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SYSTEMATIC REVIEW

Diagnostic tools used to predict the prevalence of supernumerary teeth: a meta-analysis

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Objectives: This study sought to (i) determine the variations in prevalence figures based on the diagnostic tools employed, and (ii) provide an insight into the prevalence of supernumerary teeth.
Methods: A comprehensive literature search of the prevalence reports on supernumerary teeth was conducted using two databases. Two independent observers rated these articles according to exclusion and inclusion criteria. 28 papers were included in the analysis to determine the variations in the prevalence figures in relation to the method of diagnosis, and 14 studies were included to estimate the prevalence figures for supernumerary teeth. Statistical analysis was computed using analysis of variance (ANOVA), Student Neumann–Keuls (SNK) test and multiple regression analysis.
Results: Statistically significant differences were evident in the prevalence figures based only on a clinical examination compared with groups that also employed radiographs ($p < 0.05$, ANOVA, SNK). The prevalence figures for supernumerary teeth ranged from 0% to 3%. The mean prevalence value for the European white population [1.6% ($\pm$0.6)] was lower than that of the southern Chinese population [2.7% ($\pm$0.14)]. The overall prevalence of supernumerary teeth for males was significantly higher than for females [relative risk = 1.37 (1.13–1.50)].
Conclusions: Clinical examination plus some types of radiograph(s) are essential for determining the prevalence of supernumerary teeth; nevertheless, it is still underestimated. Several disparities in the prevalence reports make the available data on supernumerary teeth questionable.
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Keywords: supernumerary teeth; prevalence; radiographs

Introduction

Various terminologies, such as supernumerary teeth, hyperdontia, polyphodontism,[1] third dentition,[2] super-dentition,[2] duplicate teeth,[3] supplemental,[4] aberrant,[5] conoidal[6] and hyperodontia,[7] have been used to describe teeth that are additional to the normal complement of 20 primary and 32 permanent teeth. The reported prevalence figures range from 0%[8] to 3.8%.[9] Most often, small sample size, different ethnicity of the population studied and the different methodologies employed are cited as the reasons for the disparities in the prevalence figures, thus inhibiting the possibility of drawing valid conclusions.

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Different diagnostic tools have been used in various epidemiological surveys and clinical reports for the identification of supernumerary teeth. Anecdotally, some authors opine that clinical examination alone is sufficient for the identification of supernumerary teeth,[10–12] especially for those occurring in the primary dentition, whereas others claim that radiographs are critical for their identification[13,14] because the majority of the supernumerary teeth are inverted and remain unerupted. Although the latter appears logical based on the available data describing the characteristics of supernumerary teeth,[15] even today there is no consensus on the best diagnostic tool that facilitates the accurate identification of supernumerary teeth.

Therefore, the objectives of the present study were to (i) determine the variations in the prevalence figures

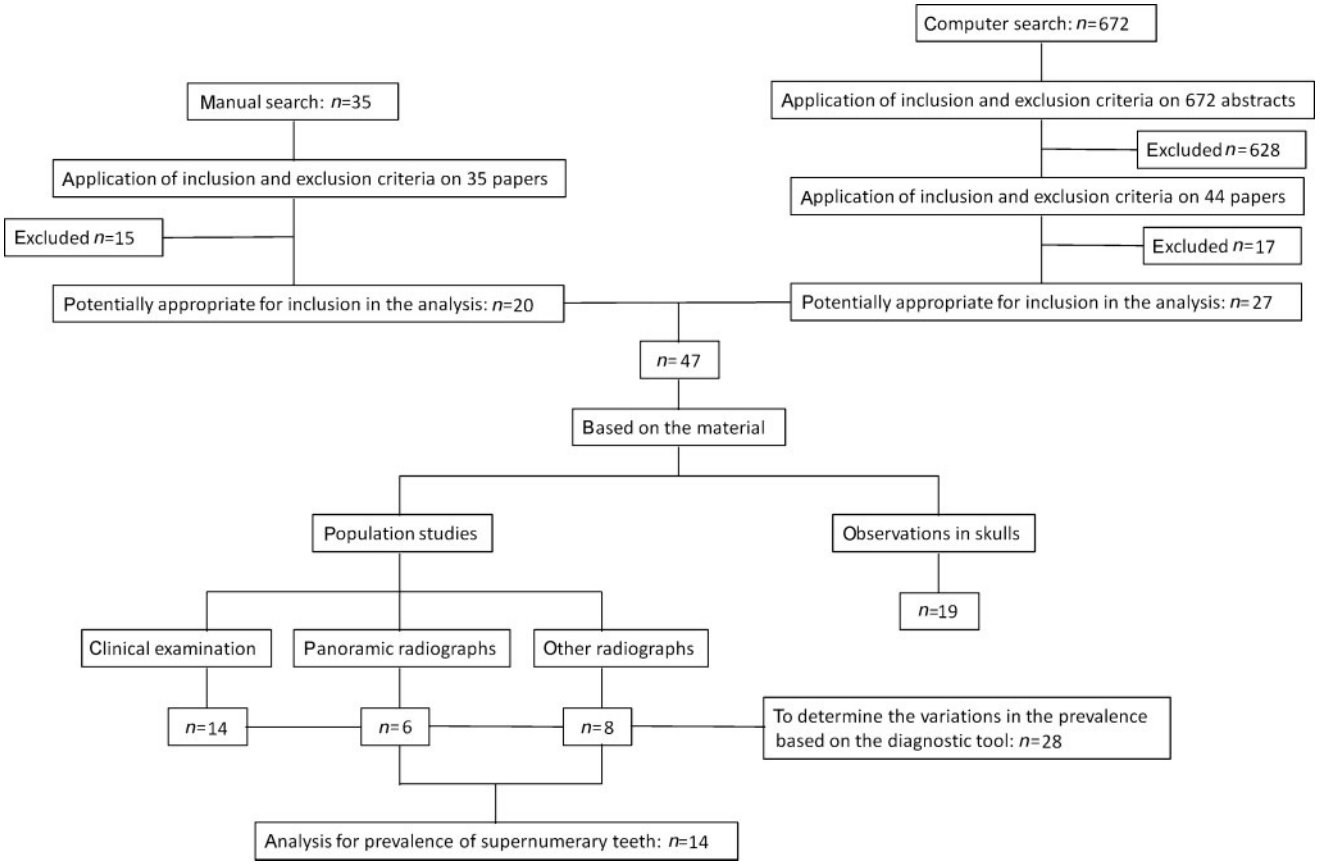

Figure 1 Flow diagram illustrating the literature search protocol

based on the diagnostic tools employed, and (ii) provide an insight in the prevalence of supernumerary teeth, using the method of meta-analysis.

Methods

In May 2011, a comprehensive literature search of the prevalence reports on supernumerary teeth catalogued in the PubMed and EMBASE databases was performed using the following MeSH terms: ''supernumerary teeth'' OR ''hyperdontia'' OR ''supplemental'' AND ''prevalence'' OR ''incidence''. This initial search resulted in 712 articles and when limited to humans, English language and from January 1966 to April 2011, it resulted in 672 citations. The citation lists from the included references were subsequently examined in an attempt to identify additional studies and a hand search was done to find letters to the editor and opinion letters in the journals.

Two independent observers rated these articles according to the following inclusion criteria:

- presence of an English abstract
- sample is representative of the underlying general population
- reports provide information on the ethnic background
- reports mentioned the diagnostic tool employed.

Studies limited to orthodontic patient groups, or patients with craniofacial syndromes or developmental disorders, isolated populations that were considered as non-representative, reports with insufficient data analysis, second reports on the same population and reports that had insufficient information on the diagnostic tool employed were excluded.

One-way analysis of variance (ANOVA) and Student Neumann–Keuls test were employed to determine the variations in the prevalence figures based on the method of diagnosis. Multiple regression analysis was used to evaluate the influence of sample size on the reported prevalence, country and year of publication. The paired *t*-test to was used to determine the differences in the prevalence figures based on gender, with $p < 0.05$ considered to be statistically significant.

Results

Literature search

Figure 1 presents the literature retrieved. The searches of the databases yielded 672 citations and abstracts (PubMed, 405; EMBASE, 267). From these citations and abstracts, 44 publications were deemed to meet the

Table 1 Prevalence studies based on a representative sample used for the identification of supernumerary teeth

Diagnostic tool/ year	*Author*	*Country*	*Ethnicity*	*Age (years)*	*Sample size* (n)	*Males* (n)	*Females* (n)	*Prevalence (%)*
Clinical examination								
1950	Birdsell[16]	Australia	Australian aborigines	–	900	–	–	0.9
1956	Gardiner[17]	UK	European white	5–15	1000	–	–	0.5
1966	Sweeney and Guzman[18]	USA	American Indian	4–14	535	–	–	1.9
1967	Curzon and Curzon[19]	USA	American white	3–9	1128	–	–	0.7
			American Indian		181	–	–	2.7
1974	Ingervall[8]	Sweden	European white	17–21	301	301	–	0
1984	Magnusson[20]	Iceland	European white	0–83 m	572	314	258	0.5
1993	Jones et al[21]	USA	African American	3–4	493	261	232	0.2
1995[a]	Lukacs[22]	USA	Indian	–	1743	964	779	0.5
1997	Yonezu et al[23]	Japan	Japanese	3	2733	1413	1320	0.07
1998	Carvalho et al[24]	Belgium	European white	3–5	750	386	364	0.8
2000	Miyoshi et al[11]	Japan	Japanese	3–6	8122	4102	4020	0.05
2006	Onyeaso and Onyeaso[25]	Nigeria	Nigerian	11–12	361	171	190	1.4
2007	Paula et al[26]	Brazil	Brazil	2–5	1755	919	836	0.3
2008	Kramer et al[12]	Brazil	White	2–5	1013	–	–	0.1
			Non-white		247			1.2
Panoramic radiographs								
1971	Haavikko[27]	Finland	European white	5–9	619	314	305	1.6
1977	Bergstrom[28]	Sweden	European white	8–9	2589	1314	1275	1.5
1980	Locht[14]	Denmark	European white	9–10	704	375	329	1.7
1994	Bruce et al[29]	USA	African American	3–17	2267	1136	1131	1.5
1997	Peltola et al[30]	Estonia	European white	14–17	392	128	264	3
2010	King et al[31]	Hong Kong	Southern Chinese	12	725	358	367	2.6
Other radiographs								
1939[b]	Pedersen[32]	Denmark	East Greenland Inuit	>7	702	–	–	1.3
1973	Thilander and Myrberg[33]	Sweden	European white	7–13	5459	2664	2795	1.1
1974	Brook[13]	UK	European white	3–5	741	–	–	0.8
				11–14	1115	572	543	2.1
1976	Jarvinen[34]	Finland	European white	7–7.9	604	314	290	1.7
1984	Hurlen and Humerfelt[35]	Norway	European white	6–12	2043	1041	1002	1.2
1986	Castillo Kaler[36]	USA	Hispanic	–	567	–	–	2.6
			African American		54	–	–	1.9
2001	Bäckman and Wahlin[37]	Sweden	European white	7	739	368	371	1.9
2010	King et al[38]	Hong Kong	Southern Chinese	5	936	493	443	2.8

[a]Based on study models.
[b]Radiographs were not available for all cases.

inclusion criteria. The references lists of these yielded an additional 35 papers. The evaluation of the whole text of the 79 papers resulted in 47 papers appropriate for analysis. Of these, 28 papers[8,11–38] were included in the analysis to determine the variations in the prevalence figures based on the diagnostic methods (Table 1). Furthermore, the other 19 papers[7,32,39–54] based on the observation of skulls (Table 2) were excluded for further analysis and so were 32 other studies[3,9,32,55–83] as the ethnicity of the sample was not presented. Two reports[31,69] investigated the same population, so only the final study[31] was included. The interobserver agreement was found to be excellent with a score of $\kappa = 1.00$.

Interpretation of data

The mean prevalence reported in the studies that used clinical examinations, panoramic radiographs and other radiographs for identifying supernumerary teeth were 0.6%, 1.9%, and 1.7%, respectively. The prevalence based only on a clinical examination compared with the groups that also employed radiography was statistically different ($p < 0.05$, ANOVA, Student Neumann–Keuls test). No differences were evident between the prevalence figures reported in the studies that used either panoramic radiography or other radiographic methods. The prevalence figures of supernumerary teeth based on the 14 studies that used radiography ranged from 0.8% to 3% (Table 1). Higher prevalence figures were found in the studies published in the period 1997–2010 than in studies published in 1939–1996. The mean prevalence of the European white population ($1.6\% \pm 0.6\%$) was lower than that of the southern Chinese population ($2.7\% \pm 0.14\%$) ($p < 0.05$).

The overall prevalence of supernumerary teeth in males was significantly higher than in females [relative risk (RR) = 1.37 (1.13–1.50)] (Table 3). The RR for

Table 2 Prevalence studies of supernumerary teeth based on observations of skulls

Year	*Author*	*Country*	*Material*	*Sample size* (n)	*Prevalencex (%)*
Visual examination					
1925	Campbell[39]	Australia	Australian aborigines	600	1.5
1925	Leigh[40]	USA	American Indian tribes		
			Sioux	92	1.1
			Arikar	129	3.1
			Havikuh Zuni	113	1.8
		USA	American Inuit	325	2.2
1937	Leigh[41]	USA	Pre-Spanish Peruvians	900	0.6
1938	Nelsen[42]		Pecos Pueblo Indians	172	0.6
1939	Pedersen and Hinch[32]	Denmark	East Greenland Inuit	513	1.1
1943	Rabkin[43]	USA	American Indian (Indian Knoll, prehistoric)	300	0
1948	Goldstein[44]	USA	American Indian	177	2.2
1950	Sinclair et al[45]	Papua New Guinea	New Guinea	209	0.9
1953	Reed[46]	USA	Am Te'ewi Indians	40	5.0
1956	Klatsky[47]	USA	Mix	8328	0.5
1956	Davies[48]	New Zealand	Pukapuka	472	2.1
1960	Snyder[7]	USA	American Indian (Point of Pines)	350	
1964	Pal[49]	India	Indian	347	2.0
1968	De Villers[50]	South Africa	Black	650	1.8
Visual and radiographic examination					
1984	Hurlen and Humerfelt[51]	Norway	Oslo medieval	942	1.7
			Lapp	439	1.4
1989	Stermer Beyer-Oslen[52]	Norway	Trondheim	140	1.4
1999	Rao[53]	Zimbabwe	Zimbabwean black	153	1.3
2009	Van der Merwe and Steyn[54]	South Africa	Gladstone	89	6.7

southern Chinese was 1.35 (0.8–1.84) and 1.23 (0.15–2.10) for the European white population groups. Furthermore, the size of the investigated sample did not seem to affect the reported prevalence ($p = 0.07$).

Discussion

The diagnostic criteria for dental anomalies of number, shape and size suggests that factors such as ethnic background, gender, age, sampling technique, dental history and full-mouth radiographic coverage are essential variables that should be considered and reported upon in epidemiological surveys.[84] Therefore, only studies that presented data on the above-mentioned factors were included in the analysis of the present study. Furthermore, vast disparities, such as insufficient data analysis, inadequate information about the subjects (craniofacial syndromes or developmental disorders), loss of skull materials on exhuming and use of limited diagnostic tools were evident in the studies based on observations in skulls and hence excluded from the final analysis.

Although age is an important factor while evaluating the prevalence figures of developmental dental disorders, it was considered inappropriate for supernumerary teeth as there is no specified time or age when supernumerary teeth begin to develop. They can occur either in the primary, mixed or permanent dentitions in any region of the dental arch. The onset of mineralization depends on the tooth type, and wide variation exists among subjects of the same chronological age. Tooth buds with a late onset of mineralization could give a false-negative diagnosis of supernumerary teeth on radiographs so may be an inappropriate diagnostic tool. The mere absence of supernumerary teeth at a particular age does not imply that the subject will not have a supernumerary tooth at a later date. It only indicates that at the time of examination there is no evidence of any supernumerary teeth germs. Subsequently, the subject may develop supernumerary teeth at a later stage or, in most instances, may not develop any supernumerary teeth.

While conducting this systematic review, it was surprising to note the high number of papers that were excluded. The study by Niswander and Sujaku,[9] which is frequently cited in the literature and which reported a prevalence value of 3.8% in Japanese subjects, was excluded from the analysis because the authors themselves clearly stated "…that we are not dealing with a representative sample of Japanese children…". Similarly, the study conducted by Huang et al[10] in a Taiwanese population, which reported a prevalence value of 7.8%, was excluded because the sample did not represent the general population.

Family and dental histories of the involved subjects are critical factors that can influence prevalence values, but they were not mentioned in most of the reports that were included in the analysis. Nevertheless, one can appreciate that reliable information on the medical and dental histories cannot be easily obtained during a survey and, if obtained, is all too often unreliable, especially from schoolchildren, owing to their young age and insufficient knowledge about their family's medical and dental conditions.

The present meta-analysis on supernumerary teeth presented particular challenges because of differences in the designs of the studies. Lack of a standard classification for supernumerary teeth, use of various

Table 3 Prevalence studies that were used to estimate the relative risk (RR) based on the gender

				Affected		
Year	*Author*	*Males* (n)	*Females* (n)	*Males* (n)	*Females* (n)	*RR (95% CI)*
1971	Haavikko[27]	314	305	7	3	1.3 (0.92–2.10)
1977	Bergstrom[28]	1314	1275	27	11	1.4 (1.15–1.73)
1974	Brook[13]	572	543	14	9	1.1 (0.85–1.66)
1976	Järvinen[34]	314	290	5	5	0.9 (0.51–1.80)
1985	Hurlen and Humerfelt[35]	1041	1002	16	9	1.2 (0.94–1.70)
1994	Bruce et al[29]	1136	1131	24	10	1.4 (1.14–1.77)
2001	Bäckman and Wahlin[37]	368	371	3	11	0.4 (0.16–1.16)
2010	King et al[31]	358	367	11	8	1.1 (0.80–1.74)
2010	King et al[38]	493	443	20	6	1.4 (1.19–1.84)

CI, confidence interval.

definitions and terminologies, ill-defined age groups, inconsistencies in the reporting of the findings and failure to report the examiner's level of training are among the variables that ultimately make the available data on supernumerary teeth questionable. Furthermore, several studies included in the meta-analysis often did not provide any information on the prevalence of affected patients, the site of supernumerary teeth, the average number of supernumerary teeth per patient and whether or not they were unilateral or bilateral. Therefore, it was impossible to gather the relevant information for this study, and this serves to highlight the disparities that exist in the published studies related to supernumerary teeth.

The present study clearly demonstrates the variations in the reported prevalence figures based on the diagnostic tool employed for the identification of supernumerary teeth. Based on these data, it appears that radiographic examination is essential for the identification of supernumerary teeth; however, the radiographic type used does not appear to influence the quality of the final figures. This implies that selection of an appropriate tool for diagnosis is a critical factor for reporting the prevalence of supernumerary teeth.

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