EVALUATION OF HOOKWORM CONTROL PROGRAM IN SOUTHERN THAILAND

Virasakdi Chongsuvivatwong[1], Suparb Pas-Ong, Weerapat Ngoathammatasna[1], Don McNeil[2], Kannika Vithsupakorn[1], Viparat Bridhikitti[1], Praphasri Jongsuksuntigul[3] and Chawalit Jeradit[3]

[1]Faculty of Medicine, Prince of Songkla University, Hat Yai, 90112 Thailand; [2]Macquarie University and NHMRC Clinical Trial Center, The University of Sydney, NSW 2109 Australia; [3]Division of Helminthology, Department of Communicable Disease Control, Ministry of Public Health, 11000 Nonthaburi, Thailand

Abstract. An intensive hookworm control program providing the rural population of southern Thailand with mass treatment with 300 mg Mebendazole and health education commenced in 1989 with a yearly budget of over US$ 1.2 million. The current research aimed to evaluate the coverage of health education and mass treatment, the effectiveness of mass treatment and the administrative process of the control program, two years after its commencement. This evaluation consisted of three studies. In the first study, 120 villages were randomly selected, from which 840 school children, 843 adults aged between 15-59 and 844 subjects aged over 60 years were interviewed to assess awareness of hookworm, latrine availability, receipt of and compliance with antihelminthics provided, and self-treatment. In the second study, 8 villages from each of the 14 provinces were randomly chosen. Stool samples from randomly selected 4,434 subjects were examined. The third study consisted of interviewing key health planners in Bangkok and 71 health officers/workers from 32 samples villages of 8 sampled provinces.

Latrine availability was 80%. Percentages of subjects who had ever heard of hookworm ranged from 70 to 95 in school children, 55 to 80 in adults and 25 to 58 in the older age group. While 63 to 85% had latrines in their homes, 27% to 47% admitted defecation outside in the past month. Percentages of coverage of drug treatment ranged from 82 to 91 in school children, 68 to 80 in adults and 54 to 59 in the older age group. Percentages of compliance with drug given ranged from 95 to 97 in school children, 72 to 85 in adults and 70 to 80 in the older age group. After adjusting for confounders, the egg count ratio for subjects aged over 60 years *vs* the other age groups was 3.05 (95% CI of 1.92-3.83) and those not having versus having latrine was 1.57 (95% CI of 1.07-1.65). The effect of drug-taking from the program on egg count was not statistically significant. While 59% of the health officers/workers considered hookworm in their 5 top priorities for disease control, 50% complained of lack of an instruction manual. All the health planners and health workers incorrectly perceived that children were the age group most vulnerable to hookworm and needed the highest consideratiion.

It was concluded that the older age group was relatively neglected in the control program and needed more emphasis. The drug regimen was not effective and needs to be improved.

INTRODUCTION

Southern Thailand has been well known for having high prevalence of hookworm problem. The prevalence rates of hookworm infestation from once national survey in 1980, using cellophane thick smear techniques (Kato and Miura, 1954) were 76% in the southern compared to 26%, 10% and 35% in the central, northeastern and northern regions (Preuksaraj *et al*, 1982). During the 1980s, control activities were concentrated on education and mass treatment of the school children in southern Thailand. In 1989 it was expanded to cover the whole rural population in the south. For mass treatment, a single dose of 300 mg Mebendazole was administered twice yearly. The budget for medication was approximately US$ 1.2 million per year. The current study was carried out to evaluate its effectiveness.

The objectives of the study were to evaluate the coverage of education and mass treatment, the prevalence and intensity of hookworm infestation two years after the commencement of the program (to be compared with those before the program commencement), to identify factor influencing intensity of infection and to assess the administrative process of this control program.

MATERIALS AND METHODS

The research consisted of three studies.

The first study was a cross-sectional survey. The study area (southern Thailand) was divided into 4 administrative zones of approximately equal population, *viz* north, central, south and southeast. In each zone, a 30-cluster sampling technique was employed (Henderson and Sundaresan, 1982). In each selected village, 7 adults 15 to 59 years old, 7 aged 60 years or above and 7 school children aged between 10 and 14 were randomly selected to be interviewed by a group of well trained research assistants using a standard questionnaire. Variables collected included awareness of hookworm (whether the respondent had ever heard of hookworm), availability of latrine, defecation outside latrine in the past month, receipt of and compliance with drug treatment and self treatment of intestinal worms.

The second study was a stool survey. Stool sampling was multi-staged and performed in the same as in 1989 (Jaranasri *et al*, 1990) to allow comparison. In each of the 14 provinces in southern Thailand, 2 districts were randomly chosen. From each chosen district, 2 subdistricts were randomly chosen and from each selected subdistrict, 2 villages were randomly chosen. In each selected village, approximately 8 households were randomly chosen. The members of the selected households were invited to participate by handing in stool samples for microscopic examination by cellophane thick smear technique (Kato and Miura, 1954). To ensure adequate subjects in each age group in each province, sub-totalling by age group was performed during data collection. Slight over-sampling of older age group was necessary in some villages where the population was relatively young. Thirty percent of the respondents who had a positive finding were randomly selected and interviewed concerning their behavior and their stool samples were further examined for the number of hookworm eggs per gram of feces using a modified Kato-Katz technique (Pawlowski *et al*, 1991). Stool examination was carried out approximately 1-2 months after the routine mass treatment.

In the third study to evaluate the program administration, six health planners including a former Minister of Public Health were interviewed. In addition, 8 provinces were randomly selected, and two districts randomly selected from each. Two health centers were randomly selected from each selected district and visited for interviewing. Information from health officers/workers responsible for program administration in the selected provincial health offices, community hospitals, district health offices and health centers was compiled.

RESULTS

In the first study, there were 844 respondents from the older age group, 843 from the adult group, and 840 school children. The overall response rate was 95%.

As seen in Table 1, the four zones had different distributions of religion and level of adult education. The southeastern zone, which is closest to Malaysia, had the highest proportion of Muslims and the lowest average number of years of formal education.

Religions was a more important predictor for preventive behaviors than level of formal education after being adjusted for each other. Of six listed preventive behaviors in Table 2, religion was associated with all but receipt of mass treatment whereas level of formal education was associated with the first three behaviors. While the Muslims were less likely to be aware of hookworm, less likely to own latrines and more often defecated on earth, they were more likely to receive mass treatment and to have self treatment.

Figs 1 to 6 show crude and religion and education-adjusted rates of behaviors listed in Table 2, stratified by zone and age group. For clarity, the 95% confidence intervals are omitted but they were close to the estimate plus and minus 2 percentage points for estimates close to 90%, and approximately equal to the estimate plus and minus 5 percentage points for estimates close to 50%. Increasing age was associated with decreasing awareness of hookworm, increasing latrine availability at home, lower likelihood to defecate outside latrine, lower likelihood to receive mass treatment, lower compliance with drug given, and lower likelihood to have self-treatment of intestinal worms. For the first three behaviors, crude rates in the southeastern zone were most unfavorable. However,

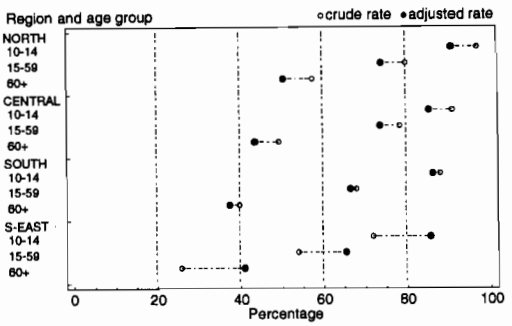

Fig 1–Hookworm awareness: Crude and education/religion adjusted rates.

Table 1

Distribution of adult education and religion in the four zones.

	Buddhists	Muslim
North	420	1
No education	86	-
Primary	276	1
More than primary	58	-
Central	403	15
No education	92	8
Primary	245	7
More than primary	66	
South	360	60
No education	78	26
Primary	235	31
More than primary	47	3
Southeast	123	303
No education	30	150
Primary	57	124
More than primary	36	29

Table 2

The association of religion and education with various behaviours related hookworm prevention (odds ratio and 95 % CI from logistic regression).

Outcome of interest	Predictors	
	Muslim/Buddhist	> Primary education
Aware of hookworm	0.34 (0.28-0.41)**	0.76 (0.62-0.87)**
Latrine availability	0.38 (0.31-0.47)**	1.11 (0.91-1.35)*
On-earth defecation	2.78 (2.91-3.38)**	0.78 (0.66-0.92)*
Receiving drug	1.19 (0.96-1.47)	0.84 (0.71-1.00)
Complied with treatment	1.77 (1.22-2.56)*	0.98 (0.75-1.29)
Self treatment	1.48 (1.15-1.90)*	1.00 (0.80-1.25)

* $0.001 < p < 0.01$
** $p < 0.001$

after adjustment for education and religion (or religion only in the school children), differences between zones were substantially reduced. For the last three behaviors, the adjusted rates were not remarkably different from the crude rates because the level of association with religion and education was not so strong.

Among the subjects who received the drug, the percentages receiving it from health workers were 42, 37, 64 and 78 in north, central, south and southeast areas, respectively. Further analysis revealed that the compliance rate was 85% if drugs were distributed by health workers and 75 percent if drugs were distributed by volunteers.

From the second study, the overall response rate was 80%. The total number of stool specimens was 4,434. Of these, 2,416 (53.3%) contained hookworm

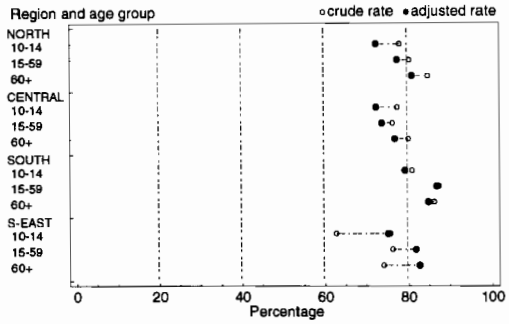

Fig 2–Latrine availability: Crude and education/religion adjusted rates.

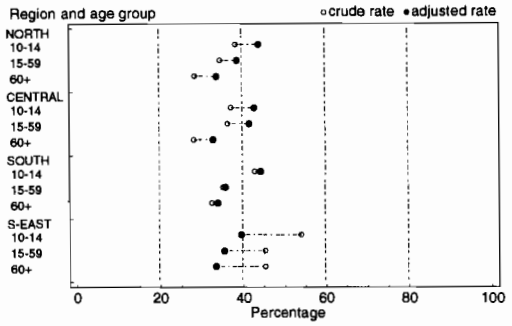

Fig 3–Outside defecation: Crude and sex/education/religion adjusted rates.

eggs. Seven hundred and forty-three of these were further examined for egg count and the subjects interviewed.

In Table 3, the provinces are listed from north to south. In all provinces except Phuket, the crude rates in the current study were lower than those in 1989. High age-standardized prevalence rates (using the hypothetical world standard population proposed by Doll *et al*, 1966) of Trichuriasis and Ascariasis in provinces close to the Malaysian border can be seen. The last column of this table shows prevalence rates of hookworm infection over 2,000 eggs per g, a level used by the control program as an indicator of success. Any infestation below this level is considered not clinically significant. The highest rate was in Narathiwat, which was 26 times of that in Phangnga.

Table 4 shows results from a multiple linear regression, carried out with base-10 logarithms of egg

Table 3

Prevalence rate of helminthic infection by province in 1989 and 1991 (in per cent).

Province	Crude rate Hookworm		Age-standardized rate (1991 only)			
	1989	1991	Hookworm	*Trichuris*	*Ascaris*	Hookworm > 2,000 epg
Chumphon	71	57	55	4	0	10
Ranong	45	32	36	12	1.3	7
Surat Thani	75	55	52	14	0.5	13
Phangnga	60	44	50	20	0.4	1
Krabi	89	65	64	18	2.0	13
Phuket	39	39	37	21	0.5	8
Nakhorn Si Thammarat	53	34	34	22	1.8	5
Patthalung	86	62	67	30	2.3	16
Trang	65	59	58	15	0	11
Songkhla	86	59	59	32	1.6	14
Satun	55	53	53	48	11	3
Pattani	87	63	64	58	28	16
Yala	78	68	70	39	13	16
Narathiwat	76	72	76	47	32	26

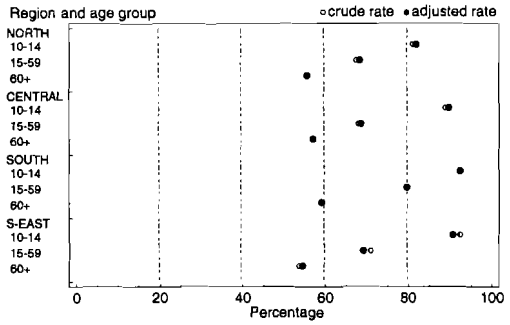

Fig 4–Coverage of drug distribution: Crude and education/ religion adjusted rates.

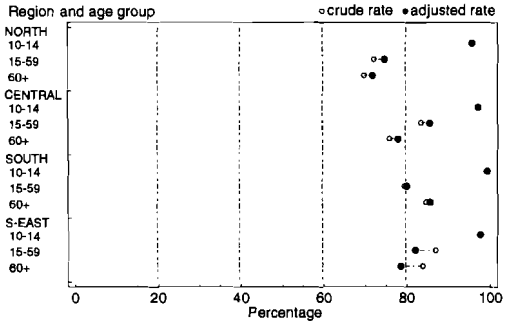

Fig 5–Drug-taking compliance: Crude and education/religion adjusted rates.

counts as the response variable. The estimates and confidence intervals for statistically significant coefficient have been transformed back as egg count ratios. Sex, latrine availability, age and province were the only statistically significant predictors whereas deworming experience (from any source) in the past 2 months, shoe-wearing and occupation were not. The residuals for this model gave no evidence of non-normality (Shapiro-Wilk test: $p = 0.74$). The variation

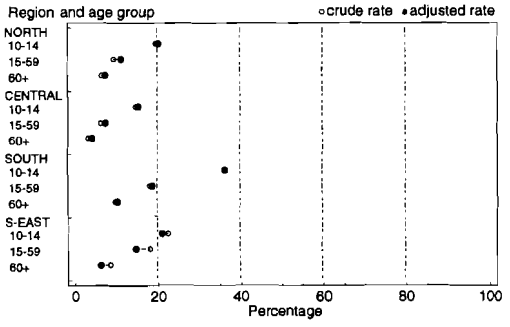

Fig 6–Self treatment: Crude and education/religion adjusted rates.

Table 4

Statistically significant determinants of hookworm egg count.

Risk factor	Egg count ratio	95 % CI
Male	1.33	(1.07-1.65)
No latrine	1.57	(1.19-2.06)
* Age 60 +	3.05	(1.92-3.83)
** Province		
Narathiwat	1.76	(1.06-2.93)
Phuket	0.50	(0.28-0.90)
Phangngna	0.38	(0.22-0.66)

* compared to children below 10 years old
** compared to Songkhla Province.

between provinces accounted for 50.8% of the r^2 value.

In the third study, 8 provincial health officers, 31 district health officers and 32 village health workers were interviewed. Of these 71 respondents, 47 considered hookworm to be within the top five priorities of health problems. All of them emphasized control activities on school children and reported over 80% of coverage of mass treatment in the whole population. Only 36 respondents received an instruction manual for campaign and 3 reported receiving expired drugs or with poor packing.

DISCUSSION

From the first study, it can be concluded that health education and mass treatment did not adequately cover the target population. Coverage of health education, mass treatment and compliance with drug treatment could be achieved up to 80% only among school children. These pitfalls were perhaps partly due to the greater emphasis placed on activities concerning school children, who were more captive.

The fact that latrine usage was reported to be higher among the older age group and outside defecation was reported to be higher among the school children may be a result of biases. Perhaps the school children were more likely to admit to outside defecation, a behavior which is viewed as not suitable in the community.

Self-treatment was also more common among the children, perhaps due to people's perception that worm infection is more a problem of children rather than of adults. Deworming drugs are available over-the-counter in Thailand. Unfortunately, promotion of self-treatment with a safe and efficacious drug has never been incorporated in the control strategy.

Comparison of coverage after adjustment for religion and education is useful in evaluation of the program. The fact that the levels of coverage were quite similar among different regions after adjustment for these confounders suggests that factors other than education and religion, such as effectiveness of the health workers, might not differ greatly across the regions.

The rates in all provinces were lower in 1991 than in 1989. However, some arguments could be raised against comparability of the results of the two studies. First, although the sampling technique and stool examination of the current study were intended to be the same as those of the earlier study, the age distribution might be different. Second, since only eight villages were sampled in each province in each study, differences in prevalence in the two studies could be due to chance. In spite of these two arguments, however, we believe that the prevalence was actually decreasing for the following reasons. In the current study, we intended to slightly over-sample older subjects and we found that our study sample had an age distribution with proportionally more older people than that in the 1989 study. Hookworm was more common among the older age group. Therefore, had age distribution of the two studies been the same, the decrease in crude prevalence rates would be even greater. (We proposed that in the future, use of age-standardized prevalence rate should be encouraged so that results from different sources will be more comparable). Furthermore, decreases in crude rates were seen in all provinces. Even though only eight villages per province were chosen in each study, consistent reductions in all provinces except one are unlikely to have been due to chance alone.

The current finding that intensity of hookworm infection was markedly higher in southern border provinces and among the older age group was also found in the 1989 survey conducted by the Department of Communicable Disease Control (Jaranasri *et al*, 1990). The fact that most of the total hookworm load in an infected community is usually carried by a relatively small section of the population has been discussed by Croll and Ghadirian (1981). From our current analysis, spending the same per capita budget on efficacious drug treatment will yield 26 times the benefit in a highly endemic area such as Narathiwat Province compared to a lightly infested area such as Phangnga Province.

Baseline data on behaviors from the previous study were not available and it is not possible to identify specific factors influencing reduction of the problem. However, from the cross-sectional component of the current study, latrine availability was negatively associate with worm intensity whereas a history of recently taking antihelminthics was not. It may thus be assumed that, in the program, latrine promotion had a more positive impact than mass treatment.

The fact that latrine availability was a preventive factor in this study confirmed to the policy-makers that promotion of latrine construction and usage really has a beneficial impact on health. On the other hand, although more than 80% of the population had latrines at home, over one-third defecated outside at least some of the time.

The efficacy of a single dose of 300 mg Mebendazole, which was the regimen in the mass compaign was not properly reviewed by the planners prior to the control program. In fact, in part of a trial conducted by Charvarria *et al* (1973), among 9 subjects with unknown mean eggs per g (MEPG), the cure rate of using this regimen was 44% and the egg reduction was 90%. In a trial of 31 subjects with 929 MEPG, Nontasut *et al* (1987) found a cure rate of only 16 percent but a satisfactory egg reduction of 90%. In another trial in 425 subjects with 333 MEPG, Butraraj *et al* (1986) found a similarly low cure rate of 23.4% and an egg reduction rate of 55%. Moreover, in a recent trial in 83 subjects with different levels of pre-treatment egg counts this regimen gave 5 percent cure rate and no egg reduction (Jongsuksuntigul and Jeradit, 1992). Although Mebendazole has many chemical forms which have different level of efficacy, this dose was most consistently found to be ineffective. Had these reviews and trials been carefully considered before the mass treatment, this regimen would not have been chosen for this control program. After this evaluation, subsequent mass treatment has been changed to a single dose of 400 mg Albendazole, which is recommended by WHO (Pawlowski *et al*, 1991). This regimen was shown to have an 84 percent cure rate and a 96% egg reduction in treating 51 subjects with 3,177 MEPG.

In addition to the likelihood of low efficacy of the treatment, re-infection might be an important prob-

lem. The time period between the mass treatment program and the evaluation was 1-2 months. While the antihelminthic might get rid of the adult worm in the intestinal lumen, the extra-intestinal larvae might escape treatment, develop into adult stage which subsequently passed out the eggs during the survey. New re-infection might also be the case. In any instance, the study showed that mass treatment in this study by itself was not effective.

In conclusion, the program needed to improve coverage of education among adults and the older age group. Self-treatment was relatively common and should be encouraged. Prevalence rates decreased. Promotion of latrine use should be continued whereas drug use for mass treatment needs to be revised.

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