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PREVALENCE OF DENTAL CARIES AND ORAL HABITS AND ITS EFFECTS ON OCCLUSION AMONG 3 - 6 YEARS OLD CHILDREN IN KOSOVO

DOCTORAL DISSERTATION

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Supervisor:

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Zagreb, 2026.

Sveučiliste u Zagrebu

Stomatološki Fakultet

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PREVALENCIJA KARIJESA I NEPOGODNIH NAVIKA I UTJECAJ NA OKLUZIJU DJECE U DOBI OD 3 DO 6 GODINA U KOSOVU

DOKTORSKI RAD

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Zagreb, 2026.

This research was carried out in kindergartens in Pristina, the capital of Kosovo.

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5. ______________________________

Date of thesis defense: ____________________ (subsequently written by hand)

Thesis contains 131 pages

25 tables

30 figures

1 CD

Acknowledgments

The pursuit of my academic ambition, including attaining a Ph.D., has been a lengthy and challenging journey. I continued my work toward my goal even though the worldwide pandemic created numerous obstacles. I achieved success after dedicating myself to this challenging task. The experience has proven to me that determination, together with focus, will help me achieve any goal I set. My Ph.D. research received essential guidance from Professor Sandra Anić Milošević whom I thank deeply for his mentorship. She has provided me with constant support while motivating me to succeed, as my dedicated research mentor. Her feedback and constructive criticism have provided me with the strength I needed to continue on my path toward reaching my objectives.

My gratitude also goes to Professor Marina Lapter Varga, for her supportive, motivating, and very positive attitude. I am deeply thankful for her cooperation.

I would like to thank all the participating kindergartens for their support of this research initiative. The enthusiasm and willingness of the participants to provide feedback made this research a pleasure. Additionally, I would also like to thank the Directorate of Education in the Municipality of Pristina, and the teachers and kindergarten principals for allowing me to conduct my research and providing any assistance requested. I express my deepest gratitude to the children from the kindergartens because they continuously offered their assistance and demonstrated their love for me.

I am very much thankful for my caring, supportive family, especially my wife and my daughter Bora, my beloved parents, for their continuing unconditional support and encouragement throughout my entire education journey.

I also thank my friends, colleagues and students for their valuable support. Bora served as my primary motivational force which drove me throughout the entire experience.

I feel privileged to dedicate my Ph.D. work to my parents and my family because they have always supported me throughout my entire life.

SUMMARY

PREVALENCE OF DENTAL CARIES AND ORAL HABITS AND ITS EFFECTS ON OCCLUSION AMONG 3- 6 YEARS OLD CHILDREN IN KOSOVO

Dental caries is one of the most common diseases in early childhood and represents a major public health problem due to its negative physical, functional and psychosocial consequences. In addition, deleterious oral habits among children such as thumb sucking, prolonged bottle feeding, pacifier use and mouth breathing are recognized risk factors for disorders in craniofacial growth and occlusal development, especially when these habits persist beyond the age of three. Despite the global importance of these conditions, epidemiological data on dental caries and undesirable habits in preschool children in Kosovo are limited. The aim of this study was to evaluate the prevalence of dental caries and unhealthy oral habits, examine their effects on occlusal features, and assess the influence of age and gender on these relationships among children aged 3 to 6 years. Over 700 children of both sexes were clinically examined. Caries was assessed using the WHO Oral Health Assessment Form for Children. Children's adverse habits and daily oral hygiene practices were recorded using a structured questionnaire for parents. The association between nominal variables was assessed using the chi-square (χ^2) test. Spearman's rank correlation coefficient and Kendall's Tau correlation were employed for continuous variables. In addition, the Mann-Whitney U test and the Kruskal-Wallis test were used to compare continuous or ordinal outcomes in groups. The binary logistic regression method was also used to investigate predictive relationships between occlusal features and variables derived from the questionnaire. The results have shown that early childhood caries (ECC) is highly prevalent among preschool children in Pristina, Kosovo, with a mean defs index value of 10.05 ± 15.35. Significant associations were observed between ECC and specific oral habits, especially pacifier use ($p = 0.031$) and mouth breathing ($p = 0.014$), while other habits did not show a statistically significant association. The analysis of occlusal features revealed that the most prevalent relationships were Class I molar, and Class I canine relationships (57.7% and 62.9%, respectively). Maintaining oral hygiene was not optimal. 52% of children brushed their teeth only once a day without parental help, while 77.6% of children visited the dentist only once a year. These results highlight the impact of long-term non-nutritional oral habits on abnormal development of primary occlusion.

Keywords: Primary dentition, early childhood caries, deleterious oral habits

PROŠIRENI SAŽETAK

PREVALENCIJA KARIJESA I NEPOGODNIH NAVIKA I UTJECAJ NA OKLUZIJU DJECE U DOBI OD 3 DO 6 GODINA U KOSOVU

Cilj istraživanja

Primarni cilj ove studije bio je istražiti prevalenciju zubnog karijesa i štetnih oralnih navika, uključujući nenutritivno sisanje, guranje jezika, dugotrajnu uporabu dude varalice i disanje na usta, među djecom u dobi od 3 do 6 godina koja pohađaju vrtiće u Prištini, glavnom gradu Kosova. Ovo istraživanje je ispitivalo kako ovi čimbenici utječu na progresiju okluzalne anomalije fokusirajući se na otkrivanje početnih pokazatelja malokluzije povezanih s karijesom u ranom djetinjstvu, oralnim navikama i provođenjem higijenskih mjera unutar ove specifične skupine.

Materijali i metode

Istraživanje je obuhvatilo djecu koja su pohađala osam javnih vrtića i tri privatne ustanove. Istraživači su prikupili kliničke podatke putem izravne procjene sudionika tijekom planiranih procjena oralnog zdravlja koje su se održavale u vrtićima. U studiji su sudjelovali sudionici koji su ispunjavali sljedeće kriterije: sudionici su morali biti državljani Kosova u dobi od 3 do 6 godina i pohađati vrtić. Ispitanici su morali imati potpuno razvijene mliječne zube, a da im trajni zubi još nisu počeli nicati. Ispitanici nisu trebali imati prethodnog iskustva u ortodontskom liječenju. Ispitanici su morali imati normalne strukture lica bez rascjepa usne ili nepca ili devijacija nosne pregrade. Ispitanici nisu smjeli imati nikakvih sistemskih stanja poput neuromuskularnih poremećaja, respiratornih problema ili kongenitalnih bolesti. Tijekom kliničkih procjena djece koristili smo validirane upitnike za istraživanje oralnih navika i higijenskih praksi. Upitnici su uključivali zatvorena pitanja za prikupljanje demografskih podataka (dob i spol) kao i detaljne uvide u oralne navike i higijenske prakse. Roditelji ili skrbnici zamoljeni su da prijave prisutnost nenutritivnih ponašanja sisanja, uključujući sisanje palca, korištenje dude varalice, grickanje noktiju, grickanje usana, potiskivanje jezika, bruksizam (škrgutanje zubima) i disanje na usta. Prikupljanje podataka za svaku naviku uključivalo je osnovne zapise kao što su datum početka, učestalost i trajanje navike. Na temelju odgovora prikupljenih iz obrasca dobili smo detalje o tome koliko često djeca peru zube, koju vrstu paste za zube koriste (fluoriranu ili nefluoriranu), kao i zapise o roditeljskom nadzoru tijekom pranja zubi te njihovu povijest prethodnih posjeta stomatologu.Osim toga, procijenjena je svijest i stavovi roditelja o značaju oralne higijene i preventivne stomatološke skrbi tijekom ranog djetinjstva. Karijes u ranom djetinjstvu (ECC) je procijenjen prema standardiziranim kriterijima iz WHO-ovog obrasca za procjenu oralnog zdravlja djece (prema površini zuba) iz 2013. godine. Statističke analize su provedene korištenjem parametarskih i neparametrijskih metoda. Deskriptivna statistika sažela je skup podataka, dok su neparametrijski testovi korišteni za varijable koje nisu zadovoljavale pretpostavke normalnosti. Hi-kvadrat testovi, korelacijske analize i binarni logistički regresijski modeli su korišteni za ispitivanje povezanosti i prediktivnih odnosa između varijabli.

Rezultati

Studija je otkrila da zubni karijes najčešće pogađa djecu u dobi od 3 do 6 godina koja pohađaju vrtiće u Prištini na Kosovu. Prosječni defs indeks je bio 10,05 ± 15,35, s karijesnim površinama (ds) koje čine najveću komponentu s 8,86 ± 14,37. Komponenta ispunjenih površina (fs) iznosi prosječno 0,15. Ovako niska vrijednost ukazuje na slabiju dostupnost ili nedovoljno korištenje usluga restorativne stomatološke skrbi. Prosječni defs rezultat stalno se povećavao s dobi, od 8,72 u dobi od 3 godine do 11,73 u dobi od 6 godina. Studija je pokazala da muška djeca pokazuju veću prevalenciju zubnog karijesa nego ženska djeca (prosječni defs: 10,69 naspram 9,18).Podatci istraživanja su pokazali da je težina karijesa rane dječje dobi (ECC-a), na temelju mjerenja defs indeksa, dala rezultate koji odgovaraju specifičnim oralnim aktivnostima. Studija je otkrila da korištenje dude varalice i disanje na usta ukazuje na jaku povezanost s višim defs vrijednostima koje su dosegle statističku značajnost pri p = 0,031, odnosno p = 0,014. Studija je pokazala da zbog ovakvih navika djeca mogu biti podložnija razvoju karijesa tijekom ranih godina života. Nije pronađena značajna ukupna povezanost između zubnog karijesa i malokluzije u mliječnoj denticiji. Istraživanje okluzalnih obrazaca je pokazalo da je ravna terminalna ravnina (koja odgovara molarnom odnosu klase I) najčešća (57,7 %), potom distalna stepenica (klasa II; 27,8 %) te mezijalna stepenica (klasa III; 2,0 %). Slično tome, rezultati ove studije otkrili su da su se odnosi s očnjacima klase I pojavili kod 62,9% djece, dok su se odnosi klase II i klase III pojavili kod 30,7% odnosno 2,1% djece. S druge strane, pronađene su jake korelacije između navika sisanja koje nisu povezane s nenutritivnim navikama sisanja i okluzalnim značajkama.

Uočeno je da je sisanje prsta ili palca značajno povezano s povećanim horizontalnim prijeklopom.Osim toga, sisanje usana i grizenje usana/obraza bili su povezani s dubokim zagrizom. Studija je pokazala da djeca s dugotrajnim navikama sisanja prsta ili palca doživljavaju značajne promjene u razvoju primarne okluzije te da trajanje tih navika izravno određuje razmjer njihova utjecaja na razvoj zuba.

Zaključak

Ovo istraživanje pokazuje da karijes u ranom djetinjstvu (ECC) pogađa veliki broj djece vrtićke dobi u Prištini na Kosovu te da je ECC veliki javnozdravstveni problem. Visoka stopa netretiranih karijesnih površina zuba i nedostatak restauracija ukazuju na to da oralnozdravstvene usluge trebaju bolje preventivne i terapijske pristupe. Studija je pokazala da učestalost karijesa raste s dobi te da je on učestaliji kod muške djece. To ukazuje na potrebu za hitnom stomatološkom skrbi koja uvažava razlike u dobi i spolu. Višestruki uzroci ECC-a postali su očiti kroz istraživanja, koja su pokazala da ponašanje ispitanika i navike oralne higijene igraju najvažniju ulogu u razvoju karijesa. Studija je pokazala da su djeca koja su koristila dude varalice ili disala na usta imala više defs vrijednosti, što ukazuje na to da ta ponašanja doprinose razvoju karijesa u ranom djetinjstvu. Sudionici studije pokazali su loše navike oralne higijene. Naime, 69,5 % njih pere zube samostalno, bez nadzora roditelja, 51,9 % pere zube samo jednom dnevno, a 77,6 % posjećuje stomatologa rjeđe od jednom godišnje. Dobiveni rezultati istraživanja ukazuju na zabrinjavajući trend: unatoč širokoj primjeni pasta za zube s fluoridom, on ne predstavlja supstitut za adekvatnu oralnu higijenu i kontinuirani roditeljski nadzor.Istraživanje nije pronašlo statistički značajnu vezu između karijesa u ranom djetinjstvu (ECC) i malokluzije; međutim, pokazalo je da produljene nenutritivne navike sisanja doprinose raznim okluzalnim problemima, uključujući povećani horizontalni prijeklop, duboki zagriz, križni zagriz i nepovoljan položaj čeljusti. Ovi rezultati ukazuju na to da produljena ustrajnost u takvim navikama nakon dojenačke dobi može imati ulogu u razvoju malokluzija tijekom faze mliječne denticije. Rezultati istraživanja pokazuju da moramo stvoriti hitne preventivne strategije za suočavanje sa svim elementima ove izvanredne situacije. Program bi trebao uključivati četiri bitna elementa: nadzirano pranje zubi za djecu od rane dobi, planirane stomatološke preglede, obrazovne programe o oralnom zdravlju za roditelje i skrbnike te brzo liječenje štetnih oralnih praksi. Provedba ovih mjera služi sljedećim dvjema svrhama: smanjenju problema povezanih s ECC-om i promicanju optimalnog razvoja zubne okluzije kod predškolske djece na Kosovu.

Ključne riječi: mliječna denticija, rani dječji karijes, defs indeks, oralne navike

TABLE OF CONTENTS

List of abbreviations:

Defs	decayed, extracted, filled surfaces
Ds	decayed surfaces
Es	extracted surfaces
Fs	filled surfaces
FTP	Flush terminal plane
DS	Distal Step
MS	Mesial Step
FDI	World Dental Federation
ECC	Early Childhood Caries
WHO	The World Health Organization
NNS	Nonnutritive Sucking
MB	Mouth Breathing
AOB	Anterior Open Bite
LSI	Lips Incompetence
TS	Thumb Sucking
TNP	Thin-neck Pacifier
M	Arithmetic Mean
SD	Standard Deviation
S.E	Standard Error
C.I.	Confidence Interval
ANOVA	Analysis of Variance
LR	Logistic Regression
OR	Odds Ratio

1. INTRODUCTION

1.1 **Dental caries**

The public health community identifies dental caries as a major issue because it leads to severe physical and mental health problems which affect children. Dental caries is associated with pain, impaired growth and development, speech disorders, and often premature tooth loss, which leads to chewing difficulties and loss of self-confidence (1-5).

The World Health Organization (WHO) identifies dental caries as one of the most widespread diseases globally, ranking third among chronic non-communicable diseases after cancer and cardiovascular disease. It is the most prevalent condition affecting permanent teeth (impacting 2.3 billion people) and ranks twelfth for deciduous teeth, affecting approximately 560 million children (3,6).

The WHO's Global Oral Health Status Report (2022) estimates that the global, average prevalence of caries in deciduous teeth is 43%. Furthermore, in 134 out of 194 WHO Member States (69%), the prevalence exceeds 40%. The prevalence rate reaches its lowest point at 38% in high-income countries, yet lower-middle-income countries report the highest rate at 46%. The lowest-middle-income countries report the highest total number of cases at 244 million, while high-income nations have 45 million reported cases (7). In 2015, an estimated 573 million children had untreated dental caries in their primary teeth (8). Primary (deciduous) teeth are particularly susceptible to dental caries because of their thinner enamel and dentine layers, which allow rapid progression of the disease. The process results in dental complications which include pulpitis and apical periodontitis that could potentially impact the development of permanent teeth. The three essential elements which cause dental caries development include consuming sugar products regularly, failing to maintain proper oral hygiene and missing dental examinations, and insufficient preventive dental services (9,10). The World Health Organization (WHO) selected five age ranges for caries rate assessment because these groups follow the essential oral health evaluation standards, and include 5 years, 12 years, 17-18 years, 35-44 years, and 65-74 years Petersen, 2003, (11), The World Health Organization, 2013 (12). It has been reported that caries distribution in primary dentition follows a typical pattern. The caries pattern shows different patterns according to three factors including age, gender and race, dietary habits, oral hygiene practices, geographic location and socioeconomic status. The different teeth face different risks when it comes to tooth decay development. Therefore, it is important to know the relative susceptibility to caries of teeth in the maxillary and mandibular arches (13).

1.1.1 Early Childhood Caries (ECC)

The presence of dental caries in the primary dentition of young children is referred to as "Early Childhood Caries" (ECC). According to the American Academy of Pediatric Dentistry, ECC is defined as the presence of one or more decayed (non-cavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth of a child aged 71 months (5 years) or younger (14). More recently, this definition was revised during the Bangkok Declaration by a group of International experts, expanding it to include the presence of one or more carious (non-cavitated or cavitated) lesions, missing (due to caries), or filled surfaces in any primary tooth of a child under six years of age (15).

The term Early Childhood Caries combines two previous dental conditions which were known as "nursing caries" and "rampant caries". The terms such as "baby bottle syndrome", "nursing caries" and "bottle mouth caries" describe a specific tooth decay pattern which primarily damages the upper front teeth and back teeth but leaves the lower front teeth mostly unaffected. Rampant caries, on the other hand, refers to extensive, aggressive carious lesions affecting multiple teeth in children aged three to four years, without necessarily following the pattern of nursing caries (16).

ECC exists as a preventable childhood disease which affects millions of children worldwide because it primarily affects children from low-income families (17). The development of ECC follows the same pattern as dental caries because it results from a long-term process where cariogenic bacteria interact with food carbohydrates and tooth surfaces (18).

1.1.2 Etiopathogenesis of Early Childhood Caries

The development of dental caries depends on multiple microorganisms which initiate and progress the disease process. The bacteria *Streptococcus mutans* (MS) and *Streptococcus sobrinus* cause the first stages of tooth decay, but Lactobacilli bacteria advance the development of carious lesions. The bacteria *Actinomyces gerencseriae* cause caries development at its beginning while Bifidobacterium species appear in the advanced stages of carious lesions. The main route of vertical transmission for these microorganisms involves mother-to-child saliva exchange, which happens most frequently during the 19 to 31 month period, known as the "window of infectivity". The combination of poor maternal oral hygiene and daily sugar intake creates conditions which enable bacteria to move between mothers and their children. Research has shown that MS can spread between family members through horizontal transmission, which involves siblings and their caregivers. Research shows that children who have high MS levels in their saliva become five times more likely to develop dental caries (19). The scientific evidence shows that sucrose, fructose, glucose and refined flour carbohydrates establish the best environment for dental caries to develop and spread. The cariogenic potential of these sugars reaches its highest point with sucrose because its breakdown produces dextrans which create surfaces for bacterial attachment to teeth, thus forming cariogenic biofilms. Despite the well-established nutritional benefits of breastfeeding, the American Association of Pediatric Dentistry (AAPD) advises caution regarding frequent night-time and on-demand breastfeeding after the eruption of teeth, as it may contribute to the development of Early Childhood Caries (ECC) (20). Multiple research studies have investigated the connection between breastfeeding methods and Early Childhood Caries but the results have not established clear evidence, so additional studies are needed (21). The British Society of Paediatric Dentistry issued guidelines in 2018 which suggested that parents should stop breastfeeding their children after their first year to prevent dental caries through the practice of avoiding nighttime feedings (22). A multitude of factors have been identified as potential predisposing elements for ECC. The following factors contribute to dental caries development, according to research: immunological deficiencies, hyposalivation, immature enamel, dental plaque accumulation, tooth structure developmental defects, and various elements that affect oral health results through socioeconomic factors (23). Saliva functions as a protective agent against dental caries through various mechanisms, which include food debris and sugars elimination, microorganism aggregation and removal, and acid neutralization through buffering and antimicrobial properties. Conversely, salivary dysfunction characterized by reduced flow rate and compromised buffering capacity has been associated with increased caries incidence (24). Some studies have examined the relationship between palatine tonsil hypertrophy and dental caries, suggesting that enlarged tonsils can lead to mouth breathing, which may predispose children to orofacial anomalies and a heightened risk of dental caries (25).

Research shows that children who do not receive treatment for their decayed teeth will have worse OHRQoL than children without tooth decay, according to both child and parent evaluations (26,27). Research indicates that preschool children who have decayed teeth become more likely to experience extended periods of limited mobility, missing school days, and poor academic performance (28). The development of caries in preschool children creates two major problems which affect their dental health and their family's economic situation. The need for parents to leave their jobs for child healthcare visits at treatment facilities creates economic challenges for families (29).

Early Childhood Caries (ECC) has major effects which impact the development, nutrition and oral health quality of life for children and their entire families (14). Numerous studies have worked to identify and classify ECC risk factors, which include sociodemographic characteristics, dietary patterns, oral care habits, bacterial populations in the mouth, and infant nutrition choices between breastfeeding and bottle-feeding (14,30,31). RM Vargas et al. published research which delivers a comprehensive evaluation of these elements in their recent studies (32), as well as DJ Blanco-Victorio et al. (33). These researchers discovered that ECC patterns connected to three factors which included child age and family income, caregiver education level, child oral hygiene practices, and sweet food intake (32,33). The research results show that we must start right away to create effective prevention strategies and early intervention protocols because ECC cases continue to rise among at-risk groups. The prevention of this condition requires parents and their communities to learn about correct oral care techniques, nutritious eating habits, and scheduled dental check-ups. The reduction of ECC cases among vulnerable populations who face high risks will be achieved through community-based oral health promotion programs and improved dental care service availability.

1.1.3 Prevalence of Early Childhood Caries (ECC)

The authors Tinanoff et al. delivered an essential summary in their work at the International Association of Paediatric Dentistry (IAPD) Conference on ECC in 2018, having reviewed 72 studies published between 1998 and 2018. The researchers tracked ECC occurrence rates which ranged from 12% to 98%, throughout the four-year research period. The research data showed that the prevalence increased progressively with age: 17% in 1-year-olds, 36% in 2-year-olds, 43% in 3-year-olds, 55% in 4-year-olds, and 63% in 5-year-olds (34).

The research analyzed 100 publications which appeared between 2011 and 2022 and originated from 49 different countries across the world. The findings reported a global random-effects pooled ECC prevalence of 49%. The research found Greece and Japan to have the lowest prevalence rates, at 19.3% and 20.6% respectively. The Middle East showed the highest prevalence at 72%, while North America had 57%, Asia-Oceania had 52%, Africa had 42%, Europe had 36%, and Central and South America 34% (35). The different rates of ECC occurrence between nations could result from variations between countries regarding their diagnostic methods, their economic status, their dental prevention initiatives, and the ability to receive oral health care.

Early Childhood Caries (ECC) in Kosovo remains a significant public health concern. Research studies have evaluated the occurrence and intensity of ECC through dmft and dmfs indices which measure decayed, missing and filled teeth surfaces. According to earlier investigations, the prevalence of ECC among preschool children in Kosovo ranged from 17.36% to 21% (37). A study by Begzati et al. (36) from 2010 assessed ECC severity through dmft index evaluation and showed that children between 3-5 years old had an average dmft score of 3.35 ± 3.84, thus demonstrating a major caries problem in this population. The study revealed that most caries cases went untreated, which produced elevated dmft values because the decayed (d) section exceeded 90% of the total score. The insufficient restorative care and restricted access to preventive services resulted in elevated dmft values because most caries cases received no treatment. The Kosovo microbiology study revealed *Streptococcus mutans* bacteria as the main cause of repeated infections leading to Early Childhood Caries in children. Begzati et al. (37) performed research which showed *Streptococcus mutans* infected 90% of ECC children proving that the bacteria acts as a primary cause of tooth decay throughout the region. Research studies have proven that children who consume sweets throughout their day will develop ECC leading to dmft ($p < 0.001$). Comparison of the dmft of children with ECC and the duration of bottle feeding showed a statistical correlation ($p < 0.001$). The mean plaque index score was 1.52 (36). ECC prevalence in Kosovo is at moderate levels compared to other parts of the world because the country has specific feeding methods, oral care routines, fluoride access, economic status and healthcare delivery patterns. The dmft scores remain at high levels while microbial risk factors stay elevated which requires Kosovo to establish immediate oral health promotion programs and early prevention measures and better dental care access for its preschool children.

1.1.4 Association Between Dental Caries and Malocclusion

Numerous epidemiological research studies have investigated how often children develop dental caries and malocclusion in pediatric populations (38). The existing research contains extensive data but scientists have not conducted enough studies to measure dental health and orthodontic status in sufficient numbers of representative participants. The scientific community lacks research about dental caries and malocclusion because no systematic studies exist to study their relationship. According to Zhang (39) and Stahl (40), dental caries is not considered a significant contributing factor in the development of the most prevalent types of malocclusions in the primary dentition. Several other authors have accepted that dental caries and the premature loss of primary teeth may act as contributing factors to the development of occlusal disturbances and space-related anomalies in the mixed and permanent dentitions (41, 42, 43). These assumptions stem from the knowledge that untreated carious lesions will result in premature tooth loss, which breaks down tooth structure and creates problems with tooth development. The scientific community has not established a direct connection between dental caries and malocclusion (44). Efforts to identify an association between these two conditions have yielded inconsistent and, at times, contradictory findings (44, 45). The different results stem from various factors, which include the different characteristics of the study participants, small research groups and inconsistent methods for determining tooth caries status. The primary dentition plays an essential role because it functions as a natural space maintainer which guides the proper eruption of permanent teeth (46). The loss of primary teeth before their time because of tooth decay causes neighboring teeth to shift in the mouth which results in teeth crowding and other occlusal anomalies. Research conducted in Shkodra, located in northern Albania (47), found a significant association between caries and malocclusion in preschool children. The study showed that children who had caries developed two main dental issues, which included increased overjet (42%) and increased overbite. The regression analysis showed that children without maxillary spacing developed caries at 2.564 times the rate of others, but deep bite reduced their caries risk to 0.814 times. The research results demonstrate that in preschool children we need a better understanding about how these two conditions affect each other. The primary dentition malocclusion develops from multiple causes, and scientists continue to debate about the significance of primary occlusal characteristics in determining permanent dentition malocclusion (48, 49). Research has not proven a direct relationship between caries and malocclusion because scientists have not found enough evidence to link these two conditions. The relationship between this condition needs clarification through studies which use standardized diagnostic methods to follow patients over time, with enough participants in their research.

1.2 Deleterious Oral Habits

Children develop their dentition and occlusion through main factors which include dental caries, deleterious oral habits, and insufficient oral hygiene practices. The craniofacial complex, together with the dental arches and occlusal relationships reach their most critical development phase during the first six years of life, beginning at age three. Children need to develop dental health and psychosocial well-being through proper oral habits during their early developmental stage. Thumb sucking, pacifier use, mouth breathing, and tongue thrusting habits affect the dental health of preschool and kindergarten children who develop these habits. Dental professionals need to identify these behaviors because their recognition enables them to stop malocclusions and other related problems from developing (50).

Children who develop deleterious oral habits will experience problems with occlusion, but these habits will also create multiple additional issues which impact their psychological and social growth. Children who keep sucking their thumbs or mouth breathing will develop malocclusion, while their self-esteem and social relationships with peers become affected because others notice their appearance (Katib et al.,2024) (51).The psychological effects of these behaviors establish an anxiety pattern which makes dental check-ups more difficult for children to handle, so they may develop dental care avoidance in their future years (Kuznetsov et al.,2015)(52). The treatment of these habits by pediatric dentists requires them to handle their physical effects while using behavioral methods which create positive dental experiences for young patients, in order to achieve better oral health and emotional wellness.

1.2.1 Types of Deleterious Oral Habits

Deleterious oral habits are defined as repetitive, non-functional behaviors involving the oral and perioral musculature which, when persisting beyond early childhood, have the potential to disrupt the normal growth and development of the craniofacial complex and occlusion. The natural process of primary dentition development will cause non-nutritive sucking behaviors to fade away, but their continuation into mixed or permanent dentition stages produces various detrimental effects on dental and skeletal structures. The following section examines the main harmful oral practices which cause dental misalignment in children, on the basis of current scientific research.

1.2.2 Mouth Breathing

Children develop mouth breathing as a functional habit because their upper airway becomes blocked by enlarged adenoids, tonsillar hypertrophy, allergic rhinitis, or chronic nasal infections. Regular breathing through the mouth leads people to adopt a specific body position, which includes dropping their jaw and tongue while their head tilts backward and their face muscles extend. The facial skeleton and dentition experience changes in their muscular force distribution because of maintenance of this position for an extended period.

The body develops these changes through its repeated response to this situation, which results in three main dentofacial alterations that affect the lower front facial area and tooth position. The mandible moves downward and backward, which leads to the formation of anterior open bite and the development of increased overjet. The extended buccal muscles create abnormal side forces, which affect the upper jaw dental structure to produce maxillary arch narrowing and posterior crossbite (53).

Souki et al. in their cross-sectional descriptive study found that mouth breathing creates a positive link with posterior crossbite development which proves how this habit affects transverse dental arch discrepancies (54). Similarly, research conducted by Grippaudo et al. demonstrated that mouth breathing functions as a primary factor, which leads to tooth position problems and changes in skeletal development patterns. The authors stated that children who breathe through their mouths face an increased danger of developing malocclusion because their facial development becomes abnormal, while their genetic makeup might already contain malocclusion risk factors (55).

Kharat et al. explains that people develop mouth breathing as a habit, but this breathing pattern can also be secondary to prolonged nasal mucosal inflammation caused by allergic reactions or chronic infections, underscoring the importance of identifying underlying medical causes (56). Research indicates that facial genotypes affect how mouth-breathing affects the relationship between teeth in different parts of the mouth, which shows that environmental factors and genetic inheritance affect the development of malocclusion in these cases (56). Healthcare providers need to detect mouth breathing habits, together with their associated pathological conditions, when they first appear to achieve successful medical and orthodontic treatment which stops the development of permanent functional and aesthetic issues.

1.2.3 Tongue thrusting

Tongue thrusting is a harmful oral behavior characterized by the persistence of the infantile swallow pattern beyond early childhood, often continuing into adolescence. This dysfunctional swallowing pattern is typically associated with protrusion of the anterior tooth segment and the development of anterior open bite malocclusions. In a normal, mature swallowing pattern, the tip of the tongue is positioned against the papilla when the dental arches are in contact, with minimal perioral muscle activity, brief occlusal contact, and no forward tongue posture during deglutition (56). Any deviation from this physiological pattern is termed “atypical swallowing”, which is commonly observed in pediatric populations and frequently associated with other oral habits such as thumb sucking and mouth breathing. Tongue thrust was defined by Begnoni et al. as the forward position of the tongue between upper and lower incisors or cuspids during swallowing (57). Maspero et al. also mentioned the anterior resting posture of the tongue during swallowing. Generally, during swallowing not only the movement of the tongue is considered an oral habit but also any change in the resting position of the tongue itself (58).

During atypical swallowing, specifically in cases of tongue thrusting, the tongue moves anteriorly to make contact with the anterior teeth and the molars while swallowing (59). The prevalence of tongue thrusting among young children, particularly those aged four to six years, has been reported to range between 40% and 80% in various epidemiological studies (60,61). This high prevalence highlights the clinical importance of early identification and management to prevent the development of malocclusion. According to Proffit, the infantile swallowing pattern is more likely to be caused by AOB (anterior open bite) rather than the other way around. On the other hand, ultrasonography assessment of swallowing has provided information indicating that infantile swallowing is an important element in anterior open bite formation (53).

Kharat et al. proposed a significant association between tongue thrusting and the development of specific malocclusions, notably anterior open bite. The tongue’s position in front of the incisors blocks tooth development which causes the incisors to grow below the normal position and creates a reversed Curve of Spee that doctors can see through lateral cephalometric X-rays (56). The distinction between a mature swallower and a tongue-thrust swallower becomes possible through clinical observation of their swallowing patterns. These include muscle over activation and buccinator hyperactivity, and no brief tooth interaction during swallowing. The oral functions of tongue thrusting create two main effects on tooth alignment and jaw relationship, which lead to worsened oral sensory skills and motor abilities that make pre-existing bite problems worse, and create additional dental anomalies (62). The ongoing practice of tongue thrusting creates difficulties for the success and maintenance of orthodontic treatment, so healthcare professionals need to

work together through myofunctional therapy, habit-breaking appliances and patient education programs.

The high occurrence rate of tongue thrusting requires immediate identification followed by treatment because it creates major problems for tooth development in children.

1.2.4 Thumb Sucking

Thumb sucking (TS) is classified as a non-nutritive sucking habit (63). It can begin as early as the 29th week of gestation, is commonly observed in infants, and typically peaks between 18 and 21 months of age (64). Dental occlusion abnormalities associated with thumb sucking are often accompanied by alterations in dental arch characteristics. The habit first appears as an infantile reflex which some research indicates people use to cope with fatigue, boredom, fear, excitement, hunger, and physical and psychological distress. This behavior provides comfort and security during stressful periods. Depending on its duration, frequency and intensity, thumb sucking may contribute to both thumb deformities and dental occlusal discrepancies (56). Sucking is a natural instinct and represents an early coordinated muscular activity in infants, contributing to oral motor development (65,66). Repetition of this action increases muscle tone and promotes proper neuromuscular coordination, supporting correct development of oral function (67).

Kumar V. et al. described thumb sucking as an adaptive functional activity, offering sensory stimulation and self-soothing benefits (68). Further investigations have detailed the mechanisms by which thumb sucking affects dental structures. Specifically, it displaces the tongue to a lower position, disrupting the balance between the outward pressure of the tongue and the inward contraction of the cheek muscles. This imbalance can lead to a narrowing of the maxillary arch (69). Ferrante reported that thumb sucking stimulates nasopalatine receptors, creating a muscular balance that alleviates both mental and physical stress (70).

Non-nutritive sucking habits, including thumb and finger sucking, are widespread among children globally, regardless of their socioeconomic background. The prevalence of thumb sucking (TS) varies by geographic region, but remains one of the most frequently observed oral habits (71). In a cross-sectional study among preschool children, Kanika Dull reported a TS prevalence rate of 12.8% (72). Similar findings were noted by Santos et al. (73) and (Abuaffan & Omer, 2015) (74) among Brazilian and Sudanese preschool populations, respectively. Additionally, a study involving 2707 children aged 7–15 years in Tirana, Albania, revealed a TS prevalence of 11.4% (75). Among 1385 Brazilian schoolchildren aged 5–6 years, finger sucking was reported by 17.2% (76). In the United States, one study found a 73% incidence of non-nutritive sucking habits in children aged 2 to 5 years, with the habit persisting in 1.9% of children at 12 years of age (63).

1.2.5 Pacifier use

Children in early developmental stages frequently display non-nutritive sucking (NNS) which research shows affects between 60% and more than 80% of children (77,78). Babies use pacifiers as comfort items which help them sleep and find relief during stressful or painful moments (79,80,81). Ideally, NNS habits should be discontinued between 24 and 36 months of age to reduce the risk of developing malocclusions (80,82). Thumb sucking and pacifier use continue to be practiced by more than 20% of children who are three years old or more (77). Children who did not breastfeed or breastfed for less than six months developed pacifier sucking habits at a four times higher rate than children who breastfed for six months or more (83). Risk factors which result in extended NNS behaviors need to be evaluated on the basis of this established link. Research shows that pacifier use has also been linked to occlusal alterations (78,84,85). The buccinator muscle operates at high levels when people use pacifiers which could may restrict transverse growth of the mandible. The tongue position which occurs during pacifier use creates an obstacle for the hard palate because it fails to generate sufficient upward force, and this blocks the normal development of the maxillary arch (86,87,88,77).

Two primary types of pacifiers are commercially available: physiological (also known as orthodontic) pacifiers and conventional ones. The current scientific evidence lacks studies which evaluate how children's occlusal development differs when using pacifiers on the basis of their natural sucking patterns instead of traditional pacifiers. With the exception of one study (89), no clinically significant differences have been identified between the two types in terms of mean overjet, mean overbite, or the occurrence of anterior open bite (AOB) and posterior crossbite (89-92). Notably, a recent study by Wagner Y et al. (93) was the first to demonstrate the advantages associated with the use of a thin-neck pacifier (TNP) compared to the previously used physiological and conventional pacifiers. The study reported improvements in overjet and overbite dimensions. Although the observed differences were small, they reached statistical significance (93), highlighting the potential impact of pacifier design modifications on occlusal development outcomes. Another recent study showed that pacifier use might influence the relationship between longer breastfeeding duration and the lower prevalence of AOB in children with primary dentition. In other words, it is possible that the negative effect of prolonged pacifier use outweighs the potential benefit of breastfeeding on dental occlusion (94). Two other Brazilian studies have reported similar results. Both observed a negative association between the occurrence of AOB and breastfeeding duration (95,49).

The recommended age does not prevent NNS habits from continuing after early life while breastfeeding restrictions lead to the development of occlusal anomalies. The current evidence shows no significant clinical differences between physiological and conventional pacifiers, but studies indicate that new pacifier designs, such as the TNP, could provide actual oral contact advantages. The research requires more studies to be conducted in controlled environments, which should run for extended periods to validate these findings.

1.2.6 Nail biting, onychophagia

Nail biting, or onychophagia, is recognized as one of the most prevalent oral habits among children and remains a frequent concern for both pediatricians and pediatric dentists (96–98). The development of this condition results from multiple factors including elements of the family environment. Research indicates that genetic predisposition, together with behavioral patterns and psychological elements, determine the development of this habit. People often report that their family members have shown similar oral behaviors before them, including nail biting and finger sucking. The way children learn these behaviors seems to involve imitating what they see their parents and siblings doing. Research indicates that onychophagia develops because children experience various emotional and psychological states, including anxiety, stress, loneliness, feelings of abandonment, embarrassment, hunger and boredom. In many cases the habit serves as a comfort behavior to help them relax during their inactive time and when they face emotional difficulties. Research shows that children who suck their fingers or thumbs during early development may develop nail-biting habits when they grow older (99,100).

It is notable that onychophagia typically does not begin before the age of three years. The prevalence of this behavior appears frequently during human development beginning in childhood and becoming more common during adolescence before reaching its highest point in adulthood (101). Research studies have proven that nail biting leads to multiple orofacial system problems because of the resulting conditions. This continuous oral behavior leads to dental and periodontal problems which result in tooth enamel breakdown, gum damage, and malocclusions, but also trauma to adjacent soft tissues, particularly the cuticles, thereby heightening the risk of secondary bacterial infections (102–105). Research shows that people who bite their nails (onychophagia) tend to have perfectionist personalities and their nail biting behavior might stem from a core element which also leads to their perfectionistic nature. Research shows that people who exhibit perfectionist behavior patterns learn to recognize their feelings of boredom and frustration and this leads them to perform repetitive oral actions, such as nail biting (106). This behavior problem has negative effects on both the physical and psychological health of children. The following conditions may occur in severe cases of the disorder: tooth root damage, malocclusion, jaw disorders, and parasitosis (107). Research shows that nail biting affects different child populations at different levels during their preschool years. The worldwide prevalence of nail biting (onychophagia) continues to affect children throughout the world where different nations and age ranges show different levels of this oral habit. Research conducted in Bitola in North Macedonia, found that 22.02% of preschool children developed this condition without any age or gender differences (Rajchanovska and Zafirova., 2011) (108). Similarly a study conducted in Mangalore, India, revealed that school children developed the habit at a rate of 12.7% while the study showed girls developed the habit more than boys (109).

Other research has examined how nail biting relates to neurodevelopmental conditions including Attention Deficit Hyperactivity Disorder (ADHD) and Tourette Syndrome (TS). The study analyzed 35 Iranian children with TS using retrospective analysis and showed that nail biting occurred in 28.6% of patients, and ADHD affected 68.6% of cases (110). Further research data shows that children who bite their nails will develop ADHD at a rate of 74.6% and tic disorder at a rate of 12.7% (111).

1.2.7 Lip Incompetence

The growth of the maxillofacial complex is influenced by both genetic and environmental factors (112,113). Among the environmental influences, oral dysfunctions during childhood — such as abnormal swallowing, non-nutritive sucking, and mouth breathing — have been shown to significantly affect maxillofacial development, with impacts comparable to other environmental factors (114–117). These dysfunctions create problems which affect the balance of the orofacial muscles, while they also change the way the face develops during growth. Early identification of these conditions is essential because they need immediate treatment. The lips serve both as essential features for facial appearance and perform vital functions in the human face. The facial features create a perfect balance which leads to facial harmony, and they also help with phonation and create a front oral barrier during swallowing processes. Lip posture refers to the habitual positioning of the lips when the facial muscles are at rest — typically characterized by a natural muscular tone without excessive contraction.

The way soft tissues in the orolabial region position themselves is a personal characteristic which people naturally acquire when their body is at rest. The process of maintaining a proper lip seal requires the circumoral muscles to stay active throughout the entire time. The body performs compensatory movements which might show evidence of orofacial dysfunction or malocclusion patterns that could lead to the formation of abnormal oral habits and perioral muscle strain (118). F.B. Naini stated that the term “competent lips” signifies that the lips are able to contact one another without tension when the mandible is in the rest position (118). The condition known as lip incompetence (LI) appears frequently in dental patients who believe their lips show too much of their teeth, according to Proffit et al. (53). The orofacial dysfunction known as incompetent lip seal (ILS) represents a major problem because it interferes with oral functions while creating facial appearance issues which can lead to dental and facial structural problems. There is a significant number of cases of incompetent lip seal in children (ILS). Research by Drevenšek and Papic (119) showed that 35.72% of children exhibited an incompetent lip seal, which led to an higher number of malocclusions, especially Class II malocclusions occurring in 53.3% of cases.

Nogami et al. conducted an epidemiological study in Japan which included 3,399 children between 3 and 12 years old to collect data about their health practices and daily activities through questionnaires. The research results showed that 7% of participants had incompetent lip seal, while the number of cases rose with the age of the participants (120).

Another study by Yata et al. (121) discovered that Japanese children between 7 and 14 years old showed ILS symptoms at 45% in subjects with normal occlusion and 43% in subjects with malocclusion. De Menezes et al. (122) found that Brazilian children between 8 and 10 years old had a 34% rate of incompetent lip seal (ILS) while mouth breathers showed a statistically significant higher rate of ILS than nasal breathers. ILS influences maxillofacial anatomy and the shape of the dental arch (123). The process of dental arch formation depends on how lip and tongue forces interact with each other (124). It also leads to symptoms of oral and dental disorders, such as gingivitis, gum disease, bad breath, and a higher risk of cavities (125). If the oral balance is disrupted by ILS, malocclusion and oral dysfunction may occur. Research by Emi Inada et al. (126) stated that if the balance between the lips and the tongue is disrupted, malocclusions and oral problems can arise. They concluded that in order to prevent these problems, it is essential to check for signs of LI during the early years, and to restore the gap between the lips, preferably before the age of 3 years. Therefore, it is very important for dentists to look for signs of ILS during childhood.

1.3. Malocclusion

1.3.1 The Etiology and Prevalence of Malocclusion

Malocclusion is defined as the presence of misaligned teeth and/or discrepancies between the maxillary and mandibular arches (127,128). The development of this condition results from multiple genetic and environmental factors which affect craniofacial growth and dental development at different stages (129,130,131). Notably, malocclusion observed in the primary dentition is considered a potential predictor of similar anomalies in the permanent dentition (132,133). The development of malocclusion results from three main factors including embryonic development problems, fetal and perinatal growth issues, and progressive dental and skeletal abnormalities that occur during childhood, adolescence and the early stages of adult life (53). The environment of the mouth is affected by three major factors which scientists identify as mouth breathing, thumb sucking and tongue thrusting, because these habits continue to exist as the child grows (53). Research now shows that these habits function as risk factors which increase the chances of development of malocclusion rather than being the primary cause of this condition (134).

The craniofacial complex remains flexible during early childhood but the body requires proper mastication, phonation, and normal deglutition functions in order to achieve proper jaw structure and occlusal alignment. The persistence of harmful oral habits after children reach three to four years of age and after their permanent teeth emerge, will create problems which affect the balance between dental structures and orofacial musculature and occlusal function (135).

Research studies focusing on the distribution of diseases in populations have shown that primary dentition malocclusion rates differ significantly between different populations. Research studies have recorded prevalence rates at 63.2% in Brazil, 61.5% in southwest Germany, and 51.8% in mainland China (136,137,138). A recent study published in a systematic review showed the prevalence of malocclusion in primary dentition teeth ranged from 28.4% to 83.9%, where more than half of the studies found a prevalence above 50%. The study found Asia to have the highest prevalence rate at 61.81%, while Europe followed with 61.50%, South America with 52.69%, and Africa with 32.50% (139). The research revealed that particular malocclusion characteristics, including deep overbite and anterior

open bite, showed different patterns across different continents, which confirms that early childhood malocclusion needs to be addressed as a worldwide public health issue (139).
There are controversies regarding the causes of malocclusion in primary dentition and whether or not these are predictive of malocclusion in the permanent dentition (48,49).

1.3.2 Non-nutritive sucking habits related to malocclusion

Warren and Bishara (77) studied non-nutritive sucking behaviors to determine their effects on dental occlusal anomaly patterns through an extensive investigation. Non-nutritive sucking habits result in particular primary dentition malocclusions which include anterior open bite, increased overjet, and Class II canine and molar relationships.
Paolantonio E.G. et al.(134) performed a recent study which showed that preschool children who breathe through their mouths while practicing harmful oral habits will develop more malocclusion problems. The researchers discovered that more than 50% of preschoolers with malocclusion problems had additional risk indicators which included mouth breathing and dangerous oral practices. The research revealed that malocclusion required immediate orthodontic treatment for 38% of preschool children who also needed additional logopedic and otorhinolaryngological (ENT) therapy to handle their underlying risk factors. The study showed that 46% of preschool children either had dental misalignment risk factors which needed treatment, or already showed signs of malocclusion that would become severe if their risk factors were not properly managed. The study results demonstrate that children need to undergo early screening tests, and their treatment should involve multiple medical specialists to stop malocclusion from advancing during the important early childhood development period (134). The research by Otsugu et al.(140) studied malocclusion development while examining its relationship to oral habits and orofacial functional characteristics. The study reported that 62.0% of the preschool children examined presented with some form of malocclusion, while 27.8% exhibited an incompetent lip seal. The study found that nail biting occurred as the most frequent oral habit where 18.9% of participants exhibited this behavior.
The authors performed binary logistic regression analysis to show that incompetent lip seal is statistically significantly associated with malocclusion development, which makes incompetent lip seal a potential risk factor for occlusal anomalies. The study revealed an unexpected negative link between nail biting and malocclusion, which contradicts typical beliefs about damaging oral behaviors. The study results indicate that nail biting does not harm dental development in this specific group of people. The research results show how oral

habits impact different population segments, so researchers need to study cultural elements and functional aspects when seeking to understand how early childhood malocclusion develops (140). The research conducted by Garde et al (135) and Perillo et al. (141) described mouth breathing, lip sucking and biting, nail biting, and digit sucking as repetitive behaviors that also harm quality of life, as reported by most pediatricians. The extent of harm depends on the characteristics of these habits, together with the time they began and their duration (135). Furthermore, the patient’s age and gender are also important factors to consider.

2. THE AIM AND HYPOTHESES

2.1 The problem statement

The problem statement demonstrates the need for a complete study to determine how many kindergarten children in Kosovo aged 3 to 6 years have dental caries and harmful oral habits. The main objective of this study involves three main goals: determining ECC prevalence through defs index assessment, and to detect deleterious oral habits and oral hygiene practices and their effects on dental occlusion formation in young children.

There are many research studies about dental caries and oral habits for different populations, but no study has examined how these factors affect occlusal characteristics in Kosovo children. The research achieves its importance through its combined research design which uses clinical tests and parental survey data to study children's oral habits, their dental hygiene practices, and their caries development, according to WHO standards.

The research provides essential clinical information which doctors can use to identify early orthodontic conditions, create personalized treatment plans and prevent occlusal problems in children in their early stages. The study provides essential epidemiological data about ECC prevalence and oral habit damage, and their links to malocclusion in Kosovo kindergarten children. This will help develop better care approaches for pediatric dental and orthodontic services in the area.

2.2 The aim and objectives of the study

The aim of this study was to determine the prevalence of dental caries in the primary dentition using the defs index, as well as deleterious oral habits among 3–6-year-old kindergarten children in Kosovo, and to evaluate their association with the prevalence of malocclusion.The research investigates which oral activities result in occlusal problems that affect children's dental alignment during their development in this particular age range.

The Objectives of the Study

1. To determine the prevalence of deleterious oral habits, such as tongue thrusting, pacifier sucking, bottle feeding, thumb or finger sucking, and mouth breathing among children aged 3–6 years in Pristina, Kosovo.

2. To assess the defs index (decayed, missing/extracted, and filled tooth surfaces) among kindergarten children aged 3–6 years.

3. To determine the prevalence of malocclusion in the primary dentition among kindergarten children.

4. To evaluate the association between the prevalence of malocclusion and the presence or absence of deleterious oral habits in children with primary dentition.

5. To investigate the association between dental caries and the prevalence of malocclusion.

2.3. The Hypotheses

1. Children with deleterious oral habits will demonstrate a higher prevalence of malocclusion compared with children without such habits.

2. Deleterious Oral habits of greater intensity and longer duration will be associated with more severe occlusal changes in the primary dentition.

3. The presence of deleterious oral habits may interfere with the normal development of primary dentition.

4. Severe dental caries may accelerate the development of malocclusion in kindergarten children aged 3–6 years.

3. MATERIALS AND METHODS

3.1 Materials

3.1.1 Sample design

This study used a cross-sectional design and was conducted between June and December 2021 in the eastern region of the Republic of Kosovo. The research included 3 to 6 year old kindergarten children who participated through cluster sampling at 11 different kindergartens in Pristina.

The research included 655 children who were divided into 378 male participants who made up 57.7% of the study group, and 277 female participants who made up 42.3% of the study group. The male participants had an average age of 4.81 years, with a standard deviation of 0.93, while the female participants had an average age of 4.68 years, with a standard deviation of 0.96.

Participation in the clinical examination required written informed consent from the children’s parents or legal guardians. The researchers included only children whose parents gave complete authorization for participation in the study. The sample was considered representative of the target population in terms of age and sex distribution within the specified region.

3.1.2 The study materials

The research data came from two sources, using parental questionnaires and clinical evaluation procedures. The questionnaires collected information regarding the children’s oral habits and oral hygiene practices, completed by the parents or legal guardians. Clinical data were gathered from 655 kindergarten children enrolled in eight public and three private kindergartens in Pristina, the capital of the Republic of Kosovo. The research design employed two evaluation approaches to investigate how behavioral elements, together with medical signs, affect dental health results in the research subjects.

3.1.3 Selection criteria

The researchers established specific selection criteria which they used to choose participants who would form an appropriate research population. Participants were required to be of Kosovar nationality, aged between 3 and 6 years, and attending kindergarten at the time of data collection. The research included children who possessed a complete set of primary teeth, without any erupted permanent teeth. The research excluded children who had previous orthodontic treatment, a diagnosis of hypodontia, or any craniofacial anomalies such as cleft lip and/or palate, or a deviated nasal septum. The study excluded children who had systemic conditions such as neuromuscular disorders, respiratory problems, and congenital birth defects. Non-cooperative children, whose behavior could interfere with accurate clinical assessment, were also excluded.

3.1.4 Study design

The research design used a cross-sectional study which analyzed data from the study population at one particular time point. The prospective observational study design enabled researchers to evaluate how dental caries, deleterious oral habits, oral hygiene practices, and occlusal features relate to each other in children between 3 to 6 years old.

3.1.5 Sample size

The target population for this study comprised all children aged 3–6 years enrolled in public and three private preschool, and pre-primary institutions in the municipality of Pristina. According to the official Education Statistics from the Kosovo Agency of Statistics (KAS) 2019/2020 (142), the total number of children enrolled in these age groups was estimated at 5,508, with 3,247 in public institutions and 2,261 in private institutions. These estimates were derived by applying the national age-group distribution for preschool enrolments to the corresponding Pristina totals, and by adding the pre-school (5–<6 years) group, as disaggregated age-specific data for Pristina were not directly available in the published tables.

The study used the finite population correction formula to determine its smallest required sample number by setting Z to 1.96 for 95% confidence, an error margin of 5% and a population proportion of 0.5, to achieve the largest possible sample size. The analysis produced a minimum participant number of 360 (143). The researchers added a 10% buffer to their calculation for handling non-response and missing data, which brought the total number of children to 400.

The researchers used G*Power 3.1 to conduct an *a priori* power analysis, which confirmed that the study would achieve appropriate statistical power for its scheduled data analysis procedures on the basis of the research variables and required statistical methods. The analysis showed that 400 participants would be enough to detect the desired effects when using a medium effect size of 0.3, and setting the error probability (α\alphaα) to 0.05 and statistical power to 0.95.

The researchers obtained data from 655 participants throughout their research. The researchers used 710 as the final number because it matched the requirements of their sampling design. Of these, 10 participants were excluded due to missing teeth, and 45 were excluded because they were older than 6.5 years. The researchers selected their final analytical data set by following the criteria they had established for study participation. The final dataset achieved statistical robustness and population representation through a 5% margin of error, which maintained a 95% confidence level and used a Z-score of 1.96.

3.1.6 Sampling design

The research followed a five-stage sequential methodology. The research received ethical approval and official authorization from three organizations: the Kosovo Dental Chamber, the Directorate of Education under the Municipal Authorities of Pristina, and the administrative boards of the participating kindergartens. The researchers gave the parents and legal guardians of the children, along with the kindergarten staff, complete details about the study goals, methods and ethical standards, through information sheets and informed consent forms. The research team selected participants on the basis of specific eligibility criteria, which limited study participation to children whose parents or legal guardians received the information letter and provided consent through written authorization. The research team provided questionnaires with additional explanatory notes to the parents and legal guardians, who answered questions about their children's development of harmful oral behaviors, and their oral care routines. Clinical examinations were then conducted to assess occlusal characteristics in the three planes of space, to determine the prevalence of Early Childhood Caries (ECC) using the defs index, in accordance with the standardized criteria outlined in the World Health Organization (WHO) Oral Health Assessment Form for Children (2013) (12), and to evaluate the presence or absence of deleterious oral habits and oral hygiene practices. The research involved children who met all the study requirements, while their parents or legal guardians provided consent through a signed written document.

3.1.7 Sample selection

The final sample included 655 children between 3 to 6 years old, after removing 45 participants who were older than the specified range, or did not fulfill the research requirements, and 10 participants who had missing teeth. The research participants showed equal distribution across their age range. Two examiners conducted the examination, VRr (orthodontist specialist) and BBRr (pediatric dentistry specialist)

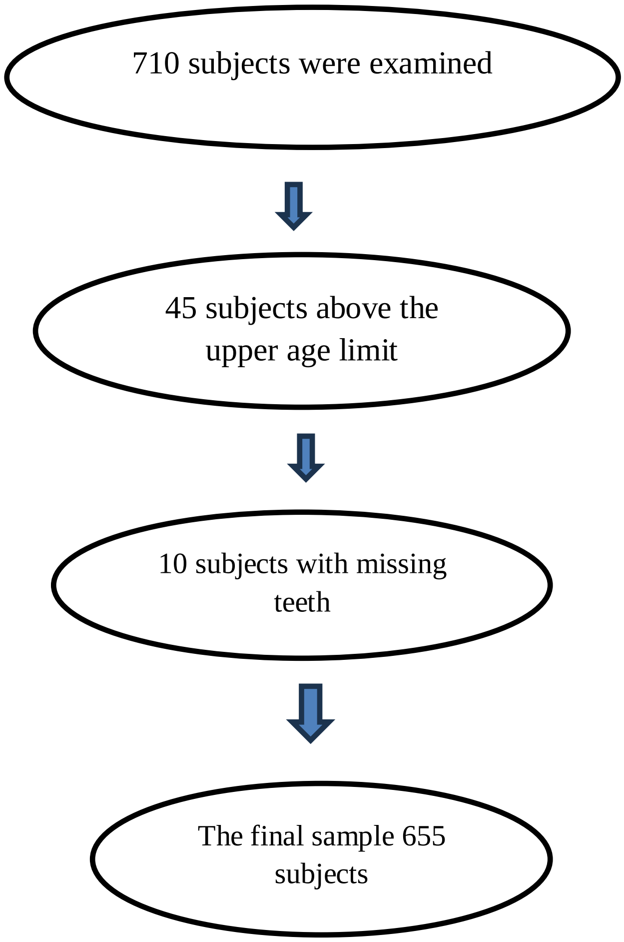

Figure 1. The flow of sample selection

3.1.8 Confidentiality

The researcher stored all collected data from the study on their personal computer which provided secure storage. Access to this information was restricted exclusively to the researcher and his mentor, and was used solely for the purposes of this study. The research findings will appear in scientific journals while protecting all study participants from identification.

3.1.9 Ethical considerations

The Ethics Committee School of Dental Medicine of the University of Zagreb, Croatia, approved this research through Reference No. 05-PA 30-XXIII-1/2021. The research received authorization from the Pristina Municipality Education Directorate through Protocol No. 03-610/01-56638/21; dated 26 March, 2021).

Written permission was also secured from the Dental Chamber of Kosovo (Protocol No. 17/2021; dated 19 July 2021) to conduct this research.

3.2. Methodology

3.2.1 QUESTIONNARIE

The research used a parent-administered questionnaire, which followed a structured format, to determine how many children practice harmful oral behaviors and maintain poor dental hygiene. The research team created the questionnaire through a review of existing studies and analysis of established measurement tools, which they used to develop a new instrument for this pediatric oral health research. The survey contained two essential parts which were combined to create the complete assessment.

Oral Habits

This section included closed-ended questions regarding demographic data (the child’s age and gender), and the presence of common non-nutritive sucking habits (thumb sucking, pacifier use), nail biting, lip biting, tongue thrusting, teeth grinding, and mouth breathing. The survey asked parents to show if their child shows these behaviors at present, while also requesting information about when the behaviors started, how often they occur, and how long they have been present.

Oral Hygiene Practices

The section obtained data about the child's daily oral care practices, which included how often they brushed their teeth, what kind of toothpaste they used, whether parents watched them brush, and their dental visit history. The survey contained questions which assessed parental comprehension about the importance of oral care and dental prevention for their children under six years old.

3.2.2 The translation, validation, and reliability of the questionnaire

The research team developed the survey in English before they performed a forward–backward translation process to create an Albanian version which confirmed both the survey's exact language and its intended meaning. Three orthodontists, together with two pediatric dentistry specialists, who were native English speakers, evaluated the three text versions to create their second draft. The research team assessed this version through its clarity and cultural suitability by showing it to 25 parents who were outside the main research participant group. On the basis of the feedback received, minor linguistic modifications were made, resulting in the final Albanian version of the questionnaire.

The research team conducted a pilot test with 70 parents to assess how well the instrument worked through its item clarity, parental understanding, and measurement precision. The pilot feedback process allowed us to make improvements which we used to modify both the questionnaire's wording and its structural design. The researchers began their data collection after all the parents had given their free consent for participation. The survey contained a cover page which described the research objectives, and promised participants that their information would remain private, while explaining the process to complete the survey. The questionnaire reached its final version before parents received it during their scheduled kindergarten meetings, or when the teachers delivered it to them personally for completion within a one-week time frame. The researchers analyzed the collected data through coding to establish the frequency and distribution of oral habits, and oral hygiene practices among the study children.

The research team applied Cronbach's alpha to assess the internal consistency of the clinical examination scale items. The first seven-item model showed a coefficient of 0.623 as its items failed to demonstrate sufficient reliability because the E4 and E5 variables showed a low correlation between them. The two items were excluded from the analysis and this resulted in a five-item model that achieved a Cronbach's alpha of 0.733. The model thereby achieved acceptable reliability because its Cronbach's alpha value exceeded 0.70. The researchers selected the five-item version for their subsequent research study. The complete results of the reliability analysis are given in Appendix A.

3.2.3 Dentition status by tooth surface

The evaluation of children's dental health serves as a vital assessment tool which helps doctors determine pediatric oral health status, while detecting Early Childhood Caries (ECC) in its beginning stages. In this study, the dentition status of the primary teeth was recorded by tooth surface, following the standardized criteria outlined in the World Health Organization (WHO) Oral Health Assessment Form for Children – 2013 (12). This globally recognized protocol enables researchers to obtain uniform data about oral health which are comparable between different population groups and geographic areas. The assessment of dental caries required a plane mouth mirror and a WHO CPI probe which operators used under proper lighting conditions. They evaluated each tooth surface and assigned it a code according to its condition between sound and decayed, and missing and filled. The research took this approach in order to obtain precise documentation of primary dentition caries and other dental problems which would help develop essential data for the creation of early childhood oral health prevention and treatment plans. Inter-examiner agreement was assessed by re-examining a random 10% sample of children on a different day in the same week. The dental examination resulted in the creation of oral health reports for all the children who underwent the assessment.

3.2.4 Clinical examination

The occlusal characteristic assessment of primary dentition was conducted using standard orthodontic diagnostic methods, following established clinical examination procedures. The assessment took place with the child in an upright position while being evaluated, under appropriate lighting combining natural and artificial light sources. The occlusal evaluation was carried out with the teeth in maximum intercuspation, with the lips relaxed and without any functional manipulation. The evaluation of occlusal characteristics used a systematic approach to study the three-dimensional occlusal space by examining it in sagittal, transverse, and vertical planes.

3.2.5 Sagittal plane examination

The sagittal plane evaluation needed dental arch assessment to check the anteroposterior placement. Baume’s Classification was used to evaluate the primary second molars’ distal surface relationship.

• The molar relationship between teeth depends on the second primary molars' distal surfaces.

Flush terminal plane

Mesial step

Distal step

• Canine relationship:

Class I: Maxillary canine cusp tip in line with the distal surface of the mandibular canine.

Class II: Maxillary canine cusp tip positioned mesial to the mandibular canine.

Class III: Maxillary canine cusp tip positioned distal to the mandibular canine.

• Overjet was defined as the distance measured in the horizontal plane from the most anterior position of the maxillary central incisor’s incisal edge to the labial surface of the mandibular central incisor, using a millimeter ruler. The examination revealed two important findings including anterior crossbite and the edge-to-edge incisal relationship.

3.2.6 Transverse plane examination

The transverse plane assessment evaluated the lateral relationships and symmetry of the dental arches.

Evaluation of the dental arch's form and symmetry was performed by visual inspection.

The dental midlines of the maxillary and mandibular teeth stayed perfectly aligned when the teeth achieved their highest point of contact.

The researcher used visual assessment to detect posterior crossbite by checking if the maxillary primary molar buccal cusps made contact with the lingual surface of the mandibular molar buccal cusps, either unilaterally or bilaterally.

3.2.7 Vertical plane examination

The vertical plane examination involved assessment of the vertical overlap of the anterior teeth.

• Overbite was determined in the vertical plane from the incisal edge of the maxillary central incisor to the incisal edge of the mandibular central incisor, where there was the highest overlap.

Normal (≤ 3 mm)

Increased (deep bite)

Edge-to-edge

Anterior open bite

The doctors used the vertical position of the incisors during centric occlusion to determine if the patient had an open bite or deep bite.

3.2.8 List of research variables

The variables in this research with the corresponding designations, their abbreviations and, in the case of categorical ones, the associated codes and category names, are listed systematically in Table 1.

Table 1. Variables

Variables		Code	Category
Code	Description		Description
ID	Number of respondents		
DOB	Date of birth		
AGE	Age of respondents		
SEX	Sex of respondents	1	Male
		2	Female
Questionnaire about oral habits and oral hygiene practices			
Q1	Has your child used a pacifier?	0	No
		1	Yes
Q2	Has your child been bottle fed?	0	No
		1	Yes
Q3	Does your child have a finger or thumb sucking habit?	0	No
		1	Yes
Q4	Does your child have a habit of sucking objects such as clothes, a key chain, toys etc?	0	No
		1	Yes
Q5	Does your child have a lip sucking habit?	0	No
		1	Yes
Q6	Does your child have a lip/cheek biting habit?	0	No
		1	Yes
Q7	Does your child have a nail biting habit?	0	No
		1	Yes
Q8	Does your child have the habit of biting pacifiers?	0	No
		1	Yes
Q9	Does your child exhibit sleeping bruxism?	0	No
		1	Yes
Q10	Does your child have open mouth during sleeping?	0	No
		1	Yes
Q11	Does your child hold his/her tongue between lips or teeth while sleeping?	0	No
		1	Yes
Q12	Does your child breathe through their mouth?	0	No
		1	Yes
Q13	If any of these habits are present, how many hours a day does your child engage in them?	0	No
		1	1-3 hours
		2	4-6 hours
		3	More than 6 hours

Q14	Does your child have a medical history?	0	No
		1	Nasal congestion
		2	Enlarged adenoids
		3	Allergy
		4	Deviated nasal septum
Q15	Does your child brush his/her teeth?	1	Yes
		2	No
Q16	Does he/she brush their teeth alone?	1	Yes
		2	No
Q17	How many times a day does your child brush his/her teeth?	1	Once a day
		2	Twice a day
		3	More than twice a day
Q18	Does your child's toothpaste contain fluoride?	1	Yes
		2	No
Q19	How often does your child visit a dentist?	0	Never
		1	One a year
		2	Once within 6 months
		3	Several times a year
ECC-Dentition status by tooth surface			
Occ*ij*	Occlusal *i=5.6. j=5.4.4.5*	These categories are common to all dental surfaces	
Mes*ij*	Mesial *i=5.6. j=5. ....1.1.....5*		
Buc*ij*	Buccal *i=5.6. j=5. ....1.1.....5*		
Dis*ij*	Distal *i=5.6. j=5. ....1.1.....5*	0	A = Sound
Oral*ij*	Oral *i=5.6. j=5. ....1.1.....5*	1	B = Caries
Occ*ij*	Occlusal *i=8.7. j=5.4.4.5*	2	C = Filled w/caries
Mes*ij*	Mesial *i=8.7. j=5. ....1.1.....5*	3	D = Filled, no caries
Buc*ij*	Buccal *i=8.7. j=5. ....1.1.....5*	4	E = Missing due to caries
Dis*ij*	Distal *i=8.7. j=5. ....1.1.....5*	6	F = Fissure sealant
Oral*ij*	Oral *i=8.7. j=5. ....1.1.....5*	7	G = Fixed dental prosthesis
ds	Decayed surface		
es	Extracted, missing surface		
fs	Filled surface		
defs	Decayed + extracted + filled tooth surface		
Clinical Examination in three planes			
E1	Overjet	1	Normal
		2	Increased-more than 3 mm
		3	Increased-more than 5 mm
		4	Reversed
		5	Edge to edge
E2	Overbite	1	Normal
		2	Deep bite
		3	Anterior Open bite (2-3 mm)
		4	Anterior Open bite (more than 3 mm)
		5	Reduce bite
		6	Under bite
E3	Crossbite	0	No presence
		1	Posterior unilateral

		2	Posterior bilateral
		3	Anterior
E6	Primary molar relationship	1	Class I. Flush terminal Plane
		2	Class II (distal step)
		3	Class III (mesial step)
E7	Primary canine relationship	1	Class I
		2	Class II
		3	Class III
Clinical Examination in three planes– binary form			
E1	Overjet	0	Normal
		1	Increased, reversed, edge to edge
E2	Overbite	0	Normal
		1	Deep bite and all other
E3	Cross-bite	0	No presence
		1	Posterior-anterior
E6	Primary molar relationship	0	Class I Flush Terminal plane
		1	Class II (distal step)-Class III (mesial step)
E7	Primary canine relationship	0	Class I
		1	Class II-III

3.3. Statistical analysis

Data analysis was performed using STATISTICA 64, version 10 for Windows, and PASW Statistics version 18 software packages.

The research focused on nominal variable analysis while it included a few continuous variables in its data set. According to the Kolmogorov-Smirnov test, the continuous variables did not follow a normal distribution.

The study presented descriptive statistics for nominal data by showing absolute and relative frequency counts, but it used continuous variable measures including the arithmetic mean, standard deviation, and range values.

The χ^2 (chi-square) test function enabled researchers to assess potential connections between the variables which existed at a nominal level. Additionally, the correlations between ordinal or ranked variables were examined using Pairwise Spearman's rank correlation coefficient and Kendall's Tau correlation coefficient, as appropriate.

Differences in continuous variables across the categories of nominal variables were evaluated using the Mann-Whitney U test for comparisons between two independent groups, and the Kruskal-Wallis test for comparisons involving more than two independent groups.

The research used binary logistic regression to analyze how the Questionnaire variables related to the Clinical Examination variables. The research established $\alpha = 0.05$ as the statistical significance threshold, which applied to all performed analyses (144-147).

4. RESULTS

4.1. Data distribution and descriptive statistics

The study sample consisted of 655 participants with 378 males (57.7%) and 277 females (42.3%), aged between 3 and 6 years. The majority of the participants were male, with an average age of 4.81 years (SD = 0.93), while the average age of the female participants was 4.68 years (SD = 0.96). The composition of the sample distribution according to age is presented in Figure 2.

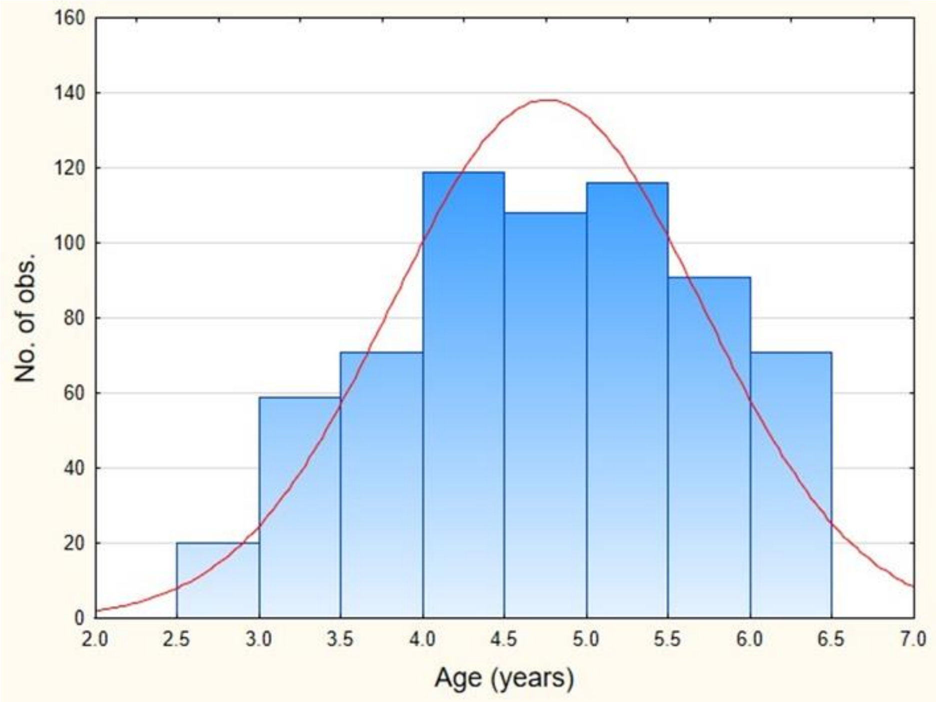

Figure 2. Distribution of respondents by age with the corresponding normal distribution (N = 655)

Figure 2 shows their distribution by age with the corresponding normal distribution. According to the Kolmogorov-Smirnov test, the age of respondents is normally distributed (N = 655, Kolmogorov-Smirnov Z = 1.173, p = 0.128).

The sample distribution according age and sex is presented in Table 2.

Table 2. Distribution of the sample according to age and sex (n=655)

AGE of the respondents (years)		SEX of the respondents		Total
		Male	Female	
`3	Count	40	39	79
	% within AGE	50.6%	49.4%	100.0%
	% within SEX	10.6%	14.1%	12.1%
4	Count	105	85	190
	% within AGE	55.3%	44.7%	100.0%
	% within SEX	27.8%	30.7%	29.0%
5	Count	137	87	224
	% within AGE	61.2%	38.8%	100.0%
	% within SEX	36.2%	31.4%	34.2%
6	Count	96	66	162
	% within AGE	59.3%	40.7%	100.0%
	% within SEX	25.4%	23.8%	24.7%
Total	Count	378	277	655
	% within AGE	57.7%	42.3%	100.0%
	% within SEX	100.0%	100.0%	100.0%
χ^2 – test		χ^2=3.340	df=3	p=0.342

4.1.1 Questionnaire

Table 3 provides a descriptive summary of 19 items from the parental questionnaire on harmful oral habits and hygiene practices. Chi-square analysis indicated no significant gender differences (p > 0.05), suggesting these behaviors are comparable in boys and girls.

Table 3. Parental Questionnaire: Harmful oral habits, and hygiene practices in children

	Oral habits, and oral hygiene practices in children			**No**	**Yes**
Q1	Has your child used a pacifier?			576 (87.9%)	79 (12.1%)
Q2	Has your child been bottle fed?			317 (48.4%)	338 (51.6%)
Q3	Does your child have a finger or thumb sucking habit?			612 (93.4%)	43 (6.6%)
Q4	Does your child have a habit of sucking objects such as clothes, a key chain, toys etc?			568 (86.7%)	87 (13.3%)
Q5	Does your child have a lip sucking habit?			579 (88.4%)	76 (11.6%)
Q6	Does your child have a lip/cheek biting habit?			599 (91.5%)	56 (8.5%)
Q7	Does your child have a nail biting habit?			575 (87.8%)	80 (12.2%)
Q8	Does your child have the habit of biting pacifiers?			632 (96.6%)	23 (3.4%)
Q9	Does your child exhibit sleeping bruxism?			633 ((96.6%)	22 (3.4%)
Q10	Does your child have open mouth during sleeping?			602 (91.9%)	53 (8.1%)
Q11	Does your child hold his/her tongue between lips or teeth while sleeping?			597 (91.1%)	58 (8.9%)
Q12	Does your child breathe through the mouth?			617 (94.2%)	38 (5.8%)
Q13	If any of these habits are present, how many hours a day does your child engage in them?	No	1-3 hours	4-6 hours	More than 6 hours
Q13		386 (58.9%)	203 (31.0%)	59 (9.0%)	7 (1.1%)
Q14	Does your child have a medical history?	No	Nasal congestion	Enlarged adenoids	Allergy
Q14		540 (82.4%)	66 (10.1%)	3 (0.5%)	46 (7,0%)
	Question 15 - 16			Yes	No
Q15	Does your child brush his/her teeth?			649 (99.1%)	6 (0.9%)
Q16	Does he/she brush their teeth alone?			455 (69.5%)	200 (30.5%)
	Question 17		Once a day	Twice a day	More than twice a day
Q17	How many times a day does your child brush his/her teeth?		340 (51.9%)	305 (46.6%)	10 (1.5%)
	Question 18			Yes	No
Q18	Does your child's toothpaste contain fluoride?			561 (85.6%)	94 (14.4%)
	Question 19	Never	Once a year	Once in 6 months	Several times a year
Q19	How often does your child visit a dentist?	17 (2.6%)	508 (77.6%)	77 (11.8%)	53 (8.1%)

Table 4 presents the results of the One-Way ANOVA test conducted to examine the association between the children's age and responses to the parental questionnaire. Age was treated as a continuous dependent variable, with individual questionnaire items as factors. The analysis revealed statistically significant age-related differences for five items, indicating that certain oral habits and hygiene behaviors vary with age among preschool children.

Table 4. Statistically significant differences in the children's ages according to responses to questionnaire items

Questionnaire Item	**Mean Age (No)**	**Mean Age (Yes)**	**Direction of Difference**	***p*-value**
Q1	4.81	4.38	No > Yes	< 0.001
Q5	4.79	4.51	No > Yes	0.017
Q9	4.74	5.17	No < Yes	0.037
Q11	4.73	5.03	No < Yes	0.020
Q16	4.60	4.82	Yes > No	0.007

4.1.2 *Parental questionnaire results disaggregated by sex and age*

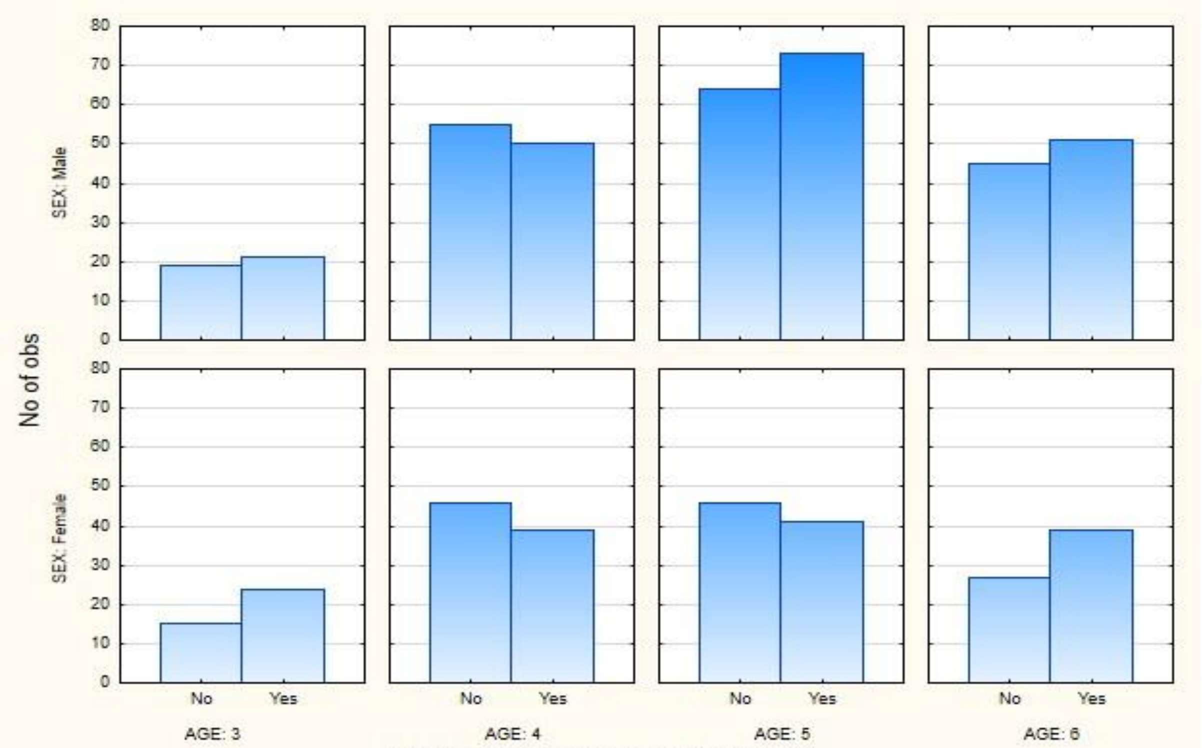

Figure 3. Has your child used a pacifier?

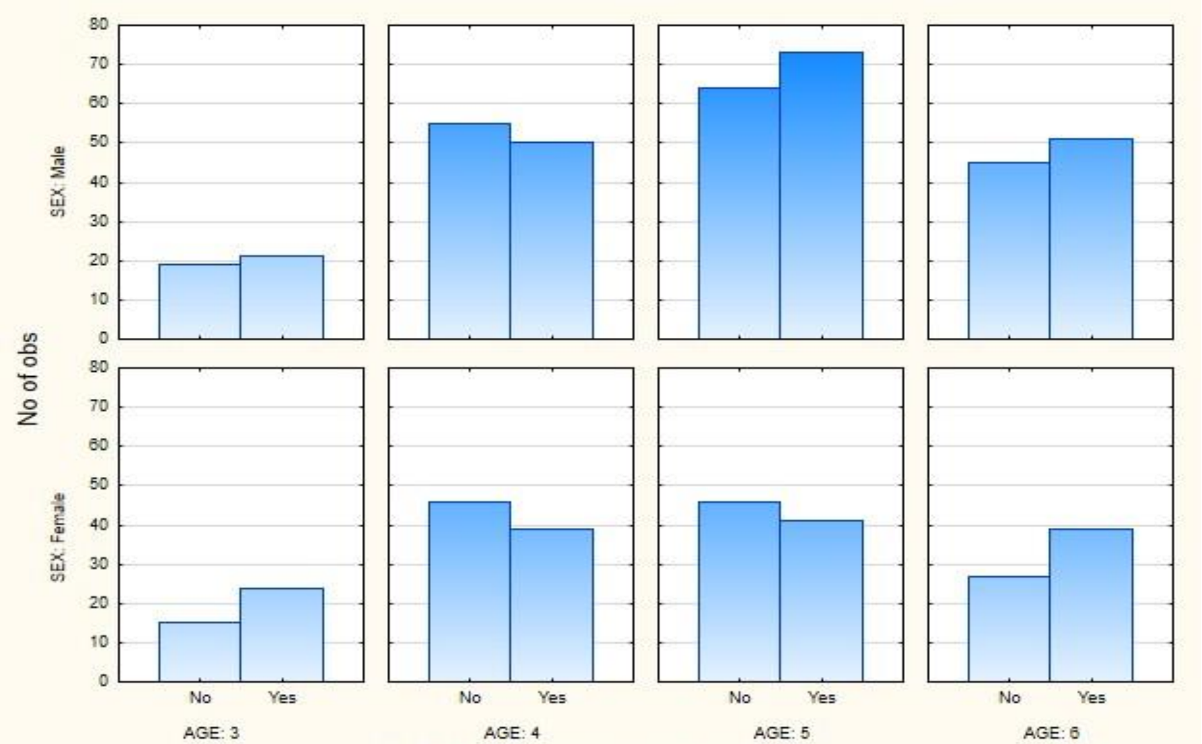

Figure 4. Has your child been bottle fed?

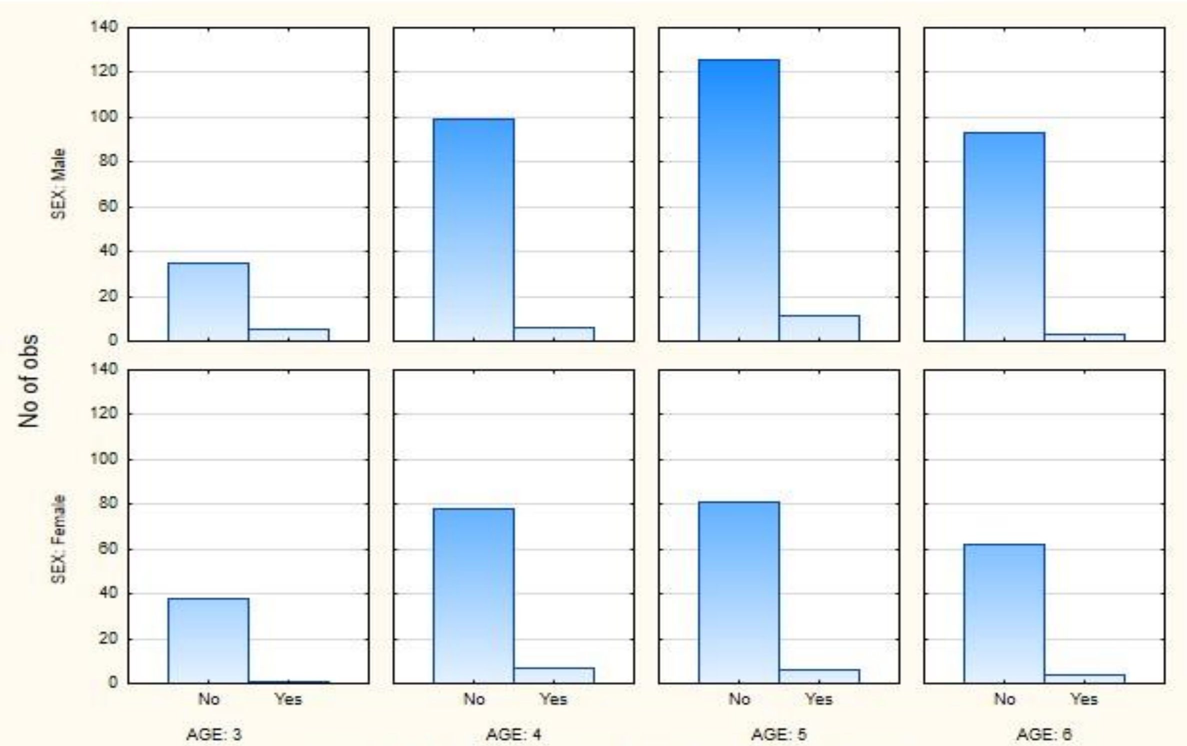

Figure 5. Does your child have a finger or thumb sucking habit?

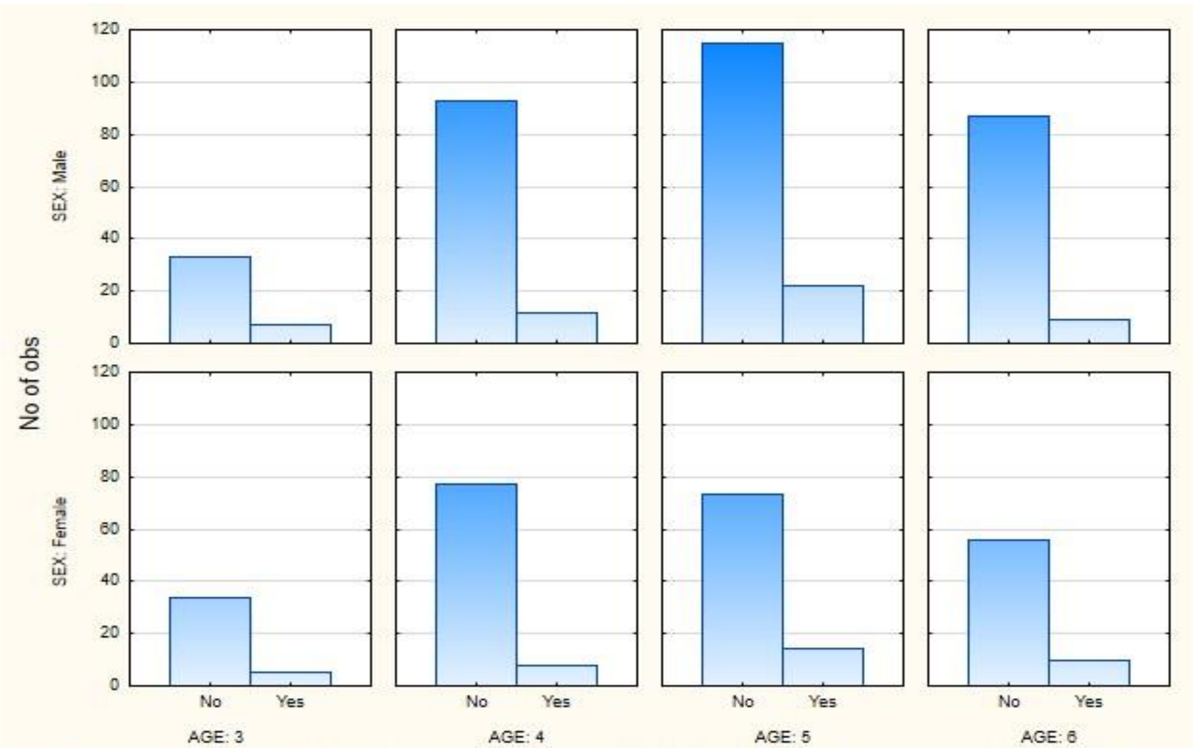

Figure 6. Does your child have a habit of sucking objects such as clothes, a key chain, toys etc?

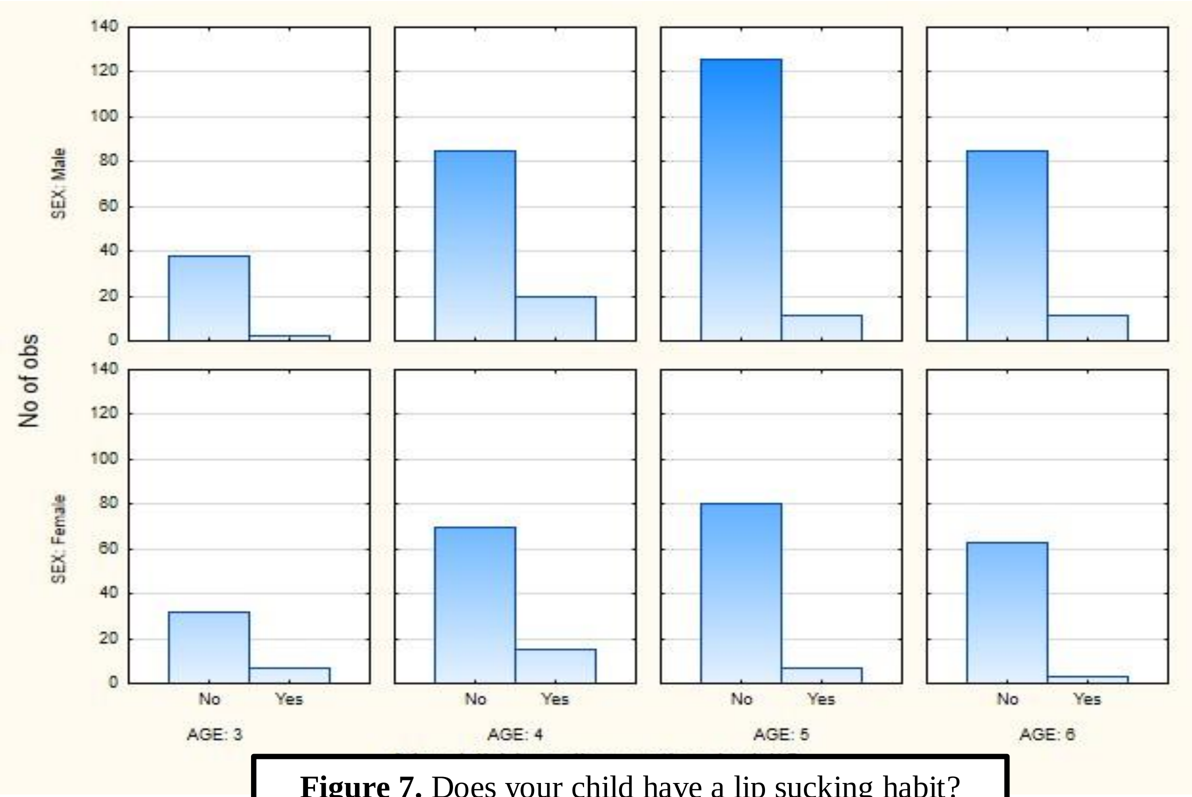

Figure 7. Does your child have a lip sucking habit?

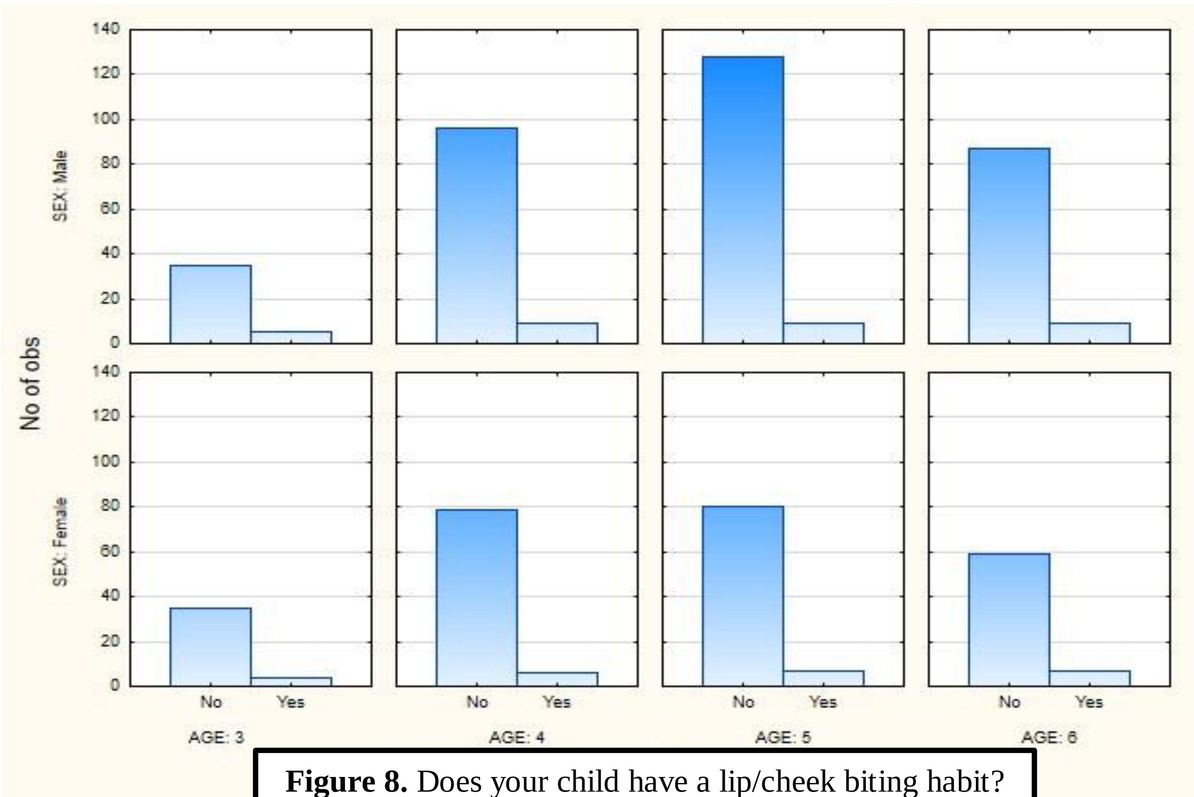

Figure 8. Does your child have a lip/cheek biting habit?

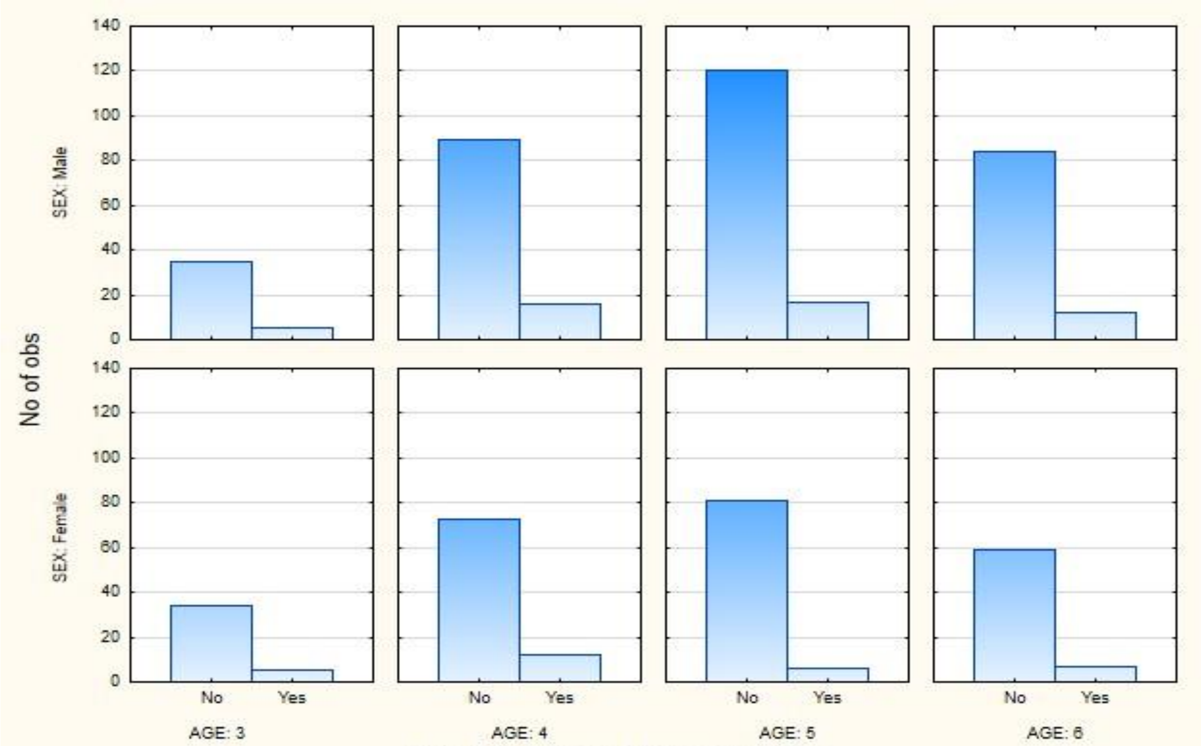

Figure 9. Does your child have a nail biting habit?

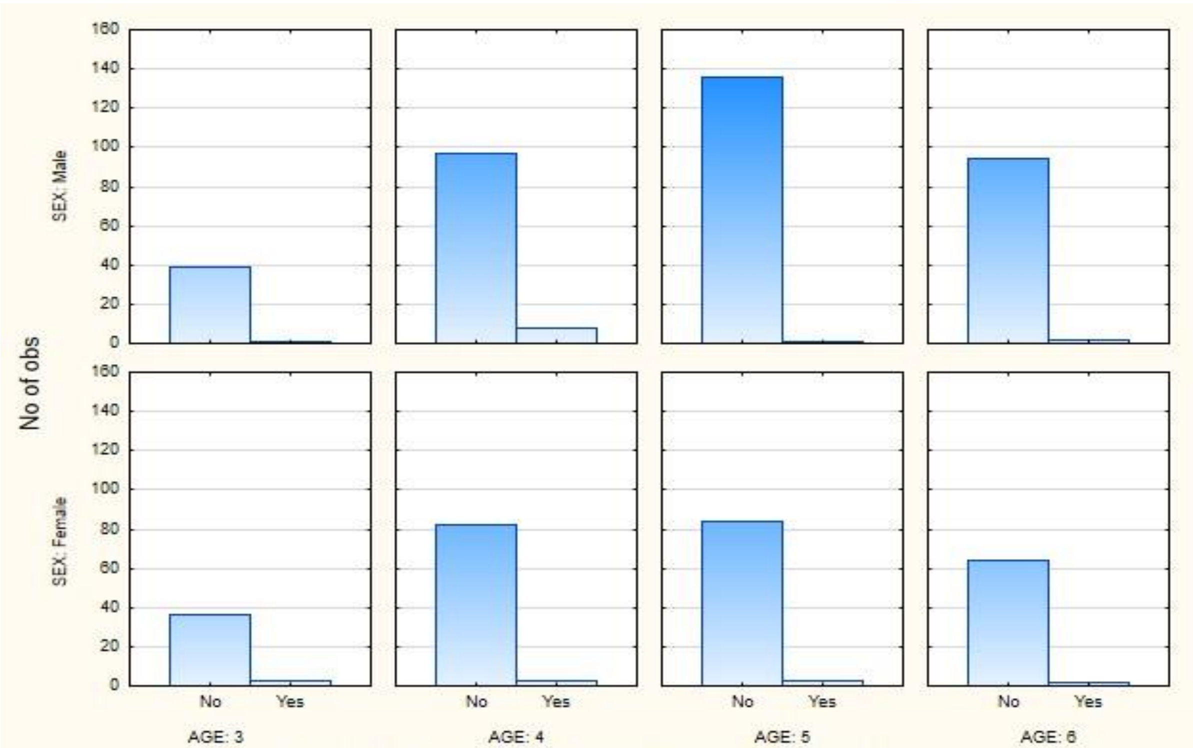

Figure 10. Does your child have the habit of biting pacifiers?

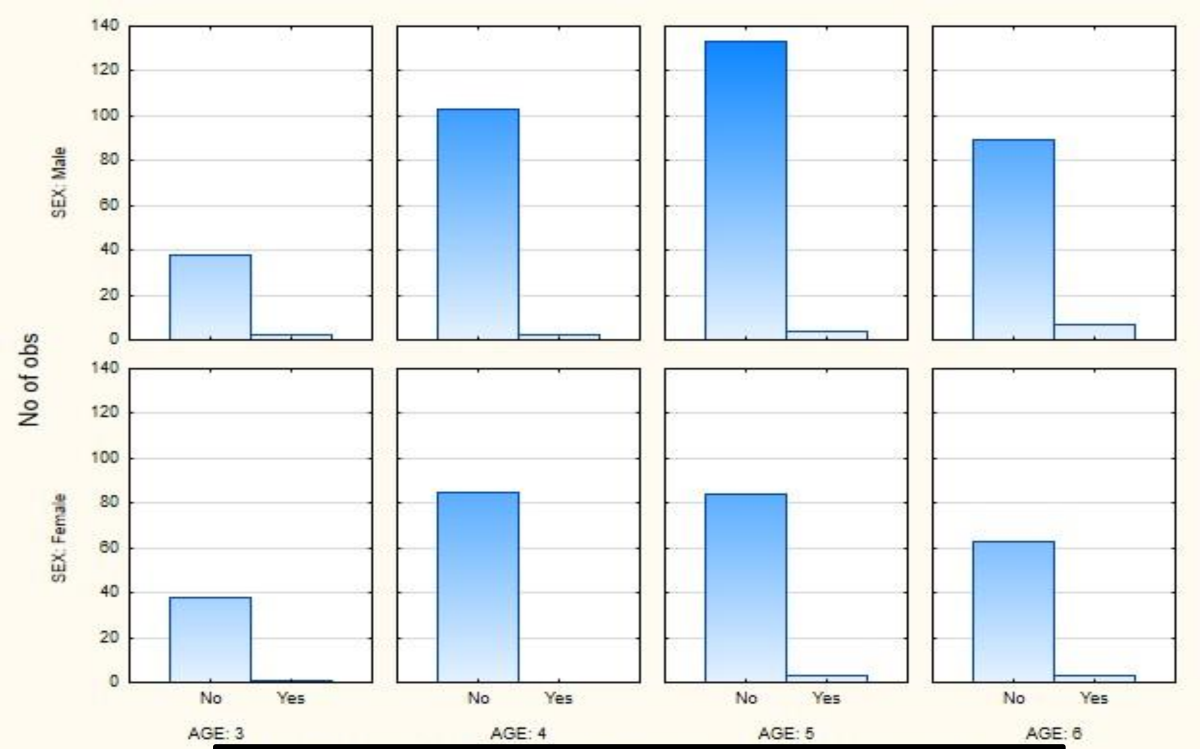

Figure 11. Does your child exhibit sleeping bruxism?

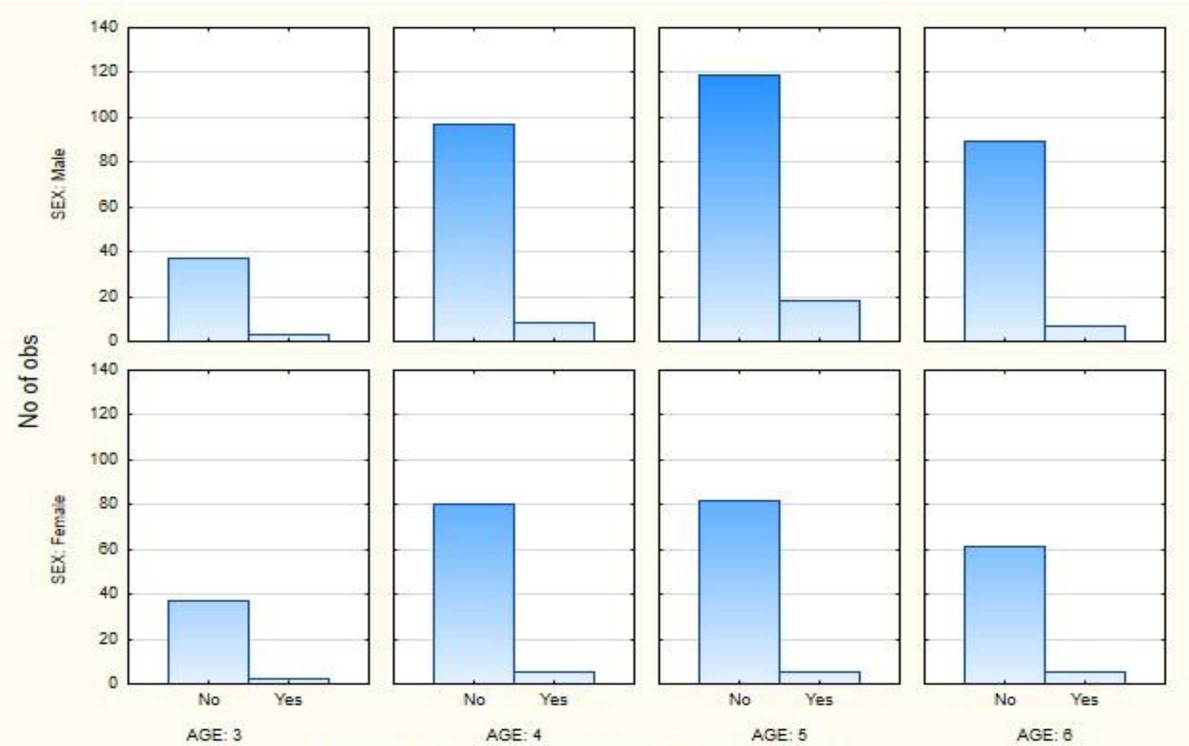

Figure 12. Does your child have open mouth during sleeping?

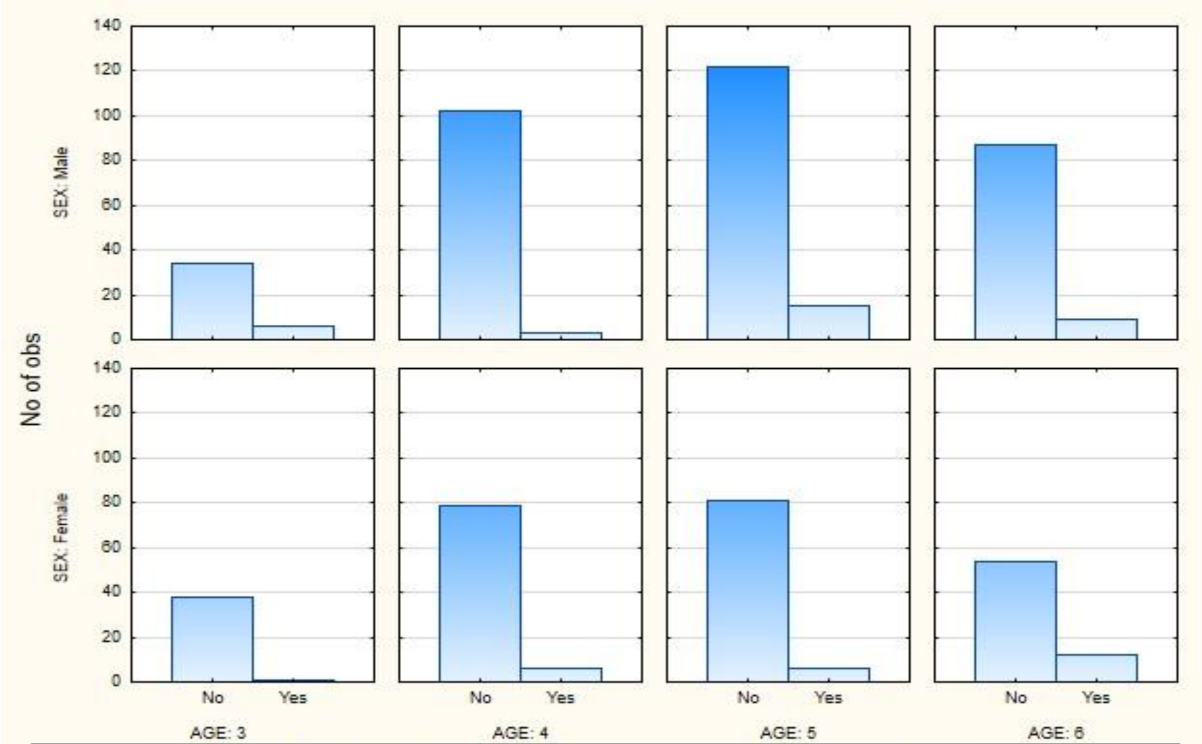

Figure 13. Does your child hold his/her tongue between lips or teeth while sleeping?

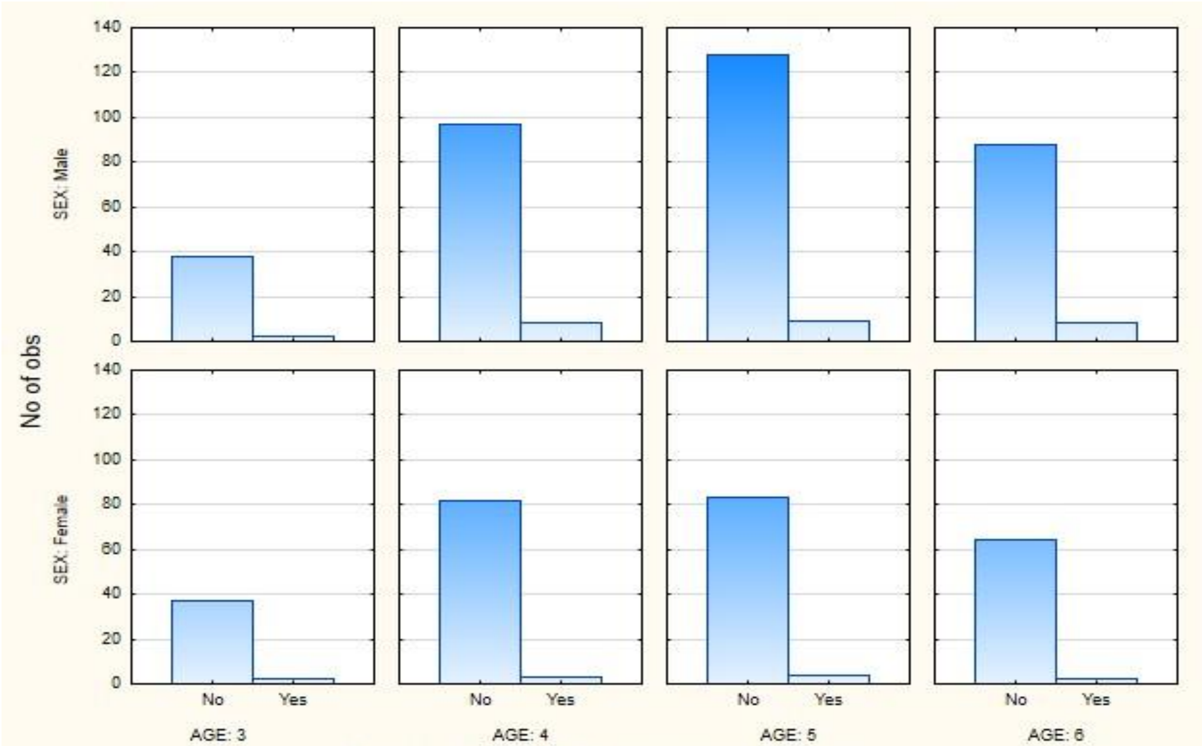

Figure 14. Does your child breathe through their mouth?

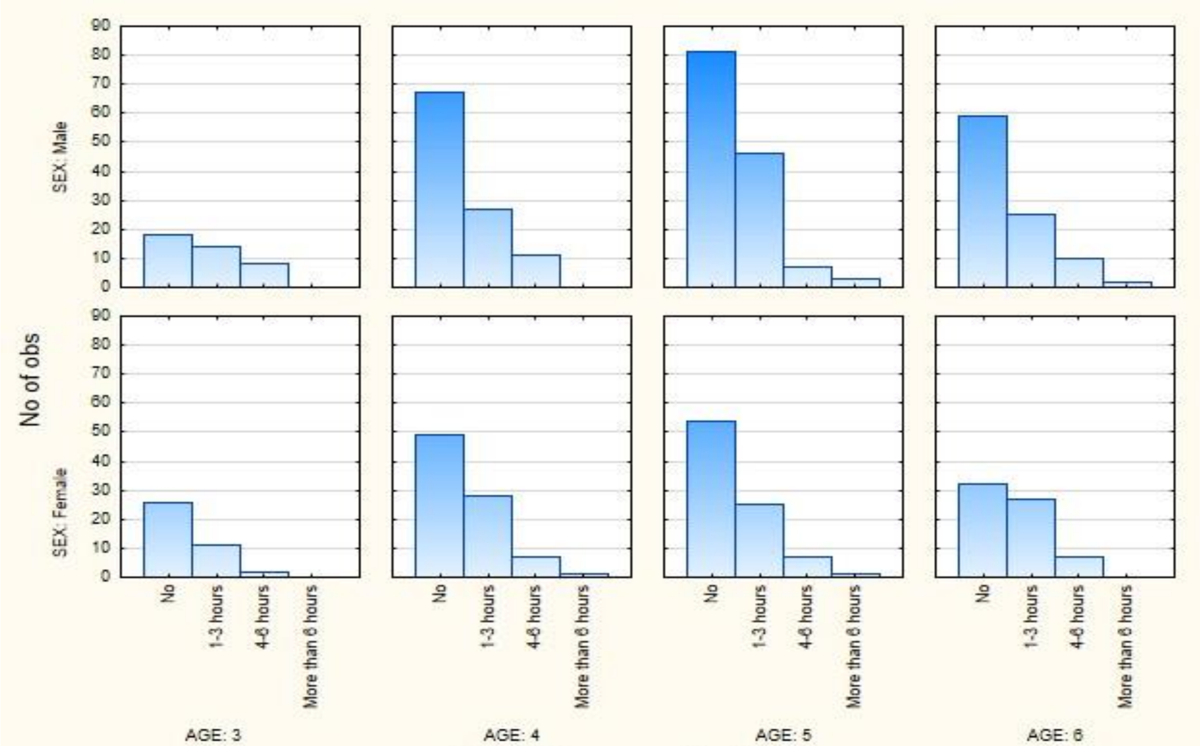

Figure 15. If any of these habits are present, how many hours a day does your child engage in them?

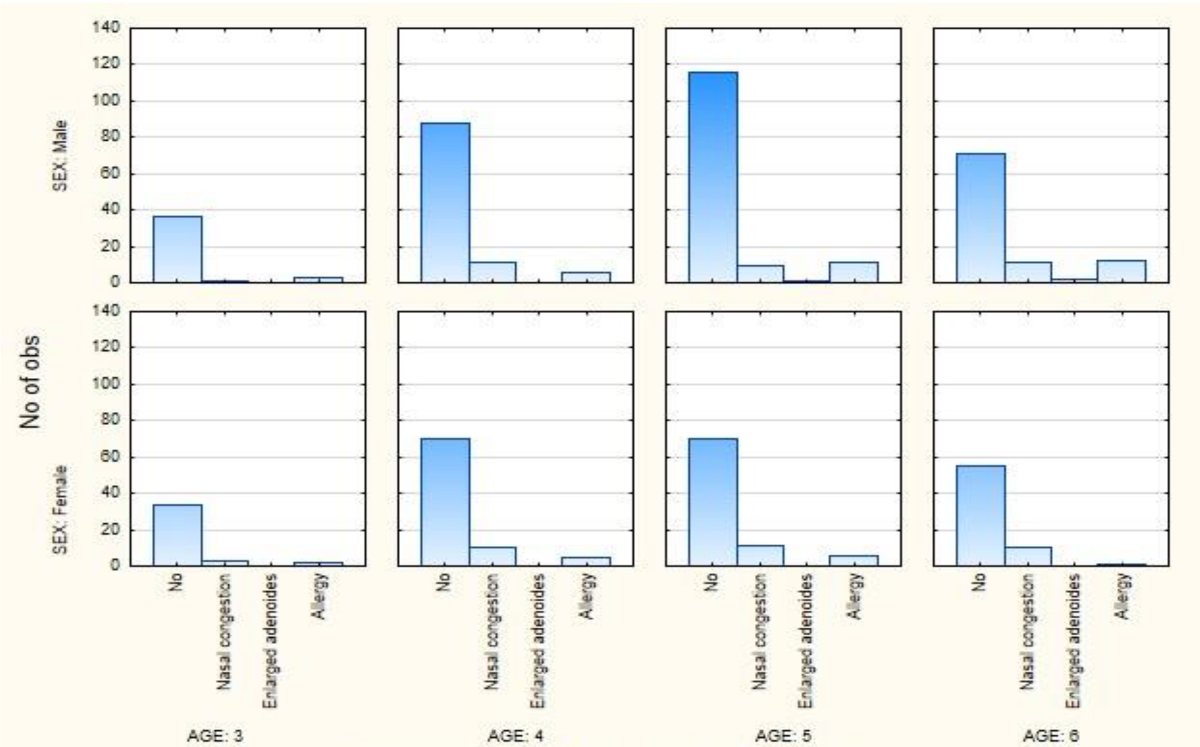

Figure 16. Does your child have a medical history?

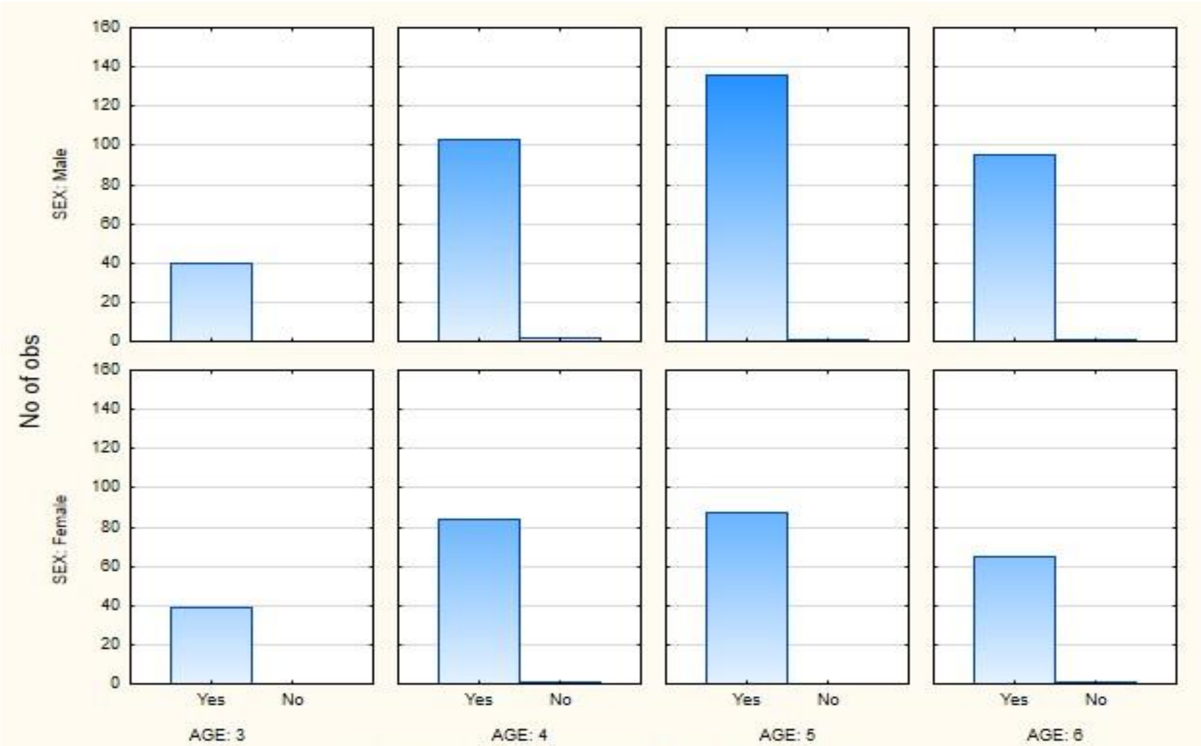

Figure 17. Does your child brush his/her teeth?

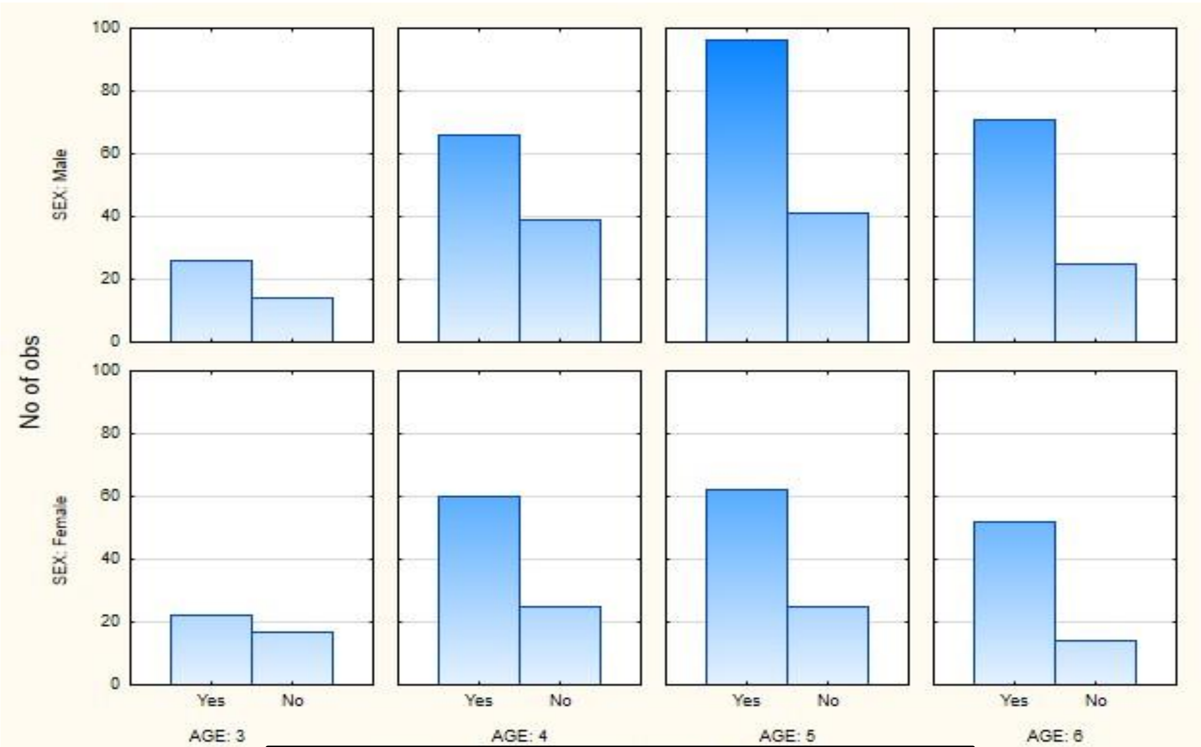

Figure 18. Does he/she brush their teeth alone?

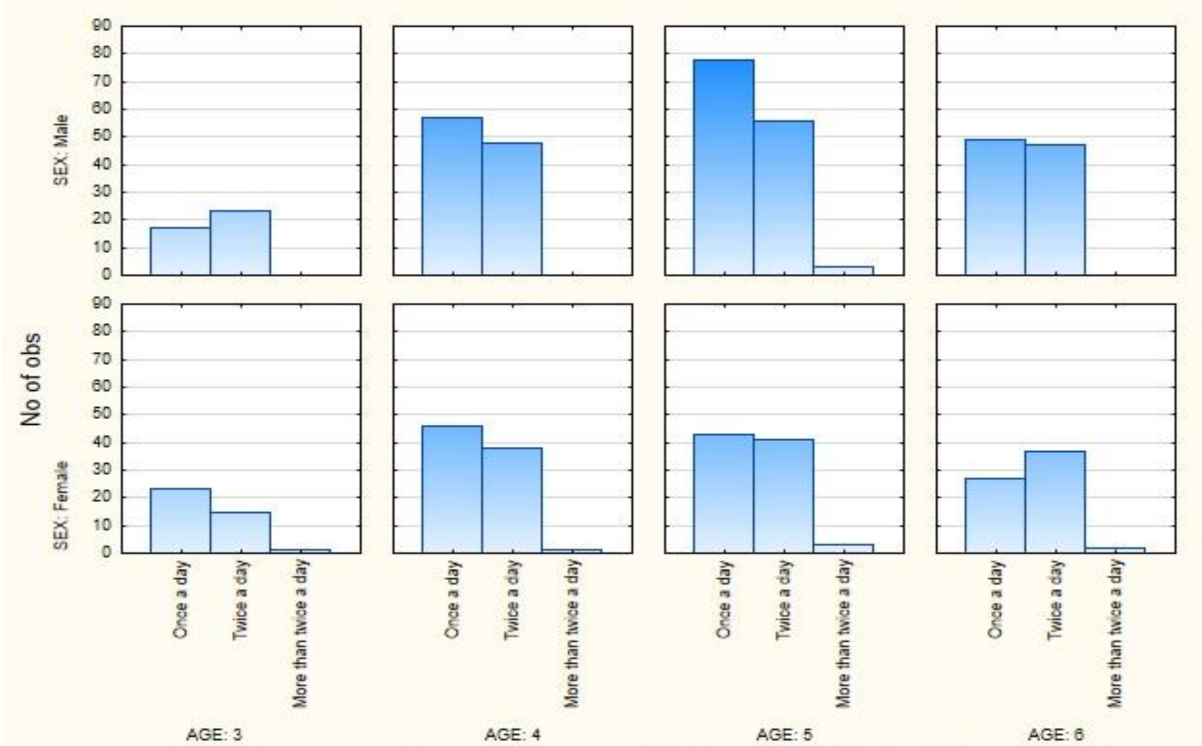

Figure 19. How many times a day does your child brush his/her teeth?

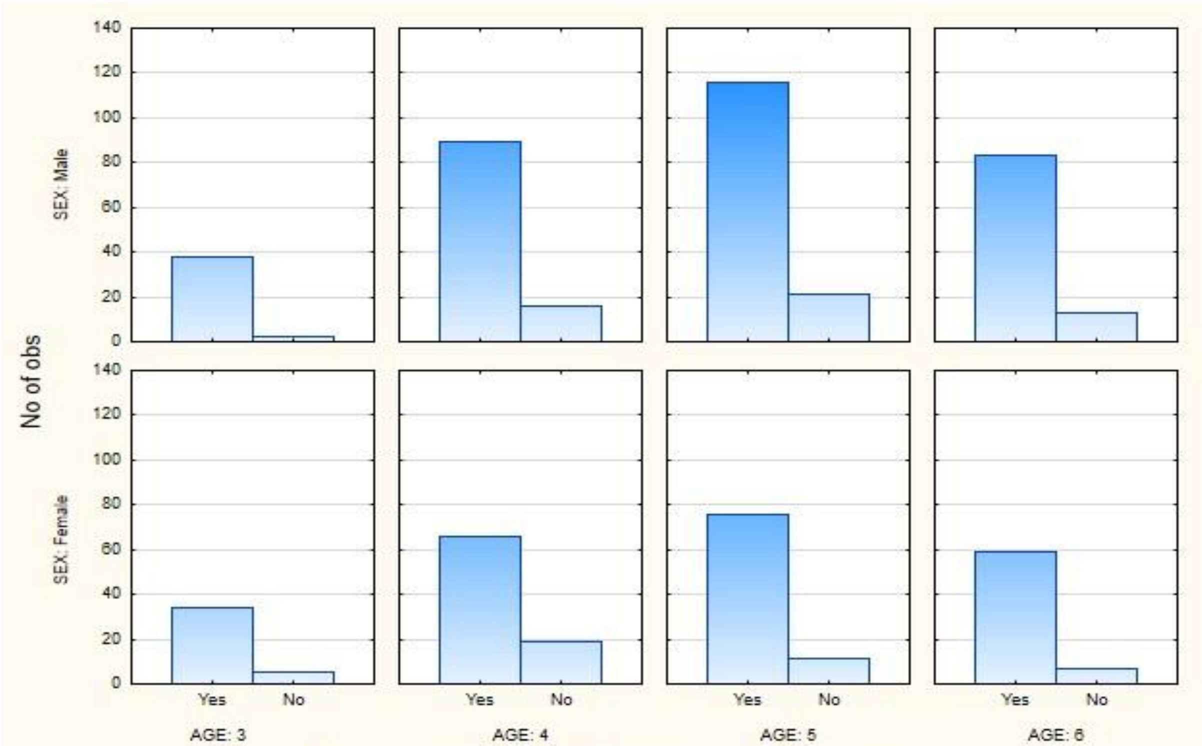

Figure 20. Does your child's toothpaste contain fluoride?

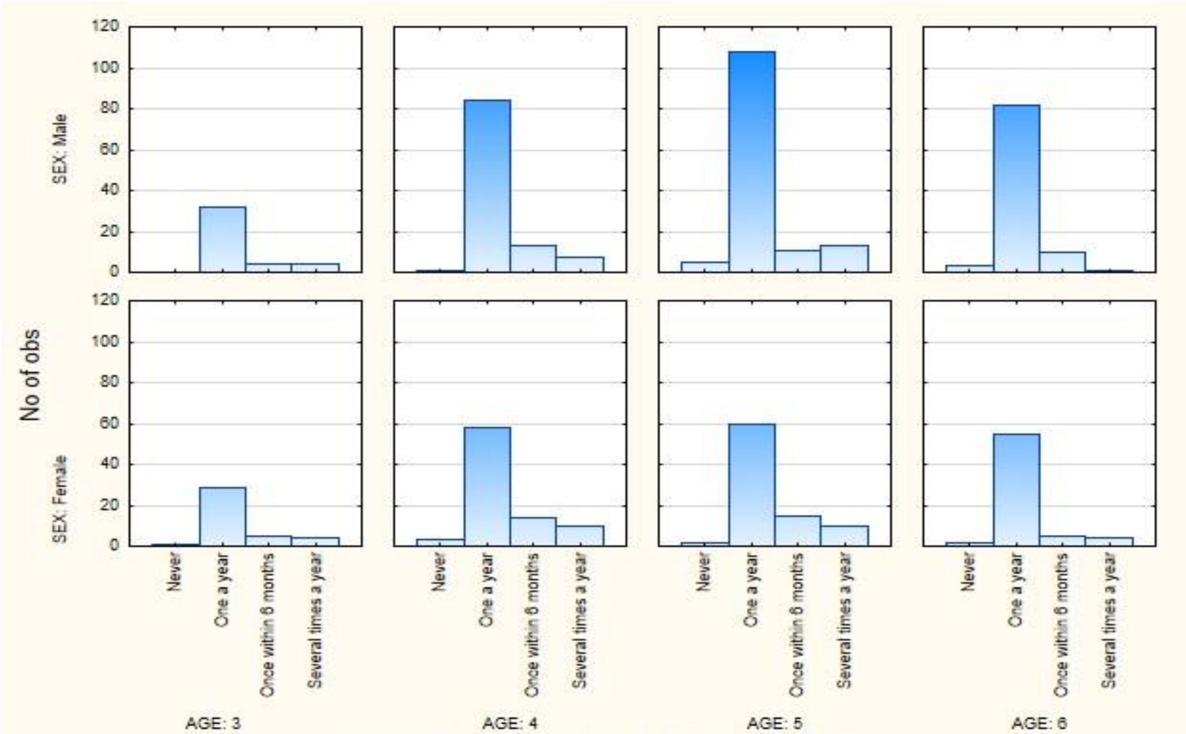

Figure 21. How often does your child visit a dentist ?

4.1.3 *Dentition status by tooth surface*

The following results present the dentition status by tooth surfaces in primary dentition, focusing on the distribution of decayed, missing, and filled surfaces across the occlusal, buccal, lingual, mesial, and distal surfaces of primary teeth in kindergarten children aged 3 to 6 years. Data collection was conducted in accordance with the guidelines of the World Health Organization WHO, Oral Health Assessment Form for tooth surfaces, 2013 (12), ensuring standardized recording and diagnostic criteria. The frequencies and relative frequencies of each dentition status category were computed for every surface within all four quadrants of the primary dentition. The analysis provides a comprehensive overview of caries experience and restorative treatment patterns by tooth surface, highlighting surface-specific vulnerabilities, and potential areas for targeted preventive and therapeutic interventions in the preschool population.

The following results in Table 5 present the dentition status by tooth surface for the upper right quadrant of the primary dentition, with data recorded individually for each tooth. The distribution of decayed, missing, and filled surfaces is reported across the occlusal, buccal, lingual, mesial, and distal surfaces, providing a detailed assessment of the condition of each tooth within this quadrant in children aged 3 to 6 years.

Table 5. Dentition status by tooth surface – upper right (N=655)

Tooth	Status	Occlusal	Mesial	Buccal	Distally	Orally
55	A*	465 (71.0%)	622 (95.0%)	626 (95.6%)	620 (94.7%)	614 (93.7%)
	B	180 (27.5%)	32 (4.9%)	28 (4.3%)	34 (5.2%)	40 (6.1%)
	C	4 (0.6%)				
	D	5 (0.8%)				
	E	1 (0.2%)	1 (0.2%)	1 (0.2%)	1 (0.2%)	1 (0.2%)
54	A	485 (74.0%)	589 (89.9%)	602 (91.9%)	582 (88.9%)	601 (91.8%)
	B	165 (25.2%)	64 (9.8%)	51 (7.8%)	71 (10.8%)	52 (7.9%)
	C					
	D	3 (0.5%)				
	E	2 (0,3%)	2 (0.3%)	2 (0.3%)	2 (0.3%)	2 (0.3%)
53	A		622 (95.0%)	606 (92.5%)	622 (95.0%)	619 (94.5%)
	B		33 (5.0%)	49 (7.5%)	33 (5.0%)	36 (0.5%)
	C					
	D					
	E					
52	A		545 (83.2%)	544 (83.1%)	562 (85.8%)	549 (83.8%)
	B		107 (16.3%)	109 (16.6%)	90 (13.7%)	103 (15.7%)
	C					
	D					
	E		3 (0.5%)	2 (0.3%)	3 (0.5%)	3 (0.5%)
51	A		499 (76.2%)	522 (79.7%)	555 (84.7%)	537 (82.0%)
	B		149 (22.7%)	126 (19.2%)	93 (14.2%)	111 (16.9%)
	C					
	D					
	E		7 (1.1%)	7 (1.1%)	7 (1.1%)	7 (1.1%)

* A – Sound, B – Caries, C – Filled w/caries, D – Filled, no caries, E – Missing due to caries

The results in Table 6 present the dentition status by tooth surface for the upper left quadrant of the primary dentition, with data recorded individually for each tooth.

Table 6. Dentition status by tooth surface – upper left (N=655)

Tooth	Status	Occlusal	Mesial	Buccal	Distally	Orally
61	A*		507 (77.4%)	529 (80.8%)	557 (85.0%)	550 (84.0%)
	B		144 (22.0%)	121 (18.5%)	94 (14.4%)	101 (15.4%)
	C			1 (0.2%)		
	D					
	E		4 (0.6%)	4 (0.6%)	4 (0.6%)	4 (0.6%)
62	A		560 (85.5%)	547 (83.5%)	568 (86.7%)	560 (85.5%)
	B		94 (14.4%)	107 (16.3%)	86 (13.1%)	94 (14.4%)
	C					
	D					
	E		1 (0.2%)	1 (0.2%)	1 (0.2%)	1 (0.2%)
63	A		620 (94.7%)	593 (90.5%)	623 (95.1%)	620 (94.7%)
	B		35 (5.3%)	62 (9.5%)	31 (4.7%)	34 (5.2%)
	C					
	D					
	E				1 (0.2%)	1 (0.2%)
64	A	469 (71.6%)	585 (89.3%)	589 (89.9%)	577 (88.1%)	594 (90.7%)
	B	174 (26.6%)	62 (9.5%)	58 (8.9%)	70 (10.7%)	53 (8.1%)
	C	4 (0.6%)				
	D					
	E	8 (1.2%)	8 (1.2%)	8 (1.2%)	8 (1.2%)	8 (1.2%)
65	A	473 (72.2%)	614 (93.7%)	625 (95.4%)	625 (95.4%)	621 (94.8%)
	B	176 (26.9)	39 (6.0%)	28 (4.3%)	28 (4.3%)	32 (4.9%)
	C	2 (0.3%)				
	D	3 (0.5%)	1 (0.2%)	1 (0.2%)	1 (0.2%)	1 (0.2%)
	E	1 (0.2%)	1 (0.2%)	1 (0.2%)	1 (0.2%)	1 (0.2%)

* A – Sound, B – Caries, C – Filled w/caries, D – Filled, no caries, E – Missing due to caries

The following results in Table 7 present the dentition status by tooth surface for the lower left quadrant of the primary dentition, with data recorded individually for each tooth.

Table 7. Dentition status by tooth surface – bottom left (N=655)

Tooth	Status	Occlusal	Mesial	Buccal	Distally	Orally
71	A*		607 (92.7%)	610 (93.1%)	605 (92.4%)	608 (92.8%)
	B		3 (0.5%)	3 (0.5%)	3 (0.5%)	4 (0.6%)
	C					
	D					
	E		45 (6.9%)	42 (6.4%)	47 (7.2%)	43 (6.6%)
72	A		645 (98.5%)	646 (98.6%)	648 (98.9%)	647 (98.8%)
	B		6 (0,9%)	3 (0.5%)	3 (0.5%)	4 (0.6%)
	C					
	D					
	E		4 (0.6%)	6 (0.9%)	4 (0.6%)	4 (0.6%)
73	A		648 (98.9%)	644 (98.3%)	648 (98.9%)	647 (98.8%)
	B		7 (1.1%)	11 (1.7%)	7 (1.1%)	8 (1.2%)
	C					
	D					
	E					
74	A	438 (66.9%)	581 (88.7%)	586 (89.5%)	559 (85.3%)	587 (89.6%)
	B	202 (30.8%)	71 (10.8%)	66 (10.1%)	92 (14.0%)	65 (9.9%)
	C	4 (0.6%)				
	D	8 (1.2%)				
	E	3 (0.5%)	3 (0.5%)	3 (0.5%)	4 (0.6%)	3 (0.5%)
75	A	345 (52.7%)	581 (88.7%)	589 (89.9%)	581 (88.7%)	579 (88.4%)
	B	273 (41.7%)	62 (9.5%)	54 (8.2%)	62 (9.5%)	64 (9.8%)
	C	12 (1.8%)				
	D	13 (2.0%)				
	E	12 (1.8%)	12 (1.8%)	12 (1.8%)	12 (1.8%)	12 (1.8%)

* A – Sound, B – Caries, C – Filled w/caries, D – Filled, no caries, E – Missing due to caries

The results in Table 8 present the dentition status by tooth surface for the lower right quadrant of the primary dentition, with data recorded individually for each tooth.

Table 8. Dentition status by tooth surface – bottom right (N=655)

Tooth	Status	Occlusal	Mesial	Buccal	Distally	Orally
85	A*	350 (53.4%)	572 (87.3%)	580 (88.5%)	576 (87.9%)	578 (88.2%)
	B	270 (41.2%)	75 (11.5%)	66 (10.1%)	70 (10.7%)	68 (10.4%)
	C	4 (0.6%)				
	D	22 (4.3%)				
	E	9 (1.4%)	8 (1.2%)	9 (1.4%)	9 (1.4%)	9 (1.4%)
84	A	413 (63.1%)	576 (87.9%)	577 (88.1%)	550 (84.0%)	574 (87.6%)
	B	223 (34.0%)	73 (11.1%)	73 (11.1%)	100 (15.3%)	77 (11.8%)
	C	5 (0.8%)				
	D	9 (1.4%)				
	E	5 (0.8%)	6 (0.9%)	5 (0.8%)	5 (0.8%)	4 (0.6%)
83	A		645 (98.5%)	646 (98.6%)	645 (98.5%)	643 (98.2%)
	B		10 (1.5%)	9 (1.4%)	10 (1.5%)	12 (1.8%)
	C					
	D					
	E					
82	A		649 (99.1%)	647 (98.8%)	649 (99.1%)	646 (98.6%)
	B		4 (0.6%)	4 (0.6%)	4 (0.6%)	7 (1.1%)
	C					
	D					
	E		2 (0.3%)	4 (0.6%)	2 (0.3%)	2 (0.3%)
81	A		608 (92.8%)	601 (91.8%)	596 (91.0%)	598 (91.3%)
	B		5 (0.8%)	5 (0.8%)	5 (0.8%)	3 (0.5%)
	C					
	D					
	E		42 (6.4%)	49 (7.5%)	54 (8.2%)	54 (8.2%)

* A – Sound, B – Caries, C – Filled w/caries, D – Filled, no caries, E – Missing due to caries

The following results present the number of tooth surfaces affected by caries per individual tooth in the primary dentition. For each tooth, the total number of decayed surfaces was recorded across the five examined surfaces: occlusal, buccal, lingual, mesial, and distal.

Table 9. Distribution of carious surfaces by individual teeth (N=655)

Number of surface with caries per tooth	Teeth				
	55	54	53	52	51
0	463 (70.7%)	475 (72.5%)	601 (91.8%)	518 (79.1%)	468 (71.5%)
1	156 (23.8%)	110 (16.8%)	19 (2.9%)	40 (6.1%)	78 (11.9%)
2	5 (0.8%)	17 (2.6%)	3 (0.5%)	9 (1.4%)	17 (2.6%)
3	3 (0.5%)	2 (0.3%)	2 (0.3%)	1 (0.2%)	1 (0.2%)
4	1 (0.2%)	2 (0.3%)	30 (4.6%)	87 (13.3%)	91 (13.9%)
5	27 (4.1%)	49 (7.5%)			
	61	62	63	64	65
0	478 (73.0%)	529 (80.8%)	590 (90.1%)	468 (75.1%)	475 (72.5%)
1	72 (11.0%)	38 (5.8%)	30 (4.6%)	110 (16.8%)	141 (21.5%)
2	16 (2.4%)	4 (0.6%)	4 (0.6%)	22 (3.4%)	11 (1.7%)
3		1 (0.2%)		4 (0.6%)	
4	89 (13.6%)	83 (12.7%)	31 (4.7%)	4 (0.6%)	
5				47 (7.2%)	28 (4.3%)
	71	72	73	74	75
0	651 (99.4%)	648 (98.9%)	643 (98.2%)	448 (68.4%)	373 (56.9%)
1	1 (0.2%)	4 (0.6%)	5 (0.8%)	116 (17.7%)	214 (32.7%)
2				21 (3.2%)	12 (1.8%)
3				4 (0.6%)	
4	3 (0.5%)	3 (0.5%)	7 (1.1%)	4 (0.6%)	3 (0.5%)
5				62 (9.5%)	53 (8.1%)
	85	84	83	82	81
0	375 (57.3%)	422 (64.4%)	640 (97.7%)	648 (98.9%)	650 (99.2%)
1	202 (30.8%)	139 (21.2%)	3 (0.5%)	3 (0.5%)	
2	14 (2.1%)	18 (2.7%)	5 (0.8%)		
3					2 (0.3%)
4	1 (0.2%)	9 (1.4%)	7 (1.1%)	4 (0.6%)	3 (0.5%)
5	63 (9.6%)	67 (10.2%)			

Instead of analyzing dentition status at the individual tooth surface level, data were summarized into cumulative indices: decayed surfaces (ds), extracted/missing surfaces (es), filled surfaces (fs), and their total (defs). Non-parametric methods were used to analyze their dependence on gender and age categories.

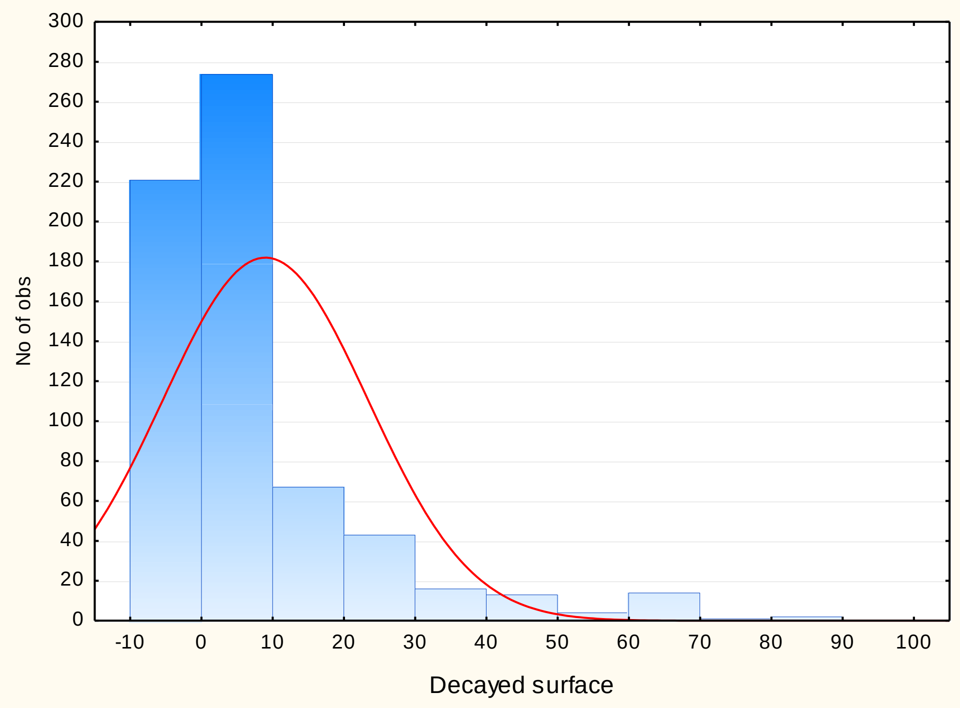

Figure 22. Distribution of decayed tooth surfaces (ds) among the study population

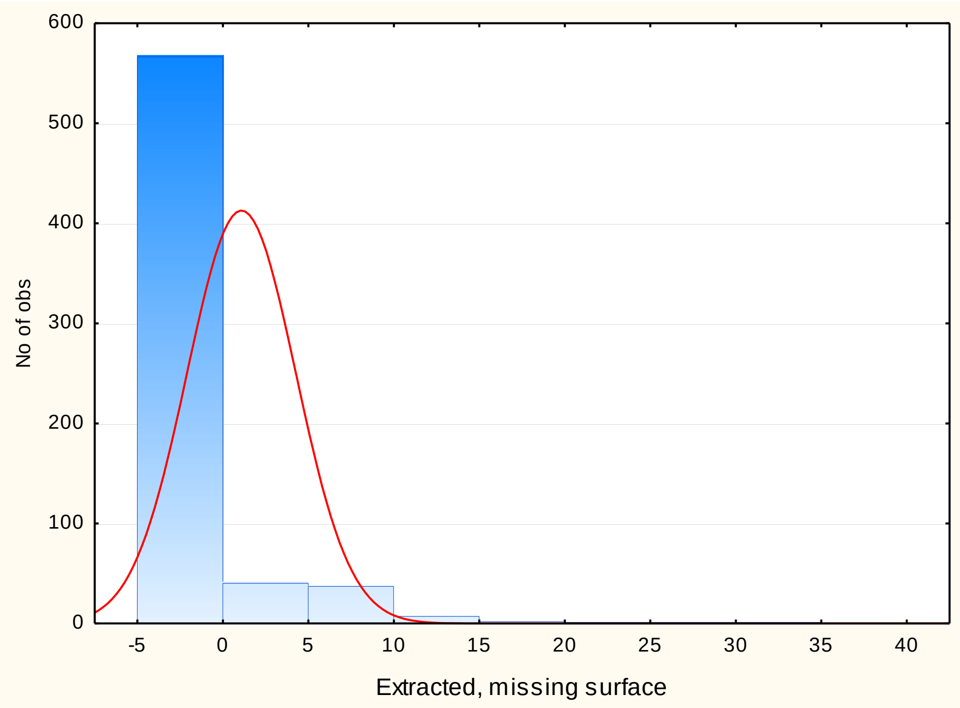

Figure 23. Distribution of extracted (missing) tooth surfaces among the study population

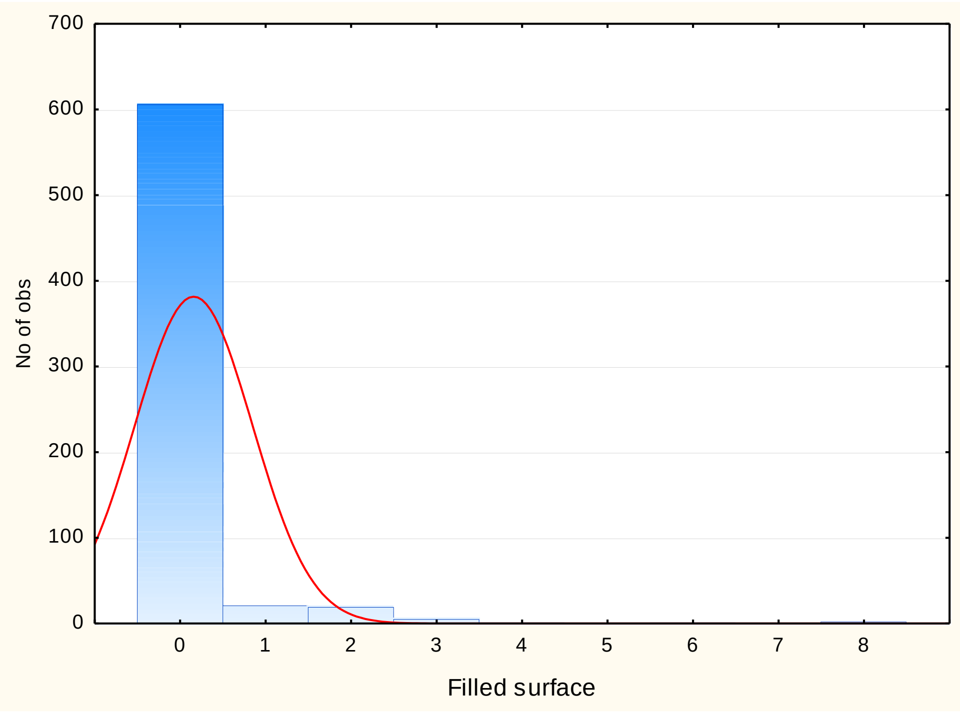

Figure 24. Distribution of respondents by filled surface (fs) among study population

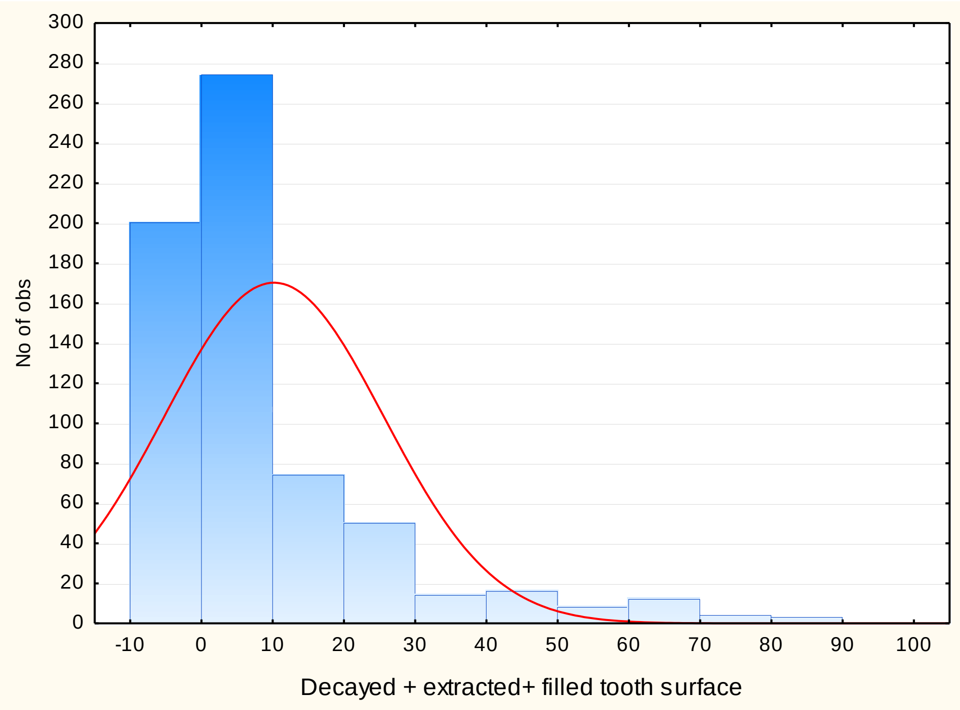

Figure 25. Distribution of decayed + extracted + filled tooth surface (defs) among study population

Table 10 present a detailed overview of the distributions of decayed surfaces (ds), extracted missing surfaces (es), filled surfaces (fs), and the total defs index (decayed, extracted, and filled surfaces) in relation to the sex of the respondents.

Table 10. Descriptive statistics for decayed (ds), extracted (es), filled (fs) and total (defs) tooth surfaces by sex

Tooth surface	Sex	n	Mean	St.dev.	95% CI*		Min.	Max.
					h1	h2		
Decayed (ds)	Male	378	**9.52**	14.233	8.08	10.96	0	88
	Female	277	**7.95**	14.524	6.23	9.67	0	66
	Total	655	8.86	14.367	7.76	9.96	0	88
Extracted (es)	Male	378	1.04	3.253	0.71	1.37	0	32
	Female	277	1.05	3.046	0.69	1.41	0	28
	Total	655	1.04	3.165	0.80	1.29	0	32
Filled (fs)	Male	378	0.13	0.496	0.08	0.18	0	4
	Female	277	0.18	0.880	0.08	0.29	0	8
	Total	655	0.15	0.685	0.10	0.21	0	8
Decayed + extracted + filled surface (defs)	Male	378	**10.69**	15.101	9.16	12.22	0	88
	Female	277	**9.18**	15.665	7.32	11.03	0	73
	Total	655	10.05	15.348	8.87	11.23	0	88

Confidence Interval for Mean, h1 lower bound, h2 upper bound

The Mann-Whitney U test was used to assess differences between male and female participants. The analysis revealed statistically significant differences for the ds and defs variables. Specifically, male respondents exhibited significantly higher mean ranks for both variables compared to their female counterparts. The mean rank for ds was 347.89 in boys, corresponding to an average of 9.52, while in girls it was notably lower at 300.85, with an average of 7.95 (p = 0.001). Similarly, for the defs index, boys had a mean rank of 345.31 (mean = 10.69) compared to 304.38 in girls (mean = 9.18), with this difference also reaching statistical significance (p = 0.006) - Table 11.

Table 11. Mann-Whitney test of difference in decayed (ds), extracted (es), filled (fs) and total (defs) tooth surfaces by sex

Tooth surface	Sex	n	Mean rank	Median.	Mann-Whitney U test.
Decayed (ds)	Male	378	347.89	4.00	M-W U = 44833.0
	Female	277	300.85	2.00	Z = -3.208
	Total	655			**p = 0.001**
Extracted (es)	Male	378	327.41	0.00	M-W U = 52131.5
	Female	277	328.80	0.00	Z = -0.155
	Total	655			p = 0.876
Filled (fs)	Male	378	328.50	0.00	M-W U = 52163.5
	Female	277	327.32	0.00	Z = -0.174
	Total	655			p = 0.862
Decayed + extracted + filled surface (defs)	Male	378	345.31	5.00	M-W U = 45811.0
	Female	277	304.38	4.00	Z = -2.776
	Total	655			**p = 0.006**

Tables 12 and 13 present a detailed descriptive analysis of the variables ds (decayed surfaces), es (extracted/missing surfaces), fs (filled surfaces), and defs (the sum of decayed, extracted, and filled surfaces), alongside the results of the Kruskal-Wallis test assessing differences across the age categories of the respondents. The analysis revealed statistically significant differences for both es and defs variables according to age. Specifically, es values were found to be significantly higher among six-year-old respondents, with a mean value of 1.64 and a corresponding mean rank of 361.58, compared to significantly lower values in younger age groups ($p < 0.001$). A similar pattern was observed for the defs index, where six-year-olds exhibited a mean of 11.73 (mean rank 363.20), which was significantly greater than that observed in other age groups ($p = 0.037$) (Table 12, and Table 13). Moreover, a progressive increase in defs values with age was evident. As shown in Table 12, the average defs scores for respondents aged three to six years were 8.72, 9.46, 9.80, and 11.73, respectively. This upward trend underscores the cumulative nature of dental caries experience with increasing age within the primary dentition period.

Table 12. Mean ± Standard deviation of decayed (ds), extracted (es), filled (fs) and total (defs) tooth surface by age groups

Tooth surface	Age (years)	n	Mean	St.dev.	95% CI*		Min.	Max.
					h1	h2		
Decayed (ds)	3	79	7.71	13.947	4.58	10.83	0	78
	4	190	8.55	15.112	6.39	10.72	0	88
	5	224	8.76	14.144	6.90	10.63	0	65
	6	162	9.91	14.040	7.73	12.09	0	65
	Total	655	8.86	14.367	7.76	9.96	0	88
Extracted (es)	3	79	**0.80**	2.339	0.27	1.32	0	10
	4	190	**0.77**	3.547	0.27	1.28	0	32
	5	224	**0.93**	2.980	0.54	1.32	0	22
	6	162	**1.64**	3.237	1.14	2.14	0	16
	Total	655	1.04	3.165	0.80	1.29	0	32
Filled (fs)	3	79	0.22	0.983	0.00	0.44	0	8
	4	190	0.14	0.811	0.02	0.25	0	8
	5	224	0.12	0.500	0.05	0.19	0	3
	6	162	0.19	0.560	0.10	0.27	0	3
	Total	655	0.15	0.685	0.10	0.21	0	8
Decayed + extracted+ filled surface (defs)	3	79	**8.72**	14.857	5.39	12.05	0	88
	4	190	**9.46**	16.132	7.15	11.77	0	88
	5	224	**9.80**	14.954	7.83	11.77	0	73
	6	162	**11.73**	15.182	9.38	14.09	0	66
	Total	655	10.05	15.348	8.87	11.23	0	88

Confidence Interval for Mean. h1 lower bound. h2 upper bound.

Table 13 present a Kruskal–Wallis analysis of decayed, extracted, filled, and total (defs) tooth surfaces by age group.

Table 13. Kruskal-Wallis analysis of tooth surface caries indices by age group

Tooth surface	Age group	n	Mean rank	Median.	Kruskal-Wallis test.
Decayed (ds)	3	79	305,53	2.00	$\chi^2 = 4.960$
	4	190	318,64	2.00	df = 3
	5	224	324,87	3.00	p = 0.175
	6	162	354,27	4.50	
	Total	655			
Extracted (es)	3	79	320,97	0.00	$\chi^2 = 20.942$
	4	190	308,34	0.00	df = 3
	5	224	322,87	0.00	**p < 0.001**
	6	162	361,58	0.00	
	Total	655			
Filled (fs)	3	79	332,51	0.00	$\chi^2 = 6.649$
	4	190	319,13	0.00	df = 3
	5	224	324,15	0.00	p = 0.084
	6	162	341,53	0.00	
	Total	655			
Decayed + extracted + filled surface (defs)	3	79	304,47	3.00	$\chi^2 = 8.511$
	4	190	312,07	3.00	df = 3
	5	224	324,36	4.00	**p = 0.037**
	6	162	363,20	6.00	
	Total	655			

4.1.4 Clinical examination

The results of the clinical examination questionnaire in three planes are presented in Table 14.

Table 14. Prevalence and distribution of occlusal characteristics in the primary dentition

Code	Name	Code	Name	N	%
E1	Overjet	1	Normal	555	84.7
		2	Increased-more than 3 mm	74	11.3
		3	Increased-more than 5 mm	16	2.4
		4	Reversed	4	0.6
		5	Edge to edge	6	0.9
			Total	655	100.0
E2	Overbite	1	Normal	338	51.6
		2	Deep bite	234	35.7
		3	Anterior Open bite (2-3 mm)	10	1.5
		4	Anterior Open bite (more than 3 mm)	9	1.4
		5	Reduce bite	58	8.9
		6	Under bite	6	0.9
			Total	655	100.0
E3	Crossbite	0	No presence	591	90.2
		1	Posterior unilateral	42	6.4
		2	Posterior bilateral	19	2.9
		3	Anterior	3	0.5
			Total	655	100.0
E6	Primary molar relationship	1	Class I. Flush terminal plane	378	57.7
		2	Class II (distal step)	182	27.8
		3	Class III (mesial step)	13	2.0
			Total	573	87.5
E7	Primary canine relationship	1	Class I	412	62.9
		2	Class II	201	30.7
		3	Class III	14	2.1
			Total	627	95.7

Chi-square (χ^2) tests were conducted to examine the potential dependence between the variables from the clinical examination questionnaire and the gender of the children. The results demonstrated no statistically significant association with the gender of the respondents. Furthermore, the relationship between the child's age and the clinical examination questionnaire items was assessed using a one-way analysis of variance (ANOVA) model, with age as a continuous dependent variable and individual questionnaire items as factors. The analysis revealed no statistically significant differences in age for any of the questionnaire items. These findings were further corroborated by additional χ^2 tests, where age was treated as a categorical variable. The tests similarly demonstrated no significant dependence between the children's age groups and the responses to the clinical examination questionnaire items.

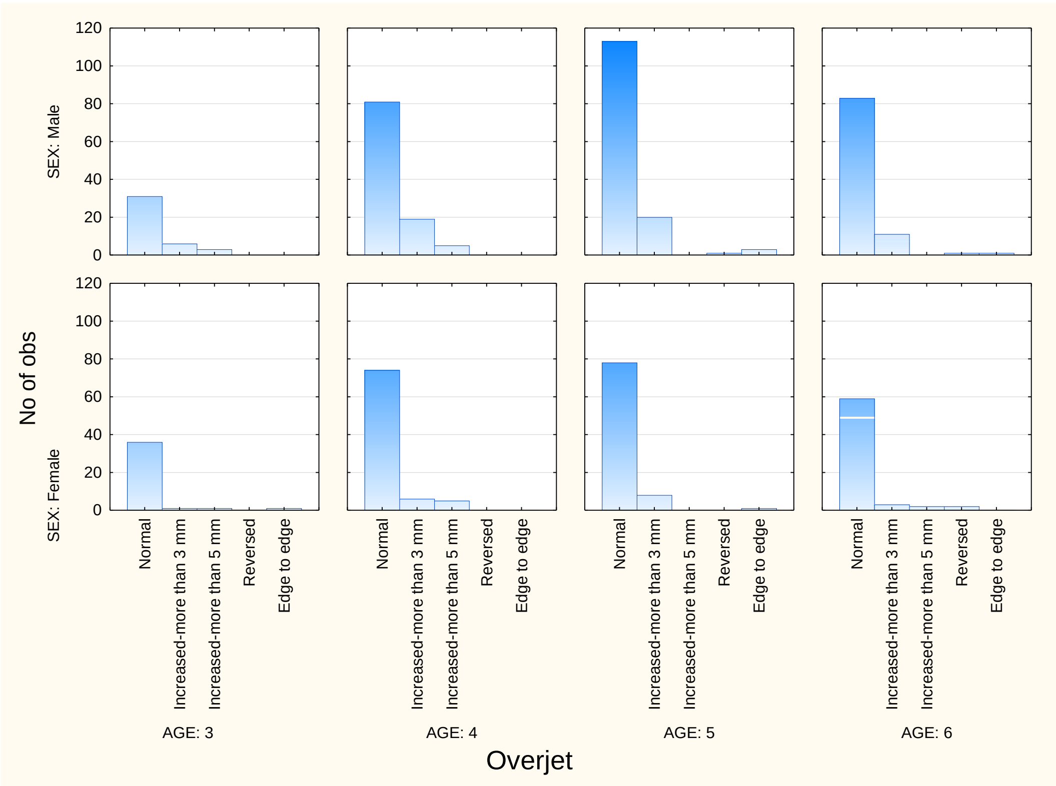

Figure 26. Distribution of respondents by sex and age upon clinical examination E1 (Overjet)

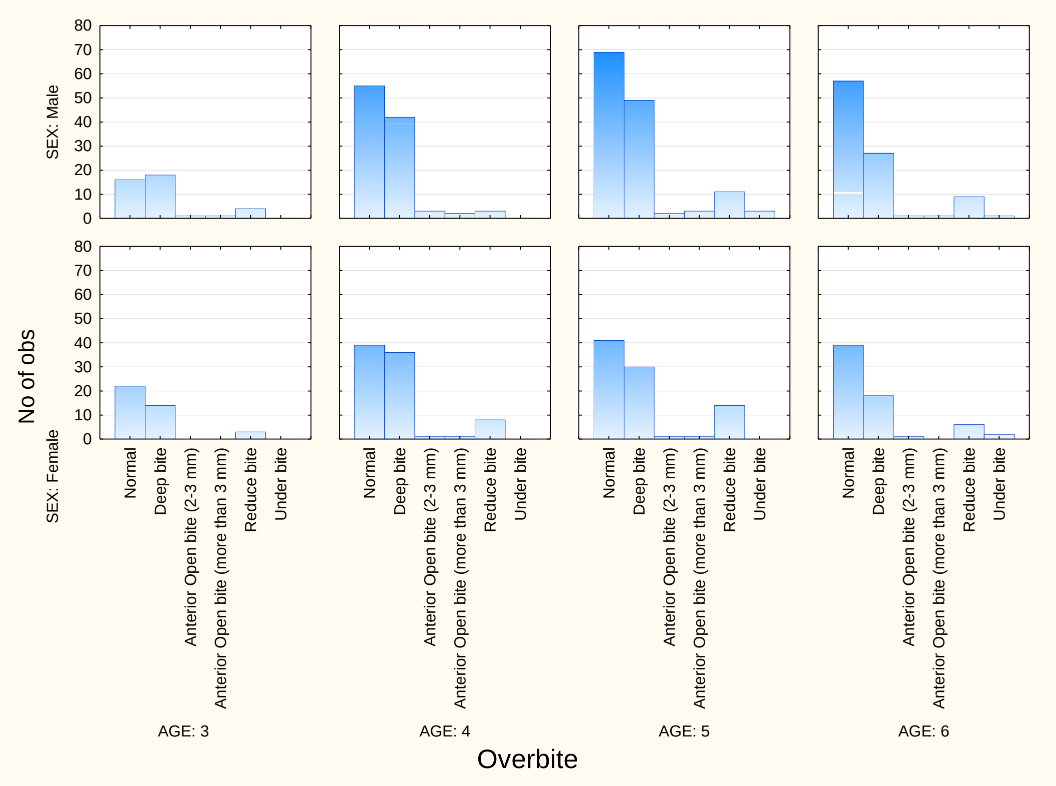

Figure 27. Distribution of respondents by sex and age for clinical examination E2 (Overbite)

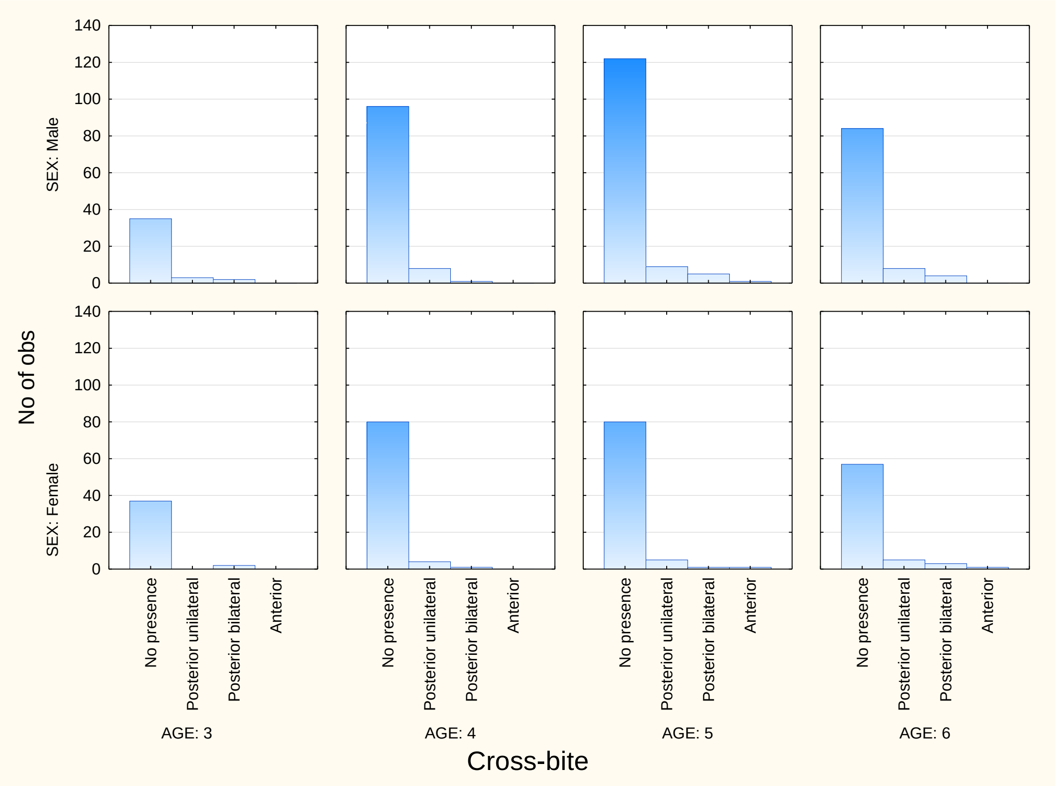

Figure 28. Distribution of respondents by sex and age for clinical examination E3 (Crossbite)

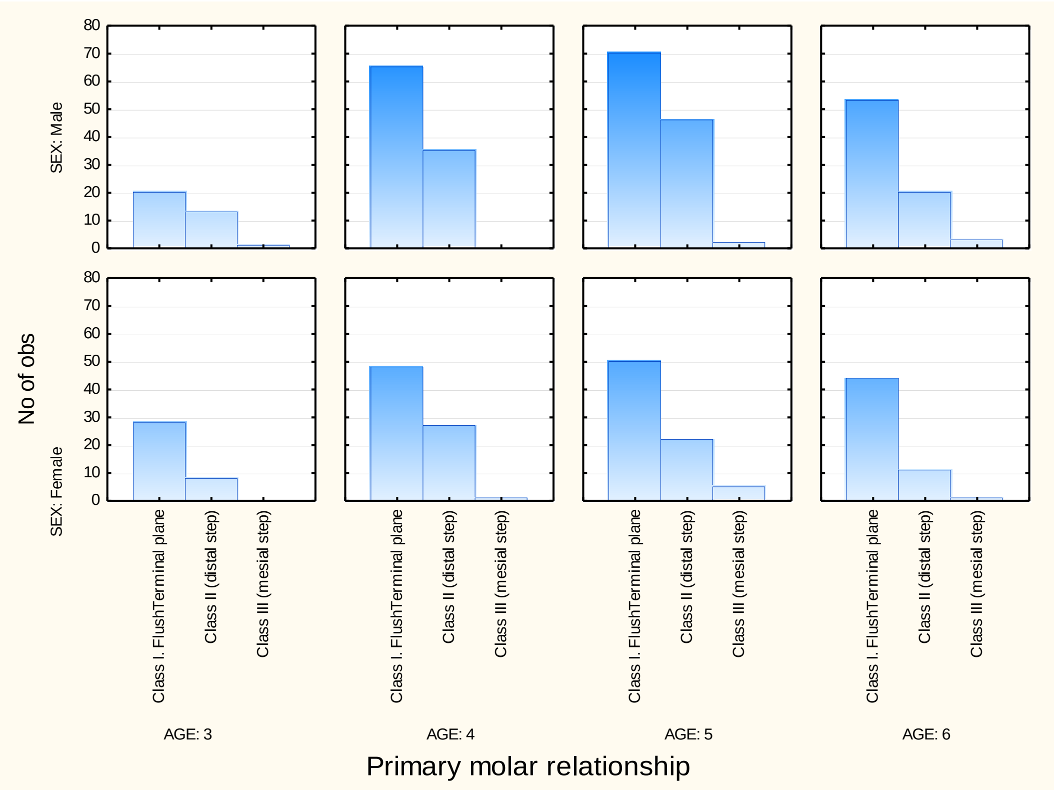

Figure 29. Distribution of respondents by sex and age for clinical examination E6

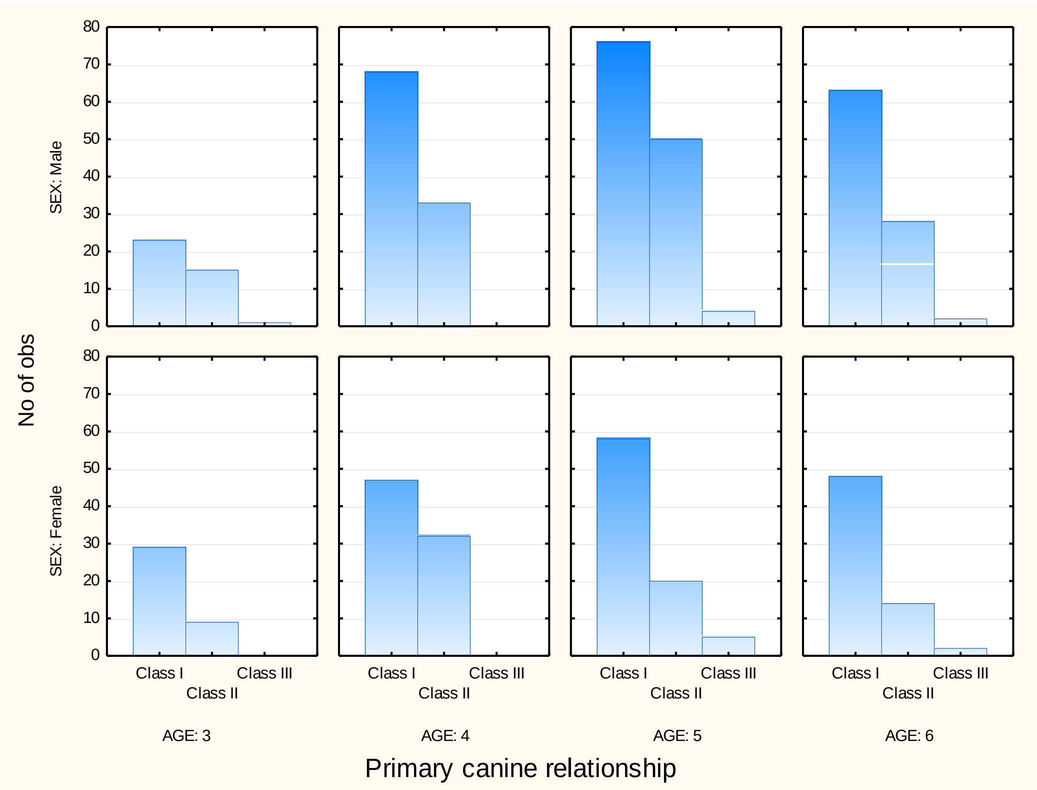

Figure 30. Distribution of respondents by sex and age for clinical examination E7

4.2. Differences in dental status according to the variables of the parental questionnaire and clinical examination

4.2.1 Associations between the defs index and parent-reported oral habits and oral hygiene practices in children

Table 15 shows the relationship between the defs index (decayed, extracted, and filled tooth surfaces) and questionnaire items Q1, Q10, and Q19. Since defs did not follow a normal distribution, the Mann-Whitney U and Kruskal-Wallis tests were used to assess differences. Statistically significant differences in defs were observed for these items, while no significant associations were found for the remaining questions.

Table 15. Oral Habits, and their association with the defs index in children aged 3–6 years

Questionnaire		n	Mean	Mean rank	Mann-Whitney U or Kruskal-Wallis test
Has your chhild used a pacifier? (Q1)	No	576	10.41	333.83	M-W U = 19391.5
	Yes	79	7.43	285.46	Z = -2.163
	Total	655			**p = 0.031**
Does your child have open mouth during sleeping? (Q10)	No	602	9.55	322.67	M-W U = 12745.0
	Yes	53	15.72	388.53	Z = -2.466
	Total	655			**p = 0.014**
How often does your child visit a dentist? (Q19)	Never	17	50.06	612.56	K-W χ^2 = 49.935
	One a year	508	9.18	311.64	df = 3
	Once in 6 months	77	9.12	270.27	**p < 0.001**
	Several times a year	53	6.89	285.68	
	Total	655			

4.2.2 *Differences in dental status (defs index) based on clinical examination findings*

The Mann-Whitney and Kruskal-Wallis tests were applied to assess differences in the number of decayed, missing, and filled tooth surfaces (defs) in relation to the variables from the clinical evaluation, in three planes of space.

Table 16. Correlation of the defs index with the occlusal features in the primary dentition of children

Clinical examination		n	Mean	Mean rank	Mann-Whitney U or Kruskal-Wallis test
E1	Normal	555	10.06	330.84	K-W χ^2 = 8.962
	Increased- more than 3 mm	74	7.92	288.61	df = 4
	Increased- more than 5 mm	16	16.63	357.00	p < 0.062
	Reversed	4	28.00	539.25	
	Edge to edge	6	5.50	333.71	
	Total	655			
E2	Normal	338	8.85	321.83	K-W χ^2 = 7.058
	Deep bite	234	11.38	324.58	df = 5
	Anterior Open bite (2-3 mm)	10	11.10	361.80	p < 0.216
	Anterior Open bite (> 3 mm)	9	16.22	329.33	
	Reduced bite	58	9.33	353.85	
	Under bite	6	22.00	500.92	
	Total	655			
E3	Absent	591	9.83	325.16	K-W χ^2 = 2.329
	Posterior unilateral	42	13.45	364.45	df = 3
	Posterior bilateral	19	7.11	323.03	p < 0.507
	Anterior	3	24.00	409.33	
	Total	655			
E6	Class I. Flush Terminal plane	378	5.93	291.13	K-W χ^2 = 3.382
	Class II (distal step)	182	5.99	273.94	df = 2
	Class III (mesial step)	13	7.38	349.69	p = 0.184
	Total	655			
E7	Class I	412	7.13	311.35	K-W χ^2 = 5.274
	Class II	201	9.20	311.92	df = 2
	Class III	14	13.36	422.04	p = 0.072
	Total	655			

4.2.3 Pairwise correlations between the parental questionnaire, dental status (defs) and clinical examination variables

To evaluate the relationships between the parent-reported questionnaire responses and objective clinical measures, Pairwise Spearman's correlation analysis was applied for assessing associations with the dental status (defs) scores, given the non-parametric nature of the data. Pairwise Spearman's correlation coefficients were calculated to assess the associations between each variable from the parent questionnaire and the dental status variables in Table 17.

Table 17. Pairwise correlations between parental questionnaire and dental status (defs) variables

	ds	es	fs	defs
Q1	-0.081939	-0.050569	-0.049306	-0.084583
Q2	0.053547	0.064432	-0.084174	0.038866
Q3	-0.010166	-0.030059	-0.050325	-0.020289
Q4	-0.058729	-0.048786	-0.044732	-0.073485
Q5	0.009341	-0.049476	0.005473	-0.000832
Q6	0.024301	0.068598	-0.045904	0.013089
Q7	-0.012358	-0.066758	-0.019194	-0.032356
Q8	-0.059190	-0.027258	-0.024046	-0.068291
Q9	0.059374	0.026720	0.008647	0.042836
Q10	0.089014	0.036498	0.044308	0.096427
Q11	0.029154	0.021503	0.014707	0.033816
Q12	-0.011422	0.021463	0.029725	-0.004313
Q13	0.023053	-0.026646	-0.021204	0.008797
Q14	0.028935	-0.028797	-0.072620	0.011173
Q15	0.073226	-0.038004	0.089199	0.061691
Q16	0.034304	-0.091717	-0.023853	0.024642
Q17	-0.000276	0.105362	0.053592	0.015790
Q18	-0.004360	0.014176	-0.100466	-0.016402
Q19	-0.199193	-0.118111	-0.009212	-0.200552

Red coefficients are significant ($p \leq 0.050$)

The following results, presented in Table 18, show the outcomes of the Pairwise Spearman's correlation analysis conducted to evaluate the strength and direction of the associations between dental status (defs) scores and the variables from the clinical examination.

Table 18. Pairwise correlations between dental status (defs) and clinical examination variables

	ds	es	fs	defs
E1	0.004134	-0.032445	-0.105493	-0.029563
E2	0.044625	0.025965	0.005572	0.052367
E3	0.069539	0.026900	-0.021208	0.045391
E6	-0.017788	-0.032014	-0.089834	-0.028300
E7	0.037158	0.054937	-0.062103	0.029824

Red coefficients are significant ($p \leq 0.050$)

Pairwise Kendall's Tau correlations were performed to evaluate the associations between the parental questionnaire responses and the clinical examination variables, results are presented in Table 19.

Table 19. Pairwise correlations between the parental questionnaire and clinical examination

	E1	E2	E3	E6	E7
Q1	0.238068	0.302954	0.131386	0.222288	0.186623
Q2	0.206759	0.165488	0.001117	0.128951	0.137934
Q3	0.460910	0.297098	0.164945	0.243033	0.240356
Q4	0.064305	0.175062	-0.025965	0.076989	0.052583
Q5	0.172696	0.240724	-0.070276	0.211081	0.189447
Q6	0.140403	0.174132	0.042712	0.168725	0.168160
Q7	0.009655	0.035000	0.181351	0.035720	0.059569
Q8	0.097520	0.105832	0.049768	0.097218	0.075292
Q9	-0.011051	-0.048939	0.023746	-0.081856	-0.047738
Q10	0.201039	0.195493	0.109047	0.090421	0.117782
Q11	0.272332	0.437868	0.280282	0.248693	0.235653
Q12	0.192999	0.261428	0.140071	0.147420	0.131031
Q13	0.277403	0.368955	0.119497	0.261646	0.245223
Q14	-0.027746	-0.045370	-0.011606	-0.062190	-0.035461
Q15	-0.040060	-0.033923	-0.031238	0.025839	0.045316
Q16	-0.035454	0.046927	-0.003769	0.110309	0.089186
Q17	-0.026802	-0.085323	0.035531	-0.142085	-0.102368
Q18	-0.027070	-0.059249	-0.105004	-0.066895	-0.063912
Q19	-0.065802	-0.086789	-0.054556	-0.013765	-0.057899

Red coefficients are significant ($p \leq 0.050$)

4.3. Logistic regression models

4.3.1 Binary logistic regression analysis

The prediction of clinical examination outcomes (E1–E7) based on parents' responses to the questionnaire items (Q1–Q19) was conducted using logistic regression models. Given the type and distribution of these variables, as well as the influence of demographic factors, such as the gender and age of the participants, a binary logistic regression model was selected as the most appropriate analytical method.

Due to the relatively low frequencies observed in certain categories of the dependent variables E1–E7, it was necessary to recode these variables into binary outcomes, distinguishing between the presence and absence of specific clinical findings. The resulting frequencies of these newly defined binary variables are presented in Table 20, providing a clear overview of their distribution within the examined sample, and forming the basis for subsequent predictive modeling.

Table 20. Clinical Examination – binary frequency tables

Code	Name	Code	Name	N	%
E1	Overjet	0	Normal	555	**84.7**
		1	Increased, reversed, edge to edge	100	15.3
			Total	655	100.0
E2	Over bite	0	Normal	338	**51.6**
		1	Deep bite and all other	317	48.4
			Total	655	100.0
E3	Cross-bite	0	No presence	591	**90.2**
		1	Posterior-anterior	64	9.8
			Total	655	100.0
			Total	655	100.0
E6	Primary molar relationship	0	Class I Flush terminal plane	378	**57.7**
		1	Class II (distal step)-Class III (mesial step)	195	29.8
			Total	573	100.0
E7	Primary canine relationship	0	Class I	412	**62.9**
		1	Class II-III	215	32.8
			Total	627	100.0

4.3.2 Predicting clinical outcome E1 (overjet) from the parental questionnaire

The results presented in Table 21 demonstrate the contribution and relative importance of each of the 19 questionnaire variables, which were analyzed as predictors of the dependent variable E1—that is, the probability that a child, according to parental reports, would be classified in the "Yes" category. According to the Wald test, only nine predictors showed statistically significant associations. Among these, the strongest predictor was Q3 (Does your child have a finger or thumb sucking habit?). Parents who responded "Yes" to this item had 123 times higher odds that their child, based on the clinical examination, would be classified in the group with increased overjet, compared to children without this habit.

Table 21. Prediction of the probability of the answer "Increased-reversed-edge to edge" of the dependent variable E1(overjet)

Variables in the equation		B	S.E.	Wald	Df	p	OR	95% CI for OR	
							Exp(B)	Lower	Upper
Q1(1) Yes		0.95	0.37	6.75	1	0.009	2.59	1.26	5.31
Q2(1) Yes		1.15	0.34	11.39	1	0.001	3.14	1.62	6.12
Q3(1) Yes		4.82	0.57	71.60	1	<0.001	123.58	40.49	377.14
Q4(1) Yes		2.53	0.46	30.43	1	<0.001	12.58	5.12	30.94
Q5(1) Yes		2.94	0.43	46.10	1	<0.001	18.81	8.06	43.89
Q6(1) Yes		3.06	0.49	39.60	1	<0.001	21.36	8.23	55.43
Q8(1) Yes		2.01	0.64	9.68	1	0.002	7.43	2.10	26.26
Q10(1) Yes		1.57	0.43	13.40	1	<0.001	4.83	2.08	11.21
Q11(1) Yes		2.39	0.46	27.05	1	<0.001	10.93	4.44	26.92
Constant		-5.36	0.48	122.75	1	<0.001	0.01		

List of retained predictors:

Q1 Has your child used a pacifier?

Q2 Has your child been bottle fed?

Q3 Does your child have a finger or thumb sucking habit?

Q4 Does your child have a habit of sucking objects such as clothes, a key chain, toys etc?

Q5 Does your child have a lip sucking habit?

Q6 Does your child have a lip/cheek biting habit?

Q8 Does your child have the habit of biting pacifiers?

Q10 Does your child have open mouth during sleeping?

Q11 Does your child hold his/her tongue between lips or teeth while sleeping?

4.3.3 Predicting clinical outcome E2 (overbite) from the parental questionnaire

Table 22 presents the results of the logistic regression analysis examining the contribution of the 19 questionnaire variables in predicting the probability of an overbite (E2) based on the clinical examination. According to the Wald test, 10 predictors were statistically significant. The strongest predictor was Q3 (Does your child have a finger or thumb sucking habit) with a reported 86-fold increase in the odds of anterior open bite among children with this habit.

Table 22. Prediction of the probability of the answer " Open bite, deep bite and all other" of the dependent variable E2 (overbite)

Variables in the equation	B	S.E.	Wald	df	p	OR	95% CI for OR	
						Exp(B)	Lower	Upper
Q1(1) Yes	1.86	0.49	14.27	1	<0.001	6.41	2.44	16.81
Q3(1) Yes	4.45	1.07	17.43	1	<0.001	85.98	10.63	695.62
Q4(1) Yes	3.52	0.36	94.29	1	<0.001	33.73	16.58	68.62
Q5(1) Yes	4.60	0.56	67.63	1	<0.001	99.38	33.21	297.36
Q6(1) Yes	4.26	0.52	66.21	1	<0.001	70.92	25.41	197.96
Q8(1) Yes	2.79	0.63	19.74	1	<0.001	16.31	4.76	55.88
Q10(1) Yes	1.10	0.54	4.11	1	0.043	3.01	1.04	8.75
Q12(1) Yes	2.01	0.72	7.81	1	0.005	7.46	1.82	30.53
Q13(2) 4-6 hours	1.54	0.61	6.40	1	0.011	4.68	1.42	15.49
Q16(1) Yes	-0.60	0.30	3.93	1	0.047	0.55	0.30	0.99
Constant	-2.15	0.29	56.23	1	<0.001	0.12		

List of retained predictors:

Q1 Has your child used a pacifier?

Q3 Does your child have a finger or thumb sucking habit?

Q4 Does your child have a habit of sucking objects such as clothes, a key chain, toys etc?

Q5 Does your child have a lip sucking habit?

Q6 Does your child have a lip/cheek biting habit?

Q8 Does your child have the habit of biting pacifiers?

Q10 Does your child have open mouth during sleeping?

Q12 Does your child breathe through their mouth?

Q13 If any of these habits are present,how many hours a day does your child engage in them?

Q16 Does he/she brush their teeth alone?

4.3.4 Predicting the clinical outcome posterior-anterior crossbite (E3) from parental questionnaire items

Table 23 presents the results of the logistic regression analysis for predicting the probability of a posterior-anterior crossbite (E3) on the basis of the 19 questionnaire variables. According to the Wald test, four predictors were statistically significant. The strongest predictor was Q7 (Does your child have a nail biting habit?), associated with a 7-fold increase in the odds of crossbite.

Table 23. Prediction of the probability of the answer "Posterior crossbite"for the dependent variable E3

Variables in the equation	B	S.E.	Wald	Df	p	OR	95% CI for OR	
						Exp(B)	Lower	Upper
Q3(1) Yes	1.22	0.43	8.02	1	0.005	3.39	1.46	7.91
Q7(1) Yes	1.95	0.36	29.43	1	0.000	7.06	3.48	14.30
Q10(1) Yes	0.96	0.43	4.89	1	0.027	2.61	1.12	6.13
Q11(1) Yes	1.93	0.37	27.72	1	0.000	6.88	3.35	14.09
Q13			8.09	3	0.044			
Constant	-3.07	0.24	169.16	1	0.000	0.05		

List of retained predictors:

Q3 Does your child have a finger or thumb sucking habit?

Q7 Does your child have a nail biting habit?

Q10 Does your child have open mouth during sleeping?

Q11 Does your child hold his/her tongue between lips or teeth while sleeping?

Q13 If any of these habits are present,how many hours a day does your child engage in them?

4.3.5 *Predicting the primary molar relationship (E6) from parental questionnaire items*

On the basis of the results presented in Table 24, the contribution was evaluated of the 19 questionnaire variables as predictors for the dependent variable E6 (Class I Flush terminal plane). According to the Wald test, 10 predictors demonstrated statistical significance. The most influential predictor was Q13, with categories Q13(2) and Q13(3) (habit duration of 4–6 hours and more than 6 hours) being significantly associated with an 8-fold increased risk of an altered primary molar relationship.

Table 24. Prediction of the probability of the answer "Class II (distal step) - Class III (mesial step)" for the dependent variable E6

Variables in the equation	B	S.E.	Wald	df	p	OR	95% CI for OR	
						Exp(B)	Lower	Upper
Q1(1 Yes)	0.65	0.31	4.37	1	0.036	1.92	1.04	3.52
Q3(1) (Yes)	1.98	0.45	19.53	1	<0.001	7.22	3.00	17.34
Q4(1) (Yes)	1.17	0.29	16.16	1	<0.001	3.21	1.82	5.66
Q5(1) (Yes)	1.71	0.31	31.32	1	<0.001	5.52	3.03	10.04
Q6(1) (Yes)	1.92	0.36	27.87	1	<0.001	6.85	3.35	13.99
Q8(1) (Yes)	1.29	0.54	5.74	1	0.017	3.63	1.26	10.42
Q11(1) (Yes)	1.67	0.39	18.03	1	<0.001	5.34	2.46	11.56
Q13(2) 4-6 hours	0.86	0.39	4.78	1	0.029	2.36	1.09	5.09
Q13(3) More than 6 hours	2.08	0.94	4.89	1	0.027	8.00	1.27	50.47
Q16(1) Yes	-0.61	0.22	7.52	1	0.006	0.54	0.35	0.84
Constant	-1.40	0.22	40.88	1	<0.001	0.25		

List of retained predictors:

Q1 Has your child used a pacifier?

Q3 Does your child have a finger or thumb sucking habit?

Q4 Does your child have a habit of sucking objects such as clothes, a key chain, toys etc?

Q5 Does your child have a lip sucking habit?

Q6 Does your child have a lip/cheek biting habit?

Q8 Does your child have the habit of biting pacifiers?

Q11 Does your child hold his/her tongue between lips or teeth while sleeping?

Q13 If any of these habits are present,how many hours a day does your child engage in them?

Q16 Does he/she brush their teeth alone?

4.3.6 *Prediction of the primary canine relationship (E7) from parental questionnaire items*

Table 25 presents the contribution of the 19 questionnaire variables in predicting the dependent variable E7 (Class I). According to the Wald test, 10 predictors were statistically significant. The strongest was Q3(1) (finger or thumb sucking habit, Yes), associated with an 8-fold increased risk of an altered primary canine relationship. Q13(2) (habit duration 4–6 hours) was also significant**.**

Table 25. Prediction of the probability of the answer Class II - Class III of the dependent variable E7

Variables in the equation	B	S.E.	Wald	Df	p	OR	95% CI for OR	
						Exp(B)	Lower	Upper
Q3(1) Yes	2.07	0.41	25.49	1	.000	7.93	3.55	17.73
Q4(1) Yes	0.98	0.27	12.94	1	.000	2.68	1.56	4.57
Q5(1) Yes	1.62	0.29	31.90	1	.000	5.07	2.89	8.90
Q6(1) Yes	1.82	0.32	32.24	1	.000	6.17	3.29	11.56
Q8(1) Yes	1.23	0.49	6.38	1	.012	3.41	1.32	8.85
Q11(1) Yes	1.54	0.34	20.88	1	.000	4.67	2.41	9.05
Q13(2) 4-6 hours	0.77	0.35	4.93	1	.026	2.15	1.09	4.23
Q16(1) Yes	-0.46	0.21	5.14	1	.023	0.63	0.42	0.94
Constant	-1.41	0.20	47.29	1	.000	0.25		

List of retained predictors:

Q3 Does your child have a finger or thumb sucking habit?

Q4 Does your child have a habit of sucking objects such as clothes, a key chain, toys etc?

Q5 Does your child have a lip sucking habit?

Q6 Does your child have a lip/cheek biting habit?

Q8 Does your child have the habit of biting pacifiers?

Q11 Does your child hold his/her tongue between lips or teeth while sleeping?

Q13 If any of these habits are present,how many hours a day does your child engage in them?

Q16 Does he/she brush their teeth alone?

5. DISCUSSION

5.1 Dental caries, oral habits and malocclusion

Children face two major oral health issues because dental caries and harmful oral habits continue to be their main dental problems, causing immediate and enduring impacts on their teeth and facial structure. The complex maxillofacial development faces major obstacles because oral dysfunction appears during the early stages and cariogenic processes begin to develop (148). Research studies have demonstrated that dental caries and oral habits such as thumb-sucking, lip-sucking, mouth-breathing and tongue-thrusting, develop from multiple causes (51). These habits, which continue over time, lead to malocclusion and they cause problems with dental arch development and orofacial muscle imbalance (149). Early Childhood Caries (ECC), the most common chronic disease in children, frequently leads to early tooth loss, disrupting occlusion and the eruption of permanent teeth (150).

This study is the first epidemiological assessment of dental caries and occlusal traits among kindergarten-aged children in Pristina, Kosovo. The research investigates how primary teeth develop carious lesions, and their occlusal features, to address an essential deficiency in knowledge which affects pediatric oral health services for this specific age range (151). The study reveals important information about how often Kosovar children have normal occlusion and which types of malocclusion occur in that population (152). Importantly, the study also explores the relationship between occlusal traits and non-nutritive oral habits, offering a basis for targeted prevention programs that support functional occlusion and long-term dental stability (149).

The study assessed vital occlusal characteristics that dentists need to know, and it examined their relationship to chewing patterns and tooth decay advancement during the first stages of occlusal development. The researchers documented oral habits through parent-completed questionnaires and clinical assessments, which they used to confirm their diagnostic results (51).

Given that the primary dentition reaches full development at age three and stays in place until children reach the age of six, it functions as the main indicator of their future dental health. The occlusal discrepancies which appear in the sagittal plane during this stage will continue to affect the permanent teeth, making it essential to maintain both the form and function of primary teeth (148, 149).

Research studies based on epidemiology have investigated the prevalence of dental caries and malocclusion affecting children in their population. However, relatively few have concurrently assessed both dental and orthodontic or occlusal parameters within adequately sized or representative samples (40). The scientific community lacks sufficient data to determine how various conditions affect each other. Studies show that dental caries and premature loss of primary teeth result in occlusal problems and space-related dental issues which become visible during the mixed and permanent dentition periods (41-43,153). It is generally accepted that early loss of primary teeth is a major factor related to the development of malocclusion in permanent dentition. However, the evidence for and basis of this association have often been questioned (154,155). According to previous studies, early loss of primary molars may result in a lack of space, development of midline discrepancies, and other malocclusions in the permanent dentition. Other effects of premature loss of primary teeth (PLPT) include tooth rotation, extrusion of the opposing tooth, dental crowding, deleterious habit formation, craniofacial growth anomalies, and especially, impaction of an erupting permanent tooth and dental arch length discrepancy (156,157). According to the results of the present study, the association between dental caries and malocclusion did not reach statistical significance in the primary dentition. These findings are in agreement with those reported by Stahl et al. (40) who conducted a population-based study in Rostock Germany, and found that caries experience did not create any statistically significant effects on clinical orthodontic anomalies that occurred in the deciduous teeth. The study proved that children with mixed dentition developed malocclusion at a statistically significant rate, which matched their tooth decay progression. The research results from Gowda S.V. et al. (158) concluded that dental crowding is strongly associated with malocclusion. The researchers found that children who show crowding of their teeth will likely develop different types of dental misalignment. The arrangement of teeth in the mouth could lead to better jaw development when patients receive treatment at an early stage. Conversely, the results of the present study differ from those reported by Zhou et al. (128) who studied the link between primary tooth caries and malocclusion through statistical methods, and found these two conditions strongly related to each other. Early Childhood Caries (ECC) exists as a complicated dental condition which occurs through various biological processes and behavioral patterns. The development of ECC in preschool children occurs because they do not practice good oral hygiene through regular tooth brushing, and their caregivers fail to provide proper supervision. Research shows that harmful oral behaviors, including extended pacifier use and mouth breathing, create conditions which increase the risk of tooth decay.

Pacifier use which includes dipping it in sweetened liquids during infancy leads to extended sugar contact and bacterial growth that causes tooth enamel to demineralize. The research tracked children from birth until they reached 2.5 years of age to show that children who used pacifiers for longer than 24 months developed tooth decay at three and a half times the rate of other children. The research found that children who drank from night bottles during sleep developed caries at the same rate as children who used pacifiers for long periods (159). A longitudinal study was conducted of Japanese preschoolers between 1.5 and 3 years old and found that children who used pacifiers at 18 months developed more tooth decay than other children at age 3 (24.4%), non users or those with a finger sucking habit (a statistically significant difference, $p < 0.01$) (160). Research about orofacial development indicated that using a pacifier for more than three years leads to dental problems, which include anterior open bite and crossbite malocclusions and these affect oral health and increase the risk of tooth decay (82). In other studies, no such association was found between pacifier use and the presence of caries (161,162). The World Health Organization (WHO) contraindicates the use of pacifiers due to their potential interference with breastfeeding practices (163). On the basis of these assumptions and the results observed in the study by Soares ME (164), it was suggested that a pacifier can meet the need for suction, while also reducing the use of a bottle, especially at night. However this association needs further investigations to verify this connection. The practice of mouth breathing results in decreased saliva production, which causes xerostomia (dry mouth) and this weakens the saliva's ability to perform its natural buffering and antimicrobial functions. This creates the conditions for cariogenic bacteria to thrive. The mouth becomes the primary breathing site for preschool children who breathe through their mouths, causing dry oral tissues that decrease saliva production and changing its chemical makeup (165). The process of eating and drinking leads to saliva breakdown which reduces its ability to clean itself and weakens its ability to neutralize acids, thus creating an environment where bacteria can accumulate and cause dental caries (166). Additionally mouth breathers develop various forms of oral bacteria in their mouths including *Streptococcus mutans*, that leads to more rapid tooth decay (167). The mucosa becomes dehydrated because the oral surfaces are exposed to air which causes the protective salivary film to become increasingly disrupted (168).

A previous study by Choi et al. (169) simulated mouth breathing in healthy participants, and found a reduction in nocturnal intraoral pH, which may be associated with the occurrence of caries and dental erosion. Therefore, mouth breathing constitutes a significant risk factor for impaired salivary defense mechanisms, with a subsequent increase in caries susceptibility in children. The research investigated Brazilian preschool children between 3 to 5 years old through a cross-sectional study which revealed that children who breathed through their mouths developed anterior dental caries at a 57% higher rate. Notably, pacifier use in that study was associated with a lower prevalence of anterior caries. According to this study, children with predominant mouth breathing had a higher prevalence of anterior dental caries compared to nasal breathers (164). Research studies focusing on small patient groups have shown that mouth breathing and pacifier use create changes in oral bacterial communities which leads to increased ECC development when patients do not practice good oral hygiene and come from disadvantaged socio-economic backgrounds (164,170).

The current study confirmed previous research by showing that Early Childhood Caries (ECC) and dmfs index scores were significantly related to children who used pacifiers and showed signs of mouth breathing whilst asleep. The defs index showed a significant relationship with both oral hygiene status and the number of times patients visited a dentist (Table 15). The study results demonstrate that harmful oral behaviors, together with insufficient dental care practices, create major problems which lead to tooth decay among young children who are three to five years old. The research results show that children need immediate behavioral therapy and scheduled dental check-ups to prevent ECC from occurring. Some research studies have not found any evidence proving that mouth breathing leads to dental caries development in children and teenagers (171,172). The different research results about this topic might arise from differences between study approaches, how the researchers diagnosed caries and measured breathing patterns, and how they handled additional factors such as diet and fluoride use, and social and economic status.

The present study reported that children between 3 and 6 years old had a mean defs (decayed, extracted, filled surfaces) index of 10.05 ± 15.35. The 'decayed surfaces' (ds) component produced the most significant results because its mean value reached 8.86 ± 14.37, showing that this population struggles with a major problem of untreated dental caries. The 'extracted surfaces' (es) component displayed average values of 1.04 ± 3.17 which were relatively low and slightly higher in 6-year-old children. The 'filled surfaces' (fs) component showed no age-related changes because it stayed at 0.15 ± 0.69 throughout all age groups (151).The defs index showed a steady rise in values as children aged from 3 to 6 years with results of 8.72, 9.46, 9.80 and 11.73. The study found that caries prevalence and severity in children follow an age-dependent pattern which previous epidemiological research has also documented (173). The research findings match a previous investigation in which Chandan et al. (174) studied Indian children between 3 and 6 years old and found their mean dmfs score to be 9.10, while most of their dental lesions remained untreated. The study by Damyanova and Borisova (173) showed that dental morbidity in children increased with age because 3-year-olds had 2.80 dmft while 6-year-olds had 5.10 dmft. Furthermore, Wang et al. (175)

investigated a Beijing-based longitudinal cohort study, and showed that dmfs scores starting at 5.60 points increased throughout the observation period. Moreover, a study by Shankar et al. (176) stated that the current definitions of indices for traditional defs fail to detect the initial stages of disease, so new diagnostic systems would provide better detection capabilities. The study shows that preschool children have a large quantity of untreated dental caries but they only receive limited restorative dental treatment because dental care access remains a critical issue. This requires immediate public health action and early prevention strategies (177).

5.2 Common oral habits and associated occlusal findings

The correlation between various deleterious oral habits and the development of malocclusions in the mixed and permanent dentitions has been well-documented in the dental literature. Notably, the prevalence of malocclusion has been shown to increase from 49.0% in the deciduous dentition to 71.3% in the permanent dentition, indicating the progressive impact of these habits over time (178). Although the etiological role of deleterious oral habits in the development of malocclusions is well recognized, relatively few studies have focused specifically on the prevalence of malocclusions in the deciduous dentition and their correlation with such habits (178-180). The present research therefore was an attempt to study the correlation between malocclusions in deciduous dentition, and the influence of various oral habits on the deciduous dentition. This study provides the first epidemiological data on occlusal characteristics among kindergarten children in Pristina, Kosovo. The research results provide essential knowledge which will help developers create preventive programs to support normal occlusion formation in children during their essential developmental stages. The research used clinical tests, together with parental survey responses to measure how biological and behavioral elements affect dental growth in young children. The research findings showed that 57.7% of children in the study group had their teeth arranged in a bilateral flush terminal plane (FTP) molar relationship. The research findings match previous epidemiological studies in Huizhou, China, which showed preschool children had the same pattern of FTP distribution (181). Notably, the prevalence of FTP in our sample was approximately 10% higher than the rates reported in comparable studies conducted in Türkiye and Greece (182,183).

Our research showed that Class I (62.9%) represented the dominant primary canine relationship, followed by Class II, and Class III was the rarest among them. These findings are consistent with several previous studies that have reported Class I as the most dominant canine relationship in the primary dentition (184,185). The research by Zhang et al. (39) also identified Class I as the most common canine relationship, but their study revealed a different pattern in the distribution of the remaining classes: the prevalence of Class III relationships was higher than that of Class II, in contrast to our findings. A previous study (132) revealed that most cases of flush terminal plane and mesial step terminal plane in the primary dentition tend to develop into Angle Class I occlusion in the permanent dentition.The mandible advances naturally, while the lower dental arch shifts anteriorly during the mixed dentition stage, leading to this change (186). The identification of these differences needs to occur at an early stage because research shows that Class II malocclusion in primary teeth can lead to Class II malocclusion in permanent teeth (187). The observed prevalence of increased overjet in our study was 11.3%, which falls within the globally reported range of 3% to 16% in the primary dentition, suggesting that Kosovo's children follow similar developmental trends (188,189). When compared to international data, the prevalence rate reported in our study can be considered moderate. In the present study, deep overbite emerged as the most prevalent trait of malocclusion, observed in 35.7% of the participants. This finding is in agreement with earlier research, which also reported deep bite as a frequent characteristic among preschool children (190,191). However it is important to recognize that deep bite in the primary dentition may often be transient, as it can spontaneously resolve, while some self-correction may occur during the vertical development of the mandibular ramus and the complete eruption of the permanent molars, as a longitudinal study suggested (192). Anterior open bite was observed in 2.9% of the participants of our study, which is a similar rate as in the previous study conducted in Turkiye (182).

In the present study, unilateral posterior cross-bite was seen in 6.4% of the kindergarten children (Table 14), which is fewer, in comparison with 8.7% in Saudi Arabian children, 7% in Jordanian children and 25.29% in Chinese children and more than in Indian children at 0.8% (193,194,190,185). Sucking behaviors are a normal part of early childhood development, and are classified as nutritive sucking (breastfeeding and bottle-feeding) and non-nutritive sucking (NNS), which includes behaviors such as pacifier use and finger or thumb sucking. The process of nutritive sucking enables infants to receive nutrition which sustains their life. but non-nutritive sucking helps infants fulfill their natural sucking instincts while bringing them relaxation. It also facilitates neuromuscular development in infants (195,77). These habits exist as typical physical behaviors which babies and young children normally display. Non-nutritive sucking habits which extend past the 3–4 year mark lead to negative dental alignment, including higher overjet and open bite in the front and crossbite in the back (196). Studies show that non-nutritive sucking habits affect different populations at rates ranging from 17.7% to 90.7% (197,198). Young children use pacifiers as their most typical non-nutritive sucking (NNS) behavior which occurs in 13% to 100% of their childhood development (199). In this present study non-nutritive sucking behaviors were present in a notable portion of the sample. The research showed that 12.1% of children used pacifiers which turned out to be lower than what other countries have documented. A study by Medeiros et al. (200) found that Brazilian preschoolers had a 36.5% prevalence of this condition. Another study conducted by Baker et al.(201) found that 58.3% had used a pacifier (74.2% for ≥12 months). Regarding the nutritive behaviors in the present study, bottle feeding was reported in 51.6% of the children, a prevalence that closely aligns with previous findings by Getachew et al. (202), who also documented a similarly high frequency of bottle feeding practices among preschool children.

Our study shows that object sucking occurs in 13.3% of participants, and nail biting occurs in 12.2% of participants at rates which match most current studies (Table 3).

In a recent study, Khattab et al. (2024) found nail biting in 21.8 % and sucking habits in 8.9 % of children aged 5–7 in Cairo, Egypt (203). Similarly, Al Mugairin (204) showed that children who displayed oral habits developed nail biting as an oral behavior which affected 25.5% of the participants (40% of the total study sample). According to Otsugu et al. (2023), nail biting (18.9%) was the most frequent habit, followed by finger sucking (7.8%) in Japanese preschool children aged 3-6 years (140). The research showed that mouth breathing occurred in 8.1% of children, while lip suction as a non-nutritive sucking habit appeared in 11.6% of the subjects. The research findings from academic studies show similar results to these reported rates, but the results vary because of different study locations, participant age groups, and research methods. Our result of 8.1% prevalence of mouth breathing is at the lower end of values reported in preschool children in previous studies. A European research project analyzed Italian preschool children and found that mouth breathing affected 23% of their study participants (134). Sharma et al. reported mouth breathing in 17% of 11–13-year-old children (205).

Research conducted with Brazilian preschool children showed that mouth breathing occurred in 11% to 57% of the participants depending on the observation method and definition of breathing (164).

The observed prevalence of lip suction in our study (11.6%) was lower than those reported in previous studies. The research conducted by Italian scientists who studied preschool children discovered non-nutritive sucking behaviors such as lip suction in 22% of their participants (134). This is similar to a cohort study conducted in Mexico by Oropeza et al., (206). That study found that children between 4 and 11 years old showed a significantly higher rate of lip sucking, that is, 49.3% of them sucked their lips. The research findings show different results because the studies used different cultural methods and diagnostic standards, and studied different age populations. The present study combined Pairwise Kendall's Tau correlation and binary logistic regression analyses to study the connection between parent-reported oral habits and clinical findings which existed in three different spatial planes. The research data showed that Q3 (finger or thumb sucking) had a statistically significant connection to Overjet ($p = 0.460$, $p \leq 0.05$) (Table19). Additionally Q11 results about tongue placement between the lips and teeth while sleeping demonstrated positive connections with E1 ($p = 0.272$), E2 ($p = 0.438$) and E3 ($p = 0.280$) which suggests that this habit might cause dental alignment modifications, resulting in open bite or incisor protrusion development. The survey includes Q13 which asks participants to indicate the daily time spent on specific habits when they exist. This was significantly correlated with E1 ($p = 0.277$), E2 ($p = 0.369$), E6 ($p = 0.262$), and E7 ($p = 0.245$) (Table19). The research findings show that the length of daily harmful oral habits determines how severe the resulting clinical symptoms will become. The logistic regression model confirmed that these behaviors function as strong predictors because nine out of 19 tested variables proved to be significant. The odds ratio (OR) for Q3 reached 123.6 (95% CI: 40.5–377.1; $p < 0.001$) which showed that children who sucked their thumbs or fingers developed significantly more overjet (Table 21). The following behaviors increased the risk level: lip suction (Q5) and lip/cheek biting (Q6), object sucking (Q4), pacifier use (Q1), bottle feeding (Q2), open mouth sleeping (Q10) and tongue posture during sleep (Q11). The study results confirmed previous research which demonstrated that non-nutritive behaviors during childhood development lead to dental arch problems and occlusion issues (207-210). Research evidence shows that pacifier and bottle use causes malocclusion. A recent systematic review proved that children who use pacifiers for long periods will develop anterior open bite, posterior crossbite, and overjet (208). Furthermore, this study investigated the influence of various oral habits and behaviors, as reported by parents, on the likelihood of children developing an altered vertical dimension—specifically deep bite—using binary logistic regression analysis. The research developed an effective predictive model which proved that particular oral activities produce measurable connections with deep bite formation. Notably, lip suction and lip/cheek biting were the most prominent predictors, both being associated with dramatically increased odds of deep bite occurrence (OR = 99.38 and

OR = 70.92, respectively;($p < 0.001$) (Table 22).These findings are consistent with the results of a previous study by Rodríguez-Olivos et al. The research (211) employed cohort data to demonstrate that children who perform lip sucking develop anterior deep bite more frequently because their lip sucking behavior creates this specific dental problem. The study found that people who bite their lips or cheeks developed anterior dental problems which caused their overbite to deepen (69). The research data showed that nail-biting habits have a statistically significant link to posterior crossbite, as shown in (Table 23). A previous MDPI study analyzed how nail biting affects the shape of upper central incisors by measuring their length and width, and their inclination. The study verified that nail biting produces changes to dental structure which affect the way teeth are arranged in their positions (212), although it did not specifically study crossbite. The research involved 503 children between 3 and 6 years old, and found nail biting to be their main oral habit, affecting 18.9% of the participants. However, logistic regression showed nail biting was negatively associated with malocclusion in this population—meaning it did not increase the risk of crossbite or other malocclusions in these young Japanese preschoolers (140).

The present findings showed that extended non-nutritive oral habits, such as finger and thumb sucking affect the formation of primary occlusion in teeth. Analysis of the primary molar (E6) and canine (E7) relationships (Table 24, Table 25) revealed that habit duration was a critical factor. Children with habits lasting for 4–6 hours or more than 6 hours throughout the day (Q13) developed an eight times higher chance of having their molar and canine teeth out of position. The strongest predictor for deviations in Class I canine relationships was found to be thumb or finger sucking (Q3). Research conducted recently supports these results because scientists have demonstrated that oral habits, both in terms of their nature and their duration, directly cause occlusal changes which mainly occur in the sagittal plane.(207,213,214).

5.3 Oral Hygiene Practices

The American Academy of Pediatric Dentistry (AAPD) advises parents to have their children brush their teeth twice daily, beginning when their first tooth emerges, for optimal oral health (14). The practice of toothbrushing that starts early in life helps children avoid Early Childhood Caries (ECC) while teaching them to maintain good oral health throughout their lives. The process of plaque removal becomes difficult for young children because they do not have enough hand skills to perform it properly, which makes it essential for parents to watch them during toothbrushing (215). The research findings from this study contradicted the established evidence because 52% of children brushed their teeth only once per day according to Rustemaj et al. (151), a frequency insufficient to prevent dental caries even when fluoride toothpaste is used, according to Marinho et al., (216). The study participants showed independent toothbrushing abilities because they performed toothbrushing tasks without any assistance from their parents. Children do not perform adequate plaque control when unsupervised which leads to higher dental caries risk. The success of brushing depends on the frequency and quality of brushing. According to the research findings of Jaggi et al. (217), and Zeng et al., (10). The current results match recent studies which show that poor toothbrushing habits lead to more tooth decay, while confirming that fluoride stands as a primary preventive measure against caries.

The study findings indicate that children need dental caries treatment and dangerous oral practice intervention because their bodies are still most susceptible to outside factors during their initial development period. However, it is important to note that our study had several limitations. The collection of parent-reported data creates the risk of recall bias which makes it difficult to record oral hygiene practices and habits accurately. The research faced a major challenge because the scientists did not have enough information about the duration and intensity of oral habits. A third limitation is that the study uses a cross-sectional research design which makes it impossible to establish cause-and-effect relationships. The study excludes children who do not attend kindergarten, which results in the inability to apply the research results to all pediatric patients. All children who are fifteen years old or younger can receive free dental care at public clinics and hospitals throughout Kosovo. Despite this, most parents or guardians in the present study reported that their children only visit the dentist once a year. This low utilization of dental services is significantly associated with both a higher rate of dental caries and suboptimal toothbrushing habits. The ability of children to maintain their oral health depends most heavily on the motivation demonstrated by the parents. The research data currently available do not cover all children from Kosovo, but they enable scientists to study occlusal development among this population. The research about oral habits and their effects on dental caries and occlusal patterns indicates the need for dental professionals to create preventive measures to protect all aspects of dentofacial development during this essential developmental stage.

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6.CONCLUSIONS

● The prevalence of malocclusion was higher among children with deleterious oral habits compared to those without such habits.

● The study revealed a high prevalence of deleterious oral habits among kindergarten children, with bottle feeding being the most prevalent habit, followed by object/toy sucking, pacifier use, lip sucking, and mouth breathing.

● The defs index was notably elevated among children aged 3–6 years, with decayed surfaces predominating across all age groups.

● The defs index increased progressively with age, with boys demonstrating slightly higher mean values compared to girls.

● The defs index showed a significant association with pacifier use and mouth breathing.

● The intensity and duration of deleterious oral habits contributed to the development and severity of malocclusion.

● The most prevalent malocclusions observed in the study population included increased overjet, deep bite, and Class II molar and canine relationships.

● The findings demonstrated that prolonged exposure to deleterious oral habits interferes with the normal development of primary dentition.

● No significant association was observed between dental caries and malocclusion.

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8. CURRICULUM VITAE

Dr. Vesel Rrustemaj was born on December 17, 1988, in Pristina, Kosovo. He completed his undergraduate studies in dentistry at the Faculty of Medicine, Hasan Pristina University, where he was awarded the degree of Doctor of Dental Medicine (DMD) in 2013. Since October 2014, Dr. Rrustemaj has been working at his private dental clinic, Dr. Dental, in Pristina. In November 2016, he commenced his specialization in orthodontics at the Department of Orthodontics, University Dental Clinical Centre of Kosovo. He achieved his specialization in 2020, which led to his receipt of the professional title of Specialist in Orthodontics .

He started his doctoral education at the School of Dental Medicine of the University of Zagreb, Croatia, in October 2017 to study orthodontics. He started his teaching career at the College of Medical Sciences AMC–Rezonanca, in Pristina when he became an orthodontics teaching assistant in 2018. Since 2022, he has served as a teaching assistant in the Department of Orthodontics at the Faculty of Dentistry, UBT–Higher Education Institution. He received his academic title as Lecturer at the department in 2025, and he remains active in teaching and research work at the institution.

Dr.Rrustemaj has taken part in multiple scientific conferences throughout the country and worldwide, through his work as author and co-author of research papers, and his presentations of posters and oral talks. He has published multiple articles which have appeared in international peer-reviewed academic journals. He is a registered member of the Dental Chamber of Kosovo and the Kosovo Orthodontic Society.

List of published artices:

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2. Rrustemaj V, Milosevic SA Rrustemaj BB, Occlusal Features among Children Aged 3 - 6 Years in Pristina, Kosovo: a cross-sectional study -Annual Conference Orthocongress 9, Peje, Kosovo 23-24 May, 2025, (domestic, **poster presentation resulting from doctoral research)**

3.**Rrustemaj V**, Rrustemaj BB, Prevalence of bad oral habits and their effects on occlusion in children aged 3-6 years in Pristina ,Kosovo,13th UBT Annual International Conference of Dental Science ,UBT Innovation Campus Lipjan, Kosovo October 26,2024,(international, **oral presentation resulting from doctoral research**)

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9. APPENDIX A

APPENDIX A: Supplementary data

These results show the reliability of the analysis of the clinical examination scale through several comparative models, using Cronbach's alpha coefficient, inter-item correlations, and the effect of removing or recording items relating to the internal consistency of the scale. Model 2 was selected for the final analysis as it demonstrated the highest level of reliability among the tested models.

9.1 Reliability Analysis, Model 1

Table 1. Case Processing Summary

Cases	N	%
Valid	563	86.0
Excluded	92	14.0
Total	655	100.0

Table 2. Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
0.623	0.587	7

Table 3. Mean and Standard Deviation of Clinical Examination Parameters

Items	Mean	Std. Deviation	N
E1 Overjet	1.21	0.591	563
E2 Overbite	1.77	1.185	563
E3 Cross-bite	1.13	0.436	563
E4 Presence of spacing	1.22	0.412	563
E5 Presence of crowding	1.78	0.417	563
E6 Primary molar relationship	1.36	0.527	563
E7 Primary canine relationship	1.35	0.520	563

Table 4. Inter-Item Correlation Matrix

Items	E1	E2	E3	E4	E5	E6	E7
E1 Overjet	1.000	0.369	0.370	-0.102	0.122	0.523	0.482
E2 Overbite	0.369	1.000	0.384	0.032	-0.013	0.434	0.418
E3 Cross-bite	0.370	0.384	1.000	0.014	-0.018	0.239	0.243
E4 Presence of spacing	-0.102	0.032	0.014	1.000	-0.948	0.080	0.104
E5 Presence of crowding	0.122	-0.013	-0.018	-0.948	1.000	-0.059	-0.083
E6 Primary molar relationship	0.523	0.434	0.239	0.080	-0.059	1.000	0.955
E7 Primary canine relationship	.482	.418	.243	.104	-.083	.955	1.000

Table 5. Inter-Item Correlation Matrix

	Mean	Minimum	Maximum	Range	Maximum /Minimum	Variance
Inter-Item Correlations	.169	-.948	.955	1.903	-1.007	.130

Table 6. Item-Total Statistics

Variables	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
E1 Overjet	8.60	4.389	.541	.370	.520
E2 Overbite	8.04	2.687	.512	.280	.561
E3 Cross-bite	8.69	5.083	.410	.216	.576
E4 Presence of spacing	8.60	6.169	-.127	.901	.682
E5 Presence of crowding	8.04	6.253	-.167	.901	.689
E6 Primary molar relationship	8.45	4.291	.691	.918	.485
E7 Primary canine relationship	8.47	4.356	.669	.913	.493

Table 7. Scale Statistics

Mean	Variance	Std. Deviation	No. of Items
9.82	6.079	2.465	7

9.2 Reliability Analysis, Model 2

Table 8. Case Processing Summary

Cases	N	%
Valid	563	86.0
Excluded	92	14.0
Total	655	100.0

Table 9. Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
.733	.798	5

Table 10. Mean and Standard Deviation of Clinical Examination Parameters

	Mean	Std. Deviation	N
E1 Overjet	1.21	.591	563
E2 Overbite	1.77	1.185	563
E3 Cross-bite	1.13	.436	563
E6 Primary molar relationship	1.36	.527	563
E7 Primary canine relationship	1.35	.520	563

Table 11. Descriptive Statistics of the Overall Clinical Examination Scale

Mean	Variance	Std. Deviation	No. of Items
6.82	6.017	2.453	5

Table 12**.** Inter-Item Correlation Matrix of Clinical Examination Variables

	E1 Overjet	E2 Overbite	E3 Cross-bite	E6 Primary molar relationship	E7 Primary canine relationship
E1 Overjet	1.000	.369	.370	.523	.482
E2 Overbite	.369	1.000	.384	.434	.418
E3 Cross-bite	.370	.384	1.000	.239	.243
E6 Primary molar relationship	.523	.434	.239	1.000	.955
E7 Primary canine relationship	.482	.418	.243	.955	1.000

Table 13. Summary item statistic

Statistic	Mean	Minimum	Maximum	Range	Maximum /Minimum	Variance
Inter-Item Correlations	.442	.239	.955	.716	3.989	.039

Table.14 Item-Total Statistics and Cronbach's Alpha for the Clinical Examination Scale

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
E1 Overjet	5.61	4.338	0.540	0.349	0.675
E2 Overbite	5.05	2.643	0.511	0.279	0.785
E3 Cross-bite	5.70	5.020	0.413	0.212	0.722
E6 Primary molar relationship	5.46	4.238	0.692	0.918	0.637
E7 Primary canine relationship	5.48	4.303	0.670	0.913	0.645

9.3 Reliability Analysis, Model 3

Table 15. Case Processing Summary for Reliability Analysis

Cases	N	%
Valid	563	86.0
Excluded	92	14.0
Total	655	100.0

Table 16. Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
.615	.574	7

Table 17. Mean and Standard Deviation of Clinical Examination Parameters

	Mean	Std. Deviation	N
E1 Overjet	1.21	.591	563
E2 Overbite	1.77	1.185	563
E3 Cross-bite	1.13	.436	563
E4_inv	1.78	.412	563
E5_inv	1.22	.417	563
E6 Primary molar relationship	1.36	.527	563
E7 Primary canine relationship	1.35	.520	563

Table 18**.** Inter-Item Correlation Matrix of the Clinical Examination Scale (After Reverse Coding)

	E1 Overjet	E2 Overbite	E3 Cross-bite	E4_inv	E5_inv	E6 Primary molar relationship	E7 Primary canine relationship
E1 Overjet	1.000	.369	.370	.102	-.122	.523	.482
E2 Overbite	.369	1.000	.384	-.032	.013	.434	.418
E3 Cross-bite	.370	.384	1.000	-.014	.018	.239	.243
E4_inv	.102	-.032	-.014	1.000	-.948	-.080	-.104
E5_inv	-.122	.013	.018	-.948	1.000	.059	.083
E6 Primary molar relationship	.523	.434	.239	-.080	.059	1.000	.955
E7 Primary canine relationship	.482	.418	.243	-.104	.083	.955	1.000

Table 19. Summary Statistics of Inter-Item Correlations

	Mean	Minimum	Maximum	Range	Maximum Minimum	Variance
Inter-Item Correlations	.162	-.948	.955	1.903	-1.007	.133

Table 20. Item-Total Statistics and Internal Consistency of the Clinical Examination Scale

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
E1 Overjet	8.62	4.322	.537	.370	.510
E2 Overbite	8.06	2.635	.507	.280	.548
E3 Cross-bite	8.70	4.992	.415	.216	.564
E4_inv	8.05	6.213	-.191	.901	.685
E5_inv	8.61	6.121	-.147	.901	.678
E6 Primary molar relationship	8.47	4.221	.689	.918	.473
E7 Primary canine relationship	8.48	4.286	.667	.913	.482

Table 21. Descriptive Statistics of the Clinical Examination Scale

Mean	Variance	Std. Deviation	No. of Items
9.83	5.991	2.448	7

9.4 Reliability Analysis, Model 4

Table 22**.** Case Processing Summary

Cases	N	%
Valid	563	86.0
Excluded	92	14.0
Total	655	100.0

Table 23. Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
.678	.715	7

Table 24**.** Descriptive Statistics of Clinical Examination Items

	Mean	Std. Deviation	N
E1 Overjet	1.21	.591	563
E2 Overbite	1.77	1.185	563
E3 Cross-bite	1.13	.436	563
E4 Presence of spacing	1.22	.412	563
E5_inv	1.22	.417	563
E6 Primary molar relationship	1.36	.527	563
E7 Primary canine relationship	1.35	.520	563

Table 25. Inter-Item Correlation

	E1 Overjet	E2 Overbite	E3 Cross-bite	E4 Presence of spacing	E5_inv	E6 Primary molar relationship	E7 Primary canine relationship
E1 Overjet	1.000	.369	.370	-.102	-.122	.523	.482
E2 Overbite	.369	1.000	.384	.032	.013	.434	.418
E3 Cross-bite	.370	.384	1.000	.014	.018	.239	.243
E4 Presence of spacing	-.102	.032	.014	1.000	.948	.080	.104
E5_inv	-.122	.013	.018	.948	1.000	.059	.083
E6 Primary molar relationship	.523	.434	.239	.080	.059	1.000	.955
E7 Primary canine relationship	.482	.418	.243	.104	.083	.955	1.000

Table 26. Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum /Minimum	Variance
Inter-Item Correlations	.264	-.122	.955	1.077	-7.852	.088

Table 27. Item-Total Statistics and Internal Consistency of the Clinical Examination Scale

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
E1 Overjet	8.05	5.206	.452	.370	.627
E2 Overbite	7.49	3.357	.464	.280	.688
E3 Cross-bite	8.14	5.766	.391	.216	.650
E4 Presence of spacing	8.05	6.213	.191	.901	.685
E5_inv	8.04	6.253	.167	.901	.689
E6 Primary molar relationship	7.90	4.935	.667	.918	.578
E7 Primary canine relationship	7.92	4.981	.657	.913	.582

Table 28. Scale Statistics

Mean	Variance	Std. Deviation	No. of Items
9.26	6.775	2.603	7

9.5 Reliability Analysis, Model 5

Table 29**.** Case Processing Summary for Reliability Analysis

Cases	N	%
Valid	563	86.0
Excluded	92	14.0
Total	655	100.0

Table 30. Reliability Analysis

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
.666	.697	7

Table 31. Item statistics

	Mean	Std. Deviation	N
E1 Overjet	1.21	.591	563
E2 Overbite	1.77	1.185	563
E3 Cross-bite	1.13	.436	563
E4_inv	1.78	.412	563
E5 Presence of crowding	1.78	.417	563
E6 Primary molar relationship	1.36	.527	563
E7 Primary canine relationship	1.35	.520	563

Table 32. Inter-Item Correlation Matrix

	E1 Overjet	E2 Overbite	E3 Cross-bite	E4_inv	E5 Presence of crowding	E6 Primary molar relationship	E7 Primary canine relationship
E1 Overjet	1.000	.369	.370	.102	.122	.523	.482
E2 Overbite	.369	1.000	.384	-.032	-.013	.434	.418
E3 Cross-bite	.370	.384	1.000	-.014	-.018	.239	.243
E4_inv	.102	-.032	-.014	1.000	.948	-.080	-.104
E5 Presence of crowding	.122	-.013	-.018	.948	1.000	-.059	-.083
E6 Primary molar relationship	.523	.434	.239	-.080	-.059	1.000	.955
E7 Primary canine relationship	.482	.418	.243	-.104	-.083	.955	1.000

Table 33. Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variane
Inter-Item Correlations	.247	-.104	.955	1.059	-9.180	.097

Table 34. Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
E1 Overjet	9.17	4.811	.555	.370	.580
E2 Overbite	8.61	3.270	.449	.280	.675
E3 Cross-bite	9.26	5.614	.385	.216	.635
E4_inv	8.60	6.169	.127	.901	.682
E5 Presence of crowding	8.61	6.121	.147	.901	.678
E6 Primary molar relationship	9.02	4.882	.618	.918	.571
E7 Primary canine relationship	9.04	4.967	.589	.913	.580

Table 35. Scale Statistics

Mean	Variance	Std. Deviation	No. of Items
10.38	6.600	2.569	7