, vitamin deficiencies markedly affect children's oral health, highlighting the need for joint efforts between dental professionals and caregivers for effective pediatric care. Addressing vitamin deficiencies through supplementation and tailored dental care emphasizes the significance of nutritional health in children's overall and dental well-being, advocating for a collaborative approach to achieve optimal health outcomes.

Keywords: children; hypoplastic teeth; oral manifestations; vitamin deficiencies; dental health; nutritional education

1. INTRODUCTION

Vitamins, diverse in chemical composition and essential for the proper functioning of living beings, are indispensable organic compounds found in a variety of foods. These substances, not synthesized internally, serve as pivotal biocatalysts in human nutrition, facilitating numerous physiological processes and being fundamental for the optimal growth and development of children. They hold significant value in the prophylaxis and treatment of a range of diseases, infections, and certain cancers, as well as in the nutritional enhancement and stabilization of food items, alongside their role as antioxidants [1–3]. Vitamins are categorized based on their solubility into two groups: fat-soluble vitamins (A, D, E, K), which are crucial for cell membrane fluidity, and water-soluble vitamins (Bgroup vitamins and vitamin C), which are essential for enzyme activation [4–7] (Figure 1). While an overdose of vitamins might lead to hypervitaminosis, a condition associated with various health issues, a lack of vitamins, or avitaminosis, poses a more frequent threat [1–7]. Insufficient vitamin intake can impair several bodily functions, resulting in conditions such as night blindness, clotting problems, and bone diseases like rickets and osteomalacia, as well as deterioration of nerve and muscle health [3,8]. These insufficiencies also compromise the dental health of children, evident through changes in both hard and soft oral tissues, manifesting as enamel defects, cheilitis, glossitis, and gingivitis [9,10]. Often, these oral signs in children stem from extended periods of vitamin scarcity. The role of vitamins is paramount across all life stages, particularly in childhood nutrition, to foster the establishment of sound dietary habits influenced by familial or community nutritional practices [3,11]. The Croatian Pediatric Society, as well as international health organizations, including the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC), underscore the criticality of averting vitamin and mineral shortages from infancy to early childhood, advocating for enhanced vitamin consumption during these crucial phases [12–14]. Contemporary lifestyles, coupled with dietary preferences such as veganism and vegetarianism, frequently result in vitamin inadequacies. Highlighting straightforward strategies for a nutritious and balanced diet is essential to circumvent these deficiencies [3,8,11].

Purpose of the Study

The purpose of this manuscript is to explore the current understanding of the oral manifestations of vitamin deficiencies in children.

2. MATERIALS AND METHODS

In conducting this review, we employed a systematic approach to data collection to ensure a comprehensive examination of the current

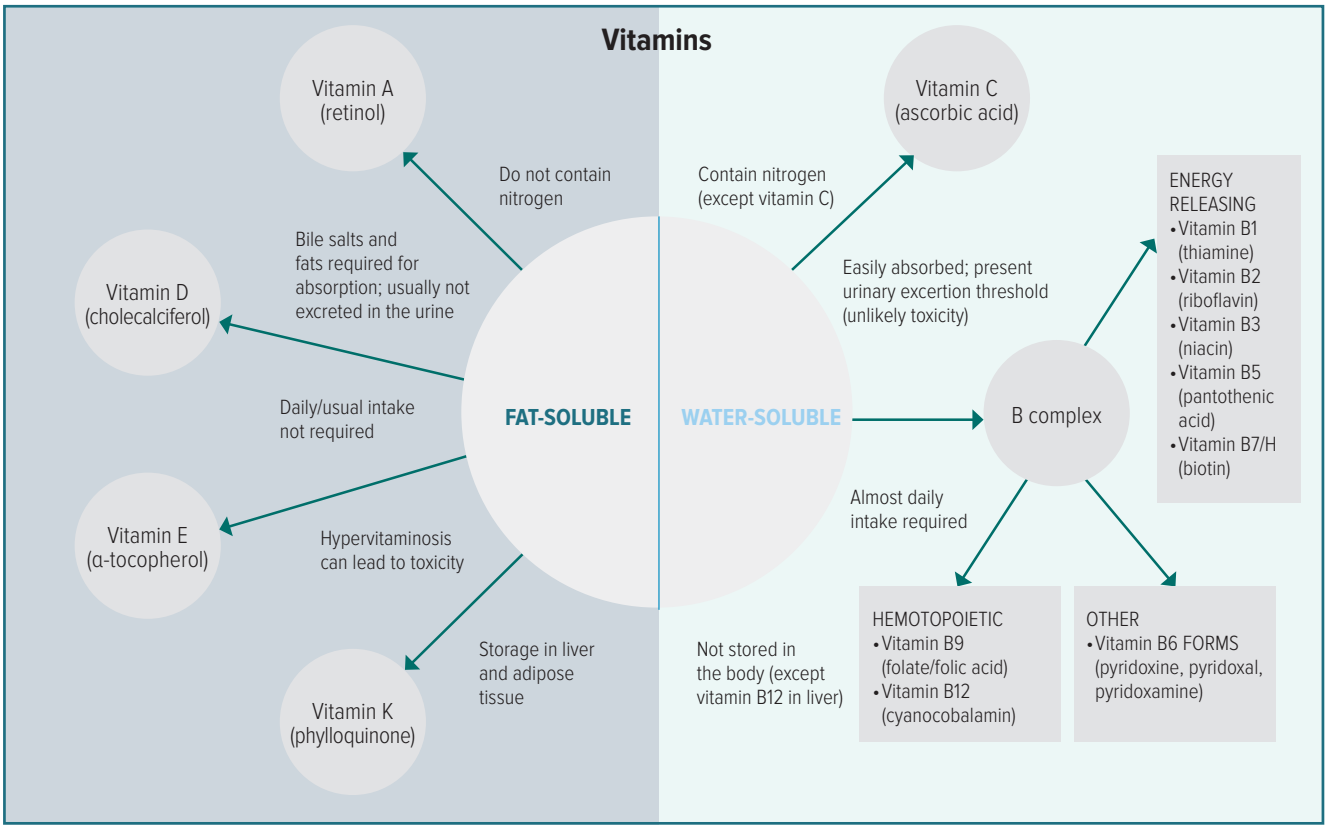


Figure 1. Vitamin classification by solubility and properties (an original scheme reproduced from Hugar et al. [1] and Mataix [2].

literature on the oral manifestations of vitamin deficiencies in children. The literature search was methodically performed using the PubMed database, targeting publications between the years 2000 and 2024. This timeframe was chosen to focus on the most recent and relevant studies, reflecting contemporary research findings and professional guidelines. Inclusion criteria were: (1) studies that explicitly explore the relationship between vitamin deficiencies and oral health issues in children, including research on oral symptoms (such as enamel defects, cheilitis, glossitis, and gingivitis) attributable to vitamin insufficiency; (2) articles providing statistical analyses of the prevalence, risk factors, and outcomes of vitamin deficiencies affecting pediatric oral health; (3) professional advisories and guidelines from recognized bodies that offer insights into best practices for diagnosing and managing vitamin-related oral health issues in children; and (4) research focusing on pediatric cases and hypoplastic teeth associated with vitamin deficiencies. Exclusion criteria were: (1) publications dated before the year 2000, to ensure the relevance and recency of the data included in our review; (2) studies not specifically addressing pediatric populations or not focusing on oral health outcomes related to vitamin deficiencies; (3) articles lacking empirical evidence or statistical analysis supporting their findings; (4) non-peer-reviewed literature, to maintain the scientific rigor and reliability of the information reviewed.

Our selection process was geared towards peer-reviewed articles, including original research papers, systematic reviews, meta-analyses, and professional guidelines. The aim was to encompass a wide range of high-quality evidence, ensuring a thorough understanding of the topic at hand.

3. FAT-SOLUBLE VITAMINS

Vitamins A, D, E, and K form a group of fat-soluble vitamins, each endowed with distinct attributes crucial for maintaining an individual's health. These vitamins participate in intricate processes of assimilation, metabolic transformation, and systemic distribution, safeguarding cellular integrity and bolstering organ function. Their mechanisms of action include improving cell membrane fluidity and facilitating transport, as well as engaging in oxidation–reduction (redox) reactions. Upon consumption and metabolic processing, these vitamins are retained within the body's reserves for future utilization. Their primary sources include a diverse array of fruits, vegetables, nuts, and animal products, distinguished by their ability to dissolve in fats and oils rather than water, a property known as lipophilicity [1,2,4,5]. The requisite daily intake of these vitamins is contingent upon a child's age, highlighting the significance of adhering to dietary recommendations to prevent deficiencies. Vitamin dosage is quantified in International Units (IU), reflecting the amount of a substance with biological efficacy. Higher dosages are denoted in micrograms (μg) or milligrams (mg), underscoring the necessity of following dietary guidelines to safeguard the health and development of children [5,15] (Table 1).

3.1. Vitamin A

Vitamin A, comprising retinoids, is available in two primary forms: preformed vitamin A (including retinol, retinaldehyde, and retinoic acid) and provitamin A (carotenoids) [17]. This vitamin group, featuring retinol and beta-carotene, is naturally present in animal sources like fish liver oil, milk, dairy, egg yolk, and a range of yellow and green fruits and

Table 1. Suggested daily intake of fat-soluble vitamins during developmental stages (an original scheme reproduced from Office of Dietary Supplements—National Institutes of Health [16]).

Vitamin	Life Stage						
	Birth–6 Months	7–12 Months	1–3 Years	4–8 Years	9–13 Years	Teen Males 14–18 Years	Teen Females 14–18 Years
Vitamin A (mcg RAE)	400	500	300	400	600	900	700
Vitamin D (mcg/IU)	10 / 400	10 / 400	15 / 600	15 / 600	15 / 600	15 / 600	15 / 600
Vitamin E (mg)	4	5	6	7	11	15	15
Vitamin K (mcg)	2	2.5	30	55	60	75	75

mcg = micrograms; RAE = retinol activity equivalents; IU = international units; mg = milligrams.

vegetables [18]. Retinol is imperative for rhodopsin production, aiding vision in low light, and is essential for immune function, skin and bone health, and growth [19]. Retinoic acid, another form of vitamin A, plays a crucial role in immune defense and tolerance in the intestines via its interaction with nuclear receptor RAR and kinase signaling pathways, and it is vital for every phase of wound healing, promoting tissue and fibroblast growth, angiogenesis, collagen synthesis, and more [20,21]. Both topical and systemic vitamin A supplementation has been shown to augment collagen deposition in the skin [19]. It also supports the development of the ectoderm in fetuses and is crucial for fetal growth [15].

Oral Manifestations of Vitamin A Deficiency

Vitamin A deficiency (VAD) is predominantly observed in infants and preschoolaged children, attributed to low retinol stores at birth and increased nutritional needs during rapid growth periods. VAD is linked to significant child and maternal mortality in developing regions, affecting approximately 1–2.5 million individuals annually [22,23]. Children suffering from VAD may exhibit symptoms like night blindness, keratomalacia, xerophthalmia, Bitot spots, and follicular hyperkeratosis, along with increased susceptibility to infections and nail fragility [18]. Oral complications from VAD include oral keratotic changes and disorders of mucosal keratinization, as well as enamel and dentin anomalies, leading to an increased risk of dental caries, enamel hypoplasia, and periodontitis (Figure 2).

Figure 2. A white keratotic lesion extended along the sublingual mucosa and the lateral edge and ventral part of the tongue, which can also be seen as individual foci on the gingiva. The peculiarity of these white lesions is that they cannot be scraped off. Hypovitaminosis A is a common cause of oral keratotic changes and disorders of mucosal keratinization (Courtesy of Prof. Dr. Marinka Mravak-Stipetić).

Enamel damage, or amelogenesis imperfecta, can result in hypoplasia or opacity, raising the risk for early childhood caries due to compromised enamel integrity. Additionally, dentin defects may show abnormal calcifications and alterations in the dental pulp's structure [21,24–26]. Less frequently, VAD can lead to fungal oral infections, characterized by white, soft plaques on the tongue and oral mucosa, complicating feeding and swallowing [27]. While VAD is a significant concern in regions with rice-based diets, like Southeast Asia and Africa, Croatia does not require routine vitamin A supplementation for healthy children, except for those with fat absorption difficulties. A diet rich in fruits and vegetables can ensure adequate vitamin A intake, with vegan diets providing sufficient levels through carotenoids in orange and yellow produce [28].

3.2. Vitamin D

Vitamin D, a steroid hormone, includes two primary forms beneficial for humans: cholecalciferol (vitamin D3) and ergocalciferol (vitamin D2), synthesized in the skin under sunlight exposure [29]. This vitamin is essential for regulating the balance of calcium and phosphorus in the bloodstream, facilitating their absorption in the intestines and reabsorption in the kidneys [30,31]. Its widespread presence of receptors across various cell types has spurred research into its potential links with numerous diseases [32]. Vitamin D is particularly known for promoting immune tolerance through its action on dendritic cells, encouraging the development of regulatory T cells [20]. It plays a pivotal role in maintaining the health of the neuromuscular, skeletal, dermal, and cardiovascular systems [33]. Furthermore, vitamin D is recognized for its tumor-suppressing, anti-inflammatory, and antibacterial capabilities, along with its contribution to calcium absorption and bone remodeling [34,35]. Children primarily obtain vitamin D from sources like fish oil, egg yolk, vitamin-fortified margarine, and vitamin-enriched baby foods [15,18,36].

Oral Manifestations of Vitamin D Deficiency

Awareness around Vitamin D deficiency (VDD) has grown significantly due to its widespread occurrence [37], raising concerns particularly in pediatric health, as highlighted by Aguiar et al. [38]. VDD is notably severe in infants, stemming from low levels in both maternal and cow's milk. In older children, deficiencies often result from inadequate dietary choices, with chronic shortages seen in those following vegan diets. The primary consequence of VDD is impaired bone mineralization, manifesting as rickets in young children or osteomalacia in adolescents. Oral impacts of this deficiency include a form of amelogenesis imperfecta during tooth development, alterations in dentin leading to dentogenesis imperfecta, and ectodermal dysplasia. VDD can also trigger decreased bone mineral density, leading to jawbone resorption [15,21] (Figure 3)

Figure 3. Image shows a decrease in bone mineral density in the mandible, particularly along the mandibular canal and an increase in alveolar porosity due to Vitamin D deficiency (Courtesy of Prof. Dr. Marinka Mravak-Stipetić).

Amelogenesis imperfecta, affecting enamel, can be linked to deficiencies in vitamins A and D or genetic factors, presenting as discoloration and structural alterations. Enamel hypoplasia, characterized by white or yellow-brown spots, primarily affects primary teeth and can lead to defects in permanent successors. This condition not only alters appearance but also increases sensitivity and caries risk [39]. Ectodermal dysplasia in the oral cavity is identified by the presence of fewer teeth of irregular shapes (cone-shaped), resulting in smaller teeth and potentially leading to asymmetrical alveolar ridge development. These cone-shaped teeth are often hypoplastic [40]. Vitamin D supplementation is globally recognized for its role in preventing rickets during infancy. The developmental stages of fetal teeth are vitamin D-dependent, suggesting the maternal vitamin D status during pregnancy influences tooth mineralization [41]. While earlier studies found no connection between vitamin D and cariogenic activity [42,43], recent research suggests that vitamin D supplementation can prevent the onset and progression of dental caries, recommending its use in children at risk of severe early-childhood caries [44,45]. High-dose vitamin D supplementation during pregnancy has been associated with a reduced risk of enamel defects in newborns [45], underscoring its preventative role against enamel deficiency. Vitamin D also plays a crucial role in the immune system, with optimal levels linked to lower chances of dental caries [46,47]. However, research findings have been mixed regarding this association [48,49]. Adequate vitamin D intake can mitigate gingivitis risks or reduce bacteria in gingival inflammation, thanks to its immunosuppressive and antiinflammatory properties, which are important for preventing infections in the oral cavity and initiating cell apoptosis. Vitamin D influences the immune system by inducing human cathelicidin (LL-37) in oral epithelial cells, which has antimicrobial and antiendotoxin activities. Children with high caries activity show low concentrations of LL-37, emphasizing its role as a "guardian of the oral cavity" and its importance in oral health [50–54]. Maternal vitamin D deficiency is linked to increased DMFT scores in children aged 12–35 months [55]. Vitamin D's effects on bone metabolism and its potential anti-inflammatory properties make it beneficial in treating periodontitis and enhancing postoperative wound healing following periodontal surgery. It acts as a potent signaling agent for alveolar bone resorption and is associated with lower levels of pro-inflammatory markers [56–58]. Given the myriad issues stemming from VDD in children, it has emerged as a public health priority, especially in developed nations. The current lifestyle and rising obesity rates among children exacerbate the risk of vitamin D deficiency. Prophylactic vitamin D3 doses range from 400 IU/day to 1000 IU/day for infants, as per European and American guidelines, emphasizing the need for supplementation throughout the first year of life [30]. Later, dietary sources rich in vitamin D should be encouraged, although consensus on adolescent vitamin D requirements remains elusive [32]. Special attention is warranted for children at higher risk of deficiency, including those with dark skin, obesity, limited outdoor activity, and certain health conditions, necessitating periodic vitamin D level monitoring [28,59].

3.3. Vitamin E

Vitamin E, encompassing tocopherols and tocotrienols, is classified into four chemical variants: alpha, beta, gamma, and delta. Alpha-tocopherol stands out as the most crucial for human health, being the primary form metabolized by the liver, whereas other tocopherols and tocotrienols are largely excreted [60–62]. Its predominant role is serving as an antioxidant, vital in conditions of heightened metabolic demand, and it also exhibits anti-inflammatory properties while stimulating naïve T cells [20]. Tocopherols are primarily found in vegetable oils from cereal germs, green leafy vegetables, avocados, legumes, and nuts [15,36,63].

Oral Manifestations of Vitamin E Deficiency

Owing to its broad distribution in numerous widely consumed foods, vitamin E deficiency is uncommon in the general and developed world populations, with only milder forms observed in South Asian regions [63–65]. The groups most at risk include preterm infants, children, and pregnant women, largely due to inadequate fat absorption or metabolic issues [63,65]. During pregnancy, only minimal amounts of vitamin E are transferred through the placenta, resulting in newborns with low vitamin E stores. A severe shortage can lead to neurodegenerative disorders such as ataxia and myopathy, affecting peripheral and motor nerves and the skeletal system [66]. Additionally, it may compromise immune function and trigger hemolytic anemia [64]. In the context of oral health, vitamin E has demonstrated effectiveness in managing oral mucositis, a condition particularly prevalent among children and adults undergoing cancer chemoradiotherapy (Figure 4). This condition involves painful ulcerations in the mouth that can significantly hinder feeding. Vitamin E, used either singly or alongside vitamin A, has been employed as a therapeutic agent [26,67]. While its impact on periodontal health may not be as pronounced as other vitamins, vitamin E is acknowledged for its capacity to modulate inflammation within the oral cavity, offering a beneficial effect in managing oral health conditions [63,65].

Figure 4. Mucositis and xerostomia in a patient undergoing radiotherapy after surgery of oropharyngeal cancer. Ulcerated and inflamed areas of the oral mucosa can be seen along with thick mucous saliva and white plaque deposits on the mucosa due to lack of serous saliva and washing of mucosa (Courtesy of Prof. Dr. Marinka Mravak-Stipetić).

Table 2. Suggested daily intake of water-soluble vitamins during developmental stages (an original scheme reproduced from Office of Dietary Supplements—National Institutes of Health [16]).

Vitamin	Life Stage						
	Birth–6 Months	7–12 Months	1–3 Years	4–8 Years	9–13 Years	Teen Males 14–18 Years	Teen Females 14–18 Years
Vitamin B1 (mg)	0.2	0.3	0.5	0.6	0.9	1.2	1
Vitamin B2 (mg)	0.3	0.4	0.5	0.6	0.9	1.3	1
Vitamin B3 (mg NE)	2 **	4	6	8	12	16	14
Vitamin B5 (mg)	1.7	1.8	2	3	4	5	5
Vitamin B6 (mg)	0.1	0.3	0.5	0.6	1	1.3	1.2
Vitamin B7/H (mcg)	5	6	8	12	20	25	25
Vitamin B9 (mcg DFE)	65	80	150	200	300	400	400
Vitamin B12 (mcg)	0.4	0.5	0.9	1.2	1.8	2.4	2.4
Vitamin C (mg)	40	50	15	25	45	75	65

mg = milligrams; NE = niacin equivalents; mcg = micrograms; DFE = dietary folate equivalents. ** only mg without NE.

3.4. Vitamin K

Vitamin K is indispensable for numerous blood coagulation pathways, with K1 (phylloquinone) and K2 (menaquinone) being crucial for human health [67,68]. Vitamin K1 is produced by intestinal bacteria, while a well-rounded diet ensures a sufficient intake of vitamin K2 [69]. However, the use of antibiotics can disrupt the balance of this essential nutrient [70]. Foods rich in vitamin K1 include liver and green vegetables, while vitamin K2 is found in dairy products [15,18,65].

Oral Manifestations of Vitamin K Deficiency

At birth, newborns exhibit low levels of vitamin K due to the limited ability of this vitamin to cross the placenta. Vitamin K is vital for the synthesis of blood clotting factors, and its deficiency may result in neonatal hemorrhagic disease. This condition is characterized by sudden and potentially life-threatening bleeding in various parts of the body, including the brain, skin, and digestive tract, which could have severe or even fatal neurological consequences [71]. To mitigate this risk, vitamin K supplementation is administered immediately after birth and continued through the third month of life, especially for exclusively breastfed infants, due to the low levels of vitamin K in breast milk [28]. Surveillance efforts and educational campaigns are essential to prevent vitamin K deficiency bleeding (VKDB), a largely preventable condition that has resulted in fatalities, particularly in cases of home births and parental refusal of vitamin K prophylaxis [71]. Zellweger spectrum disorders (ZSDs), which involve a disruption in peroxisome biogenesis, leading to various metabolic issues, also highlight the potential complications of vitamin K deficiency, such as hepatic dysfunction and coagulopathy, often presenting as bleeding complications in affected patients (Figure 5).

Figure 5. Submucosal bleeding manifesting as a sublingual hematoma in patients with a blood coagulation disorder due to vitamin K deficiency (Courtesy of Prof. Dr. Marinka Mravak-Stipetić).

These issues can be partially alleviated through oral or IV vitamin K supplementation, which improves overall vitamin K status and blood clotting capabilities [72,73]. Individuals with cystic fibrosis or those undergoing anticoagulant therapy are at increased risk for vitamin K deficiency, affecting coagulation and elevating the risk of bleeding during dental procedures. This underscores the importance of careful management and supplementation in these populations [74,75]. Furthermore, dietary supplements combining vitamins K1 and D3 are marketed for their synergistic effects on bone health and the development of a robust skeletal system in children, underscoring the broad utility and significance of vitamin K in human nutrition and health [28].

4. Water-Soluble Vitamins

Water-soluble vitamins encompass the B-complex group (vitamins B1, B2, B3, B5, B6, B7, or vitamin H, B9, and B12) along with vitamin C, all of which play pivotal roles in human health [2,6]. These vitamins are readily absorbed through the intestines and are sourced from a diverse array of foods, including fruits, vegetables, dairy products, legumes, meats, eggs, and cereals. The occurrence of a complete deficiency in all watersoluble vitamins is uncommon but may be seen in specific populations such as alcoholics, individuals with malabsorption syndromes, those adhering to a vegan diet without proper supplementation, and in cases of malnutrition [6,7]. The recommended daily intake of these essential nutrients tends to increase with age and is quantified in micrograms (mcg) and milligrams (mg), underscoring the importance of a balanced diet in maintaining optimal levels of these vitamins (Table 2).

4.1. B-Complex Vitamins

B-complex vitamins, comprising B1 (thiamin), B2 (riboflavin), B3 (niacin), B5 (pantothenic acid), B6 (pyridoxine), B7 (biotin or vitamin H), B9 (folate),

and B12 (cobalamin), are foundational to cell metabolism and replication and are vital for neurological functions. These vitamins are crucial for cytotoxic cellular immunity, modulating T cell responses, and are found in a wide variety of foods, including yeast, meat, legumes, whole grains, nuts, offal, dairy products, seeds, fish, eggs, green vegetables, and sprouted grains [20,76,77]. They are also frequently added to processed foods such as flours, rice, pasta, and cereals, with vitamin B2 commonly used as a coloring agent for its yellow hue [15,28].

Oral Manifestations of B-Complex Vitamin Deficiency

While deficiencies in B-group vitamins are uncommon in children due to their broad availability in the diet, deficiencies can impact the immune, cardiovascular, and nervous systems. Thiamin (vitamin B1) is essential for energy production, nerve impulse transmission, and the maintenance of the myelin sheath. Severe deficiency can lead to diseases such as beriberi and Wernicke–Korsakoff syndrome, especially in individuals with high rice consumption, chronic alcoholism, or those suffering from malnutrition and malabsorption syndromes [65,78,79]. Riboflavin (vitamin B2) is key for energy metabolism and is found in high concentrations in yeast extract, organ meats, wheat bran, milk products, eggs, and meat. It is notably sensitive to light, with its degradation accelerated by the presence of sodium bicarbonate during cooking [36]. Oral health can be significantly affected by deficiencies in vitamins B1 and B2, leading to conditions such as recurrent aphthous stomatitis (RAS), glossitis, and angular cheilitis (Figure 6).

Figure 6. Angular cheilitis due to hypovitaminosis of B2 vitamine (Courtesy of Prof. Dr. Marinka Mravak-Stipetić)

These deficiencies may also impair postnatal amelogenesis, resulting in enamel hypomineralization [76,80–82]. RAS presents as painful ulcers on the non-keratinized oral mucosa, affecting speech and eating, with the minor form being most common in children [83,84]. This condition, which may also be related to systemic diseases such as celiac disease, underscores the importance of evaluating children with RAS for nutritional status and considering screening for underlying conditions in cases of hematological abnormalities [85]. Effective management includes topical steroid therapy, good oral hygiene, and supplementation with essential nutrients, including B1, B2, B6, B12, and vitamin C [65,83,84]. Glossitis, characterized by inflammation and changes in the tongue's appearance and texture, can also result from deficiencies in vitamins B1 and B2. Treatment involves nutritional supplementation to address the underlying deficiency [86].

Deficiency of vitamin B3, known as niacin, results in pellagra, characterized by dermatological manifestations. Historically prevalent in the early 1900s among populations consuming niacin-deficient corn-based diets, pellagra is identified by dermatitis, glossitis, unpleasant breath odor due to bacterial growth or dry mouth, cheilitis, and RAS [87,88]. Pantothenic acid, or vitamin B5 deficiency, often occurs in those who are highly physically active, such as athletes, or suffer from severe undernutrition. Rich dietary sources of B5 include mushrooms, legumes, eggs, alfalfa, avocados, dairy, organ meats like liver, kidney, and heart, as well as whole grains and yeast [18,36]. Symptoms manifest as headaches, fatigue, muscle cramps, paresthesia, and nausea [89]. B5 plays a significant role in managing dry mucosal conditions, including xerosis and cheilitis, with its deficiency leading to similar oral complications observed with other B vitamins [90]. Vitamin B6, or pyridoxine, is essential for embryonic development and early childhood, contributing to hemoglobin synthesis, amino acid metabolism, and protein synthesis. Although it is added to various multivitamin supplements and food items, making deficiency rare, it can lead to poor absorption in the gastrointestinal tract, liver disorders, weakened immunity, and dermatological issues. Oral symptoms in children due to B6 deficiency encompass angular cheilitis, glossitis, RAS, and halitosis (Figure 7). Immune system decline may also precipitate fungal infections in the oral cavity, akin to those seen with vitamin A shortages [91,92].

Figure 7. Exfoliative glossitis and angular cheilitis due to hypovitaminosis of B2 and B6 vitamins. Inflammatory changes in the tongue mucosa are usually accompanied by a burning symptom, which is particularly pronounced in vitamin B1 deficiency (Courtesy of Prof. Dr. Marinka Mravak-Stipeti´c).

Biotin (vitamin H or B7) serves as a vital coenzyme for the metabolism of fats, carbohydrates, and amino acids, supporting cellular proliferation and the health of hair and nails [21,93]. Despite its abundance in egg yolk, offal, yeast, mushrooms, bananas, and peanuts, deficiency can occur from consuming raw egg whites, which inhibit biotin absorption, or from prolonged antibiotic use [36,91,94]. Biotin deficiency symptoms include dermatitis, hair loss, anemia, depressive symptoms, vomiting, and nail inflammation [18]. In children, it may lead to conjunctivitis, ataxia, developmental delays, muscle weakness, paralysis, and vision issues [18]. Oral candidiasis, caused by Candida albicans, is a notable symptom, presenting as white patches within the oral cavity that can hinder swallowing [27]. To counteract biotin and other vitamin deficiencies, the market provides mixed vitamin and mineral supplements, particularly beneficial for selective eaters, ensuring up to 100% of daily nutritional needs when consumed in appropriate volumes [95]. Folic acid (vitamin

B9) is imperative in the diets of pregnant women for DNA synthesis and fetal development, with deficiencies previously observed in infants consuming goat's milk. Nowadays, breastfeeding and fortified formulas have significantly reduced this risk. Lack of B9 leads to megaloblastic anemia and is especially critical for children with gastrointestinal disorders such as celiac disease, Crohn's disease, and ulcerative colitis [96]. Oral symptoms of B9 deficiency include gingivitis, characterized by swollen and bleeding gums, as well as angular cheilitis and glossitis, mainly affecting the soft tissues of the mouth [28,97]. Cyanocobalamin, or vitamin B12, plays a pivotal role in several critical bodily functions, including nerve cell function, DNA replication, and the production of mood-regulating neurotransmitters. It is also integral to managing homocysteine levels, which, when elevated, are associated with an increased risk of cardiovascular diseases. B12 deficiency can lead to pernicious anemia and chronic fatigue, significantly impacting intellectual and neurological development [98]. It acts as a crucial cofactor in the human body for two specific enzymatic reactions: the conversion of homocysteine to methionine in the cytosol and the conversion of methylmalonyl CoA to succinyl-CoA in the mitochondria. Interruptions in these processes can trigger a B12 deficiency [98]. The effects and severity of a B12 deficiency vary, influenced by the deficiency's extent and duration. It predominantly affects the blood, bone marrow, and nervous system, leading to megaloblastic anemia due to impaired DNA synthesis in rapidly dividing cells. Neurological manifestations can range from issues with myelin synthesis and repair to cognitive decline and psychosis [98]. Notably, vitamin B12 deficiency is reported in 10–50% of women of childbearing age and pregnant women globally [99]. Newborns might not show symptoms at birth but can develop significant, potentially irreversible, multisystemic issues, including developmental delays, later in infancy. Early diagnosis and treatment in such cases can facilitate normal development and also benefit mothers who were previously undiagnosed [100]. For primary prevention of B12 deficiency, systematic supplementation during pregnancy is advised, especially for those without gastrointestinal malabsorption issues. Early pregnancy assessments for B12 levels can aid in identifying and treating asymptomatic mothers with atrophic gastritis, a condition marked by severe B12 deficiency [99]. Vitamin B12 is primarily found in animal products like milk, eggs, and fish, and is less common in plant-based sources, placing vegetarians, vegans, and their infants at a heightened risk for deficiency. Fortification of cereals, yeast, and some beverages with B12 has been implemented to address this gap [91]. The Croatian Pediatric Society advocates for B12 supplementation among breastfeeding vegan mothers [12], emphasizing its necessity for preventing anemia and its oral manifestations such as mucosal pallor, anemic gingiva, glossitis, dry mouth, and taste alterations in vegan children [28,35,93,101] (Figure 8).

Figure 8. Exfoliative (Moeller Hunter) glossitis. Inflammation and complete loss of filiform papillae of the dorsal tongue mucosa in patients with pernicious anemia due to vitamin B12 deficiency (Courtesy of Prof. Dr. Marinka Mravak-Stipetić).

Research by Khan et al. [102] and Liu et al. [103] highlighted the prevalence of haematinic deficiencies in patients with RAS, with significant reductions observed in serum folic acid and B12 levels. Consequently, inflammation of the lips and perioral skin can often be linked to nutritional deficiencies, including B12 and sideropenic anemia, which are implicated in the etiology of exfoliative cheilitis [104,105]. These findings underscore the importance of evaluating vitamin and mineral status in patients presenting with inflammation of the lips, perioral skin, or oral cavity, particularly in persistent cases.

4.2. Vitamin C

Vitamin C, also known as ascorbic acid, is integral to the metabolism of carbohydrates, proteins, and lipids, and plays a pivotal role in the body's redox reactions [106]. It serves as a cofactor in numerous enzymatic processes essential for the growth, repair, and development of tissues [107], including the hydroxylation of collagen, a critical step in connective tissue repair [108]. Moreover, vitamin C is involved in the biosynthesis of carnitine and norepinephrine, the metabolism of tyrosine, and the amidation of peptide hormones [109]. Its primary role involves the maintenance of collagen, vital for the regeneration of skin, bones, and ligaments, and it significantly contributes to wound healing, serves as an antioxidant, and plays a crucial role in preventing bacterial infections [110]. Beyond its antioxidant capabilities, vitamin C influences cell signaling and epigenetic modifications [20]. Rich sources of vitamin C include citrus fruits, green leafy vegetables, and bell peppers [93,111].

Oral Manifestations of Vitamin C Deficiency

In children, vitamin C deficiency can arise from restrictive eating patterns, including anorexia and bulimia. It is essential for iron absorption, a vital mineral for hematopoiesis. Vitamin C is thermolabile, meaning its content diminishes with cooking [111]. Scurvy, the disease caused by vitamin C deficiency, though often considered a historical condition, persists today, especially among children with neurodevelopmental issues or selective diets. The diagnosis of scurvy can be challenging due to its rarity and the diversity of its nonspecific symptoms, which include gingival changes [112]. Vitamin C is also crucial for immune function, with a noted increase in infection susceptibility in deficient individuals; it is even considered for adjunctive sepsis therapy [113]. Signs of deficiency typically emerge after 30 to 90 days of inadequate intake, with clinical symptoms reflecting its various metabolic roles [114,115]. These symptoms can mimic rheumatological, infectious, or hematological conditions due to their musculoskeletal and mucocutaneous manifestations [116]. Scurvy is characterized by gum hypertrophy, swelling, bleeding, follicular hyperkeratosis, extremity swelling, poor wound healing, and petechiae [117]. Oral signs are particularly indicative of scurvy, though gingival overgrowth can also suggest other conditions, necessitating careful differential diagnosis [118,119] (Figure 9). As mentioned, in scurvy, gums become swollen, tender, and bleed easily, which leads to tooth loss and secondary infections as wounds heal poorly [120]. Despite being rare in developed countries, scurvy occurs in individuals at risk, such

▶▶

as the elderly, those with malabsorption syndromes, eating disorders, and children with restrictive diets [121].

As humans cannot synthesize vitamin C, it must be obtained through diet [122]. Serum vitamin C levels, a standard diagnostic test, reflect recent dietary intake and can indicate the risk of developing scurvy [123]. The resurgence of scurvy in children, especially those with neurodevelopmental disorders and selective diets, highlights the need for dietary guidance and supplementation [124]. Post-surgical applications of vitamin C-enriched pastes/gels have been shown to enhance wound healing, and supplementation with vitamins A, B, E, and omega-3 fatty acids improves outcomes following periodontal interventions [65]. Vitamin C supplementation can alleviate gingival inflammation by enhancing collagen stabilization and reducing bleeding and inflammation [65]. Deficiency may also predispose children to fungal infections of the oral mucosa and xerostomia due to decreased salivary secretion [28,93,106]. Furthermore, vitamin C is beneficial in managing oxidative stress associated with periodontal diseases, a response to bacterial toxins causing mucosal damage in gingivitis and periodontitis [65,107,125].

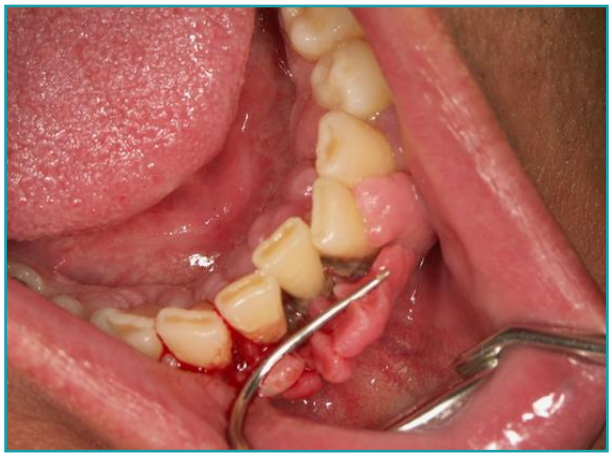


Figure 9. Hyperplastic gingivitis and periodontitis. Inflammation and hypertrophy of gums with bleeding and deep periodontal pockets as a result of hypovitaminosis C (Courtesy of Prof. Dr. Marinka Mravak-Stipetić).

5. The Importance of Recognizing Vitamin Deficiencies in the Oral Cavity

Vitamins, as indispensable micronutrients, play a vital role in supporting the myriad of biological processes within the human body and are essential for the healthy growth and development of children. Nutritional advice has become a cornerstone of preventive dentistry, significantly impacting long-term oral health outcomes [21,126]. Early detection of vitamin deficiencies during childhood is a key focus in pediatrics and pediatric dentistry to ward off oral, dental, and craniofacial diseases. An integral aspect of understanding the relationship between vitamin deficiencies and oral health, particularly in the development of dental anomalies, involves the consideration of vitamin absorption processes and potential concomitant systemic pathologies. For instance, dental fluorosis, characterized by changes in the appearance of tooth enamel in children exposed to high levels of fluoride during teeth development, has been the subject of increased scrutiny [127]. Recent studies have begun to explore how certain vitamins might influence the body's response to fluoride and the subsequent development of fluorosis. For instance, research indicates that adequate levels of vitamin D might reduce the risk of dental fluorosis by enhancing calcium metabolism, thus promoting healthy tooth mineralization and potentially counteracting fluoride's adverse effects [128]. Furthermore, the antioxidant properties of certain vitamins might offer protective mechanisms against oxidative stress induced by fluoride, suggesting a complex interplay that warrants further investigation [129]. These findings underscore the importance of a balanced nutritional status in children, not only to prevent vitamin deficiencies but also as a potential factor influencing the risk and severity of dental fluorosis. Moreover, the efficiency of vitamin absorption can significantly influence the severity and manifestation of vitamin-related oral health issues, including dental anomalies. This is because systemic conditions often affect the body's ability to absorb, metabolize, and utilize essential vitamins, thereby exacerbating the risk of deficiencies. Several systemic pathologies, such as gastrointestinal disorders including celiac disease, Crohn's disease, and cystic fibrosis, have been identified as critical factors that impair vitamin absorption. For instance, celiac disease affects the small intestine's ability to absorb nutrients from food, leading to a deficiency in various vitamins [130]. Similarly, Crohn's disease and cystic fibrosis can result in malabsorption syndromes, directly impacting the body's vitamin levels [131,132]. The presence of such systemic conditions is therefore crucial in assessing the risk and development of dental anomalies linked to vitamin deficiencies. Vitamins A, D, E, and K, which are fat-soluble, as well as the B-group vitamins and vitamin C, play pivotal roles in oral health. For example, vitamin D's role in calcium and phosphate metabolism is essential for dental development and bone health, with deficiencies linked to enamel defects and an increased risk of dental caries [44]. The impact of systemic diseases on these vitamins' absorption underscores the complexity of diagnosing and managing dental anomalies associated with vitamin deficiencies. Given the intricate relationship between systemic health, vitamin absorption, and oral health, a holistic approach to patient assessment is essential. This should include a thorough examination of dietary habits, gastrointestinal health, and a comprehensive medical history to identify any underlying conditions that may affect vitamin status. Incorporating such considerations into clinical practice and research can enhance our understanding of the etiological factors contributing to dental anomalies and guide more effective prevention and treatment strategies. Adopting a nutritious diet is a pivotal strategy in enhancing oral and systemic health, where altering dietary and lifestyle habits can foster the amelioration of these conditions [133]. Modifying diet represents a readily adjustable factor, crucial not just for oral health but also for systemic well-being, including its influence on the autologous self-renewal of stem cell niches related to oral mucosal integrity [134,135]. However, genetic variations among populations may significantly affect vitamin assimilation [136], emphasizing the concept of biochemical individuality and the toxicological principle that the dose determines the poison. Assessing a vitamin's therapeutic efficacy involves considering the dosage, form, source, bioavailability, and interactions with other nutrients. Child malnutrition, including hypovitaminosis, can stem from adverse cultural practices, environmental degradation, gender inequality, healthcare accessibility, lack of education, family size, overpopulation, and poverty [137]. Upon noticing initial signs of vitamin deficiency in the oral cavity, immediate actions should be taken to rectify the deficiency and address its dental consequences. This includes supplementing the deficient vitamin and potentially initiating dental interventions such as endodontic or restorative treatments, especially critical for conditions exacerbated by chronic

vitamin D deficiency, affecting caries incidence and periodontal disease progression [45,58]. Childhood represents a critical period for instilling proper dietary habits, influenced by familial and societal practices. Modern lifestyles often contribute to inadequate vitamin consumption. The role of parents is crucial in setting dietary examples, promoting family meals, discouraging meal skipping, and offering diverse, healthy food options without resorting to food as a reward or bribe. However, the challenge remains in educating children on balanced nutrition amidst the prevailing fast-food culture, the marketing of unhealthy foods, and dietary habits centered on convenience. Particularly, special diets like veganism and vegetarianism can lead to nutritional deficiencies, as evidenced by numerous studies. The Croatian Pediatric Society, WHO and CDC emphasize the importance of preventive measures against such deficiencies [12–14]. Despite challenges, including the influence of technology on dietary choices, initiatives aimed at integrating healthier food options into educational settings and employing nutritionists to devise child-friendly menus are steps towards improving children's overall and oral health. Educating both children and parents about the implications of vitamin deficiencies on health is paramount, alongside regular dental check-ups for early identification of vitamin-related oral changes. Dental professionals and healthcare providers must be adept at recognizing signs of vitamin deficiencies in the oral cavity and initiating appropriate interventions to mitigate the effects of such deficiencies.

6. Conclusions

Vitamins are indispensable for sustaining life, playing a critical role in maintaining the health and functionality of the body, including the stomatognathic system in children. Manifestations of vitamin deficiencies are observable in both the hard and soft tissues of the oral cavity, underscoring the importance of prevention and early detection in their management. The fields of pediatric dentistry and pediatrics are vital in identifying and addressing these deficiencies early on. Deficiencies in vitamins such as A, D, and K prominently affect the hard tissues within the oral cavity, such as teeth and the jawbone. Conversely, deficiencies in water-soluble vitamins, notably the B-complex and vitamin C, tend to present symptoms primarily in the soft tissues, including the tongue, gingiva, buccal mucosa, and lips. While some deficiencies lead to discernible anomalies in teeth or the alveolar ridge, others might not exhibit specific signs yet play a significant role in treating various conditions and complications within pediatric and general dentistry. The initial approach to managing vitamin deficiencies involves their supplementation, subsequently addressing the resultant changes within the pediatric dental care spectrum. This strategy emphasizes the integral role of nutritional health in the overall well-being and dental health of children, highlighting the collaborative effort required between dental professionals and caregivers to ensure optimal health outcomes.

Author Contributions:

Conceptualization, S.L., Z.I. and M.Š.; methodology, S.L., Z.I. and B.Š.; software, B.Š. and M.T.; validation, S.L. and Z.I.; formal analysis, S.L., Z.I., B.Š. and M.T.; investigation, S.L., Z.I., B.Š. and M.Š.; resources, M.T. and A.V.; data curation, S.L., Z.I., B.Š. and M.T.; writing—original draft preparation, S.L., Z.I., B.Š. and M.Š.; writing—review and editing, S.L., Z.I., B.Š., M.T., M.Š. and A.V.; visualization, B.Š.; supervision, A.V.; project administration, B.Š. and M.T. All authors have read and agreed to the published version of the manuscript.

Funding:

This research received no external funding.

Institutional Review Board Statement:

Not applicable.

Informed Consent Statement:

Patients signed an informed consent for the use of photographs for scientific purposes.

Data Availability Statement:

Not applicable.

Acknowledgments:

We hereby thank Marinka Mravak-Stipeti´c, Faculty of Dental Medicine and Heatlh Osijek, University of Josip Juraj Strossmayer Osijek, Osijek, Croatia for provided photographs of clinical cases.

Conflicts of Interest:

The authors declare no conflicts of interest.

REFERENCES

1. Hugar, S.M.; Dhariwal, N.S.; Majeed, A.; Badakar, C.; Gokhale, N.; Mistry, L. Assessment of Vitamin B12 and Its Correlation with Dental Caries and Gingival Diseases in 10- to 14-year-old Children: A Cross-sectional Study. *Int. J. Clin. Pediatr. Dent*. **2017**, *10*, 142–146.
2. Mataix, J. *Nutrición para Educadores*, 2nd ed.; Diez de Santos: Madrid, Spain, **2013**; pp. 117–126.
3. O'Brien, S.K.; Malacova, E.; Sherriff, J.L.; Black, L.J. The Prevalence and Predictors of Dietary Supplement Use in the Australian Population. *Nutrients* **2017**, *9*, E1154. [CrossRef] [PubMed]
4. Youness, R.A.; Dawoud, A.; ElTahtawy, O.; Farag, M.A. Fat-soluble Vitamins: Updated Review of Their Role and Orchestration in Human Nutrition Throughout Life Cycle with Sex Differences. *Nutr. Metab*. **2022**, *19*, 60. [CrossRef] [PubMed]
5. Stevens, S.L. Fat-Soluble Vitamins. *Nurs. Clin. N. Am*. **2021**, *56*, 33–45. [CrossRef]
6. Rodwell, V.W.; Bender, D.A.; Botham, K.M.; Kennelly, P.J.; Weil, A.P. *Harper's Illustrated Biochemistry*, 31st ed.; Mc Graw Hill: New Delhi, India, **2018**; pp. 535–549.
7. Said, H.M.; Nexo, E. Gastrointestinal Handling ofWater-Soluble Vitamins. *Compr. Physiol*. **2018**, *8*, 1291–1311.
8. Madhusudhan, K.S.; Pallavi, M.R. Malnutrition-a Risk for Oral Health. *Int. J. Sci. Res*. **2019**, *8*, 74–77.
9. Shaik, P.S.; Pachava, S. The Role of Vitamins and Trace Elements on Oral Health: A Systematic Review. *Int. J. Med. Rev*. **2017**, *4*, 22–31. [CrossRef]
10. Tolkachjov, S.N.; Bruce, A.J. Oral Manifestations of Nutritional Disorders. *Clin. Dermatol*. **2017**, *35*, 441–452. [CrossRef]
11. Radochová, V.; Slezák, R.; Radocha, J. Oral Manifestations of Nutritional Deficiencies: Single Centre Analysis. *Acta Medica (Hradec Kral.)* **2020**, *63*, 95–100. [CrossRef]
12. Croatian Pediatric Society. Available online: https://pedijatrija.hlz.hr/ (accessed on 1 February 2024).
13. World Health Organization. Available online: https://www.who.int/health-topics/nutrition (accessed on 23 March 2024).
14. Centers for Disease Control and Prevention. Available online: https://www.cdc.gov/nutrition/micronutrient-malnutrition/ index.html (accessed on 23 March 2024).
15. Mardeši´c, D.; Bari´c, I. *Pedijatrija*, 8th ed.; Školska knjiga: Zagreb, Croatia, 2013; pp. 83–93.
16. Office of Dietary Supplements—National Institutes of Health. Available online: https://ods.od.nih.gov/factsheets/list-VitaminsMinerals/ (accessed on 1 February 2024).
17. Reddy, P.; Jialal, I. *Biochemistry, Fat Soluble Vitamins*; StatPearls Publishing: Treasure Island, FL, USA, 2024. Available online: https://www.ncbi.nlm.nih.gov/books/NBK534869/ (accessed on 1 February 2024).
18. Ross, A.C.; Caballero, B.; Cousins, R.J.; Tucker, K.; Ziegler, T. *Modern Nutrition in Health and Disease*, 11th ed.; Wolters Kluwer Health/Lippincott Williams & Wilkins: Philadelphia, PA, USA, 2014; pp. 260–398.
19. Zinder, R.; Cooley, R.; Vlad, L.G.; Molnar, J.A. Vitamin A and Wound Healing. *Nutr. Clin. Pract*. 2019, *34*, 839–849. [CrossRef]
20. Elmadfa, I.; Meyer, A.L. The Role of the Status of Selected Micronutrients in Shaping the Immune Function. *Endocr. Metab. Immune Disord. Drug Targets* **2019**, *19*, 1100–1115. [CrossRef] [PubMed]

21. Gutierrez Gossweiler, A.; Martinez-Mier, E.A. Chapter 6: Vitamins and Oral Health. *Monogr. Oral Sci*. **2020**, *28*, 59–67. [PubMed]
22. Álvarez, R.; Vaz, B.; Gronemeyer, H.; de Lera, Á.R. Functions, Therapeutic Applications, and Synthesis of Retinoids and Carotenoids. *Chem. Rev*. **2014**, *114*, 1–125. [CrossRef] [PubMed]
23. Meléndez-Martínez, A.J. An Overview of Carotenoids, Apocarotenoids, and Vitamin A in Agro-Food, Nutrition, Health, and Disease. *Mol. Nutr. Food Res*. **2019**, *63*, e1801045. [CrossRef] [PubMed]
24. Park, J.A.; Lee, J.H.; Lee, H.J. Association of Some Vitamins and Minerals with Periodontitis in a Nationally Representative Sample of Korean Young Adults. *Biol. Trace Elem. Res*. **2017**, *178*, 171–179. [CrossRef]
25. Chaitanya, N.C.; Muthukrishnan, A.; Babu, D.B.G. Role of Vitamin E and Vitamin A in Oral Mucositis Induced by Cancer Chemo/Radiotherapy—A Meta-Analysis. *J. Clin. Diagn. Res*. **2017**, *11*, ZE06–ZE09. [CrossRef]
26. Lacruz, R.S.; Habelitz, S.;Wright, J.T.; Paine, M.L. Dental Enamel Formation and Implications for Oral Health and Disease. *Physiol. Rev*. **2017**, *97*, 939–993. [CrossRef] [PubMed]
27. Warren, N.G.; Body, B.A. Candidiasis. In *Sexually Transmitted Diseases: Epidemiology, Pathology, Diagnosis, and Treatment*; Routledge: London, UK, **2023**; pp. 149–163.
28. Grgurí˘c, J.; Jovan˘cevi˘c, M. *Preventivna i Socijalna Pedijatrija*; Medicinska Naklada: Zagreb, Croatia, **2018**; pp. 279–285.
29. Janoušek, J.; Pila˘rová, V.; Macáková, K.; Nomura, A.; Veiga-Matos, J.; Silva, D.D.D.; Remião, F.; Saso, L.; Malá-Ládová, K.; Malý, J.; et al. Vitamin D: Sources, Physiological Role, Biokinetics, Deficiency, Therapeutic Use, Toxicity, and Overview of Analytical Methods for Detection of Vitamin D and Its Metabolites. *Crit. Rev. Clin. Lab. Sci*. **2022**, *59*, 517–554. [CrossRef]
30. Grossman, Z.; Hadjipanayis, A.; Stiris, T.; Del Torso, S.; Mercier, J.C.; Valiulis, A.; Shamir, R. Vitamin D in European Children-Statement from the European Academy of Paediatrics (EAP). *Eur. J. Pediatr*. **2017**, *176*, 829–831. [CrossRef]
31. Sassi, F.; Tamone, C.; D'Amelio, P. Vitamin D: Nutrient, Hormone, and Immunomodulator. *Nutrients* **2018**, *10*, 1656. [CrossRef]
32. Patseadou, M.; Haller, D.M. Vitamin D in Adolescents: A Systematic Review and Narrative Synthesis of Available Recommendations. *J. Adolesc. Health* **2020**, *66*, 388–407. [CrossRef]
33. Khammissa, R.A.G.; Fourie, J.; Motswaledi, M.H.; Ballyram, R.; Lemmer, J.; Feller, L. The Biological Activities of Vitamin D and Its Receptor in Relation to Calcium and Bone Homeostasis, Cancer, Immune and Cardiovascular Systems, Skin Biology, and Oral Health. *Biomed. Res. Int*. **2018**, *2018*, 9276380. [CrossRef] [PubMed]
34. Bishop, L.E.; Ismailova, A.; Dimeloe, S.; Hewison, M.; White, J.H. Vitamin D and Immune Regulation: Antibacterial, Antiviral, Anti-Inflammatory. *JBMR Plus* **2020**, *5*, e10405. [CrossRef] [PubMed]
35. Uwitonze, A.M.; Rahman, S.; Ojeh, N.; Grant,W.B.; Kaur, H.; Haq, A.; Razzaque, M.S. Oral Manifestations of Magnesium and Vitamin D Inadequacy. *J. Steroid Biochem. Mol. Biol*. **2020**, *200*, 105636. [CrossRef] [PubMed]
36. Combs, G.F. *The Vitamins: Fundamental Aspects in Nutrition and Health*, 3rd ed.; Elsevier Academic Press: Amsterdam, The Netherlands, **2008**; pp. 3–177, 345–354.
37. Swapna, L.A.; Abdulsalam, R. Vitamin D Deficiency and Its Effects on Tooth Structure and Pulpal Changes. *Open Access Maced. J. Med. Sci*. **2021**, *9*, 81–87. [CrossRef]
38. Aguiar, M.; Andronis, L.; Pallan, M.; Högler, W.; Frew, E. The Economic Case for Prevention of Population Vitamin D Deficiency: A Modelling Study Using Data from England and Wales. *Eur. J. Clin. Nutr*. **2020**, *74*, 825–833. [CrossRef] [PubMed]
39. Toupenay, S.; Fournier, B.P.; Manière, M.C.; Naulin, C.I.; Berdal, A.; Molla, M.L.D. Amelogenesis Imperfecta: Therapeutic Strategy from Primary to Permanent Dentition Across Case Reports. *BMC Oral Health*. **2018**, *18*, 108. [CrossRef]
40. Wright, J.T.; Grange, D.K.; Fete, M. *Hypohidrotic Ectodermal Dysplasia. GeneReviews®*; University of Washington: Seattle, WA, USA, 1993. Available online: https://www.ncbi.nlm.nih.gov/books/NBK1112/ (accessed on 1 February 2024).
41. Mortensen, N.B.; Haubek, D.; Dalgård, C.; Nørgaard, S.M.; Christoffersen, L.; Cantio, E.; Rasmussen, A.; Möller, S.; Christesen, H.T. Vitamin D Status and Tooth Enamel Hypomineralization Are Not Associated in 4-y-old Children: An Odense Child Cohort Study. *J. Steroid Biochem. Mol. Biol*. **2022**, *221*, 106130. [CrossRef]
42. Dudding, T.; Thomas, S.J.; Duncan, K.; Lawlor, D.A.; Timpson, N.J. Re-examining the Association Between Vitamin D and Childhood Caries. *PLoS ONE* **2015**, *10*, e0143769. [CrossRef]
43. Herzog, K.; Scott, J.M.; Hujoel, P.; Seminario, A.L. Association of Vitamin D and Dental Caries in Children: Findings from the National Health and Nutrition Examination Survey, 2005–2006. *J. Am. Dent. Assoc*. **2016**, *147*, 413–420. [CrossRef]
44. Hujoel, P.P. Vitamin D and Dental Caries in Controlled Clinical Trials: Systematic Review and Meta-Analysis. *Nutr. Rev*. **2013**, *71*, 88–97. [CrossRef]
45. Nørrisgaard, P.E.; Haubek, D.; Kühnisch, J.; Chawes, B.L.; Stokholm, J.; Bønnelykke, K.; Bisgaard, H. Association of High-Dose Vitamin D Supplementation During Pregnancy with the Risk of Enamel Defects in Offspring: A 6-Year Follow-Up of a Randomized Clinical Trial. *JAMA Pediatr*. **2019**, *173*, 924–930. [CrossRef] [PubMed]
46. Rosier, B.T.; Marsh, P.D.; Mira, A. Resilience of the Oral Microbiota in Health: Mechanisms That Prevent Dysbiosis. *J. Dent. Res*. **2018**, *97*, 371–380. [CrossRef] [PubMed]
47. Zhou, F.; Zhou, Y.; Shi, J. The Association Between Serum 25-Hydroxyvitamin D Levels and Dental Caries in US Adults. *Oral Dis*. **2020**, *26*, 1537–1547. [CrossRef] [PubMed]
48. Wójcik, D.; Krzewska, A.; Szalewski, L.; Pietryka-Michałowska, E.; Szalewska, M.; Krzewski, S.; Pels, E.; Be´n-Skowronek, I. Dental Caries and Vitamin D3 in Children with Growth Hormone Deficiency. *Medicine* **2018**, *97*, e9811. [CrossRef] [PubMed]
49. Gyll, J.; Ridell, K.; Öhlund, I.; Karlsland Åkeson, P.; Johansson, I.; Lif Holgerson, P. Vitamin D Status and Dental Caries in Healthy Swedish Children. *Nutr. J*. **2018**, *17*, 11. [CrossRef] [PubMed]
50. Wang, Q.; Zhang, W.; Li, H.; Aprecio, R.; Wu, W.; Lin, Y.; Li, Y. Effects of 25-Hydroxyvitamin D3 on Cathelicidin Production and Antibacterial Function of Human Oral Keratinocytes. Cell. *Immunol*. **2013**, *283*, 45–50. [CrossRef] [PubMed]
51. Davidopoulou, S.; Diza, E.; Sakellari, D.; Menexes, G.; Kalfas, S. Salivary Concentration of Free LL-37 in Edentulism, Chronic Periodontitis, and Healthy Periodontium. Arch. *Oral Biol*. **2013**, *58*, 930–934. [CrossRef] [PubMed]
52. Hans, M.; Madaan Hans, V. Epithelial Antimicrobial Peptides: Guardian of the Oral Cavity. *Int. J. Pept*. **2014**, *2014*, 370297. [CrossRef]
53. Khurshid, Z.; Naseem, M.; Yahya, I.A.F.; Mali, M.; Sannam Khan, R.; Sahibzada, H.A.; Zafar, M.S.; Moin, S.F.; Khan, E. Significance and Diagnostic Role of Antimicrobial Cathelicidins (LL-37) Peptides in Oral Health. *Biomolecules* **2017**, *7*, 80. [CrossRef]
54. Grant, M.; Kilsgard, O.; Akerman, S.; Klinge, B.; Demmer, R.T.; Malmstrom, J.; Jonsson, D. The Human Salivary Antimicrobial Peptide Profile According to the Oral Microbiota in Health, Periodontitis, and Smoking. *J. Innate Immun*. **2018**, *11*, 432–444. [CrossRef] [PubMed]
55. Singleton, R.; Day, G.; Thomas, T.; Schroth, R.; Klejka, J.; Lenaker, D.; Berner, J. Association of Maternal Vitamin D Deficiency with Early Childhood Caries. J. *Dent. Res*. **2019**, *98*, 549–555. [CrossRef]
56. Tang, X.; Pan, Y.; Zhao, Y. Vitamin D Inhibits the Expression of Interleukin-8 in Human Periodontal Ligament Cells Stimulated with *Porphyromonas gingivalis*. *Arch. Oral Biol*. **2013**, *58*, 397–407. [CrossRef] [PubMed]
57. Nebel, D.; Svensson, D.; Arosenius, K.; Larsson, E.; Jönsson, D.; Nilsson, B.O. 1α,25-Dihydroxyvitamin D3 Promotes Osteogenic Activity and Downregulates Proinflammatory Cytokine Expression in Human Periodontal Ligament Cells. *J. Periodont. Res*. **2015**, *50*, 666–673. [CrossRef] [PubMed]
58. Jagelavi˘ciene, E.; Vaitkevi˘ciene, I.; Šilingaite, D.; Šinknuaite, E.; Daugelaite, G. The Relationship Between Vitamin D and Periodontal Pathology. *Medicina* **2018**, *54*, 45. [CrossRef]
59. Antonucci, R.; Locci, C.; Clemente, M.G.; Chicconi, E.; Antonucci, L. Vitamin D Deficiency in Childhood: Old Lessons and Current Challenges. *J. Pediatr. Endocrinol. Metab*. **2018**, *31*, 247–260. [CrossRef]
60. Szewczyk, K.; Chojnacka, A.; Górnicka, M. Tocopherols and Tocotrienols-Bioactive Dietary Compounds; What Is Certain, What Is Doubt? *Int. J. Mol. Sci*. **2021**, *22*, 6222. [CrossRef]
61. Meganathan, P.; Fu, J.Y. Biological Properties of Tocotrienols: Evidence in Human Studies. *Int. J. Mol. Sci*. **2016**, *17*, 1682. [CrossRef]
62. Jiang, Q. Metabolism of Natural Forms of Vitamin E and Biological Actions of Vitamin E Metabolites. *Free Radic. Biol. Med*. **2022**, *179*, 375–387. [CrossRef]
63. Kemnic, T.R.; Coleman, M. Vitamin E Deficiency. In *Nutrition and the Eye: A Practical Approach*; Butterworth-Heinemann: Oxford, UK, **2023**; pp. 121–122.
64. Jilani, T.; Iqbal, M.P. Vitamin E Deficiency in South Asian Population and the Therapeutic Use of Alpha-Tocopherol (Vitamin E) for Correction of Anemia. Pak. *J. Med. Sci*. **2018**, *34*, 1571–1575. [CrossRef]
65. Najeeb, S.; Zafar, M.S.; Khurshid, Z.; Zohaib, S.; Almas, K. The Role of Nutrition in Periodontal Health: An Update. *Nutrients* **2016**, *8*, 530. [CrossRef] [PubMed]
66. Shahidi, F.; Pinaffi-Langley, A.C.C.; Fuentes, J.; Speisky, H.; de Camargo, A.C. Vitamin E as an Essential Micronutrient for Human Health: Common, Novel, and Unexplored Dietary Sources. *Free Radic. Biol. Med*. **2021**, *176*, 312–321. [CrossRef] [PubMed]
67. Schwalfenberg, G.K. Vitamins K1 and K2: The Emerging Group of Vitamins Required for Human Health. *J. Nutr. Metab*. **2017**, *2017*, 6254836. [CrossRef]
68. Riley, P.; Glenny, A.M.; Worthington, H.V.; Littlewood, A.; Fernandez Mauleffinch, L.M.; Clarkson, J.E.; McCabe, M.G. Interventions for Preventing Oral Mucositis in Patients with Cancer Receiving Treatment: Cytokines and Growth Factors. *Cochrane Database Syst. Rev*. **2017**, *11*, CD011990. [CrossRef] [PubMed]
69. Halder, M.; Petsophonsakul, P.; Akbulut, A.C.; Pavlic, A.; Bohan, F.; Anderson, E.; Maresz, K.; Kramann, R.; Schurgers, L. Vitamin K: Double Bonds beyond Coagulation Insights into Differences between Vitamin K1 and K2 in Health and Disease. *Int. J. Mol. Sci.***2019**, *20*, 896. [CrossRef]
70. Akbulut, A.C.; Pavlic, A.; Petsophonsakul, P.; Halder, M.; Maresz, K.; Kramann, R.; Schurgers, L. Vitamin K2 Needs an RDI Separate from Vitamin K1. *Nutrients* **2020**, 12, 1852. [CrossRef]
71. Zurynski, Y.; Grover, C.J.; Jalaludin, B.; Elliott, E.J. Vitamin K Deficiency Bleeding in Australian Infants 1993-2017: An Australian Paediatric Surveillance Unit Study. *Arch. Dis. Child*. **2020**, *105*, 433–438. [CrossRef] [PubMed]

72. Magnusson, M.; Ignjatovic, V.; Hardikar, W.; Monagle, P. A Conceptual and Practical Approach to Haemostasis in Paediatric Liver Disease. *Arch. Dis. Child*. **2016**, *101*, 854–859. [CrossRef]
73. Zeynelabidin, S.; Klouwer, F.C.C.; Meijers, J.C.M.; Suijker, M.H.; Engelen, M.; Poll-The, B.T.; van Ommen, C.H. Coagulopathy in Zellweger Spectrum Disorders: A Role for Vitamin K. *J. Inherit. Metab. Dis*. **2018**, *41*, 249–255. [CrossRef]
74. Jagannath, V.A.; Thaker, V.; Chang, A.B.; Price, A.I. Vitamin K Supplementation for Cystic Fibrosis. *Cochrane Database Syst. Rev*. **2017**, *8*, CD008482. [CrossRef]
75. Engelen, E.T.; Schutgens, R.E.; Mauser-Bunschoten, E.P.; van Es, R.J.; van Galen, K.P. Antifibrinolytic Therapy for Preventing Oral Bleeding in People on Anticoagulants Undergoing Minor Oral Surgery or Dental Extractions. *Cochrane Database Syst. Rev*. **2018**, *7*, CD012293. [CrossRef] [PubMed]
76. Kennedy, D.O. B Vitamins and the Brain: Mechanisms, Dose and Efficacy—A Review. *Nutrients* **2016**, *8*, 68. [CrossRef] [PubMed]
77. Chen, Y.B.; Wang, Y.F.; Hou, W.; Wang, Y.P.; Xiao, S.Y.; Fu, Y.Y.; Wang, J.; Zheng, S.W.; Zheng, P.H. Effect of B-Complex Vitamins on the Antifatigue Activity and Bioavailability of Ginsenoside Re after Oral Administration. *J. Ginseng Res*. **2017**, *41*, 209–214. [CrossRef] [PubMed]
78. Liu, K.L.; Zheng, J.B.; Chen, F.S. Relationships between Degree of Milling and Loss of Vitamin B, Minerals, and Change in Amino Acid Composition of Brown Rice. *LWT-Food Sci. Technol*. **2017**, *82*, 429–436. [CrossRef]
79. Wiley, K.D.; Gupta, M. *Vitamin B1 (Thiamine) Deficiency*; StatPearls Publishing: Treasure Island, FL, USA, 2024. Available online: https://www.ncbi.nlm.nih.gov/books/NBK537204/ (accessed on 1 February 2024).
80. Cavalcoli, F.; Zilli, A.; Conte, D.; Massironi, S. Micronutrient Deficiencies in Patients with Chronic Atrophic Autoimmune Gastritis: A Review. *World J. Gastroenterol*. **2017**, *23*, 563–572. [CrossRef]
81. Edwards, K.A.; Tu-Maung, N.; Cheng, K. Thiamine Assays—Advances, Challenges, and Caveats. *ChemistryOpen* **2017**, *6*, 178–191. [CrossRef]
82. Moskovitz, M.; Dotan, M.; Zilberman, U. The Influence of Infantile Thiamine Deficiency on Primary Dentition. *Clin. Oral Investig*. **2017**, *21*, 1309–1313. [CrossRef] [PubMed]
83. Al-Maweri, S.A.; Halboub, E.; Ashraf, S.; Alqutaibi, A.Y.; Qaid, N.M.; Yahya, K. Single Application of Topical Doxycycline in Management of Recurrent Aphthous Stomatitis: A Systematic Review and Meta-Analysis of the Available Evidence. *BMC Oral Health* **2020**, *20*, 231. [CrossRef]
84. Plewa, M.C.; Chatterjee, K. Recurrent Aphthous Stomatitis. In *European Handbook of Dermatological Treatments*, 3rd ed.; Springer: Berlin/Heidelberg, Germany, 2023; pp. 67–71.
85. Yılmaz, S.; Tuna Kırsaçlıo ˘ glu, C.; ¸Saylı, T.R. Celiac Disease and Hematological Abnormalities in Children with Recurrent Aphthous Stomatitis. *Pediatr. Int*. **2020**, *62*, 705–710. [CrossRef]
86. Sharabi, A.F.;Winters, R. *Glossitis*; StatPearls Publishing: Treasure Island, FL, USA, 2024. Available online: https://www.ncbi.nlm.nih.gov/books/NBK560627/ (accessed on 1 February 2024).
87. Li, R.; Yu, K.; Wang, Q.; Wang, L.; Mao, J.; Qian, J. Pellagra Secondary to Medication and Alcoholism: A Case Report and Review of the Literature. *Nutr. Clin. Pract*. **2016**, *31*, 785–789. [CrossRef]
88. Redzic, S.; Hashmi, M.F.; Gupta, V. Niacin Deficiency. *South Med. J*. **2023**, *45*, 775.
89. Palmer, C.A.; Boyd, L.D. *Diet and Nutrition in Oral Health*, 3rd ed.; Pearson Prentice Hall: Upper Saddle River, NJ, USA, **2016**; pp. 187–230.
90. Sanvictores, T.; Chauhan, S. Vitamin B5 (Pantothenic Acid). In *Clinical Guide to Nutrition & Dietary Supplements in Disease Management*; Churchill Livingstone: London, UK, 2023; pp. 699–701.
91. Alibabi´c, V.; Mujı´c, I. *Pravilna Prehrana i Zdravlje*, 1st ed.; Veleu˜cilište u Rijeci: Rijeka, Croatia, 2016.
92. Brown, M.J.; Ameer, M.A.; Daley, S.F.; Beier, K. *Vitamin B6 Deficiency*; StatPearls Publishing: Treasure Island, FL, USA, 2024. Available online: https://www.ncbi.nlm.nih.gov/books/NBK470579/ (accessed on 1 February 2024).
93. Bistas, K.G.; Tadi, P. *Biotin*; StatPearls Publishing: Treasure Island, FL, USA, 2024. Available online: https://www.ncbi.nlm.nih.gov/books/NBK554493/ (accessed on 1 February 2024).
94. Wolf, B. Biotinidase Deficiency. In *GeneReviews®*; University ofWashington: Seattle,WA, USA, 1993. Available online: https://www.ncbi.nlm.nih.gov/books/NBK1322/ (accessed on 1 February 2024).
95. Hu, L.; Zhou, M.; Young, A.; Zhao,W.; Yan, Z. In Vivo Effectiveness and Safety of Probiotics on Prophylaxis and Treatment of Oral Candidiasis: A Systematic Review and Meta-Analysis. *BMC Oral Health* 2019, *19*, 140. [CrossRef] [PubMed]
96. Anonymous. *LiverTox: Clinical and Research Information on Drug—Induced Liver Injury. Folic Acid*; National Institute of Diabetes and Digestive and Kidney Diseases: Bethesda, MD, USA, 2012.
97. Rathee, M.; Jain, P. Gingivitis. *Aust. J. Pharm*. **2023**, *96*, 64–67.
98. Green, R.; Miller, J.W. Vitamin B12 Deficiency. *Vitam. Horm*. **2022**, *119*, 405–439. [PubMed]
99. Gramer, G.; Hoffmann, G.F. Vitamin B12 Deficiency in Newborns and Their Mothers-Novel Approaches to Early Detection, Treatment, and Prevention of a Global Health Issue. *Curr. Med. Sci*. **2020**, *40*, 801–809. [CrossRef] [PubMed]
100. Hawthorne, S.; Levy, H.L. Can Newborn Screening for Vitamin B12 Deficiency be Incorporated into All Newborn Screening Programs? *J. Pediatr.* **2020**, *216*, 9–11.e1. [CrossRef] [PubMed]
101. Green, R. Vitamin B12 Deficiency from the Perspective of a Practicing Hematologist. *Blood* **2017**, *129*, 2603–2611. [CrossRef] [PubMed]
102. Khan, N.F.; Saeed, M.; Chaudhary, S. Haematological Parameters and Recurrent Aphthous Stomatitis. *J. Coll. Physicians Surg. Pak*. **2013**, *23*, 124–127.
103. Liu, H.L.; Chiu, S.C. The Effectiveness of Vitamin B12 for Relieving Pain in Aphthous Ulcers: A Randomized, Double-blind, Placebo-controlled Trial. *Pain Manag. Nurs*. **2015**, *16*, 182–187. [CrossRef]
104. Lugovi´c-Mihi´c, L.; Špiljak, B.; Blagec, T.; Delaš Aždaji´c, M.; Franceschi, N.; Gaši´c, A.; Para´c, E. Factors Participating in the Occurrence of Inflammation of the Lips (Cheilitis) and Perioral Skin. *Cosmetics* **2023**, *10*, 9. [CrossRef]
105. Blagec, T.; Glavina, A.; Špiljak, B.; Bešli´c, I.; Bulat, V.; Lugovi´c-Mihi´c, L. Cheilitis: A Cross-Sectional Study-Multiple Factors Involved in the Aetiology and Clinical Features. *Oral Dis*. **2023**, *29*, 3360–3371. [CrossRef]
106. Abdullah, M.; Jamil, R.T.; Attia, F.N. Vitamin C (Ascorbic Acid). In *Encyclopedia of Toxicology*, 3rd ed.; Academic Press: Cambridge, MA, USA, 2023; pp. 962–963.
107. DePhillipo, N.N.; Aman, Z.S.; Kennedy, M.I.; Begley, J.P.; Moatshe, G.; LaPrade, R.F. Efficacy of Vitamin C Supplementation on Collagen Synthesis and Oxidative Stress After Musculoskeletal Injuries: A Systematic Review. *Orthop. J. Sports Med*. **2018**, *6*, 2325967118804544. [CrossRef] [PubMed]
108. Padayatty, S.J.; Levine, M. Vitamin C: The Known and the Unknown and Goldilocks. *Oral Dis*. **2016**, *22*, 463–493. [CrossRef] [PubMed]
109. Pullar, J.M.; Carr, A.C.; Vissers, M.C.M. The Roles of Vitamin C in Skin Health. *Nutrients* **2017**, *9*, 866. [CrossRef] [PubMed]
110. Corpe, C.P.; Eck, P.; Wang, J.; Al-Hasani, H.; Levine, M. Intestinal Dehydroascorbic Acid (DHA) Transport Mediated by the Facilitative Sugar Transporters, GLUT2 and GLUT8. *J. Biol. Chem*. **2013**, *288*, 9092–9101. [CrossRef] [PubMed]
111. Alagl, A.S.; Bhat, S.G. Ascorbic Acid: New Role of an Age-Old Micronutrient in the Management of Periodontal Disease in Older Adults. *Geriatr. Gerontol. Int*. **2015**, *15*, 241–254. [CrossRef] [PubMed]
112. Gicchino, M.F.; Romano, A.; Cioffi, S.; Fiori, F.; Miraglia del Giudice, E.; Lucchese, A.; Olivieri, A.N.; Serpico, R. Oral Manifestations in Scurvy Pediatric Patients: A Systematic Review and a Case Report. *Appl. Sci.* **2021**, *11*, 8323. [CrossRef]
113. Fujii, T.; Luethi, N.; Young, P.J.; Frei, D.R.; Eastwood, G.M.; French, C.J.; Deane, A.M.; Shehabi, Y.; Hajjar, L.A.; Oliveira, G.; et al. Effect of Vitamin C, Hydrocortisone, and Thiamine vs Hydrocortisone Alone on Time Alive and Free of Vasopressor Support among Patients with Septic Shock: The VITAMINS Randomized Clinical Trial. *J. Am. Med. Assoc*. **2020**, *323*, 423–431. [CrossRef] [PubMed]
114. He, H.; Qiao, Y.; Zhang, Z.;Wu, Z.; Liu, D.; Liao, Z.; Yin, D.; He, M. Dual Action of Vitamin C in Iron Supplement Therapeutics for Iron Deficiency Anemia: Prevention of Liver Damage Induced by Iron Overload. *Food Funct*. **2018**, *9*, 5390–5401. [CrossRef]
115. Smirnoff, N. Ascorbic Acid Metabolism and Functions: A Comparison of Plants and Mammals. *Free Radic. Biol. Med*. **2018**, *122*, 116–129. [CrossRef]
116. Perkins, A.; Sontheimer, C.; Otjen, J.P.; Shenoi, S. Scurvy Masquerading as Juvenile Idiopathic Arthritis or Vasculitis with Elevated Inflammatory Markers: A Case Series. *J. Pediatr*. **2020**, *218*, 234–237.e2. [CrossRef] [PubMed]
117. Hahn, T.; Adams, W.; Williams, K. Is Vitamin C Enough? A Case Report of Scurvy in a Five-Year-Old Girl and Review of the Literature. *BMC Pediatr*. **2019**, *19*, 74.
118. Sharp,W.G.; Berry, R.C.; Burrell, L.; Scahill, L.; McElhanon, B.O. Scurvy as a Sequela of Avoidant-Restrictive Food Intake Disorder in Autism: A Systematic Review. *J. Dev. Behav. Pediatr*. **2020**, *41*, 397–405. [CrossRef] [PubMed]
119. Chapple, I.L.C.; Mealey, B.L.; Van Dyke, T.E.; Bartold, P.M.; Dommisch, H.; Eickholz, P.; Geisinger, M.L.; Genco, R.J.; Glogauer, M.; Goldstein, M.; et al. Periodontal Health and Gingival Diseases and Conditions on an Intact and a Reduced Periodontium: Consensus Report ofWorkgroup 1 of the 2017WorldWorkshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. *J. Periodontol*. **2018**, *89*, S74–S84. [CrossRef] [PubMed]
120. Fortenberry, M.; Rucker, H.; Gaines, K. Pediatric Scurvy: How an Old Disease Is Becoming a New Problem. *J. Pediatr. Pharmacol. Ther*. **2020**, *25*, 735–741. [CrossRef] [PubMed]
121. Agarwal, A.; Shaharyar, A.; Kumar, A.; Bhat, M.S.; Mishra, M. Scurvy in Pediatric Age Group—A Disease Often Forgotten? *J. Clin. Orthop. Trauma* **2015**, *6*, 101–107. [CrossRef] [PubMed]
122. Byard, R.W.; Maxwell-Stewart, H. Scurvy-Characteristic Features and Forensic Issues. Am. *J. Forensic Med. Pathol*. **2019**, *40*, 43–46. [CrossRef] [PubMed]
123. Robitaille, L.; Hoffer, L.J. A Simple Method for Plasma Total Vitamin C Analysis Suitable for Routine Clinical Laboratory Use. *Nutr. J*. **2016**, *15*, 40. [CrossRef]
124. Vaezipour, N.; Leibundgut, K. Nonalimental Scurvy with Relapse Symptoms after Stopping Oral Vitamin C Supplementation. *Pediatrics* **2018**, *142*, e20172139. [CrossRef]
125. Plevin, D.; Galletly, C. The Neuropsychiatric Effects of Vitamin C Deficiency: A Systematic Review. *BMC Psychiatry* **2020**, *20*, 315. [CrossRef]

126. Cazzolla, A.P.; Cosola, M.D.; Ballini, A.; Santacroce, L.; Lovero, R.; Testa, N.F.; Lacarbonara, V.; De Franco, A.; Troiano, G.; Cantore, S.; et al. The Association between Nutritional Alterations and Oral Lesions in a Pediatric Population: An Epidemiological Study. *Biomed. Res. Int.* **2021**, *2021*, 9992451. [CrossRef] [PubMed]
127. Niazi, F.C.; Pepper, T. *Dental Fluorosis*; StatPearls Publishing: Treasure Island, FL, USA, 2024. Available online: https://www.ncbi.nlm.nih.gov/books/NBK585039/ (accessed on 23 March 2024).
128. Patel, P.P.; Patel, P.A.; Zulf, M.M.; Yagnik, B.; Kajale, N.; Mandlik, R.; Khadilkar, V.; Chiplonkar, S.A.; Phanse, S.; Patwardhan, V.; et al. Association of dental and skeletal fluorosis with calcium intake and serum vitamin D concentration in adolescents from a region endemic for fluorosis. *Indian J. Endocrinol. Metab.* **2017**, *21*, 190–195.
129. Andrés, C.M.C.; Pérez de la Lastra, J.M.; Juan, C.A.; Plou, F.J.; Pérez-Lebeña, E. Antioxidant Metabolism Pathways in Vitamins, Polyphenols, and Selenium: Parallels and Divergences. *Int. J. Mol. Sci.* **2024**, *25*, 2600. [CrossRef]
130. Fasano, A.; Catassi, C. Clinical practice. Celiac disease. *N. Engl. J. Med.* **2012**, *367*, 2419–2426. [CrossRef] [PubMed]
131. Bernstein, C.N.; Blanchard, J.F.; Rawsthorne, P.; Yu, N. The prevalence of extraintestinal diseases in inflammatory bowel disease: A population-based study. *Am. J. Gastroenterol.* **2001**, *96*, 1116–1122. [CrossRef] [PubMed]
132. Williams, K.M.; Darukhanavala, A.; Hicks, R.; Kelly, A. An update on methods for assessing bone quality and health in Cystic Fibrosis. *J. Clin. Transl. Endocrinol.* **2021**, *27*, 100281. [CrossRef]
133. Freitas, L.G.; Cortés, M.A.P.; Stein, C.; Cousin, E.; Faustino-Silva, D.D.; Hilgert, J.B. Dietary Intake Quality and Associated Factors in One-Year-Old Children Seen by Primary Healthcare Services. *Ciênc. Saúde Coletiva* **2020**, *25*, 2561–2570. [CrossRef]
134. Posa, F.; Colaianni, G.; Di Cosola, M.; Dicarlo, M.; Gaccione, F.; Colucci, S.; Grano, M.; Mori, G. The Myokine Irisin Promotes Osteogenic Differentiation of Dental Bud-Derived MSCs. *Biology* **2021**, *10*, 295. [CrossRef]
135. Charitos, I.A.; Ballini, A.; Cantore, S.; Boccellino, M.; Di Domenico, M.; Borsani, E.; Nocini, R.; Di Cosola, M.; Santacroce, L.; Bottalico, L. Stem Cells: A Historical Review about Biological, Religious, and Ethical Issues. *Stem Cells Int.* 2021, *2021*, 9978837. [CrossRef]
136. Kresevic, D.M.; Denton, J.E.; Burant, C.J.; Pallaki, M. Racial Difference in Response to Vitamin D Supplementation. *J. Natl. Med. Assoc.* **2015**, *107*, 18–24. [CrossRef]
137. Girish Babu, K.L.; Subramaniam, P.; Madhusudan, K.S. Association of Nutritional Status and Dental Health among 3–6 -year-old Children of a South Indian Population. *Saudi J. Oral. Sci.* **2019**, *6*, 31–36.

CONTINUING PROFESSIONAL DEVELOPMENT QUESTIONNAIRE – ARTICLE 3

THE IMPACT OF VITAMIN DEFICIENCIES ON ORAL MANIFESTATIONS IN CHILDREN

11. An overdose of vitamins could lead to which of the following conditions?
    a. Hypervitaminosis, a condition associated with various health issues.
    b. Avitaminosis, a condition associated with various health issues.
    c. Acute acedonosis, a condition associated with various health issues.
    d. Sepsis, a condition associated with various health issues.

12. Insufficient vitamin intake can impair several bodily functions, which could result in?
    a. Conditions such as night sweats, bleeding problems, and neurological diseases.
    b. The host immune response.
    c. Conditions such as night blindness, clotting problems, and bone diseases like rickets and osteomalacia, as well as deterioration of nerve and muscle health.
    d. Conditions such as psoriasis, clotting problems, and liver diseases, as well as deterioration of nerve and muscle health.

13. Why are vitamins A, D, E, and K considered crucial for the preservation of life?
    a. These vitamins participate in intricate processes of assimilation, metabolic transformation, and systemic distribution, safeguarding cellular integrity and bolstering organ function.
    b. These vitamins participate in intricate processes of dysregulation, metabolic enhancements, and systemic distribution, safeguarding digestive integrity and bolstering organ function.
    c. These vitamins participate in intricate processes of excretion, metabolic transformation, and mineral distribution, safeguarding cellular integrity and bolstering cellular function.
    d. These vitamins participate in intricate processes of assimilation, systemic transformation, and fluid distribution, safeguarding cellular integrity and bolstering metabolic function.

14. Why is vitamin D alone considered to be vitally important in preserving our health?
    a. It is recognised for its disease-suppressing, anti-inflammatory, and antiviral capabilities, along with its contribution to mineral absorption and bone remodelling.
    b. It is recognised for its tumour-suppressing, anti-inflammatory, and antibacterial capabilities, along with its contribution to calcium absorption and bone remodelling.
    c. It is recognised for its cancer-suppressing, anti-inflammatory, and antifungal capabilities, along with its contribution to calcium absorption and bone remodelling.
    d. It is recognised for its tumour-suppressing, anti-inflammatory, and antimicrobial capabilities, along with its contribution to calcium absorption and bone remodelling.

15. What are oral manifestations of Vitamin D deficiency in children?
    a. A form of amelogenesis imperfecta that takes place during tooth development, alterations in dentin leading to dentogenesis imperfecta, and ectodermal dysplasia.
    b. They have a lower load and diversity of pathogenic microorganisms leading to oral thrush and amelogenesis imperfecta.
    c. They have a higher load and diversity of pathogenic microorganisms as well as poor adaptive immune response leading to amelogenesis imperfecta.
    d. A form of amelogenesis imperfecta during tooth development, alterations in enamel structure leading to calcinogenesis imperfecta, and ectodermal dysplasia.

16. Given the intricate relationship between systemic health, vitamin absorption, and oral health, a holistic approach to patient assessment is essential. What should this include?
    a. A thorough examination of social habits, dietary intake, and a genetic test to identify any underlying conditions that may affect vitamin status.
    b. A thorough examination of dietary habits, neurological health, and a comprehensive dental history to identify any underlying conditions that may affect vitamin status.
    c. A thorough examination of dietary habits, gastrointestinal health, and a comprehensive medical history to identify any underlying conditions that may affect vitamin status.
    d. A thorough examination of dietary habits, swallowing abilities, parents overall health, and a comprehensive medical history to identify any underlying conditions that may affect vitamin status.

SWISS PREMIUM
ORAL CARE

CURAPROX

GROW WITH LOVE

Scan to order

EARLY CHILDHOOD ORTHODONTIC THERAPY

USING PACIFIERS

Authors: Cornelia Filippi[1], Andreas Filippi[2], Carlalberta Verna[3]

[1] Schulzahnklinik in Basel, Public Dental Clinics, Basel-Stadt
[2] Klinik für Zahnärztliche Chirurgie, -Radiologie, Mund- und Kieferheilkunde, Universitätskliniken für Zahn- medizin at Basel University
[3] Klinik für Kieferorthopädie und Kinderzahnheilkunde, Universitätskliniken für Zahn- medizin at Basel University

Correspondence: Dr. Cornelia Filippi Schulzahnklinik Basel, Public Dental Clinics Basel-Stadt, St. Alban-Vorstadt 12, 4010 Basel
E-Mail: cornelia-filippi@me.com

Source: SWISS DENTAL JOURNAL SSO VOL 125 9 P 2015

Introduction

Tongue function is negatively impacted by the use of soothers. A new product features different morphology than other soothers, affecting the functioning of the tongue. It is intended to prevent or even correct crossbites. The aim of the case series is to evaluate the impact of the soother on incorrect tongue function and open bites. The effect on transversal development will also be assessed.

Results

The children accepted their new soothers and used them as habitually as before. The patients who had previously experienced tongue thrusting found a new tongue position. All open bites were closed. Transversal problems were improved in all cases.

Discussion

These results were achieved by the use of the Curaprox™ soother, not the discontinuation of dummy use. We have been able to rule out that jaw corrections were caused by other influencers. Due to the new tongue position or the new distribution of pressure affecting the gums, it was possible to change transversal relationships. The partial success of transversal corrections could be accredited to the length of the soother, which does not reach further than the first milk molars.

Conclusions

1. The morphology of the Curaprox™ soother allows for an open bite to be corrected.
2. There is a positive effect on transversal relationships.

As ever, in order to form evidence-based statements from these observations, we would need randomised, clinically controlled studies made up of control groups with a range of ages. At the same time, biomechanical studies are needed on the three-dimensional effect of the pressure exercised on the gums by the soother.

Keywords: Open bite, crossbite, swallowing, soother, corrections

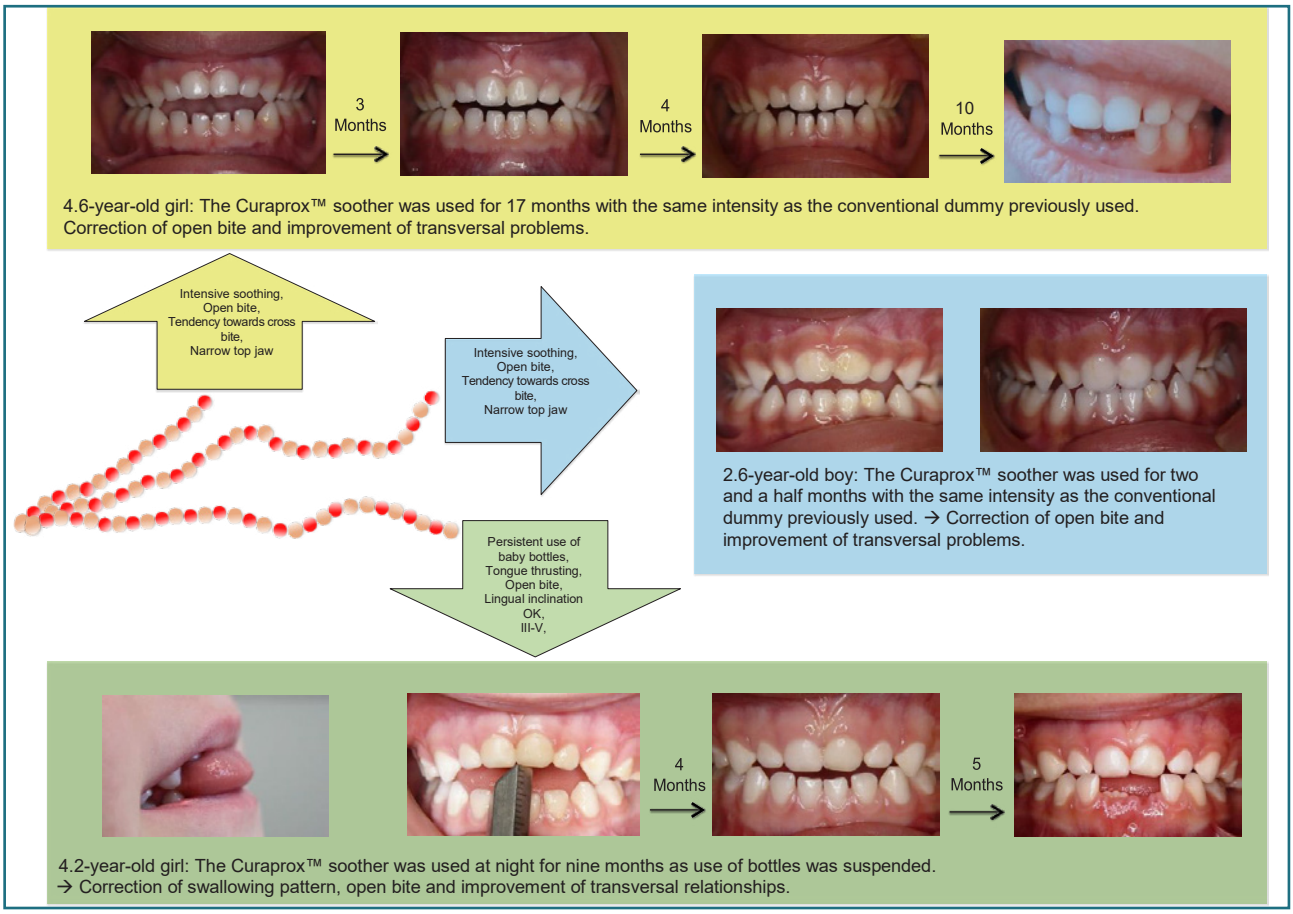
INTRODUCTION

Even in the womb, suckling is observed. The first evidence is seen between the 15th and 18th week of pregnancy (Miller at al., 2003). From the 34th week of pregnancy, the ability to suckle is complete (Hack et al., 1985). In newborns, the suckling reflex can be encouraged by stimulating the lips or tongue, in which case it is used to stimulate the baby to continue suckling during feeding (Fucile et al., 2002). Mechanical-sensory stimulation, e.g. through the use of a soother, triggers this reflex via the N. trigeminus (Barlow & Estep, 2006). Through repetition, movement patterns are established. Suckling is not just about the uptake of nutrition–it serves to calm the infant, put it to sleep or tackle tiredness and boredom (Largo, 2001). Bottles, thumbs, fingers, nappies, bedding and other objects are used. In Switzerland, 80 per cent of one to two-year-old children use a soother, while almost 20 per cent suckle on other objects. More than half of all children still suckle at age three and four, 35 per cent at five and 5 per cent at seven (Largo, 2001).

The fact that using soothers can lead to dental and orthodontic misalignment is well known and established (Hensel & Splieth, 1998, Stahl et al., 2007, Correa-Faria et al., 2014, Sousa et al., 2014). The consequences can include lengthy and expensive orthodontic treatments. These improper developments of the jaw influence language development due to changed myofunctional processes. At the Sprachheilpädagogischen Förderzentrum, a speech therapy centre in Rostock, only seven per cent of patients with abnormal speech development presented with regular orthodontic development (Voss, 2007).

During breastfeeding, babies must stabilise the mother's nipple using an anterior movement of the lower jar to take up milk efficiently. This movement pattern strengthens the child's mouth, tongue and jaw muscles. As a result, language development is better than in children fed by bottle (Dee et al., 2007). In contrast, similar frequent drinking from a baby bottle leads to persistent infantile swallowing pattern (tongue thrusting) as the tongue has to steer the amount of liquid released. The texture of the synthetic teat and its round shape push the tongue downwards.

Negative pressure (vacuum) is required to pull the liquid into the mouth. At the same time, the cheeks are pulled inwards. But the teeth are not supported if the tongue is present at the bottom of the mouth rather than at the gums. The dental arch is affected by this inward



pressure (centripedal pressure). Transversal growth is prevented or impacted in the opposite direction. This limitation of growth could be the cause for the formation of a side crossbite. In addition, the round shape of the teat encourages the development of an open bite. Tongue thrusting keeps the open bite open, as the anterior teeth are displaced; this encourages lisping.

Also observed are side crossbites, backwards displacement of the bottom jaw and displacement of the tongue with swallowing and language disruptions (Correa-Faria et al., 2014). As all children generally suckle in their first years of life, the question is: which object is best to suck on? The object should satisfy the infant's need to suckle without limiting, damaging, stunting or otherwise disrupting jaw growth or dental health (Largo, 2001). Ideally, suckling should end once all milk teeth have grown in–around the age of two and a half. The side effects of soothers depend on the intensity of use as well as the morphology of the soother. Some available soothers with modified morphology may limit, for example, the development of an open bite (Dentistar, Novatex, Pattensen, Germany). The new Curaprox soother (Curaden, Dietikon, Switzerland) promises to encourage a different distribution of pressure on the top jaw than provided by any models that were previously available. The flat shape of the soother imitates the naturally flat shape of the oral cavity when suckling, which could prevent the development

Fig. 1 Comparison of soothers: the largest size from left to right, example of standard morphology MAM (BAMED AG, Wollerau, Switzerland), Dentistar modified morphology (Novatex, Pattensen, Germany), new Curaprox morphology (Curaden, Dietikon, Switzerland)

of an open bite (fig. 1). The soft central semicircle is squeezed by the baby's tongue during suckling, creating transversal pressure that could prevent the development of narrow upper jaws and crossbites (fig. 2 and 3). The lip plate sits away from the lower jaw. This is intended to give the lip muscles the required space to ensure that the lower jaw is not pushed into a retrograde position by the pressure of the lip plate. In the following selected cases, it is presumed that the effectiveness of pressure distribution is not just preventative, but also therapeutic. Therapeutic options are shown using three case studies.

MATERIAL AND METHOD

A survey was carried out at the start of this study to establish whether a baby bottle, soother (dummy) or other object was used for suckling. The size two test soother has a triangular shape and transitions at its tip into a shaft that is 20mm wide at its narrowest point. The mouthpiece is 25mm wide at its widest point. At the longest point from the anchorage on the plate to the most anterior point, it measures 23mm with the smallest distance in the middle of the soother towards the anterior at 21mm. There is also a semicircular elevation in a lingual and palatinal direction with a 10mm diameter. The wings are 4mm thick and both semicircles total 10mm in height complete with the air cushion. The side wings have recesses at the edges, which can be positioned along the rows of teeth on narrow upper jaws. In order for the new soother to be effective, no other objects would have been used. The use of baby bottles was replaced by drinking from cups or bottles with an opening of at least 15mm (e.g. the opening of a mineral water bottle). Only the new test dummy provided was used for suckling. The duration of use differed on a case-by-case basis. The soother was used at least every night or to get to sleep.

CASE REPORTS

Case 1

An active-cavity patient at the Schulzahn Clinic in Basel at the age of four years a two months with an open bite. She still used a baby bottle (at night, but also for comfort), had accumulated sufficient plaque and had recently stopped using a soother (dummy).

Morphologically and functionally she showed a prominent open bite of 7mm with mouth breathing (the mild molars had occlusal contact, tooth 75 was missing) and persistant infantile swallowing pattern (fig. 4).

Therapeutically, brushing was intensified and the baby bottle at night was swapped for a Curaprox soother (Curaden, Dietikon, Switzerland, size 2) (fig. 5). There was no further functional therapy. At recall, a reduction of the open bite to 5mm was seen after six weeks (fig. 6), then to 2mm after five months (fig. 7) and finally to a regular overbite after nine months, along with considerably improved oral hygiene (fig. 8). The swallowing pattern also changed from visceral to adult swallowing action (fig. 9). The new soother was accepted by the parents and child during the treatment period. The transition from baby bottle to soother was smooth. Giving up the dummy after a treatment period of nine months was not a problem.

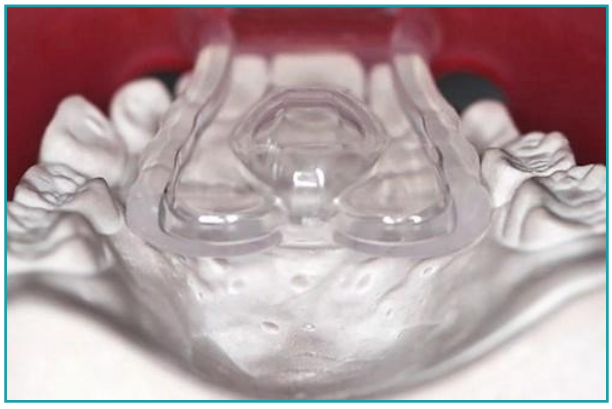


Fig. 2 Soother on model: passive position of the new soother in the mouth

Fig. 3 Soother on model: pressure of the tongue on the semicircle in the middle of the soother exerts transverse force on the upper jaw.

Fig. 4 Initial situation in case 1 before treatment began (frontal view)

Fig. 5 Case 1: size 2 Curaprox soother in situ before treatment began
The soother applies transversal pressure on the upper jaw.

Fig. 6 Case 1: reduction of the open bite after six weeks of treatment to 5mm (no photo was taken before treatment began). Teeth 53 and 63 are buccally tilted; the tilting and transversal dimension changed over time (see fig. 7 and fig. 8).

Fig. 7 The open bite has been reduced to 2mm after five months. A transversal increase and straightening of teeth 53 and 63 can be seen.

Fig. 8 Case 1: a regular overbite (frontal view) can be seen after nine months with transversal growth...

Fig. 9 ... and the tip of the tongue visibly moves towards the papilla incisiva when swallowing. The swallowing pattern also changed from visceral to adult swallowing action. In this moment of swallowing, the occlusion is not in maximum contact with the side of the tooth.

Case 2

A girl was presented at the Schulklinik in Basel for the second time at the age of four years and six months. The patient was seen for the first time around one year. The recommendation of weaning the child off the dummy was not implemented. The girl always used a dummy to get to sleep. One year later, her father brought her to the clinic again. He had noticed her dental positioning and wanted some advice. Morphologically and functionally, the patient presented with an open bite with edge-to-edge bite on teeth 53 and 83, a crossbite on teeth 63 and 73, but no persistent infantile swallowing pattern (tongue thrusting) (fig. 10). A baby bottle was no longer used. Therapeutically, the patient's dummy was swapped for the Curaprox soother (size 1), which was intended for use to fall asleep. After one month, the size 1 Curaprox soother was replaced with a size 2 Curaprox soother. After just three months of treatment, there was a significant reduction of the open bite and correction of the edge-to-edge/crossbite of the milk canines (fig. 11). After a total of two years of therapy, the patient displayed a normal overbite of the anterior milk teeth; the edge-to-edge/crossbite around the milk canines were corrected (fig. 12). Again, the new soother was accepted during the whole treatment period. Weaning the child off the soother after the treatment period was no problem according to the parents, who had moved the family to Turkey by this time.

Case 3

A mother presented her son at the Schulzahnklinik in Basel for the first time at age two years and five months. She had noticed a change in his dental positioning. Morphologically and functionally, he displayed a frontal open bite as well as an edge-to-edge bite on the first milk molars (fig. 13). The second milk molars were breaking through. The patient no longer drank from a baby bottle, but the dummy was used more or less all day and all night. Therapeutically, the patient's dummy was swapped for the Curaprox soother (size 2). After three months of treatment, the bite had closed and the second milk molars had broken through (fig. 14). The final image shows that the patient had slight protrusion. The occlusion is therefore not conclusively evaluated. It seems that the first milk molars are in a regular overbite. There was no problem in giving up the soother after the end of treatment.

Fig. 10 Initial situation in case 2 before treatment began, age four years and six months (frontal view): open bite with edge-to-edge bite in teeth 53 and 83 and crossbite in teeth 63 and 73.

Fig. 11 Case 2: reduction of the open bite after three months of treatment and correction of the edge-to-edge/crossbite in the milk canines.

Fig. 12 Case 2: normal overbite in the anterior milk teeth and second dentition has begun to come through after a total of two years of use (image from the parents who moved to Turkey).

Fig. 13 Initial situation in case 3 before treatment began, age two years and five months (frontal view): frontal open bite and edge-to-edge bite in the 1st milk molars.

Fig. 14 Case 3: after three months of therapy: closed bite; the second milk molars have broken through.

DISCUSSION

The regulating effect of the Curaprox soother was observed in the three cases presented. With all children, it was clear that jaw misalignment was caused by suckling habits. In contrast to all the comfort soothers described in literature up to now, this one possibly features different pressure distribution on the upper jaw. Pressure is probably distributed as follows: when viewing the suckling part of the soother on a model from the inside, one can see that pressure from below pushes the side wings of the soother along the roof of the mouth. The pressure is presumably not distributed onto the palatine suture.

It is much more likely that pressure is distributed across a wide surface. Up to this point, the biomechanical behaviour of soothers had only been studied on flat and round soothers. Soothers with flat morphology tend to distribute pressure evenly over the gums and put less pressure on the frontal alveolar ridge (Levrini et al., 2007). Until today, there has been no study of a flat soother where the lateral dimension is activated by the tongue, as with the Curaprox soother. This impulse, which can directly affect the horizontal growth of the top jaw, may have corrected the open bite in all three described cases as well as the edge-to-edge bite in cases 2 and 3 and the beginning of a crossbite in case 2. Even when only the tip of the tongue presses on the thicker area, pressure is distributed across the whole upper jaw. The tongue is pressed downwards by the spherical part in the middle of the front third of the tongue. This turns the edge of the tongue upwards. The tip of the tongue also follows this palatal movement. This moves the tongue from the visceral swallowing pattern into the adult swallowing pattern (see case 1). The lips must hold the shaft in place. This trains the lips and the tongue. The movement patterns learned remain after the training devices are removed. This means that pressure from the lips and tongue correct dental positioning without further use of the soother.

Until now, only one study had covered the orthodontic effects of soothers. The Dentistar comfort soother (Novatex, Pattensen, Germany) was studied when given to a group of babies after birth. After 16 months of treatment, 5 per cent of cases presented with an open bite, compared to 38 per cent with a standard dummy (NUK, Mapa, Zeven, Germany) and not a single case (0 per cent) with breastfeeding and no soother (Zuralski, 2013).

Data about the influence on abnormal transversal development of the upper jaw was not collected. It is also possible for open bites to correct themselves. As a study of 3,041 children showed, this is less frequent than one might expect. While an open bite was diagnosed in the milk teeth of 11.4 per cent of children, 9.5 per cent of the children still had an open bite after their adult teeth had started to come in. Therefore, auto-correction of an open bite is comparatively rare (Salbach et al., 2012). To ensure this happens, baby bottles, training cups or attachments such as those on sports bottles should no longer be used. Tongue thrusting continues as long as these drinks containers are used, preventing the swallowing pattern from transitioning. The lips should be able to close while swallowing; this is only possible with drinks containers that have a suitably large opening.

Acceptance in parents and children was achieved in all the cases described. The desired success was achieved after a matter of months or two years at the most. After this, there was no problem giving up the

soother. Whether this soother can be used to prevent open bites or side crossbites cannot currently be confirmed. What is also desirable is a correction of tongue thrusting in children with Down syndrome and improved transversal development of the upper jaw in children with lip-jaw-palate clefts. With better control of tongue and lip function, the introduction of such training could be offered for mouth breathers who suffer from cavities and gingivitis more commonly (Nascimento Filho et al., 2004, Voss 2007). If the correction of swallowing patterns were observed in a larger number of cases, this would result in a completely new therapy option that could be implemented en passant.

CONCLUSION

The initial results of using the new soother are encouraging. In order to develop an evidence-based recommendation, we need further tests covering the acceptance among children as well as the therapeutic and biomechanical effects.

ABSTRACT

Filippi C, Filippi A, VernaC: Orthodontic therapy in the early child- hood using pacifier? A case series. (in German). SWISS DENTAL JOURNAL SSO 125: 959–964 (2015)

Dental malocclusions (open bite and lateral cross-bite) or functional disturbances (persistent infantile swallowing) in young children do not occur rarely. They are often induced or reinforced by oral habits, such as thumb sucking or bottle feed- ing.

The aim of this case series is to show the effect of a new type of pacifier on the development of open bite, cross-bite or tongue dysfunction. Three cases selected from the case series are reported to describe the effect of early treatment through the pacifier on the above-mentioned malocclusions in the 2nd and 5th years of age.

The longitudinal observation after 3, 9 and 24 months of use has shown that the open bite and the posterior cross-bite can be reduced. A shift from an infantile swallowing pattern to a mature one has also been observed.

The results are promising: the method is simple and possibly cost-reducing. However, the limited number of cases presented does not support the reproducibility of the results. For this rea- son the reported observations have to be verified by a longitudi- nal study in a larger population.

LITERATURE

Barlow S M, Estep M: Central pattern generation and the motor infrastructure for suck, respira- tion and speech. J Com Dis 39: 366–380 (2006)

Correa-Faria P, Ramos-Jorge M L, Martins-Ju- nior P A, Vieira-Andrade R G, Marques L S: Mal- occlusion in preschool children: prevalence and determinant factors. Eur Arch Paediatr Dent 15: 89–96 (2014)

Dee D L, Li R, Lee L C, Grummer-Strawn L M: Associ- ations between breastfeeding practices and young children's language and motor skill devel- opment. Pediatrics: 119 Suppl 1: S92–98 (2007)

Fucile S, Gisel E G, Lau C: Oral stimulation acceler- ates the transition from tube to oral feeding in preterm infants. J Pediatr 141: 230–236 (2002)

Hack M, Estabrook M M, Robertson S S: Develop- ment of sucking rhythm in preterm infants.

Early Hum Dev 11: 133–240 (1985)

Hensel E, Splieth C: Gesundheitszustand, Mor- phologie und Funktion der 1. Dentition. Dtsch Zahnärztl Z 53: 398–402 (1998)

Miller J L, Sonies B C, Macedonia C: Emergence of oropharyngeal, laryngeal and swallowing activ- ity in the developing fetal upper aerodigestive tract: an ultrasound evaluation. Early Hum

Dev 71: 61–87 (2003)

Nascimento Filho E, Mayer M P A, Pontes P, Pigna- tari A C C, Weckx L L M: Caries prevalence, levels of mutans Streptococci, and gingival and plaque indices in 3.0- to 5.0-year-old mouth breathing children. Caries Res 38: 572–575 (2004)

Largo R: Babyjahre. Piper Verlag München: 462–463 (2001)

Levrini L, Merlo P, Paracchini L: Different geomet- ric patterns of pacifiers compared on the basis of finite element analysis. Eur J Paediatr Dent Dec 8(4): 173–8 (2007)

Salbach A, Grabowski R, Stahl de Castillon F: Der Einfluss orofazialer Dysfunktionen auf die Gebissentwicklung im Milch- und frühen Wechselgebiss. Quintessenz 63: 1427–1437

(2012)

Sousa R V, Ribeiro G L, Firmino R T, Martins C C, Granville-Garcia A F, Paiva S M: Prevalence and associated factors for the development of ante- rior open bite and posterior crossbite in the pri- mary dentition. Braz Dent J 25: 336–34 (2014)

Stahl F, Grabowski R, Gaebel M, Kundt G: Zusam- menhang von Okklusionsbefunden und orofa- zialem myofunktionellen Status im Milch- und frühen Wechselgebiss Teil II: Häufigkeit von orofazialen Dysfunktionen. In: Fortschritte der Kieferorthopädie Vol. 68: 74–90 (2007)

Voss E: Zahngesundheit, Gebissentwicklung und myofunktioneller Status bei Kindern eines Spracheilpädagogischen Förderzentrums. Med Diss Universität Rostock (2007)

Zuralski H E: Klinische Studie zur Bewertung der kieferorthopädischen Bedeutung eines neuarti- gen Schnullers bei 27 Monate alten Kindern. Med Diss Universität Düsseldorf (2013)

SENSODYNE

HALEON

Take control with DUAL ACTION

Protects against sensitivity

Improves gum health in just 2 weeks[**2]**

"IT WORKS"

DR ARNOLD
DENTIST
ENGLAND

#1 DENTIST RECOMMENDED BRAND*

***#1 dentist recommended brand for sensitive teeth**

*Expert Performance Tracking 2023
**vs a regular toothpaste, with twice daily brushing

References: 1. Haleon Data on File, SUB-09774. 2. Haleon Data on File, SUB-12217.

MEET THE OHASA EXCO TEAM

KWA-ZULU NATAL BRANCH CHAIR

Mateenah Jajbhay

Mateenah Jajbhay Amod is a dedicated oral hygienist with a rich academic background and extensive experience in private practice. Graduating with a Bachelor of Oral Hygiene from the University of the Western Cape (UWC) in 2015, Mateenah's commitment to excellence in oral healthcare was evident from the outset. Her academic prowess earned her membership in the prestigious Golden Key Honor Society, a testament to her dedication and achievement in the field.

Eager to expand her knowledge beyond the realm of oral hygiene, she pursued further education, obtaining a Postgraduate Diploma in Social and Behavioural Studies from Unisa in 2016. This interdisciplinary approach equipped her with a deeper understanding of the social dynamics that influence oral health outcomes.

Recognising the importance of public health initiatives in promoting overall well-being, Mateenah undertook another postgraduate diploma, this time in Public Health, from her alma mater, the UWC in 2018. Armed with this additional expertise she is committed to addressing broader health concerns within her community.

With close to a decade of experience in private practice, Mateenah currently holds the position of Head Oral Hygienist and Practice Manager at a reputable practice in Durban, KwaZulu-Natal. Her leadership skills and clinical expertise have earned her the trust and respect of both her colleagues and patients.

Beyond her clinical responsibilities, Mateenah is deeply passionate about education. She actively engages with the University of KwaZulu-Natal, providing invaluable pre-clinical training, lectures, and clinical supervision to aspiring oral hygiene students. Her dedication to nurturing the next generation of oral health professionals is evident in her commitment to excellence and mentorship.

While currently immersed in the joys of motherhood, Mateenah remains eager to further her academic pursuits. She aspires to pursue a Masters in Medical Science in the near future thereby continuing her quest for knowledge and professional growth.

Outside of her professional endeavours, Mateenah finds solace in her love for travel, animals, reading, and long walks in the fresh air. She believes in maintaining a healthy work-life balance and cherishes moments spent with her family and loved ones.

Having recently completed two terms as the Chairperson of the OHASA KwaZulu-Natal Branch, she looks forward to embracing new opportunities and adventures in the coming year. Her passion for service and leadership will undoubtedly continue to make a positive impact on her community and the profession.

GAUTENG BRANCH CHAIR


Mmakaoka Sepuru

Mmakaoka Sepuru, known to many as Kaokie, is an independent oral hygienist who attained her qualification at the University of Pretoria in 2015. She worked in private practice, providing orthodontic treatment in her early years as a hygienist. She then progressed to prosthodontics and general dentistry where she is currently employed in Waterfall, Johannesburg.

She has a keen interest in community dentistry and she offers primary preventative treatment as a consultant oral hygienist to the young and old in impoverished communities around South Africa on a mobile dental unit.

She has served as the OHASA Gauteng Branch Chairperson since 2017 and also served on the OHASA EXCO.

She has hosted and facilitated numerous South African Dental Association events for their Oral Hygiene programme as well as their international congress and participated in a radio interview during oral health week. She is also the host of numerous OHASA webinars and seminars.

Kaokie, attended the iTOP educator course in 2022 in Dubai and is an iTOP instructor as of 2023.

EASTERN CAPE BRANCH CHAIR

Celiwe Hatana

Celiwe Hatana qualified at the University of the Western Cape as an Oral Hygienist with Expanded Functions. She developed a strong foundation in preventive care and patient education, and since then she has showcased her skills in orthodontic and general practices. She is known for her compassionate and empathetic approach and takes pride in creating a comfortable environment for patients of all ages. Celiwe is an active member of OHASA and has served as the Eastern Cape Branch Chairperson since 2021.

NEWS FROM THE

KWAZULU-NATAL BRANCH

Dear Members,

We are thrilled to announce the successful hosting of our in-person full day seminar for 2024. The event was marked by an outstanding turnout, with passionate members and esteemed speakers coming together to enrich our collective knowledge and foster professional growth. It was truly a day filled with insightful discussions, valuable connections, and memorable moments.

I would like to extend a heartfelt thank you to all our speakers for sharing their expertise and insights, which contributed to the success of our seminar. Your dedication to advancing the field of oral hygiene is truly commendable and we are grateful for your valuable contributions.

Additionally, I would like to express our sincere appreciation to our Traders who participated in the event, showcasing innovative products and services that enhance the practice of oral hygiene. Your support is instrumental in providing our members with access to cutting-edge tools and resources that empower them to deliver exceptional care to their patients.

Last but certainly not least, I want to extend a heartfelt thank you to our members. Your active participation and engagement are the lifeblood of our association and it was truly wonderful to reconnect with each and every one of you during the seminar. Your dedication to advancing oral hygiene practices and your commitment to lifelong learning inspire us all.

As we reflect on the success of our recent seminar, let us carry forward the spirit of camaraderie and collaboration that defines our association. Together, we will continue to strive for excellence in oral hygiene and have a positive impact on the oral health of our communities.

Thank you once again to everyone who contributed to the success of our event. I look forward to our continued journey of growth and achievement together.

Warm regards,

Mateenah Jajbhay Amod
Chairperson: KZN Branch Oral Hygienist Association of South Africa

NEWS FROM THE

EASTERN CAPE BRANCH

PREVENTION IS BETTER THAN CURE: EDUCATION, EDUCATION, EDUCATION!

My favourite part of being an Oral Hygienist is educating others. I like to make a difference in people's lives for the better! I'm very service oriented and passionate.

I love engaging with people and explaining and demonstrating oral hygiene instructions, techniques and giving them dietary advice, and tips etc. Most of my patients (and I see a lot of new patients and feel like I'm up to my eyeballs in perio!) have no clue what to do. Some have never even heard of floss! And have never had their teeth cleaned.

Most of them are so grateful and appreciative that I have educated them on how to maintain optimal oral health, and we work as a team as long as they are invested in their mouths.

I especially love working with children and giving talks at schools from playschools to high schools.

Smaller children are so adorable, honest and enthusiastic. They are like little sponges. We sing tooth brushing songs together and I show them how to brush and what foods to avoid and what Montie the tooth monster does in their mouth. They are super excited about a simple sticker and beam from ear to ear!

I also educate the teachers and assistants and tell them to spread the word to their families and friends.

I like to shock the teenagers so they remember what I have said as they are usually not as enthusiastic as the little ones. I show horrid photos of ANUG, hairy tongue, perio, oral stds etc. They gasp and won't forget those photos in a hurry. Hee hee!

I also tell them about the importance of a custom made gum guards for sport. I include all the learners in my talks and quiz them on my topic. I award small dental prizes for the correct answers which they enjoy thoroughly.

A wise man, Nelson Mandela, once said, "***Education is the most powerful weapon which you can use to change the world***".

The HPCSA figures that I was made aware of at my local OHASA seminar recently are alarming!!!

In a 2016 study approximately 84% of 6 year olds had dental caries. 85% of 15 year olds had periodontal disease.

Oral hygienists only make up about 15% of the oral health workforce in South Africa. And we have a population of 60 million!

Therefore the ratio per clinician is about 46 000 people...

So go out and use your powerful weapon to do good in your community. Even if it's an hour per month! It could make a big difference!!!!

Vicky Edelson
OHASA Eastern Cape Member

OHASA EASTERN CAPE SEMINAR, 18 MAY 2024

With great excitement about catching up with colleagues and learning new information, we met up at the Victoria and Alfred Collection in Port-Elizabeth on Saturday, 18 May 2024 for a full day seminar.

Our first lecture was a very informative talk on how to be effective in communicating and treating children that are on the Autistic Spectrum, which was presented by Mr Abdol, a local optometrist.

Our next lecture by Prof. Brijlal from the University of the Western Cape, reminded us of the desperate need for oral healthcare in the community, and encouraged us to get involved in the community as a form of social accountability.

After a lovely tea-break and the opportunity to spend time with our traders, Dr TA Muslim guided us through An Ethical Approach to Dealing with Dilemmas. We were reminded of amongst others, our ethical principles and the professional virtues of compassion, integrity, trustworthiness and conscientiousness. May we all live up to these standards.

Our last lecture before lunch was by Dirna Grobbelaar on Guided Biofilm Therapy, where we learned useful tips on scaling and sharpening. She continued after lunch, introducing us to the Oclean Sonic toothbrushes, and the new Balene double-sided toothbrush – an amazing innovation indeed.

During the lunch break we were able to spend more time with our very friendly traders: Colgate, Ivodent, Prime Dental, SciVision and Haleon and received lovely goodie bags with products to try at home.

After our last lecture we held lucky draws and there was great excitement among the winners. We closed the day by thanking the speakers, attendees, and traders, while saying goodbye until we meet again.

It was indeed a wonderful, informative day.

Celiwe Hatana
Chairperson: Eastern Cape

Prof. Brijlal with her former students

Dirna Grobbelaar and Celiwe Hatana

Celiwe with Prof Priscilla Brijlal and Dr T A Muslim

Prof. Brijlal with Dirna and Vicky Edelson

Prof. Brijlal with her two former students- Cubeka Kunene and Liya Mvimbi

PRIZE WINNERS

SciVision Winner: Amanda Bouwer

Colgate Winner: Gerrida Howard

Prime Dental Winners: Noxolo Mjoli, Celiwe Hatana and Tilla Nell

NEWS FROM THE

GAUTENG BRANCH

"A smile remains the most inexpensive gift I can bestow on anyone and yet its power can vanquish kingdoms", Og Mandino

You the oral hygienist, dental therapist, dental assistant, or dentist have given that quote meaning! You are the ones who help others to create their smiles!

GAUTENG BRANCH SEMINAR

It has been a great start to the year with the Gauteng Branch hosted a seminar at River Meadow Manor that included lectures from Dr Rutendo Kudenga on Vaping; Lucinda Risseeuw on *Dental and Mental*; Dr Christa Blignaut on *Peri-implantitis in Private Practice*; Marko Pretorius on the *Tax Implications in Independent vs. Supervised Practice* and Dr Coenie Bezuidenhout on *The first Two Years*.

Thank you to each and every speaker who enthusiastically gave of their time and presented world-class lectures to our delegates. The members were thoroughly engaged and educated. We were treated to amazing topics that were thankfully live streamed to the rest of the OHASA members as well!

The day gave the delegates insight on various topics that are fundamental to our everyday dental lives. Members were treated to a lovely array of food and lunch, with the dental sponsors providing all our members with dental products and information on the research behind all products.

SAAPD – GIVE A SMILE BACK

The South African Association of Pediatric Dentistry collaborated with OHASA for an outreach called: Give a smile back at Cure Day Hospital in Pretoria East. The morning comprised dental surgeries being provided to pediatric patients pro bono. The parents, caregivers and children were given oral hygiene instructions on how to optimise their cleaning routines. It was a lovely day spent with the team and special mention must made of Elmien Grove who was able to give of her time on the day.

We look forward to more outreach days with the team and thank Curaprox for their willingness to sponsor dental hampers for all the families. Giving back to the community is fulfilling and makes one realise our privilege. Thank you to the SAAPD team for their invitation and we hope to have this initiative spread all over South Africa in collaboration with further sponsors.

CLOSING

The first five months of this year have been a rollercoaster ride for a lot of our delegates. Starting new jobs, hygienists graduating last year and beginning their dental journeys in the workforce, The NHI Bill being signed, leaving hygienists and dental professionals questioning everything along with life's everyday challenges and having to stay afloat. We know that all of us have a lot that we may be dealing with but thank you to the dental professionals who wake up daily to provide services that normally go unnoticed by the public. Even with everything happening in the world, you all still manage to put a smile on a person's face, and put aside whatever may be on your mind, to put someone else's mind at ease regarding their own dental health.

You might not hear this very often, but, THANK YOU! Your work does not go unnoticed.

Should you know of someone who loves this profession and would be suitable to be the Gauteng Branch representative, please email the OHASA Gauteng Branch and nominate this future leader of the branch. My time as chair has been wonderful, but it is time I let go of the reigns at the close of the year and help another individual guide the branch to greater and more prosperous heights! If you believe that you have the traits required, please nominate yourself as well. We're looking forward to hearing from you all as this is YOUR branch that we are helping you lead!

Regards,
Mmakaoka "Kaokie" Sepuru
Chairperson: Gauteng Branch


OHASA
OHASA


OHASA


OHASA
OHASA


OHA
HASA

SURGICAL DAY AT CURE DAY HOSPITALS: A COLLABORATION BETWEEN SAAPD AND OHASA GAUTENG

This was a special day spent with the community, giving back and providing donations of time and goodie bags arranged by the South African Association of Dentistry (SAAPD) in collaboration with OHASA's Gauteng branch.

The day comprised OHASA branch members educating and aiding guardians and their children. Children from the greater Roodepoort area were treated pro bono for dental care under general anaesthetic.

The OHASA Gauteng representatives were on hand to supply oral health aids including toothbrushes and toothpaste as well as educational pamphlets for all who attend.

The SAAPD thanked OHASA after the outreach at Cure Day Hospital Wilgeheuwel stating, "The difference you have made in these children's lives and that of their families is something not many institutions can say they have accomplished, please give yourselves a pat on the back and know that you are angels from above. As all healthcare professionals know, treatment means very little without preventative aids and education."

Thank you to all our sponsors who are always willing to provide dental cleaning aids to all in attendance. It means more than we realise, and they are always truly appreciative. I hope the partnerships continues for years to come!