

Prevalence of Dental Anomalies in Indonesian Individuals with Down Syndrome

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Abstract

Objective: To determine the frequency distribution of dental anomalies in people with Down syndrome. **Material and Methods:** This cross-sectional study was developed in Jakarta, Indonesia, and evaluated 174 individuals with Down syndrome aged 14–53 years. Were collected information regarding the tooth number, tooth size, shape, and structure. Descriptive statistics were used to calculate the absolute and relative frequencies. The Pearson chi-square test was used in bivariate analysis. The significance threshold was set at 5%. **Results:** There were 70 female subjects (40.2%) and 104 male subjects (59.8%) with an average age of 19.2 years. In terms of anomalies of tooth number, hypodontia (80.9%), supernumerary teeth (12.4%), and combined hypodontia and supernumerary teeth (12.4%) were identified. In terms of anomalies of tooth size, microdontia (98.8%) is the most common anomaly. Anomalies of tooth shape included fusion (66.67%) and talon's cusp (33.3%), whereas anomalies of tooth structure included enamel hypoplasia (70.8%), enamel hypocalcification (4.2%), combined enamel hypoplasia and hypocalcification (12.5%), and tooth discoloration (12.5%). **Conclusion:** Individuals with Down syndrome in Jakarta showed a high prevalence of dental anomalies, with hypodontia and microdontia being the most common anomalies showing a tendency to occur predominantly in males.

Keywords: Tooth Abnormalities; Tooth, Supernumerary; Anodontia; Down Syndrome.

Introduction

Down syndrome is the most common chromosomal abnormality globally, occurring at a rate of 1:1000 to 1:1100 births [1,2]. People with Down syndrome are characterized by impaired mental and physical development [3]. They also commonly exhibit growth abnormalities, which include microcephaly, flat face, small nose, distressed nasal bridge, short and wide neck, and particularly dental anomalies [4,5].

Dental anomalies in people with Down syndrome are five times more common than in the normal population [6]. Each individual has a different dental anomaly phenotype and shows at least one dental anomaly in the oral cavity [2,6]. A study stated that dental anomalies were experienced by 94% of people with Down syndrome in Turkey with a mean age of 13.5 years old [6]. The high prevalence of dental anomalies in people with Down syndrome should not be considered an isolated phenomenon, but as part of a set of genetically determined traits probably associated with slow cellular growth and a consequent reduction of cell numbers [7].

Dental anomalies can be grouped into those associated with the number, size, shape, and structure of teeth. This system also groups anomalies based on the stage of dental development at which each anomaly is predicted to originate [8-10]. Dental anomalies found in people with Down syndrome are as follows: anomalies of tooth number, namely, hypodontia and supernumerary conditions; anomalies of tooth size, namely, microdontia from permanent teeth; anomalies of tooth shape, such as short root, taurodontia, talon cusp, fusion, and gemination; as well as anomalies of tooth structure, such as enamel hypoplasia and enamel hypocalcification [11,12]. Besides these abnormalities, tooth eruption in people with Down syndrome may occur in asymmetric sequences and may be delayed for 2 to 3 years compared with that in healthy individuals [6].

Dental anomalies have different clinical implications in terms of both functional and esthetic aspects [13]. The early diagnosis of permanent dental anomalies enables more comprehensive long-term treatment planning and results in better prognosis so that it can improve the quality of life of people with Down syndrome. Therefore, there is a need for clinicians to be aware of the findings of dental anomalies in people with Down syndrome so that, when oral health evaluation is performed, a comprehensive treatment plan can be established [2,6].

Jakarta is the capital city of Indonesia, which concerns about the health and education conditions of its people. This applies to all people including those with special needs such as people with Down syndrome. It has been proven by the presence of a quite large special needs school in Jakarta where those with special needs can get education and training to improve their life in general. Previous studies on the conditions of the oral cavity in people with Down syndrome were performed in Yogyakarta and Jakarta, Indonesia, but these did not focus on the frequency distribution of dental anomalies in such individuals however more focused on the problem of tooth eruption and reduction of tooth size [14,15].

This kind of frequency distribution information can be representative data of Jakarta that can be used to determining public policy for society needs. Therefore, this study evaluated the frequency distribution of anomalies of permanent teeth found in Down syndrome cases in Jakarta.

Material and Methods

Study Design and Sample

This study cross-sectional was developed in Jakarta, Indonesia, from September to October 2017. The subjects were individuals with Down syndrome aged 14 years and above who attend school at Jakarta Type C Special Needs School called Sekolah Luar Biasa C Jakarta (SLB C Jakarta) obtained by a purposive sampling technique.

The inclusion criteria were subjects who had already developed permanent dentition, those for whom their guardians or parents gave permission for their children to be examined, and those who were cooperative during the clinical examination. The exclusion criteria included subjects who were undergoing dental treatment, such as a crown, bridge, or orthodontic treatment.

Were collected information regarding the tooth number (hypodontia and supernumerary), tooth size, shape, and structure. The intraoral examination was performed by pediatric residents of the Faculty of Dentistry, University of Indonesia.

Clinical examination to determine the tooth size was performed using a pocket probe and adjusted to the table of normal permanent tooth size [16]. The results were defined as microdontia when a tooth was much smaller (tooth has the same shape, but the size is very small) than the normal size as seen from the mesiodistal side of the labial surface and macrodontia when a tooth was much larger (tooth has the same shape, but the size is very large) than normal.

The anomaly of shape involves abnormalities of tooth crown shape and includes talon cusp, gemination, and fusion. Measurement of this variable was performed by clinical examination, visualization of talon cusp, if there was an additional cusp on the lingual side of the anterior tooth, and by counting the number of permanent teeth in the oral cavity to distinguish gemination and fusion.

The anomaly of structure involves a structural abnormality of the dental crown that does not match the normal structure. This includes enamel hypoplasia, enamel hypocalcification, and discoloration. Enamel hypoplasia involves thin enamel with pits or grooves on the enamel surface, exhibiting a yellow to brownish color without the exposure of the dentin. Enamel hypocalcification is the result of a reduction in the quality of enamel due to its maturation; here, the quantity of enamel does not change, so pits or grooves are not shown on the enamel surface. Discoloration involves a change in color of teeth either extrinsically or intrinsically, having multifactorial etiologies, which can be found along a spectrum of nine different colors: black, brown, blue, green, gray, orange, pink, red, and yellow. Measurement of this was performed by assessing the clinical appearance and probing enamel with defects using a half-moon explorer.

Data Analysis

Data were analyzed using IBM SPSS Statistics for Windows Software, version 20 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to calculate the absolute and relative

frequencies. The Pearson Chi-square test was used in bivariate analysis. The significance threshold was set at 5%.

Ethical Aspects

This study has been approved by the Research Ethical Commission, Faculty of Dentistry Universitas Indonesia and also followed the principles of the Helsinki declaration. Informed consent was obtained before the examination.

Results

The study included 174 subjects aged 14 to 53.2 years, with a mean age of 19.2 years \pm 5.8. There were 104 male subjects in which 76 of them had the presence of dental anomalies and 70 female subjects which 62 of them had the presence of dental anomalies. There was a statistically significant difference in the presence of anomalies between males and females ($p=0.002$). Specifically, males with Down syndrome had a tendency to experience dental anomalies 2.85 times more than females with Down syndrome. The most prevalent anomalies were hypodontia and microdontia, affecting 83 subjects (47.7%) (Table 1). Males showed a greater tendency to exhibit hypodontia, supernumerary teeth, microdontia, talon cusp, and enamel hypoplasia than females with Down syndrome.

Table 1. Prevalence of dental anomalies.

Dental Anomalies	Male		Female		Total		p-value	OR 95% CI
	N	%	N	%	N	%		
Hypodontia	44	25.3	39	22.4	83	47.7	0.11	1.72 (0.93 - 3.16)
Supernumerary	10	5.7	7	4.0	17	9.8	1.00	1.04 (0.37 - 2.88)
Microdontia	48	27.6	35	20.1	83	47.7	0.73	1.17 (0.63 - 2.14)
Macrodontia	0	0.0	1	0.6	1	0.6	0.40	**
Talon cusp	1	0.6	1	0.6	2	1.1	1.00	1.49 (0.92 - 24.3)
Fusion	4	2.3	0	0.0	4	2.30	0.15	**
Enamel Hypoplasia	10	5.7	8	4.6	18	10.3	0.90	1.21 (0.45 - 3.24)
Enamel Hypocalcification	3	1.7	1	0.6	4	2.30	0.65	0.59 (0.05 - 4.78)
Discoloration	3	1.7	0	0.0	3	1.72	0.27	**

**Could not be counted; $p<0.05$: Statistically significant.

A total of 89 subjects (51.1%) experienced anomalies of tooth number. Seventy-two subjects (80.9%) had hypodontia, six subjects (6.74%) had supernumerary teeth, and eleven subjects (12.4%) had a combination of hypodontia and supernumerary teeth. Table 2 shows the frequency distribution of agenesis in certain tooth elements in people with Down syndrome. The highest numbers of such cases were subjects who experienced mandibular lateral incisor tooth agenesis. Some subjects experienced agenesis of more than one tooth element. Tooth agenesis or hypodontia of first molar and central incisor showed a significant difference between mandible and maxilla ($p<0.05$). There was a tendency for hypodontia to occur in mandibular first molars, lateral incisors, and central incisors than in maxilla with Odds Ratio (OR) >1 . Subjects who experienced agenesis of one and two

tooth elements were the most common, which were 23 subjects (23.7%) for each. On the other hand, mesiodens tooth in the maxilla was the most common supernumerary tooth in the subjects which were experienced by six subjects. Some of the subjects had supernumerary teeth in more than one area (mesiodens/ palatal canine/ parapremolar/ paramolar).

Table 2. Frequency distribution of subjects who experienced hypodontia on each jaw.

Tooth Agensis	Mandible	Maxilla	p-value	OR 95% CI
	N	N		
Second Molar	8	8	1	1 (0.11 – 8.94)
First Molar	8	1	0.03	64 (3.38 – 1210.55)
Second Premolar	9	14	0.18	0.32 (0.08- 1.25)
First Premolar	3	5	0.62	0.36 (0.48 – 2.73)
Canine	6	8	0.69	0.54 (0.11 – 2.55)
Lateral Incisor	32	29	0.69	1.28 (0.58 – 2.82)
Central Incisor	10	3	0.01	15 (2.02 – 111.17)

p<0.05: Statistically significant.

From the sample, 84 subjects (48.3%) experienced anomalies of tooth size. Eighty-three subjects (98.8%) had microdontia, and one subject (1.2%) had macrodontia that affected the maxillary second molar teeth bilaterally. Among the 83 subjects who experienced microdontia, 16 (19.3%) presented true generalized microdontia in all teeth and 67 subjects (80.7%) presented true microdontia that involved microdontia in one or more specific teeth. Table 3 shows that the teeth most commonly exhibiting microdontia in this study were maxillary lateral incisors, maxillary second premolars, and maxillary second molars. These three types of teeth showed significant differences between bilateral and unilateral presence (p<0.05). They also showed a tendency to present bilaterally (OR >1).

Table 3. Frequency distribution of most common microdontia teeth in this study based on bilateral or unilateral presence.

Microdontia Teeth	Bilateral	Unilateral	p-value	OR 95% CI
	N	N		
Maxillary Lateral Incisor	42	9	0.001	21.78 (7.87 – 60.28)
Maxillary Second Premolar	22	8	0.001	7.56 (2.41 – 23.75)
Maxillary Second Molar	21	8	0.002	6.89 (2.18 – 21.80)

p<0.05: Statistically significant.

Six subjects (3.4%) experienced anomalies of tooth shape. These included two subjects (33.3%) with talon cusp teeth and four (66.7%) with fused teeth. A total of twenty-four subjects (13.8%) experienced anomalies of tooth structure. These included 17 subjects (70.8%) had tooth enamel hypoplasia, 3 (12.5%) had tooth enamel hypocalcification, 1 (4.2%) had a combination of tooth hypoplasia and hypocalcification, and 3 (12.5%) had tooth discoloration.

Discussion

This study was performed in 43 SLB C in Jakarta, Indonesia. The reason for selecting these study sites was that these schools had students with Down syndrome who were aged 14 and above,

and who met the study criteria while being in an approachable location. The cross-sectional study design was chosen because this is a useful approach to investigate feature, which is a permanent characteristic of an individual [17].

The determination of subjects was performed using a non-probability purposive sampling method, which is used for the identification and selection of information - rich cases for the most effective use of limited resources. It is allowed the researchers to select individuals or groups of individuals that are especially knowledgeable about or experienced with a phenomenon of interest. [18].

Down syndrome is a physically recognizable syndrome with inhibited mental and physical development [3,6]. According to the WHO, 12 years old is the age at which all permanent teeth have erupted in normal individuals, but tooth eruption in people with Down syndrome may be delayed by 2 or 3 years, so the age of 14 and above was selected to investigate the conditions of permanent dentition in this population [6,19]. In the field of pediatric dentistry, dental care is continuously provided for patients with special needs even later in life. The skills of pediatric dentists are useful in managing problems such as poor communication and uncontrolled movements, even in elderly patients [20]. The data obtained in this study include anomalies of tooth number, size, shape, and structure. Based on the literature, almost all people with Down syndrome experience mild or moderate intellectual disability, whereas only a minority have severe intellectual disability, making it possible to perform early treatment for dental anomalies in people with Down syndrome [21].

In this study, 138 subjects (79.3%) had dental anomalies in their oral cavity, which means that, among all of the studied subjects, those with dental anomalies were more common than those without them. This is in line with studies in Turkey and Sudan on people with Down syndrome. The study in Turkey stated that 204 of such subjects (94%) had dental anomalies [6], whereas the study in Sudan stated that 51 of 92 subjects (55.4%) had them [22]. From Table 1, the prevalence of dental anomalies in the current study was greater, with them being more likely to be experienced by males with Down syndrome than by females in SLB C Jakarta, especially for hypodontia, supernumerary teeth, microdontia, talon cusp, and enamel hypoplasia. The most common dental anomalies in people with Down syndrome aged 14 years and above in SLB C Jakarta were shown to be the anomaly of the tooth number of hypodontia and the anomaly of tooth size of microdontia. This supports the assertion that hypodontia in people with Down syndrome is more common than in the normal population, highlighting it as a phenotype typical of Down syndrome [6].

A little over half of the subjects exhibited anomalies of tooth number, which included hypodontia, supernumerary teeth, and a combination of hypodontia and supernumerary teeth. The results are in line with studies on people with Down syndrome in Turkey, Malaysia, and Sudan, which described that hypodontia is more common than supernumerary teeth. A study in Turkey found that 29% had permanent dental agenesis, whereas only 9% presented supernumerary teeth in the oral cavity [6]. Meanwhile, in Malaysia and Sudan, no supernumerary dental anomalies were found, but only hypodontia was experienced by 50% of subjects in Malaysia and 54.9% of subjects in

Khartoum, Sudan [12,22]. The high prevalence of hypodontia in people with Down syndrome is predicted to be related to neurodevelopmental disorders or abnormal chondral element development at the time of permanent tooth bud initiation starting from the 10th week of fetal development [6,23,24]. Changes in the peripheral nervous system of people with Down syndrome include a reduced number of branches of peripheral nerves or nerves that do not grow to the same level as in the normal population [24]. This supports the statement that hypodontia is more common in people with Down syndrome than in the normal population, making it a recognized phenotype of Down syndrome [6].

Hypodontia or tooth agenesis was found in all types of teeth, ranging from the central incisors to the second molars (Table 2). Some subjects had hypodontia not only in one jaw but in both jaws simultaneously. Hypodontia showed a tendency to be experienced by the mandibular jaw rather than the maxilla for some particular teeth; namely, first molar, lateral incisor, and central incisor, with OR >1. This is in line with the results of studies in Turkey and Sudan. A study in Turkey showed that 63% of dental agenesis occurred in the mandible, whereas a study in Sudan found that 58.7% of hypodontia occurred there [6,22]. The most common affected teeth by agenesis in this study were the mandibular lateral incisors, followed by the maxillary lateral incisors and the maxillary second premolars.

In comparison, in the study from Turkey, the teeth most commonly affected by agenesis were the mandibular second premolars, followed by the maxillary lateral incisors and maxillary second premolars [6]. In contrast, in the study from Khartoum, Sudan, the teeth most commonly affected by agenesis were mandibular second premolars at a rate of 34.7%, followed by mandibular lateral incisors at a rate of 21.4% and maxillary lateral incisors at a rate of 17.3% [22]. When considering the severity, in this study, hypodontia most commonly affected one to two teeth; agenesis became more rare for cases in which a greater number of teeth were affected. This is in line with the findings of the study in Turkey, in which 83% of subjects experiencing hypodontia had lost one to two teeth [6]. In a study in Indonesia focused specifically on Jakarta, it was found that children with Down syndrome had fewer permanent teeth than normal children, which is most likely to be caused by the non-eruption or agenesis of teeth [14]. As for supernumerary teeth, in this study, supernumerary teeth were generally located in the anterior region between maxillary incisors. This is in line with the findings of a Turkish study suggesting that 67% of supernumerary teeth were found in the premaxilla region with mesiodens as the most common finding [6].

Less than half of the subjects (48.3%) experienced anomalies of tooth size. The results of this study are in line with studies on people with Down syndrome in Turkey [6] and Brazil [25], which described that microdontia was more common than macrodontia. Specifically, in Turkey, microdontia was found in 13% of the sample and macrodontia in 1% [6]. Meanwhile, in Brazil, microdontia occurred in 9.4%, whereas no macrodontia was found [25]. Other findings in this study include that 16 subjects experienced true generalized microdontia or microdontia generalist, whereas the remaining 67 subjects experienced true microdontia in certain teeth only. Microdontia in people with

Down syndrome is associated with a decrease in the activity of trisomy cell mitosis in developing permanent tooth buds, which produce fewer ectomesenchymal cells to form dentin and fewer inner enamel epithelial cells in DEJ to differentiate into ameloblasts; these, in turn, secrete the enamel matrix in the proliferating phase of permanent tooth buds, when the tooth crown is forming [23]. True generalized microdontia or generalized microdontia is a rare condition, and its occurrence is associated with the endocrine disorder hypopituitarism [9,26].

In this study, the teeth most commonly affected by microdontia were the maxillary lateral incisors, followed by the maxillary second premolars and the maxillary second molars (Table 3). These three tooth elements showed a tendency to have microdontia bilaterally, rather than unilaterally. In comparison, in a study from Brazil, the most common teeth with microdontia were maxillary second molars, at a rate of 77.8% among all teeth with microdontia, and the most common teeth with conus were the maxillary lateral incisors, at a rate of 7.3% [25]. A study in Indonesia also showed that 60.9% of people with Down syndrome who were examined had microdontia of deciduous lateral incisors, indicating that microdontia in the lateral incisors is one of the oral manifestations in people with Down syndrome [26]. In another study in Indonesia, specifically in Yogyakarta, it was also stated that people with Down syndrome have a reduced mesiodistal size of permanent dental crown and the smallest reductions occur in the central incisors, lateral incisors, and first molars in men, whereas the smallest reductions in women occur in both maxillary central incisors and first molars [27]. A study in Spain about the dimension of central incisors, canines and first molar in patients with Down syndrome (DS) measured on cone-beam computed tomographs also stated that the teeth were smaller (in overall tooth length: reduction in crown height, progressive decreases in mesiodistal diameter, etc.) than those of the general population, although the crown-to-root ratio remained within the normal range [28]. As for macrodontia, in this study, this was found to affect the maxillary second molars bilaterally in one subject; in contrast, in a study in Turkey, macrodontia was shown to affect maxillary central incisor teeth in two subjects [6]. However, both of these studies showed the same prevalence rates of patients who presented macrodontia teeth, with it appearing in no more than 1%.

A low percentage of participants (3.5%) experienced anomaly of tooth shape, distributed into four with fused teeth and two with talon cusp. The fusion of teeth in this study affected the maxilla and mandibular incisors, as well as maxillary canines and premolars, with a prevalence of 2.3%. When compared with a study in Brazil, the prevalence is quite balanced but greater because the prevalence of fused teeth in Brazil was only 1.1% [25]. Meanwhile, for talon cusp, in a Turkish study, it was found 6%, affecting the maxillary central incisors [6]. In contrast, in this study, talon cusp affected the maxillary lateral incisors bilaterally in both of two subjects, with a prevalence of 1.1%. The anomaly of tooth shape in people with Down syndrome was reported to be associated with the decreased mitotic activity of dental progenitor cells during embryogenesis (histodifferentiation and morphodifferentiation phases), in which progenitor cells have the ability to differentiate into specific cell types [8,9,23].

A total of 13.7% had anomalies of tooth structure, which were distributed in enamel hypoplasia, enamel hypocalcification, tooth discoloration, and a combination of hypoplasia and enamel hypocalcification. This is in line with a study from Massachusetts that showed that a common structural anomaly in people with Down syndrome is enamel hypoplasia (32%) [29]. The enamel hypoplasia in people with Down syndrome is the result of a reduced amount of enamel matrix and reduced opacity of the enamel layer [30]. Meanwhile, enamel hypocalcification is the result of reduced quality of enamel maturation [23].

The enamel hypoplasia in people with Down syndrome can be associated with abnormal blood supply to the embryonic jaw, which inhibits tissue growth and causes some degeneration of the odontoblasts, which are involved in formation of the dentin; dentin is required to induce preameloblasts to become ameloblasts, which secrete enamel matrix [23,31]. Regarding tooth discoloration, no previous study has focused on this in people with Down syndrome, but this study found three subjects experiencing it. This involved discoloration of the teeth either extrinsically (superficially, either on the surface of the tooth or on the acquired pellicle) or intrinsically (possibly arising during the development of different tooth appearance and degree of severity) [32]. Tooth discoloration can occur along a spectrum of nine different colors: black, brown, blue, green, gray, orange, pink, red, and yellow. Tooth discoloration has been reported in several syndromes, including congenital erythropoietic porphyria (CEP), which exhibits a red-purple or red-brown alteration in deciduous or permanent teeth. CEP is a rare autosomal recessive metabolic disease with a mutation in the gene encoding uroporphyrinogen-III synthetase, which causes the accumulation of porphyrin in urine, skin, bone, and dentin [33]

Conclusion

Individuals with Down syndrome in Jakarta showed a high prevalence of dental anomalies, with hypodontia and microdontia being the most common anomalies showing a tendency to occur predominantly in males.

Authors' Contributions: LA performed the data collection, data analysis and interpretation, wrote the manuscript. MFR wrote the manuscript, performed the data collection, analysis and interpretation. ISI designed the study, analysis and interpretation, wrote the manuscript and reviewed the manuscript. All authors declare that they contributed to critical review of intellectual content and approval of the final version to be published.

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