
Prevalence and pattern of permanent tooth agenesis among multiracial orthodontic patients in Malaysia

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Objective: To determine the prevalence and pattern of hypodontia among multiracial orthodontic patients in Malaysia.

Materials and methods: Digital panoramic radiographs of 813 patients were obtained from the records of the orthodontic clinic over five years (2014–2018). The presence of hypodontia was recorded and crosschecked with clinical notes. The association of gender and ethnicity was analysed using the Chi-squared test ($p < 0.05$).

Results: The prevalence of hypodontia was 7.9%, with both mandibular and maxillary lateral incisors being most commonly and equally affected teeth at 17.9%. Three patients had up to five missing teeth. No severe hypodontia was recorded. The prevalence was highest among the Chinese (8.3%), followed by Malay (7.9%) and the Indian (6.3%) population. Gender and ethnicity were found not to be associated with hypodontia. The most common missing tooth for Malays was the mandibular central incisor, for the Chinese was the mandibular lateral incisor and for the Indian population was the mandibular second premolar.

Conclusion: The prevalence of hypodontia was 7.9%. The prevalence of hypodontia was 8.3% for the Chinese, 7.9% for Malay and 6.3% for the Indian population. The most common missing teeth were the mandibular and maxillary lateral incisors. (Aust Orthod J 2021; 37: 79 - 84. DOI: 10.21307/aoj-2021-008)

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Introduction

Hypodontia is the congenital absence of one or more teeth, excluding third molars.¹ The aetiology behind the anomaly is multifactorial and related to both genetic and environmental components. Genes such as the muscle segment homeobox 1 (MSX1), paired box 9 (PAX 9) and axis inhibition protein 2 (AXIN 2) have been linked to the absence of specific tooth formation.² Hypodontia can occur in the primary or permanent dentition and ranges from a single missing tooth to complete anodontia. The severity of hypodontia can be classified as mild (one to two missing teeth), moderate (three to five missing teeth) or severe (six or more missing teeth).³

A patient's genetic background has been suggested to highly influence the pattern of hypodontia between different racial groups.⁴ The prevalence of hypodontia has been reported to be 6.4%; the highest in Africa at 13.4%, followed by Europe 7%, Asia 6.3% and Australia 6.3%, with a lower prevalence in North America of 5.0% and Latin America/Caribbean at 4.4%.⁵ Hypodontia is more common in females and most commonly affects mandibular second premolars (3%) followed by the maxillary lateral incisors (2%) and maxillary second premolars (<1%).⁵ This large variation in prevalence between continents suggests that racial background could potentially play an important role in the prevalence of hypodontia.

Malaysia is unique in its diverse and multicultural population, which is comprised mainly of Bumiputera (69.3%), Chinese (22.8%) and Indian (6.9%) ethnic groups.⁶ This makes Malaysia ideal to study the influence of ethnicity on the prevalence of hypodontia in an Asian population. Bumiputera further consists of Malay, indigenous of Peninsular and natives of Sabah and Sarawak. A previous study conducted at the Faculty of Dentistry, Universiti Malaya in 1989, showed that the prevalence of hypodontia was much lower at 2.8% in an assessment of children from 6–15 years of age. Maxillary lateral incisors were reported to be the most commonly affected teeth, followed by mandibular lateral incisors and mandibular second premolars.⁷ Another more recent study in 2014 that limited its findings to Malay children reported a slightly higher prevalence at 3.2%, and found upper lateral incisors were the most commonly affected teeth.⁸ However, no study has specifically investigated the influence of ethnicity on the prevalence of hypodontia among orthodontic patients in Malaysia.

The purpose of this study was to provide contemporary data on the prevalence and pattern of hypodontia among orthodontic patients seeking treatment in Malaysia. It was expected that the data from this study would contribute to an understanding of the impact of hypodontia on orthodontic services, to serve as a reference for future multi-centre data collection and to create a hypodontia database for future research.

Materials and methods

This was a retrospective study using dental panoramic tomographs (DPT), obtained from patients who attended the orthodontic clinic at the Faculty of Dentistry, Universiti Malaya from 2014 to 2018. Ethical approval was obtained from the Faculty of Dentistry Medical Ethics Committee of this institution prior to the study, with reference number DF CD1801/0009(L). Data were analysed by two

researchers. The incidence of missing teeth was recorded, excluding the third molars. The findings from the DPTs were cross checked with the clinical records and clinicians to verify that the teeth were congenitally missing as opposed to lost due to a history of extraction or trauma. The inclusion criteria were orthodontic patients who fell into the three main ethnic subgroups of Malaysia: those of Malay, Chinese and Indian origin. This data were readily available from clinical records. Patients who did not fall into these three main groups, or had ambiguous ethnic origins, were excluded. Incomplete or poor-quality records (unclear DPT image) and patients having craniofacial or cleft syndromes were also excluded. The digital radiographs were examined using Syngo Imaging (Siemens), a digital imaging system for radiographic images.

The Statistical Package for the Social Sciences (SPSS) version 12.0.1 for Windows was used for statistical analysis. The prevalence of hypodontia was compared between gender and ethnic groups using Chi-square test and Fisher's exact test with the significance level set at $p < 0.05$.

Results

From a total of 875 records, 813 patients met the inclusion criteria. These consisted of 295 males (36.29%) and 518 females (63.71%) aged 10 to 55 years (mean age of 22 years, S.D. 6.03 years). All were from the three main ethnic groups in Malaysia, which comprised 380 Malay (46.74%), 338 Chinese (41.57%) and 95 Indian (11.67%) people. The distribution of hypodontia within ethnicity groups and gender is shown in Table I.

A total of 64 patients (7.9%) had one or more congenitally missing teeth (excluding third molars). The present study showed that there was no association between hypodontia and gender for each ethnic group, with p values of 0.131 for the Malay, 0.168

Table I. Distribution of recorded cases and prevalence of hypodontia.

Ethnicity	Hypodontia			Total sample	Prevalence (%)
	Male	Female	Combined		
Malay	6	24	30	380	7.9
Chinese	8	20	28	338	8.3
Indian	4	2	6	95	6.3
Overall	18	46	64	813	7.9

for Chinese and 0.183 for the Indian populations, respectively. Overall, missing teeth were found more commonly in females (8.9%) than in males (6.1%), and the ratio of affected females to males was 2.6:1. Even though the prevalence of hypodontia in females was higher, the chi-square test indicated no association between gender and hypodontia ($X^2(1) > 2.001$, $p = 0.157$). The prevalence of hypodontia based on ethnicity showed that the prevalence was highest among Chinese (8.3%), followed by Malay (7.9%) and the Indian (6.3%) populations, but no association between ethnicity and hypodontia was detected ($X^2(2) > 0.397$, $p = 0.820$).

Table II indicates the level of hypodontia ranging from one to five teeth. There were 117 instances of missing teeth found in 64 affected individuals. Most of the affected individuals (82.8%) were missing one or two teeth. The greatest number of missing teeth recorded was five teeth, found in three individuals. There was no recording of oligodontia or > 6 missing teeth. Table III shows the pattern of hypodontia according to site. The most commonly missing teeth were the mandibular and maxillary lateral incisors followed by the mandibular central incisors and maxillary second premolars. The mandibular molars and mandibular first premolars were not missing in any of the patients. In the present study, hypodontia occurred 1.1 times more frequently in the maxilla than in the mandible.

The distribution of missing teeth according to ethnicity is shown in Table IV. Out of 117 missing teeth, the Malay population accounted for 57 (48.7%), the Chinese 43 (36.8%) and the Indian population 17 (14.5%) of the cases. The most commonly missing teeth for Malays were the mandibular central incisors, for the Chinese were the mandibular lateral incisors and for Indians were the mandibular second premolars.

Discussion

Hypodontia-related studies have been widely published. However, direct comparisons between studies need to be read with caution due to the significant variation in study designs and heterogeneity of the samples. Hypodontia has been shown to range from 3–11% in European and Asian populations.^{9,10} According to a meta-analysis by Khalaf et al. (2014), the Asian population prevalence fell within this range at 6.3%. This percentage was obtained from an examination of a heterogeneous group of countries that included Saudi Arabia, Turkey, India, China, Japan, Iran, South Korea, Jordan, Israel, Pakistan, Africa and Tunisia.⁵ South East Asian countries, including Malaysia, were not represented. In the present findings, the prevalence of hypodontia was much higher at 7.9%, whereas a previously reported Malaysian prevalence was 2.8–3.2%.⁷⁻⁸ Generally, a steady increase in the incidence of hypodontia has been shown elsewhere in Asia (4.7 to 6.3%), Europe (5.5 to 7.0%) and North America (3.9 to 5.0%).¹¹ Most likely, the increased prevalence in the present study was due to the difference in the general population compared to an orthodontic population. A similar increase in prevalence was seen in a study by Zhang et al. (2015), within a Mainland Chinese population, in which the prevalence of hypodontia fluctuated from 5.89% to 7.48% when the sample population was restricted to orthodontic patients.¹¹ Although Khalaf et al. reported that there was no statistically significant differences in the prevalence between population type (schoolchildren, dental and orthodontic patients), the results had high heterogeneity and hence should be interpreted with caution.^{5,12}

A recent Singaporean study examining orthodontic patients showed a higher prevalence of hypodontia at 11.7%.¹³ Sharing similar ethnic diversity compared

Table II. Number of missing teeth and frequency distribution.

No. of missing teeth	Males, N (%)	Females, N (%)	Total, N (%)
1	9 (50)	23 (50)	32 (50)
2	7 (39.9)	14 (30.4)	21 (32.8)
3	0 (0)	4 (8.7)	4 (6.3)
4	1 (5.6)	3 (6.5)	4 (6.3)
5	1 (5.6)	2 (4.4)	3 (4.7)
Total	18 (100)	46 (100)	64 (100)

Table III. Hypodontia according to side and uni- or bilateral occurrence.

Tooth type	Right side			Left side			Bilateral agenesis			Unilateral agenesis			Total		
	No.	% of sample	% of missing teeth	No.	% of sample	% of missing teeth	No.	% of sample	% of missing teeth	No.	% of sample	% of missing teeth	No.	% of sample	% of missing teeth
32/42	11	1.4	9.4	10	1.2	8.5	5	0.6	4.3	11	1.4	9.4	16	2.0	17.9
12/22	11	1.4	9.4	10	1.2	8.5	7	0.9	6.0	7	0.9	6.0	14	1.7	17.9
35/45	7	0.9	6.0	8	1.0	6.8	4	0.5	3.4	7	0.9	6.0	11	1.4	12.8
15/25	9	1.1	7.7	7	0.9	6.0	6	0.7	5.1	4	0.5	3.4	10	1.2	13.7
13/23	7	0.9	6.0	5	0.6	4.3	2	0.2	1.7	8	1.0	6.8	10	1.2	10.3
31/41	8	1.0	6.8	8	1.0	6.8	7	0.9	6.0	2	0.2	1.7	9	1.1	13.7
14/24	3	0.4	2.6	3	0.4	2.6	2	0.2	1.7	2	0.2	1.7	4	0.5	5.1
33/43	2	0.2	1.7	1	0.1	0.9	0	0.0	0.0	3	0.4	2.6	3	0.4	2.6
16/26	1	0.1	0.9	2	0.2	1.7	1	0.1	0.9	1	0.1	0.9	2	0.2	2.6
17/27	1	0.1	0.9	2	0.2	1.7	1	0.1	0.9	1	0.1	0.9	2	0.2	2.6
11/21	1	0.1	0.9	0	0	0	0	0	0	1	0.1	0.9	1	0.1	0.9

to Malaysia, the study reported the prevalence among Malay, Chinese and Indian patients at 14.4%, 13.7% and 6.0%, respectively. Malay and Chinese were found to be significantly higher compared to the Indian ethnic group. The present study supported a higher prevalence of hypodontia among the Chinese (8.3%) and Malay (7.9%) ethnic groups compared to the Indian ethnic group (6.3%), but the finding was not statistically significant.

In the present study, the number of female patients experiencing hypodontia was higher than males, 8.9% and 6.1%, respectively. This has consistently been reported in previous studies.^{5,14} Although the current study found the difference to be statistically insignificant, previous literature has been equivocal.^{5,7,8,15} It has been hypothesised that this may not necessarily reflect an increased prevalence of hypodontia among females but rather the increased tendency to seek treatment by females as they are more concerned about aesthetics. This was also reflected in the clinic gender bias of those attending. Although this may seem plausible, several earlier studies have shown that gender has no association with a desire to seek orthodontic treatment.^{16,17}

The majority of patients presented with mild hypodontia (congenitally missing one or two teeth),

Table IV. Missing teeth according to ethnicity.

Tooth type	Ethnicity			Total
	Malay	Chinese	Indian	
32/42	10	10	1	21
12/22	12	7	2	21
31/41	13	3	0	16
15/25	6	6	4	16
35/45	5	5	5	15
13/23	7	4	1	12
14/24	2	2	2	6
33/43	1	2	0	3
16/26	0	1	2	3
17/27	0	3	0	3
11/21	1	0	0	1
Total	57	43	17	117

82.8%. Only 17.2% had moderate hypodontia (congenitally missing three to five teeth) and none presented with severe hypodontia (oligodontia). This was not unexpected as syndromic patients were excluded from the study. It has previously been reported that more severe forms of hypodontia tend to occur in conjunction with syndromes such as ectodermal dysplasia, Down syndrome and Ehlers Danlos syndrome.² Hence, this group was excluded

from the present study as they did not represent the average patient seeking orthodontic treatment, and are usually limited to hospital-based management. In general, unilateral dental agenesis is more common than bilateral occurrence; however, certain teeth have a higher predilection for bilateral agenesis.¹⁴ Several earlier studies reported symmetrical hypodontia.¹⁸⁻²⁰ In the present study, bilateral hypodontia was observed in 35 patients (54.7%) and the most commonly bilaterally missing teeth were the maxillary lateral incisors (20%) and mandibular central incisors (20%). The mandibular lateral incisor was the most frequent unilaterally missing tooth (23.4%), followed by the maxillary canine (17%), maxillary lateral incisors and mandibular second premolars (14.9%).

The most commonly missing teeth were the mandibular and maxillary lateral incisors (17.9%), which is similar to findings of a previous study that examined Malaysian schoolchildren.^{7,21} This was followed by mandibular second premolars and maxillary second premolars. According to Butler's field theory, the most distal tooth in each tooth group is the least stable and therefore more likely to be congenitally missing. An exception is the lower anterior region where mandibular central incisors are more commonly missing.²² Although the present study found a high frequency of missing mandibular central incisors (13.7%), the agenesis of mandibular lateral incisors had greater incidence. Interestingly, the agenesis of maxillary canines was 1.23%, a higher prevalence than studies previously reported in Malaysia (0.13% – 1%).^{7,8} The prevalence of missing maxillary canines among other populations ranged from 0.01% to 2.10%.^{23,24} The prevalence of missing mandibular canines was 0.37% in the present study, which was much lower than for the maxillary canine and similar to other reports.^{23,25}

When comparing the pattern of hypodontia between different ethnicities, the present study found that the mandibular second premolars were the most commonly missing teeth within the Indian population, which is similar to Caucasian populations.⁵ Studies conducted in India have also reported mandibular second premolars as the most commonly affected teeth.²⁶ However, mandibular incisors were the most commonly missing teeth among the Malay and Chinese ethnic groups, with agenic mandibular central incisors more common in Malay and mandibular lateral incisors more commonly

absent among the Chinese.^{5,19} There is evidence that indicates that mandibular incisor agenesis is more prevalent in an Asian population.^{19,27} In the present study, the incidence of missing mandibular incisors was 31.6%, which is close to the reported range of 32.1% and 48.5% and supporting the high frequency of missing mandibular incisors in this population.^{7,28} The major racial groups of the world are broadly classified as Caucasoids, Mongoloids, Negroids, and Australoids. In Malaysia, both the Malay and Chinese fall into the Mongoloid group, whereas Indians fall under a subgroup of the Caucasoids. These inherited racial characteristics might explain the present findings regarding the trend of missing teeth within this multiracial population.²⁹

A limitation of this study was the collection of data from a single centre. Future studies should aim for a multi-centre approach to improve representation of the Malaysian population. Although the data were limited to orthodontic patients, the study offers useful information to provide better planning of healthcare resources related to tooth agenesis, which usually requires complex multidisciplinary management. An additional limitation of the retrospective nature of this study is the inability of the subjects to recall previous dental experiences (extractions or trauma), especially if those experiences occurred at an earlier age or were managed at another dental clinic.

Conclusion

The prevalence of hypodontia (7.9%) was found to be higher than previous reports in Malaysia and Asian countries, but still fell within the average range for globally reported hypodontia prevalence among orthodontic and non-orthodontic patients. The prevalence of hypodontia was 8.3% for Chinese, 7.9% for Malay and 6.3% for the Indian populations. The most common missing teeth were the mandibular and maxillary lateral incisors.

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Conflict of interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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