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TOOTH MORTALITY IN SWEDEN

A STATISTICAL SURVEY OF TOOTH LOSS IN THE SWEDISH POPULATION

by

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INTRODUCTION

Tooth loss may be caused by diseases of local as well as of systemic nature but is probably also influenced by less relevant factors such as finances, time, communications, and others. It can be reasoned that the social structure of a community has an impact on the indications for extractions. It seems, therefore, that in a survey of the mortality of teeth no general conclusions can be drawn without considering geographical aspects. In the courses of events which ultimately may lead to a complete demolition of the masticatory apparatus epidemiological studies provide means of collecting data that describe the history of dental and oral diseases in populations, and of assessing the relative importance of the factors involved in their etiology.

A knowledge of the relative importance of factors leading to the destruction of the human dentition will influence dental educa-

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TABLE I

Cumulative data for tooth mortality reported by Brekhus, Allen and Krogh

Author	Number of Patients	Number of Teeth	Caries	Periodontal Disease	Prosthetic Reasons	Other Reasons
Brekhus (1929)	2,723	13,909	52.8 %	32.9 %	—	14.3 %
Allen (1944)	353	1,424	48.8 %	40.7 %	2.8 %	7.7 %
Krogh (1958)	2,337	7,109	39.7 %	20.2 %	20.2 %	19.9 %

tion, public health agencies, and, above all, means of prevention of disease.

Dental disease as a cause of loss of human teeth, called "tooth mortality", has been studied by Brekhus (1929) and later by *Allen* (1944), *Krogh* (1958), and *Miller* (1958). All these investigations were performed in the U.S.A. (Table I).

Brekhus found that at the ages of about 40—45 periodontal disease superseded caries as the main cause of tooth loss, periodontal disease being slightly more active in males.

In the comprehensive review of *Krogh,* all diagnoses were established in private praxis by one person and were based on clinical and roentgenological findings. Caries exceeded periodontal disease as a cause of tooth mortality up to the ages 60—69. Males lost more teeth from periodontal disease than did females.

Miller did not analyze the different indications for extractions but instead gave the frequency for the different teeth in 82,316 extractions and 57,280 respectively, in two university studies. The extraction rate was notably higher in the molar regions than in other places.

Caries and periodontal disease as the foremost threat to dental health, have, of course, been confirmed by reports from many other areas. In Latin America, *Russel* (1963) concluded that "periodontal disease must be managed as well as dental caries if the typical adult is to retain a functional natural dentition through his middle and later years." These conclusions were based upon examination of 10,745 persons 5 to 80 years of age in four national areas.

Paffenbarger (1962) discussed the problem of saving teeth rather than to extract them. A compilation of available statistical data outlined in an interesting way that caries and periodontal

diseases combined were responsible for a total tooth mortality of 60 to 90 percent. The proper question was asked: "... what can research do to prevent this tooth loss, and where should the emphasis be placed?"

The cited authors have reported that caries is responsible for tooth loss in approximately 40—50 % of selected groups in the U.S.A. There is less agreement concerning periodontal disease, 20—40 % while other reasons include a major group, the prosthetic indication.

The need for more information on causes of tooth loss was recently emphasized by probability samples of 7,710 men and women in the U.S.A. (*Johnson, Kelly & Van Kirk,* 1965) in a nation-wide Health Examination Survey. It was estimated that 19.6 % of persons aged 25 to 74 years were edentulous. Distributed on age groups the accumulated effects of dental disease has led to "about 1 in every 100 persons 18—24 years of age was edentulous; by age 65—74 years nearly 1 in 2 had lost all of his teeth." The factor, missing teeth, in the DMF score shows a continuous loss of teeth through the ages. The periodontal index, PI, showed the prevalence of periodontal disease to rise from 1 in 10 for ages 18 to 24 to more than 5 in 10 for the oldest age groups.

The reviewed epidemiological studies have few counterparts in Europe, particularly if the objective has been to evaluate all factors related to indications for a removal of teeth. One important study ought to be reviewed, however, recently published by *Smedby* (1965) who studied 594 persons representatively selected in Sweden. In all, 24 % were edentulous above the age of 16 with a higher frequency among women than men. The impressive figure of 31 % having a complete upper or lower denture was obtained. Some teeth may fall out unnoticed by the dentist, as pointed out by *Waerhaug* (1965), which would lead to an underestimation of periodontal disease as a cause of tooth loss if only judged by the dentists' extractions.

The cited authors agree as to which causes are the main ones leading to permanent tooth mortality. Differences appear in the frequency of indications for extractions. Further studies in other geographical areas are therefore of interest and will eventually influence public health agencies, dental educations and the preventive measures.

The present investigation was carried out in order to:

study all causes of tooth loss in the Swedish population,

evaluate the indications for dental extractions in the permanent dentition during the life span, and to

record the rate and influence of extractions on the dentition.

METHOD

Recording of indications for extractions

The Swedish dental profession was engaged in this investigation 1959—1961 which was preceded by a pilot study. The dentist register of the Royal Medical Board was used. Every dentist was requested to record all patients requiring tooth extractions during a period of two weeks. A special form was to be filled in for every individual, giving equal emphasis to all indications without any other guidance than a printed instruction about the object of the investigation and practical hints. The dental assistant was separatly informed and asked to function as a reminder.

The study was controlled by mail and telephone between the investigator and the dentists. The distribution of dentists both geographically and timewise over the years was selected at random.

Every patient requiring one or several extractions was identified by

sex

age

number of permanent teeth

community (rural or urban)

geographical area (county)

type of service (private or social)

The reasons for extractions were recorded for every single tooth. The indications were listed as follows with subgroups:

1. Caries (painless lesion — pulpitis — gangrene — acute or chronic periapical osteitis — radicular cyst)
2. Periodontal disease [gingivitis — chronic periodontitis (firm or loose tooth) — acute marginal abscess]
3. Orthodontic indication (impacted tooth, 4 subgroups; erupted tooth, 7 subgroups)

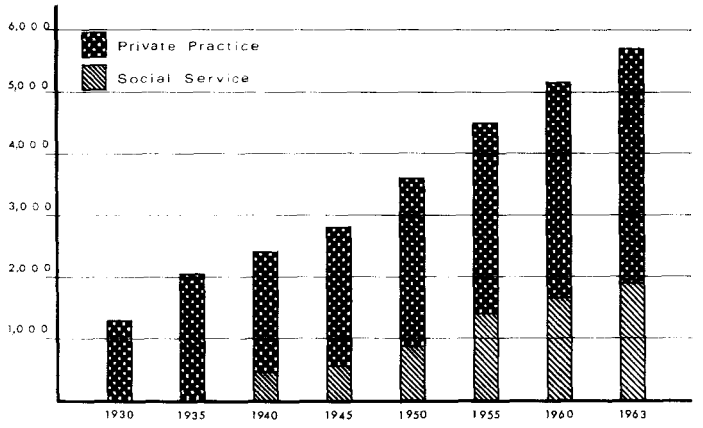

Fig. 1. Distribution of Swedish dentists on private practice and social service 1930—1963.

4. Impacted tooth (completely or partially)
5. Fracture (crown, root, alveolar process, alv. proc. and jaw)
6. Preprosthetic indication [preparation for partial denture (inconvenient position), preparation for complete denture (too few teeth left), other preprosthetic indications]
7. Radiotherapeutic indication
8. Cosmetic indication
9. Other indications

At the time of this investigation approx. 5,000 dentists in Sweden (1955: 4,500; 1960: 5,150; 1962: 5,190) were divided on social service (1/3) and private practice (2/3), Fig. 1. The participation is presented in Table II from which it can be seen that 4,568 dentists were contacted originally. 1,311 were not reporting and for that reason again contacted. 770 failed to cooperate, giving a percentage of 80.2 % reporting whether they had any extractions or not during the period. 2,692 or 58.7 % recorded actual extractions during their assigned examination period.

The resulting examination forms were returned to the principal investigator and were arranged geographically in 24 counties. The entire material was transferred to punch cards without control punching. The punch card recordings were in their turn

TABLE II

Number of dentists participating in the investigation

Examination periods	Number of contacted dentists	Participation Active (extractions performed)	Non-active	Total reporting dentists	Non-cooperating
1—12	4,568	2,422	835	3,257	1,311
Of the non-reporting 1,311 dentists 1,176 were once more contacted (135 could not be identified).					
13—16	1,176	270	136	406	770
All examination periods	4,568	2,692 (58.7 %)	971	3,663 (80.2 %)	770

transported to tape and automatically typed in a programmed computer. The results published here were produced in five different computer operations.

In the process of computing statistical data there is a phase open for errors. The transfer of original data to punch cards was performed manually. In order to analyze the reliability of the method, one county (Älvsborg) was selected. All data on the original examination forms comprising 770 patients were transferred to punch cards in two independent operations. The same operator did the work and a comparison was then performed between the two. Differences between the first and second transfer would, thus, give information about the order of errors. Table III shows that an average error of approximately two and a half percent was introduced. This error, which may be involved in several computer analyses, is not always appreciated. It can be highly diminished by a double check but costs involved limited this ambition.

MATERIAL

Sweden has a population of more than 6½ million people distributed in 24 counties. The population density in the southern-

TABLE III

Analysis of data processing errors in 770 patients
Two independent transfers to punch cards (1 and 2)

Factor	Number of Differences (1 and 2)	Percentage
Sex	6	0.78
Age	18	2.34
Number of teeth before extraction	23	2.99
Type of treatment, private or social	38	4.94
Rural — urban	3	0.39
Type of tooth	23	2.99
Indication for extraction	25	3.25

most county of Malmöhus is 124 inh./sq.km). Stockholm, Göteborg and Malmö represent the major cities with 1.5 million people.

The dentist: population ratio at the time of this investigation was 1 : 1,490 with a concentration in the three major cities of 1 : 880. There was a direct proportion between the number of patients undergoing extractions and the population for all counties except Stockholm and Malmöhus where an overrepresentation was prevalent (Table IV).

Most patients applied voluntarily for dental treatment and no screening or selection has been performed. Instead, every type of dental service, private, social, military, or hospital was included. Dental treatment of school children was included in the social service and extractions fall into that group.

Distribution of patients

The patients constituting the material in this study amounted to 17,595. They were distributed throughout the age groups 5—9 up to 80—89, the oldest patient being 86 years of age. The major proportion involves the ages 20—59 (Table V). For clarity the material was divided in five-year age groups up to 29 and ten-year groups thereafter.

Fig. 2 demonstrates the sex distribution to be almost identical, male and female. Approximately 1/4 emanated from urban districts compared with 3/4 from rural areas. A pronounced dip

TABLE IV

Distribution of patients requiring dental extractions in different counties.

County	No. of inhabitants	No. of patients				
		Urban districts	Rural districts	Private practice	Social service	Total
Malmöhus	606,540	1,534	501	1,348	687	2,035
Kristianstad	258,672	343	343	415	271	686
Blekinge	144,833	322	143	295	170	465
Kalmar	236,815	440	139	377	202	579
Kronobergs	159,291	155	199	297	57	354
Hallands	166,909	330	48	268	110	378
Gotlands	56,511	54	79	22	111	133
Jönköpings	280,514	464	183	425	222	647
Göteborgs o. Bohus	597,061	1,288	166	971	483	1,454
Älvsborgs	369,679	510	241	523	228	751
Skaraborgs	249,189	380	225	514	91	605
Östergötlands	356,598	651	142	553	240	793
Södermanlands	221,891	515	66	374	207	581
Stockholms	407,907	2,756		2,160	596	2,756
Västmanlands	226,216	495	111	420	186	606
Uppsala	162,827	360	37	252	145	397
Örebro	258,104	444	126	484	86	570
Värmlands	289,641	352	230	360	222	582
Kopparbergs	281,197	389	243	401	231	632
Gävleborgs	294,881	361	322	323	360	683
Jämtlands	143,854	129	138	139	128	267
Västernorrlands	289,744	318	241	334	225	559
Västerbottens	239,465	303	176	277	202	479
Norrbottens	253,303	393	210	299	304	603
Total	6,551,642	13,286	4,309	11,831	5,764	17,595
%		75.5	24.5	67.2	32.8	

in the age distribution curve was noticeable for the 25—29 year age group, reflecting a refrain from tooth extractions at that age.

While private practice still constitutes the major source for dental treatment, the Social Dental Service offers free dental treatment for school children and runs a subsidized programme for adults. It was interesting to note the distribution of dentists and patients in private and social service to be in the ratio of 2:1 (Fig. 3).

Extracted teeth

During the investigation period when 17,595 patients underwent tooth extractions, the individual situation was recorded for

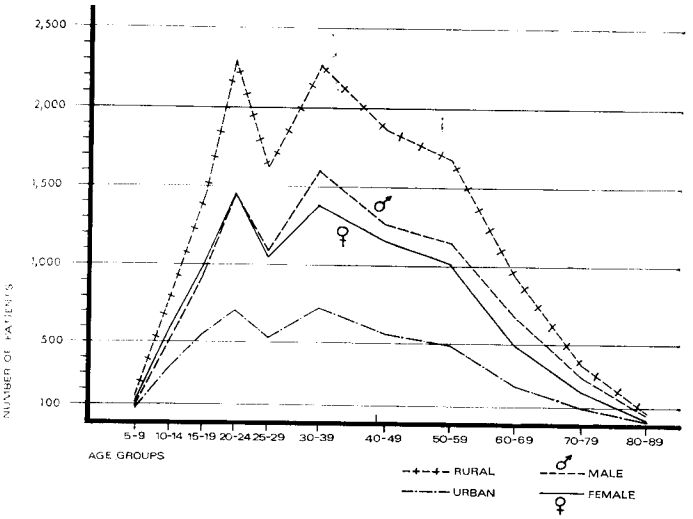

Fig. 2. Distribution of 17,595 patients according to residence and sex.

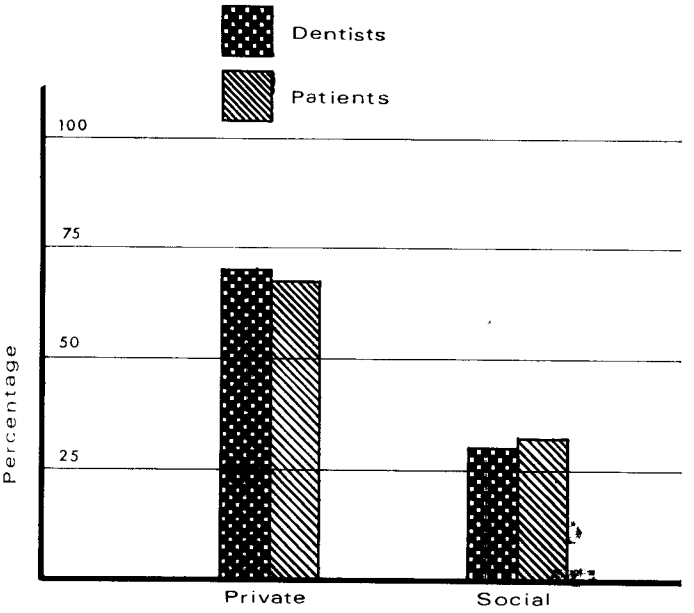

Fig. 3. Percentage of 2,692 dentists and percentage of 17,595 patients in private and social service. 22,264 and 12,192 teeth were extracted in this two types of services, respectively.

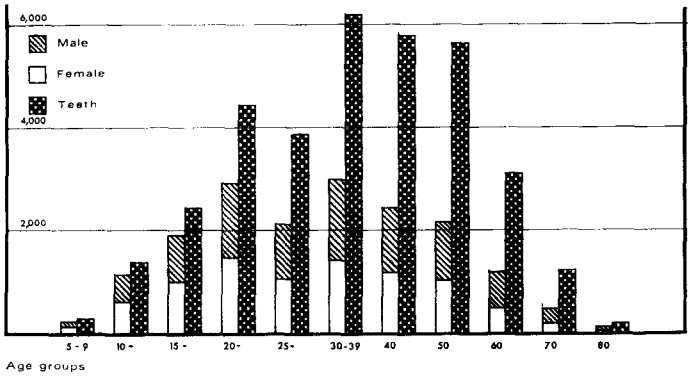

Fig. 4. Number of patients and extracted teeth in age groups.

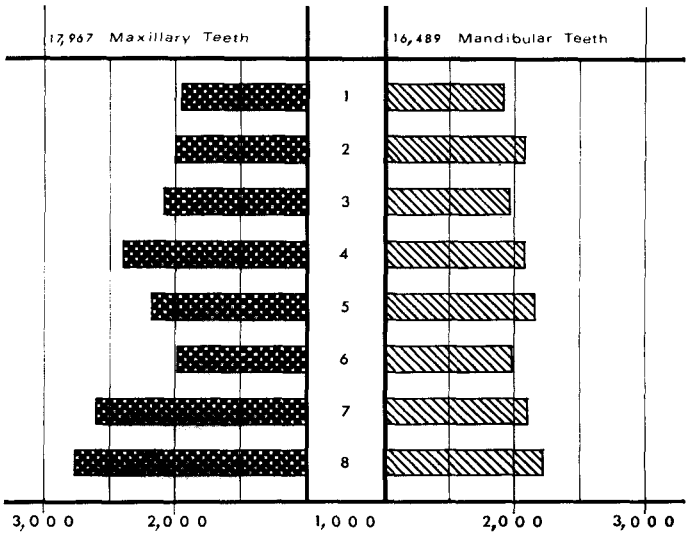

Fig. 5. Distribution of 34,456 extracted teeth.

TABLE V

Number of patients and extracted teeth in different age groups

Age group	Male	Female	Total	Number of teeth	Number of extracted teeth per patient
5—9	100	116	216	266	1.23
10—14	528	594	1122	1359	1.21
15—19	926	947	1900	2430	1.21
20—24	1453	1456	2909	4433	1.52
25—29	1093	1050	2143	3886	1.81
30—39	1602	1400	3002	6165	2.05
40—49	1264	1160	2424	5787	2.39
50—59	1148	1010	2158	5616	2.60
60—69	684	493	1177	3116	2.65
70—79	296	168	464	1221	2.63
80—89	60	20	80	177	2.21

TABLE VI

Analysis of extraction rate for birst molars in different age groups Percentage for +6+ and —6— of all extracted teeth)*

Age groups	No. of +6+	No. of —6—	Total no. of extr. teeth	% +6+	% —6—
5— 9	63	162	266	23.7	60.9
10—14	192	242	1,359	14.1	17.8
15—19	209	319	2,430	8.6	13.1
20—24	276	340	4,433	6.2	7.8
25—29	242	242	3,886	6.2	6.2
30—39	326	305	6,165	5.3	5.0
40—49	298	164	5,787	5.1	2.8
50—59	238	135	5,616	4.2	2.4
60—69	107	57	3,116	3.4	1.8
70—79	25	19	1,221	0.2	0.2
80—89	1	4	5	—	—

*) The teeth are designated + for the upper and — for the lower jaw according to Haderup's system.

34,456 teeth. This material was the source of information from which the indications for tooth removal will be reported. Table V shows the distribution of extractions in relation to age groups which is also illustrated in Fig. 4.

The material was analyzed as to indications for tooth removal and number of teeth present before extractions were made.

RESULTS

The distribution of the 34,456 extracted teeth over the entire dentition is demonstrated in Fig. 5. Considering the great number of teeth and patients involved it was surprising to find the even distribution of lost teeth, about 2,000 of every tooth type only surpassed by maxillary first premolars, second and third molars. It was evident that all tooth types in the dentition run the same risk of being extracted, which points to the tendency of complete eradication of all teeth. It would be expected that the 6-year molars with their high caries incidence would present the highest extraction rate but, indeed, they were the lowest. The explanation was found when analyzing the material in relation to age (Table VI). 84.6 % of all extracted teeth in the 5—9 year age group are 6-year molars, followed by 31.9 % in the 10—14 year group. It can be concluded that the high extraction rate for 6-year molars in childhood accounted for the low extraction rates in the total mostly adult material; the 6-year molars were already removed when other teeth had to be extracted at later age.

The number of teeth removed per patient within the observation period exhibited a steady increase from 1.2 up to 2.6 through the ages, indicating a demolition of the dentition related to age. As the number of teeth before extraction was recorded in every individual, a more complete picture will later be presented.

The causes of tooth loss were evaluated from the complete material in order to determine the weight of different factors influencing the indication for surgery. The main data are given in Fig. 6 and 7 and Table VII. Among the listed nine main causes, caries, periodontal disease, orthodontic and prosthetic indications were by far the most important factors, outweighing all other factors by 27 : 1. Fig. 8 illustrates the distribution of the four main causes of permanent tooth loss through the life span.

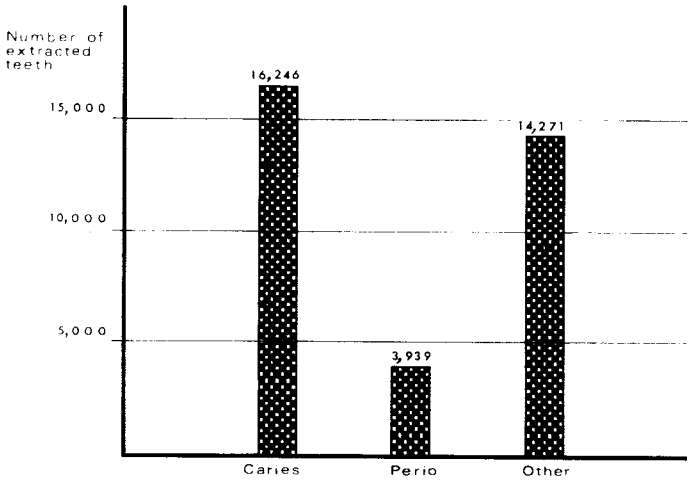

Fig. 6. Caries, periodontal disease, and other causes of tooth loss. Entire Sweden. All age groups combined.

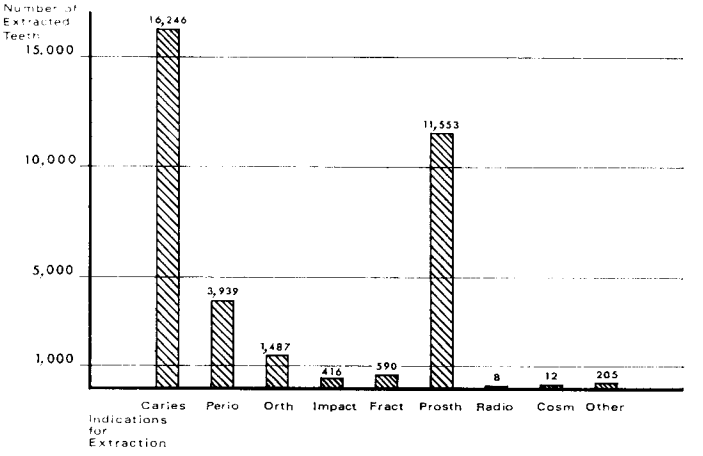

Fig. 7. Analysis of all causes of tooth loss in Sweden. All age groups combined.

TABLE VII

Causes of tooth loss in all age groups
Percentage of teeth for each age group

Indication for extraction	Age Groups										
	5—9	10—14	15—19	20—24	25—29	30—39	40—49	50—59	60—69	70—79	80—89
Caries	80.0	27.4	75.7	73.9	63.5	53.6	37.9	26.0	24.6	23.3	37.3
Perio.	4.9	0.8	0.6	0.9	1.6	5.1	16.5	24.7	25.0	25.8	24.9
Orth.	12.4	69.2	13.4	1.8	0.8	0.8	0.3	0.1	0.2	0.08	0.6
Imp.	2.3	1.0	1.8	3.6	2.0	1.4	0.4	0.2	0.1	0.08	0.5
Fract.	0	0.7	1.0	0.8	1.0	1.8	2.7	2.1	2.0	2.6	2.8
Prosth.	0	0.7	6.1	18.2	30.6	36.6	41.6	46.5	47.5	47.7	29.9
Radiol.	0	0	0	0	0	0.1	0	0	0	0	0
Cosm.	0	0	0	0	0	0.01	0.02	0.2	0	0	0
Other	0.4	0.2	1.4	0.8	0.5	0.5	0.6	0.2	0.6	0.3	4.0
Total no. of teeth	266	1359	2430	4433	3886	6165	4787	5616	3116	1221	177

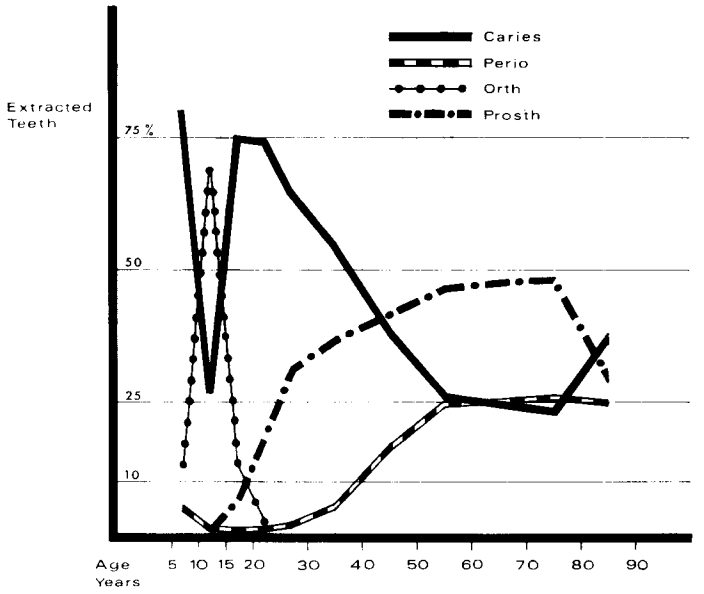

Fig. 8. The four main causes of tooth loss in all age groups.

Indications at various ages

In the 5—9 year group caries was initially the dominant factor of 80.0 % while in the 10—14 year group the orthodontic inversed the picture and became the leading factor by 69.1 %. This was only for a brief period of time, as caries was again dominant, 75.7 % in the 15—19 year group. While caries and its complications gradually diminished from that age and orthodontia almost disappeared as an indication for extractions, periodontal disease and prosthetic indications growed in importance. Periodontal disease became equally important to caries at the age of 50 and above. Even before the age of 20 the effect of the prosthetic indication was noticed and grew to a major factor with increasing age. Between the ages of 40—50 the need for prosthetic restorations in itself resulted in tooth loss, surpassing all other factors, and became equally as important as caries and periodontal disease combined. Obviously the need for artificial substitutes for teeth acted as a motivation for dental extractions to a startling extent.

The need for surgical treatment due to impacted teeth commenced in early childhood and culminated between 20—24 years, the latter group reflecting the third molar extractions. Fractures of teeth were of low frequency as a cause reaching 2 % or more over the age of 40. Radiotherapeutic, cosmetic and other causes were well below 1 %.

Loss of different tooth types

By considering caries and periodontal disease and by combining the prosthetic indication with all other factors, the extraction rate for the different teeth is demonstrated in fig. 9 and in Tables VIII and IX in three age groups. The relative influence of caries versus periodontal disease was observed on a percentage basis. This was particularly clear for the lower incisors, where the relationship was reversed from the 20—24 to the 50—59 year group. The increasing role played by periodontal disease was visible in the 50—59 year group, where the most affected teeth leading to extractions was —1—, —2—, —7—, +6+, and +1+ in this order. Other causes were dominated by the prosthetic indication.

In order to illustrate the role of the main indications for ex-

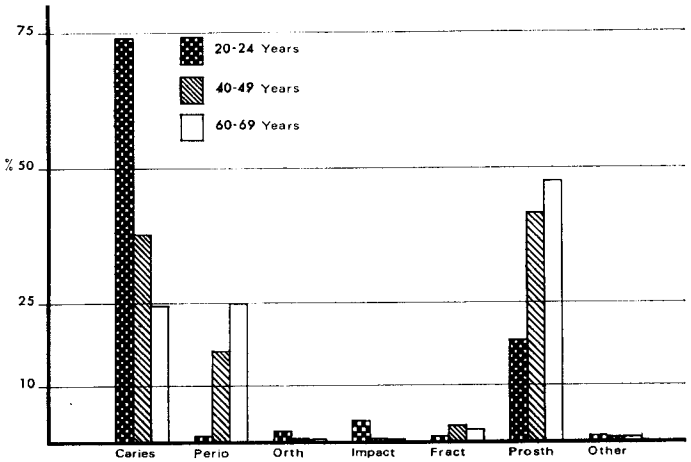

Fig. 9. Indications for 13,336 extractions in age groups. Percentage teeth.

TABLE VIII

Main causes of loss of maxillary teeth in three age groups
Percentage for each tooth type
C = caries PD = periodontal disease O = other causes

Age group, years	Indication for extrac.	Incisors		Canine	Premolars		Molars		
		Central	Lateral		First	Second	First	Second	Third
		+1+	+2+	+3+	+4+	+5+	+6+	+7+	+8+
20—24	C	31.2	36.7	31.1	52.2	62.0	71.4	78.6	89.9
(2,909 patients	PD	0	0.6	0	0	0.8	0.4	1.6	0.7
4,433 teeth)	O	68.8	62.7	68.9	47.8	37.2	28.3	19.8	9.4
30—39	C	26.4	33.3	30.4	48.5	49.3	60.4	66.8	78.1
(3,002 patients	PD	5.4	4.9	4.3	5.7	6.1	5.4	5.5	3.1
6,165 teeth)	O	68.2	61.8	65.3	45.8	44.6	37.3	27.7	18.8
50—59	C	12.3	19.9	19.1	31.7	30.2	29.4	39.0	47.8
(2,158 patients	PD	25.0	21.3	17.8	23.4	23.6	26.1	23.1	19.1
5,616 teeth)	O	62.7	58.8	63.1	44.9	46.2	37.4	38.0	33.1

TABLE IX

Main causes of loss of mandibular teeth in three age groups
Percentage for each tooth type
C = caries PD = periodontal disease O = other causes

Age group, years	Indication for extrac.	Incisors		Canine	Premolars		Molars		
		Central	Lateral		First	Second	First	Second	Third
		—1—	—2—	—3—	—4—	—5—	—6—	—7—	—8—
20—24	C	35.0	39.0	45.5	62.0	73.9	89.7	92.6	75.7
	PD	10.0	14.6	2.2	0.9	1.1	0.6	0.3	0.5
	O	55.0	46.3	52.3	37.0	24.5	9.7	7.1	23.8
30—39	C	15.0	19.7	31.9	55.0	65.4	82.3	80.2	84.6
	PD	13.5	8.2	6.1	6.0	3.6	3.9	4.0	1.2
	O	71.5	72.0	62.0	39.0	31.0	13.8	15.8	14.2
50—59	C	10.9	17.2	19.1	28.1	23.3	57.0	49.8	54.6
	PD	38.5	36.5	20.5	21.3	13.7	21.5	26.3	19.7
	O	50.6	46.3	60.4	50.6	63.0	21.5	23.9	25.7

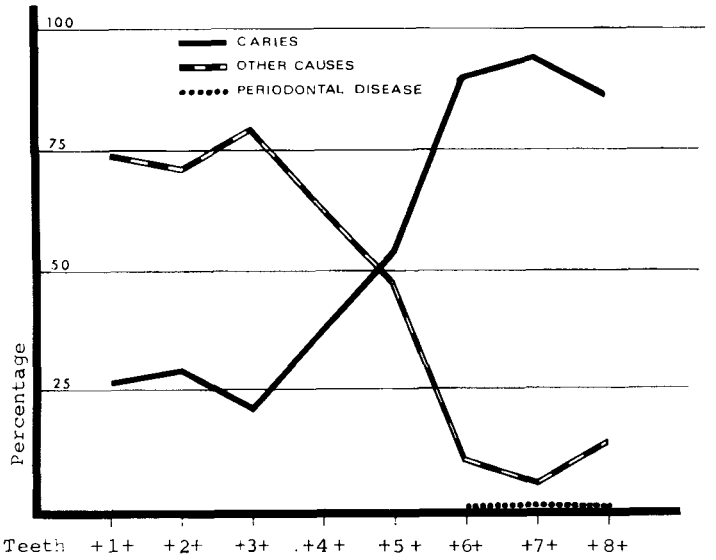

Fig. 10. Extraction rate for maxillary teeth. Age group 15—19 years.

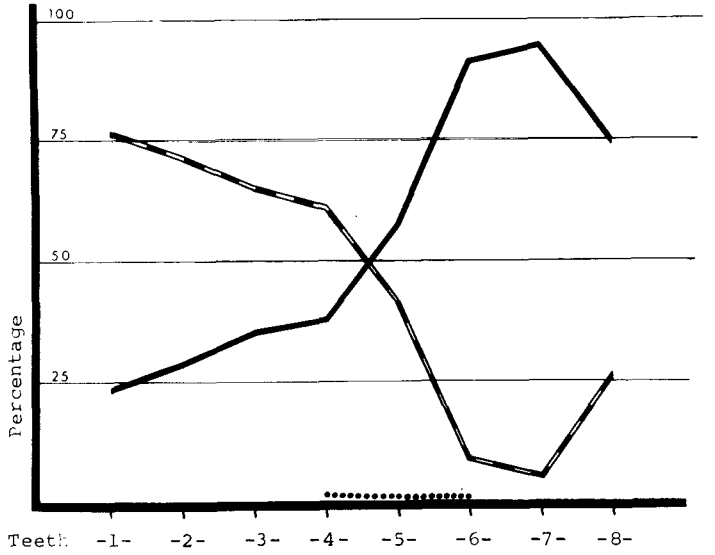

Fig. 11. Extraction rate for mandibular teeth. Age group 15—19 years.

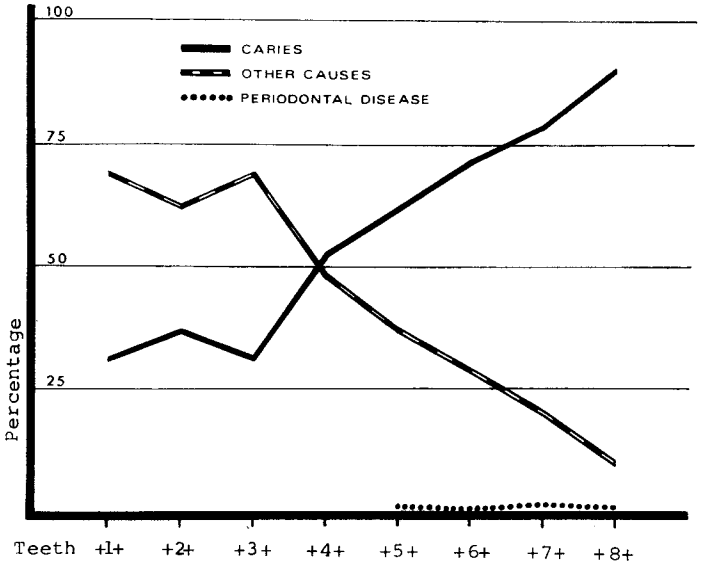

Fig. 12. Extraction rate for maxillary teeth. Age group 20—24 years.

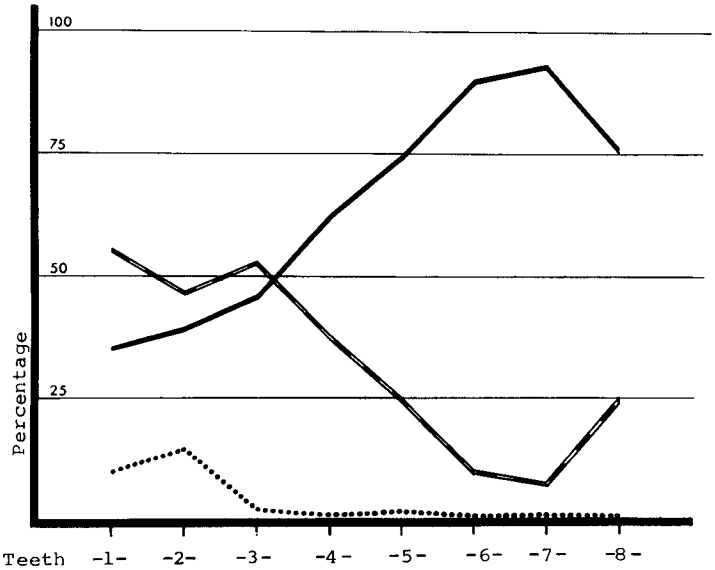

Fig. 13. Extraction rate for mandibular teeth. Age group 20—24 years.

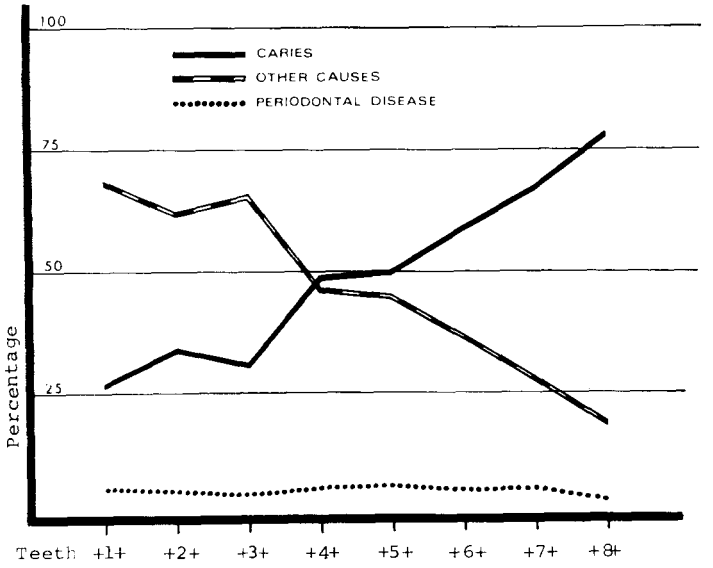

Fig. 14. Extraction rate for maxillary teeth Age group 30—39 years.

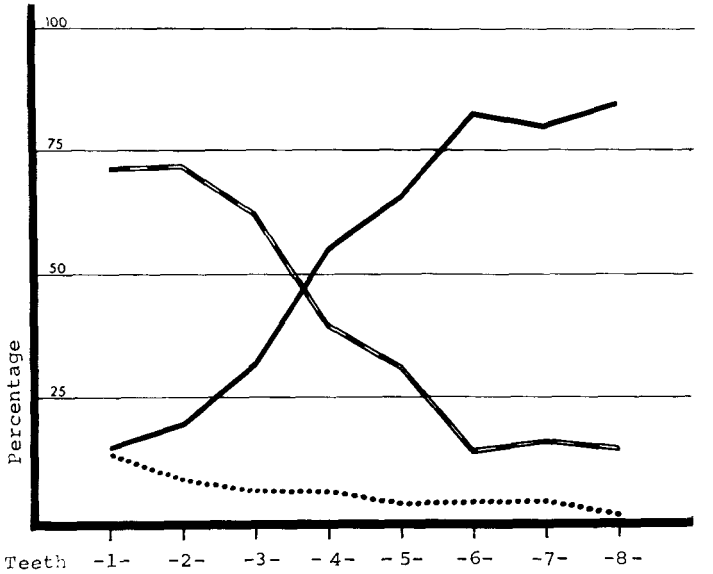

Fig. 15. Extraction rate for mandibular teeth. Age group 30—39 years.

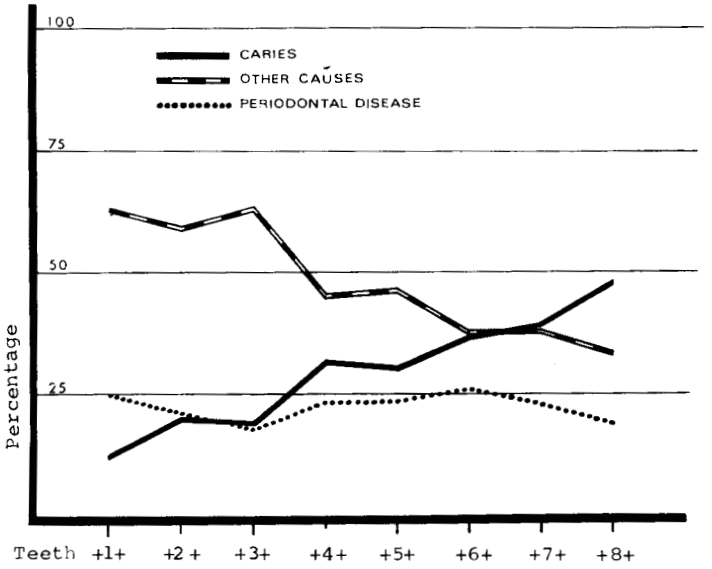

Fig. 16. Extraction rate for maxillary teeth. Age group 50—59 years.

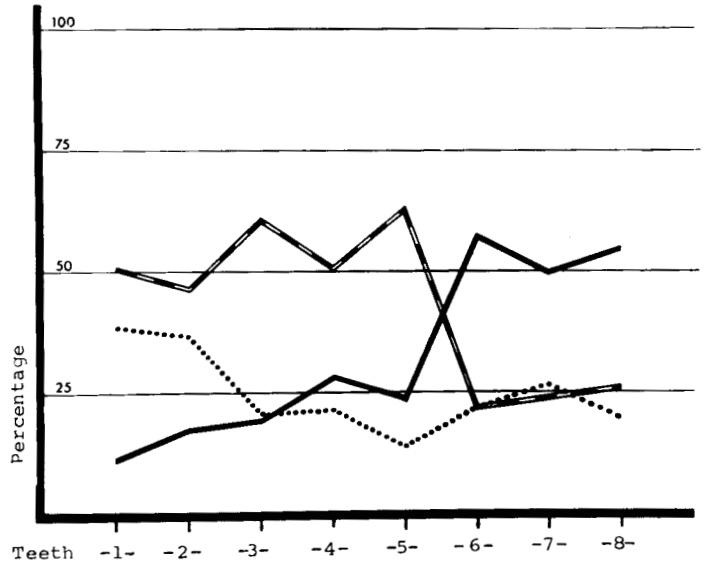

Fig. 17. Extraction rate for mandibular teeth. Age group 50—59 years.

tractions of the different tooth types reference is also given to Figs. 10–17 from representative age groups. Again, while caution should be taken in drawing general conclusions from the age groups below 20 years, due to limited material, the reasons for tooth mortality due to disease varied through the ages. Caries was the dominating factor for tooth extractions, particularly of molars and premolars, up to the age of forty although following a declining curve already in the early twenties. Periodontal disease endangered the incisors more than caries did. The canine area proved to be a turning point as periodontal disease competed with caries as the major cause in the premolar and molar area from the forty year age group and onwards.

Prosthetic indications for tooth extractions

In recording reasons for tooth removal, an entry was given to mark when extractions were needed solely or mainly because the patient needed a prosthetic restoration, a partial or complete denture. Fig. 18. Out of 17,595 patients, 2,489 underwent surgery on this indication, leading to the removal of 11,553 teeth, averaging 4.6 teeth/patient. Even though the number of patients was comparatively small, the great numer of teeth involved motivated a

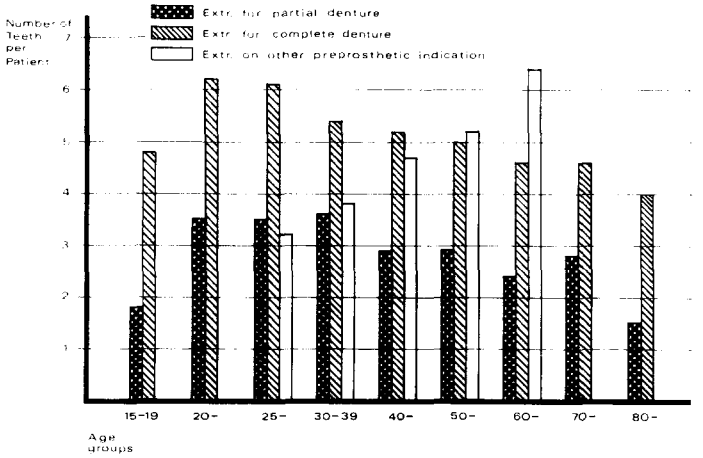

Fig. 18. Number of teeth extracted per patient for prosthetic reasons.

TABLE X

Prosthetic indications for extraction of teeth in 2,489 patients

Age group	Number of Patients	Preparation for partial denture		Inconvenient position of tooth		Preparation for complete denture		Too few teeth left		Other preprosthetic indications	
		Patients	Teeth	Patients	Teeth	Patients	Teeth	Patients	Teeth	Patients	Teeth
5—9	1					1	6				
10—14	4	1	5	1	1	2	4				
15—19	35	5	10	1	1	29	138				
20—24	144	29	105	2	3	103	656	9	42	1	1
25—29	217	46	161	2	7	154	957	10	50	5	16
30—39	462	117	418	4	22	300	1,648	25	108	16	60
40—49	531	142	412	9	19	333	1,765	32	141	15	71
50—59	584	138	413	16	30	385	1,971	36	148	9	47
60—69	359	76	190	7	13	241	1,129	28	104	7	45
70—79	136	19	58	5	10	102	481	8	25	2	9
80—89	16	4	6			8	37	2	3	2	7
	2,489	577	1,778	47	106	1,658	8,792	158	621	57	256

further analysis. Table X splits up the main heading in subgroups. It was immediately noticeable that total removal of teeth, i.e. the preparations for complete dentures, carried the main weight (9,413 teeth lost in 1,816 cases). The other preprosthetic indications accounted for a proportion of approximately 1 : 4.

The material cannot be analyzed further from this point but opens a problem for study, particularly in regard to the very young ages represented in this group, starting from the 5—9 year age group.

Number of teeth present

The number of teeth present at different ages was also calculated. Obviously the results refer only to cases requiring extractions. The percentage of cases having from 1 to 32 teeth was divided in four groups and presented in Table XI and Fig. 19.

DISCUSSION

The main object of this investigation was to evaluate factors motivating the extraction of teeth. Under the influence of changing attitude of the patients, of dental education, and of preventive measures it would be natural to expect that public dental health would improve to a level where extractions would be scarce. The influence of different indications for this type of surgery may therefore vary and change with time. The preservation of the complete dentition as the physiologic ideal and the com-

TABLE XI

Diminution of the dentition with age in Sweden. Percentage of patients with different numbers of teeth before extraction

Number of teeth before extraction	Age Groups					
	20—24	25—29	30—39	40—49	50—59	60—69
25—32	80.4	61.0	39.7	21.1	15.6	9.7
17—24	15.7	27.6	38.5	40.7	32.8	26.2
9—16	3.2	7.9	14.8	22.8	27.9	33.3
1—8	0.7	3.5	7.0	15.4	23.7	30.8

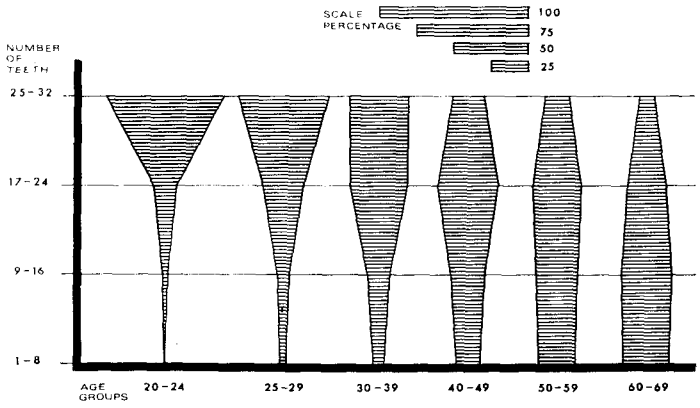

Fig. 19. Diminution of the dentition with age in Sweden.

plete denture as the most economical approach would form the limits of dental therapy in a present day community.

The reliability of the recording method was evaluated in relation to the computer procedure, as used in the present study. In addition, the results have been influenced by variations between the examiners, having determined the indications for tooth extractions. It must be foreseen that there were probably great differences in the clinical determination of oral disease and also of indications for surgery. The great number of participants may permit conclusions of a general character, reflecting common concepts of causes of tooth loss.

On the other hand, dental disease when leading to tooth extractions is usually diagnosed in advanced stages. The uncertainties of diagnosing early lesions were therefore eliminated. The prosthetic reason to remove one or several teeth as a preparation for a prosthetic appliance constituted an indication in itself. This group probably included dental disease, the proportion of which is not known. Additional factors for tooth removal, i.e. esthetic and socioeconomic reasons, may seem of little biological significance, but played undoubtedly a role, and were included in the overall evaluation of causes of tooth mortality. In every division of indications there was a leeway for nonlisted causes. The examiners were thus not forced to comply with a set scheme.

The survey of factors involved in the loss of teeth gave evidence that the degree of specificity of the diagnosis may vary. These points should be borne in mind when results of this investigation are evaluated.

The results of the present study can be directly compared with the previous observations by *Brekhus, Allen* and *Krogh* (Tables I and XII). While more extensive clinical material has been recorded, there is a certain resemblance in the cumulative figures in regard to indications for tooth removal. Considering the number of teeth lost, caries accounted for 39.7 % up to 52.8 % as compared with 47.1 % in this investigation. Periodontal disease accounted for the loss of 11.1 % of the teeth which is a lower figure than previous authors: 20.2 % up to 40.7 %. The variation in tooth mortality rate pertaining to periodontal disease was apparently influenced by the magnitude of teeth removed for prosthetic reasons: the higher the values for prosthetic indications, the lower for periodontal disease. This reflects the probability of a certain proportion of teeth removed for prosthetic reasons being actually periodontally involved. This reasoning was supported by the fact that other causes of tooth loss did not show quite as high a variation: 8.7 % up to 19.9 % as compared with the present 7.9 %.

It might be more appropriate to calculate the proportion of patients rather than the number of teeth extracted as the basis for comparison in dealing with a human disease. If so, again, about 10 % (9.8 %) lose teeth due to periodontal disease. Table IX proves conclusively the influence of age, as caries belongs to

TABLE XII

Comulative data for tooth mortality in present investigation. Percentage of patients and teeth respectively. (Compare Table I)

		Indications for extractions			
	Number	Caries	Periodontal disease	Prosthetic reasons	Other reasons
Patients	17,595	63.3 %	9.8 %	14.2 %	12.7 %
Teeth	34,456	47.1 %	11.1 %	33.8 %	7.9 %

young individuals and the late results of periodontal disease show up in the fifties and thereafter.

It is interesting to note that *Krogh* stated "On a cumulative percentage basis . . ., 54.8 per cent of the teeth lost from dental caries were lost by age 40, as compared with 14.7 per cent of those lost from periodontal disease. In the next three decades of life, percentage loss for caries and periodontal disease were nearly equal."

The present data show a high degree of similarity with *Krogh*'s findings. As the latter material emanated from one private practice and the compared material from 2,692 dental surgeons, the conclusions drawn supported each other.

Caries was the dominating pathological factor for dental destruction in the present material up to age 50, when periodontal disease has reached a level to equal caries as the main cause of permanent tooth mortality. The prosthetic reason for tooth removal was, of course, a consequence of the main types of disease and it seems reasonable to assume that caries and periodontal disease would maintain the interrelationship found in this study if the examiners had been instructed to limit their use of this indication. That was thought to be leading intrusion in the free choice of indications and was, therefore, refrained from.

In viewing the extraction rate for the individual teeth, there was a sequence of events reflecting the spread of periodontal disease.

Already in the twenties periodontal disease accounted for extractions of second and third upper molars and also engaged the whole lower jaw with the highest rate for lower incisors. In the thirties all teeth were involved, again with the lower incisors most exposed and starting to equal caries as a cause for extraction. In the fifties periodontal disease has crossed the caries curve and the upper central incisors were lost at a higher frequency due to periodontal disease. For canine teeth both causes accounted for an equal number. Caries remained the chief cause of tooth mortality among premolars and molars in both jaws.

It was observed that the rate of tooth loss for the individual tooth types in this nationwide investigation was almost parallel to *Krogh*'s findings.

This study does not lend itself to an estimate of the proportion

of edentulous people in Sweden. The problem of tooth loss can be discussed from another angle. Ideally all cases should belong to class 25—32 teeth all through the age groups. In the present material, however, 80.4 % had 25—32 teeth at the age of 20—24, but only 9.7 % belonged to that same class at the age of 60—69. Nearly 2/3 of the cases had only between 1—16 teeth left. During a period of 40 years adult patients tend to lose more than half their dentition.

A decrease in tooth mortality rate can be expected as a result of operative and preventive measures directed toward caries and periodontal disease. Prosthetic indications for extractions, a problem in itself, will be influenced accordingly.

SUMMARY

TOOTH MORTALITY IN SWEDEN

Mortality of permanent teeth has been statistically evaluated in a nationwide survey in Sweden. The indications for removal were recorded by 2,692 dentists who extracted 34,456 permanent teeth in 17,595 patients. Both sexes were equally represented, urban and rural populations in the ratio 1 : 3. Private practice and social service were in the ratio 2 : 1, Age groups from 5 to 89 years were analyzed. All the permanent tooth types are represented, averaging about 2,000 of each with slightly higher values for maxillary first premolars, second and third molars.

The following conclusions were made:

1. Caries, periodontal disease, orthodontic, and prosthetic indications outweighed all other factors by 27 : 1 as causes of extractions.

2. While caries alone was directly responsible for the majority of extractions of permanent teeth in the two first decades of life, the orthodontic indication for tooth removal reached the magnitude of 69.1 % in the 10—14 year group.

3. Caries continuously receded as a main cause from the twenties, and periodontal disease growed in importance from the early thirties and became equally responsible for tooth loss in the fifties and onwards.

4. The need or urge for artificial substitutes for teeth, the prosthetic indication, was a major factor for tooth loss from the early twenties all through life, frequently leading to an edentulous condition. Ten per cent of the cases became edentulous as one-fourth of the total number of teeth in this investigation were extracted for prosthetic reasons. The early age carious destruction of the dentition followed by periodontal disease in the middle ages are the reasonable explanations of this condition.

5. Within the dentition the canine teeth were turning points for periodontal disease, which accelerated anteriorly and superseded caries as cause of tooth loss, while caries still dominated posterioly during the life span.

6. Other indications for tooth removal were impactions (max. 3.6 % at 20—24 years), fractures (max. 2.7 % at 40—49), radiotherapeutic measures, cosmetic and economic reasons.

7. Patients subject to extractions may lose teeth at such a rate that while 80.4 % have 25—32 teeth at 20—24 years of age, only 9.7 % had an equal number at 60—69. At that age two-thirds had 1—16 teeth left.

RÉSUMÉ

LA MORTALITÉ DENTAIRE EN SUÈDE

Au cours d'une enquête faite en Suède sur le plan national, une évaluation statistique de la mortalité des dents permanentes a été faite. Les indications motivant l'extraction ont été enregistrées par 2.692 dentistes ayant pratiqué 34.456 extractions de dents permanentes chez 17.595 patients. Les deux sexes étaient également représentés, la population urbaine et la population rurale étant dans la proportion de 1 : 3. La proportion des cabinets dentaires privés et des services dentaires publics était de 2 : 1. L'analyse a été faite sur des groupes répartis suivant l'âge et allant de 5 à 89 ans. Toutes les sortes de dents permanentes étaient représentées, soit en moyenne environ 2.000 dents de chaque sorte, avec une légère prédominance en ce qui concerne les premières prémolaires, les deuxièmes molaires et les dents de sagesse de la mâchoire supérieure.

Les conclusions principales ont été les suivantes:

1. La carie dentaire, les parodontopathies, les indications orthodontiques et prothétiques l'emportaient comme cause d'extraction sur tous les autres facteurs par 27 : 1.

2. Alors que la carie à elle seule était directement responsable de la majorité des extractions de dents permanentes pendant les vingt premières années de la vie, les indications orthodontiques se montaient à 69,1 % dans le groupe âgé de 10—14 ans.

3. L'importance de la carie en tant que cause principale diminuait d'une manière continue après la vingtième année, et on notait après la trentaine une augmentation de l'importance des parodontopathies, qui devenaient à partir de la cinquantaine au même degré que la carie responsables de la perte des dents.

4. Le besoin ou le désir de remplacer des dents par des dents artificielles, l'indication prothétique, était un facteur capital de la perte des dents à partir de la vingtième année et pendant tout le reste de la vie, aboutissant souvent à l'édentation. Dix pour cent des cas sont devenus édentés alors qu'un quart du nombre total des dents considérées dans la présente étude étaient extraites pour raisons d'ordre prothétique. Les destructions causées par la carie dentaire pendant le jeune âge, puis l'attaque des parodontopathies à l'âge mûr constituaient vraisemblablement les explications de cet état de chose.

5. Les canines représentaient dans la denture un lieu de démarcation du point de vue des parodontopathies, celles-ci accélérant leur cours dans la région antérieure et y supplantant la carie comme cause de pertes dentaires, alors que la carie continuait à jouer le rôle principal dans la région postérieure pendant toute la vie.

6. Les extractions avaient comme autres indications les rétentions (max. 3,6 % à 20—24 ans), les fractures (max. 2,7 % à 40—49 ans), les mesures prises avant radiothérapie, les raisons cosmétiques et économiques.

7. Les patients subissant les extractions peuvent perdre leurs dents à un tel degré que, tandis que 80,4 % d'entre eux avaient

25—32 dents à l'âge de 20—24 ans, 9,5 % d'entre eux seulement atteignaient ce nombre à l'âge de 60—69 ans. A cet âge, les deux tiers des patients devant subir de nouvelles extractions n'avients déjà plus que 1—16 dents.

ZUSAMMENFASSUNG

URSACHEN DER ZAHNVERLUSTE IN SCHWEDEN

Die Sterblichkeit der permanenten Zähne ist durch Prüfung in ganz Schweden statistisch geschätzt worden. Die Indikationen für 4Entfernung wurden von 2.692 Zahnärzten registriert, die 34.446 permanente Zähne bei 17.595 Patienten extrahierten. Beide Geschlechter waren gleichmässig repräsentiert, Stadt- und Landbevölkerung im Verhältnis 1 : 3. Privatpraxis und ämtliche Tätigkeit im Verhältnis 2 : 1. Altersgruppen von 5 zu 89 Jahren wurden analysiert. Alle Typen von permanenten Zähnen sind repräsentiert, im Durchschnitt ungefähr 2.000 von jeder Type mit ein wenig höheren Werten für maxilläre erste Prämolare, zweiten und dritten Molar.

Hier folgen die hauptsächlichen Schlüsse:

1. Die Karies, die Parodontalerkrankung, orthodontische und prothetische Indikationen wiegen alle anderen Extraktionsursachen auf (im Verhältnis 27 : 1).

2. Während die Karies allein für die Mehrkeit von allen Extraktionen dauernder Zähne in den zwei ersten Jahrzehnte direkt verantwortlich ist, erreicht die orthodontische Indikation für Zahnentfernung eine Grösse von 69,1 % in der Gruppe von 10—14 Jährigen.

3. Die Karies weicht vom zwanzigsten Jahr unaufhörlich als Hauptursache zurück, und die Parodontalkrankheit wird ungefähr vom dreissigsten Jahr immer bedeutungsvoller und ist gleich verantwortlich für Zahnverlust nach dem 50sten Jahre und später.

4. Das dringende Bedürfnis von künstlichen Ersatzmitteln für Zähne, die prothetischen Indikationen sind eine wichtigen Ursache des Zahnverlusts von dem zwanzigsten Jahr des ganze Le-

ben hindurch. Zehn Prozent (10 %) von den Fällen werden zahnlos, da ein Viertel von der totalen Zahnanzahl in dieser Untersuchung aus prothetischen Gründen extrahiert wurde. Die frühe Zerstörung in jungen Jahren von dem natürlichen Gebiss durch die Karies und die Parodontalerkrankung in den mittleren Jahren sind natürliche Ursachen dieses Zustandes.

5. In dem natürlichen Gebiss stellen die Eckzähne die Weichen für die Parodontalerkrankung die in Schneidezahn-Regionen beschleunigt wird und ersetzt die Karies als Ursache des Zahnverlusts, während die Karies in Prämolar- und Molarregionen während des ganzen Lebens dominiert.

6. Andere Indikationen für Zahnentfernung sind Impaktierungen (Höhepunkt: 3,6 % im Alter von 20 zu 24 Jahren), Frakturen (Höhepunkt: 2,7 % im Alter von 40—49 Jahren), preradiotherapeutische Mittel, verschönende und ökonomische Gründe.

7. Patienten, deren Zähne extrahiert werden, können ihre Zähne so schnell verlieren, dass während im Alter von 20 zu 24 Jahren 80,4 %, 25—32 Zähne haben, im Alter von 60 zu 69 Jahren nur 9,7 % dieselbe Anzahl Zähne haben. In diesem Alter haben 2/3 1—16 Zähne übrig.

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