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## ORAL HEALTH SURVEY OF PRESCHOOL CHILDREN IN ICELAND

*by*

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### INTRODUCTION

It is generally recognized that dental disease is very prevalent in children. The obvious need to reduce and eventually prevent diseases in this segment of the population makes it important to accumulate accurate information on their prevalence in population groups and to assess the differences observed between groups.

The great majority of dental health surveys pertain to children of school age because they are easily accessible. The preschool age group has been largely neglected, except for institutionalized children or children seeking treatment at dental clinics (*Finn, 1952*). As a consequence, the few studies involving children in this age group can hardly be said to represent a general population sample.

The opportunity to participate in an epidemiologic study on oral disease in Icelandic people was given to the writer in June 1961 (*Volker, 1961*). It was decided that the summer months of

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1961 should be used for an investigation of the oral health of Icelandic preschool children, as a subcategory of the main study and also as a pilot project. The preschool group was selected in the hope that the study would augment the knowledge on the prevalence of oral disease in this age group. The investigation was performed during July and August and consisted of careful clinical examinations of 609 children between the ages of two and seven. The actual examinations were done by the writer with the assistance of Dr. J. B. Dunbar, co-director of the project.

Precise prevalence data on oral disease in the Icelandic people is non-existent. There are a few scattered references to the excellent condition of the Icelanders' dentition in the reports of a scientific expedition to Iceland about a century ago (*Beaugrand*, 1866). These observations are supported by findings in 19th century Icelandic skulls in the Department of Anatomy at the University of Iceland (*Steffensen*, 1961). The results of annual examinations of school children, performed by physicians of the governmental medical service, suggest that dental caries has now become a serious problem. These reports are not sufficiently detailed regarding dental diseases to allow for standard prevalence estimates. During ten years of general practice in Iceland, the writer was constantly appalled by the unmet need for dental treatment of Icelanders in all age groups. These individuals, however, were seen only when they sought dental treatment. Consequently, they cannot be considered representative of the population.

The opportunity to obtain an adequate sample of preschool children in Iceland is unique. The country is small, only 39,900 square miles, or the approximate size of Kentucky. It has been estimated that only 41 % of the entire country is habitable (*Bjornsson*, 1961). From north to south the longest line is about 190 miles and the longest east to west distance is approximately 300 miles. Modern travel facilities are available. The coast to coast travelling time is approximately 24 hours by automobile and two hours by plane. The island is situated in the North Atlantic with the northernmost tip of the country touching upon the Arctic Circle. A branch of the Gulf Stream virtually encircles the island, causing a much milder climate than might be expected from the latitude of the country. The winters in Iceland are long but fairly mild; average January temperature is 30° F in

Reykjavik. The summers are short and cool; the average July temperature in Reykjavik is 52° F. The average annual number of hours of sunshine is 1,340 in Reykjavik, the capital, and 986.5 in Akureyri, the largest town in North Iceland.

The population of the country is approximately 172,000 with the largest portion in the southwestern region. Reykjavik, the largest city, has a population of 77,000 and the second largest, Akureyri, less than 9,000. The remaining population lives on the lowlands of the coastal fringe, mostly in small towns and villages close to the sparsely populated farming areas.

During the 9th and 10th century, Iceland was permanently settled by persons of Norse and Celtic descent. Although spurts of emigration have occurred in the last 150 years, immigration has been negligible since the first settlement. At the 1940 census, only 1.0 per cent of the total population was of foreign nationality (*Bjornsson, 1961*). Nearly every Icelander can trace his ancestry back to the first settlers of the country. The Icelandic people are probably the most inbred of the civilized nations.

The National Registry of Iceland lists the name, age, address and occupation of every person living in the country. The Registry, which is corrected annually, was of immense value in plotting the distribution of the age group under consideration, and to substantiate birth dates and occupational data. The Registry lists the total population of the country according to place of residence. It facilitated the search for children in the prescribed age group living in the farming areas. These children had to be examined at their homes and access to the Registry allowed the investigators to select the farms in the area, where children of preschool age could be found.

The climatic and soil conditions limit the country's food production. Although fish and lamb are available to meet the national needs, refined products including sugar and flour must be imported. Detailed import and food production statistics are available for many past years.

The greater part of the nation was literate by the end of the 18th century. Today, education is compulsory for children between the ages of 7 to 15, and illiteracy is practically non-existent. The relatively high educational level enjoyed by the Icelandic people enhances the reliability of interview information and in-

creases the degree of cooperation required to conduct a health survey of any kind.

Iceland is divided into 55 medical districts with a physician, appointed by the Governmental Health Service, residing in each district. These physicians are responsible for detailed health statistics collected annually by the office of the State Physician. Such health reports, extending over the last 50 years, are available for study. Because they are chiefly medical in scope, they do not contain detailed dental data. Almost all of the more recent reports, however, comment on the deplorable condition of the Icelanders' dentition.

#### METHOD AND MATERIAL OF THE INVESTIGATION

*Dental caries* and to a lesser degree, *gingivitis*, comprise the greatest part of dental impairment in young children. Accordingly, the major portion of the study was devoted to these two categories. *Occlusion* was observed and any divergence from the normal that could be detected by clinical examination was recorded. *Supernumerary* and *missing teeth*, *gross malformations of the teeth*, *staining of the teeth*, *cleft palate and/or harelip* were noted. Obvious variance from the normal appearance of the *tongue* and *buccal mucosa* were included in our observations.

#### Caries

Dental caries is the primary cause of extractions in the one to ten years age group (*Allen, 1944*). The caries attack rate appears to reach one of its highest levels in children of primary school age, that is, in the six to eight year olds (*Massler & Chand, 1950*). Because destruction of the enamel and dentin is not self-reparative, the effects of caries accumulate over the years. For this reason, the number of teeth or tooth surfaces attacked is not only an indication of the present caries experience of an individual or a population group, but also an index of the past caries experience. Thus, the caries picture observed in six year old children reflects caries activity from the time of eruption of the primary teeth to the sixth year. This is usually designated as the preschool period.

It is recognized that all methods currently available for clinical examinations of dental caries have certain deficiencies. The differences in the findings of various studies on comparable population groups may in part be due to some or all of the following conditions: (a) *variance in definition of carious lesions*, (b) *variation in interpretation by examiners*, (c) *physical equipment used in the studies*, (d) *supplementation of the clinical examination by the cleaning and drying of the teeth and a radiographic survey*.

A most important phase of a report on a dental caries investigation is the statement of the examiner's definition of a carious lesion. The criteria used may not agree with that of other studies. A detailed description of the examiner's criteria and method of investigation, however, will permit comparisons of the findings with those of other studies providing certain allowances are made for the overall conduct of the investigations.

In the present investigation, the following principles were emphasized throughout the caries examination:

- A. Every surface of each tooth present was examined carefully, using a mouth mirror and two types of explorers.
- B. Macroscopic defects of the enamel and dentin, from which carious material could be readily excavated with an explorer were accepted as carious.
- C. A pit or fissure was counted as carious only if softened dentin was encountered by the explorer point.
- D. Stained or opaque light areas on buccal and lingual surfaces of the teeth and translucent areas on marginal ridges were not called carious, unless positive evidence of enamel discontinuity could be detected.

These rules are in general agreement with statements found in reports on comparable dental caries studies (*Klein, Palmer & Knutson, 1938; Jackson, 1950; Savara & Suher, 1954; Kruger, 1955; Russell, 1956*).

*Mellanby (1949), Knowles (1948) and Barnsby & Knowles (1949)* utilized a grading system based on the size of the cavity in their investigations. The examiners participating in the extensive Vipeholm Dental Caries Study (*Gustafsson et al., 1954*)

used the Scandinavian Moulage System in the grading of the cavities in their subjects. This method was devised in accordance with suggestions made by *Dahlberg* (1940) and compares the clinical cavity with respect to location, extent and depth with a series of models showing varying degrees of caries. Although this method is of great value in caries control projects, it is too costly and time-consuming for a field study of large population groups.

A few reports in the literature deal with the unreliability of dental caries records caused by the difference between examiners as to the definition of carious lesions and the fact that some lesions are not detected (*Deatherage et al.*, 1939; *Radusch*, 1941; *Berggren & Welander*, 1960). In the present study, the same examiner performed all the evaluations in each child. Although this procedure does not exclude the examiner variable when comparing the findings with those of other studies, it does permit a reliable comparison of the observations made on the subgroups within the study.

The sickle-shaped and the right angle explorers were used in the examination of each child. The explorers were tested for sharpness at frequent intervals and sharpened when necessary with a rotating sandpaper disc. A sufficient number of explorers and mouth mirrors were available to permit adequate sterilization of the instruments between examinations. Although the clinical examinations of the children in this present study were performed in well lighted rooms, it was thought greater consistency would result if uniform illumination was used. Accordingly, an adjustable lamp with a 100 watt bulb was used in all examinations.

A collapsible dental field-chair used by the Armed Services was used initially in this study. However, it was observed quickly that the children showed signs of anxiety when confronted with unaccustomed equipment. Consequently, the use of the chair was discontinued in favor of a detachable headrest clamped to any available hardbacked chair.

It is generally accepted that the diagnosis of all carious lesions of the teeth is a physical impossibility. *Burket* (1941) made comparative gross, roentgenologic and microscopic examinations of 460 teeth. He showed that the histologic examination added 24 per cent to the number of lesions found on clinical and roentgenographic examination.

The importance of thorough cleansing and drying of the teeth and the use of radiographs in dental caries investigations was emphasized by *Sognaes* (1940). He examined 32 children, progressively utilizing (1) mouth mirror and explorer, (2) aided by an initial drying of the teeth, (3) aided by a cleaning and drying of the teeth and (4) aided by roentgenographic diagnosis. *Sognaes* found that almost one-fourth of the total number of carious surfaces remained undetected when only the mouth mirror and explorer were used. *Sognaes* devoted approximately 90 minutes to the examination of each child.

A detailed clinical examination for caries in 429 children was checked for accuracy with bitewing and fullmouth serial radiographs by *Cheyne & Horne* (1948). They found the difference between clinical examination alone and clinical plus radiographic to be approximately five per cent. They concluded that if the investigation aims at establishing the caries picture for comparison between groups of children, radiographs are of little value. A similar conclusion was drawn by *Chilton & Greenwald* (1947). They discussed the limited increase in accuracy obtained by using radiographs as compared to the cost of roentgenologic equipment and the lack of facilities for their proper use in field studies, plus the usual paucity of funds available for dental public health work. *Parfitt* (1954) showed a significant group of children and adults would have to be discarded as subjects for a dental survey if roentgenologic evidence was expected. He also pointed out that in prevalence studies of dental caries only comparatively gross lesions are counted, while investigations of preventive measures rely on the appearance of new, and most frequently, small cavities. For the reasons stated in the three lastly reviewed publications, radiographs were not utilized in this study. It is also pertinent to a study concerned with very young children that the differences in the reported findings between the clinical and clinical + radiographic examinations were found to be less in younger age groups than in older subjects. It has been shown that these differences increase as the number of permanent teeth increase.

The time factor and the lack of an engine unit did not permit a prophylaxis or drying of the teeth in preparation for the examination of the children. Dental floss was used on those occa-

sions where food debris was a hindrance to a thorough examination.

In the present study, the DMFT (decayed, missing and filled teeth) and the DFS (decayed and filled surfaces) were used to indicate dental caries prevalence. Each carious lesion and filling was noted according to the surface or surfaces on which it occurred. Proximal lesions were recorded as involving one surface unless extension on the occlusal surface extended beyond the marginal ridge of the tooth. Proximo-occlusal fillings were listed as involving two surfaces even though the occlusal extension may have been for retentive purposes only. Remaining roots were considered as equal to five carious surfaces. Carious lesions and fillings were recorded separately. Teeth with both a carious lesion and a restoration were placed in the category of decayed teeth. A surface with caries about the margins of a restoration was recorded as a decayed surface. Missing teeth and teeth with non-carious pits and fissures were noted. The DMFT and DFS were used for both permanent and deciduous teeth. The DMF Index can be used with safety for the deciduous dentition of two to five year old children since exfoliation of primary teeth rarely begins before the child reaches five years of age (*Jackson, 1950*). In the present study, a distinction was made between exfoliated and extracted deciduous teeth and only the latter category was included in the DMF. This decision was made from information gathered from the parent or custodian and, when needed, was confirmed by consultation of the dentist or physician who treated the child.

#### **Periodontal Disease**

Periodontal disease is considered by many to be a disease of middle aged and elderly people. This opinion reflects the fact that the loss of teeth due to the deterioration of the tooth-supporting tissues usually does not occur until mature life. It is obvious, however, that the cause of adult periodontal disease is already manifest in childhood. Until recently, the study of periodontal disease in children has been a rather neglected phase of dental research. Gingivitis has been reported to be quite common in six year old children (*Massler, Cohen & Schour, 1952*). Early detection and treatment of periodontal disease in children

may possibly lead to prevention of this condition later in life. The most common type of periodontal disease in children is gingivitis (*Parfitt, 1957; Cohen, 1961*). *Massler (1958)* states that alveolar bone destruction is rarely seen in children because the bone is actively growing. *Baer (1958)* is of the opinion that, in most instances, periodontal disease in the deciduous dentition is of the marginal gingivitis type. He reasons that the deciduous teeth are lost before they have an opportunity to become seriously involved. *Schour & Massler (1947)* and *Sandler (1952)* agree that inflammatory changes in the gingiva are most characteristic of the younger ages.

In this present study, the investigation of the periodontium was limited to inspection of the gingiva and evaluation of the severity of inflammation. The condition of the buccal or labial gingiva of every tooth present was examined and evaluated according to a four degree severity scale.

The examination of the gingiva was performed after the caries evaluation of each child. The artificial light, already described, was used and the mouth mirror was utilized to reflect the cheeks and the lips.

For the evaluation of the gingival condition the color, size, contour, consistency, surface texture and position of the gingiva were considered (*Cheraskin & Langley, 1956*). The gingival condition was accepted as normal when the following conditions were met: 1. Pale pink color. 2. Firm attachment of the attached gingiva to the alveolar bone and close adherence of the free gingiva to the teeth. The papillae should be bulky and completely fill the interproximal space between two adjacent teeth. 3. The epithelial surface should be soft and with a number of irregularities (stippling). 4. There should be no bleeding on firm digital pressure. The assessment of the gingival condition was based on the following grading system:

<i>Points</i>	<i>Code</i>	<i>Clinical Criteria</i>
0	0	: Indicates there is no clinical evidence of inflammation whatever in the area examined.
1	†	: Denotes there is slight inflammation present, with mild change in color and a little loss of contour.

- 2 †† : Indicates there is present a distinct discoloration of the gingiva, with bleeding on pressure, swelling and loss of stippling.
- 3 ††† : Denotes severe inflammation, with spontaneous hemorrhage or bleeding on the slightest touch of food or toothbrush. Intense swelling and redness or ulceration is present.

#### Malocclusion and Other Anomalies

The limited study time and resources prohibited a refined diagnosis of malocclusion. An effort was made, however, in each individual examination to note any obvious deviations from the accepted normal. The presence of Class II or Class III malocclusion (*Angle*, 1907), anterior and posterior crossbites and anterior open bites (Class I), were recorded by having each child close his jaws in centric relationship.

The examiner kept in mind the wide range of normal variations existing in the primary dentition. It has been pointed out by *Baume* (1950) and *Cohen* (1961) that the terminal plane of the distal surfaces of the maxillary and mandibular second deciduous molars may in many instances form a vertical line. This does not necessarily indicate a malocclusion, unless it exists in the presence of unsatisfactory maxillary and mandibular cuspid positions and abnormal anterior occlusal relationship.

In addition to obvious signs of malocclusion, congenitally missing and supernumerary teeth, harelip and any obvious deviations from normal in the shape of the palate, if present, were also recorded. The tongue of each child was also observed and any variations in color and shape were noted.

#### Material of the Study

This study was based on the examination of 609 Icelandic children. The children ranged in age from 2 to 7 years and included an approximately similar distribution of both sexes (Table 1). Age was considered in years as of the last birthday. All of the children were in good health at the time of the examination.

**Table 1**  
*Age and sex distribution of 609 children examined*

Age	Number of children		
	Boys	Girls	Combined
2	15	14	29
3	86	79	165
4	86	74	160
5	75	57	132
6	52	50	102
7	13	8	21
2--7	327	282	609

Reykjavik, Selfoss and Vestmannaeyjar are all located in the southwest region of Iceland and represent this area in the study. Reykjavik (pop. 72,270), the capital and largest city in Iceland, is represented by 310 children examined. The city is the commercial and industrial center of the nation. At Selfoss (pop. 1,768), a commercial center for the surrounding farms, 29 children were examined. Vestmannaeyjar (pop. 4,675), the largest fishing center in the nation, is represented by 49 children.

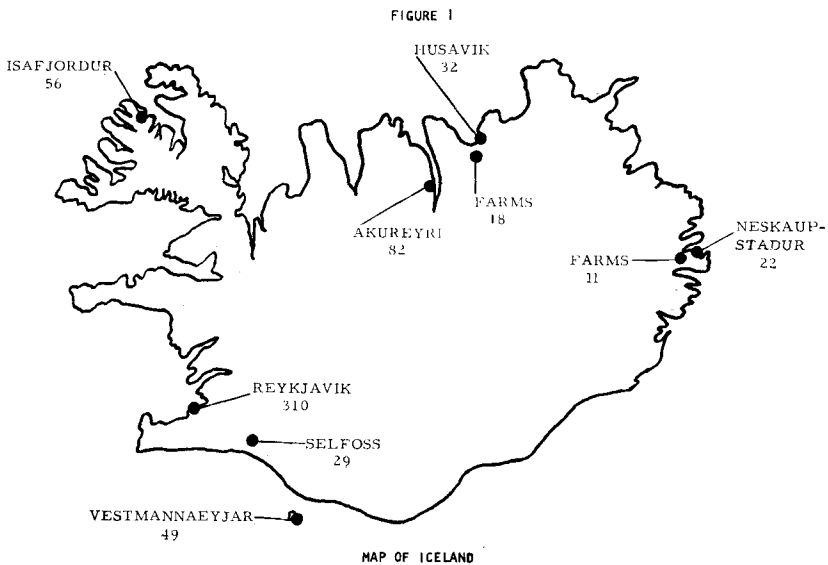


Table 2

Number of children examined in each location

Location	Number of children examined according to age and sex													
	2 years		3 years		4 years		5 years		6 years		7 years			
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls		
Reykjavik	10	7	45	39	38	36	31	34	31	26	8	5		
Selfoss	1	0	3	2	3	2	8	3	4	2	1	0		
Vestmannaeyar	0	0	5	8	12	8	9	0	3	4	0	0		
Neskaupstadur	0	1	4	5	3	4	3	2	0	0	0	0		
Farms around Neskaupstadur	1	0	0	1	1	3	3	0	1	0	1	0		
Isafjordur	1	3	6	7	10	4	8	7	4	4	1	1		
Akureyri	2	2	16	13	11	9	10	8	4	3	2	2		
Husavik	0	0	6	3	3	5	2	3	4	6	0	0		
Farms around Husavik	0	1	1	1	5	3	1	0	1	5	0	0		

Table 3

*Percentage figures of population sample*

Age	No. of children living in Iceland		Children examined in study			
			Number		Percentages	
	Boys	Girls	Boys	Girls	Boys	Girls
2	2292	2237	15	14	0.7	0.6
3	2410	2235	86	79	3.6	3.5
4	2319	2181	86	74	3.7	3.3
5	2214	2163	75	57	3.4	2.6
6	2191	2029	52	50	2.4	2.5
7	2172	2023	13	8	0.6	0.4
2-7	13598	12868	327	282	2.4	2.2

Akureyri (pop. 8,836), the main commercial center of North Iceland and the second largest town in the country, and Husavik (pop. 1,495), a fishing village, represent the northern region of Iceland, with 82 and 32 children respectively. Neskaupstadur (pop. 1,441), center of the fishing industry and commerce on the East coast, is represented by 22 children examined. Isafjordur (pop. 2,714), a fishing and commercial town on the West coast, is represented by 56 children. The 29 rural children were living on farms in the vicinity of Husavik and Neskaupstadur. Figure 1 shows the geographic distribution of the children examined and the location of the towns, villages and farming areas visited. The geographic distribution of the children, according to age and sex, is presented in Table 2.

Most of the children examined were found in day- and play-schools. These institutions are operated with the support of the communities. They are open to children of all socio-economic classes. No such institutions were available in Isafjordur or Husavik. In these locations the children were found by consulting the National Registry and assembled for examination with the assistance of the district physicians. The farms with children of the prescribed age group were located from the Registry and visited by the examining team.

**Table 4**  
*Number of children examined  
 grouped according to occupation of provider*

Occupation of provider	No. of children
Professional, executive and managerial	75
White collar workers	174
Farmers	31
Skilled laborers	98
Semiskilled laborers	138
Laborers	93

The number of children living in Iceland and the number and percentages examined in the study are shown in Table 3. The occupational distribution of the custodians of the children examined, permits a reasonable assumption of representation of the socio-economic classes in the population sample (Table 4).

#### FINDINGS

The collected data were analyzed regarding: (1) *dental decay*, (2) *gingivitis*, (3) *malocclusion*, and (4) *other oral abnormalities*. These four categories were considered for the entire group of examined children and also according to their geographic location in Iceland. Only the data concerning the entire group will be presented in this paper.

#### Dental Decay

The caries evidence was analyzed for prevalence among the children according to age and sex. Deciduous and permanent teeth were considered separately.

##### *Dental Decay in the Deciduous Teeth*

The findings are presented in four categories: (1) *percentage of children affected by caries*, (2) *average number of decayed*,

Table 5  
Prevalence of dental caries in deciduous teeth in 609 Icelandic children

Age	Boys			Girls			Combined		
	No. of children	No. with caries	% with caries	No. of children	No. with caries	% with caries	No. of children	No. with caries	% with caries
2	15	10	66.7	14	6	42.9	29	16	55.2
3	86	72	83.7	79	65	82.3	165	137	83.0
4	86	77	89.5	74	69	93.2	160	146	91.3
5	75	70	93.3	57	56	98.3	132	126	95.5
6	52	48	92.3	50	50	100.0	102	98	96.1
7	13	13	100.0	8	8	100.0	21	21	100.0
2-7	327	290	88.7	282	254	90.1	609	544	89.3

missing and filled teeth per child, (3) percentile distribution of children according to number of decayed teeth and (4) average number of decayed and filled surfaces per child.

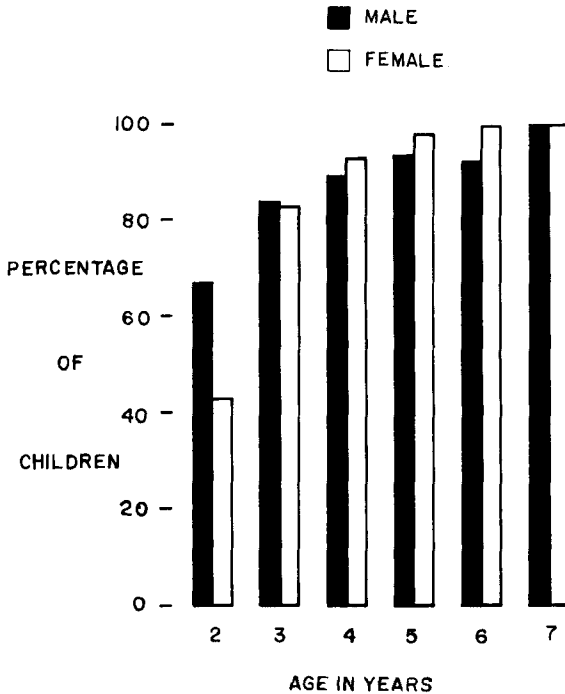
*Percentage of Children Affected by Caries:* Dental caries is an accumulative disease and its prevalence increases with age. Of the two year old Icelandic children, 55.2 per cent had one or more decayed deciduous teeth (Table 5 and Figure 2). The prevalence of the disease increased rapidly to 83.0 per cent of the children affected at three years of age. A subsequent slower but steady increase was noted with advancing age. At four, five, six, and seven years of age, 91.3, 95.5, 96.1, and 100 per cent of the children examined were affected, respectively.

The substantial increase in the percentage of affected children of approximately 30.0 per cent between the second and third year is probably explained by the eruption of the first and second primary molars. The rate of increase is slower at four, five, six, and seven years because no new deciduous teeth are erupting and the number of teeth available for initial attack by dental decay is decreasing with increase in age.

Analysis of prevalence of caries according to the sex of the children revealed that two and three year old boys had a higher prevalence rate than the girls. This difference was reversed at four years, but was not significant at any age level.

The percentage of affected children compiled from the total 609 children examined was 89.3. Of the 327 boys examined, 290 or 88.7 per cent, had one or more decayed deciduous teeth, and 254, or 90.1 per cent of 282 girls examined were affected.

FIGURE 2  
PERCENTAGE OF ICELANDIC CHILDREN WITH  
ONE OR MORE DECAYED DECIDUOUS TEETH



*dmf Teeth:* As stated previously, the commonly used def index, or decayed, extraction-indicated and filled teeth, was not used in this study. The age of the subjects and the opportunity to interview parents and attending dentists and physicians, made it possible to ascertain whether a missing tooth had exfoliated or had been extracted. The def index, which groups severely decayed deciduous teeth under the extraction-indicated heading, is based merely on the examiners assumption. A field study usually prohibits the excavation of carious teeth as well as the use of roentgenographs, necessary for a prognosis opinion.

**Table 6**  
*Average number of decayed, missing and filled (dmf) deciduous teeth per child*

Age	Boys		Girls		Combined	
	No. of children	Average dmf deciduous teeth per child	No. of children	Average dmf deciduous teeth per child	No. of children	Average dmf deciduous teeth per child
2	15	2.67	14	1.93	29	2.31
3	86	5.33	79	5.06	165	5.20
4	86	7.14	74	6.12	160	6.67
5	75	7.08	57	6.95	132	7.02
6	52	7.50	50	8.02	102	7.75
7	13	7.85	8	7.38	21	7.67
2—7	327	6.53	282	6.16	609	6.36

In this survey, the dmf index represents decayed teeth, teeth missing due to extractions, and filled or restored teeth. The small letters indicate that the index is being used in analysis of deciduous teeth. The capital letters DMF serve the same purpose when the findings in the permanent teeth are analyzed.

The average number of dmf teeth per child (Table 6 and Figure 3) was 2.31 at two years and rose to 5.20 dmf at three years of age. The average number of dmf teeth per child was 6.67, 7.02, 7.75, and 7.67 at four, five, six, and seven years of age, respectively. The increase of nearly 3 dmf teeth from two to three years of age, supports the contention that the increased prevalence of dental decay at three years of age is related to the eruption of the deciduous molars.

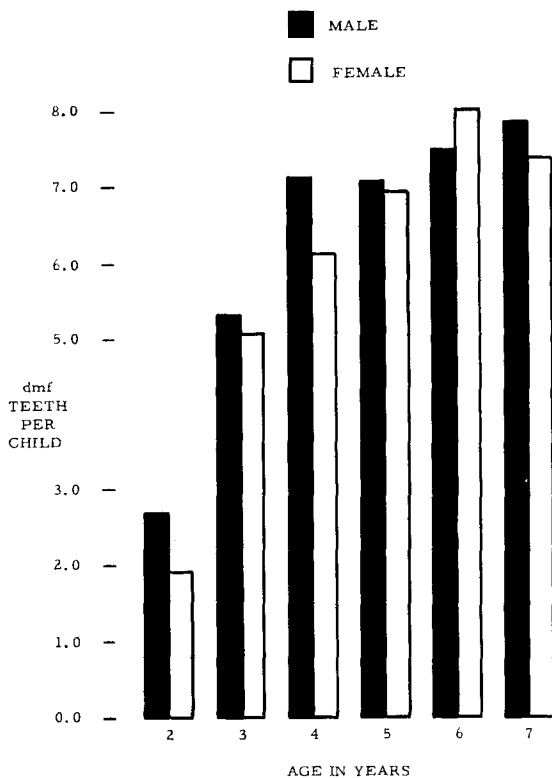
Difference in the average number of dmf teeth between the two sexes was insignificant. The average number of dmf teeth in 327 boys examined was 6.53, and the 282 girls revealed an average of 6.16 dmf teeth. The total group of 609, two to seven years old, Icelandic children had an average of 6.36 dmf teeth per child.

*Percentile Distribution of Children According to Number of Decayed Teeth:* A more accurate analysis of the caries experience of the children is illustrated in Figure 4. This graph shows the percentile distribution of children according to their number of decayed deciduous teeth. The data is grouped at three age levels,

that is, two and three years, four and five years and six and seven years.

The percentage of children with no decayed deciduous teeth present, decreases rapidly from 21.1 per cent in the youngest age

FIGURE 3  
AVERAGE NUMBER OF DECAYED, MISSING AND FILLED  
DECIDUOUS TEETH IN 609 ICELANDIC CHILDREN

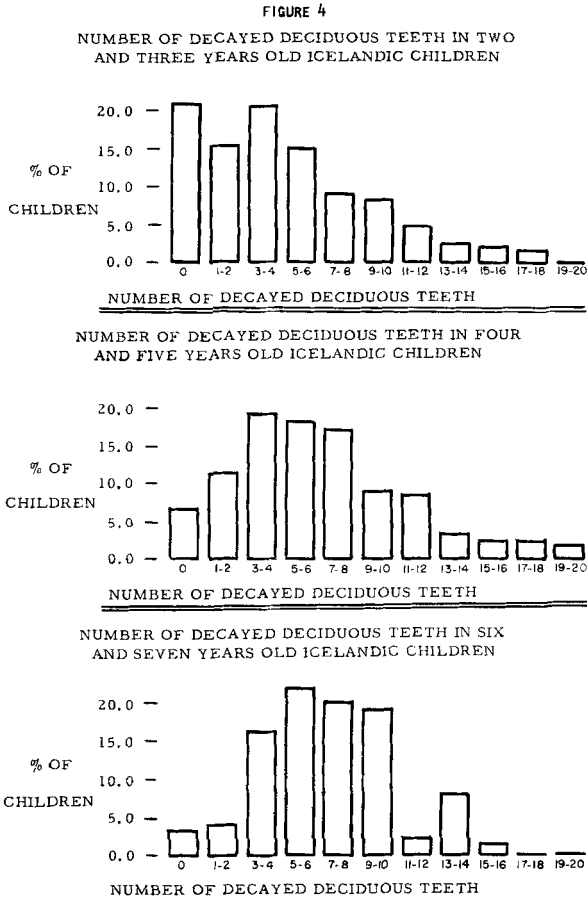


group to 6.9 in the four and five year olds. A further decrease to 3.3 per cent in the six and seven year old children may be noted.

The percentage of children with more than half of the deciduous teeth affected by caries was 10.8 in the two and three year age class. At the four and five year age level, this percentage increases to 18.5. A further increase to 34.2 per cent occurs in the six and seven year old children.

Five of the 292 children, or 1.7 per cent, in the four and five years age group, showed clinical evidence of carious lesions in all of the deciduous teeth present.

*Decayed and Filled Tooth Surfaces:* The average number of df surfaces of the children is illustrated in Table 7 and Figure 5.



The df surface count was 2.83 in the two year old children, and this figure was more than doubled in the three year olds to an average count of 7.42 df surfaces per child. A rapid increase continued to be evident between the three and four year olds. This group had a df surface count of 11.50. The five, six, and seven

**Table 7**  
*Average number of decayed and filled deciduous tooth surfaces in 609 Icelandic children*

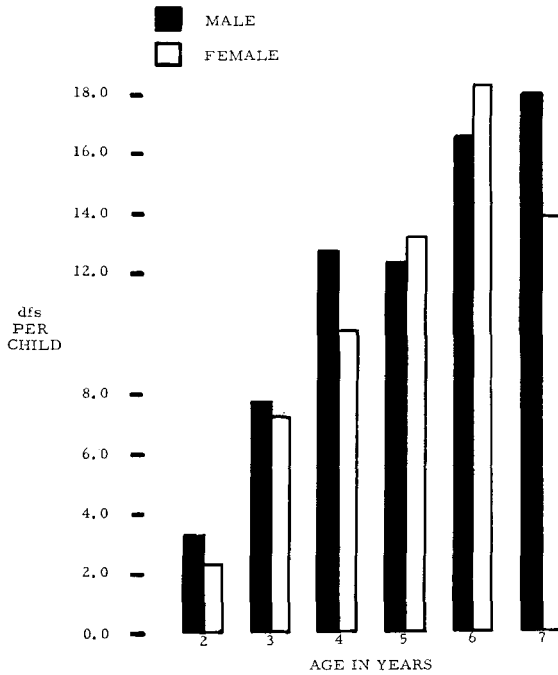
Age	Boys						Girls						Combined			
	No. of children	Average no. of surfaces			No. of children	Average no. of surfaces			No. of children	Average no. of surfaces			Average no. of surfaces		df	
		Decayed	Filled	df		Decayed	Filled	df		Decayed	Filled	Decayed	Filled			
2	15	3.33	0.00	0.33	14	2.29	0.00	2.29	29	2.83	0.00	2.83	2.83			
3	86	7.56	0.09	7.65	79	7.08	0.07	7.15	165	7.33	0.08	7.42	7.42			
4	86	12.55	0.19	12.74	74	10.00	0.05	10.05	160	11.37	0.13	11.50	11.50			
5	75	12.07	0.20	12.27	57	12.95	0.26	13.21	132	12.45	0.23	12.67	12.67			
6	52	16.21	0.27	16.48	50	17.34	0.96	18.30	102	16.76	0.61	17.37	17.37			
7	13	17.92	0.08	18.00	8	12.63	1.25	13.88	21	15.90	0.52	16.43	16.43			

year old children had 12.67, 17.37, and 16.43 df surfaces, respectively.

In general, the boys showed a higher average count of df surfaces before five years of age than the girls. This was true also for the seven year olds. In the five and six year old children this incidence was reversed with the average girl having 13.21 df sur-

FIGURE 5

AVERAGE NUMBER OF DECAYED AND FILLED DECIDUOUS TOOTH SURFACES IN 609 ICELANDIC CHILDREN



faces at five years and 18.30 at six years of age. The boys had an average df surface count of 12.27 and 16.48 at five and six years of age, respectively.

Filled surfaces of the deciduous teeth increased from 0.08 per child at three years of age to 0.52 per child at seven years of age. The girls had a higher incidence of filled surfaces than the boys at all age levels, except the four year olds. The highest average

number of filled surfaces, 1.25 per child, was in seven year old girls, while the highest number for the boys, 0.27 filled surfaces per child, was found in the six year olds.

The average number of filled surfaces for the 609 children examined was 0.23 per child. The girls had 0.29 filled surfaces on the average, and the boys had an average number of 0.17 filled surfaces.

*Dental Decay in the Permanent Teeth*

The clinical evidence of caries in the permanent teeth is presented in three categories: (1) *percentile distribution of children according to the number of erupted and decayed permanent teeth*, (2) *average number of decayed, missing, and filled teeth (DMF)*, and (3) *decayed and filled surfaces*.

*Percentile Distribution of Children According to Eruption and Decay of the Permanent Teeth:* Table 8 and Figure 6 illustrate the number and percentage of erupted permanent teeth and the prevalence of decayed permanent teeth in five, six, and seven year old children.

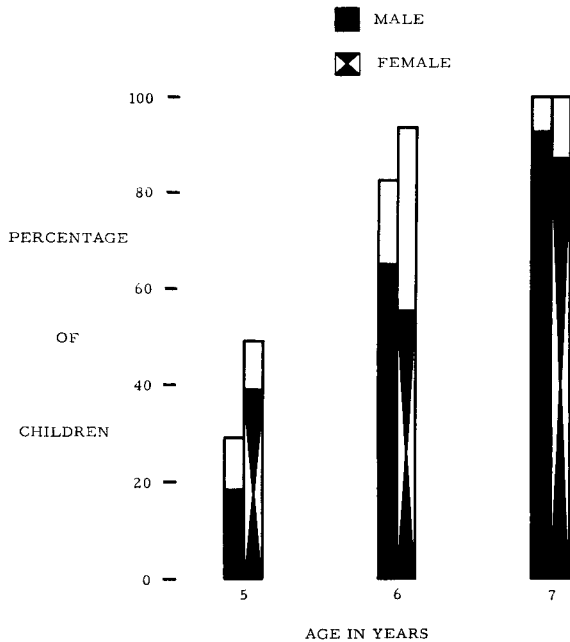
The percentages of five and six year old boys, with one or more erupted permanent teeth, were 29.3 and 82.7, respectively. At these same age levels, 29.1 and 94.0 per cent of the girls had one or more erupted permanent teeth. All of the seven year olds, both boys and girls, had some erupted permanent teeth.

Table 8  
*Prevalence of caries in permanent teeth of five, six and seven year old Icelandic children*

Age	Children with one or more erupted permanent teeth				Children with one or more decayed permanent teeth				Total number of erupted permanent teeth		Decayed permanent teeth			
	Boys		Girls		Boys		Girls		Boys	Girls	Boys		Girls	
	No.	%	No.	%	No.	%	No.	%			No.	%	No.	%
5	22	29.3	28	49.1	4	18.2	11	39.3	72	106	7	9.7	18	17.0
6	43	82.7	47	94.0	28	65.1	26	55.3	228	271	72	31.6	63	23.2
7	13	100.0	8	100.0	12	92.3	7	87.5	120	71	32	26.7	20	28.2

At five years of age, the boys had a lower prevalence, 18.2 per cent, of decayed permanent teeth than the girls, 39.3 per cent. At six and seven years this was reversed. The percentage of six and seven year old boys with decayed permanent teeth was 65.1

FIGURE 6  
 PERCENTAGE OF FIVE, SIX AND SEVEN YEARS OLD ICELANDIC CHILDREN WITH ONE OR MORE ERUPTED PERMANENT TEETH AND PERCENTAGE WITH ONE OR MORE DECAYED PERMANENT TEETH



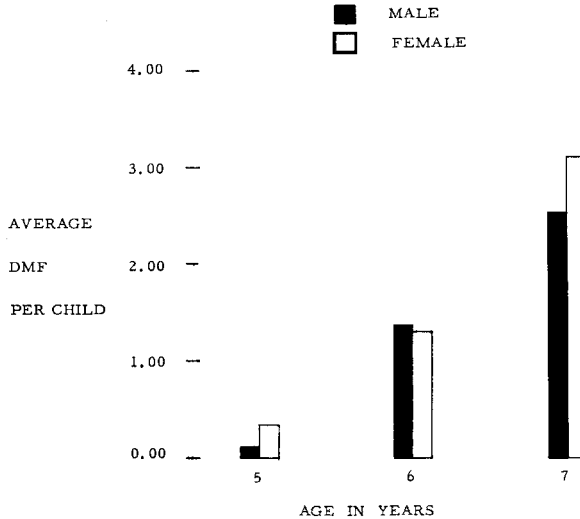
and 92.3 respectively. At these age levels, 55.3 and 87.5 per cent of the girls had decay in the permanent teeth.

Table 8 shows further that 9.7, 31.6, and 26.7 per cent of the permanent teeth present in the boys were decayed at five, six, and seven years of age, respectively. The girls had carious lesions in 17.0, 23.2 and 28.2 per cent of the erupted permanent teeth at these same age levels.

*Average Number of Decayed, Missing and Filled Teeth (DMF):* The average number of DMF teeth in five, six, and seven year old children is illustrated in Table 9 and Figure 7.

At five years, the children had on the average 0.20 DMF teeth.

FIGURE 7  
 AVERAGE NUMBER OF DMF PERMANENT TEETH  
 PER CHILD IN FIVE, SIX AND SEVEN YEARS  
 OLD ICELANDIC CHILDREN



This increased to 1.34 and 2.76 at six and seven years of age, respectively. At five years of age, the boys had an average DMF of 0.09. This count increased substantially to 1.38 at six years and further increased to 2.54 DMF teeth at seven years. The girls

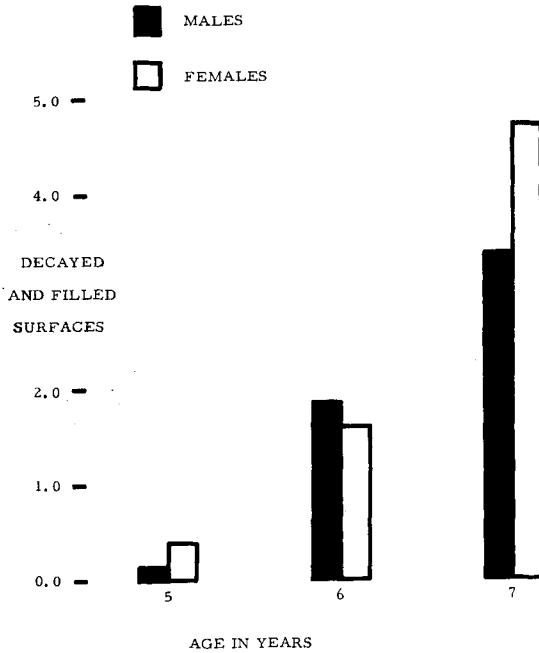
Table 9

*Average number of decayed, missing and filled permanent teeth per child in five, six and seven year old Icelandic children*

Age	Boys		Girls		Combined	
	No. of children	Average DMF permanent teeth per child	No. of children	Average DMF permanent teeth per child	No. of children	Average DMF permanent teeth per child
5	75	0.09	57	0.33	132	0.20
6	52	1.38	50	1.30	102	1.34
7	13	2.54	8	3.13	21	2.76

FIGURE 8

AVERAGE NUMBER OF DECAYED AND FILLED PERMANENT TOOTH SURFACES IN FIVE, SIX AND SEVEN YEARS OLD ICELANDIC CHILDREN



had a DMF count of 0.33, 1.30, and 3.13 at five, six, and seven years of age, respectively.

*Average Number of Decayed and Filled Surfaces:* There were no children with extracted permanent teeth in the population

Table 10  
Average number of decayed and filled permanent tooth surfaces in five, six and seven year old Icelandic children

Age	Boys				Girls				Combined			
	No. of children	Average no. of surfaces			No. of children	Average no. of surfaces			No. of children	Average no. of surfaces		
		De-cayed	Filled	DF		De-cayed	Filled	DF		De-cayed	Filled	DF
5	75	0.13	0.00	0.13	57	0.37	0.04	0.41	132	0.23	0.02	0.25
6	52	1.85	0.00	1.85	50	1.52	0.08	1.60	102	1.67	0.04	1.71
7	13	3.31	0.08	3.39	8	3.25	1.50	4.75	21	3.29	0.62	3.91

sample. Therefore, the surface analysis obviously will not include missing tooth surfaces.

Table 10 and Figure 8 show the average number of decayed and filled permanent tooth surfaces in five, six, and seven year old Icelandic children. The average DF surface count increases rapidly from 0.25 at five years to 1.71 at six years and 3.91 at seven years of age.

The boys had a higher DF surface count at six years of age than the girls, but the girls had a higher count at five and seven years. The boys had a DF surface count of 0.13, 1.85, and 3.39 at five, six, and seven years, respectively. The girls showed DF surface counts of 0.41, 1.60, and 4.75 at these same age levels.

The boys had fewer filled surfaces in the permanent teeth than the girls, at all three age levels. The five and six year old boys had no filled surfaces, as compared to an average number of 0.04 and 0.08 filled surfaces in the five and six year old girls, respectively. At seven years, the boys had 0.08 filled surfaces on the average, while the girls had 1.50 filled surfaces on the average at that age.

### Gingivitis

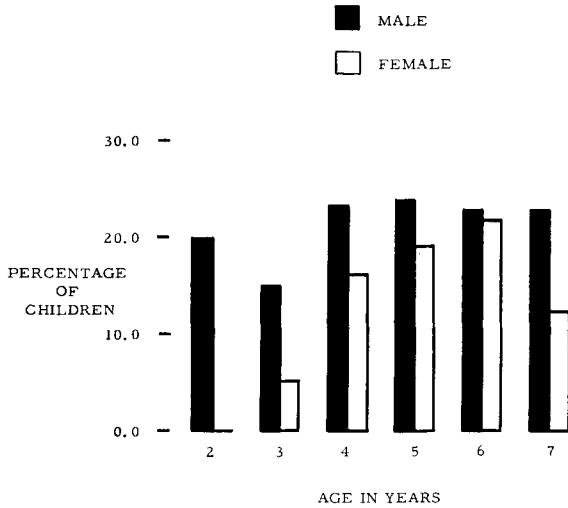
The data pertaining to the gingival condition of each of the 609 children was analyzed in the following categories: (1) *percentage of children affected*, (2) *severity of clinical signs of gingivitis*, and (3) *number of teeth affected*.

Table 11  
*Prevalence of gingivitis in 609 Icelandic children*

Age	Boys			Girls			Combined		
	Number examined	No. with gingivitis	% with gingivitis	Number examined	No. with gingivitis	% with gingivitis	Number examined	No. with gingivitis	% with gingivitis
2	15	3	20.0	14	0	0.0	29	3	10.3
3	86	13	15.1	79	4	5.1	165	17	10.3
4	86	20	23.3	74	12	16.2	160	32	20.0
5	75	18	24.0	57	11	19.3	132	29	22.0
6	52	12	23.1	50	11	22.0	102	23	22.6
7	13	3	23.1	8	1	12.5	21	4	19.1

*Percentage of Children Affected:* Table 11 and Figure 9 illustrate the percentage of children examined with clinical evidence of gingivitis. At two and three years of age, 10.3 per cent of all the children examined has gingivitis. This percentage is almost doubled at four years of age, and remains relatively steady for

FIGURE 9  
PREVALENCE OF GINGIVITIS IN  
609 ICELANDIC CHILDREN



the examination group after that. The percentage of affected children at five, six, and seven is 22.0, 22.6, and 19.1, respectively.

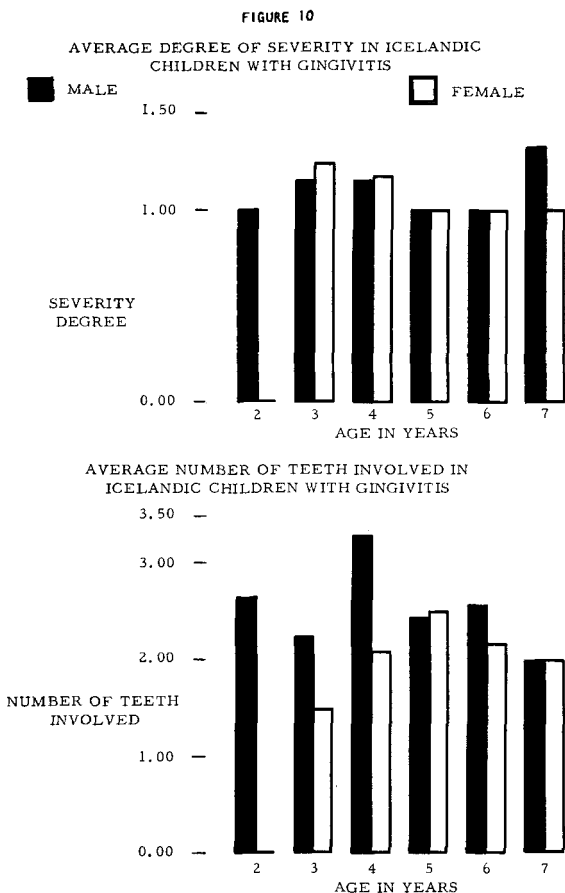
An analysis of the prevalence of gingivitis in each sex indicated a higher percentage of boys affected at each age level examined. The lowest percentage, 15.1, of affected boys was found at three years of age, while none of the two year old girls had any signs of gingivitis. The highest value, 24.0 per cent was found in the five year old boys, as compared to the high of 22.0 per cent in the six year old girls.

An analysis of the total 609 children shows that 108, or 17.7 per cent, were affected by gingivitis. Of the 327 boys, 21.1 per cent were affected, while 13.8 per cent of the 282 girls examined showed clinical evidence of gingivitis.

Table 12  
*Grouping of children with gingivitis according to severity of the inflammation*

Age	Severity degree 1—						Severity degree 2—					
	Number of children			Percentage of children			Number of children			Percentage of children		
	Boys	Girls	Combined	Boys	Girls	Combined	Boys	Girls	Combined	Boys	Girls	Combined
2	3	0	3	100.0	0.0	100.0	0	0	0	0.0	0.0	0.0
3	11	3	14	84.6	75.0	82.4	2	1	3	15.4	25.0	17.6
4	17	10	27	85.0	83.3	84.4	3	2	5	15.0	16.7	15.6
5	18	11	29	100.0	100.0	100.0	0	0	0	0.0	0.0	0.0
6	12	11	23	100.0	100.0	100.0	0	0	0	0.0	0.0	0.0
7	2	1	3	66.7	100.0	75.0	1	0	1	33.3	0.0	25.0
2—7	63	36	99	91.3	92.3	91.7	6	3	9	8.7	7.7	8.3

*Severity of Clinical Signs of Gingivitis:* Table 12 and Figure 10 represent the distribution of children according to the severity of their gingivitis. Of the affected children, 91.7 per cent showed the lowest degree of inflammation clinically observable, or severity degree of one †, and only 8.3 per cent of the children



showed signs of severity degree of two ††. All of the affected children at two, five, and six years of age were in the one † severity class. The percentages of affected children at three, four and seven years of age who showed signs of two †† severity were 17.6, 15.6, and 25.0, respectively.

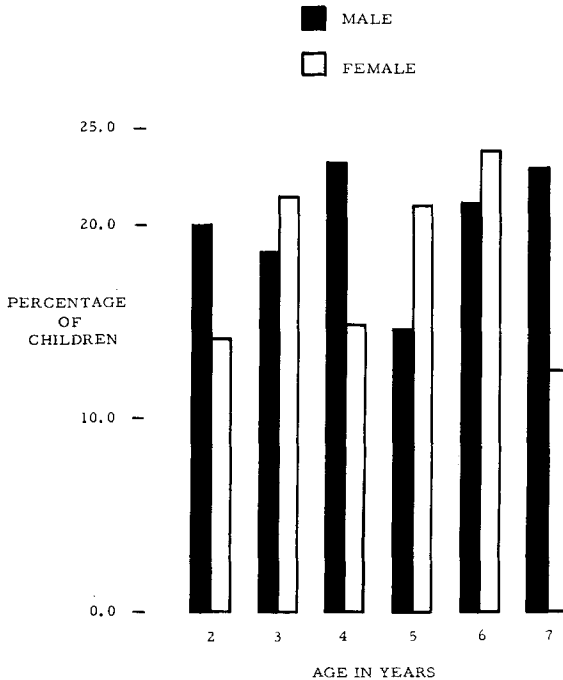
The percentage of boys (8.7) with moderate gingivitis (two †† severity degree) was comparable to that of the girls (7.7).

Table 13  
Prevalence of malocclusion in 609 Icelandic children

Age	Boys			Girls			Combined		
	No. of children	No. with malocclusion	% with malocclusion	No. of children	No. with malocclusion	% with malocclusion	No. of children	No. with malocclusion	% with malocclusion
2	15	3	20.0	14	2	14.1	29	5	17.2
3	86	16	18.6	79	17	21.5	165	33	20.0
4	86	20	23.3	74	11	14.9	160	31	19.4
5	75	11	14.7	57	12	21.1	132	23	17.4
6	52	11	21.2	50	12	24.0	102	23	22.5
7	13	3	23.1	8	1	12.5	21	4	19.1

*Number of Teeth Affected:* Figure 10 illustrates the average number of gingival units (buccal and/or labial gingivae) affected per child. Only the four year old boys showed more than three gingival units involved on the average per child. The highest

FIGURE 11  
PREVALENCE OF MALOCCLUSION IN  
609 ICELANDIC CHILDREN



average number of gingival units affected in the girls was observed in the five year olds.

An analysis of the entire group of affected children shows an average figure of 2.53 involved gingival units per boy, and an average figure of 1.72 affected gingival units per girl.

**Malocclusion**

The data concerning the orthodontic condition of each child examined are presented in the following categories: (1) *percentage of children with malocclusion*, (2) *percentage of children affected with Class I, Class II, and Class III malocclusion*, and

Table 14  
*Percentage distribution of malocclusion in Icelandic children*

No. of children with malocclusion	Class I malocclusion		Class II malocclusion		Class III malocclusion	
	No. of children	% of children	No. of children	% of children	No. of children	% of children
119	74	62.1	42	35.3	3	2.5

(3) *percentage of children affected by different types of Class I malocclusion.*

*Percentage of Children with Malocclusion:* Table 13 and Figure 11 illustrate the percentage of children examined having signs of malocclusion. The lowest percentage, 17.2, of affected children was observed in the two year olds. This percentage increased to 20.0 and 19.4 at three and four years of age, respectively. At five years, it decreased to 17.4 with an increase to 22.5 and 19.1 in the six and seven year olds, respectively.

An analysis of the prevalence of malocclusion in each sex revealed that of the total group of boys examined, 20.2 per cent had malocclusion, while 18.0 per cent of the girls were affected.

*Percentages of Children with Class I, Class II, and Class III Malocclusion:* Table 14 shows the grouping of the children with malocclusion according to the classification of *Angle* (1907). Of the 119 affected children, 74 or 62.1 per cent had evidence of malocclusion of Class I category. Forty-two children, or 35.3 per cent of the affected children had Class II malocclusion. The remaining 2.5 per cent presented clinical evidence of Class III malocclusion.

Table 15  
*Analysis of Class I malocclusion*

Form of occlusal abnormality	No. of children	Percentage prevalence
Anterior Crossbite	20	27.0
Right Posterior Crossbite	20	27.0
Left Posterior Crossbite	15	20.2
Rt. and Lt. Posterior Crossbite	3	4.1
Anterior Open Bite	16	21.6

Table 15 presents the prevalence of different types of Class I malocclusion in the affected children. The most common types were anterior crossbite and right posterior crossbite. Each of these types were found in 20, or 27.0 per cent, of the children with Class I malocclusion. Together, these two orthodontic problems comprise more than half of all the Class I malocclusion cases. Anterior open bite and left posterior crossbite were observed in 21.6 and 20.2 per cent of the affected children, respectively. Only 3, or 4.1 per cent, of the 74 children with Class I malocclusion, were found to have posterior crossbites of both the right and left sides.

**Oral Abnormalities**

Table 16 summarizes the abnormalities observed in the 609 Icelandic children examined in this survey. Included in this category are oral conditions caused by biological agents (green and orange stain on the teeth) and developmental disturbances (supernumerary teeth, congenitally missing teeth, gemination, harelip, cleft palate and geographic tongue). Of the 327 boys examined, 13 presented oral abnormalities and 11 of the 282 girls had some oral abnormality. On a percentage basis there is no difference between the prevalence of these conditions in the two sexes. Approximately 4.0 per cent of either sex had some type of

**Table 16**  
*Oral abnormalities in 609 Icelandic children*

Type of abnormality	Number of children		
	Boys	Girls	Combined
Green stain	7	3	10
Orange stain	1	3	4
Supernumerary teeth	4	1	5
Congenitally missing teeth		1	1
Harelip and cleft palate		2	2
Gemination		1	1
Geographic tongue	1		1
<b>Total</b>	<b>13</b>	<b>11</b>	<b>24</b>

**Table 17**  
*Frequency (percentages) of oral abnormalities in 609 Icelandic children*

Group	Number examined	Green stain	Orange stain	Supernum. teeth	Cong. missing teeth	Harelip and cleft palate	Gemination	Geographic tongue
Boys	327	2.1	0.3	1.2	0.0	0.0	0.0	0.4
Girls	282	0.9	0.9	0.4	0.4	0.7	0.4	0.0
Both sexes	609	1.6	0.6	0.8	0.2	0.3	0.2	0.2

the abnormalities listed in Table 16. The girls, however, showed a greater variance in the types observed.

The results of an analysis of the frequency of the abnormalities are presented in Table 17. The most commonly observed condition was *green stain on the teeth*. Of the children examined, 1.6 per cent had green stain. Seven (2.1 %) of the boys and three (0.9 %) of the girls showed evidence of this condition. *Orange stain* was observed in one (0.3 %) boy and three (0.9 %) girls.

*Supernumerary teeth* was the second most commonly observed anomaly. It was found in 0.8 per cent of the children examined. This anomaly was found in four (1.2 %) boys and one (0.4 %) girl. All the supernumerary teeth were mandibular deciduous incisors. One (0.4 %) girl living on a farm near Neskaupstadur presented a history of a *congenitally missing* mandibular deciduous lateral.

*Harelip and cleft palate*, both repaired, were observed in two (0.7 %) girls. This developmental anomaly was not observed in any of the boys seen in the survey. Its frequency in the population sample was 0.3 per cent. *Gemination* of the upper left lateral incisor was observed in one (0.4 %) girl. The double formation of the crown was verified radiographically. Clinical evidence of geographic tongue was seen in one (0.2 %) boy.

#### DISCUSSION

##### **Comparative Analysis of Prevalence of Oral Disease in Iceland and Other Countries**

Although many surveys of oral disease have been conducted throughout the world, a considerable number of these do not lend themselves readily to comparative analysis because of the method

Table 18  
*Caries prevalence rates (percentages) of children of seven nationalities*

Nationality	Percentage of children with decayed teeth, age							Author
	2	3	4	5	6	7		
American (Hartford)	22.6	37.9	64.7	76.5	83.4	—	Menezes (1956)	
American (New York)	34.7	63.2	85.4	87.0	—	—	Ast (1944)	
American (Oregon)	23.1	61.8	70.9	78.3	83.3	—	Savara and Suher (1954)	
Australian	—	43.4	76.3	85.2	91.8	97.9	Kruger (1955)	
Danish	47.9	72.9	84.4	89.3	95.8	—	Pedersen (1944)	
English	34.0	53.0	59.0	84.0	91.0	95.0	Parfitt (1955)	
German	—	51.5	67.0	78.4	—	—	Hulsmann (1960)	
Norwegian	35.0	—	73.0	—	87.0	—	Toverud (1949)	
Icelandic (present study)	55.2	83.0	91.3	95.5	96.1	100.0	Moller (1962)	

of investigation, the presentation of the data or the age groups studied. From a review of the literature, it appears that the more refined surveys have been conducted within the last two decades. Consequently, the findings in the present study will be compared with reported results of surveys performed since 1940. An effort was made to include reports from as many countries as possible. The analysis will be presented as comparison of prevalence rates for: (1) *dental decay*, (2) *gingivitis*, (3) *malocclusion* and (4) *dental anomalies*.

#### *Dental Decay*

The two most commonly used presentation methods of results of caries prevalence surveys are: (1) *percentage of children with decayed teeth* and (2) *the average number of decayed, missing or extraction-indicated, and filled deciduous and permanent teeth*. Accordingly, these two phases of the caries prevalence picture will be used in the comparative analysis of dental decay.

*Percentage of Children with Evidence of Dental Decay:* The percentage of affected children of seven nationalities is presented in Table 18.

The data published by *Ast* (1944) indicate the highest prevalence rates of the three reports on examinations of American children listed in Table 18. He examined 522 New York children and found 34.7, 63.2, 85.4, and 87.0 per cent of two, three, four, and five year old children, respectively, with evidence of dental decay. These figures are considerably lower than the figures reported in the present study on Icelandic children. The difference between the findings in these two studies ranges from 15.9 per cent for the four year olds to 20.5 per cent in the two year old children. The *Ast* study does not include examination of six and seven year old children.

The other two American studies listed in Table 18 report dental decay in six year old children. *Menezer* (1956) and *Savara & Suher* (1954) present nearly identical percentage figures (83.4 and 83.3) of six year old children with evidence of decay in the deciduous dentition. These figures are approximately 12.5 per cent lower than what was found in the six year old Icelandic children.

*Kruger* (1955) presented his findings from the examination of 536 three to seven year old Australian children. It may be ob-

served in Table 18 that the percentage of affected three, four, and five year olds is considerably lower than the prevalence rate in the Icelandic children. Although the six and seven year old Australian children show lower prevalence rates than the six and seven year old Icelandic children, the difference is not as marked as it is in the younger children.

*Parfitt* (1955) published the findings from a caries examination of over 1,600 two to seven year old English children. The percentage of affected English children is lower, at all age levels, than the rates of the Icelandic children. This difference ranges from 5.0 per cent in the seven year olds to 30.0 per cent in the three year old children.

The prevalence rates observed in three, four, and five year old German children, reported by *Hulsmann* (1960) are considerably lower than the results obtained in the Icelandic children at the same age levels.

The results of a caries examination reported by *Toverud* (1949) are not easily compared with the results of the present study. Toverud groups together two and three, four and five, and six and seven year old children. The percentage figures of affected children in these three age groups are: 35.0, 73.0, and 87.0, respectively. When compared to an identical age grouping of the children in the present study, the Norwegian children show substantially lower prevalence rates than the Icelandic children.

*Pedersen* (1944) has published the results of a survey of the dental conditions of two to six year old Danish children. The prevalence rates of these children, although lower at all age levels, approach the results obtained in the present study. The difference between the percentages of affected Danish and Icelandic children is 7.3, 10.1, 6.9, 6.2 and 0.3 in the two, three, four, five, and six year olds, respectively.

It is obvious that the percentage of children with decayed teeth in the two to seven year old Icelandic children is higher at all age levels, than the rates of children of the six other nationalities presented in Table 18.

The caries prevalence rates quoted for Norway and Denmark, however, may have been affected, to some degree, by the reduction in caries among children in these countries during World War II.

Table 19  
*Average number of dmj or def deciduous teeth in children of seven nationalities*

Nationality	Average number of dmj or def teeth per child, age							Author
	2	3	4	5	6	7	7	
American (Cleveland)	—	—	—	5.38	6.19	6.43	Fulton (1952)	
American (Hartford)	0.97	1.95	3.50	4.25	5.41	—	Menezes (1956)	
American (Illinois)	0.22	1.06	2.82	4.07	—	—	Fulton (1952)	
American (Oregon)	0.83	2.72	4.05	4.76	5.13	—	Savara & Suher (1954)	
American (Providence)	—	—	3.83	5.01	5.22	4.94	Clune (1957)	
Australian	—	2.70	4.20	5.40	—	—	Kruger (1955)	
Canadian	—	—	3.94	4.86	—	—	Compton <i>et al.</i> (1959)	
Danish	1.14	3.55	5.18	5.69	7.17	—	Pedersen (1944)	
English (Acerington)	1.03	1.75	3.58	4.16	—	—	Jackson (1952)	
English (London)	—	—	—	4.58	6.41	6.90	Parfitt (1954)	
Hungarian	0.78	1.99	3.19	4.40	4.85	—	Toth & Szabo (1959)	
Icelandic (present study)	2.31	5.20	6.67	7.02	7.75	7.67	Moller (1962)	

*Average Number of Decayed, Missing or Extraction-indicated, and Filled Deciduous Teeth:* A more revealing picture of the prevalence of caries in preschool children of seven nationalities is presented in Table 19.

The results of five caries studies on American preschool children are shown in Table 19. The highest prevalence, 0.97, def teeth per child, of the American two year olds, is found in the Hartford children examined by *Menezzer* (1956). The Oregon children seen by *Savara & Suher* (1954) had the highest def average figures for three and four year old American children viz. 2.72 and 4.05 def teeth per child at three and four years, respectively. The five, six, and seven year old children examined by *Fulton* (1952) in Cleveland had the highest def counts of the American children listed in Table 19. The highest scores of the American children were considerably lower than the dmf counts of the Icelandic children, at all age levels. The Icelandic children had from 1.24 to 2.62 more dmf teeth per child than the American children.

The three, four, and five year old Australian children examined by *Kruger* (1955) showed similar average numbers of affected deciduous teeth as the American children. This also held true for the four and five year old Canadian children reported by *Compton et al.* (1959), the two to five year old English children examined by *Jackson* (1952), and the five to seven year old London children observed by *Parfitt* (1954).

The two to six year old Hungarian children examined by *Toth & Szabo* (1959) had slightly lower def rates than the American children. The average count of defective deciduous teeth observed by *Pedersen* (1944) in two to six year old Danish children approximates the dmf rates of the Icelandic children most closely of the six nationalities considered. *Pedersen* reported average caries figures of 1.14, 3.55, 5.18, 5.96 and 7.17 per child for the two, three, four, five, and six year old Danish children, respectively. The average dmf counts for the Icelandic children were 2.31, 5.20, 6.67, 7.02, and 7.75 at the same age levels.

The average count per child of defective deciduous teeth in the Icelandic children was higher at all age levels than the figures obtained from caries studies of preschool children of six other nationalities listed in Table 19.

*DMF Permanent Teeth:* The average number of decayed, miss-

ing and filled (DMF) permanent teeth in five, six, and seven year old children of seven nationalities is presented in Table 20.

Four caries studies on American children are included in this table. The highest DMF count of five year old American children is reported by *Finn* (1947) in the Kingston study. *Savara & Suher* (1954) observed a high of 0.84 DMF teeth in the six year old Oregon children and *Clune* (1957) found a high of 1.69 DMF teeth in the seven year olds in Providence. The highest DMF count of the five year old American children is only 0.01 lower than the average DMF figure for the Icelandic five year olds. This difference increases greatly in the six and seven year old children. The average DMF figures for the six and seven year old Icelandic children is 0.50 and 1.07 higher than the DMF count in the six and seven year old American children. The five year old Canadian children examined by *Compton et al.* (1959) had a DMF count identical to that of the Kingston children. The five, six, and seven year old English children studied by *Parfitt* (1954) showed DMF average figures slightly lower than the highest scores observed in the American children. The five and six year old Hungarian children seen by *Toth & Szabo* (1959) had the lowest DMF figures of all the seven nationalities presented in Table 20. *Bazant & Miksa* (1961) in their report on a caries examination of Czechoslovakian children show the highest DMF count of six year old children encountered in the reviewed re-

Table 20  
Average number of DMF permanent teeth in children of seven nationalities

Nationality	Average number DMF permanent teeth, age			Author
	5	6	7	
American (Kingston)	0.19	0.39	1.09	Finn (1947)
American (New Jersey)	0.12	0.64	1.54	Wisn & Chilton (1948)
American (Oregon)	0.13	0.84	—	Savara & Suher (1954)
American (Providence)	0.12	0.65	1.69	Clune (1957)
Canadian	0.19	—	—	Compton <i>et al.</i> (1959)
Czechoslovakian	—	1.50	—	Bazant & Miksa (1961)
English	0.10	0.58	1.53	Parfitt (1954)
Hungarian	0.03	0.18	—	Toth & Szabo (1959)
Norwegian	—	—	2.70	Hougen (1958)
Icelandic (present study)	0.20	1.34	2.76	Moller (1962)

ports, including the present study. The seven year old Norwegian children examined by *Hougen* (1958) revealed an average DMF count of 2.70, only 0.07 lower than the average figure of the Icelandic children.

Five of the six nationalities considered in the comparison analysis of children with decayed, missing and filled permanent teeth, showed lower average DMF rates per child than the Icelandic children. Only the six year old Czechoslovakian children had a higher DMF count than the Icelandic children.

#### *Gingivitis*

A review of the literature discloses a scarcity of reports on the prevalence of gingival inflammation in the preschool age group. Most of the surveys on the periodontal status of children have been done on boys and girls of school age (*Day & Shourie*, 1947; *Messner et al.*, 1936; *Bruckner*, 1943; *Day*, 1940; *King*, 1945; *Schour & Massler*, 1947, and *Massler et al.*, 1950).

The results of four studies on the prevalence of gingivitis in preschool children are presented in Table 21 for comparison with the results obtained in the present study. Because of the lack of a uniform system of classification and examination for the evaluation of gingivitis in population groups, the simplest measurement of the prevalence, the percentage of affected children will be used in the comparison analysis.

*Massler* (1958) reported on the prevalence of gingivitis among 50,000 children in Chicago and Philadelphia. The prevalence rises from zero at three years to 5.0 per cent at five and further in-

Table 21  
*Prevalence of gingivitis in children of four nationalities*

Nationality	Percentages of children with gingivitis, age						Author
	2	3	4	5	6	7	
American (Chicago and Philadelphia)	—	0.0	—	5.0	—	38.0	Massler (1958)
American (Massachusetts)	—	—	—	22.3	20.7	12.0	Stahl & Goldman (1953)
Danish	1.8	5.9	10.6	12.9	24.7	—	Pedersen (1944)
English	0.0	11.4	12.9	18.5	27.9	31.4	Zappler & Person (1948)
Icelandic (present study)	10.3	10.3	20.0	22.0	22.6	19.1	Moller (1962)

creases to 38.0 per cent in the seven year olds. These prevalence rates reported by Massler are much lower for the three and five year old children than those observed in the Icelandic children. This is reversed at seven years, the American children showing twice as high a percentage of involved children as the Icelandic. The results of an examination of 2,610 five, six, and seven year old Massachusetts children was reported by *Stahl & Goldman* (1953). Their findings approximate the findings in the present study, the greatest difference, 7.1 per cent, being found in the seven year olds.

*Pedersen* (1944) reported on the prevalence of gingivitis in two to six year old Danish children. The prevalence rates of gingivitis in Danish children is considerably lower at two, three, four, and five years, than in the Icelandic children. This difference is reversed in the six year olds, the percentage of affected Danish children in this age group being slightly higher than the percentage of involved Icelandic children. *Zappler & Person* (1948) published the findings of an examination on two to seven year old English children. None of the two year olds showed clinical evidence of gingivitis. The four and five year old English children showed lower percentages of involved children than the Icelandic, but the rates were higher in the three, six, and seven year olds in England than in Iceland.

Clinical evidence of gingivitis is encountered more commonly in two to five year old Icelandic children than in American, Danish, and English children, according to the reports quoted in Table 21. The six year olds in these four countries appear to have similar prevalence rates, while the seven year old Icelandic children would seem to have a lower rate than the American and English children.

#### *Malocclusion*

There is only a limited number of published papers on the prevalence of malocclusion in preschool children. Table 22 shows the prevalence (percentages of affected children) of malocclusion in children of four nationalities, including the Icelandic children. *Cohen & Green* (1954) conducted a clinical examination of 443 four and five year old children in Massachusetts. Of

**Table 22**  
*Prevalence of malocclusion in children of four nationalities*

Nationality	Percentages of children with malocclusion, age						Author
	2	3	4	5	6	7	
American	—	—	34.5		—	—	Cohen and Gren (1954)
Danish	14.6	18.2	23.0	21.0	—	—	Pedersen (1944)
English	—	—	20.0	18.5	33.0	53.0	Miller & Hobson (1961)
Icelandic (present study)	17.2	20.0	19.4	17.4	22.5	19.1	Moller (1962)

these children, 157 or 34.5 per cent had malocclusion. This prevalence rate was approximately twice as high as the rate (18.5 per cent) found in the Icelandic four and five year olds. Distribution according to the three major classes of malocclusion (*Angle*, 1907) indicated that 67.3, 30.7, and 2.0 per cent of the 157 affected children had Class I, Class II, and Class III malocclusion, respectively. This distribution closely resembles the one observed in the present study.

The prevalence of malocclusion in two to five year old Danish children reported by *Pedersen* (1944) appears to be very similar to the findings reported for the Icelandic children. Unfortunately, *Pedersen's* paper does not lend itself to an analysis of the distribution of the different classes of malocclusion. *Miller & Hobson* (1961) have published a paper on the prevalence of malocclusion in four to seven year old English children. The percentage of affected English children is higher than was found in the present study of Icelandic children. The difference between these two groups is highest at seven years. The English report notes that 53.0 per cent of seven year olds are affected as compared to 19.1 per cent of the Icelandic children. Analysis of the distribution of the English malocclusion cases between *Angle's* three major classes shows that 67.0 per cent of the affected children had Class I malocclusion, with 29.0 and 4.0 per cent in the Class II and Class III categories, respectively. This ratio between the classes of malocclusion resembles that already observed in the American and Icelandic children.

The prevalence of malocclusion in Icelandic children is very

similar to the prevalence reported in Danish children, but considerably lower than the rates observed in the American and English children.

*Dental Anomalies*

The literature concerning dental anomalies in preschool children consists mainly of case reports. The limited number of frequency studies must be viewed with caution. Relatively rare conditions such as dental anomalies demand a large population sample for any conclusive statements on the prevalence rate.

Table 23 shows the frequency of dental anomalies (supernumerary teeth, congenitally missing teeth, and gemination and/or fusion) in preschool children of four nationalities. The differences in the frequencies of dental anomalies in American, Polish, Swedish and Icelandic children are very slight.

The highest percentage of children with one or more supernumerary teeth was observed in the Icelandic study, with the lowest frequency seen in the Polish children. The Polish children revealed the highest and the American children the lowest frequency of congenitally missing teeth. Double formation of the crowns of the teeth (gemination and fusion) was most frequently seen in the Swedish children. The Icelandic children had the second highest frequency of this anomaly reported in the four studies considered.

Table 23

*Frequency of dental anomalies in preschool children of four nationalities*

Nationality	Age	Super-numerary teeth	Cong. missing teeth	Gemination and fusion	Author
American	2-6	0.23	0.09	0.13	Menezes (1955)
Polish	2-6	0.20	0.70	0.10	Plaetschke (1938)
Swedish	3-5	0.30	0.40	0.50	Grahnén & Granath (1961)
Icelandic (present study)	2-7	0.80	0.20	0.20	Moller (1962)

Table 24  
*Annual consumption of sugar per person in Iceland 1703—1959*

Year	Sugar per person	
	Kilograms	Pounds (American)
1703	0.0	0.00
1800	0.2	0.44
1900	20.0	44.09
1910	24.0	52.91
1920	28.1	61.95
1930	39.2	86.42
1940	45.6	100.50
1950	39.8	87.76
1954	46.1	101.65
1955	45.2	99.67
1956	54.1	119.29
1957	56.2	123.92
1958	48.5	106.94
1959	55.3	121.93

#### SUMMARY AND CONCLUSIONS

This study was designed to investigate the prevalence of oral disease in Icelandic preschool children. The prevalence of dental decay, gingivitis, malocclusion, and other oral abnormalities were considered. The conclusions are based on examination of 609 children, two to seven years of age, residing in nine locations in Iceland.

Findings of the study are compared to those of other studies in North America, Australia and Europe. The most apparent difference in the oral health status of the nationalities considered was observed in the prevalence rate of dental decay. The Icelandic children show a much higher prevalence rate of dental decay than most of the other nationalities.

The increase in the percentage of caries-affected Icelanders from a virtual zero to a high of 90 per cent of the preschool population sample, within a span of one hundred years, appears to parallel the steady increase in consumption of refined carbohydrates by the Icelandic people. Approximately 200 years ago, the diet of the Icelandic people consisted of fish, lamb, potatoes

and dairy products. Sugar, coffee, candy and pastry were infrequent commodities. Table 24 shows the annual consumption of sugar per capita in Iceland from 1703 to 1959. It can be seen that the annual consumption of sugar per capita increased from 0.44 pounds in the year 1800, when dental decay was a rarity in Iceland, to 121.93 pounds in 1959, when the Icelandic people present one of the highest prevalence rates of dental decay reported. Similar findings are presented in a recent report (*Cromwell House*, 1961) on the deterioration of the dental health of inhabitants of Tristan da Cunha. The increase in caries on this island appears to parallel the increase in consumption of refined carbohydrates.

#### RÉSUMÉ ET CONCLUSIONS

#### ÉTUDES SUR L'ÉTAT SANITAIRE DE LA CAVITÉ BUCCALE DES ENFANTS ISLANDAIS D'ÂGE PRÉSCOLAIRE

Le but de cette étude a été de constater la fréquence des affections bucco-dentaires chez les enfants islandais d'âge préscolaire. On a examiné la fréquence de la carie, des gingivites, des malocclusions et autres anomalies de la cavité buccale. Les conclusions sont basées sur l'examen de 609 enfants âgés de 2 à 7 ans et habitant en neuf endroits différents d'Islande.

Les résultats de ces examens sont comparés aux résultats d'examens analogues faits en Amérique du Nord, en Australie et en Europe. La différence la plus frappante en ce qui concerne l'état sanitaire de la cavité buccale des diverses nationalités examinées a été celle trouvée pour la fréquence de la carie. La fréquence de la carie constatée chez les enfants islandais est beaucoup plus élevée que celle de la plupart des autres nationalités.

Il apparaît que l'augmentation du pourcentage d'Islandais atteints de carie, qui, partant d'à peu près zéro, a, en une période de 100 ans, atteint 90 % des enfants d'âge préscolaire, s'est développée parallèlement à la continuelle augmentation de la consommation d'hydrates de carbone raffinés par la population islandaise.

L'alimentation de la population islandaise consistait, il y a environ 200 ans, en poisson, agneau, pommes de terre et laitages.

Le sucre, le café, les confiseries et les pâtisseries étaient des produits rares. Le tableau 24 montre la consommation annuelle de sucre par habitant en Islande de 1703 à 1959. On constate que la consommation annuelle de sucre par habitant est passée de 0,2 kg pendant l'année 1800, où la carie était un phénomène rare en Islande, à 55,3 kg en 1959, où la fréquence de la carie chez la population islandaise se trouve être une des plus élevée qui ait nulle part été constatée. Des résultats analogues ont été communiqués récemment dans un rapport (*Cromwell House, 1961*) concernant le délabrement dentaire des habitants de Tristan da Cunha. Il apparaît que l'augmentation de la fréquence de la carie dans cette île se développe parallèlement à l'augmentation de la consommation des hydrates de carbone raffinés.

#### ZUSAMMENFASSUNG UND SCHLUSSFOLGERUNGEN

##### UNTERSUCHUNGEN DES GESUNDHEITZUSTANDES DER MUNDHÖHLE BEI ISLÄNDISCHEN KINDERN IM VOR-SCHULPFLICHTIGEN ALTER

Die Untersuchung bezweckte eine Feststellung der Häufigkeit, mit der Mund- und Zahnkrankheiten bei isländischen Kindern im vor-schulpflichtigen Alter auftreten.

Untersucht wurde die Häufigkeit von Karies, Gingivitis, Malokklusion und anderen Anomalien in der Mundhöhle. Die Schlussfolgerungen basieren auf einer Untersuchung von 609 Kindern im Alter von 2 bis 7 Jahren aus 9 verschiedenen Ortschaften in Island.

Die Untersuchungsbefunde werden mit den Ergebnissen entsprechender Untersuchungen aus Nordamerika, Australien und Europa verglichen. Der auffälligste Unterschied hinsichtlich des gesundheitlichen Zustandes der Mundhöhle bei den untersuchten Nationalitäten wurde in der Karieshäufigkeit festgestellt. Die isländischen Kinder weisen eine weit höhere Karieshäufigkeit auf als die meisten anderen Nationalitäten.

Es zeigt sich, dass die prozentuale Zunahme an kariesbefallenen Isländern von praktisch 0 % auf so viel wie 90 % der Kinder im vor-schulpflichtigen Alter innerhalb einer Zeitspanne von hundert Jahren mit dem stets zunehmenden Verbrauch des isländischen Volkes an raffinierten Kohlehydraten parallelläuft.

Vor rund 200 Jahren bestand die Kost des isländischen Volkes aus Fisch, Lammfleisch, Kartoffeln und Molkereierzeugnissen. Zucker, Bohnenkaffee, Zuckerwaren und Gebäck waren seltene Waren. Tafel 24 zeigt den jährlichen Zuckerverbrauch pro Einwohner in Island von 1703 bis 1959. Man sieht, dass der Jahresverbrauch an Zucker pro Einwohner von 0,2 kg im Jahre 1800, als Karies auf Island eine Seltenheit war, auf 55,3 kg im Jahre 1959 anstieg, wo das isländische Volk eine der grössten Karieshäufigkeiten aufweist, die je in einem Land vorgefunden ist. Entsprechende Resultate wurden kürzlich in einem Bericht (*Cromwell House*, 1961) betreffend den Zerfall der Zähne bei den Einwohnern der Insel Tristan da Cunha mitgeteilt. Es zeigt sich, dass der Anstieg in der Karieshäufigkeit auf dieser Insel mit einem zunehmenden Verbrauch an raffinierten Kohlehydraten parallelläuft.

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