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The incidence and extraction causes of third molars among young adults in Poland

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ABSTRACT: Despite many years of observation, the issue of third molars is still open for discussion. Among human teeth, third molars vary the most in number and morphology, which results from genetic changes and environmental factors affecting the evolution of the human dentition. This research aims to study various aspects of third molars in the population of young Poles, such as the incidence, time of eruption and causes of extraction in men and women. The analyses consider the socio-economic status of the respondents, including the frequency of visits to the dentist. Eight hundred students, aged 19–25 (14.4% of men and 85.6% of women) of the universities located in Wroclaw, Poland, took part in an online questionnaire survey. The incidence of third molars was smaller in the women (32.4–34.9%) than in men (47.8–56.5%) ($p<0.001$). For both sexes, the most frequent causes of extraction were abnormal tooth position (29.6–54.5%) and orthodontic treatment (15.5–27.3%). Both incidence and causes of extraction were related for all the examined pairs of teeth (upper–lower teeth and right–left teeth). The men (17.94–18.49 year) and women (18.42–18.83 year) did not differ in the mean age of their third molars' eruption. The men visited the dentist less often than the women did ($p<0.001$). The study presents original research and confronts it with published results. Despite the limitations of an online survey, the results can contribute to more advanced research conducted on a larger scale. In particular, more detailed research is recommended for the Polish population, for which such studies are scarce.

KEY WORDS: third molar, tooth eruption, tooth extraction, dentition

Introduction

Despite many years of observation, the issue of third molars (wisdom teeth) is still open for discussion. Third molars erupt relatively late during ontogenesis, between the ages of 17 and 30 (Malinowski and Bożiłow 1997). Complete mineralization of these teeth takes place between the ages of 12 and 16 while roots are fully developed between the ages of 18 and 25. Several research groups have studied sexual dimorphism in the timing of third molars eruption, but results of their studies remain inconclusive (Engström et al. 1983; Daito et al. 1992; Bolanos et al. 2003). Among human teeth, these are the third molars, which vary the most in number and morphology. The rate of variation results from the genetic alterations

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and modulated effects of environmental factors, the changing lifestyle and living conditions that an individual has met over time (Scarel et al. 2000). It is estimated that, because of the evolution of teeth and their bone structure, in future people will have five teeth in each quadrant: one incisor, one canine, one premolar, and two molars (Pindborg 1970; Vastardis 2000; Biedziak 2004).

One of the most common dental developmental defects is tooth agenesis, in which teeth are missing due to a developmental failure. The main reasons for tooth agenesis are the developmental disorders of the ectoderm tissue, metabolic disorders, hormonal disorders, and the negative impact of the environment. Tooth agenesis is estimated to occur in about 20–24% of the Polish population, and it most often affects third molars (Machorowska-Pieniążek et al. 2010). Such a large incidence may be due to mutations in the *MSX1* and *MSX2* genes, which are responsible for the formation and development of teeth at the right time (Dyrkas et al. 2003). Because of these mutations, either tooth buds are not formed or, when they are, the tooth's shape and size are affected. In addition to the above causes of agenesis, the agenesis of third molars may be associated with changes in the *PAX9* gene (Jędryszek et al. 2009). Researchers study various theories of developmental disorders and discuss interesting changes in the skeletal system of people affected by hypodontia, such as shortening the jaw and mandible or changing the mandibular angle (Al-Ani et al. 2017).

The most common causes of extraction of third molars located in the mandible are the tooth's non-functionality, orthodontic treatment, infections, and pain (Osborn et al. 1985). Such information is lacking for third molars located in the jaw. Other researchers have also studied extraction causes, but they usually focused on all teeth, not only on third molar (Aida et al. 2006). Currently, third molars are the most often removed teeth, accounting for 90% of all tooth extractions (Szubert et al. 2007). More and more patients are deciding to have their third molars removed for various reasons, such as increased awareness, better hygiene, and the threat of serious consequences of not removing underdeveloped teeth (like infections, cysts, dental caries, and even cancer). Women have their third molars removed more often than men do, and mandibular third molars are more often removed than jaw third molars (Szubert et al. 2007).

The prophylactic removal of third molars is considered hazardous (Friedman 2007) and it is difficult to support or refute this procedure unambiguously (Costa et al. 2013; Normando 2015). The prediction of the biological condition of an erupted third molar with any degree of reliability is difficult to estimate. Literature review reveals that third molar extraction, as a surgical interference, may result in complications. Complication rates related to third molar may vary between 2.6 and 30.9%, and depends on various factors, including age, gender, tooth position and impact level, the surgeon's experience, smoking, oral hygiene, surgical technique and a few others (Chiapasco et al. 1993; Boloux et al. 2007; Normando 2015; Deliverska and Petkova 2016). Schwartz-Arad et al. (2017) revealed that overall prevalence of postsurgical complications was 17%. Contar et al. (2010) showed complications in 3.47% of cases. The complication risk increases in proportion to the surgical difficulty. Most common com-

plications after third molar surgery are pain, hemorrhage, dry socket, swelling, paresthesia of the lingual or inferior alveolar nerve, bleeding, and infection root tip fracture, alveolar osteitis, temporomandibular joint discomfort, and oroantral fistula (Deliverska and Petkova 2016; Salik et al. 2019).

No reliable studies, however, have been published about third molars in the Polish population that would deal with important aspects of the development of third molars—such as the time of eruption, causes of extraction, and incidence in men and women—in the context of the respondents' socio-economic status, including frequency of visits to the dentist. This research aims to fill this gap by conducting such a study for the population of young adults, represented by students of the universities located in Wroclaw, Poland.

Material and methods

A web-based questionnaire study was conducted in January–February 2017 among 800 students of all universities in Wroclaw, Poland, aged 19–25 (born in 1992–1998). All the data were kept anonymous. Men constituted 14.4% (N= 115) while women 85.6% (N= 685) of the respondents (Table 1). Only adult individuals were examined. Exclusion criteria from the study include malformation of the facial skeleton, defects as a result of some head and neck injuries or specific chronic diseases.

Teeth were analyzed according to their localization (upper and lower teeth, left and right side). The between incidence of third molars and (i) sex and (ii) frequency of visits to the dentist and the between causes of extraction of third molars and sex were tested using the χ-squared test.

Table 1. Respondent age distribution by year of birth

Year of birth	Males		Females		Total	
	n	%	n	%	n	%
1992	11	1.4	52	6.5	63	7.9
1993	18	2.2	72	9.0	90	11.2
1994	15	1.9	117	14.6	132	16.5
1995	36	4.5	169	21.1	205	25.6
1996	20	2.5	135	16.9	155	19.4
1997	14	1.8	133	16.6	147	18.4
1998	1	0.1	7	0.9	8	1.0
Total	115	14.4	685	85.6	800	100.0

The conditions of third molars were compared between men and women, which was done with the test for the difference between two proportions. The *t*-test was used to compare the mean ages of third molars' eruptions between men and women; this analysis was conducted independently for the upper and lower teeth as well as for the left and right sides. For all the analyzes, a $p<0.05$ significance level was used.

Results

Incidence of third molars

The incidences of third molars differed between men and women. Most men had these teeth well-positioned (47.8–56.5%, depending on a tooth). Less frequently (27.8–31.3%), their third molars did not erupt or were missing (agenesis). Abnormally positioned third molars were reported by 7.8–13.1% of the male respondents; 5.2–13.1% of the men had their third molars removed (Table 2).

For the men, third molars significantly co-occurred in the following pairs: upper right–upper left, lower right–lower left, upper right–lower right, and upper left–lower left. When one tooth was missing (either totally or from the tooth

Table 2. Third molars incidence in both sexes

Third molar	Well-positioned		Not erupted or missing		Abnormally positioned		Removed	
	n	%	n	%	n	%	n	%
Males								
Upper right	60	52.2	35	30.4	12	10.4	8	7.0
Lower right	55	47.8	36	31.3	9	7.8	15	13.1
Upper left	65	56.5	32	27.8	12	10.5	6	5.2
Lower left	56	48.7	35	30.4	15	13.1	9	7.8
Females								
Upper right	239	34.9	293	42.8	81	11.8	72	10.5
Lower right	228	33.3	303	44.2	67	9.8	87	12.7
Upper left	230	33.6	310	45.2	80	11.7	65	9.5
Lower left	222	32.4	301	43.9	82	12.0	80	11.7

socket), often the other tooth from the pair was in the same condition. This situation was most frequent for the right teeth ($\chi^2 = 70.65$, $p<0.001$) and lower teeth ($\chi^2 = 110.42$, $p< 0.001$). Similarly, when one tooth was well-positioned, the other of the pair was likely well-positioned too, most frequently for the lower teeth ($\chi^2 = 143.18$, $p< 0.001$). The corresponding χ^2 values and p-values were as follows:

1. Upper right and upper left teeth: $\chi^2 = 143.177$, $p< 0.001$,
2. Lower right and lower left teeth: $\chi^2 = 110.42$, $p< 0.001$,
3. Upper right and lower right teeth: $\chi^2 = 70.66$, $p<0.001$,
4. Upper left and bottom left teeth: $\chi^2 = 59.92$, $p<0.001$.

Unlike the men, many women had third molars either not erupted or missing (42.8–45.2%, depending on a tooth). Less often, the teeth were well-positioned (32.4–34.9%). Abnormally positioned teeth were reported by 9.8–12.0% of the female respondents; 9.5–12.7% of the women had their third molars removed (Table 2).

For the women, third molars co-occurred in the same pairs as for the men: upper right–upper left, lower right–lower left, upper right–lower right, and upper left–lower left. Again, when one tooth was missing, the other tooth from the pair was likely in the same condition. For a given pair, well-positioned teeth often co-occurred, especially for the upper teeth ($\chi^2 = 877.95$, $p<0.001$). The corresponding χ^2 values and p-values were as follows:

1. upper right and upper left teeth: $\chi^2 = 877.95$, $p<0.001$,
2. lower right and lower left teeth: $\chi^2 = 835.52$, $p<0.001$,
3. upper right and lower right teeth: $\chi^2 = 372.99$, $p< 0.001$,
4. upper left and bottom left teeth: $\chi^2 = 490.73$, $p<0.001$.

The men significantly more often than the women had third molars and had them well positioned. For females not erupted or missing third molars were more often observed than for males ($p<0.001$) (Table 3).

The men who rarely (once in 2–3 years and less often) visited the dentist usually had none of the third molars (i.e. the teeth were either invisible above the gum line or were completely missing from the tooth socket). Those who often (at least once a year) visited the dentist usually had all their third molars well

Table 3. Relationship between incidence of third molars and the sex of the respondents

Third molar	Males (%)	Females (%)	*p*-value
Not errupted or missing			
Upper right	30.4	42.8	0.0062
Lower right	31.3	44.2	0.0048
Upper left	27.8	45.2	0.0002
Lower left	30.4	43.9	0.0033
Well-positioned			
Upper right	52.2	34.9	0.0002
Lower right	47.8	33.3	0.0013
Upper left	56.5	33.6	<0.00001
Lower left	48.7	32.4	0.0003

positioned. The corresponding χ^2 values and *p*-values were as follows:

1. upper right tooth: $\chi^2 = 13.68$, $p=0.003$,
2. lower right tooth: $\chi^2 = 9.54$, $p=0.023$,
3. upper left tooth: $\chi^2 = 12.96$, $p=0.005$,
4. lower left tooth: $\chi^2 = 5.30$, $p=0.15$.

Like the men, the women who rarely visited the dentist usually had none of the third molars. Those who often visited the dentist usually had their third molars removed. The corresponding χ^2 values and *p*-values were as follows:

1. upper right tooth: $\chi^2 = 3.91$, $p=0.27$,
2. lower right tooth: $\chi^2 = 9.37$, $p=0.025$,
3. upper left tooth: $\chi^2 = 4.26$, $p=0.23$,
4. lower left tooth: $\chi^2 = 14.20$, $p=0.003$.

The analyses for the upper teeth were statistically non-significant.

Worth mentioning is that 60.9% of the men and 75.6% of the women declared to visit the dentist often (at least once a year) while 39.1% of the men and 24.4% of the women declared rare visits (once in 2–3 years and less often). Men visited the dentist significantly less often than women did ($\chi^2 = 11.00$, $p=0.0009$).

Only 38.3%–42.6% (depending on a tooth) of the men and 36.9%–39.7% of the women remembered when their third molars had erupted. Worth mentioning is that in both men and women the lower left tooth erupted the latest. Although the mean age of tooth eruption was greater for the women than for the men, the difference was according to the *t*-test- non-significant (Table 4).

Causes of extractions of third molars

For the men, the most frequent cause of removal of each third molar was its abnormal position (30.2–54.5%, depending on a tooth) while the second most frequent cause was orthodontic treatment (15.0–27.3%). Other causes (e.g., related to a disease process or a surgical procedure in the jaw or mandible) were reported by 9.1–15.5% of the male respondents. For

Table 4. The mean ages of third molars' eruptions between men and women

Third molar	Age of tooth eruption (years)			
	Males: Mean±SD	Females: Mean±SD	*t*	*p*-value
Upper right	17.94±4.42	18.52±4.70	−1.72	0.086
Lower right	18.09±3.93	18.42±4.17	−0.98	0.329
Upper left	18.27±4.65	18.81±4.91	−1.50	0.133
Lower left	18.49±3.60	18.83±3.80	−1.02	0.308

the women, the results were similar: the most frequent cause of removal of each third molar was its abnormal position (29.6–39.2%) followed by orthodontic treatment (19.8–25.2%). Other causes were reported by 14.8–19.8% of the female respondents (Table 5).

For each sex, the causes of removal of all the studied pairs of teeth (upper right–upper left, lower right–lower left, upper right–lower right, and upper left–lower left) were related. These causes occurred in mirror pairs and were as follows: orthodontic treatment, abnormal position, and other causes. The corresponding χ^2 values and p–values were as follows:

1. upper right and upper left teeth: $\chi^2 = 240.83$, $p<0.00001$,
2. lower right and lower left teeth: $\chi^2 = 252.001$, $p<0.001$,
3. upper right and lower right teeth: $\chi^2 = 173.95$, $p<0.001$, and
4. upper left and bottom left teeth: $\chi^2 = 180.002$, $p<0.001$.

Discussion

The large sample size of the research (N=800) ensures the high reliability of the results for the population studied, in contrast to previous research, which either used much smaller samples (Byahatti et al. 2011) or did not cover the Polish population (Carter and Worthington 2015).

Studying the Thai population, Punwutikorn et al. (1999) reported that in 83% of the cases the wisdom teeth were at least partly erupted while in the remaining 17% of the cases they did not erupt altogether. The study, however, dealt with the jaw teeth only. Studying the New Zealand population, Kruger et al. (2001) concluded that about 11–15% of people aged 20 had no wisdom teeth at all. Byahatti et al. (2011) found that 93.5% of the Libyans aged 17–26 had all third molars; 33% of them had completely erupted teeth while 66% had teeth in the different stag-

Table 5. Causes of extraction of third molars for males and females

Third molar	Abnormally positioned		Orthodontic treatment		Bad tooth condition (e.g. carries)		Disease process		Dental cysts		Other		Respondent does not know	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Males														
Upper right	4	30.2	3	23.2	0	–	1	7.9	0	–	2	15.5	3	23.2
Lower right	10	50.0	3	15.0	3	15.0	0	–	0	–	3	15.0	1	5.0
Upper left	6	54.5	3	27.3	0	–	0	–	0	–	1	9.1	1	9.1
Lower left	9	52.9	3	17.6	0	–	1	5.9	1	5.9	2	11.8	1	5.9
Females														
Upper right	40	39.2	20	19.8	10	9.8	2	1.9	1	0.9	16	15.7	13	12.7
Lower right	41	35.7	29	25.2	9	7.8	7	6.1	0	–	17	14.8	12	10.4
Upper left	27	29.6	20	22.0	11	12.1	2	2.2	0	–	18	19.8	13	14.3
Lower left	34	33.4	25	24.5	6	5.9	6	5.9	1	0.9	18	17.6	12	11.8

es of eruption. Daito et al. (1992) showed that 9.5% of Japanese men and 12.0% of women did not have any wisdom teeth. In the study of the Polish population, 20.9% of subjects with agenesis of third molars also did not have tooth buds of at least one other tooth, especially the lower second premolar (19.4%) and the upper second premolar (17.9%) (Machorowska-Pieniążek et al. 2010). Bolanos et al. (2003) showed that 7.8% of a sample of Spanish children and young adults were affected by a bilateral third molar agenesis. Various studies have confirmed that the congenital absence of tooth buds can be observed more frequently in women than in men and that it occurs more often in the jaw than in the mandible (Celikoglu et al. 2010; Carter and Worthington 2015). According to Almonaitiene et al. (2010), various factors influence the eruption of teeth, like genes, socio-economic factors, hormones, and the morphology of the facial part of the skull.

Because questionnaire studies enable one to collect only declarative information about the condition of respondents' teeth, agenesis had to be joined into one group with unerrupted teeth (in the gum). The men more often than the women had third molars erupted and well positioned. In both sexes, third molars co-occurred in the following pairs: upper right-upper left, lower right-lower left, upper right-lower right, and upper left-lower left. For the men, when one tooth was missing (i.e. the tooth that was either invisible above the gum line or was completely missing from the tooth socket), the other one from the pair was likely missing. When the tooth was present, the other was likely present too. Similar co-occurrence was observed for the women, but for missing teeth (understood as above) and well-positioned teeth.

In Yun-Hoa and Bong-Hae's (2013) study, men, more often than women, had at least one wisdom tooth. Caries was the most frequent pathological change. With age, especially over 30, the number of teeth affected by any disease decreased, the most likely reason being the extraction of sick and abnormally positioned teeth.

For both sexes, the number of third molars was related to the frequency of visits to the dentist. The men who rarely visited the dentist usually had none of the third molars (i.e. they were either invisible above the gum line or completely missing from the tooth socket). Those who often visited the dentist usually had third molars and the teeth were well-positioned. Also the women who rarely visited the dentist usually had none of the third molars, but those who often visited the dentist often usually had their third molars removed. The men and the women differed in the frequencies of visiting the dentist: 60.9% of the men and 75.6% of the women visited the dentist at least once a year, while 39.1% of the men and 24.4% of the women did that less often. This result confirms that women visit the dentist more often and have greater oral health awareness (Jamieson and Thomson 2002; Thomson et al. 2010).

This research also compared the eruption time of third molars in men and women. Daito et al. (1992) showed that third molars developed faster in girls than in boys (aged 7–17), as confirmed in the present research, while Engström et al. (1983) reported the opposite conclusions. Bolanos et al. (2003) found that age and sex did not affect the presence or absence of wisdom teeth.

For both men and women, abnormal position (30.2–54.5% for the men and 29.6–39.2% for the women) and orthodontic treatment (15.0–27.3% for the

men and 19.8–25.2% for the women) were the most frequent causes of removal of third molars. The other causes, such as those related to a disease or a surgical procedure in the jaw or mandible, were reported by 9.1–15.5% of the men and 14.8–19.8% of the women. According to Osborn et al. (1985), the most common cause of extraction of third molars was "non-functionality" of the tooth (32.9%) followed by orthodontic treatment (16.6%), infections (6.0%), and pain (2.1%). In Aida et al.'s (2006) study, the most frequent causes were dental caries with its consequences (43.3%) and periodontitis (including gingivitis) (41.8%); the study, however, dealt with all teeth, not just third molars. Aida's team reported also a set of "other" (unspecified) reasons, most often related to third molars. In the present study, third molars from the following pairs shared causes of extraction (mainly orthodontic treatment and abnormal position) for both men and women: upper right–upper left, lower right–lower left, upper right–lower right, and upper left–lower left. The results show that the extraction causes of wisdom teeth in the presented pairs are related. More detailed studies will help analyze these relationships in detail.

Conclusion

Considered analysis of the incidence of third molars is valuable, however, one should be aware of its limitation. The age range of the respondents is narrow, so we cannot be sure that it is only the spectrum for the group of young adults. Hence, we cannot be sure that in many cases third molars may still erupt in the future. Observations are also limited to the student environment, what in the context of socio-economic conditions mentioned here, may be crucial. Due to large differences in the numbers of males and females, one should be aware of potential possibility of fallacy in between sexes calculations. However, for female sample all results seem to be relevant. The problematic issue of this paper is the research method used in the work. As the research relay on the views and opinion of participants, the credibility of the results of the survey carried out were based on the assumption of a good memory as well as the good will of the participants of the survey. However, all questionnaire surveys are burdened with such an error. Additional matter is appropriate competence and medical knowledge of the participants. The fact that the tooth is not visible does not mean its absence in the maxilla or mandible. From a clinical point of view, the third molars impacted during development are particularly important. Such a condition may result in numerous complications, such as recurrent pericoronitis, caries, periodontitis, resorption of the second molars, cysts, and cancers (Santosh 2015).

The paper studies the incidence, age of eruption, and causes of extraction of third molars of students of the universities in Wroclaw, Poland. The research confirmed the results by other authors, but it also offered new insights into how third molar teeth are related in upper-lower and right-left pairs. Unlike similar studies, this one considered an important socio-economic factor, the frequency of visits to the dentist; these results open an area for further research. Third molars have been confirmed to be among the most diverse of human teeth.

Studying the evolution of human dentition is cumbersome and complex, but such evolutional research is crucial

if we want to predict the condition and number of human teeth in the future. Additional but more detailed studies are thus needed, especially for the Polish population, for which-compared to other countries-dentition research is relatively scarce. The analyzed sample – although taken among students of the Wroclaw universities – should well represent the population of young adults represented by students in Poland. Less likely, however, will they represent the whole population of young adults aged 19–25, for which a wide-scale study is needed. Despite the limitations of an online survey, the results can contribute to more advanced research conducted on a larger scale. In particular, more detailed research is recommended for the Polish population, for which such studies are scarce.

Authors' contributions

MS conceived the paper, collected data, performed statistical computations and drafted the manuscript. AT was project supervisor, drafted and translated the manuscript, co-edited the final version of the manuscript. All authors carefully read and accepted the final version of the manuscript.

Conflict of interest

With the submission of this manuscript the authors would like to undertake that the above mentioned manuscript is without any conflict of interest and has not been published elsewhere.

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