

Common infections during the first five years of life*

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INTRODUCTION AND METHODS

The object of this study was to obtain an insight into the morbidity of common infections in infants and children up to the age of 5 years. For this purpose observations were made from the day of their birth on 116 infants from 116 different families belonging to my own general practice. The investigation started in June 1951 and was completed in July 1959. The plan was explained to the parents in detail to obtain their full co-operation and one of them—either the mother or father—was asked to maintain a written record over the period of the 5 years of the nature and duration of any affection suffered by any member of the family, but with special reference to the infant who was the main subject of the inquiry. In addition to my own records, each family record was checked every 6 weeks by myself and more often where necessary. The morbidity data on the other members of the family are not the direct concern of this communication but are contained in a more comprehensive report (Pel, 1960). In a routine inquiry of this nature, even when full bacteriological and virological laboratory facilities are available, it is not possible to make an exact aetiological diagnosis in the majority of minor infections and in this study no attempt to do so has been made. Instead a simple and practicable method has been adopted for the classification of the common infections under five headings: (1) common colds, (2) other respiratory infections, (3) infections of the digestive tract, (4) infections of the skin and mucosa, and (5) infectious diseases in the restricted sense.

(1) *Common colds*

The term common cold is used to refer to nasal catarrh and/or coughs without defining a period of time, sometimes associated with a sore throat but without any significant disturbance of the general well-being.

(2) *Other respiratory infections*

This category includes all infections of the upper and lower air passages except common colds and also those cases of pyrexia of unknown (obscure) origin—PUO.

(3) *Infections of the digestive tract*

This group refers to periods of vomiting with or without diarrhoea and with or without pyrexia.

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(4a) *Skin infections*

This term is used exclusively for pyodermia—skin infections mainly caused by staphylococci and to a less extent by streptococci.

(4b) *Mucosal infections*

In this study such infections were confined to conjunctivitis and gingivostomatitis.

(5) *Infectious diseases in the restricted sense*

This group includes the conditions set out in Table 2. The undifferentiated exanthemata cover all exanthematous affections, except measles, rubella and scarlet fever. The majority of these cases were probably examples of *exanthema subitum*.

RESULTS

The frequency of the various groups of infective conditions per year of life is set out in Table 1 and the frequency on a three-monthly basis is shown in Fig. 1.

Common colds

In the first few months of life, common colds were relatively infrequent (an average of 1.9 incidents per infant per year), but there was a considerable increase in frequency during the remainder of the first year and the increase continued

Table 1. *Frequency of common infections during the first 5 years of life*

Year of life	Average number of affections per child per year					
	Common colds	Other respiratory infections	Infections of the digestive tract	Skin infections	Mucosal infections	Infectious diseases in restricted sense
1	3.1	0.3	0.6	0.3	0.3	0.2
2	4.3	0.8	1.2	0.2	0.3	0.3
3	4.0	1.1	1.1	0.2	0.3	0.3
4	3.6	1.4	1.2	0.2	0.1	0.4
5	3.5	1.8	1.2	0.1	0.1	0.6

throughout the second year reaching a maximum in the early part of the third year (an average of 4.6 colds per infant per year). Thereafter the incidence began to decline as the age increased. Data with regard to other members of the families showed that the declining incidence continued beyond the fifth year to an average minimum of 2.0 colds per adult per year.

Other respiratory infections excluding common colds

In this group there were 637 incidents among the 116 children in the first five year period. The distribution of the different types of infection was: undifferentiated respiratory infections, 42 %; PUO, 23 %; otitis media, 17 %; tonsillitis, 11 %; and influenza, 7 %. These affections were not very common during the first 6

months of life, but with increasing age they gradually became more frequent. Fig. 1 suggests that the maximum incidence of these infections was reached by the fifth year and this is confirmed by the data obtained from other members of the families. Children attending kindergarten had the highest incidence (an average of 1.52 incidents per child per year) and this decreased with advancing age to 1 incident every second year in adults.

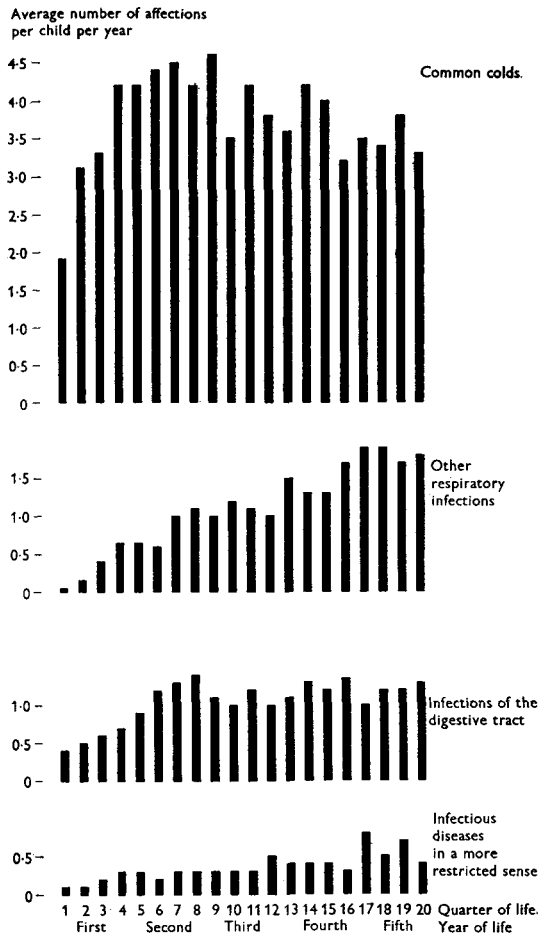


Fig. 1

If the common colds are grouped together with other respiratory infections the incidence in the first year averaged 3.4 per infant, rising to 5 during the second year and remaining at this level until the fifth year, after which they became less frequent.

Gastro-intestinal infections

The incidence picture of these infections during the first 5 years of life was very similar to that of the respiratory infections. In the first year the attacks averaged 0.6 per infant, rising to 1.2 in the second year and the incidence then was fairly

constant for the next few years. Children in the 6–12 year age-group were less frequently attacked and the average number of incidents was 0·8 per child per year.

Skin and mucosal infections

While most of the common infections showed the lowest incidence during the first few months of life in the 0–5 years age-group, suppurative skin infections in the young infant were relatively commoner than those found during the remaining period of the first 5 years, in which the frequency levels were fairly constant. Data collected from other members of the family groups indicated that the normal school-year period showed an unmistakable increase in the frequency of skin infections; after this period the incidence decreased.

With regard to infections of the oral mucosa, 21 % of all children in the 0–5 year age-group were affected and the maximum incidence occurred during the third year. Conjunctivitis was more frequent and 42 % of the children were attacked at least once, often more frequently, during the period especially during the first 2 years.

Table 2. *Cumulative percentage of children with a history of various infectious diseases between age 1 and age 5*

Authors ...	Personal observations					(Miller	(Dykes	(Douglas &
	1951–59					<i>et al.</i> 1960)	<i>et al.</i> 1953)	Blomfield
Period studied ...	Middelburg					Newcastle	Luton	Gt Britain
Area studied ...	1	2	3	4	5	5	5	5
Years of life ...	1	2	3	4	5	5	5	5
Measles	3	12	22	31	49	64	46	55
Rubella	3	11	16	21	26	15		
Undiff. exanthema	9	12	16	20	24			
Chicken-pox	4	8	17	30	46	28	14	
Parotitis	—	2	3	5	17	13	10	20
Pertussis	—	—	1	2	3	46	32	

Infectious diseases in the restricted sense

In Table 2 the percentage incidence in each year, 1–5 age-groups, of measles, rubella, chicken-pox, parotitis, pertussis and undifferentiated exanthema is set out together with some comparable data from Great Britain. In addition to the six diseases listed there were two cases of scarlet fever, one of infectious hepatitis and one of poliomyelitis, all in children aged 5 years. There was also a case of bacterial meningitis in an infant less than 1 year old. At the end of the 5 year period of observation for each child in the original study group of 116, 92 together had a total of 208 attacks of these infectious diseases. The relatively low incidence for the bacterial infectious diseases was a striking feature. There were no cases of diphtheria in the group studied and only six cases of pertussis; the immunization standard against these two infections was high and 107 of the 116 children could be said to have been fully immunized.

Factors influencing morbidity

The possible influence on the morbidity of these common infectious conditions was examined with regard to a number of factors, such as breast feeding, kindergarten attendance, sex, family size, standard of hygiene in the family, seasonal influence. The first two factors were studied over the first and fifth years respectively, while the other factors were studied over the whole of the first 5 year period. For this purpose the 116 children were divided into equal sized groups on the basis of different criteria for the study of each of the factors being investigated (see Fig. 2).

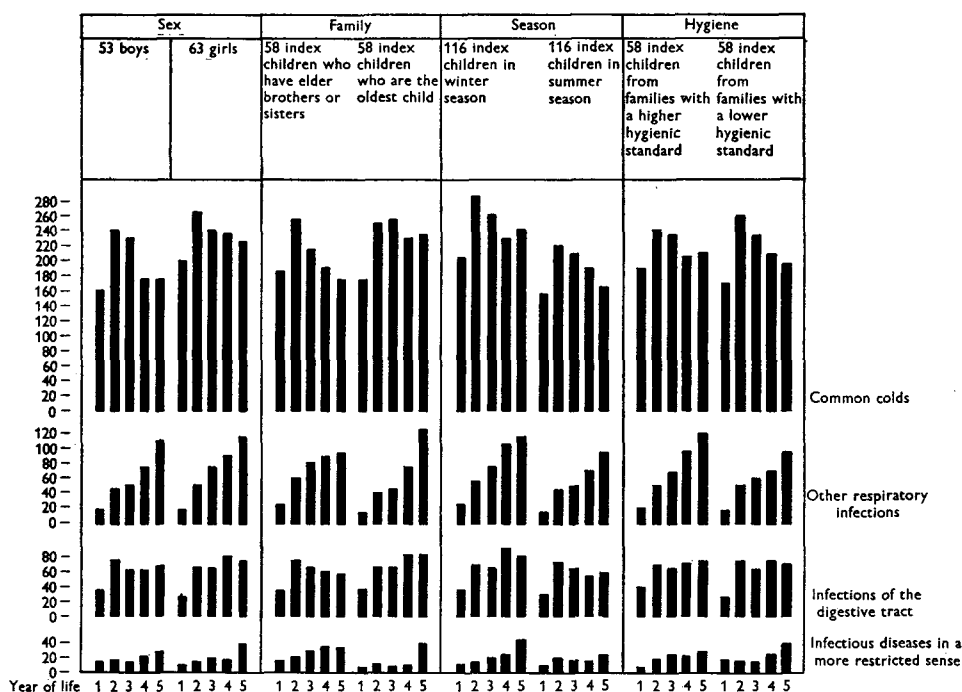


Fig. 2

Duration of breast feeding

Of the 116 infants 94 % were breast-fed for more than 1 week, 69 % for 5 weeks, 50 % for 13 weeks and 32 % for about 26 weeks. After the age of 42 weeks breast feeding was discontinued for the remaining 2 % of the infants. The morbidity in 58 infants breast-fed for 13 weeks or less (average 5½ weeks per child) was compared with that in 58 children completely or partly breast-fed for 13 weeks or more (average 28½ weeks). Apart from a lower incidence of skin and mucosal infections in infants in those predominantly breast-fed for longer periods (of doubtful significance owing to the small numbers involved) there was no indication that the duration of breast-feeding had any influence on the incidence or severity of the common infections during the first year of life.

Influence of the kindergarten

The morbidity during the fifth year of 55 children who started at kindergarten at the age of 3 years and 10 months was compared with that of 61 who first attended kindergarten at the age of 4 years and 7 months. There was no significant difference in the frequency of common colds, gastro-intestinal or mucosal infections between those who attended kindergarten before the age of 4 years and those who were still at home at that age, but there were, unmistakably, higher incidences among those who started attending kindergarten at the earlier age with regard to respiratory infections (other than the common cold), skin infections and the specific fevers.

Sex influence

There was no indication that sex played any part in the incidence of the specific fevers, or the respiratory infections. Gastro-intestinal and mucosal infections were slightly more frequent among the boys, but skin infections were definitely more common among the boys, which is probably associated with the greater accident-proneness of boys and the subsequent secondary infection of the lesions resulting from such accidents.

Family size

The morbidity of common infections was studied in two groups of children (58 in each group), the first comprising families in which the index child was the first born and the second in which there was, at least, one other older child. Common colds and gastro-intestinal infections were more frequently noted during the first 2 years of life of children belonging to families in which there were also older children than those without older brothers or sisters. These infections were, however, more common in the single-child group during the third, fourth and fifth years. It is suggested that the single child is less exposed to the risk of these infections during the first years of life than the child with older brothers and sisters and that the difference in the incidence of these infections at different ages is directly related to degree of risk of exposure to infection. In the same way the degree of risk of exposure to other respiratory infections and the specific fevers was much greater in the case of children with older brothers and sisters than the single child. Thus the incidence of the respiratory infections and the specific fevers was less in the single-child group than in the other group during the first four years, but was greater during the fifth year.

Skin infections during the first year of life were equally common in the two groups, but after that age they were more frequent in those with older brothers and sisters.

In general it was observed that the presence of older siblings in the family caused a shift of the onset of all common infective conditions to an earlier age.

Influence of standard of hygiene in the family

The standard of hygiene practised in the 116 families was assessed on my own observations and personal knowledge of the families concerned and two groups, 'high' and 'low' hygiene family groups with 58 families in each group, were formed in order to find out whether there was any correlation between standards of family hygiene and the incidence of the common infections. In general it was found that in families where the standard of hygiene was low the records of the child's illnesses were less accurate than those of families whose hygiene standards were high. Associated with this lack of care there appeared to be a certain amount of under-notification of illnesses, and at the same time an increase in the incidence of septic skin conditions. But apart from these, there were no significant differences in the incidence of other infections, including gastro-enteritis.

Seasonal influence

In comparing winter morbidity (1 October to 1 April) with the summer morbidity, common colds had an unmistakable predilection for the winter months and this would have been more marked had the 'winter' months included September. The graphs recording the number of fresh colds per week per family member showed that in each year the peak incidence occurred in the second to third week of September. After this the number of new colds remained at a relatively high level for 8-9 months with minor peaks every 6-8 weeks; the minimal incidence occurred in June, July and August.

Table 3. Total number of 'other' respiratory infections during the first 5 years of life in the winter and the summer season in 116 index children

	6 summer months	6 winter months
Undifferentiated respiratory infection	104	164
Tonsillitis	37	30
Otitis	36	72
Pyrexia of obscure origin	90	59
Influenza	5	40
Total	272	365

The other respiratory diseases were more common in the winter months but the seasonal influence was not always the same for all conditions under this heading (see Table 3). Undifferentiated respiratory infections, otitis media and influenza were more frequent in winter. Tonsillitis was equally common in winter and summer and gastro-intestinal infections were slightly more common during the winter months for the younger children and more definitely so in the fourth and fifth years of life. There was no seasonal incidence in the case of conjunctival or skin infections. Gingivitis was more common in summer and the so-called PUO group, which probably includes a considerable number of enterovirus infections (poliomyelitis, Coxsackie and ECHO viruses) was more frequently encountered during the summer months.

The specific infectious diseases are not suitable, in a study of this sort, for the determination of seasonal influence since they tend to occur in epidemic form so that the overall incidence may be very high one year and very low the next year and an analysis of relatively small numbers of children might well give misleading information.

DISCUSSION

In planning an investigation of the sort described in this paper it was obviously not feasible to deal with an unselected population and since much of the information required depended on detailed records maintained by the parents of the children being investigated it was necessary to select families where the wife, at any rate, was fully co-operative and reasonably intelligent. All the families selected were economically in comfortable circumstances and settled in their homes where they remained for the period of the study. All the newly born infants accepted for study were personally delivered by the author himself. The practice itself was a typical family practice in which all the members were well known to me personally; of the families selected for the study described 19% came from employees and self-employed people, 46% from professional or salaried classes and 35% from the so-called working class.

One of the objections to this study is that although the main observer trained and advised each family observer and frequently checked the observations recorded, a very great deal depended on the intelligence and interest of the parents who compiled and maintained each family record. The ability to recognize some of the very mild illnesses suffered by the children is a faculty which cannot readily be standardized and the results of all investigations of this sort can have only a relative significance.

Since the methods used in the various morbidity studies are so widely diverse, it is difficult to compare results of different investigations. Spence, Walton, Miller & Court (1954) found a frequency of 0.7 respiratory infections for the first year of life, and one of 4.4 for the first five years of life. In this study, in the course of which families were visited once in every seven weeks, mild common colds were not taken into consideration. Dykes, Grundy & Lewis-Faning (1953), who visited their families only once a year, found only 0.2 respiratory infections per infant during the first year of life. Van Volkenburg & Frost (1933), investigating 114 Baltimore families, found values well corresponding with ours, viz.: 1.92, 5.14, 4.50, 4.18 and 5.00, respectively, for the first five years of life.

The very exactly planned study made by Dingle, Badger, Feller, Hodges, Jordan & Rammelkamp (1953*a, b, c*), however, yielded unmistakably higher figures (6.9, 8.3, 8.5, 8.6 and 8.1, respectively, for the first five years of life). Brimblecombe, Cruickshank, Masters, Reid & Stewart (1958) found the largest number of respiratory infections in the age-group 0-4. Further analysis within this group showed no definite peak.

The frequency of gastro-intestinal catarrh according to Dingle *et al.* (1953*a, b, c*) and Hodges, Corkle, Badger, Curtiss, Dingle & Jordan (1956) was 1.2 per child during the first year, rising to a maximum of 2.6 during the fourth year and then

decreasing to an average of 0.9 per year in the 10-year-old. The Newcastle investigation (Miller, Court, Walton & Knox, 1960) revealed 100, 169, 277, 142 and 105 infections of the digestive tract in 847 children during the first five years of life. Sydenstricker (1925-1928) found a maximum frequency of gastro-enteritis in the 3-4 year group. In this study the frequency of these affections in age-group 0-4 was 13 per 100 per year.

No comparative figures are available for skin infections and conjunctivitis.

Stomatitis was found in 13.5% of children in the Newcastle study (Miller *et al.* 1960) before the fifth birthday; in the present series the affection showed a predilection for the second year of life. Table 2 presents a few comparative figures on infectious diseases in the restricted sense.

A number of recent investigations (Miller *et al.* 1960; Stewart & Westropp, 1953; Levin, MacKay, Neill, Oberholzer & Whitehead, 1959; Mellander, Vahlquist & Melbin, 1959) have confirmed the fact that the duration of breast feeding in contemporary western European society no longer has an unmistakable effect on the incidence of common infections.

Brimblecombe *et al.* (1958), Dingle *et al.* (1953*a, b, c*) and Miller *et al.* (1960) found that respiratory infections were equally frequent in boys and girls. Sydenstricker (1925-1928) and van Volkenburg & Frost (1933), however, saw a male predominance.

With regard to gastro-intestinal infections Miller *et al.* (1960), in the Newcastle investigation, found no difference in frequency between the two sexes. The Cleveland investigation again showed a male predominance. No comparative figures are available on the other common infections.

Little is known about the influence of family size on the frequency of common infections.

Van Loghem (1928), studying common colds, found no difference in frequency between members of large and those of small families. Dingle *et al.* (1953*a, b, c*), however, mentioned that the frequency of common respiratory infections was influenced by family size. Families of 3 averaged 4.4 respiratory infections per person per year, as against an average of 6.7 in families of 5 members.

The Newcastle investigation revealed no difference in the frequency of gastro-intestinal infections between large and small families. Dingle found a higher frequency in pre-school children with than in pre-school children without older sisters and brothers.

Because Dingle *et al.* (1953*a, b, c*) and van Volkenburg & Frost (1933) confined their investigations to families of the higher income groups, they were unable to study a possible influence of hygiene on morbidity. Brimblecombe *et al.* (1958), who studied twelve social factors, found that of these, only insufficient housing accommodation and insufficient clothing somewhat increased the incidence of respiratory infections. Dykes *et al.* (1953) was unable to demonstrate a correlation between social class and morbidity. The Newcastle investigation likewise failed to reveal a correlation between the total number of respiratory infections and the occupational grouping. Such a correlation was, however, demonstrable for infections of the lower respiratory tract (pneumonia and bronchitis).

In the last mentioned study, gastro-intestinal infections and skin infections

were more frequently seen in insufficiently accommodated families and in families in which maternal care was insufficient.

There is general agreement as to the fact that respiratory infections in general are typical winter illnesses.

Dingle and van Volkenburg found calendar fluctuations in common cold frequency virtually identical with our findings. A Danish inquiry (Jacobsen, 1959) showed that only 5% of all common colds occurred during the three summer months, as against 30% during each of the three other seasons. Tonsillitis—not demonstrably subject to seasonal influences in our series—in the Newcastle investigation also occurred relatively constantly throughout the year. The family investigation by Brimblecombe *et al.* (1958) revealed no definite correlation between season and the presence of streptococci in the throat. The predilection of obscure febrile affections for the summer months was also demonstrable in English general practice. Logan & Cushion (1959) report that 'pyrexia of unknown origin' was preponderant in the period June to October. Dingle's Cleveland investigation showed a marked increase in gastro-intestinal infections during October and November, with a decrease in the remaining winter months and during springtime to a summer minimum. Norval & Kennedy (1949) observed that gastro-intestinal infections during the first year of life were not subject to seasonal influences, while the English morbidity statistics (Logan & Cushion, 1959) show that 'winter vomiting disease' (Goodall, 1954) had its maximum during October, November and January.

Of course it cannot be excluded with certainty that re-opening of the schools in September may influence the frequency of respiratory infections by increased risk of contamination. In our series, however, seasonal differences were demonstrable from the first years of life onward.

The striking parallelism between the epidemiological aspects of common colds and gastro-intestinal catarrhs in infants, which we believe is demonstrated in our study, was also found in the Cleveland study (Hodges *et al.* 1956), in which the authors report: 'There are many epidemiologic similarities between gastro-intestinal illness and the common respiratory diseases in this population'.

In our series the children with a higher frequency of common colds also showed a higher frequency of gastro-intestinal symptoms but no higher frequency of other minor infections.

SUMMARY

Of the ordinary infections sustained by children during the first 5 years of life 56% were common colds, 16.5% other infections of the respiratory tract, 16% gastro-intestinal catarrhs, 6% infections of the skin and mucous membranes and 5.5% infectious diseases in a strict sense.

Common colds were most frequent in the second year, namely, an average of 4.3 common colds per child per year. As the child grew older the number of colds decreased. Adults showed an average of two common colds per year.

Of the 'other infections of the respiratory tract', 42% were undifferentiated respiratory tract infections, 23% febrile affections without definite localization,

17% otitis, 11% pharyngitis and 7% influenza. The frequency of these 'other infections of the respiratory tract' rose from 0.3 in the first to 1.8 in the fifth year of life. After the fifth year the frequency diminished to one infection every 2 years in adults.

The frequency of gastro-intestinal catarrhs in the first year of life, namely, 0.6 per child per year, was doubled in the second year, and then remained constant for a few years. After the fifth year a decrease was observed in this figure too.

Fifty-four per cent of the 116 index children sustained at least one suppurative skin affection during the first 5 years of their lives, 28% had more than one. Most pyodermias occurred in the first few months of life, a second maximum being observed in schoolchildren, 21% of the index children had stomatitis in the first 5 years, 42% conjunctivitis.

By their fifth birthday, 49% of the 116 children had had measles, 46% chicken pox, 26% rubella, 24% exanthema subitum, 17% mumps, 3% whooping cough, while 2 of the 116 children had had scarlatina, 1 child hepatitis, 1 poliomyelitis and 1 bacterial meningitis.

No difference in morbidity was found between boys and girls in respect of respiratory tract infections. The boys had skin infections distinctly more often than the girls, and infections of the mucous membranes and of the gastro-intestinal tract were also slightly more frequent in boys. Apart from infections of the skin and mucous membranes, which were more often observed in mainly bottle-fed children, ordinary infections were equally frequent in this latter category and in children mainly breast-fed.

The index child with older brothers and sisters contracted the ordinary infectious diseases younger than the index child who was the eldest child in the family. On account of the presence of older children in the family, a child was ill not more often, but earlier. The infections of the respiratory tract showed a distinct preference for the winter months, and the frequency of gastrointestinal infections was also slightly higher in that season.

Febrile affections without definite localization, as well as infections of the oral mucosa, occurred especially during the summer months.

Going to the kindergarten did not lead to an increase of the frequency of common colds and gastro-intestinal catarrhs, but the number of infectious diseases in a strict sense became higher. The 'other infections of the respiratory tract' became more frequent under the influence of school only in those index children who were the eldest in the family. The index children from families with a low level of hygiene experienced more infections of the skin and mucous membranes than those from families with a high hygienic level.

No difference between these two groups was demonstrable in regard to the other ordinary infections.

There was a parallelism between the frequency of common colds and of gastro-intestinal catarrhs but not with the other minor infections.

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