The prevalence of developmental anomalies among school children in Southern district of Andhra Pradesh, India

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Abstract

Background: The developmental anomalies of oral cavity are malformations affecting dental and oral tissues. Anomalies of teeth can be associated with primary, mixed or adult dentitions. Anomalies are the results of perturbations in the developmental stages of tissues which may be influenced by genetic and/or environmental factors.

Aim and Objectives: The primary objective of this study was to estimate the prevalence of oral and dental anomalies among school attending children in Chittoor and Kadapa districts of Andhra Pradesh. The secondary objective of this study was to compare occurrence of anomalies based on the age stratification to denote primary, mixed and adult dentitions.

Materials and Methods: A total of 5000 school children, aged 3–15 years were invited to participate in the study. Information regarding age, sex, level of school education, brushing and hygiene habits were collected using a questionnaire. Intra- and extra-oral examinations were conducted by trained dental surgeons. Clinical data were collected by a single examiner and the details of these anomalies were recorded on the data sheet of the study. The obtained data were statistically analyzed using Chi-square test.

Results: Overall prevalence of developmental anomalies was 11.40% and documented 14 types of anomalies. The prevalence of documented anomalies is as follows: tongue-tie 197 (3.90%), dental fluorosis 171 (3.40%), high frenal attachments 156 (3.10%), cusp of Carabelli 14 (0.30%), supernumerary teeth 11 (0.20%), microdontia 4 (0.10%), congenitally missing teeth 4 (0.10%), lip pits 3 (0.08%), fusion 2 (0.04%), retained deciduous teeth 2 (0.04%) and one case of angular cheilitis, cleft lip and cleft palate, talon cusp, amelogenesis imperfecta (0.02%). The prevalence of dental anomalies was 18.10% in 3–5 years, 52.30% among 6–12 years and 29.6% in 13–15 years. Chi-square test was statistically significant (P = 0.003).

Conclusions: Tongue-tie was the most frequent oral tissue developmental anomaly and fluorosis was the most common developmental anomaly affecting dental tissue. The prevalence rate of the study was compared...
INTRODUCTION
The development of the face and oral cavity is a complex process with temporal and spatial summation. The disturbances in the growth may result in abnormalities or anomalies. Oral and dental anomalies are frequently encountered by dental practitioners. However, due to the low level of clinical significance associated to anomalies in diagnosis or treatment, reports are not made frequently. Prevalence and the extent of clinical appearance of dental anomalies are varied across geographical areas. In addition, epidemiological studies on dental anomalies can provide information on phylogenetic, genetic or environmental characteristics. Dental abnormalities are uncommon when compared to dental caries and/or periodontal diseases. Dental abnormalities may result in malocclusion, functional and esthetic challenges; as well as it can complicate dental treatment.

Dental anomalies can result when the genetic pathways and epithelium–mesenchyme interaction are disturbed. The most common anomalies in odontogenesis are related to ameloblasts or odontoblasts differentiation that result in enamel and/or dentine disturbances. Such disturbances affect the size and structure of the affected teeth. A total lack of initiation of tooth development can lead to tooth agenesis, whereas hyperactivity of the dental lamina may result in supernumerary teeth. Environment, hereditary and nutrition may play a significant role in the development of such anomalies. Dental anomalies can either occur as isolated cases or accompanied by systemic abnormalities constituting syndromic version. Dental anomalies may result from local or systemic factors that may either begin before, after or at the time of birth. Thus, either primary, permanent or both dentitions can be affected. The problems associated with dental anomalies include: unesthetic appearance of teeth, malocclusion, delayed or incomplete eruption of teeth, risk of developing dental caries, gingivitis, periodontitis, attrition, cusp fracture, speech and mastication difficulty, temporomandibular joint and atypical facial pain.

Few dental disturbances-related epidemiological studies from India have been observed from database, but none has been studied at Chittoor and Kadapa districts of Andhra Pradesh. The primary objective of this study was to provide an estimate of the prevalence of dental anomalies among school going children at two Southern districts of Andhra Pradesh – Chittoor and Kadapa. The secondary objective was to compare the findings of the study in primary, mixed and adult dentitions.

MATERIALS AND METHODS
Study population
The study population comprised 5000 school children, aged 3–15 years. All of the study participants underwent an oral screening examination for oral health and dental and/or oral developmental disturbances by trained dental surgeons. A total of 568 children, 337 males and 231 females, aged 3–15 years who had dental and/or oral developmental disturbances participated in the study. All the children who had given parental/guardian consent to participate in the study were recruited for the study and completed an interviewer-administered study data collection questionnaire.

Ethical approval
The study protocol was reviewed and approved by the Institutional Review Board (IRB) of the CKS Theja Institute of Dental Sciences and Research, Tirupati, Andhra Pradesh, India. The IRB of the above-captioned institution reviewed and approved the proposal, consent form and data collection form/questionnaire. Written, informed consent was obtained from the parent/guardian of the study participants before the inclusion of their findings in the present study. The present study was conducted in full accordance with the World Medical Association Declaration of Helsinki.

Selection criteria
All children attending the participating school(s) and their parent/guardian signed consent forms were included in the study.

The exclusion criteria of the study are as follows: (1) participants with difficulty in opening their mouth, (2) participants with severe dental pain, (3) participants with emergency oral conditions such as Ludwig’s Angina (a bilateral space infection affecting submandibular, sublingual and submental region) and space infections that are extending...
into the throat and cause dyspnea (difficulty breathing),
dysphagia (difficulty swallowing) and/or dysarthria
(difficulty speaking) and (4) parents/guardians of the
children who did not consent to participate in the study.

Questionnaire

The interview was conducted with parents/guardians of
the children. Information on the age, sex, level of school
education, brushing and hygiene habits, history of dental
visits and treatment received were asked.

Examination

All the children were examined in their respective schools
while they were seated on ordinary chairs, unless they were
confined to wheelchairs. The oral examination was done
under natural light by using a standard mouth mirror and
a probe. All the teeth were screened for developmental
enamel defects of teeth. The developmental enamel lesions
were diagnosed without drying or cleaning the teeth before
the examination. The type and the localization of the
enamel developmental defects were classified according
to the modified Developmental Defects of Enamel index,
which was introduced by Clarkson J and O’Mullane. The
data which were obtained were analyzed using the SPSS
package, (SPSS Inc., Version 18.0, Chicago, USA) package,
version 18. The differences were tested for statistical
significance by using the Pearson’s Chi-square test.

Statistical analysis

The data obtained were statistically analyzed using the
SPSS (SPSS package, SPSS Inc., Version 18.0, Chicago,
USA). Descriptive statistics were performed to analyze
demographic parameters. Group comparison was
performed using Pearson’s Chi-square test and Fisher’s
exact test. The level of significance was set by odds ratio
calculation at 95% confidence interval. P < 0.05 was
considered statistically significant.

RESULTS

The total prevalence of dental anomalies in school
children, aged 2–15 years, was 11.4% (568 out of 5000) in
two Southern districts of Andhra Pradesh [Table 1]. The
study observed greater in male 59.3% (337 out of 568)
predilection in dental anomalies, females predilection was
40.7% (231 out of 568). The study documented 14 types
dental anomalies. The study stratified age groups into
3–5 years, 6–12 years and 13–15 years to document the
prevalence of dental anomalies in primary, mixed and
adult dentitions. The prevalence of dental anomalies in
3–5-year-old was 18.10%, 6–12-year-old was 52.30% and
13–15-year-old was 29.6%. The comparison of groups
using Chi-square test was statistically significant (P = 0.003).
Tongue-tie was the most common developmental
disturbance observed in 6–12-year-old (57.90%) and in
13–15-year-old (29.90%). High frenal attachment was
frequent among 3–5-year-old (26.30%). Tongue-tie and
fluorosis showed a male predilection whereas, the other
types of anomalies showed equal predilection [Table 1].

The distribution of developmental dental anomalies was
higher in the maxilla. The prevalence of anomalies in the
maxillary arch was 83.30% compared to 16.70% in
mandibular arch. The cusp of Carabelli and supernumerary

### Table 1: Prevalence and distribution of dental anomalies by age and gender in 568 school children

| Anomaly                  | Study participants with anomalies (n=568; 11.4%), n (%) | Age, n (%)       | Gender, n (%) |
|--------------------------|--------------------------------------------------------|------------------|---------------|
|                          |                                                        | 3-5 years | 6-12 years | 13-15 years | Male | Female |
| Tongue-tie               | 197 (3.9)                                               | 24 (12.20) | 114 (57.90) | 59 (29.90) | 127 (64.5) | 70 (35.5)   |
| High frenal attachments  | 156 (3.1)                                               | 41 (26.30) | 78 (50)    | 37 (23.70) | 76 (48.7)  | 80 (51.3)   |
| Lip pits                 | 3 (0.1)                                                 | -          | 3 (100)    | -           | 2 (66.7)   | 1 (33.3)    |
| Angular cheilitis        | 1 (0.02)                                                | -          | -          | 1 (100)    | 1 (100)    | -           |
| Cleft lip and cleft palate | 1 (0.02)                                               | 1 (100)  | -          | -          | -         | 1 (100)    |
| Fusion                   | 2 (0.04)                                                | -          | 2 (100)    | -          | 2 (100)    | -           |
| Talon cusp               | 1 (0.02)                                                | 0          | 1 (100)    | 0          | 1 (100)    | -           |
| Supernumerary teeth      | 11 (0.2)                                                | 1 (9.1)   | 4 (36.4)   | 6 (54.5)   | 6 (54.5)   | 5 (45.5)    |
| Congenitally missing teeth | 4 (0.1)                                                | 0          | 3 (75)     | 1 (25)     | 3 (75)     | 1 (25)      |
| Microdontia              | 4 (0.1)                                                 | 0          | 4 (100)    | 0          | 1 (25)     | 3 (75)      |
| Amelogenesis             | 1 (0.02)                                                | 0          | 0          | 1          | -         | 1 (100)     |
| imperfecta               |                                                        |            |            |            |           |             |
| Fluorosis                | 171 (3.4)                                               | 32 (18.72) | 78 (45.6)  | 61 (35.7)  | 109 (63.7) | 62 (36.3)   |
| Retained deciduous teeth | 2 (0.04)                                                | 0          | 0          | 2 (100)    | 2 (100)    | -           |
| Prominent cusp of carabelli | 14 (0.3)                                               | 4 (28.60) | 10 (71.40) | 0          | 7 (50)     | 7 (50)      |

Age - Estimated using Chi-square test (49.967) and statistically significant with P=0.003, Gender - Estimated using Chi-square test (20.833) and statistically insignificant with P=0.075
Anomalies of oral cavity in Chittoor and Kadapa

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Teeth were more commonly observed in the maxilla than mandible. The group comparison using Chi-square test was 18.600 and the association was statistically significant ($P = 0.005$) [Table 2].

The prevalence of developmental dental anomalies was more common in Kadapa. The frequency observed in Kadapa was 52.80%, whereas it was 47.20% in Chittoor. The two district groups were compared using Chi-square test (28.311) and results were insignificant ($P = 0.008$) The most common anomalies observed in Kadapa district were tongue-tie, 60.90%, enamel fluorosis, 51.50% and high frenval attachment, 51.30%. Whereas, the prevalent anomalies in Chittoor district were enamel fluorosis – 48.50%, high frenval attachment – 48.70% and tongue-tie – 39.10% [Table 3].

The overall prevalence of developmental dental anomalies in the present study was 11.4% (568 out of 5000). The study participants who had one anomaly was 10.2% ($n = 509$), participants who had ≥1 anomaly was 1.2% ($n = 59$). The prevalence of soft-tissue anomalies was 7.2% and other anomalies were 3.7. Dental anomalies were classified into three categories of disturbances: shape of teeth – 0.1%, number of teeth – 0.3%, size and structural anomalies were 0.1%. The most common anomalies observed among one anomaly participant was soft-tissue disturbances, 85.5%, followed by disturbance of the size and structure of teeth [Table 4].

DISCUSSION

Prevalence studies of developmental anomalies are useful to establish frequency rates, to document changes over a period and to identify the changing pattern of anomalies and clues to etiology of disease occurrence. The diagnosis of developmental anomalies also assists in the identification of syndromes and/or any associated systemic diseases. Most dental anomalies attribute to the risk of dental caries and gingival/periodontal disease development. However, due to a lack of subjective symptoms associated with these anomalies, they are usually under reported. Prevalence studies also provide scope for preventive strategies, i.e., hygiene practices and prompt dental visits when a problem such as dental caries and/or periodontal disease is present. Early dental care for developmental anomalies may reduce the severity of dental caries, periodontitis as well as addressing associated esthetic and functional problems. Most epidemiological studies on developmental anomalies of the oral cavity either focused on institutional-based populations, orthodontic-related concerns, radiological reports or geographically pertinent findings. The present study documented both geographical and school-based approaches. Since most of the children were available in the schools, sampling will be more convenient. The total prevalence of developmental disturbances among school children in this study was 11.4%. The prevalence rates of various studies from India reported in the

### Table 2: Prevalence and distribution of dental anomalies by arch in 36 school children

| Dental anomaly          | Maxilla (n=30; 83.3%), n (%) | Mandible (n=6; 16.70%), n (%) |
|-------------------------|-----------------------------|-------------------------------|
| Fusion                  | 1 (50)                      | 1 (100)                       |
| Talon’s cusp            | -                           | -                             |
| Supernumerary teeth     | 10 (100)                    | -                             |
| Congenitally missing teeth | 3 (25)                  | 1 (25)                        |
| Microdontia             | 1 (33.3)                    | 2 (66.7)                      |
| Retained               | 1 (50)                      | 1 (50)                        |
| deciduous teeth         | 14 (100)                    | -                             |
| Prominent cusp of Carabelli | 78.6%                   | 0.2%                          |

Estimated using Chi-square test (18.600) and statistically significant with $P=0.005$

### Table 3: Prevalence and distribution of dental anomalies in Kadapa and Chittoor districts

| Anomaly              | Study participants with anomalies (n=568; 11.4%), n (%) | District, n (%) |
|----------------------|--------------------------------------------------------|-----------------|
| Tongue-tie           | 197 (3.9)                                               | 120 (60.9)      | 77 (39.1) |
| High frenval attachments | 156 (3.1)                                      | 80 (51.3)       | 76 (48.7) |
| Lip pits             | 3 (0.1)                                                 | 3 (100)         | -              |
| Angular cheilitis    | 1 (0.2)                                                 | 1 (100)         | -              |
| Cleft lip and cleft palate | 1 (0.2)                              | 1 (100)         | -              |
| Fusion               | 2 (0.4)                                                 | 2 (100)         | -              |
| Talon cusp           | 1 (0.2)                                                 | 0               | 1 (100)       |
| Supernumerary teeth  | 11 (0.2)                                                | 5 (36.4)        | 7 (63.6)      |
| Congenitally missing teeth | 4 (0.1)                   | 2 (50)          | 2 (50)        |
| Microdontia          | 4 (0.1)                                                 | -               | 4 (100)       |
| Amelogenesis imperfecta | 1 (0.2)                                 | -               | 1 (100)       |
| Fluorosis            | 171 (3.4)                                               | 88 (51.5)       | 83 (48.5)     |
| Retained deciduous teeth | 2 (0.4)                             | -               | 2 (100)       |
| Prominent cusp of Carabelli | 14 (0.3)                          | 3 (21.4)        | 11 (78.6)     |

Estimated using Chi-square test (28.311) and statistically insignificant with $P=0.008$
range of 1.8%–39.2%\[13,20\] [Table 5]. The current study observed male predilection which was similar to published reports,\[14,15,17\] whereas fewer studies documented female predilection.\[13,18,20\] This study documented 14 types of developmental anomalies that were prevalent among participants [Table 1].

Ankyloglossia (Tongue-tie) was the most frequent (3.9%) developmental anomaly observed in the present study. The majority of the participants with ankyloglossia were 6–12 years old; followed by the 13–15 years old and then the 3–5 years of age group. School children of Kadapa district showed higher prevalence for ankyloglossia when compared to Chittoor district. There was no significant association with other developmental anomalies. A study investigated ankyloglossia among infants and reported prevalence of 0.52% in the Indian population.\[21\] The prevalence reports of ankyloglossia ranges between 0.02% and 10.7%.\[22\] The participants with ankyloglossia usually will have challenges in speech articulation due to restricted tongue movements. However, the present study did not collect data on speech difficulties.

Fluorosis was the most common dental anomaly among the study participants with a prevalence rate of 3.4%, with male predilection. Similarly, a published report from Madhya Pradesh documented male predilection.\[23\] The cases with fluorosis in the present study showed white flecks, persistent presence of perikymata, staining or discrete pitting of enamel. A greater number of fluorosis cases were observed in the 6–12-year-age group followed by the 13–15 and the 3–5-year-age groups. Higher number of fluorosis cases were observed in the Kadapa district versus Chittoor. The majority of the participants with fluorosis presented as isolated developmental disturbances. Only a few cases showed concomitant occurrence of fluorosis and supernumerary teeth, tongue-tie or cusp of Carabelli. The association was statistically insignificant. A study from Kadapa district reported higher fluoride concentration (4.22 mg/l) in ground water sample in Gandlatimmayyapalle, Kadapa.\[24\] Another study from Khammam district of Andhra Pradesh reported prevalence of enamel fluorosis of 74.9% due to consumption of ground water and their results were statistically significant. Those results reported dental caries prevalence of 56.5%.\[25\] However, the present study did not document caries since the central focus was on developmental anomalies.

The third most prevalent anomaly was high frenal attachments (3.10%) which had slight female predilection. The majority of the high frenal attachments were found among the 6–12-year-age group; followed by the 3–5 and 13–15 years of age groups. Kadapa district showed more cases of high frenal attachment than Chittoor district participants. One of the Middle East countries studies on frenal attachment and malocclusion reported prevalence of 3.9%. The study reported an association of malocclusion among their study population.\[26\] Two studies from Andhra Pradesh (Nellore and Bhimavaram) documented the association of high frenal attachment and gingival recession.\[27,28\] Although this study is the first documented

### Table 4: Prevalence and distribution of dental anomalies by age and gender in 568 school children

| Anomalies | Study population (n=568) | Isolated anomaly (n=509; 89.6%), n (%) | Concomitant anomalies (n=59; 10.4%), n (%) |
|----------|-------------------------|--------------------------------------|----------------------------------------|
| Soft tissue | 358 | 306 (85.5) | 52 (14.50) |
| Disturbances in shape of teeth | 3 | 3 (100) | - |
| Disturbances in number of teeth | 15 | 13 (86.7) | 2 (13.3) |
| Disturbances in size and structure of teeth | 5 | 5 (100) | - |
| Other anomalies | 187 | 182 (97.3) | 5 (2.7) |

Estimated using Chi-square test (19.605) and statistically significant with $P=0.001$.

### Table 5: Indian epidemiological reports on developmental anomalies

| Years | Location | Study population | Most common disturbance | Predilection | Prevalence (%) | Reference |
|-------|----------|------------------|-------------------------|--------------|----------------|-----------|
| 2017  | Nellore  | School children  | Supernumerary teeth     | Male         | 2.27           | Shilpa et al.\[17\] |
| 2016  | West Godavari | School children | Enamel hypoplasia       | Female       | 3.6            | Prasad et al.\[20\] |
| 2015  | North Karnataka | Outpatients of dental institution | Impaction | Male         | 15.9           | Solanki et al.\[28\] |
| 2015  | Haryana  | School children  | Enamel hypoplasia       | Female       | 29.1           | Gupta et al.\[20\] |
| 2014  | Jodhpur  | Outreach patients | Impaction              | Male         | 28.8           | Solanki et al.\[28\] |
| 2014  | West Bengal | School children | Hypodontia              | Female       | 1.8            | Mukhopadhyay and Mitra\[50\] |
| 2013  | Maharashtra | School children | Impaction              | Male         | 39.2           | Kathariya et al.\[41\] |
| 2011  | Indore   | Outpatients of dental institution | Hypodontia | Male         | 34.28          | Gupta et al.\[36\] |
| 2015  | Rajasthan | School children | Double teeth (fusion/gemination) | Female | 4 | Deolia et al.\[22\] |
prevalence of high frenal attachment in Kadapa and Chittoor districts, no clinical observations of gingival recession or malocclusion were done.

Cusp of Carabelli was observed in 0.3% of the study population. All participants with cusp of Carabelli showed well-developed prominent fifth cusp bilaterally symmetrical on the maxillary molars. Teeth with minimally developed fifth cusps such as small, indented or grooves, depressed were not considered in this study. A study from Nellore district of Andhra Pradesh documented the prevalence of cusp of Carabelli in 63.7% of their study population with no significant sexual dimorphism. Another comparative study from India reported prevalence of cusp of Carabelli of 58.7% in Rajasthan, 50% in Gujarat and 61.7% in Karnataka. The variation in the prevalence reported may be due to ethnic diversity among the Indian population.

Supernumerary teeth were observed in 0.22% of study participants and had a male predilection. Mesiodens were the only type of supernumerary teeth documented in the study and only one mandibular case of mesiodens was reported. A study from Tamil Nadu reported prevalence of supernumerary teeth was 1.56% with a higher occurrence of mesiodens. A North Indian study documented prevalence of 1.6% for supernumerary teeth which had an association with malocclusion. A few cases of mandibular mesiodens were reported from India. The present study did not document the occlusal challenges with supernumerary teeth.

Congenitally, missing teeth was observed in 0.1% of the study population with male and maxillary jaw predilection. Maxillary lateral incisors were the most common missing tooth. Missing teeth was reported in the 13–15 years of age group. Missing anterior teeth in the 3–5 years of age group and in the <7–8 years of the study population were disregarded considering chronology of teeth eruption. This study documented no missing teeth was observed in primary dentition. Kadapa district showed higher prevalence of missing teeth than Chittoor district. No specific epidemiological studies on congenitally missing teeth were available from Andhra Pradesh or other areas of India. However, isolated case reports of congenitally missing teeth were documented from India. The present study did not attempt to document malocclusion associated with congenitally missing teeth.

Microdontia was observed in 0.1% of the study population with male predilection. Microdontia was observed in the maxillary and mandibular anterior regions. An epidemiological study from Maharashtra reported the microdontia prevalence of 4.3% Lip pits were observed in 0.1% of the study population with male predilection. The lip pits were frequently seen in participants in the 6–12 years of age range and presented as bilateral distribution over the corner of lips. No syndrome components among the participants with lip pits were reported. A study from South Kerala reported prevalence of 0.3% on commissural lip pits with unilateral predilection.

The study documented 0.04% of fusion and retained deciduous teeth. Both anomalies were observed in male participants. Fusion was presented as an isolated anomaly. The retained deciduous teeth were maxillary canines and mandibular central incisors. The study also documented 0.02% of angular cheilitis, cleft lip and cleft palate, talon cusp and amelogenesis imperfecta. Amelogenesis imperfecta and cleft lip with cleft palate were observed as an isolated developmental anomaly in female participants, whereas, angular cheilitis and talon’s cusp were observed in male participants. Amelogenesis imperfecta was presented as hypomineralized areas of the tooth with pitting, discoloration, fractures, exposed the dentine surface. The appearance was generalized to all permanent teeth.

The two major limitations of this study were that no clinical correlation was made in relation to malocclusion, dental caries or periodontal disease. No investigations (clinical radiographs or biopsy) were performed to confirm clinical diagnosis, since the study is focused only on clinical examination and no samples were collected.

CONCLUSIONS

The most common developmental anomalies were tongue-tie, fluorosis and high frenal attachment. The study observed male predilection. Comparison of the prevalence rates in the studies reported from across the country showed variation. Such variation may be due to genetic and environmental causes. Future research is required to correlate the developmental anomalies with dental and/or oral diseases.

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