



CLINICAL RESEARCH:

Prevalence of Developmental Dental Anomalies in Pediatric Patients and an Assessment of Students' Knowledge in Two Mexican Dental Schools: A Cross-Sectional Study

Prevalencia de anomalías del desarrollo dental en pacientes pediátricos y evaluación del conocimiento de estudiantes de dos facultades de odontología mexicanas: un estudio transversal

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ABSTRACT: Dental anomalies (DAs) in children refer to conditions affecting the structure, number, shape, and size of teeth. This study aimed to assess the prevalence of these anomalies in both primary and permanent dentitions among two Mexican pediatric populations aged 2-14 years. Additionally, the level of knowledge about DAs among students pursuing a degree in dentistry in both universities was determined. A cross-sectional study was conducted on children making their first visit to the Pediatric Dental Clinics of the Universities of Nuevo León and San Luis Potosí in México between March and May 2017. The prevalence of DAs was estimated. In addition, a questionnaire comprising 20 closed items regarding DAs was administered to 100 undergraduate students to evaluate their level of knowledge. Ninety-four children (54 boys and 42 girls; mean age 9.73 ± 2.1 years) were included. Twenty-two patients (23.4%) exhibited at least one DA in their primary or permanent teeth. The most common DAs were in size (macrodontia) and structure (enamel hypoplasia). Agenesis occurred three times, and there were two cases of mesiodens. Regarding gender, 10 patients were girls (45.4%), and 12 were boys (54.6%). The prevalence of DAs in permanent teeth (57.5%) was higher than that in primary teeth (42.5%, $p=0.031$). Only two patients presented DAs in both primary and permanent teeth. No tooth-shaped anomalies were



detected. Regarding the level of knowledge among the university students, the percentage of correct answers was 61.6%. Our findings emphasize the importance of encouraging parents to initiate pediatric dental visits early. Additionally, the study highlights the significance of conducting a thorough evaluation of the patients.

KEYWORDS: Pediatric dentistry; Dental anomalies; Macrodoncia; Enamel hypoplasia; Supernumerary and missing teeth; Students' knowledge.

RESUMEN: Las anomalías dentales (ADs) son defectos en la estructura, número, forma y tamaño de los dientes. En el presente estudio se evaluó la prevalencia de estas anomalías, tanto en la dentición primaria como permanente, en dos poblaciones mexicanas de 2 a 14 años de edad. Además, se determinó el nivel de conocimiento sobre ADs entre los estudiantes de la carrera de cirujano dentista, en ambas universidades. Se realizó un estudio transversal en niños que acudieron por primera vez a las Clínicas Odontopediátricas de las Universidades de Nuevo León y San Luis Potosí (México), entre marzo y mayo de 2017. Se estimó la prevalencia de las ADs, y se aplicó un cuestionario de 20 ítems relacionados con éstas a 100 estudiantes de licenciatura para determinar su nivel de conocimiento. Se incluyeron 94 niños (54 niños y 42 niñas; edad media 9.73 ± 2.1 años). Veintidós pacientes (23.4%) presentaban al menos una AD. Las más frecuentes fueron macrodoncia e hipoplasia del esmalte. La agenesia ocurrió en tres ocasiones, y hubo dos casos de mesiodens. En cuanto al sexo, 10 pacientes eran niñas (45,4%) y 12 niños (54,6%). La prevalencia de ADs en dientes permanentes (57.5%) fue superior a la de dientes temporales (42.5%). Sólo dos pacientes presentaron ADs en los dientes temporales. Sólo dos pacientes presentaban ADs en ambas denticiones. No se detectaron anomalías de forma. En cuanto al nivel de conocimientos entre los estudiantes universitarios, el porcentaje de respuestas correctas fue de 61.6%. El 23.4% de los participantes presentaba al menos una AD en los dientes primarios o permanentes, como macrodoncia e hipoplasia del esmalte. Estos resultados demuestran lo crucial que es alentar a los padres a visitar al odontopediatra a una edad temprana y la importancia de realizar una evaluación integral de los pacientes.

PALABRAS CLAVE: Odontopediatría; Anomalías dentales; Dentición primaria; Dentición permanente; Prevalencia; Estudio transversal.

INTRODUCTION

Dental anomalies (DAs) encompass craniofacial abnormalities related to the size, structure, or number of teeth. These anomalies arise from abnormal events during odontogenesis, influenced by genetic mutations and environmental factors. Dental development, a highly intricate process, is regulated by a series of molecular and cellular interactions. Disruptions and alterations during the initiation, morphogenesis, and histodifferen-

tiation phases can lead to the occurrence of DAs (1). Various genetic mutations have been identified as contributing factors in tooth number and shape, impacting molecules within the signaling networks that regulate early tooth morphogenesis (2). Environmental causes include prolonged administration of antimicrobials (e.g., tetracycline) in young children, extended fluoride exposure and poor nutrition. DAs can manifest in diverse ways and can be classified into several categories, including anomalies in number, size, shape, root

formation, and matrix deposition and mineralization (1, 2). DAs of the permanent dentition, unlike those of the deciduous dentition, can result in complications and subsequent long-lasting damage (2, 3). The literature indicates that DAs encompass a spectrum, ranging from missing teeth, supernumerary teeth, microdontia, and macrodontia, to structural aberrations such as odontomas, dens invaginatus, germination, fusion, enamel or dentin hypoplasias, and taurodontism. These anomalies are typically asymptomatic and can be diagnosed clinically using intra- and extraoral radiographs for a more comprehensive diagnosis. They often lead to a delayed and troublesome eruption, tooth wear, poor esthetics, crowding, malocclusions, as well as speech and mastication disturbances (2-4). Additionally, DAs can enhance susceptibility to dental caries, gingivitis, and periodontal disease due to increased plaque accumulation, the risk of tooth breakdown, pulpitis-induced pain, unpleasant appearance, and difficulties during endodontic or surgical procedures on the affected tooth (3-6). All these consequences can have a detrimental impact on the oral health-related quality of life of affected children (7, 8).

The prevalence and degree of expression of DAs in children and adolescents can be determined through phylogenetic and genetic studies, providing insights into diverse possible variations. This prevalence varies depending on the population under study (4). Historically, the occurrence of dental abnormalities in children has been evaluated clinically and radiographically in several epidemiological studies; results have ranged from 0.012 percent to more than 6.0 percent worldwide (2, 9). For example, studies from Europe and the Middle East countries have found that congenitally missing teeth (hypodontia) is the most prevalent anomaly among children (10). In Saudi Arabia, a clinic-based study reported a prevalence of 25.39% (higher in boys than girls), being hypodontia as the most

common anomaly (8). Similarly, a study conducted in Turkey found hypodontia to be the most common condition, with a prevalence of 5.56% (11). In South India, the prevalence of deciduous dental anomalies was around 2.3%, most commonly congenitally missing and supernumerary teeth (2, 12).

DAs in both primary and permanent dentition can lead to short and long-term complications, subsequently causing various types of damage. Anomalies might affect a single tooth or be part of a syndrome (3, 10). Therefore, pediatric dentists can contribute to the diagnosis of such syndromes through the early identification of these anomalies (2, 7). DAs generally go unnoticed in clinical practice, as they are rarely the chief complaint of the patient and are often underestimated compared with other common oral diseases, such as dental caries or periodontal diseases (5).

Morphological variations in the primary and permanent dentitions are of great concern in pediatric dentistry, as they may pose associated clinical problems. Early diagnosis of these anomalies can provide vital information and enable more comprehensive long-term treatment planning, favorable prompt prognosis, and less extensive interception (1, 8, 10). Timely interventions might minimize future complications.

Hence, it is crucial to detect these irregularities at an early stage, as it might facilitate the prompt detection of more complex genetic defects, especially in the craniofacial region.

This might yield valuable information about a patient's anthropology and also could help with the prediction of potential difficulties and be involved with dental procedures, such as orthodontic treatment in children (7). However, many cases of dental anomalies (DAs) that occur in childhood are frequently misdiagnosed or receive inadequate

treatment due to a lack of awareness during the initial clinical oral examination (13).

In developing and multicultural countries such as Mexico, determining the prevalence of DAs in both primary and permanent dentitions is crucial, since this information can be utilized for early identification and complete treatment of these diseases. Therefore, it is crucial to carry out clinical investigations on pediatric populations in order to ascertain the frequency of developmental DAs, including anomalies related to the number, shape, and size (13, 14). Therefore, the present study aimed to determine the prevalence of various dental anomalies, in both primary and permanent dentitions, among children and young adolescents receiving care at specialized pediatric dental clinics associated with two renowned public dental faculties in Mexico. Additionally, the study evaluated and compared the level of knowledge regarding various aspects of DAs in children and adolescents among students in the final two semesters of the dental career program at both universities, considering factors such as sex, socioeconomic level, and the academic level of their parents.

PATIENTS AND METHODS

STUDY SETTING AND SAMPLE

The current cross-sectional study was conducted in two Mexican pediatric dentistry postgraduate programs affiliated with public faculties of dentistry in northeastern Mexico, namely, the Autonomous University of Nuevo Leon (UANL) and the Autonomous University of San Luis Potosi (UASLP). The study sample comprised all pediatric patients making their first visit to both institutional specialized pediatric dentistry clinics between March and May 2017. The inclusion criteria were children aged between 2 and 14 years and whose parents/legal guardians provided specific written informed consent. Participants were recruited

with consideration for their diverse socioeconomic backgrounds, encompassing both urban and suburban populations. Exclusion criteria involved children with medical/systemic conditions, craniofacial defects, syndromes associated with DAs (e.g., cleft palate), a history of previous orthodontic treatment, or a history of orofacial traumatic injuries or diseases that could increase the risk of developing DAs.

DATA COLLECTION

Data were collected through personal interviews utilizing a pre-designed structured questionnaire. The sociodemographic characteristics (age and sex) of the child were recorded during the interview. All eligible participants underwent an oral clinical examination to assess hard-tissue DAs. These examinations were conducted in the dental chair, under the dental unit's light, using sterile mouth mirrors and probes. Teeth were examined after debris removal via a prophylaxis procedure with pumice. Diagnostic clinical and radiographic criteria for DA were adopted from Lam (9) and Wagner *et al.* (10). The conditions were classified and recorded as follows: (1) Structure anomalies (amelogenesis imperfecta, dentinogenesis imperfecta, dentinal dysplasia, enamel hypoplasia, and molar incisor hypomineralization); (2) Number anomalies (dental agenesis and supernumerary teeth); (3) Shape anomalies (dental gemination and fusion); and (4) Size anomalies (microdontia and macrodontia). Documented DAs were confirmed through periapical or panoramic radiograph evaluation. The collected data were entered into a Microsoft Office Excel 2019 spreadsheet and subsequently exported to specialized software for statistical analysis. Confidentiality was maintained regarding all patients' identifiable information.

To ensure consistency in diagnosing DAs, intra- and interexaminer agreement tests were performed to calibrate the principal evaluators (S.R.R. and E.C.R.). These tests involved observing

a series of clinical pictures and radiographs depicting various DA in primary and permanent teeth. The pictures were pre-selected by an experienced pediatric dentist and were presented in two consecutive independent sessions. In the first session, each picture was scored dichotomously (e.g., absent/present anomaly) and recorded. The same procedure was repeated in the second session, with a 1-week interval. The results of these sessions were compared using Cohen's kappa statistics. Both intra- and interexaminer reliability scores were considered substantial for both examiners (>85%).

STUDENT SURVEY

A knowledge survey was conducted from June through August 2018, utilizing a written questionnaire administered to 100 randomly selected students attending the last two semesters of undergraduate dental program in the two faculties of dentistry. The students were fully briefed about the study, and their informed consent was obtained. The sample size of 100 participants was previously calculated to achieve a power of 80% and a significance level of 5%.

The questionnaire consisted of 20 items (Figure 1) and was adapted from four similar instruments previously validated (15-18). Initial validation of the questionnaire was performed by expert pediatric dentists. Subsequently, a pilot study was conducted in which the questionnaire was administered to 20 randomly selected students; however, the results were not included in the final analysis. The instrument was then analyzed using Cronbach's alpha, resulting in a value of

0.84, indicating acceptable internal consistency. The final version of the questionnaire was anonymous and confidential and consisted of closed questions (multiple-choice responses: "yes," "no," and "I do not know"), assigning 1 point to each correct answer. The questionnaire characterized the sample in terms of age, sex, socioeconomic level, parent's educational level, and questions covering various topics about DAs to assess the level of knowledge within the student sample. The participants were instructed to answer the questions without consulting any literary material or their professors.

DATA ANALYSIS

The ages of the study participants were categorized into three groups for data analysis: ≤6 years, 7-10 years, and 11-14 years. A descriptive analysis was conducted to describe the demographic characteristics of the study sample and determine the prevalence of different DAs through frequencies and percentages, considering the faculty of dentistry, sex, and age category. Comparative non-parametric tests for continuous and dichotomous variables (Chi-square, Fisher's exact, and Mann-Whitney-Wilcoxon tests) were also performed, with a significance level set at 5%. Concerning the knowledge survey, the results were presented as the number and percentage of correct answers for each surveyed student, subsequently compared by sex, socioeconomic level, and parents' educational level through Fisher's exact tests. The analyses were performed using the Jamovi software for Windows (<https://www.jamovi.org/>).

GENDER: M () F ()			
ACCORDING TO THE FAMILY BUDGET, YOUR STANDARD OF LIVING IS: LOW () MIDDLE () HIGH () Consider "low" with less than 3000 pesos per person per month, "medium" between 3001 and 15,000, and "high" with more than 15,000 pesos per person.			
MOTHER'S SCHOOLING: PRIMARY*SECONDARY () HIGH SCHOOL*BACHELOR'S DEGREE () SPECIALTY*MASTER'S () PARENT SCHOOLING: PRIMARY*SECONDARY () HIGH SCHOOL*BACHELOR'S DEGREE () SPECIALTY*MASTER'S ()			
BASED ON YOUR KNOWLEDGE:	YES	NO	I DO NOT KNOW
Dental fusion consists of the union of two or more adjacent dental germs in pre-eruptive phases with the result of a single tooth.			
When a dental fusion occurs, it has an excessive number of teeth compared to the normal dental formula.			
Dental fusion is detected only by radiographic means.			
Dental fusion occurs along teeth located in the same plane and can be total, or limited to the crown or the root.			
Any supernumerary tooth that is located between the mesial of the 11th and the mesial of the 21st are considered mesiodens.			
The use of X-rays is necessary for the correct diagnosis of mesiodens.			
The most common complication caused by mesiodens is the eruptive acceleration of OTs 11 and 21.			
Treatment of a mesiodens involves giving it an anatomy like adjacent teeth.			
Gemination is the union that occurs between the germ of a normal tooth and that of a supernumerary.			
When dental gemination occurs, an excessive number of teeth is present in the arch compared to the normal dental formula.			
The most observed dental gemination is that of lower molars.			
The only way to identify gemination is by using an X-ray.			
Amelogenesis imperfecta occurs only in incisors and permanent molars.			
Amelogenesis imperfecta manifests clinically as yellow crowns			
Enamel hypoplasia manifests as zones of demineralization ranging from discolored areas to cavitations in the enamel.			
Dentinogenesis imperfecta presents clinically as yellow crowns			
Dental fluorosis presents clinically as gray/bluish crowns			
Enamel beads are globular structures 1mm to 3mm in diameter located ectopically at the root of natural teeth.			
Enamelomas are mostly found in the roots of the upper molars			
The enamel beads are found in the central region of the mesio-palatine lobe, between the occlusal and middle thirds of the first upper molars.			

Figure 1. Questionnaire used for the student survey.

RESULTS

The present study enrolled a total of 94 children, comprising 54 boys (57.4%) and 42 girls (42.6%). The overall mean age was 9.73 ± 1.9 years, with an age range of 2.3-14.5 years. Patients with any type of DA exhibited a mean age of 9.22 ± 2.4 years, which was significantly higher than that of patients without any anomaly (mean age = 7.86 ± 2.58 years; $p < 0.01$). Among the 94 patients, 22 (23.4%) had at least one DA present in their primary or permanent teeth. The most common hard-tissue DAs were in size (macrodontia) and structure (enamel hypoplasia; all cases in the permanent dentition). Agenesis occurred three times, with the mandibular second premolar being the most affected (two times), and there were two cases of mesiodens (both in the permanent teeth). Regarding the sex of children with a DA, 10 patients were girls (45.4%), and 12 were boys (54.6%), with no significant difference between them ($p = 0.44$). Regarding the type of dentition, the prevalence of DAs in permanent teeth was 57.5%, considerably higher than the prevalence in primary teeth (42.5%, $p = 0.031$). Only two patients presented DAs in both primary and permanent teeth. No tooth-shaped anomalies were detected. According to the location of teeth with DAs, more lesions were found in the maxilla than in the mandible ($p = 0.044$). There were no significant differences in the number of DAs in terms of the dental arches' sides, left or right ($p = 0.61$) or the institutional clinic (UNL vs. UASLP) where the patients were examined ($p = 0.78$).

STUDENT SURVEY

The average time to answer the questionnaire ranged from 5 to 10 minutes. The total percentage of correct answers regarding the knowledge of DAs among the surveyed students was 61.6%. When compared by sex, the percentages were similar (60.6% women and 63.02% men; $p = 0.55$). Regarding the variables of socioeconomic level and

parents' educational level, there were no significant differences ($p = 0.61$ and 0.74 , respectively).

DISCUSSION

A comprehensive understanding of the prevalence, severity, and distribution of DAs in primary and early permanent dentitions provides crucial information for timely detection and clinical treatment. In growing subjects, oral hard-tissue alterations can lead to various pathological conditions, such as caries, esthetic problems, and malocclusions, often necessitating a multidisciplinary management approach (3-7).

In the present study, a global prevalence of DAs of 26% was observed among the 42 patients attending the UASLP Postgraduate Pediatric Dentistry clinic for the first time, while the prevalence was 21% in the 52 children reviewed at the UNL. Two previous studies on DAs in children and adolescents were also conducted in Mexican populations (Estado de México and Puebla, respectively). Murrieta-Pruneda *et al.* (14) reported a surprisingly high overall prevalence rate for DA of 92% in a 12-15-year-old population of Valle de Chalco, Mexico; with anomalies in color and shape being the most frequent (81.8% and 65.9%, respectively). On the other hand, Ibarra *et al.* (13) evaluated 720 clinical records of children aged 1-10 years and reported a 9% prevalence of any type of anomaly, of which 3.1% were fused and geminated teeth, 1.1% tooth agenesis, 1.9% supernumerary teeth, 0.27% macrodontia, and 0.11% macrodontia.

Several recent international reports mention a wide, even contradictory, range of DA prevalence. For example, in 1998, Carvalho *et al.* (19) estimated the prevalence of DAs in a sample of 750 Belgian children aged 3 ± 5 years. The most commonly observed DAs were supernumerary teeth, hypodontia, double teeth, and malformed maxillary lateral incisors. In 2011, Spahić-

Dizdarević *et al.* (20) conducted a study on preschool and school children, including a total of 740 children from Sarajevo (Bosnia and Herzegovina); DAs were observed in 11.7% (preschool children) and 14.8% (school children). In India, Kathariya *et al.* (21) determined the prevalence of DAs in a group of 600 school children (male: n=293 (48.8%), female: n=275 (45.8%)), with maxillary impactions (39.2%) being the most common anomaly, followed by hypodontia, microdontia, and talons cusp. Gomes *et al.* (22) assessed a sample of 2 to 5-year-old Brazilian children, reporting a DA prevalence of 1.8%, with no significant differences between sexes. Among children with affected primary dentition, 54.8% were found to have dental malformations on their erupting permanent teeth. Aglarci *et al.* (11) studied 3600 Turkish patients (mean age: 19.2±6.3 years) through panoramic radiographs; the prevalence of DAs was 6.8%, higher in females, and the most frequently observed anomaly was hypodontia (4.3%). Two studies conducted in 2017 in Australia (4) and Nigeria (10) reported DA prevalences of 5.1% and 4.2%, respectively. In Costa Rica (23), a global frequency of 8.3% in tooth number anomalies was found among patients aged 6-12 years. In a similar age group of Brazilian children, Wagner *et al.* (10) reported a prevalence of 61.3% with at least one DA. Bakhurji *et al.* (8) observed a prevalence of approximately 4% for non-syndromic DAs in patients aged 6-18 years in Saudi Arabia, with the prevalence being 0.5% for supernumerary teeth, 0.3% for gemination, and 0.1% for fusion. It is evident that pediatric dentistry literature published in the last 15 years exhibits significant discrepancies in the prevalence of DAs among pediatric dentistry studies, possibly explained by inherent variations or ethnic differences among the assessed populations or the different diagnostic criteria or sampling methods used by the researchers (6, 7, 15, 21, 24-27).

In the current study, the level of knowledge of students in the 9th and 10th semesters of the Degree in Dental Surgeon at the two universities was also evaluated. Several questions employed here were based on a previously validated questionnaire used in a similar work. This cross-sectional study was carried out in 2017 with 71 students coursing the ninth semester of their dentistry career at the Universidad Central del Ecuador (18). The survey was applied among the participants, which consisted of ten multiple-choice questions about dental anomalies of shape, number, and size. In addition, clinical images related to the questions were shown. In this study, a high overall rate of incorrect answers was observed (69.7%).

Nowadays, dental students must possess a broader understanding of the dental alterations that pediatric patients may present. These anomalies not only contribute to the emergence and development of carious lesions but also impact the normal process of orofacial growth and development. Therefore, future practitioners in pediatric dentistry need to learn how to promote and provide timely oral care in children and adolescents, as well as design oral diagnosis, prevention, and management protocols, all under a comprehensive and multidisciplinary approach.

LIMITATIONS

Certain limitations should be considered when interpreting the findings of the current study. The study relied on data obtained from a small sample of children visiting two public university dental clinics in the northeastern region of Mexico. In this regard, relying solely on the number of pediatric patients attending dental outpatient departments can be misleading for global prevalence calculations. Nevertheless, we consider that the results from this study may reasonably repre-

sent patients living in these areas. Furthermore, we should exercise caution when extrapolating the findings to children attending different dental settings in different regions of the country.

CONCLUSIONS

Among the participants included in the study, 23.4% exhibited at least one DA in their primary or permanent teeth. The most common DAs observed were macrodontia and enamel hypoplasia. Regarding the level of DAs knowledge among the university students, the percentage of correct answers was 61.6%, a rate considered as minimally acceptable. These findings underscore the importance of encouraging parents and children to visit the pediatric dentist at an early age. Pediatric dentists must be mindful of the fact that the presence of hard-tissue DAs can be associated with poor oral hygiene, which predisposes the emergence of new carious lesions and gingival inflammation. This also emphasizes the necessity of conducting a thorough clinical examination to plan an effective long-term oral treatment tailored to each patient's requirements. Therefore, an awareness of common DAs in children and adolescents is crucial for all pediatric dentistry practitioners, including undergraduate students.

AUTHOR CONTRIBUTION STATEMENT

Conceptualization and design: E.M.C.R. and M.S.R.R.
 Literature review: J.M.S.S., M.A.R.B. and M.S.R.R.
 Methodology and validation: A.P.G. and E.M.C.R.
 Formal analysis: A.P.G. and J.A.G.R.
 Investigation and data collection: E.M.C.R., M.S.R.R. and J.M.S.S.
 Resources: E.M.C.R., M.A.R.B. and M.S.R.R.
 Data analysis and interpretation: A.G.R. and A.P.G.
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 Writing-review & editing: A.P.G.
 Supervision: M.A.R.B.
 Project administration and funding acquisition: E.M.C.R., M.S.R.R. and J.M.S.S.

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