ACTA ODONTOLOGICA SCANDINAVICA
2022, VOL. 80, NO. 3, 203–209
https://doi.org/10.1080/00016357.2021.1985167

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ORIGINAL ARTICLE

Is the third molar erupting at a younger age than before?

Eveliina Tuovinen[a], Marja Ekholm[b,c] and Irja Ventä[a]

[a]Department of Oral and Maxillofacial Diseases, University of Helsinki, Helsinki, Finland; [b]Institute of Dentistry, University of Turku, Turku, Finland; [c]South West Finland Imaging Centre, Turku University Hospital, Turku, Finland

ABSTRACT

Objectives: The aim of this study was to update the much-cited knowledge, published over half a century ago, of the age of eruption of the third molar in the Finnish population.

Methods: The study followed a retrospective and cross-sectional protocol and included 710 digital panoramic radiographs of patients (49.3% men, 50.7% women) aged 15–23 years visiting the public oral health care services of the City of Helsinki in 2015. Age and sex of the subjects were recorded. The radiographs were examined for inclination of the third molars in both jaws and vertically located teeth were further classified into four stages of eruption: (A) in bone, (B) alveolar emergence, (C) gingival emergence, and (D) complete emergence. Statistics included chi-squared, Mann–Whitney *U*, and median tests.

Results: Of altogether 2502 third molars, 53.0% ($n = 1325$) were in vertical position. The median age of gingival emergence (stage C) of the third molar varied between 19.8 and 20.8 years, and the median age of reaching the occlusal level (stage D) between 20.8 and 21.8 years depending on sex and the jaw.

Conclusion: The median ages for the third molar to pierce the gum were lower than reported over half a century ago.

ARTICLE HISTORY
Received 16 April 2021
Revised 9 August 2021
Accepted 16 September 2021

KEYWORDS
Third molar; tooth eruption; panoramic radiography; young adult; adolescent

Introduction

It is common to refer to the study of Rantanen [1] published in 1967 when discussing the age of eruption of third molars [2–7]. Clinical examinations of the Finnish university students were carried out in 1949–1951, and the subjects aged 18–23 years were born in 1926–1931 [1]. Because seven decades have passed since the clinical examinations of that much-cited study, it would be useful to update the knowledge of the age of third molar eruption.

In the middle of the last century, median ages for the first cusp to emerge through the gingiva in men were 21.7 years for maxillary and 21.8 years for mandibular third molars [1]. The corresponding values in women were 23.3 and 23.0 years. Thus, the third molars erupted at an earlier age in men than in women. Significant differences in median eruption ages for the upper and lower jaws could not be detected in either sex [1].

An aspect to reconsider in third molar eruption is the possible impact of missing teeth in the dental arches. Among the 2218 subjects of Rantanen [1], 12.6% of the total number of first molars and 2.6% of second molars had been removed, and moreover, some subjects had full or partial dentures. Over the decades, the level of oral health among Finnish citizens has increased and full dentitions occur more frequently than before [8]. Full dentition and the lack of space for eruption are some of the reasons for third molars to impact or erupt only partially [2,7]. This leads to the idea of delayed eruption of third molars, and therefore, missing teeth were one of the interests of our study.

Current literature related to third molar development and eruption is mainly focussed on forensic age estimation and the effect of ethnicity. This has been a current issue also due to asylum seekers. A few of these studies measure the stage of eruption [4,5,9,10], but many focus on mineralization of the crown and roots [11–15]. In addition, third molars are infrequently included in mineralization studies [14]. Most recently, a fully automated system was proposed to classify a third molar into its developmental stage [16].

Related to variation in third molars, Olze *et al.* [4] presented that the median age of emergence through the gingiva in a German population aged 12–26 years was from 20.9 to 22.7 years in men and from 20.2 to 20.3 years in women. Kutesa *et al.* [10] studied the Ugandan population aged 10–20 years and found that the median age for gingival emergence was 17.0–17.5 years for men and 15.0–17.0 years for women. In a Turkish population aged 8–22 years, the mean age of gingival emergence ranged from 17.8 to 18.4 years and for complete emergence in the occlusal plane from 20.0 to 20.3 years [5].

The aim of this study was to reassess the knowledge of the timing of third molar eruption defined 70 years ago, and consequently, we examined the age of eruption of third

CONTACT Irja Ventä irja.venta@helsinki.fi Department of Oral and Maxillofacial Diseases, Faculty of Medicine, University of Helsinki, P.O. Box 41, Helsinki FI-00014, Finland

molars based on dental panoramic tomographs (DPTs) among Finnish subjects aged 15–23 years.

Materials and methods

A total of 900 digital DPTs obtained from Finnish subjects in 2015 were gathered for retrospective analysis. Subjects were selected randomly from the communal database of the Department of Social Services and Health Care of the City of Helsinki. The selection protocol included 100 subjects within every birth year between 1991 and 1999, and both sexes were equally represented in each age group. Originally, the DPTs had been taken for various dental indications at the communal dental healthcare.

The final study material consisted of a total of 710 DPTs. Reasons for exclusion were as follows: 1) an inaccessible DPT or one with inadequate image field of at least one-third molar ($n = 48$), 2) a subject with their full name being something other than Finn or Finn-Swede ($n = 138$), and 3) age at the time of radiography $\geq$24 years ($n = 4$). A three-digit identification number, sex, date of birth, and date of radiography were recorded for each subject. In addition, missing teeth other than third molars on the dental arches were recorded for older subjects ($n = 409$), born in 1991–1995, and thus, aged >19 years. The exact age for every subject at the time of their radiography was calculated afterwards and used in the analysis. When referring to age groups, the division was made as follows: e.g. group 15 included subjects aged 15.0 to 15.9 years.

The inclination was recorded from all third molars using the method of Hugoson and Kugelberg [17], where the longitudinal axis of a third molar was compared with the longitudinal axis of the adjacent second molar (Table 1). The category of 'transversal' was added for bucco-orally inclined teeth. The angulation was measured visually using a translucent sheet with drawn angles of 25 and 75 degrees to help with the estimation. Concerning the vertical third molars, the recorded information also contained the state of eruption classified into four stages by the method of Olze *et al.* [4] (Figure 1).

The DPTs were examined under optimal viewing conditions with Digora® for Windows 2.5 software (Soredex Dental Malaysia, Helsinki, Finland) adjusting brightness, contrast, and softness. All DPTs were interpreted by the first author (ET) trained and assisted by a senior oral radiologist (ME) and a senior oral surgeon (IV). Intraobserver reliability was assessed by reanalysing randomly chosen 71 DPTs (10%) after one month. Cohen's kappa test was performed to estimate the intraobserver agreement. Kappa values were from 0.741 to 0.973 for inclination and from 0.635 to 0.922 for state of eruption in vertical teeth ($p < 0.001$), and thus, the agreements were considered substantial or almost perfect.

First, the results were presented for subjects to describe the sample, and then, in the detailed analysis of the age of eruption, the observation unit was the third molar. Categorical differences in frequencies were tested using the Chi-squared test, differences in mean ages for eruption with the nonparametric Mann–Whitney *U* test for independent samples, and medians with the independent-samples median test. SPSS Statistics 27 software (IBM Corp., Armonk, NY, USA) was used for statistical analyses.

The study was approved by the Department of Social Services and Health Care of the City of Helsinki (HEL 2015-014148). Approval by an ethics committee and patients' informed consents were not required according to the national legislation since this is a retrospective, register-based study without any patient intervention.

Results

The mean age of the 710 subjects was 19.9 years (SD 2.4; median 20.0, range 15.1–23.9 years), and 49.3% were men and 50.7% women (Table 2).

Table 1. Methods for measuring the inclination and state of eruption of the third molar.

Study	Category	Definition
Hugoson and Kugelberg [17]	Vertical	0–25 degrees
	Mesioangular	26–75 degrees
	Distoangular	<0 degrees
	Horizontal	>75 degrees
	Transversal	Bucco-oral inclination
Olze et al. [4]	Stage A	In bone; occlusal surface of tooth covered with alveolar bone
	Stage B	Alveolar emergence; complete resorption of alveolar bone over occlusal surface of tooth
	Stage C	Gingival emergence; penetration of gingiva by at least one dental cusp
	Stage D	Complete emergence in occlusal plane

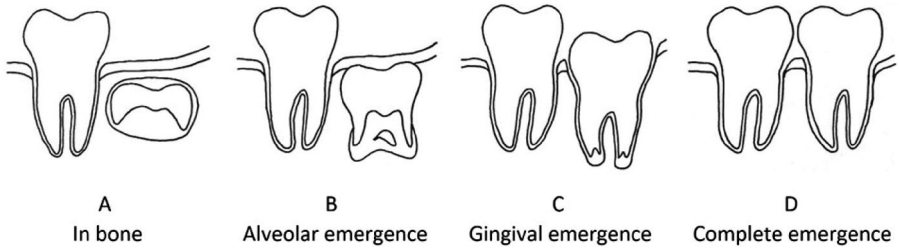

Figure 1. Stages of vertical third molar eruption, modified from Olze *et al.* [4].

The total number of third molars in the 710 DPTs was 2502 (a mean of 3.5 per subject), of which 49.8% was found in the maxilla and 50.2% in the mandible, and 49.2% in men and 50.8% in women. Slightly over half of the third molars (53.0%, $n = 1325$) were in vertical position (Table 3). Vertical teeth occurred more often in the mandible than in the maxilla (55.2% vs. 44.8%), while angular third molars dominated in the maxilla (55.6% vs. 44.4%; $\chi^2 = 29.137$; df = 1; $p < 0.001$). However, the angulation (classified as vertical and others) did not differ by sex ($\chi^2 = 1.242$; df = 1; $p = 0.265$), and therefore, men and women are combined in Table 3.

Among the 409 subjects aged >19 years and examined for missing teeth, a total of 115 permanent teeth (other than third molars) were missing without replacement by a deciduous tooth or implant in 58 subjects (33 men, 25 women). For the 721 vertical third molars in these 409 subjects, the median age of eruption did not differ whether a missing tooth was in the third molar quadrant or not (independent-samples median test; $p = 0.952$ for stage C and $p = 0.413$ for stage D). Thus, these subjects with missing permanent teeth were analysed together with other subjects.

Stages of eruption for the 1325 vertical teeth are presented in Table 4. The median age of gingival emergence (stage C) of the third molar varied between 19.8 and 20.8 years, and the median age of reaching the occlusal level (stage D) between 20.8 and 21.8 years depending on the sex and the jaw. According to the table, significant differences were detected between the jaws in stages A, B and D, indicating that mandibular third molars were more advanced in their eruption than maxillary ones. Analysis of differences between the sexes revealed a significant difference only in stage B (alveolar emergence), where the age of eruption was more advanced in men than in women ($p < 0.05$ in maxilla and $p < 0.001$ in mandible).

In Figures 2–5, the stages of eruption of vertical third molars ($n = 1325$) are visualized as smoothed curves separately for each sex and jaw. A clearly visible similarity for all figures is a descending curve for stage A (in bone) and an ascending curve for stage D (complete eruption). It is also evident that although these third molars were in vertical position, all of them did not reach stage D by the age of 23 years.

Table 2. Age and gender distribution of study subjects ($n = 710$).

Age (years)	Men *n* (%)	Women *n* (%)	Total *n* (%)
15	15 (40.5)	22 (59.5)	37 (5.2)
16	32 (47.8)	35 (52.2)	67 (9.5)
17	46 (50.5)	45 (49.5)	91 (12.8)
18	31 (54.4)	26 (45.6)	57 (8.0)
19	44 (43.6)	57 (56.4)	101 (14.2)
20	53 (53.5)	46 (46.5)	99 (13.9)
21	37 (43.0)	49 (57.0)	86 (12.1)
22	43 (53.8)	37 (46.2)	80 (11.3)
23	49 (53.3)	43 (46.7)	92 (13.0)
Total	350 (49.3)	360 (50.7)	710 (100)

Discussion

The study was conducted to update the age of eruption of the third molar in Finland, last presented by Rantanen [1] in 1967. We were most interested in stage C, i.e. emergence of the first cusp through the gingiva. Our main finding was that the median ages for eruption through the gingiva in both

Table 3. Distribution of vertical and angular third molars ($n = 2502$ teeth) according to the maxilla and the mandible by subjects' age.

	Vertical			Angular			Total *n* (%)
Age (years)	Maxilla *n* (%)	Mandible *n* (%)	Total *n* (%)	Maxilla *n* (%)	Mandible *n* (%)	Total *n* (%)	
15	39 (45.9)	46 (54.1)	85 (6.4)	27 (64.3)	15 (35.7)	42 (3.6)	127 (5.1)
16	65 (44.5)	81 (55.5)	146 (11.0)	57 (60.0)	38 (40.0)	95 (8.1)	241 (9.6)
17	81 (44.3)	102 (55.7)	183 (13.9)	87 (58.0)	63 (42.0)	150 (12.7)	333 (13.3)
18	49 (47.1)	55 (52.9)	104 (7.8)	56 (57.1)	42 (42.9)	98 (8.3)	202 (8.1)
19	82 (42.7)	110 (57.3)	192 (14.6)	103 (56.9)	78 (43.1)	181 (15.4)	373 (14.9)
20	70 (39.3)	108 (60.7)	178 (13.4)	96 (60.0)	64 (40.0)	160 (13.6)	338 (13.5)
21	59 (41.8)	82 (58.2)	141 (10.6)	90 (54.5)	75 (45.5)	165 (14.0)	306 (12.2)
22	74 (55.2)	60 (44.8)	134 (10.1)	66 (46.8)	75 (53.2)	141 (12.0)	275 (11.0)
23	74 (45.7)	88 (54.3)	162 (12.2)	72 (49.7)	73 (50.3)	145 (12.3)	307 (12.3)
Total	593 (44.8)	732 (55.2)	1325 (53.0)	654 (55.6)	523 (44.4)	1177 (47.0)	2502 (100)

Table 4. Comparison of ages (years) for eruption of vertical third molars ($n = 1325$) in maxilla and mandible according to sex and stage.

		Maxilla				Mandible				
Stage	Sex	*n*	Mean (SD)	Median	Min–max	*n*	Mean (SD)	Median	Min–max	*p* Value*
A	Male	45	18.0 (2.2)	17.3	15.7-23.4	35	16.7 (1.2)	16.4	15.3-20.9	0.002**
	Female	54	17.5 (2.0)	16.8	15.1-23.9	74	17.3 (1.7)	16.6	15.1-21.4	0.572
B	Male	141	19.1 (2.5)	19.0	15.3-23.8	81	18.4 (2.2)	17.8	15.3-23.6	0.038**
	Female	146	19.7 (2.3)	19.5	15.2-23.8	112	19.6 (2.3)	19.7	15.2-23.7	0.747
C	Male	36	20.3 (2.3)	20.8	16.3-23.6	65	19.7 (2.2)	19.8	15.5-23.9	0.147
	Female	55	20.6 (2.2)	20.8	15.9-23.8	94	20.3 (2.0)	20.2	15.8-23.9	0.248
D	Male	67	21.5 (1.8)	21.4	17.2-23.9	168	20.8 (2.1)	20.8	15.8-23.9	0.012**
	Female	49	21.5 (1.6)	21.8	17.0-23.9	103	20.7 (2.0)	20.8	16.3-23.9	0.021**
Total		593				732				

SD: standard deviation. *Mann–Whitney *U* test. **Statistically significant difference.
A = in bone, B = alveolar emergence, C = gingival emergence, and D = complete emergence.

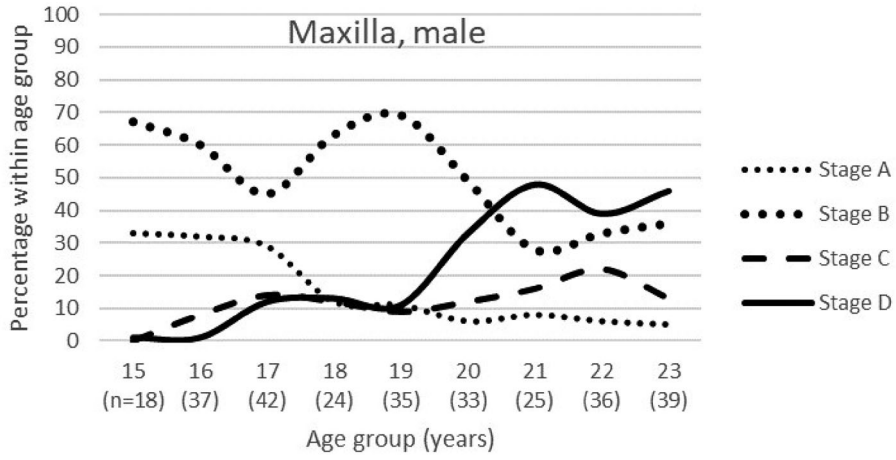

Figure 2. Eruption of maxillary third molars ($n = 289$) in men according to stages A to D by subjects' age. A = in bone, B = alveolar emergence, C = gingival emergence, D = complete emergence. Numbers in parenthesis indicate number of third molars in each age group.

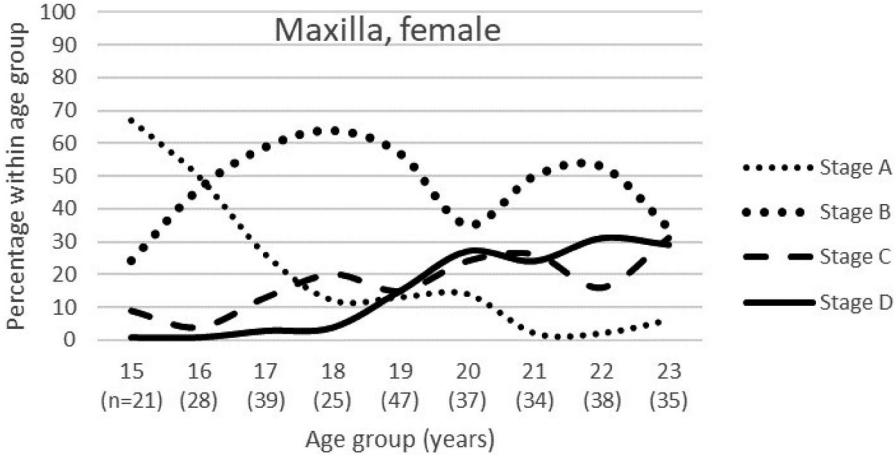

Figure 3. Eruption of maxillary third molars ($n = 304$) in women according to stages A to D by subjects' age. A = in bone, B = alveolar emergence, C = gingival emergence, D = complete emergence. Numbers in parenthesis indicate number of third molars in each age group.

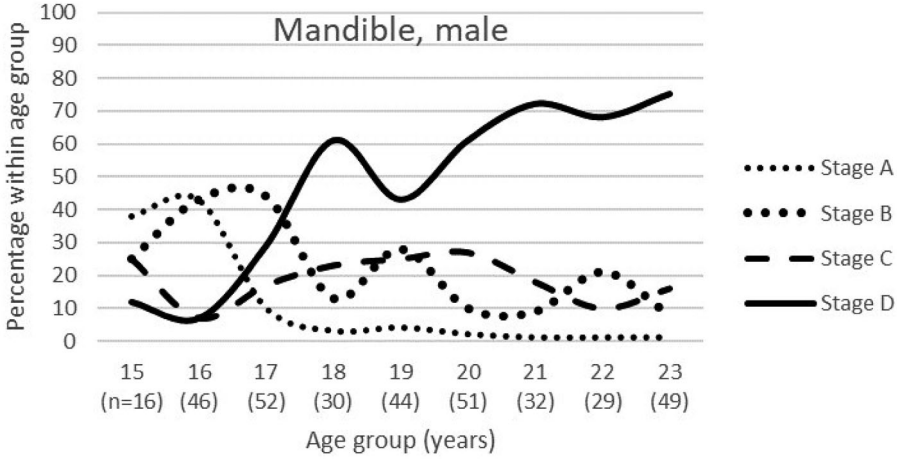

Figure 4. Eruption of mandibular third molars ($n = 349$) in men according to stages A to D by subjects' age. A = in bone, B = alveolar emergence, C = gingival emergence, D = complete emergence. Numbers in parenthesis indicate number of third molars in each age group.

sexes and jaws were between 19.8 and 20.8 years. A corresponding stage of eruption was available for comparison in Rantanen [1]; our median ages were a few years younger.

It is clear, that mean and median ages of eruption depend on the age range of the sample. In many studies, the age intervals are wide, often including 10 to 16 separate age groups [4,5,9,10], while we analysed nine of them. To explore the difference between our study and the earlier Finnish study [1], we analysed the same age interval, namely 18–23 years, instead of our 15–23 years. Subsequent calculations (not reported in the results) revealed that our median ages for gingival emergence ranged from 20.3 (Standard

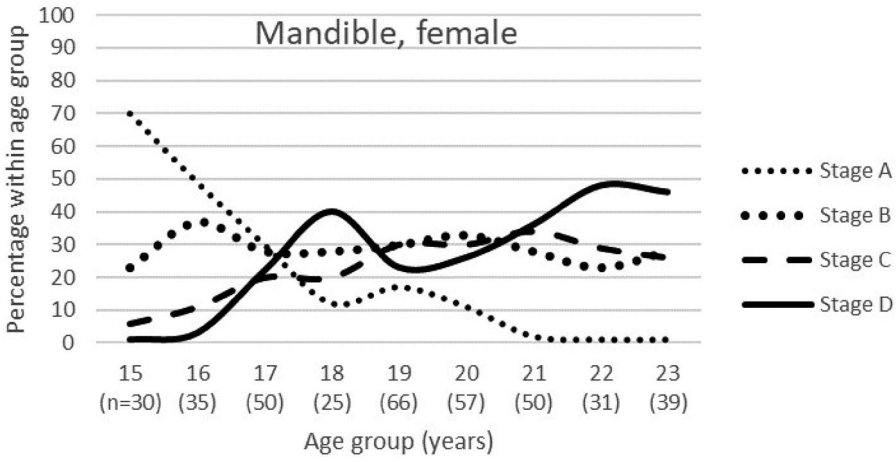

Figure 5. Eruption of mandibular third molars ($n = 383$) in women according to stages A to D by subjects' age. A = in bone, B = alveolar emergence, C = gingival emergence, D = complete emergence. Numbers in parenthesis indicate number of third molars in each age group.

error, SE 0.23) to 21.5 (SE 0.25) years (depending on the sex and the jaw) and were still lower than in the earlier study, where they varied between 21.7 (SE 0.17) and 23.3 (SE 0.41) years. This comparison implies that third molars erupt nowadays at a younger age than previously reported for our country.

Comparison of our results with earlier reports revealed differences between populations in third molar eruption; this finding is also reported in other studies [18,19]. Our median age for gingival emergence in men was 19.8–20.8 years, and the corresponding value in the earlier Finnish study [1] was slightly higher, 21.7–21.8 years. A higher median age than ours also appeared in the German male population, where it was 20.9–22.7 years [4]. The median ages of 17.0–17.5 years reported for the Ugandan male population [10] were lower than our median ages. The results from the Turkish [5] and Portuguese [9] populations are presented as mean ages and were in men 17.8–17.9 and 17.8–18.1 years, respectively, both lower than our mean values. Similarly, in women, our ages for gingival emergence were lower than in the earlier Finnish study, higher than in the Ugandan, Turkish, and Portuguese populations, and very close to those in the German study [1,4,5,9,10].

In a Chinese study, comparisons of the maxillary right third molar eruption were made between five ethnic groups: Chinese, Japanese, South African, German, and Canadian [6]. According to that study, and with our results inserted, South Africans had the earliest gingival emergence at stage C in men (median 20.5 years), followed by Finns (20.8 years), Chinese (21.0 years), Germans (21.3 years), Japanese (21.5 years), and Canadians (21.5 years). For females, that study reported the earliest emergence also for South Africans (median 19.2 years), followed by Canadians (19.7 years), Germans (20.2 years), Finns (20.8 years), Japanese (20.9 years), and Chinese (22.0 years). There was, however, great variation in the number of cases in these ethnic groups at stage C, varying from 6 to 133 cases.

In Finland, the patient records do not include data on patients' origin, and therefore, we conducted the exclusion of subjects by considering the origin of their full name. The inaccuracy of this method is evident, but with this procedure our aim was to make our material correlate better with the 1949 data of Rantanen [1]. However, the prevalence of persons of foreign background is low in Finland [20]. Finnish statistics indicate that in 1990 the prevalence of people with foreign background in Helsinki was as low as 2.0%, and certainly it was much lower in 1949. By contrast, in 2015, when the DPTs of this study were obtained, the prevalence had increased to 14.3% [20]. In the present study, 15% of subjects were excluded by ethnicity, which is about the prevalence of people with foreign background in Helsinki, indicating that the exclusion was reliable.

Contrary to our speculations about the possible impact of missing teeth in dental arches on the eruption of third molars, we did not find such an association. In orthodontic patients, extracted premolars increase the retromolar space, but do not change the angulation of the third molar [21]. Furthermore, in a distinguished study of causes of impaction [22], the space component did not emerge.

We did not find earlier studies on the change in timing of third molar eruption. However, permanent teeth other than third molars have been shown to erupt earlier than before. In Japan, advancement in the emergence of permanent teeth was observed from 1934 to 1980 [23]. In a French study, earlier emergence of permanent second molars were discovered in 2003 compared to a similar data collected in 1958 [24]. In Finnish children born around 2000 compared to children born around 1980, teeth erupted earlier in the first phase of mixed dentition [25]. In contrast to these results, in a British study the emergence data published in 1912, 1925, and 1976 were compared with the data from 1998–2001 leading to the conclusion that permanent teeth in the 1998–2001 sample emerged later than in the twentieth century [26]. Results from Uganda also show later emergence of permanent teeth in 2013 compared to data from 1971 [27]. Thus, all these studies discussed changes, either progress or regress, in eruption timing related to teeth other than third molars.

Several factors are reported to influence the emergence of permanent teeth, including genetics, gender, nutrition, preterm birth, socioeconomic factors, body height and weight, craniofacial morphology, hormonal factors, and various systemic diseases [28]. Of these factors, at least improved

socioeconomic status, better nutrition and the resultant weight gain have occurred in Finland over the past few decades [29,30]. In contrast, the subjects of the study of Rantanen [1] lived their childhood during the Great Depression in the 1930s followed by the Second World War. However, only a few studies on third molars and environmental or social factors affecting their eruption are published. Among Ugandan adolescents, overweigh but not socioeconomic status is shown to influence early eruption of the mandibular third molar [31]. According to a Portuguese study on subjects aged 6–27 years, higher socioeconomic status showed consistent advancement in the maturation of third molars in the late crown formation and early root formation stages [32]. Related to the first and second permanent molars, a nationally representative US study showed an association with obesity and earlier emergence of these teeth [33].

A few parts of the estimation of states of eruption in DPTs turned out to be challenging. As expected, the estimation between alveolar and gingival emergence of vertical teeth (stages B and C) was difficult in some cases because of poor visibility of soft tissues in DPTs. Despite the contrasting tools of the Digora software, the soft tissues were not always discernible. In such cases, the location of the gingiva was estimated to be 2–3 mm above the alveolar cortex based on Gargiulo *et al.* [34]. Secondly, maxillary third molars often tend to erupt buccally, which cannot be seen in DPTs. Thus, the gingival emergence in maxillary third molars likely occurs at an earlier age than the present results indicate. In these difficult cases, a clinical examination would have offered more accurate results, as was done in the study by Rantanen [1] in which the age of eruption for subjects $\geq$18 years was determined with clinical examination alone. The precise age for gingival emergence could be determined by using both clinical and radiographic examinations [19]. Thirdly, in a recent systematic review on agreement between Demirjian's [35] developmental stages of third molars and chronological age, a concern about sample sizes was raised [36]. According to the review, in most studies the material is biased because of unequal numbers of cases in each analysed stage. In our Figures 2–5, the number of third molars in each age group varied between 16 and 66. However, similar variation in sample size occurred in the study of Rantanen [1] as well as in several other studies using the method of Olze.

To get a better idea of the stages of eruption and the variations between age groups, we visualized the eruption curves in Figures 2–5. These kinds of figures are infrequently reported, and indeed, we did not find any other study illustrating the four stages. Some figures of development of third molars are presented in the earlier Finnish study and in a few mineralization studies [1,11,13,15,37]. Our curves indicate that in every age group during the observation year, up to 34% of vertical third molars were in stage C (with a cusp piercing the gingiva), and thus, prone to pericoronitis.

The clinical relevance of our results lies in patient counselling. Before surgery, the patient is informed about the risks and benefits of retaining or removing third molars and the usual course of life of these teeth, including timing of eruption. Clinicians treating young adults know that when the third molar pierces the gum to emerge in the oral cavity, the circumstances are favourable for pericoronitis. In our study, the median ages from gingival emergence to full eruption varied from 19.8 to 21.8 years, i.e. two years, and the minimum observed age for gingival emergence was 15.5 years. These findings may affect clinical decision-making to prevent pericoronitis.

Acknowledgements

The authors thank Tuomo Maisala, DDS, from the Department of Social Services and Health Care of the City of Helsinki for providing the list of subjects with panoramic radiographs.

Disclosure statement

The authors report no conflicts of interest.

Funding

The authors received no funding for the study.

ORCID

Eveliina Tuovinen http://orcid.org/0000-0002-2123-8443
Marja Ekholm http://orcid.org/0000-0002-7469-9729
Irja Ventä http://orcid.org/0000-0003-2753-8444

References

[1] Rantanen AV. The age of eruption of the third molar teeth: a clinical study based on Finnish university students. Acta Odontol Scand. 1967;25(Suppl 48):1–86.
[2] Andreasen JO, Kolsen Petersen J, Laskin DM. Textbook and color atlas of tooth impactions. Copenhagen: Munksgaard. 1997; p. 221–227.
[3] Olze A, Schmeling A, Taniguchi M, et al. Forensic age estimation in living subjects: the ethnic factor in wisdom tooth mineralization. Int J Legal Med. 2004;118(3):170–173.
[4] Olze A, Peschke C, Schulz R, et al. Studies of the chronological course of wisdom tooth eruption in a German population. J Forensic Leg Med. 2008;15(7):426–429.
[5] Karadayi B, Kaya A, Kolusayın MO, et al. Radiological age estimation: based on third molar mineralization and eruption in Turkish children and young adults. Int J Legal Med. 2012;126(6):933–942.
[6] Guo YC, Yan CX, Lin XW, et al. Studies of the chronological course of third molars eruption in a Northern chinese population. Arch Oral Biol. 2014;59(9):906–911.
[7] Viisaudenhammas. Käypä hoito -suositus [Third molar. Current Care Guideline]. Working group appointed by the Finnish Medical Society Duodecim and the Finnish Dental Society Apollonia. Helsinki, Finland: The Finnish Medical Society Duodecim, 2020. Mar 12 [cited 2021 Aug 9]. Finnish. Available from: www.kaypahoito.fi.
[8] Koskinen S, Lundqvist A, Ristiluoma N. editors. Terveys, toimintakyky ja hyvinvointi Suomessa 2011. [Health, functional capacity and welfare in Finland in 2011]. Helsinki, Finland: National Institute for Health and Welfare; 2012. p. 102–107 [cited 2021 Aug 9]. Finnish. (Report 68/2012). Available from: https://www.julkari.fi/bitstream/handle/10024/90832/Rap068_2012_netti.pdf.

[9] Caldas IM, Carneiro JL, Teixeira A, et al. Chronological course of third molar eruption in a Portuguese population. Int J Legal Med. 2012;126(1):107–112.
[10] Kutesa AM, Rwenyonyi CM, Mwesigwa CL, et al. Dental age estimation using radiographic assessment of third molar eruption among 10–20-year-old Ugandan population. J Forensic Dent Sci. 2019;11(1):16–21.
[11] Martin-de las Heras S, García-Fortea P, Ortega A, et al. Third molar development according to chronological age in populations from Spanish and Magrebian origin. Forensic Sci Int. 2008; 174(1):47–53.
[12] Chen JW, Guo J, Zhou J, et al. Assessment of dental maturity of Western Chinese children using Demirjian's method. Forensic Sci Int. 2010;197(1-3):119.e1–119.e4.
[13] Maia MC, Martins Mda G, Germano FA, et al. Demirjian's system for estimating the dental age of Northeastern Brazilian children. Forensic Sci Int. 2010;200(1–3):177.e1–4.
[14] Lewis JM, Senn DR. Dental age estimation utilizing third molar development: a review of principles, methods, and population studies used in the United States. Forensic Sci Int. 2010;201(1-3): 79–83.
[15] Zandi M, Shokri A, Malekzadeh H, et al. Evaluation of third molar development and its relation to chronological age: a panoramic radiographic study. Oral Maxillofac Surg. 2015;19(2):183–189.
[16] Banar N, Bertels J, Laurent F, et al. Towards fully automated third molar development staging in panoramic radiographs. Int J Legal Med. 2020;134(5):1831–1841.
[17] Hugoson A, Kugelberg CF. The prevalence of third molars in a swedish population. An epidemiological study. Community Dent Health. 1988;5:121–138.
[18] Olze A, van Niekerk P, Ishikawa T, et al. Comparative study on the effect of ethnicity on wisdom tooth eruption. Int J Legal Med. 2007;121(6):445–448.
[19] Shaweesh AI. Timing of clinical eruption of third molars in a jordanian population. Arch Oral Biol. 2016;72:157–163.
[20] Statistics Finland. Foreign citizens. Helsinki, Finland: 2019. [cited 2021 Aug 9]. Available from: www.tilastokeskus.fi/tup/maahanmuutto/maahanmuuttajat-vaestossa/ulkomaan-kansalaiset_en.html.
[21] Miclotte A, Grommen B, Cadenas de Llano PM, et al. The effect of first and second premolar extractions on third molars: a retrospective longitudinal study. J Dent. 2017;61:55–66.
[22] Carter K, Worthington S. Predictors of third molar impaction: a systematic review and Meta-analysis. J Dent Res. 2016;95(3): 267–276.
[23] Höffding J, Maeda M, Yamaguchi K, et al. Emergence of permanent teeth and onset of dental stages in Japanese children. Community Dent Oral Epidemiol. 1984;12(1):55–58.
[24] Rousset MM, Boualam N, Delfosse C, et al. Emergence of permanent teeth: secular trends and variance in a modern sample. J Dent Child. 2003;70:208–214.
[25] Eskeli R, Lösönen M, Ikävalko T, et al. Secular trends affect timing of emergence of permanent teeth. Angle Orthod. 2016;86(1): 53–58.
[26] Elmes A, Dykes E, Cookson MJ. A cross-sectional survey to determine the ages of emergence of permanent teeth of caucasian children of the colchester area of the UK. Br Dent J. 2010;209(6): E10.
[27] Kutesa A, Nkamba EM, Muwazi L, et al. Weight, height and eruption times of permanent teeth of children aged 4-15 years in Kampala, Uganda. BMC Oral Health. 2013;13:15.
[28] Almonaitiene R, Balciuniene I, Tutkuviene J. Factors influencing permanent teeth eruption. Part one – general factors. Stomatologija. 2010;12(3):67–72.
[29] Central Statistical Office. Statistical Yearbook of Finland 1951. Helsinki, Finland: 1952. [cited 2021 Aug 9]. Available from: https://www.doria.fi/bitstream/handle/10024/78743/xyti_stv_195100_1952_dig.pdf?sequence=1&isAllowed=y.
[30] National Institute for Health and Welfare. Statistical yearbook on social welfare and health care 2015. Tampere, Finland: 2016. [cited 2021 Aug 9]. Available from: http://urn.fi/URN:ISBN:978-952-302-569-1.
[31] Kutesa AM, Ndagire B, Nabaggala GS, et al. Socioeconomic and nutritional factors associated with age of eruption of third molar tooth among Ugandan adolescents. J Forensic Dent Sci. 2019; 11(1):22–27.
[32] Carneiro JL, Caldas IM, Afonso A, et al. Examining the socioeconomic effects on third molar maturation in a Portuguese sample of children, adolescents and young adults. Int J Legal Med. 2017; 131(1):235–242.
[33] Pahel BT, Vann WF, Jr Divaris K, et al. A contemporary examination of first and second permanent molar emergence. J Dent Res. 2017;96(10):1115–1121.
[34] Gargiulo AW, Wentz FM, Orban B. Dimensions and relations of the dentogingival junction in humans. J Periodontol. 1961;32(3): 261–267.
[35] Demirjian A, Goldstein H, Tanner JM. A new system of dental age assessment. Hum Biol. 1973;45:221–227.
[36] Rolseth V, Mosdol A, Dahlberg PS, et al. Age assessment by Demirjian's development stages of the third molar: a systematic review. Eur Radiol. 2019;29(5):2311–2321.
[37] Arge S, Wenzel A, Holmstrup P, et al. Transition analysis applied to third molar development in a Danish population. Forensic Sci Int. 2020;308:110145 [cited 2021 Aug 9]; Available from: http://dx.doi.org/10.1016/j.forsciint.2020.1101450379-0738