



VILNIUS UNIVERSITY
FACULTY OF MEDICINE

Dentistry Programme

Institute of Dentistry

Nikan Pezeshgi, Year 5, Group 1

INTEGRATED STUDY MASTER'S THESIS

**Epidemiology of Dental Caries and The Level of Oral Health Literacy
among Adolescents Worldwide**

Supervisor

Assoc. Prof. Dr. Rūta Bendinskaitė

Head of Institute of Dentistry Prof. Dr. Vilma Brukienė

Vilnius, 2024.

Student's email: nikan.pezeshgi@mf.stud.vu.lt

TABLE OF CONTENTS

1. INTRODUCTION
2. EPIDEMIOLOGY OF DENTAL CARIES
 - 2.1 PREVALENCE AND INCIDENCE OF DENTAL CARIES AMONG ADOLESCENTS
3. ORAL HEALTH LITERACY
 - 3.1 DEFINITION OF ORAL HEALTH LITERACY FOR ADOLESCENTS
 - 3.2 THE IMPACT OF SOCIAL MEDIA ON ORAL HEALTH LITERACY AMONG ADOLESCENTS
 - 3.3 MEASUREMENT AND GLOBAL DISPARITIES OF ORAL HEALTH AND GENERAL HEALTH LITERACY
4. THE CORRELATION BETWEEN DENTAL CARIES AND ORAL HEALTH LITERACY
 - 4.1 RISK FACTORS OF DENTAL CARIES
 - 4.2 THEORETICAL FRAMEWORKS RELATING DENTAL CARIES AND ORAL HEALTH LITERACY
5. CHALLENGES AND DEFICITS IN EXISTING LITERATURE
 - 5.1 IDENTIFIED RESEARCH DEFICITS IN DENTAL CARIES EPIDEMIOLOGY
 - 5.2 LIMITATIONS AND INCONSISTENCIES IN STUDIES ON ORAL HEALTH LITERACY
6. IMPLICATIONS FOR PUBLIC HEALTH AND DENTAL PRACTICE
 - 6.1 PUBLIC HEALTH INTERVENTIONS TO ADDRESS DENTAL CARIES IN ADOLESCENTS
 - 6.2 APPROACHES FOR PROMOTING ORAL HEALTH LITERACY AMONG ADOLESCENTS IN DAILY DENTISTRY
7. RECENT DEVELOPMENT IN DENTAL CARIES INCIDENCE
8. CONCLUSION

REFERENCES

ABBREVIATIONS

BDJ	British Dental Journal
BREALD-30	Brazilian Rapid Estimate of Adult Literacy in Dentistry
BSS	Basic Screening Survey
DIY	Do-It-Yourself
NHANES	National Health Interview Survey
OHL	Oral Health Literacy
OTC	Over-The-Counter
REALM	Rapid Estimate of Adult Literacy in Medicine

ABSTRACT:

Adolescent dental caries prevalence is still a major worldwide health concern, emphasizing the need for thorough knowledge and strategies to address this problem. The aim of this literature review is to illustrate the epidemiology and prevalence of dental caries among adolescents worldwide. The tasks are as follows: Firstly, measuring the disparities of caries incidences and oral health literacy among adolescents on a global scale. For this, the incidence of dental caries will be assessed on a worldwide scale and the corresponding risk factors will be described. The second part will include the definition and measurement of oral health literacy, while also describing the impact of social media on oral health literacy. Further on, the correlation between caries incidence and oral health literacy will be described. Finally, the last part will cover the challenges and deficits in existing literature, as well as implications and interventions for public health.

Keywords: oral health literacy, caries epidemiology, adolescents, prevalence

1. INTRODUCTION:

Since the beginning of mankind dental caries has always been a health risk for humans. It is for good cause that even the peoples of ancient Babylon already tried to prevent tooth decay by using a tooth-cleaning branch from the salvadora persica tree as early as 3500 BC [1].

Even today, amid the global health landscape, dental caries represents one of the greatest health burdens. To put an exact figure on this, the WHO estimates that oral diseases affect approximately 3.5 billion people worldwide, with three out of four people living in a middle-income country. Globally, an estimated two billion people suffer from caries in permanent teeth, as well as 514 million children from caries in primary teeth. Thus, untreated dental caries in permanent teeth is the most common medical condition according to the Global Burden of Disease 2019. Considering that the treatment of caries is usually expensive and not part of the universal health coverage (UHC), the situation conceals an even higher health risk worldwide, especially among adolescents and children [2].

Taking this evidence into account, one quickly assumes that the incidence of dental caries in western industrialized countries should be much lower due to better health care infrastructure.

However, taking a look at the worldwide caries incidence in different countries, one quickly realizes that this assumption seems to be a fallacy [3]. Analyzing the indicators of dental caries at a more detailed level, we quickly become aware of the broader factors that are decisive, such as a low socioeconomic status, low educational level, or inadequate exposure to fluoride. Particularly in the times of globalization it is of great importance to comprehend the epidemiology of dental caries. Thus, understanding the correlation between incidence and indicators, as it not only sheds light on global health trends but also provides essential information that provide insights for public health strategies, aiming to improve dental health care on a global scale.

It is the objective of this thesis to establish the theoretical frameworks relating dental caries incidence and oral health literacy worldwide. Furthermore, it is crucial to observe and describe the measurement of prevalence and literacy of oral health conditions. Ultimately, focusing on the challenges and deficits in the existing strategies and literature, pointing out implications for public health and daily dentistry.

Search Strategy: The literature research was conducted through PubMed and information published by the WHO. As one of the most widely accessible biomedical online libraries, PubMed was used since it is a free and highly serious resource for medical and dental information. The articles were screened based on the title and abstract, from which a total of 49 remained.

Inclusion criteria: Full text articles available; Languages: English, German, Persian or French; Only individuals without systemic diseases; Date of publication: not older than 2013 (with few exceptions that feature classifications, guidelines or basic principles)

Exclusion criteria: No full text article available; Literature written in other language; Articles/reviews with conflict of interest; Articles reviews based on other diseases

2. EPIDEMIOLOGY OF DENTAL CARIES

2.1. PREVALENCE AND INCIDENCE OF DENTAL CARIES AMONG ADOLESCENTS

Before establishing the broader context of the correlating factors between dental caries and oral health literacy, it is important to have a closer look at the prevalence and incidence of dental caries among adolescents worldwide. Since there is no uniform, regularly updated worldwide caries index, it is recommended checking the official health reports of each country or region or accessing the latest WHO publications directly. As the international statistics primarily focus on permanent teeth rather than specifically adolescent teeth, it is crucial to include individual regional and national studies as well, in order to get a comprehensive picture of the situation. The WHO last published statistics on the prevalence of untreated caries of permanent teeth in people over the age of 5 in 2019 (Fig. 1). Particularly notable in this regard were the South American nations of Chile and Colombia, which in an international comparison had the highest prevalence (49.53% & 44.15%). Comparing across Europe, Eastern European countries like Romania (41.31%), Serbia (41.11%), and Croatia (40.69%) had the highest incidences. Suriname (21.86%) in South America has the lowest incidence worldwide, closely followed by Malaysia (22.84%) and Myanmar (22.76%) in South East Asia. Mexico (23.63%) and the United States (24.29%) are following in the top 10. With 24.56%, Denmark has by far the lowest incidence in Europe. Comparing continents on an international scale, Africa performed the best, with only eleven countries finding their way to the top 30 lowest incidences, making the lowest incidence of caries in permanent teeth on this continent. Very poorly compared internationally for Lithuania. Their incidence places them at 169th place with 37.28% [4]. The scientific research of the incidence of tooth decay began in the late 19th and early 20th centuries. During this time, researchers developed an increasing understanding of the causes and risk factors of tooth decay. The Decayed, Missing, and Filled Teeth (DMFT) Index is one of the instruments for the measurement of the incidence of caries and has been used since the 1930s. The index provides an overview of the degree of caries, including severely decayed teeth and possible consequences (such as fillings or tooth loss). The number of teeth that are filled, missing, and decaying is known as DMFT. There are no teeth that are filled, decaying, or missing when the DMFT number is 0. More severe dental or oral health conditions are suggested by higher DMFT scores. An individual with an average of four teeth

affected, whether from decay, extraction, or fillings, would have a DMFT score of 4 [5].

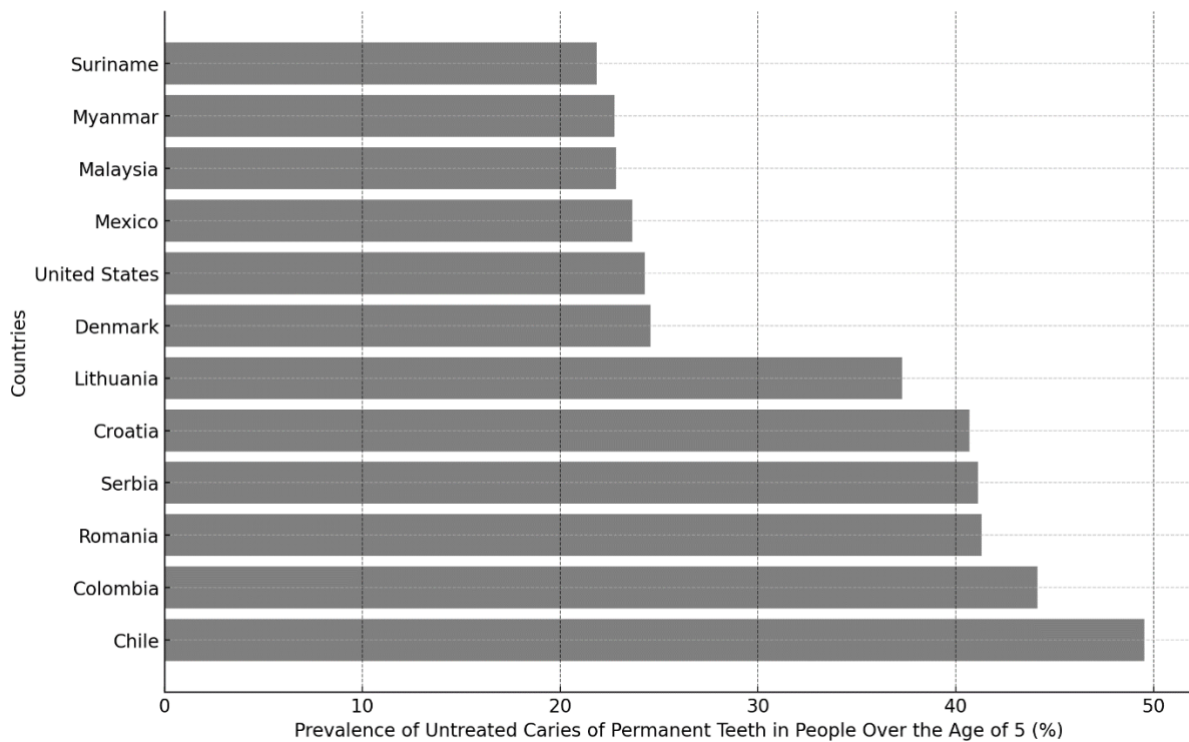


Fig. 1: Prevalence of untreated caries of permanent teeth in people over the age of 5 in 2019 [1]

It is especially crucial to consider national studies since the WHO publishes international DMFT statistics irregularly, leaving us with a lack of comparative values. The Department of Preventive and Paediatric Dentistry of Lithuanian University of Health Sciences conducted a study in 2016, in which they investigated the prevalence and severity of dental caries among 18-year-old Lithuanian adolescents. In total, 1063 18-year-old school-age adolescents—427 males and 636 females—from ten counties in Lithuania—both urban and rural—were part of the cross-sectional study. The multistage cluster sampling approach was applied. The examinations were done according to the WHO guidelines and the DMFT score, dental caries prevalence, dental care index, and Significant Caries Index were calculated. The results showed that 78.3% of 18-year-old Lithuanian adolescents had dental caries overall. The average DMFT of the study population was 2.93 [SD, 2.81]. Gender differences in DMFT scores were found: for girls and boys 3.03 [SD, 2.88] versus 2.73 [SD, 2.71]; these differences were also seen in rural versus urban areas 3.02 [SD, 2.98] versus 2.89 [SD, 2.73]. The significant caries index was 6.14, indicating that the group most affected by caries has an average of 6.14 affected teeth. The dental care index was 62.3%, indicating that 62.3% of 18-year-old adolescents in the study population have received dental care. In accordance with the WHO report, the scientists concluded that tooth decay is relatively high among adolescents [6]. Comparatively

few clinical investigations have focused more specifically on caries prevalence in adolescents than they have in the early childhood stage. As a comparison, a U.S study indicates that 67% of 16 to 19-year-olds and 50% of 12- to 15-year-olds in the United States, respectively, presently have or have had caries [7].

Another WHO meta-analysis for the Eastern Mediterranean region looked at nine different nations' dental caries prevalence rates for children between the ages of five and fifteen. According to the study, children between the ages of 6 and 15 had a pooled prevalence of caries in their permanent dentition, or permanent teeth, of 66%. The prevalence was 65% for five-year-olds, 61% for twelve-year-olds, and 70% for fifteen-year-olds. The analysis uncovered relevant research for the following nations: Islamic Republic of Iran, Iraq, Yemen, Jordan, Libya, United Arab Emirates, Bahrain, Lebanon, and Egypt. In total, 21 papers with 37 estimates were included in the study. These figures are interesting, as all available statistics show a particular increase in tooth decay in adolescence [8].

3. ORAL HEALTH LITERACY

3.1. DEFINITION OF ORAL HEALTH LITERACY FOR ADOLESCENTS

Understanding the exact definition of oral health literacy (OHL) for adolescents is of great importance. It forms the foundation for age-specific dental treatment plans and successful health promotion interventions. It will be challenging to address the unique oral health care needs of adolescents and put effective interventions in place in the absence of a precise and thorough definition. The definition of oral health literacy for adolescents will be emphasized in this section, along with an explanation of its fundamental elements and terminology.

In modern times, the definition of OHL among adolescents has expanded considerably beyond the conventional idea of educational attainment. OHL has expanded to include preventive techniques and practices that promote health in addition to the comprehension and application of dental knowledge. OHL is regarded as a crucial component of health promotion and education in the field of public health [9]. It involves informing people about oral health issues and putting preventive measures in place, like scheduling regular checkups with the dentist and encouraging a diet that is good for teeth. These preventive measures are especially important since they may help in the prevention of frequent oral health conditions like periodontitis and tooth decay. Furthermore, in the context of public health, OHL has the role of empowering young people to make informed decisions about their oral health. This includes being aware of the benefits of fluoride and using oral hygiene products appropriately. Another crucial

component of OHL is the capacity to assess health information critically and spot false information in advertisements or news reports [10].

Thus, there is a growing emphasis in public health initiatives on providing adolescents with the information and abilities to make long-term health decisions, in addition to teaching them the fundamentals of oral hygiene. Further, it can be said that strengthening OHL in adolescents not only helps to improve individual oral health, but also represents an important investment in public health. By promoting OHL in this target group, a significant contribution is made to reducing health disparities and improving the general health of the population [11].

However, in order to gain a deeper understanding of this, firstly it is important to understand the precise manner, in which oral health education is being passed on to adolescents in today's world. As a result of the technological revolution in the 20th century, psychologists began to investigate how people gain information and, above all, how they process it as early as the 1960s [12]. In the 21st century, the acquisition of education is divided into different sources of information [13]. These psychological sources can also be applied to oral health literacy. In the case of oral health literacy there are three different sources of information that are of fundamental importance. The primary source of information in this case are parents. They play a crucial role in imparting basic knowledge and values to their children. Parents are often the child's first teachers and significantly influence the child's education and development in the early years, imparting not only knowledge but also behavior, cultural values, and social norms. Normally parents teach their children basic skills and inform them about important areas of life such as oral health, nutrition, morality, and social interaction. In the best-case scenario, the child is educated about brushing their teeth correctly and an appropriate diet within the framework of what is understandable for the child at the respective age [14].

Therefore, parents are in many ways primary sources of information for children and adolescents, as they lay the foundation of their children's understanding and education of oral health.

Schools, universities, and even kindergartens at an early age can serve as secondary sources of information on oral health issues. In many different countries across the world, oral health education is imparted to children and adolescents at an early age in school education. The degree to which the particular educational institution engages in oral health education is the deciding factor in this case. Many schools in European countries therefore take children on excursions to dental practices or clinics at an early age, in order to not only allay their fears, but also to bring them closer to their direct contact person for oral hygiene, the dentist. The

basics of oral hygiene are also taught in many schools, creating a general sense of health for children from an early age [15]. However, the tertiary and final source of information, social media, has become one of the biggest for adolescents in the recent decade.

3.2 THE IMPACT OF SOCIAL MEDIA ON ORAL HEALTH LITERACY AMONG ADOLESCENTS

Especially in times of digitalization, the internet and social media play a bigger role than ever before. Platforms such as Facebook, Instagram, and TikTok have a remarkable impact on young people's oral health education. These platforms have been widely used by the public for a considerable amount of time and have become an integral part of the process by which adolescents and young adults obtain information.

However, this tertiary source of information also harbors dangers. Social media is setting global health trends that go hand in hand with constantly growing beauty ideals. These not only change oral health education, but also harbor unprecedented risks of misinformation that can be harmful to adolescents. Particularly during the start of the covid pandemic in 2020, the average social media usage time saw enormous growth. Scientists estimate that usage time has increased globally by 20% based on study results. National survey results from various countries even showed an increase in usage time of up to 70% during the first wave and up to 89% during the second wave of the pandemic [16]. Further, during this time, more than just the average usage duration has altered. Social media content consumption habits have also evolved. For instance, the popular short video platform TikTok saw an annual growth of 85.3% [17].

Social media has undergone significant change in recent years, and this shift has made short-form content extremely important. The popularity of platforms like TikTok has increased due to their emphasis on quick, snappy content that can be viewed in a matter of seconds. This pattern illustrates how consumers have come to value information that moves quickly and briefly.

Social media users, which are predominantly adolescents, show a clear tendency: they want to capture and consume content in the shortest possible time. Short, immediately engaging content has replaced long, in-depth texts and videos on social media in terms of user behavior. The ability to communicate ideas quickly is becoming more and more important in a world where information is flowing constantly. Users' attention spans are shorter, which has raised the need for condensed content. This development affects how people consume health information as

well, including that related to oral health. Short, entertaining formats may now be more effectively viewed than traditional, in-depth content [18].

There are significant implications for how people consume information, particularly health information, from this change in social media usage. However, there are risks associated with the "snackable content" trend. The content's brevity may cause complex subjects to be simplified, which could lead to an inaccurate or incomplete understanding of oral health-related issues. With the constant barrage of short, quickly consumable content, a superficial treatment of oral health topics could increase, posing risks to the accurate dissemination of oral health literacy. The question is whether shorter content can adequately convey the depth and nuance that is often required in these topics.

The dissemination of false information about oral health is another risk linked to young people's increased use of social media. Social media's widespread use makes it possible for people to spread their purported knowledge of oral health issues without having the necessary qualification or in-depth expertise. This presents the possibility that unqualified opinions will impact oral health trends and beauty standards, which could ultimately result in the dissemination of false information in this area, which may cause a deluge of questionable advice and unverified information to appear on digital platforms. These false pieces of information can potentially have negative consequences on young people's behavior and decision-making in addition to influencing attitudes about oral health practices [19].

The correlation between adolescents' oral hygiene and social media use has been the subject of numerous studies. According to a study comparing the habits of 4414 British adolescents between the ages of 12 and 15, adolescents who use social media and the Internet for oral health education are more likely to develop dental caries [20].

Further, social media has an impact on adolescents by presenting them with unattainable standards, especially when it comes to beauty standards. When unscientific advice about teeth whitening or other aesthetic procedures is spread, for instance, it can directly affect oral health practices. Therefore, in order to effectively promote oral health and counteract misinformation, it is becoming more and more important to foster critical thinking skills to distinguish between reliable information and misleading content. A significant amount of research addresses and investigates the shift in beauty standards. A 2023 study conducted in China investigated how social media affects teenage body image ideals. The study's conclusion makes the case that adolescents' negative body image is positively correlated with their exposure to media content featuring idealized body images. While negative feelings about various body parts change with age, there is no statistically significant difference between genders [21].

This includes, for example, the beauty ideal of whiter teeth, which is intended to suggest good oral health [22]. Here, bleaching kits play an essential role. The significance of social media in the marketing and sales of these whitening kits is examined in the article "Social media and tooth whitening: Intrinsically linked?". It demonstrates how social media has grown to be a significant player in the dissemination and acceptance of teeth-whitening products. Due to the active promotion of many of these items by influencers and marketing campaigns on social media sites like Facebook and Instagram, their popularity and demand are rising [23].

Concerns have been raised over the lack of information and safety around teeth-whitening products that are sold online, especially on social media. A British Dental Journal (BDJ) study alerts readers to the risks associated with over-the-counter (OTC) teeth-whitening products. Sodium chlorite, which these products occasionally include, when mixed with acid, can dramatically lower teeth's hardness and raise the risk of further surface abrasion. Additionally, the DIY kits may contain harmful amounts of hydrogen peroxide, which could result in gum recession, nerve and enamel damage, blistering and burning of the gums, and mouth infections [24].

There is no direct risk of tooth decay in this context. However, it is very alarming that the beauty trend of white teeth is equated with a healthy body image. In young people who are influenced by social media, this can lead to neglect of oral hygiene and ultimately to tooth decay.

3.3 MEASUREMENT AND GLOBAL DISPARITIES OF ORAL HEALTH AND GENERAL HEALTH LITERACY

The measurement of health literacy among adolescents, particularly in relation to oral health, is an essential aspect of research into global health disparities. It is crucial to understand that the evaluation of oral health knowledge can also be correlated to general medical knowledge. An in-depth understanding of global oral health disparities in children and adolescents is conducted in the study 'Understanding oral health disparities in children as a global public health issue'. This study highlights the need to treat disparities in oral health as an important worldwide public health concern. It emphasizes the necessity of putting specific preventative measures and interventions into practice, in order to enhance oral health, particularly in marginalized communities. From this perspective, it is evident that disparities in oral health literacy reflect a variety of social, economic, and cultural issues and have both local and global implications. Furthermore, this study highlights a crucial problem, that

researchers face in this field. As with the incidence of caries, there is no internationally recognized standard index or measurement method to assess the disparities of health literacy on a global scale [25]. This gap in the methodology of standardized assessments emphasizes the necessity to thoroughly investigate and comprehend the different influencing factors that lead to disparities in health literacy. In the following, some studies, that deal in detail with the causes and correlating factors of global disparities in health literacy, are presented. The available data demonstrates that adolescents from various socioeconomic and cultural backgrounds differ significantly in their level of awareness and accessibility to information regarding dental care and general health practices.

A notable approach to studying oral health literacy in adolescents was used in a study that examined a group with a variety of social and cultural backgrounds. This study shows that oral health literacy is significantly impacted by financial barriers. The majority of participants reported that they found it extremely difficult or impossible to pay for the necessary dental or medical treatment to maintain their health. Results demonstrate the significant influence of socioeconomic variables on health literacy, especially regarding oral health [26].

Another relevant study that examines global disparities in the area of dental and oral health in developing countries is the scoping review "What makes inequality in the area of dental and oral health in developing countries?". This study analyzes over 73 articles to identify the main determinants of inequality in access to oral health care in developing countries. Analyses were conducted on developing country original and review publications.

The methodology included qualitative thematic analysis in addition to data collection and analysis using Microsoft Excel and Endnote software. In the study, eleven factors were found to be associated with disparities, including personal traits, health needs and status, socioeconomic and cultural factors, and insurance and policy-related issues [27].

The research demonstrates that the issue of oral health literacy and general health education is closely linked to the global societal problem of opportunity inequality. One approach that shows this discrepancy involves the unequal distribution of educational opportunities and access to health-related information. In certain countries, education—and oral health education in particular—is widely available and recognized as a fundamental human right, but in other countries, information and resources are conspicuously lacking.

4. THE CORRELATION BETWEEN DENTAL CARIES AND ORAL HEALTH LITERACY

4.1. RISK FACTORS OF DENTAL CARIES

Looking at the risk factors related with dental caries in adolescents one encounters a broader spectrum of different risk factors that act as causes for increased caries incidence. The risk factors for tooth decay in adolescents are diverse and include both behavioral and environmental factors. According to a cross-sectional study, dental caries in adolescents is linked to environmental factors such as low socioeconomic position and low oral health literacy. Particularly, low socioeconomic position and prior caries exposure have been identified by longitudinal studies as risk factors for caries in adolescents [26].

However, these factors cannot be changed and can only be included in prevention strategies. The authors of this longitudinal study searched for other, potentially modifiable causes of caries in adolescents. As a result, they identified increased exposure to fluoride as another risk factor for a higher caries prevalence in adolescents, referring to the Iowa Fluoride Study, that made use of a birth cohort that was born between 1992 and 1995. Every six months, participants completed fluoride exposure questionnaires, and additional clinical examinations to determine the caries index of permanent teeth (DFS). One of the study's most significant findings was the confirmation of the advantages of fluoride in preventing dental decay. The study found that kids and adolescents with adequate fluoride intake, primarily from drinking water, had lower rates of cavities and tooth decay than kids with inadequate fluoride intake [7]. This outcome underlines fluoride's role in dental health and shows that this type of fluoride exposure is equally important to the amount of fluoride absorbed through toothpaste.

The prevalence of tooth decay in adolescents is also closely linked to behavioral factors. Eating and drinking sugary, acidic foods and beverages is one important factor that increases the risk of dental decay since sugar encourages the production of plaque. Another risk factor is poor oral hygiene, which includes not flossing and brushing adequately, leading to the development of plaque. In order to identify and treat tooth decay early on, routine dental check-ups are essential [28]. Failure to have regular dental check-ups can be both an environmental and a behavioral factor. For example, a certain inertia or lack of habit of integrating dental care into personal routines may lead to neglect of regular dental check-ups. Untreated tooth decay cases could increase in the absence of such examinations. Furthermore, frequent snacking, especially of sugary or acidic snacks, increases acid exposure in the mouth. Another factor, especially in adolescence, is the care of braces and other orthodontic appliances, which is also very

important. Poor care can increase the risk of tooth decay as it makes cleaning more difficult and creates areas where bacteria can accumulate [29].

Lastly genetic and family history factors are significant contributors to the caries incidence. Research has indicated that several genetic factors influence a person's risk for dental caries [30]. Increased sensitivity of dental enamel, variations in salivary composition and volume, and alterations in the natural microbial composition of the mouth are indications for this. Conditions such as xerostomia are particularly relevant here. To determine a person's caries risk more accurately and to create specialized preventative measures, it is crucial to take family history, as well as environmental and behavioral factors into account when assessing dental health.

4.2 THEORETICAL FRAMEWORKS RELATING DENTAL CARIES AND ORAL HEALTH LITERACY

This field of research focuses on the relationship between oral health education and awareness, as well as the onset and progression of dental caries. Additionally, this field looks at how people take in, interpret, and apply knowledge regarding oral health and how that influences their decisions and behaviors related to oral health. A study examined the correlation between adolescents' carious lesions and oral health literacy (OHL) in northeastern Brazil. The study included 769 teenagers from public and private schools who were between the ages of 15 and 19, males and females enrolled in school. Adolescents with medical illnesses that impair learning, learning-related syndromes, and hearing impairments were not included in the study. The level of OHL was assessed using a tool called BREALD-30. The BREALD-30 (Brazilian Rapid Estimate of Adult Literacy in Dentistry) is a tool specifically designed to measure the functional oral health literacy (OHL) in the Brazilian population. It is a modified form of the original REALM (Rapid Estimate of Adult Literacy in Medicine), which was created in the United States to evaluate adult people's reading and writing abilities in the health sector. The results of this research demonstrated that cavitating carious lesions were more common in adolescents with lower oral health literacy levels. Further, the study implied that improving OHL may help reduce disparities in oral health. The researchers emphasized the significance of evaluating teenagers' oral health literacy, especially in relation to preventative dental behaviors and attitudes [31].

Looking at the theoretical frameworks relating dental caries and oral health literacy,

one quickly understands that the educational level of parents, who are primary educators since childhood, is just as important as the education of adolescents themselves and thus a crucial risk factor for the prevalence of caries.

A Brazilian cross-sectional study aimed to evaluate the association between OHL and the prevalence of cavitated caries in early adolescence. The cross-sectional study that was conducted with 740 twelve-year-old students showed a relation between students with low OHL and increased caries lesions. Furthermore, a low level of family cohesion and sociodemographic factors could be linked as predictors of caries lesions in early adolescence [32].

Another trial study examined the correlation between parents' oral health literacy and the amount of fluoride toothpaste used on young children between the ages of 0 and 4. Additionally, the scientists examined the efficacy of different educational efforts aimed at encouraging toothpaste use and evaluated parents' capacity to choose toothpaste with the appropriate fluoride concentration. The correct amount of fluoride toothpaste was used by parents with higher oral health literacy after the educational interventions, while they were also more adept at dosing the recommended dosage before and after. Furthermore, the selection of the appropriate toothpaste was linked to increased parental education, highlighting the significance of education in oral health decision-making [33]. One recent study from Lithuania examined the role of parental education and socioeconomic status in dental caries prevention among Lithuanian children. The results showed that parents with a high level of education and sufficient income were more likely to pay attention to their children's dental health [34]. Further, it can be concluded that people who are better educated in oral health issues are more likely to recognize and avoid potential tooth decay risk factors, take regular dental care, and appreciate the value of good dental health.

These studies suggest that oral health literacy is not only an important factor for dental health directly in the context of adolescents. Certainly, the educational level of the adolescent themselves is always of primary importance. However, the family's level of education in the area of oral health literacy should always be considered.

5 CHALLENGES AND DEFICITS IN EXISTING LITERATURE

5.1 IDENTIFIED RESEARCH DEFICITS IN DENTAL CARIES EPIDEMIOLOGY

There are several identified research deficits in the epidemiology of dental caries. Identifying the research deficits in dental caries epidemiology can help to improve ways and mechanisms, which measure the prevalence of caries.

One major issue is the use of visual/tactile indices for the identification and evaluation of carious lesions, in spite of their known limitations. Dentists have always recognized and evaluated dental caries using the visual and tactile methods. These methods have changed little over the last four to five decades and depend on the dentist's visual inspection and direct examination using instruments.

During the visual examination the dentist searches for visual signs of decay, such as discoloration or changes in the enamel's surface structure. Discoloration can be an indicator for the onset of decay, especially when it is seen in pits and fissures or areas that are known to be susceptible to caries. For visual help the dentist uses a light source and a mirror.

During the tactile examination the dentist uses a probe or an explorer. Using these instruments, the dentist carefully examines the teeth by feeling for soft or hard spots that could be indicators of advanced caries. To identify regions where the enamel is demineralized or the tooth structure has been damaged, the probe is gently pushed over the tooth surfaces.

Although these methods are widely used and easy to apply, they have some limitations. The dentist's experience and clinical judgment play a major role in how accurate the visual and tactile examination is. Furthermore, early stages of caries that are underneath the tooth surface might frequently go unnoticed because they are usually not tactilely and visually identifiable. Additionally, these techniques may require invasive procedures that damage the tooth structure, particularly if the probe is used excessively. A visual and tactile examination alone is therefore not sufficient for diagnosis. Digital x-rays are often used, although the quality standards and evaluation of the diagnosis are also not standardized, which distorts the uniformity of the studies on a global scale [35].

In the existing literature on the epidemiology of dental caries, this creates the problem of inconsistency in methodology. Although most studies explain which methodology was used for measurement, in practice these are heavily dependent on the clinical judgement of the treating dentist.

Furthermore, most studies focus on the number of caries lesions in a patient's mouth, but do not consider the depth of the caries lesions. The literature often lacks the measurement of the extent of caries. Although most studies can be used to recognize how many caries lesions patients have in a certain area, it is often not possible to consider the extent of the caries lesions. Especially in developing countries, the methodology for measuring caries incidence is questionable. When evaluating global epidemiology and comparing incidence, the question quickly arises as to whether western industrialized countries have more caries or whether more caries is simply diagnosed in these countries. This inconsistency in the measurement of caries incidence on a global scale creates a distorted picture. Certainly, it is possible to recognize clear tendencies in the worldwide epidemiology of dental caries. Nevertheless, deviations should be expected in the evaluation.

Another deficit in the research of the epidemiology of dental caries it's risk factors is the lack of inclusion of genetic factors in the understanding of caries development. Although genetic contributions to caries susceptibility are mentioned in some studies, these components have not been adequately investigated in most of the research [36].

5.2 LIMITATIONS AND INCOSISTENCIES IN STUDIES ON ORAL HEALTH LITERACY

Research on oral health literacy, particularly among adolescents, includes a variation of limitations and inconsistencies that may impact the interpretation and generalizability of their results.

A major problem is the absence of a standardized measurement methodology to assess the oral health literacy of adolescents. Different studies use different instruments and approaches, which makes it difficult to compare them. There is no gold standard for the measurement of oral health literacy. The various definitions of health literacy and the wide variety of issues it covers make this issue more problematic.

Further, in many Western countries, there is a conspicuous gap in research on oral health literacy. While some nations, like the US and several European countries, are very engaged in this field of study, other Western nations have few or no studies specifically focused on oral health literacy. Different healthcare systems, educational standards, and cultural perspectives on health and education may contribute to this in part. Consequently, there are often insufficient comparable values to put the conducted investigations in a global frame of mind.

Apart from this, the correlation between parental oral health literacy and caries in adolescents is often investigated, however in many Western countries there is a lack of studies on the direct relationship between oral health literacy of adolescents themselves and caries incidence. Certainly, the relationship between parental oral health literacy and caries incidence in adolescents is of great importance. Nevertheless, it is crucial to understand the direct connection between indicators and incidence of caries in adolescents [37].

If direct research on this relationship is conducted, it is mostly through self-reported data, which is susceptible to biases such as memory distortion or social desirability. Adolescents may overestimate or underestimate their knowledge, abilities, or behaviors related to oral health. There are many questionnaires, which target adolescents directly, asking about general questions, such as the frequency of everyday oral health behaviours [38]. Despite the factors mentioned above, these questionnaires are of great importance and one of the few ways to research about adolescents' level of oral health literacy. However, unfortunately, many studies fail to test this knowledge with direct clinical evidence in the next step. As a result, many studies fail to establish the direct connection between oral health literacy and dental caries incidences. In order to establish a direct correlation, it would be essential to determine how the incidence behaves in these population groups.

Another limitation in research on oral health literacy is the predominance of local or regional studies. Many studies have small sample sizes and therefore limited generalizability, as they are limited to a small number of participants or specific geographical areas and populations.

Examining the students of one particular school or city may be interesting for a certain area but does not show a representative benchmark for other areas. Of course, it is relevant to carry out regional or local studies. However, when researching, one increasingly comes across such local studies instead of finding more studies that research OHL on a national or global scale. Regional studies can often be good as an example, but it is important to consider that they can only serve as an example for regional preventive strategies precisely in this area. Furthermore, such local or regional study results should always be directly related to environmental factors in the area, such as fluoride levels in the water and socio-economic factors of the population.

Lastly, the cross-sectional format of many oral health literacy studies makes it challenging to determine exact causal relationships. One major source of limitation in oral health literacy research, especially with regard to adolescents, is the absence of longitudinal studies. Understanding how oral health literacy changes over time requires longitudinal studies. This is especially important for adolescents, whose abilities, attitudes, and behaviors can alter as they become older and more independent. It is challenging to create efficient education and

intervention strategies that are adapted to the unique requirements and developmental phases of this age group in the absence of such studies. Moreover, longitudinal research helps to investigate the long-term impacts of oral health literacy on health-related behaviors, health status, and health services. This is useful in determining when interventions are most needed and in comprehending how early experiences affect later health decisions and results. Furthermore, this sort of research might aid in identifying patterns and trends in the development of oral health literacy. For instance, it is possible to analyze the way contemporary factors like education, socioeconomic level, and access to information sources affect the evolution of oral health literacy throughout time. Cross-sectional studies, however, can show correlations, but they cannot determine the direction of causality. To comprehend the causal relationships between health outcomes and health literacy, longitudinal studies are required [39].

6 IMPLICATIONS FOR PUBLIC HEALTH AND DENTAL PRACTICE

6.1 PUBLIC HEALTH INTERVENTIONS TO ADDRESS DENTAL CARIES IN ADOLESCENTS

The aforementioned limitations and inconsistencies that emerged in the research on caries incidence and oral health literacy of adolescents raise the question of how the public health system can develop strategies and interventions to address oral health literacy in adolescents and consequently reduce the incidence of caries.

Public health efforts should focus primarily on establishing generalized measurement standards to specifically identify disparities in oral health literacy. If the previously mentioned limitations and inconsistencies of the research are addressed directly, prevention strategies can be identified much better. It would also be possible to teach adolescents in a much more targeted manner, both nationally and globally, and take measures to improve oral health literacy. The first step, however, is to introduce a general measurement standard for detecting the incidence of caries. If these incidences can be recognized more precisely, direct location-dependent causalities of environmental factors can be identified. An interesting approach is implementing targeted preventative programs based on the findings of surveys like the Basic Screening Survey (BSS). These surveys gather information on dental sealants, the use of fluoride, caries experience, untreated caries, and treated tooth decay. Risk categories can be identified, and suitable measures may be developed based on this data [40].

In a second step, it is then relevant to identify the behavioral factors of adolescents through targeted studies and questionnaires in order to work on these disparities on a national or even on a global level. For that matter, in the research of adolescents, it is particularly important to carry out longitudinal studies. These assist, above all, to better analyze time-dependent factors, which are crucial for adolescents, whose abilities, attitudes, and behaviors can alter as they become older and more independent. For instance, the aforementioned Brazilian study featured some innovative research methods for assessing adolescents' oral health literacy. In order to assess oral health literacy for this research, the BREALD-30 index was modified and adapted from a different American index [31]. The use of such indices, if standardized at a national or global level, can be a potential means of early detection of caries incidence trends and thus can be followed by the direct means of taking action. One approach for behavioral intervention is community-based intervention programs that focus on promoting oral health. These programs often include dietary and behavioral suggestions, like eating a daily diet high in fruits and vegetables, avoiding sugary foods, and brushing the teeth properly. The interventions can take a variety of forms, such as social networking applications, one-on-one consultations with medical professionals, or group conversations [40]. Additionally, it was discovered that adolescents and children from low-income families or with migratory backgrounds can benefit from preventative techniques [41].

6.2 APPROACHES FOR PROMOTING ORAL HEALTH LITERACY AMONG ADOLESCENTS IN DAILY DENTISTRY

Dentists may use a variety of approaches in daily dentistry to address oral health literacy among adolescents. During dental treatment, education and information sharing are essential. To provide targeted preventive strategies, it is of great importance to identify adolescents who are at high risk of dental decay at an early age. Regular dental examinations and the evaluation of personal risk factors can help to achieve this [42]. Dentists should take use of the time spent in treatment to teach adolescents about important aspects of oral health in a preventive manner, particularly to those who are at a higher risk of dental caries. This can include details on the origins of dental decay, the importance of fluoride, the right choice of toothpaste and the necessity of routine dental examinations. Here, communication that is straightforward and uncomplicated is crucial. The American Dental Association emphasizes the importance of simple communication with patients to ensure understanding and minimize misunderstandings. This may include making sure that adolescents truly comprehend the

information they are given and presenting it in straightforward manner. Practicable examples, like the proper way to use dental floss or a toothbrush, can also aid adolescents in comprehending and putting everyday oral hygiene routines into practice.

In addition, it's crucial to actively involve adolescents in nutrition and lifestyle discussions. Adolescents often do not have adequate knowledge about how their diet and lifestyle choices affect their oral health. Dentists can offer assistance on this, especially with regard to snacks and beverages high in sugar. Providing educational materials is an additional possibility. Adolescents can take home brochures, fliers, and other educational materials from dental offices. These resources may contain nutritional guidelines, advice on maintaining good dental hygiene, and details on how smoking affects oral health.

Additionally, dentists have to inform their patients about social media and internet usage. Dentists can use social media, which is often used by adolescents, to spread educational content. This can be done by posting instructional content on social media, blogging, or using interactive apps. But above all, it's crucial to educate them to have a critical mindset when it comes to social media. It's important for adolescents to learn to be aware of the sources of the information they consume. Involvement from parents and guardians is also possible. Including parents in the educational process can help encouraging the adoption of suggested oral hygiene habits at home. Parents can be encouraged by dentists to set a positive example for their children and to make dental health a family concern.

Furthermore, including dental health into school-based health initiatives can be a successful strategy for reaching adolescents. This may include offering educational resources, seminars, or interesting lectures in classrooms. Dentists may empower adolescents to take charge of their own oral hygiene by employing such strategies to raise awareness and understanding about oral health. Not to mention, a welcoming and positive environment in the dental office can make adolescents feel more at ease and receptive to learning [43].

7 RECENT DEVELOPMENT IN DENTAL CARIES INCIDENCE

Recent developments in the incidence of dental caries show interesting aspects. Dental plaque has a complicated microbial interaction, as demonstrated by large-scale pediatric research. Dental caries was traditionally believed to be largely caused by *Streptococcus mutans*. However, recent research indicates that *Selenomonas sputigena*, another type of bacterium, may be crucial to the progression of caries. By interacting with *S. mutans*, this bacterial species increases its cariogenic potential. The study reveals novel biofilm

development mechanisms and offers insights into new caries prevention strategies that may potentially be applicable in other clinical contexts [44]. Regarding the incidence, interestingly, the overall prevalence of untreated caries in adolescents declined from 1999 to 2016, according to the NHANES data, which may indicate an improvement in oral hygiene practices [45].

This is confirmed by another study that was published in the Journal of Clinical Pediatric Dentistry in 2022. The prevalence of decaying primary and permanent teeth declined between 2011 and 2020, according to the U.S study that examined caries trends in the adolescent dental population. However, this study also revealed significant disparities in the distribution of the disease, with ethnic minorities and those from poorer households bearing the majority of the disease burden [46].

Furthermore, technological progress has also changed methods and working practices. High-throughput mass spectrometry, sequencing, and microarray technologies are being used more and more in modern research. These "omics" studies have shed new light on the complexity of oral microbial communities and their role in caries development. Despite the fact that these techniques are effective and repeatable, they are limited by the probes' limitations, meaning that only microorganisms that the probes can detect can be identified [47, 48, 49].

Additionally, the entire measurement of incidences, as well as measured values for recording oral health education have changed significantly in the technical age due to the globalisation. This offers scientists enormous opportunities to expand research in this area in the coming years.

8 CONCLUSION

The assessment of global dental caries prevalence and oral health literacy among adolescents, as described in the first task, reveals both development and challenges. Measuring the disparities of caries incidences and oral health literacy among adolescents on a global scale, paints a shockingly weak picture of the incidences by industrialised European countries. Despite the high level of development and access to modern dental technologies, including comprehensive programs for prevention, the countries of Europe still show problematically high rates of caries. The current incidences should serve as a wake-up call and highlight an urgent need for action. The populations of these countries must become aware of the continuing risks and make greater efforts in the areas of prevention and health education in order to significantly reduce the prevalence of caries and improve general oral health. The research showed that dental caries management and prevention depend heavily on oral health literacy.

Adolescents who possess greater oral health knowledge are more capable of embracing preventive measures and making knowledgeable choices regarding their oral well-being. Another research task about social media's influence on adolescents' health-related behaviors and attitudes presents both an opportunity and a challenge, requiring the development of more complex methods to maximize its beneficial effects and minimize false information. The last research task in this field reveals extensive literature, but still with certain deficits—above all, regarding the degree of standardization of methods. Many studies had very small sample sizes, which in turn decreased their generalizability. Further, there is the need for more longitudinal studies in this case to properly understand the theoretical frameworks that exist between oral health literacy and incidences of dental carries. The same could also be used to adequately determine the effectiveness of oral health initiatives. This illustrates an in-depth need to improve oral health literacy through health-promoting interventions amongst the general population, in this case, the youth or adolescents. This should be done through the use of community-based intervention programs, oral health education in learning institutions, and the use of social media for dissemination of factual health information. Furthermore, dental practices could reach more of the adolescents by adopting simple communication strategies and tailor-made treatment plans, owing to the wide and varying backgrounds and capacities of the adolescents. Targeted public health initiatives are also necessary due to the large disparities, especially among young individuals from low socioeconomic or cultural backgrounds or with a history of migration.

In conclusion, there are many challenges in the future, which could be managed adequately with the help of the technological progress of the last two decades. Surveys or polls can be conducted much more efficiently, indexes can be created more easily, locally and in a more timely manner, initiatives to improve oral health can be implemented much more promptly.

REFERENCES

1. Shirzaei M, Sarani Z, Bagheri S. Miswak/Derum Manipulation, a Common Habit in Baluchestan, Iran. *Int J High Risk Behav Addict*. 2016 Apr 25;5(2):e25948. doi: 10.5812/ijhrba.25948. PMID: 27622167; PMCID: PMC5002340.
2. World Health Organization. Oral health. Geneva: WHO; 2023 Mar 14
3. Frey S. What countries have the lowest prevalence of cavities [Internet]. *Smile-365*; 2012 Nov 27.
4. Prevalence of untreated caries of permanent teeth in people 5+ years [Internet]. Geneva: World Health Organization; [cited 2024 Apr 14].
5. AShulman JD, Cappelli DP. DMFT Index. In: *Prevention in Clinical Oral Health Care*. Journal of Dentistry, 2015. 2008. <https://doi.org/10.1016/B978-0-323-03695-5.50005-7>
6. Žemaitienė M, Grigalauškienė R, Vasiliauskienė I, Saldūnaitė K, Razmienė J, Slabšinskienė E. Prevalence and severity of dental caries among 18-year-old Lithuanian adolescents. *Medici*. 2016; doi: 10.1016/j.medici.2016.01.006.
7. Warren JJ, Van Buren JM, Levy SM, Marshall TA, Cavanaugh JE, Curtis AM, Kolker JL, Weber-Gasparoni K. Dental caries clusters among adolescents. *Community Dent Oral Epidemiol*. 2017 Dec;45(6):538-544. doi: 10.1111/cdoe.12317. Epub 2017 Jul 3. PMID: 28671327; PMCID: PMC5680144.
8. Kale S, Kakodkar P, Shetiya S, Abdulkader R. Prevalence of dental caries among children aged 5–15 years from 9 countries in the Eastern Mediterranean Region: a meta-analysis. *East Mediterr Health J*. 2020;26(6):726–735. doi: 10.26719/emhj.20.050
9. American Dental Association. Health Literacy in Dentistry [Internet]. Chicago: American Dental Association; [cited 2024 Apr 14].
10. Roundtable on Health Literacy; Board on Population Health and Public Health Practice; Institute of Medicine. *Oral Health Literacy*. Washington (DC): National Academies Press (US); 2013 Feb 19. 3, Overview and Statement of the Problem
11. Guo Y, Logan HL, Dodd VJ, Muller KE, Marks JG, Riley JL III. Health Literacy: A Pathway to Better Oral Health. *Am J Public Health*. 2014 Jul;104(7):e85–e91. doi: 10.2105/AJPH.2014.301930.
12. Greeno JG. Psychology of learning, 1960–1980: One participant's observations. *Am Psychol*. 1980;35(8):713–728. doi: 10.1037/0003-066X.35.8.713.

13. College of Staten Island Library. Plagiarism - CSI Library Information Literacy [Internet]. Staten Island: College of Staten Island, CUNY; [cited 2024 Apr 14].
14. Joshua Jeong , Emily E. Franchett, Clariana V. Ramos de Oliveira, Karima Rehmani, Aisha K. Yousafzai: Parenting interventions to promote early child development in the first three years of life: A global systematic review and meta-analysis, 2021, <https://doi.org/10.1371/journal.pmed.1003602>
15. Harzer W, Tausche E, Gedrange T. Harmonisation of Dental Education in Europe - a survey about 15 years after visitation of dental schools participating in the DentEd project. *Eur J Dent Educ.* 2017 Feb;21(1):22-27. doi: 10.1111/eje.12171. Epub 2015 Sep 7. PMID: 26344938.
16. Cho H, Li P, Ngien A, Tan MG, Chen A, Nekmat E. The bright and dark sides of social media use during COVID-19 lockdown: Contrasting social media effects through social liability vs. social support. *Comput Human Behav.* 2023 Sep;146:107795. doi: 10.1016/j.chb.2023.107795. Epub 2023 Apr 24. PMID: 37124630; PMCID: PMC10123536.
17. Statista. Social media use during coronavirus (COVID-19) worldwide [Internet]. Hamburg: Statista; 2023
18. Shutsko, Aliaksandra. (2020). User-Generated Short Video Content in Social Media. A Case Study of TikTok. 10.1007/978-3-030-49576-3_8.
19. Raja ZH, Shaheed M. Misinformation about COVID-19 and Dentistry on the Internet. *Biomedica.* 2020;36:227-32.
20. Almoddahi D, Machuca Vargas C, Sabbah W. Association of dental caries with use of internet and social media among 12 and 15-year-olds. *Acta Odontol Scand.* 2022 Mar;80(2):125-130. doi: 10.1080/00016357.2021.1951349. Epub 2021 Jul 15. PMID: 34265227.
21. Zhu, Y. (2023) The Influence of Social Media on Adolescent Body Image Ideals: A Study of Middle School Students in Guangzhou-Foshan, China. *Advances in Applied Sociology*, 13, 604-621. doi: 10.4236/aasoci.2023.138038.
22. Khalid, Abeer & Quiñonez, Carlos. (2015). Straight, white teeth as a social prerogative. *Sociology of health & illness.* 37. 10.1111/1467-9566.12238.
23. Henry, S. Social media and tooth whitening: Intrinsically linked?. *BDJ Student* 28, 17 (2021). <https://doi.org/10.1038/s41406-020-0174-2>
24. Dentists and Which? warn of risks from buying teeth whitening products online. *BDJ In Pract* 34, 7 (2021). <https://doi.org/10.1038/s41404-021-0782-8>

25. Ramos-Gomez, Francisco, Janni Kinsler, and Hamida Askaryar. "Understanding Oral Health Disparities in Children as a Global Public Health Issue: How Dental Health Professionals Can Make a Difference." *Journal of Public Health Policy* 41, no. 2 (2020): 114–24. <https://www.jstor.org/stable/48725252>.
26. King, S., Thaliph, A., Laranjo, L. et al. Oral health literacy, knowledge and perceptions in a socially and culturally diverse population: a mixed methods study. *BMC Public Health* 23, 1446 (2023). <https://doi.org/10.1186/s12889-023-16381-5>
27. Bastani, P., Mohammadpour, M., Mehraliain, G. et al. What makes inequality in the area of dental and oral health in developing countries? A scoping review. *Cost Eff Resour Alloc* 19, 54 (2021). <https://doi.org/10.1186/s12962-021-00309-0>
28. Hahn TW, Kraus C, Hooper-Lane C. Clinical Inquiries: What is the optimal frequency for dental checkups for children and adults? *J Fam Pract.* 2017 Nov;66(11):699-700. PMID: 29099514.
29. Schätzle M, Golland L, Patcas R, Ronay V, Sener B, Attin T, Peltomäki T, Schmidlin PR. Cleaning Efficacy of Manual Toothbrushes Around Brackets-A pilot randomised control trial. *Oral Health Prev Dent.* 2017 Jan 1;15(1):33-9.
30. Mihiri J. Silva, Nicky M. Kilpatrick, Jeffrey M. Craig, David J. Manton, Pamela Leong, David P. Burgner, Katrina J. Scurrah; Genetic and Early-Life Environmental Influences on Dental Caries Risk: A Twin Study. *Pediatrics* May 2019; 143 (5): e20183499. [10.1542/peds.2018-3499](https://doi.org/10.1542/peds.2018-3499)
31. Lima LCM, Neves ÉTB, Dutra LDC, Firmino RT, Araújo LJS, Paiva SM, Ferreira FM, Granville-Garcia AF. Psychometric properties of BREALD-30 for assessing adolescents' oral health literacy. *Rev Saude Publica.* 2019 Aug 15;53:53. doi: [10.11606/S1518-8787.2019053000999](https://doi.org/10.11606/S1518-8787.2019053000999). PMID: 31432910; PMCID: PMC6703894.
32. Neves ÉT, Dutra LD, Gomes MC, Paiva SM, de Abreu MH, Ferreira FM, Granville-Garcia AF. The impact of oral health literacy and family cohesion on dental caries in early adolescence. *Community dentistry and oral epidemiology.* 2020 Jun;48(3):232-9.
33. Ota, Yamamoto, T., Ando, Y., Aida, J., Hirata, Y., & Arai, S. (2013). Dental health behavior of parents of children using non-fluoride toothpaste: a cross-sectional study. *BMC Oral Health*, 13(1), 74–74. <https://doi.org/10.1186/1472-6831-13-74>
34. Saldūnaitė K, Bendoraitienė EA, Slabšinskienė E, Vasiliauskienė I, Andruškevičienė V, Zūbienė J. The role of parental education and socioeconomic status in dental caries

- prevention among Lithuanian children. *Medicina (Kaunas)*. 2014;50(3):156-61. doi: 10.1016/j.medic.2014.07.003. Epub 2014 Jul 29. PMID: 25323543.
35. Frencken J. Caries Epidemiology and Its Challenges. *Monogr Oral Sci*. 2018;27:11-23. doi: 10.1159/000487827. Epub 2018 May 24. PMID: 29794449.
36. Haworth S, Esberg A, Lif Holgerson P, Kuja-Halkola R, Timpson NJ, Magnusson PKE, Franks PW, Johansson I. Heritability of Caries Scores, Trajectories, and Disease Subtypes. *J Dent Res*. 2020 Mar;99(3):264-270. doi: 10.1177/0022034519897910. Epub 2020 Jan 6. PMID: 31905308; PMCID: PMC7036480.
37. Khodadadi E, Niknahad A, Sistani MM, Motalebnejad M. Parents' Oral Health Literacy and its Impact on their Children's Dental Health Status. *Electron Physician*. 2016 Dec 25;8(12):3421-3425. doi: 10.19082/3421. PMID: 28163858; PMCID: PMC5279976.
38. Xiang B, Wong HM, Cao W, Perfecto AP, McGrath CP. Development and validation of the Oral health behavior questionnaire for adolescents based on the health belief model (OHBQAHBM). *BMC Public Health*. 2020 Dec;20:1-1.
39. Shek DT, Ng CS. Longitudinal research design in adolescent developmental research. *International Journal on Disability and Human Development*. 2016 Nov 1;15(4):349-58.
40. Deghatipour, M., Ghorbani, Z., Mokhlesi, A.H. et al. Community-based interventions to reduce dental caries among 24-month old children: a pilot study of a field trial. *BMC Oral Health* 21, 637 (2021). <https://doi.org/10.1186/s12903-021-01999-x>
41. Wei L, Griffin SO, Robison VA. Disparities in Receipt of Preventive Dental Services in Children From Low-Income Families. *Am J Prev Med*. 2018 Sep;55(3):e53-e60. doi: 10.1016/j.amepre.2018.04.039. Epub 2018 Jul 14. PMID: 30017612; PMCID: PMC7962422.
42. Guideline Development Group. Strategies to prevent dental caries in children and adolescents guidance on identifying high caries risk children and developing preventive strategies for high caries risk children in Ireland.
43. The value of preventive oral health care [Internet]. Chicago: University of Illinois Chicago College of Dentistry; 2016
44. Dentists identify new bacterial species involved in tooth decay [Internet]. University of Pennsylvania; 2023

45. National Center for Health Statistics. (2021). National Health and Nutrition Examination Survey 2017-March 2020 Data Documentation, Codebook, and Frequencies: Oral Health - Recommendation of Care
46. Bashir, Nasir. (2022). Trends in the prevalence of dental caries in the US pediatric population 2011-2020. *The Journal of clinical pediatric dentistry*. 46. 51-57. 10.22514/jocpd.2022.007.
47. Lin, Y., Liang, X., Li, Z. et al. Omics for deciphering oral microecology. *Int J Oral Sci* 16, 2 (2024). <https://doi.org/10.1038/s41368-023-00264-x>
48. Cui, M., Cheng, C. & Zhang, L. High-throughput proteomics: a methodological mini-review. *Lab Invest* 102, 1170–1181 (2022). <https://doi.org/10.1038/s41374-022-00830-7>
49. Dai Xiaofeng, Shen Li, *Advances and Trends in Omics Technology Development*, *Frontiers in Medicine*, 2022

FIGURES:

1. Prevalence of untreated caries of permanent teeth in people 5+ years [Internet]. Geneva: World Health Organization; [cited 2024 Apr 14].