"COMMON COLD" AND HOUSING CONDITIONS IN SINGAPORE

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INTRODUCTION

This is a report on a study into the relation of housing conditions and morbidity caused by the "common cold" in a tropical city.

The present study was undertaken within the framework of a multi-phased survey to investigate the influence of re-housing on disease patterns.

As in former studies by the author (*Kleevens*, 1966, 1967, *Kleevens* and *Lee*, 1966), two populations were compared: Chinese children up to the age of 13 years living in Housing Board flats (with modern sanitation) and a comparable group living in an adjacent squatter area. Both groups of children belonged to low-income families living in the Bukit Ho Swee Area in Singapore. Period of study was 12 weeks, from mid-September to mid-December 1965.

The objective was to study the influence of housing conditions on the morbidity experience of children in relation to a common predominantly airborne transmitted disease. Because the period of observation had to be limited the disease chosen had to be one with a conveniently acute onset and of a reasonably short duration. To allow for multiple and reinfections as an indication of the degree of risk to airborne transmission the disease had also to produce negligible residual immunity or a condition resembling it. If, for instance, a syndrome can be induced by a number of agents, a quick succession of infections by the various agents might give the impression that none of the infections left a considerable state of immunity. In fact, however, the individual may have developed sufficient immunity against each of the agents separately. In addition, the source of infection had to be man.

The "common cold" fitted the requirements most suitably, even though its transmission might not occur exclusively by droplets or droplet-nuclei.

In temperate climates respiratory tract infections are an important cause of morbidity. All age-groups are affected, the youngest and the oldest more than the other. Mortality due to these diseases follows the same pattern. In the two decades after the Second World War there has been an increased interest in the epidemiology of respiratory tract infections. This is reflected in a series of reports published (e.g. *Andrewes*, 1949, *Lidwell & Sommerville*, 1951, *Badger* et al. 1953, *Buck*, 1956, *Hope-Simpson*, 1958). An admirably comprehensive account of research and knowledge about "common cold" and related diseases was given recently by *Tyrrell* (1965).

The incidence of upper respiratory tract infections in a sample population in Singapore has been reported by *Lloyd Davies* and *Mills* (1961). In a two-year period they found these diseases to top a list of 20 groups of selected diseases, infectious and non infectious.

Another investigation carried out in a tropical area is discussed by *Tyrrell* (1965, page 30): *Sutton* compared incidence of colds in families in Britain and Trinidad. He found similar seasonal fluctuations in both areas. It was suggested that as far as weather conditions are concerned, temperature itself might not be of importance but rather a drop in temperature. It is interesting to note that in *Sutton's* studies the overall incidence was not much different in both areas. A full account of *Sutton's* studies was not available. Without further details (e.g. the composition of his two populations), no conclusions can be drawn.

Evans et al. (1967) compared acute respiratory disease patterns and incidence in students at the University of the Philippines with those in students at the University of Wisconsin (U.S.A.). Respiratory infections were a common cause of hospital admission in both institutions.

The majority of the respiratory tract infections can be conveniently grouped under the name Acute Viral Respiratory Disease including Acute Febrile Respiratory Disease and Common Cold. (A.P.H.A. (1965) Control of Communicable Diseases in Man, Tenth Edition). Occurrence of this group of respiratory diseases is worldwide except for small isolated communities.

Some 20 or more virus serotypes of myxovirus, adenovirus and picornavirus families are the etiologic agents of Acute Febrile Respiratory Disease. Causative agents of the "common cold" include 50 or more rhinovirus types, ECHO 28 and Coxsackie A21 of the picornavirus family.

Material and Methods

The heads of households and housewives included in the previous surveys were approached again and their participation obtained. For reasons previously explained (*Kleevens*, 1967), the number of families in each study area had to be limited to approximately 150. The selection of these families was made randomly from those willing to be included again.

The families were visited once every two weeks by experienced field investigators who could speak the necessary Chinese dialects.

A "cold" was defined as: Any disease or condition that was felt as such and was associated with a running nose. In the different Chinese dialects "cold with running nose" is a well understood condition and is distinctly differentiated from syndromes associated with allergic rhinitis. Cough, general malaise, chilliness and fever were recorded as associated symptoms but not insisted upon for the diagnosis of a "cold". During the home-visits the field investigators inquired into the disease experience of members of the family (0-13 years) during the past fortnight and recorded the number of sick-days for each spell (running nose). The survey was kept this simple in order to maintain full co-operation of the housewives. A "cold" was limited to the running nose type because this is a syndrome familiar even to the less educated, an important advantage as far as our sample population was concerned.

A spell was considered "new" in the same child when the mother was certain that between the present and the previous spell there was *at least one* symptomless day, or when the mother was convinced that the more recent spell was indeed an additional experience for the child. At interviews some mothers could not remember whether her child had at least one symptomless day but were for themselves convinced that the new spell should be clearly distinguished from the previous one. *Hope-Simpson* (1958) carrying out a survey on colds in families in which symptoms were recorded by members of the family also used a break of symptoms of at least 24 hours. It was anticipated that the relative privacy of families in flat-dwellings would result in more accurate observations by mothers.

Whenever applicable and relevant the chi-square test was used to test the significant level of the recorded and calculated differences. When P was found to be 0.05 or less, the difference was called statistically significant, and, when P was 0.01 or less, highly significant.

FINDINGS

Table I and Figure 1 show the morbidity for "colds" in the two populations during the survey period. The grouping into unconventional age-groups needs some explanation. It was felt that infants should be kept as a separate group because of their very close relationship with the mother and the limited physical contact with other members of the family. The next group (1, 2 & 3 years) include the very young children in the family whose movements are not so restricted but are assumed to have limited contact outside the household. The "pre-scholars" (4 & 5 years of age) have more extensive contact with the outside world (e.g. in corridors and staircases with neighbours etc.). The 6-year old children might be called "first scholars" children in their first year of intensive group contact outside the household. The last age-group are the "established scholars".

Spells: Under the age of 4 years, both flat-dwellers and squatters had proportionally the same number of spells. Peak rates occurred among the young toddlers. The "pre-scholars" experienced less spells, the fall in incidence for flat-dwellers was much steeper than that for squatters. The difference between the two was highly significant ($P<0.01$).

While the "first scholars" among flat-dwellers showed a rise in incidence, squatters of the same age-group remained on the same level as the preceding age-group. The difference, although marked, was statistically not significant ($0.50>P>0.30$). Among the "established scholars" the rates were the lowest in both groups for the whole series. The difference between the two rates was significant ($0.02>P>0.01$). The incidence (totals) for squatters was significantly higher than for flat-dwellers ($0.02>P>0.01$).

Persons: The same pattern as described above was observed for the incidence of sick persons. A statistically highly significant difference was found among the "pre-scholars" ($P<0.01$) and a marked difference was found among the "established scholars" ($0.10>P>0.05$).

As regards the *number of spells per sick child*, not much variation was recorded between the different age-groups among flat-dwellers. For squatters sick children of the age of 6 years experienced many more spells than younger or older children.

The *average duration of spells* on the whole was longer for flat-dwellers than for squatters.

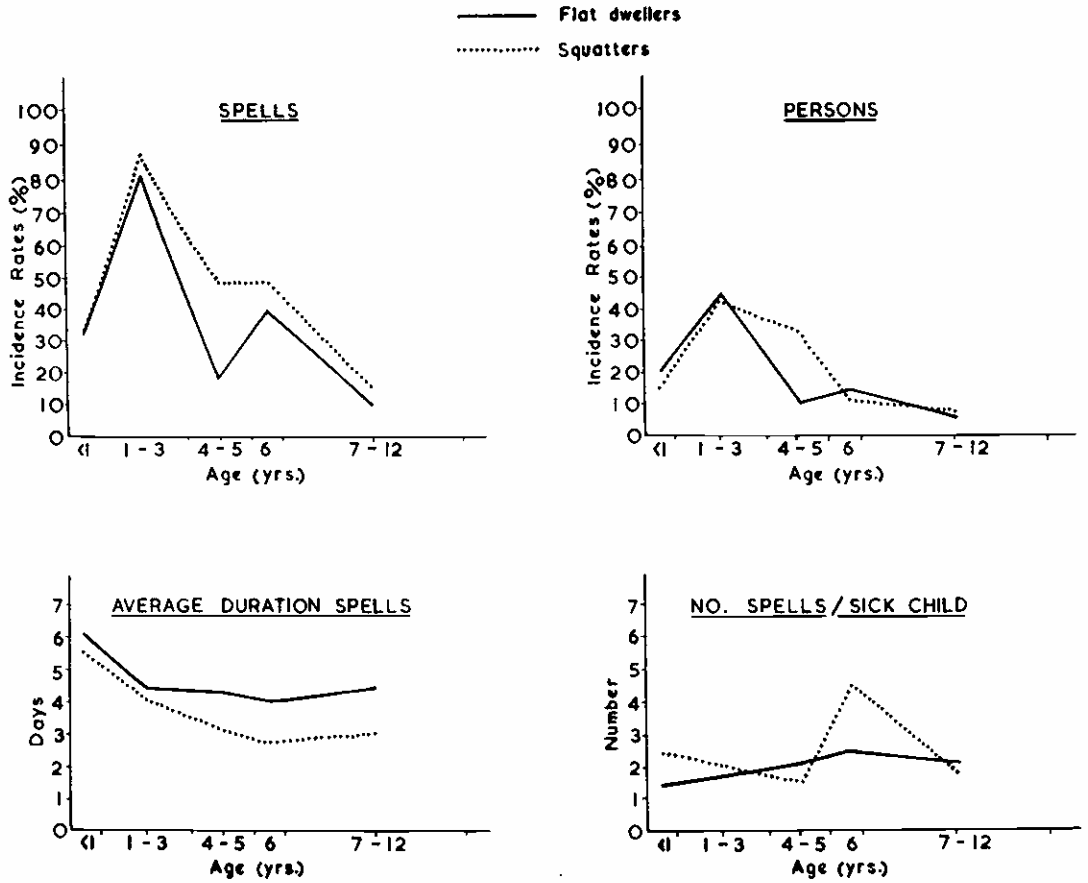
TABLE I

"COLDS", SINGAPORE, BUKIT HO SWEE AREA, CHINESE CHILDREN O-12 YEARS
(SEPTEMBER — DECEMBER 1965, 12 WEEKS OBSERVATION PERIOD)

AGE-GROUPS (Year of Birth)	FLAT-DWELLERS								SQUATTERS							
	No. of Children Observed	Reported No. of Spells	No. of Sick Children	Incidence Rates Spells (%)	Incidence Rates Persons (%)	No. of Spells p. Sick Ch.	No. of Sick Days	Average Duration Spells (Days)	No. of Children Observed	Reported No. of Spells	No. of Sick Children	Incidence Rates Spells (%)	Incidence Rates Persons (%)	No. of Spells p. Sick Ch.	No. of Sick Days	Average Duration Spells (Days)
Under 1 year* (1965)	25	8	5	32.0	20.0	1.6	49	6.1	37	12	5	32.4	13.5	2.4	68	5.7
1, 2 and 3 years (1964, 1963, 1962)	143	118	64	82.5	44.8	1.8	544	4.6	121	105	52	86.8	42.9	2.0	444	4.2
4 and 5 years (1961, 1960)	118	23	11	19.5	9.3	2.1	102	4.4	95	45	30	47.4	31.6	1.5	137	3.0
6 years (1959)	28	11	4	39.3	14.3	2.8	44	4.0	47	23	5	48.9	10.6	4.6	63	2.7
7 to 12 years incl. (1953-1958)	246	15	7	6.1	2.8	2.1	67	4.5	227	29	15	12.8	6.6	1.9	88	3.0
TOTAL	560	175	91	31.3	16.3	1.9	806	4.6	527	214	107	40.6	20.3	2.0	800	3.7

* There were 7 children among flat-dwellers and 15 among squatters born during the survey period and thus not observed for the full 12 weeks.

FIG. I. MORBIDITY CAUSED BY "COLDS" BUKIT HO SWEE AREA SINGAPORE, SEPTEMBER - DECEMBER 1965.



Generalising it can be said that more squatters had colds than flat-dwellers; sick children from both environments had the same average number of spells and in flat-dwellers the "colds" lasted longer.

TABLE II

RELATION BETWEEN DISEASE-EXPERIENCE ("COLD") AND HOUSING

	Flat-dwellers	Squatters
No. of children	560	527
No. of houses*	149	56
Children per house	3.8	9.4
No. of houses with "cold"	87 (58.3%)	33 (58.9%)
No. of spells	175	214
No. of spells per house	2.0	6.5

* A house in the squatter-area usually had subpartitioning into smaller units each containing one family (household), while each flat contained one family (household) only.

Table II shows the relation of observed morbidity with housing available to each group under study. Density of children per house among squatters was 2.6 times that among flat-dwellers. Morbidity-experience per house among squatters as expressed in spells per house, was 3.3 times that among flat-dwellers. This may suggest that the higher morbidity experience among squatters was a function of density of children per house.

When the data were grouped according to families with or without schoolchildren (Tables IIIa and IIIb) the following observations could be made.

Flat-dwellers: A comparison between the recorded number of spells among children under the age of 6 years from families *with* and *without* schoolchildren did not show a significant difference ($0.70>P>0.50$). The number of sick children under the age of 6 years from families *with* schoolchildren was significantly higher than in the comparable group from families *without* schoolchildren ($0.05>P>0.02$). It seems therefore that the higher Incidence Rate (spells) among the non-schooling children in flat-dwellers from families *with* schoolchildren

TABLE IIIa

INCIDENCE OF "COLDS" IN FAMILIES WITH AND WITHOUT SCHOOLCHILDREN*

		FLAT-DWELLERS					
	Age-Group (years)	No. of Children	No. of Spells	No. of Sick Children	I. R. Spells %	I. R. Persons %	Spells P. Sick Person
Without Schoolchildren	< 1	18	6	4	33.3	22.2	1.5
	1	30	40	15	133.3	50.0	2.7
	2	22	17	12	77.3	54.6	1.4
	3	24	11	5	45.8	20.8	2.2
	4	32	3	1	9.4	3.1	3.0
	5	38	4	1	10.5	2.6	4.0
	Total	164	81	38	49.4	23.2	2.1
With Schoolchildren	< 1	7	2	1	28.6	14.3	2.1
	1	14	19	12	135.7	85.7	1.6
	2	24	18	14	75.0	58.3	1.3
	3	29	13	6	44.8	20.7	2.2
	4	27	9	4	33.3	14.8	2.3
	5	21	7	5	33.3	23.8	1.4
	6	28	11	4	39.3	14.3	2.8
	7-9	129	8	4	6.2	3.1	2.0
	10-12	117	7	3	6.1	2.6	2.3
	Total	396	94	53	23.7	13.4	1.8
All flat-dwellers	—	560	175	91	31.3	16.3	1.9

* Children 6-12 years of age.

TABLE IIIb

INCIDENCE OF "COLDS" IN FAMILIES WITH AND WITHOUT SCHOOLCHILDREN*

		SQUATTERS					
	Age-Group (years)	No. of Children	No. of Spells	No. of Sick Children	I. R. Spells %	I. R. Persons %	Spells P. Sick Person
Without Schoolchildren	< 1	21	7	2	33.3	9.5	3.5
	1	19	22	14	115.8	73.7	1.6
	2	23	18	7	78.3	30.4	2.6
	3	19	11	5	57.9	26.3	2.2
	4	24	9	6	37.9	25.0	1.5
	5	22	9	7	37.5	31.8	1.3
	Total	128	76	41	59.4	32.0	1.9
With Schoolchildren	< 1	16	5	3	31.3	18.8	1.7
	1	15	14	7	93.3	46.7	2.0
	2	21	21	12	100.0	57.1	1.8
	3	24	19	7	79.2	29.2	2.7
	4	26	14	8	53.8	30.8	1.8
	5	23	13	9	56.5	39.1	1.4
	6	47	23	5	48.9	10.6	4.6
	7-9	149	21	10	14.1	6.7	2.1
	10-12	78	8	5	10.3	6.4	1.6
	Total	399	138	66	34.6	16.5	2.1
All squatters	—	527	214	107	40.6	20.3	2.0

* Children 6-12 years of age.

can be explained by the higher number of sick persons, each having experienced an approximately same number of spells. This is markedly illustrated by the observed number of spells and sick persons in the 4 and 5 year's age-groups together (spells: $0.02>P>0.01$, significant; persons: $P<0.01$, highly significant). Although the "first scholars" showed an increase in the number of spells per sick child, the schoolchildren showed less disease.

Squatters: There were no significant differences between the numbers of spells and sick persons among children under the age of 6 years from families *with* and *without* schoolchildren (spells: $0.50>P>0.30$; persons: $0.50>P>0.30$). There were marked differences among the 4 and 5 year olds. Children from families *with* schoolchildren suffered more spells. The differences, however, were statistically not significant (spells: $0.30>P>0.20$; persons: $0.50>P>0.30$). The 6 years age group showed the highest number of spells per sick child. In general, it can be said that the disease-experience in squatters showed the same pattern as in flat-dwellers with less pronounced differences between incidences among children from families *without and with* schoolchildren.

DISCUSSION

Extensive studies into the epidemiology of "common cold" have been carried out by several investigators to throw light on factors operating within the family on the spread of "common cold" and other upper respiratory tract infections.

The main objective of this study was different. It was to study how morbidity experience with a disease predominantly transmitted by air was influenced by housing conditions.

The reasons for "common cold" being selected were given.

The definition of a new spell as adopted in this survey might be criticised. In the light of available literature, however, it is clear that each investigator may choose his own definition as long as it does not conflict with existing, often vague and incomplete information. The great variety of causative agents and their specific properties are sufficient reasons to accept different lengths of incubation periods ranging from hours to days (*Roden*, 1963). If we accept the lower end of this range an interval of one day between spells is not unreasonable. Although interference between many viruses can be observed in laboratory experiments, no epidemiological evidence seems available that interference really occurs in natural infections of the respiratory tract. For example, *Tyrrell* (1963) could not demonstrate interference by innoculating volunteers with a large dose of attenuated A2 virus and then infecting them with coxsackievirus A21 (a "cold" - producing virus).

In the present study where the determination of the beginning and end of a spell was left to non-medical persons, the chance of having a variety of interpretations is obvious. Equating a spell to a "running nose" narrows the observed duration of a spell considerably. On the other hand a "running nose" is almost always the only objective symptom that can be diagnosed without difficulty by the not sufficiently educated. Usually the layman will include coryza and purulent nasal discharge under "running nose". These two symptoms were reported by *Roden* (1963) as appearing in 68.6% and 51.3% of volunteers which showed marked symptoms of colds (experimentally induced). Of course the shorter the interval between spells is set the greater the liability of counting relapses as new spells. Adding to this all, the "real" duration of a common cold is reported to be extremely variable. In two communities with essentially similar ethnic, social, economic and educational characteristics, the factors that may influence the observations are expected to throw their weight equally over both groups. Discussions, comparisons and conclusions should not go beyond the survey populations and the limitations within them.

In a previous paper (*Kleevens*, 1966) it was made clear that overcrowding still occurred in the new flats. However, a major advantage was that a housing-unit (structural) was occupied by one family (household), while in the squatter-area sub-partitioning of a structural unit was common and the families were not all really segregated. A second advantage in flat-dwellings was the better provision for ventilation.

With a greater number of children-per-house among squatters (Table II) and the same proportion of houses in which a "cold" was recorded, it is likely that the difference in morbidity between flat-dwellers and squatters (Table I) was influenced by the density of children per house. In addition, a house with 9 children will be more liable to receive primary cases than a house with 4 children.

That infants showed a lower morbidity than the toddlers (1, 2 & 3 years) seems reasonable. It may be explained by transplacentally achieved immunity and less frequent contact with potential sources of infection. In addition, more than

28% of the infants among flat-dwellers and 41% among squatters were not observed for the full period because they were born in the survey period.

It is acceptable to assume that in the squatter (slum) situation children that are allowed to move around will come into contact more often with infectious children from other households. This may have contributed to the significant difference in both infection rates spells and persons among the children of ages 4 and 5 years.

Going to school, in general, means to flat-dwellers a new epidemiological experience in the sense that they will leave the relative seclusion of their flat-dwelling characterised by limited contacts with neighbours, to spend a part of the day in an environment conducive to close-contact and airborne transmission. Introduction of any "common cold" producing virus is likely to be followed by classroom epidemics. The chances for introduction of an infectious agent are great as a large number of pupils come from highly endemic housing areas. There is supporting evidence in the picture that is shown by squatters of the same age-group. The school environment in Singapore can, in most instances, be regarded as less detrimental to health than squatter-housing. The only factor that can be counted as being in favour of the residential environment is that the susceptibles are more diluted among persons in various states of immunity. In the classroom factors of herd-susceptibility specific to certain age groups may play a dominant role. There is no satisfactory explanation for the increased number of spells per sick child among 6 year old squatters. One would expect an increased number of spells accompanied by an increased number of sick persons; eventually with a slight increase in number of spells per sick child. Could it be that in the earlier years of their life these schoolchildren managed to escape frequent infections and that the school environment increased their risk to infection? The low incidence among "established scholars" may be partly due to under-recording but may also be a consequence of the high risks of infection in the preceding years.

With the observed morbidity in this survey the flat-dwellers from 0-12 years would have 1.3 spells per exposed child per year against 1.6 for squatters.

The longer duration of spells among flat-dwellers could also have contributed to the observed difference in morbidity. The shorter the spell, the sooner the person can be regarded as being exposed again. This might apply especially to diseases like "common cold" where immunity in the younger age-groups seems to be negligible. A short survey period will accentuate the inter-dependence.

There is no ready explanation for the longer duration of spells in flat-dwellers. Better observation by mothers is a possible factor. The improved facilities for family-privacy might lead to more accurate recording of occurrences in the family.

As has been said, it is difficult to draw conclusions from comparisons of findings obtained in surveys by other workers. The sample populations are not identical and the definition of a "common cold" is very much subject to facilities available to the investigator. In addition, as has been pointed out, the syndrome of the "common cold" is not really a uniform and well circumscribed one (*Tyrrell*, 1965).

Lidwell & Sommerville (1951) in a study on common cold in a rural community (England) reported that school children were most affected and that the presence of schoolchildren in a household "doubled the numbers of colds experienced by both adults and children under 5 years of age". Like the present study they limited their survey to the running nose type of cold.

Badger et al. (1953) in a survey on "common respiratory diseases" in Cleveland families (U.S. A.) of high occupational class (professional workers) found the highest incidence in the 1-5 years age group which is in accord with the findings in the present study.

They also found that schoolchildren were the main culprits in the introduction of common respiratory disease in the households. The influence of the presence of schoolchildren on the disease-experience of the younger children in the families was not clear in the present study. No attempt was made to distinguish between primary and secondary cases. The main reason was again to keep the information required from the mothers as simple as possible. Without knowing who brought the disease into the family it is difficult to ascertain the age-group most responsible for spread of "colds" in the family.

Comparing children under the age of 6 years among flat-dwellers it was observed that the presence of schoolchildren in families resulted in more sick children with proportionally the same number of spells. It further seems that the 4 and 5 years old children played a predominant role, they in fact determined the significant differ-

ences in spells and persons of the whole group under the age of 6 years. Among squatters, as has been described before, the same pattern was shown as in flat-dwellers but less pronounced.

Although no clear evidence can be produced, the findings from this study suggest that the difference in incidence of "colds" between flat-dwellers and squatters in the Bukit Ho Swee area in Singapore is mainly due to the difference in housing conditions, in particular the greater density of children per housing-unit in the squatter area.

SUMMARY

1. Two populations of Chinese children in the Bukit Ho Swee area in Singapore were compared in their morbidity experience in relation to "common cold".
2. Reasons for selecting "common cold" as an indicator of common air-transmitted diseases were given.
3. The overall morbidity incidence among squatters was higher than among flat-dwellers. Age-group 4 & 5 years contributed most to this difference. On the whole the number of spells per sick child did not show much difference between the respective age-groups in the two populations with one exception: 6 years old squatter children showed a much higher figure. The average duration of spells was longer in flat-dwellers.
4. Discussion was focussed around housing conditions, the main argument being the higher density of children per house in the squatter-area.
5. The role of schoolchildren in the morbidity experience of younger children in the household was discussed. It was found that younger children from families with schooling children did show an increased morbidity. The pattern among flat-dwellers was more pronounced than among squatters.

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