RE-HOUSING AND INFECTIONS BY SOIL-TRANSMITTED HELMINTHS IN SINGAPORE (A FOLLOW-UP STUDY)

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INTRODUCTION

This is a report on a follow-up study into the influence of re-housing of (urban) Chinese families on the prevalence of infections by soil-transmitted helminths in children under the age of 13.

Findings from the primary survey were discussed in a previous paper (Kleevens, 1966)[1]. The population examined in the follow-up study was essentially the same, so were laboratory methods and availability of staff.

Period in which the follow-up study was conducted was September-December 1965 (12 weeks), approximately one year after the primary survey.

SAMPLING

The families included in the primary survey were asked to participate again. Most of them agreed, a number of mothers objected.* The follow-up study was part of a broader programme of obtaining information into the effects of re-housing on health. Two weekly home visits were necessary. Because of this the number of families in each area had to be limited to a maximum of 150. Selection of families was done randomly out of those that consented to participate for the second time. Sampling of stool specimen was done exactly as before.

COMPARISON BETWEEN FLAT-DWELLERS AND SQUATTERS IN THE SURVEY POPULATION

Only when gross differences were found in the composition of both survey groups will exact data be produced. Division of families according to dialect group, family size and accommodation available did not show much difference as compared to figures given for 1964. Grouping according to income however, showed an improved situation. The average income per family in the flats-area was Mal. dollars 181.73 (1964: Mal. dollars 164.58) and the squatter-family were calculated to earn an average of Mal. dollars 161.32 (1964: Mal. dollars 130.49). As discussed before (Kleevens, 1966)[1] information on income is often not reliable. There may be two reasons for the observed increased average income: The greater confidence that had been achieved by our field investigators, and a real increase in income per head.

Response to stool sampling was again satisfactory: only 6·1% of the registered children from the flats and 6·8% from the squatter-area failed to contribute (5·0% and 5·1% respectively in 1964).

Age distribution differences between flat-dwellers and squatters were of the same order as in the primary survey with one exception: There were now fewer infants among flat-dwellers (See Table 1).

FINDINGS

(Data from the primary survey are also given for comparison.)

Only once were hookworm eggs detected. *Ascaris* (total) prevalence rate for flat-dwellers was slightly lower than in 1964 but the difference is not statistically significant**. In contrast the *Trichuris* (total prevalence rate was significantly lower. The *Ascaris* total and *Trichuris* (total) prevalence rates among squatters were slightly lower than in 1964. Again, however, the differences were not statistically significant.

The species-specific rates for each age-group as in 1964, were for flat-dwellers in all age groups significantly lower than those of the squatters.

*The main reason for refusal was that the mothers did not want "to be bothered again". The characteristics of the group of refusals were not much different from that of the whole sample population in 1964. Also there seemed to be no relation between refusal and infection rates in 1964. It is therefore considered that exclusion of the refusal group has not introduced a bias factor in the follow-up study.

**A test of significance was used to show that differences in proportions were significant.
Significant levels: $D \geqslant 2.S.E.$ significant
$D \geqslant 3.S.E.$ highly significant

Species pattern

TABLE I

INFECTION RATE *PER WORM SPECIES* AS A PERCENTAGE OF THE TOTAL NUMBER OF SPECIMEN EXAMINED

Flat-dwellers

Age groups (years)	Tot. Nr. exam.		*Hookworm*		*Ascaris*		*Trichuris*	
	1964	1965	1964	1965	1964	1965	1964	1965
below 1	58	22	-	-	1·7	-	5·2	-
1 - 3	152	141	-	-	0·2	4·9	8·5	5·7
4 - 6	162	145	-	-	12·3	10·3	32·7	10·3
7 - 9	122	130	0·8	0·8	7·4	11·5	45·9	26·9
10 - 12	80	88	6·2	-	8·7	4·5	47·5	19·3
Total	574	526	1·0	-	8·9	7·8	28·4	14·3
Squatters								
below 1	29	32	-	-	10·3	3·1	3·4	-
1 - 3	120	104	-	-	60·0	51·0	27·5	23·1
4 - 6	150	120	2·6	-	67·3	67·5	68·0	65·8
7 - 9	158	115	1·4	-	67·5	65·2	67·4	65·2
10 - 12	105	120	5·7	-	74·3	72·5	78·1	73·3
Total	548	491	2·2	-	62·8	60·5	57·5	54·2

INFECTION TYPE

TABLE II

RATE OF SINGLE AND MIXED INFECTIONS AS A PERCENTAGE OF SPECIMEN EXAMINED PER AGE GROUP

Flat-dwellers

Age groups (years)	Tot. Nr. exam.		*Hookworm* only		*Ascaris* only		*Trichuris* only		Mixed inf	
	1964	1965	1964	1965	1964	1965	1964	1965	1964	1965
below 1	58	22	-	-	-	-	3·4	-	1·7	-
1 - 3	152	141	-	-	6·6	4·3	5·9	4·9	2·6	0·7
4 - 6	162	145	-	-	3·7	6·2	24·1	11·7	8·6	9·6
7 - 9	122	130	-	-	3·3	5·4	41·0	20·8	4·9	6·2
10 - 12	80	88	-	-	1·2	2·3	35·0	17·0	12·5	2·3
Total	574	526	-	-	3·6	4·5	22·3	11·8	6·1	3·2
Squatters										
below 1	29	32	-	-	6·9	3·1	-	-	3·4	-
1 - 3	120	104	-	-	34·1	27·9	1·6	-	25·8	23·1
4 - 6	150	120	-	-	15·3	25·8	16·0	24·2	52·0	41·7
7 - 9	144	115	-	-	12·5	17·4	16·6	17·4	50·7	57·8
10 - 12	105	120	-	-	12·4	13·3	17·1	14·2	61·9	59·2
Total	548	491	-	-	17·7	19·8	12·4	13·4	45·2	40·7

Again among flat-dwellers single infections by *Trichuris* dominated but not as distinctly as in 1964. Among squatters, mixed-infections were again seen in the majority of cases except in the first and second age groups where *Ascaris* single infections were predominant.

The lower prevalence rates (totals) for *Ascaris* in both groups and *Trichuris* among squatters found in the re-survey could be partly explained by observer's variation and sampling error. The same observer may have different findings when he examined a series of stools on different occasions. Stools from the same persons might show different infection grades in time and even become negative (Lie Kian Joe *et al.* 1966)[2]. The reasons for the insignificant difference between *Ascaris* rates found in 1964 and 1965 will be discussed later. Longer stay in a favourable environment with less risks to re-infection must have led to further elimination of the *Trichuris* population.

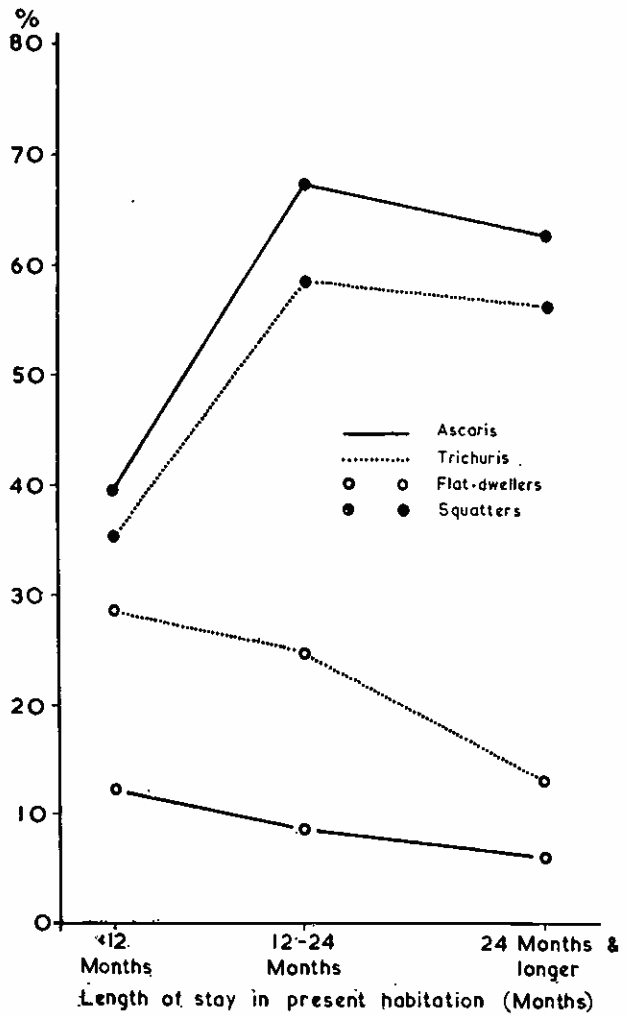

Fig. 1. Infection rates (%) ASCARIS & TRICHURIS, 0-12 yrs. children according to length of stay in present habitation (1964, 1965).

In combining the findings from both surveys we are in a better position to discuss the influence of time on the prevalence in each population.

The children were divided into three groups according to their families' length of stay in present habitation.

As discussed previously (Kleevens, 1966)[1] both groups "shorter than 12 months" showed characteristics that sufficiently explained the unexpected low rates. For the flat-dwellers it became obvious that the decline in prevalence rates had started before our observations began because even those who came originally from the destroyed squatter area enjoyed an improved environment for at least ten months. The comparitively low rates for squatters in this group could be explained by the small number of children involved with a relative high proportion of them with a more favourable sanitary history (37 out of 51, see Table 14 in the previous article).

Among squatters, maximum transmission seems to be reached between 12-24 months for both *Ascaris* and *Trichuris*, the former being on a slightly higher level.

Textbooks in parasitilogy give little conclusive evidence on the life span of *Ascaris*. However there seems to be agreement on that it is short, approximately one year[3,4].

Keller (1931)[5] in a study on a small group of children concluded that when children with *Ascaris* infection were removed from an environment conducive to transmission the worm population in them will die out within 15 months (the time lapse he chooses for the follow-up examination).

If it is accepted that *Ascaris*' life span is approximately one year we may expect the *Ascaris* population in flat dwellers to die out in approximately this period after rehousing if re-infection is completely prevented.

In the "24 months and longer" group, however, the rate is still slightly over 5%. Direct contact with infected soil in the flats' area is negligible because there is adequate provision for disposal of faeces and although toddlers were seen to defaecate indiscriminately, this nearly always happened in concrete drains. Washing away by rain water into the main drains or drying out makes it unlikely that this

will eventually lead to seeding of the soil around the flats at least not to such an extent that transmission is continued.

Indirect transmission, however, remains possible. The Chinese are known to have a habit of outdoor eating from road side stalls and hawkers. Well cooked and hot eaten foods pose not a great danger but raw fruits and drinks continuously exposed during hawking do.

This may explain why *Ascaris* seems to maintain itself between 5-10% level in flat dwellers.

The rate of decline for *Trichuris* seems to accelerate after the second year after re-housing†.

Subdividing the flat-dwellers according to (primary) sanitary history shows the same trend in each sub-group with consistent higher rates for those with a less favourable sanitary history.

CONCLUSION

The findings in this re-survey showed a further reduction of prevalence of *Trichuris* infection in flat-dwellers while *Ascaris* seems to maintain itself on a low level (5-10%) mainly because of indirect means of soil-contact (foodborne).

Future investigations should be aimed at solving the problems that remain. Flat-dwellers will be observed for another year at least to study further elimination of the helminth population (or its re-establishment). It would also be useful to follow up a group of squatters from the beginning of the change in environment in a longitudinal study because knowledge is lacking about decline of rate in the first months.

ACKNOWLEDGEMENTS

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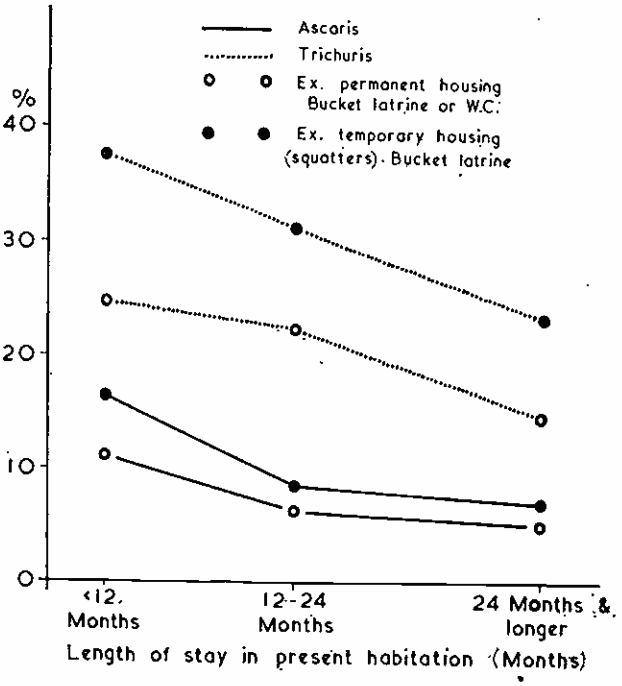

Fig. 2. Infection rates (%) ASCARIS & TRICHURIS, 0-12 yrs. children (FLAT DWELLERS) according to length of stay in present habitation and sanitary history.

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†For *Ascaris* the difference in rates between the first two groups and between second and third groups are statistically not significant. Between the first and third groups the difference is significant. For *Trichuris* these differences were respectively statistically *not* and statistically highly significant.