Epidemiology and Control of Ascariasis in Korea

Byong-Seol Seo

Department of Parasitology, Seoul National University
College of Medicine, Seoul 110-460, Korea

Abstract: In view of the epidemiology and control strategy, ascariosis was reviewed with special reference to the data obtained for the past years in Korea. The range of length and prepatent period of *A. lumbricoides* to become fertile were 12.5~13.5 cm and 1.8~2.1 months for females, and 10.5~11.5 cm and 2.1~2.5 months for males, respectively. In the female worm burden 1 per case, the egg-laying capacity steadily increased from 12.6 cm of their length up to 25.0 cm and then decreased significantly after their growth to 27.5 cm. Analysed the egg discharging pattern, it was turned out that the cases with six or more worms have no probability to be false negative or unfertilized ova passer, and 52% of all false negatives were found infected only with male(s). The sex ratio was in the range of 0.74~0.82 (male/female). Basic reproductive rate was calculated in the range of 1.16~2.11 in rural areas, but it was approaching nearly to the ‘break point’ in some areas. It was observed that the ‘U-rate’ was increased from 19.4% (1973) to 61.1% (1989) for the past seventeen years. According to the survey in 6 rural areas, the average worm burden was 2.2 per population and 4.5 per infected. The frequency distribution pattern of *A. lumbricoides* per person in a rural community was well fitted to the negative binomial distribution. Seasonal fluctuation was shown in two, smaller and larger, peaks. The annual prevalence in student group was initially 55.4% in 1969, but decreased to 0.3% in 1989, and it is evident that the decrease has been greatly owing to the national control project.

It was proved that the efficacy of a quarter dose of pyrantel pamoate used in long term control programme was almost equal to that of conventional dose (10 mg/kg). The comparative efficacy of various interval mass chemotherapy schemes was evaluated through 2 year observations, and it was confirmed that at least biannual mass chemotherapy is necessitated to expect gradual lowering of reinfection. In the case of blanket treatments with 2-month interval in a village, all of inhabitants have been free from reinfection for the period of 28 months after the initial treatment.

It was fully recognized that without specific legislation and organization supported by the government, the national mass control programme has almost no chance of success, especially in developing countries. For the past three decades, The Korea Association for Parasite Eradication (KAPE) has carried out successfully the student-directed mass control programme, which greatly contributed to the decreasing trend of ascariasism in Korea.

Key words: *Ascaris lumbricoides*, epidemiology, control, egg production, chemotherapy (pyrantel pamoate), reinfection
INTRODUCTION

Ascariasis caused by *Ascaris lumbricoides* is one of the commonest and globally distributed human helminthic infections. Though it has been well recognized as the most important public health problem in many countries, not enough attention has been paid to the control, especially in developing countries.

Recently according to Crompton (1988), excluding the available information for the USSR and European countries, there are 83 countries with a population of more than 2 million each and a total population of 3,691 million. The estimated number of ascariasis cases in these countries is 1,008 million. This figure indicates that about 22% of the world's population (4,653 million) is infected with *A. lumbricoides*. The Stoll's (1947) estimate of global prevalence was 29.7% (644,4 million) of the world population of 2.2 billion in 1947. It is surprising that the Crompton's current figure of 1 billion is not much different from what it was more than four decades ago, considering drastic increase of the population in developing countries, where ascariasis is highly endemic.

The national project of ascariasis control since 1960s has resulted in a remarkable decrease of its prevalence in Korea. There are certainly many factors involved in that the prevalence and intensity of ascariasis have been reducing to a lower level. However, it is generally admitted as a major cause of reduction that the national programme of biannual mass examination and mass treatment has been successfully carried out by The Korea Association of Parasite Eradication (KAPE) under the auspices of the Government.

This paper deals with the control problems of ascariasis as well as biological and epidemiological parameters related to the control, investigated by our workers.

EPIDEMIOLOGY

Analysis of Reproductive Potential:

From the measurement of the maximum length of the collected worms after various interval mass chemotherapy repeated on rural inhabitants with pyrantel pamoate, it was attempted to figure out the chronologic growth pattern of *A. lumbricoides*. The maximum length in each interval treatment, 2-, 4-, 6-, and 12-month was 12.5, 16.4, 19.2, and 22.8 cm in males, and 14.2, 22.0, 26.2 and 30.8 cm in females, respectively. It was revealed that females grew more rapidly than males. The ages of collected worms were estimated adding 0.75 month to each interval, taking account of both the period of about 2 weeks of migration of larval worms and the delay of about one week between the successive treatments.

From the growth curve in the length and weight, the relationship between the length of worms of each sex and the results of egg examination was analysed in 241 cases infected with single female and 48 cases with a pair of worms. It was revealed that the minimum length of fertile female was 12.5~13.5 cm and that of fertile male was 10.5~11.5 cm (Seo, 1981; Seo and Chai, 1980b) (Fig. 1).

The length and weight of worms were plotted according to the calculated ages, which showed a clear correlation between length (*Y*, in cm) and age of worms (*X*, in month) as follows;

\[ Y = 9.213\ln(X + 1) + 0.025 \]

in case of male and

\[ Y = 11.953\ln(X + 1) + 0.025 \]

in female (Seo and Chai, 1980b). The prepatent period calculated from the length growth curves was 1.8~2.1 months in females and 2.1~2.5 months in males (Seo, 1981).

Chai et al. (1981) studied the fluctuation pattern of E.P.G., according to the number of infected worms and developmental status of *A. lumbricoides*. They reported that the eggs could be detected after the female worm grew longer than 12.6 cm and the amount of eggs increased until the worm became about 25.0 cm, where a
plateau was made in E.P.G. 1,300~1,400, and decreased significantly after 27.5 cm. And yet, wide variations in E.P.G. counts were noted even among the worms of similar growth.

There can be three kinds of results in stool examination of *Ascaris* infected cases; false negative, unfertilized egg positive, and fertilized egg positive with or without unfertilized egg(s). Seo et al. (1979b) attempted to analyse quantitatively the egg discharging patterns of *Ascaris* infected cases with low worm burdens. They reported that the higher the worm burden the possibility to produce fertilized eggs increased remarkably, whereas the possibility to be false negative or positive only for unfertilized eggs increased as the worm burden became lower. Actually, almost all of the false negative and unfertilized egg cases haboured less than 5 worms of any sex. In other words, the case with six or more worms has no probability to be false negative or an unfertilized ova passer. They also reported that among 125 false negative cases, 52.0% were infected with only male worm(s) and 24.8% were infected with immature young female(s) with or without male(s). Remaining 23.2% had mature female(s), however, the cause of infertility was not morphologically recognized, except that some of them were old worms, longer than 30 cm and heavier than 8.0 g (Seo, 1983) (Fig. 2). In 1,861 worms collected from 853 cases, male and female worms were 769 and 1,093 respectively, and in 55 worms it was not able to identify the sex. In average, the sex ratio was 1:0.74 (female:male). In another study, it was observed as 1:0.82 among 487 worms examined from 285 infected cases (Seo and Chai, 1980b).

Basic reproductive rate ($R$) is defined as the average number of female offsprings produced throughout the life time of a mature female, which themselves achieve reproductive maturity for the next generation. It is the transmission potential of the parasite. In ascariasis, density-dependent processes seem to act mainly on the worm fecundity. The severity of density dependence of the worm is 'Z' (0.96 by
Anderson, 1982), and the mean worm burden 'M'. The following equation is given by these parameters, \( R = \frac{M(1-Z)}{K+1} \), where 'K' is the degree of worm aggregation. Chai et al. (1985) analyzed the relationship of epidemiological parameters such as prevalence, worm burden and basic reproductive rate in 8 rural villages. The frequency distribution pattern of the worm number per person showed negative binomial distribution with 'k' values of 0.38–0.54. Their results showed that the prevalence rates (worm) in each village was almost identical with the theoretical ones from Anderson and May's equation: \( p = 1 - (1 + M/k)^{-k} \) (p; worm prevalence). The basic reproductive rate 'R' of *Ascaris* was calculated from 1.03 to 2.11 in these villages.

**Epidemiological Parameters Related to Control:**

**Unfertilized egg passer**—It is well known that the ratio of unfertilized egg passers to all egg passers (U-rate) is inversely correlated with the prevalence. Seo et al. (1979c) reported that the regression equation between U-rate (Y) and prevalence (X) was \( Y = 69.2 - 0.90X \) \( (r = -0.93) \), where 'X' is in the range from 23.9% to 66.7% (in average, 33.1%). From the stool examination results of students in Korea, it was observed that the prevalence decreased from 48.1% in 1973 to 0.3% in 1989, while the U-rate increased from 19.4% (in 1973) to 61.1% (in 1989). It was also noted that the decreasing pattern of the prevalence rate was highly correlated with the rate of fertilized eggs, while the unfertilized egg rate was relatively constant in the range from 4.1 to 9.4%. This denotes the relatively constant proportion of light worm burden cases among the population irrespective of any change in the endemicity.

**Intensity of infection**—Many reports have been made on the intensity of infection by egg counts (E.P.G.; number of eggs per gram of feces) in various groups of population in Korea. According to the KAPE's report, mean E.P.G. in student group was reduced from about 3,000 to 1,800 during the period from 1973 to 1978. In whole age group, it was 9,723 in 1967 but reduced to 2,584 in 1981 (Ministry of Health and Social Affairs; MHSA and KAPE, 1981).
On the other hand, the distribution pattern of E.P.G. grade was often used as an index of intensity of infection because the mean value of egg counts is much variable depending on a few high E.P.G. cases. It was observed that as the prevalence decreased, the proportion of cases with low E.P.G. grades under 1,000 increased significantly while those over 10,000 relatively decreased (MHSA and KAPE, 1976 & 1981).

Worm burden—Cho (1977) estimated the average worm burden of Ascaris in a rural population by chemotherapy using pyrantel pamoate, and reported that in three areas where the egg rates were 28.5, 53.8 and 72.3%, respectively, the average worm burdens were 2.0, 3.4 and 10.2. Seo et al. (1979c) also observed in a local county that the average worm burden was 2.7 among the infected cases and 1.1 among the whole inhabitants.

As is also the case with egg counts, average values of worm burden may vary greatly depending upon a few number of heavy burden cases. Therefore, the distribution pattern of number of cases with certain worm burden in a group of population is also more important so as to understand better the severity of infection. In 6 local areas in Korea where the egg positive rates were in the range from 23.9% to 66.7% (33.1% in average) and the index of endemicity revealed by worm collection was in the range 39.1~79.5% (48.2% in average), Seo et al. (1979c) reported that from 411 infected cases out of total 853 subjects, 1,861 worms were collected with the average 2.1 worms per inhabitant (in the range 1.1~8.4) and 4.5 worms per infected (in the range 2.7~10.6).

They also described the distribution pattern of A. lumbricoides in rural Koreans. According to them, out of total 853 cases, 442 cases had no worms in the intestine at the time of examination and treatment, 150 out of 411 worm positives (36.5%) were infected with one worm, 69 cases (16.8%) with two worms, 48 cases (11.7%) with three worms and so on. The lower the number of worms in a case, the higher the number of cases. It was concluded that negative binomial distribution was fitted well to the observed frequencies of each worm burden in those endemic population.

An interesting relation between the degree of worm burden and change of endemicity was also noted by them. The relative frequencies of '0' burden per case were 60.9% in low endemic areas, 40.9% in moderately endemic areas, and 25.5% in highly endemic areas. The frequencies of the cases with 1~4 worms were 33.5%, 40.5% and 32.6% respectively in three different endemic population. Statistical test revealed that the relative percentile of each burden in the three areas was significantly different (p<.001). However, the relative frequencies of 1~4 worms burden per case were not statistically different (.1<p<.25) (x=3.50, df=2). From the above observation, it was suggested that the overdispersed frequency distribution pattern of Ascaris in an endemic area is changed by a relatively rapid decrease of heavy burden cases toward lower worm burdens and finally increase of non-infected cases, according to lowering of endemicity by chemotherapeutic control.

Seasonal fluctuation—The reinfection rates were checked monthly throughout two years in six villages where the blanket mass chemotherapy with pyrantel pamoate was performed at 6 month-interval. The reinfection rates were expressed in terms of egg or worm positive rates and immature young worm detection rates. The former is the accumulated reinfection rates during the preceding 6 months and the latter is recent reinfection rates during 1~2 months before (Cho, 1977; Seo and Chai, 1980a; Chai et al., 1981).

Seasonal fluctuation was remarkable and there were roughly two peaks both in the egg and worm positive rates in a year. The larger peak was observed from February to March and the smaller one from August to September in case of egg and total worm rates. However, immature worms were more frequently detected
one or two months earlier. Therefore, the actual time of occurrence of reinfection was considered during November to December for the larger peak and May to June for the smaller one, deducting 2 months from the prepertent period (Seo et al., 1979a; Seo, 1981).

Prevalence in Korea—The egg positive rate among Korean people had been higher than 80% until the Korean war, 1950~1953. After then, although there are few data to verify it, the prevalence has increased rather higher as a sequelae of the war. Seo et al. (1969) performed a nationwide prevalence survey in Korea and reported the average egg positive rate of *Ascaris* was 58.2% among 40,581 randomly selected people from all over the country.

Annual trend of prevalence was presented by the summarized yearly results of the stool examinations in the student group during the period of 1970~1989 (Table 1). The prevalence was initially 55.4% in 1969 but decreased to 0.3% in 1989. It is evident that the remarkable decrease of the annual prevalence has been greatly owing to the national control project. Since 1971, the quinquennial national prevalence surveys on intestinal helminthic infections have been undertaken under the auspices of Ministry of Health and Social Affairs (MHS&A) and KAPE to assess the indirect impact of the student-directed mass control programme on the general status of parasitic infections among Koreans. Approximately 40,000 cases (10,000 households) in 215 sampling areas (81 rural and 134 urban), selected from whole area samples of National Census by means of multistage stratified random sampling method, were subjected for these surveys (Table 2). As shown in Table 2, the egg positive rates of *Ascaris lumbricoides* in the surveyed year of 1971, 1976, 1981 and 1986 were 54.9, 41.0, 13.0 and 2.1%, respectively.

To determine the age (sex)–specific reinfection rate, Chai et al. (1983) conducted epidemiological study on the reinfection pattern in

**Table 1. Annual prevalence of *Ascaris lumbricoides* in student group (KAPE, 1989)**

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of examined</th>
<th>E-P. rate (%)*</th>
<th>U-rate (%)#</th>
</tr>
</thead>
<tbody>
<tr>
<td>1969</td>
<td>6,551,926</td>
<td>55.4</td>
<td>-</td>
</tr>
<tr>
<td>1970</td>
<td>10,871,280</td>
<td>55.6</td>
<td>-</td>
</tr>
<tr>
<td>1971</td>
<td>11,813,868</td>
<td>51.6</td>
<td>-</td>
</tr>
<tr>
<td>1972</td>
<td>11,243,033</td>
<td>45.8</td>
<td>-</td>
</tr>
<tr>
<td>1973</td>
<td>12,116,892</td>
<td>48.1</td>
<td>19.4</td>
</tr>
<tr>
<td>1974</td>
<td>11,901,236</td>
<td>38.2</td>
<td>19.7</td>
</tr>
<tr>
<td>1975</td>
<td>12,480,942</td>
<td>38.7</td>
<td>19.3</td>
</tr>
<tr>
<td>1976</td>
<td>13,523,636</td>
<td>33.7</td>
<td>21.6</td>
</tr>
<tr>
<td>1977</td>
<td>14,160,212</td>
<td>29.7</td>
<td>22.9</td>
</tr>
<tr>
<td>1978</td>
<td>15,030,061</td>
<td>19.4</td>
<td>23.5</td>
</tr>
<tr>
<td>1979</td>
<td>15,592,977</td>
<td>15.1</td>
<td>31.8</td>
</tr>
<tr>
<td>1980</td>
<td>15,495,361</td>
<td>12.2</td>
<td>38.2</td>
</tr>
<tr>
<td>1981</td>
<td>16,229,764</td>
<td>10.2</td>
<td>39.9</td>
</tr>
<tr>
<td>1982</td>
<td>16,216,136</td>
<td>6.9</td>
<td>44.7</td>
</tr>
<tr>
<td>1983</td>
<td>16,220,369</td>
<td>4.7</td>
<td>50.8</td>
</tr>
<tr>
<td>1984</td>
<td>16,001,005</td>
<td>3.1</td>
<td>52.2</td>
</tr>
<tr>
<td>1985</td>
<td>15,812,300</td>
<td>2.0</td>
<td>55.3</td>
</tr>
<tr>
<td>1986</td>
<td>14,861,006</td>
<td>1.4</td>
<td>56.3</td>
</tr>
<tr>
<td>1987</td>
<td>13,206,807</td>
<td>0.9</td>
<td>53.7</td>
</tr>
<tr>
<td>1988</td>
<td>12,703,799</td>
<td>0.6</td>
<td>56.9</td>
</tr>
<tr>
<td>1989</td>
<td>9,594,316</td>
<td>0.3</td>
<td>61.1</td>
</tr>
</tbody>
</table>

* Egg positive rate  
# ratio of unfertilized egg passers to all egg passers

**Table 2. Quinquennial prevalence of *A. lumbricoides* in nationwide inhabitants (MHS&A & KAPE, 1986)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Area</th>
<th>No. of exam.</th>
<th>No. of egg posit. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971</td>
<td>Urban</td>
<td>8,911</td>
<td>4,135 (46.4)</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>15,976</td>
<td>9,529 (59.6)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>24,887</td>
<td>13,664 (54.9)</td>
</tr>
<tr>
<td>1976</td>
<td>Urban</td>
<td>11,294</td>
<td>3,410 (30.2)</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>15,884</td>
<td>7,723 (48.6)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>27,178</td>
<td>11,133 (41.0)</td>
</tr>
<tr>
<td>1981</td>
<td>Urban</td>
<td>20,569</td>
<td>1,743 ( 8.5)</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>14,449</td>
<td>2,800 (19.4)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>35,018</td>
<td>4,543 (13.0)</td>
</tr>
<tr>
<td>1986</td>
<td>Urban</td>
<td>27,318</td>
<td>208 ( 0.7)</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>16,272</td>
<td>716 ( 4.4)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>43,590</td>
<td>924 ( 2.1)</td>
</tr>
</tbody>
</table>
a Korean rural village, and performed blanket mass treatment with 2, 4, 6, and 12 month interval scheme. According to them, the age reinfection rate was much higher in younger individuals than in older ones in all of the 4 interval schemes. The highest rates (in egg and worm rates) were observed in preschool children age, followed by primary school students, and these were more pronounced in males than in females. It was also noted that there was a significant tendency of familial aggregation among the reinfected cases.

CONTROL

1. Control Strategies

Mass examination and mass treatment—For the mass diagnosis in our national control programme of *Ascaris*, cellophane thick smear technique has been applied because it is simple, time saving and economic as well as highly detectable for the *Ascaris* eggs (Cho et al., 1969; Chai et al., 1982).

For the mass treatment, pyrantel pamoate and/or mebendazole was selected as the drug of choice. The efficacy of single treatment with pyrantel pamoate (10 mg/kg) was satisfactory. Approximately over 93% of negative conversion rate (= cure rate) and over 95% of egg reduction rate have been reported (Rim and Lim, 1972; Seo et al., 1972; Soh et al., 1974; Kim, 1975; Seo et al., 1977; Lee and Lim, 1978). Moreover, pyrantel and mebendazole were proved highly effective even with reduced doses, 2.5 or 5.0 mg/kg for pyrantel and 100 mg for mebendazole in single doses. In this case, the negative conversion and egg reduction rates were over 85% and 93% respectively (Seo et al., 1973 & 1978).

Therefore, these drugs had better be used in reduced doses in mass control programme in consideration of cost-effectiveness. Furthermore, Seo and Chai (1980a) proved that the efficacy of quarter dose of pyrantel pamoate (2.5 mg/kg) used in long-term control programme was nearly equal to that of higher doses by repeated use every other month for one or more years.

Mass chemotherapy can be carried out either on egg positive cases (selective treatment) or on whole population residing in a community (blanket treatment). Considering the prevalence, intensity of infection, budget, and manpower, the priority should be given among these two treatment schemes. However, blanket scheme is hardly recommendable for nationwide application. The more generally applied one is selective treatment on egg positive cases. In any case, special attention should be given to fertilized egg passers as an important target, who actually participate in the transmission of infection.

Reinfection incidence—The persistent reinfection is an essential factor for maintaining vicious cycle of ascariasis in a community. The incidence of reinfection is largely affected by the frequency of mass treatment. According to our experiences, it was observed that when the egg positive rate and worm burden at pretreatment were 35.2% and 2.1 respectively, these values were returned nearly to the same level of pretreatment, such as 36.4% and 2.4 one year after mass treatment (Seo et al., 1980).

According to Chai (1983), in some rural areas where the reinfection rate is still high, it was presumed that only about 7.2 months were required for the prevalence to return to the previous level even after a blanket mass treatment. Yun et al. (1979) observed that reinfection occurred in 14% of residents in a month and average amount of reinfection was 0.2 per month per person in a slum population of suburban Seoul. These observations indicate that one year period seems sufficient for this infection to attain equilibrium among host population. Consequently mass chemotherapy should be carried out more frequently than once a year, especially where the prevalence is fairly high.

It is well known that the rapidity of reinfection during shorter than one year period was largely variable according to the epidemiological conditions and socio-economic situations of the
community concerned. In Japan where *Ascaris* was nearly eradicated, the reinfection rate during 6 months was less than 1.0% in 1971–73 (Morishita, 1974). On the other hand, in some areas of the Philippines where the prevalence rate was in the range of 85–90%, there were much higher reinfection rate up to 68.6% during 4.5 months after chemotherapy with pyrantel pamoate (Cabrera *et al.*, 1975). The situation in Korea was between the above two countries and 33–42% of pre-treatment egg positive rates returned to one-third level after 4 months and to about a half after 6 months (Seo *et al.*, 1980).

It was evidently shown that the reinfection incidence decreased as much as the control activity progressed. According to Seo and Chai (1980a), the monthly new infection rate in a continuously treated group with 2-month interval scheme of blanket mass treatment was about 1.0% at initial stage but decreased to 0.25% at the 18th treatment. However, in treatment interruption group, the rate was elevated to about 2.0% within one year after the interruption (Seo, 1981).

**Interval, timing and duration of mass chemotherapy**—As described above, repeated mass treatment can reduce the prevalence and reinfection rate. To maximize the efficacy of control of *Ascaris*, there are three important points to decide. The one is interval of mass treatment in a year and others are adequate timing and total duration of treatment in the project programme.

To observe the effect of various interval mass treatment on *Ascaris* egg and worm positive rates and worm burden per population, Seo *et al.* (1980) evaluated comparative efficacy of 2-, 4-, 6-, and 12-month interval schemes in nine villages in Korea (Fig. 3). Each village consisted of 100–140 people, however, there had been 20–40 drop-outs in each treatment. Pyrantel pamoate was used in the dose of 10 mg/kg. They summarized the results as follows;

The pretreatment infection status of *A. lumbricoides* was not significantly different between groups; 32.5–42.2% and 33.8–46.2% in egg and worm positive rates, respectively. The mean worm burden was in the range; 1.6–4.2 per infected and 0.61–1.42 per

![Fig. 3](image-url) Comparative efficacy of various interval mass chemotherapy revealed by egg positive rates (Seo *et al.*, 1980).
population. Twelve-month interval treatment was by no means useful to be adopted as a strategy of *A. lumbricoides* control because egg and worm positive rates and mean worm burden were returned to pretreatment level. The shorter the treatment interval, the lower the egg/worm positive rates and worm burden became. By repeating 6-, 4-, and 2-month interval treatments in a year, the indices of prevalence showed a tendency of further lowering during the 2 year follow-up. Conclusively, it was suggested that at least biannual mass treatment is necessitated to expect gradual lowering of reinfection. However, before deciding the interval scheme, many factors should be taken into accounts according to the local situations such as prevalence, intensity of infection, availability of suitable drugs, funds and resources, community participation, etc.

The adequate timing of mass chemotherapy is determined depending upon the seasonal variation of transmission cycle. It is generally suggested that in areas where a large seasonal variation of *A. lumbricoides* occurs, treatment should begin four to six weeks after transmission starts and be continued until two months after the end of the transmission season. In this respect, biannual or triannual mass chemotherapy seems to be adequate and recommendable in Korea, considering the two seasonal peaks in reinfection incidences; larger one from November to December and smaller one from May to June (Seo *et al.*, 1979a; Seo, 1981). Therefore, late December and late June were considered appropriate timings in case of biannual scheme, and late November, late March and late July in case of triannual scheme. If modification is allowed in triannual scheme, timing of treatment may also be recommended during winter season, taking account of the transmission cycle, i.e., late December, late February and late July.

**Duration of control**—Theoretically, it should be longer than the survival time of contaminated eggs in the environment (Seo and Chai, 1980b). However, it is very difficult to determine the duration because the longevity of the infective eggs in soil was reported much variable—up to 6~9 years according to geographical conditions (WHO, 1981). In this connection, Seo and Chai (1980a) reported that it took 28 months to eradicate *A. lumbricoides* infection in the project area applied blanket bimonthly scheme. It was suggested that the longevity of eggs in soil may be shorter than 2 years in the area surveyed.

In Japan, it took 16 years to reduce the nationwide prevalence from 8.2% to 0.1% by annual mass treatment scheme (Hayashi *et al.*, 1981). Based on mathematical analysis by theoretical model for evaluation of the control efficacy of soil-transmitted helminthiases (Hayashi, 1977), the activity in Japan was not so effective because declination of prevalence was not so rapid and remarkable. However, it was revealed that the final level would reach zero percent because of negligible reinfection rate. Contrarily in Korea, although the current prevalence is about 10% and biannual mass chemotherapy scheme is applied only on student group, the duration of control period needed may not be much shorter because the reinfection rate is still not negligible (Seo *et al.*, 1983).

**A model of eradication programme**—Seo and Chai (1980a) attempted to control reinfection cycle of *A. lumbricoides* in Korean rural villages by blocking the process of new infection. Three rural villages (Group A, B, and C) were subjected for this study. Inhabitants of each Group were treated bimonthly with 2.5, 5.0 and 10.0 mg/kg of pyrantel pamoate, respectively. Blanket treatment was repeated 18 times in Group A, while it was interrupted after 10 times in Groups B and C. In every treatment trials, the inhabitants of all age groups were subjected to treatment without preliminary check of egg positivity. For the follow-up and evaluation, the whole-day stool specimens were collected for 2 days after each treatment from each case. The specimens collected were examined for both eggs and
expelled worms. The number of expelled worms per case was counted and the length and weight of individual worms were measured. Male worms under 10.5 cm and 0.40 g and females under 12.5 cm and 0.53 g were considered to be sexually immature young worms. The percentage of cases with young worm(s) in the population was calculated in each follow-up. The purpose of measuring worms was to discriminate young worms which were reinfected during the recent 2 months.

From the above field trials they reported the following results: 1) The lowest dose of pyrantel pamoate, 2.5 mg/kg was equally effective as higher doses in case of repeated use for reinfection control, 2) When the blanket mass chemotherapy was continued 18 times in Group A, all of the examined inhabitants were free from reinfection and egg production from the 15th treatment (28 months after the 1st treatment) until the end of the study period (8 months more), 3) When the mass chemotherapy was stopped after 10 times in Groups B and C, the egg positive rate returned gradually up to half of the pretreatment level within one year (Fig. 4).

The results obtained in Group A certainly suggest a successful eradication in that area. However, this does not necessarily mean no more reinfection even afterwards, because new infective eggs may be introduced again from the outside of the project area due to social communication, food supply, etc. Similar project of Ascaris eradication was carried out by Biagi and Rodriguez (1960) by repeated monthly administration of piperazine in a tropical village in Mexico. According to them, reinfestation has been controlled after 8 months' trial, in contrast to our study which took 28 months with a quarter dose (2.5 mg/kg) of pyrantel pamoate. This difference may be attributed to the different conditions between Mexico and Korea, such as egg positive rates, treatment intervals, drugs used, and other factors.

It should be noted that the young worm detection results are the more reliable index for evaluation of 2-month model in the reinfection control, rather than the egg or total worm positive rates, because the true reinfection cases between the two successive treatments show neither any eggs in stool, nor any mature worms in worm collection.
2. Legislation and Administration

The mass parasite control approach has usually met with relatively low acceptance among developing countries because of many socio-economic, technical and programmatic factors of constraints. Also it is not easy to gain widespread interest among health performances. Therefore, actually it has been left alone for a long time without having taken any consideration for the practical measures of control activity in a nationwide scale. From the past experiences, it was fully recognized that without specific legislation and organization supported by the government, control programmes have almost no chance of success, particularly in developing countries. On the other hand, it is also true that it is impossible to legislate a disease out of existence.

The Bill of the Law for the Prevention of Parasitic Diseases had been passed in the National Assembly, ROK in April 1966. Hence, the legislation of the control activities in Korea has been set up through the Enforcement Order of the Law. In the Article, it is stipulated that the school master or principal is responsible to find positive cases of parasitic infections, especially ascariasis among school children and to treat them twice a year. For the implementation of the national control programme, the national assessment of the problem has initiated to determine the magnitude or urgency of parasitic diseases.

The Prohibition Order of night soil utilization—A Cabinet Ordinance was passed at the cabinet meeting (Jan. 1969) to ban the use of night soil as a fertilizer in areas, cities and towns in province, designated by the Ministry (MHSA). There were a total of 55 areas, including Seoul and Pusan at the 1960s.

Expert committee for parasite control—For the programme design, implementation and evaluation, expert committee was set up in a separate section for chronic diseases in the Ministry according to the Prevention Law. The committee members consisted of expert groups from various fields; The Korean Society for Parasitology, KAPE, Ministries of Education, Internal Affairs, Culture and Information, and others.

Control organization—Government can provide legal and administrative support for the programme. However, voluntary, non-governmental organizations are generally efficient in the use of human and financial resources. The Korea Association for Parasite Eradication (KAPE) was founded in 1964 as one of the voluntary agencies under the influence of The Ministry of Health and Social Affairs, such as The Korea Association of Tuberculosis and The Korea Association of Leprosy.

According to the regulation of KAPE which is a corporate juridical person, the major financial sources of the association consist of fees of fecal examination from primary, middle and high schools. KAPE is authorized to perform these examinations twice a year through an Actment of the Prevention Law. The fees from the school health expenditure in the local government budget are collected directly from the relevant schools through the permission of the Local or City Education Board under the recognition of Governor or City Mayor. This amount should in part be recompensated by mass treatment with free of charge. Each provincial and city branches of KAPE should employ a certain number of licenced technicians, which varies to the size of branch laboratory and depends upon the number of specimens examined (Seo, 1974).

Integration programme—The immediate and visible effects of controlling ascariasis through mass chemotherapy usually promote the community participation in other health programme. The parasite control as a simple health component is considered appropriate to encourage community participation and self-help in the improvement of health and welfare. JOICFP (Japanese Organization for International Cooperation in Family Planning) developed an idea that integration of parasite control into an established health care programme, especially family planning, nutrition, etc. can successfully
promote community concern for family health care. The objectives of their integrated project with parasite control services as an incentive for the promotion of family planning, were secondly to reduce the prevalence of soil-transmitted helminthiases (Seo, 1984).

**Technical transfer to health service system**—Taking account of the recent trend of remarkable decreases of infection rate of soil-transmitted helminthiases, especially ascariasis, KAPE has gradually shifted their activities of parasite control to health service programmes in compliance with the need of the people. Then, the establishment of a new organization was planned to emerge from the existing health system. Eventually, at 1982, the Korea Association of Health (KAH) started the activities to deal with the health service programme (Seo, 1985). KAPE’s parasite control activity was merged into the new health service system of KAH at 1986. KAH aims primarily to make the earliest detection of morbidity and also to exercise all types of activities for health promotion according to the basic needs of routine health check-up among school children, community people and industrial workers.

**REFERENCES**


KAPE (1980) The evaluation of mass control project on students against *Ascaris* infection. (A monograph in Korean text).


Prevalence of intestinal parasitic infections in
Korea. The first, second, third, and fourth reports
in monographic series (in Korean).
Morishita, K. (1972) Studies on epidemiological
aspects of ascariasis in Japan and basic knowledge
in Japan, 4:1–153.
Morishita, K. (1974) Parasite control activity in
Japan—A brief review. *Proceed. 1st APCO Conf.*, 
Tokyo, 50–59.
Rim, H.J. and Lim, J.K. (1972) Treatment of
toebiasis and ascariasis with combantrin
Seo, B.S. (1974) Control problems of parasitic in-
fec tions in Korea. *Proceed. 1st APCO Conf.*, 
Tokyo, 27–37.
Seo, B.S. (1984) Integrated family planning and
118.
Seo, B.S. (1985) Qualitative technological expansion
from parasite control to preventive medicine. I.
“Applicable Experiences,” *Proceed. 7th JOICFP
Seo, B.S. and Chai, J.Y. (1980a) Effect of two-
month interval mass chemotherapy on the reinfection
of *Ascaris lumbricoides* in Korea. *Korean J.
Seo, B.S. and Chai, J.Y. (1980b) Chronologic growth
pattern of *Ascaris lumbricoides*. *Korean J.
Seo, B.S., Cho, S.Y. and Chai, J.Y. (1978) Reduced
single dose of mebendazole in treatment of *Ascaris
lumbricoides* infection. *Korean J. Parasit.*, 16:
21–25.
Seo, B.S., Cho, S.Y. and Chai, J.Y. (1979a) Seasonal
fluctuation of *Ascaris* reinfection incidences in
Seo, B.S., Cho, S.Y. and Chai, J.Y. (1979b) Egg
discharging pattern of *Ascaris lumbricoides* in
low worm burden cases. *Korean J. Parasit.*, 17:
97–104.
Seo, B.S., Cho, S.Y. and Chai, J.Y. (1979c) Frequent
ance distribution of *Ascaris lumbricoides* in rural
Koreans with special reference on the effect of
113.
Seo, B.S., Cho, S.Y., Chai, J.Y. and Hong, S.T.
(1980) Comparative efficacy of various interval
mass treatment on *Ascaris lumbricoides* infection
Seo, B.S., Cho, S.Y., Kang, S.Y. and Chai, J.Y.
(1977) Anthelmintic efficacy of methyl-5-benzoyl-
benzimidazole-2-carbamate (mebendazole) against
multiple helminthic infections. *Korean J. Parasit.*, 
15:11–16.
evaluation on the student-directed mass control
programme against ascariasis in Korea (1969–
Seo, B.S., Lee, S.H., Cho, S.Y., Kang, S.Y., Uh,
K.B., Kang, S.C., Lee, W.J., Lee, J.W. and
Whang, K.I. (1972) Mass treatment of *Ascaris*
and hookworm infections with pyrantel pamoate
584 (in Korean).
Soh, C.T., Lee, B.O., Min, D.Y., Choi, S.J. and
Stoll, N.R. (1947) This wormy world. *J. Parasitol.*, 
33:1–8.
Yun, C.K., Cho, S.Y. and Soo, B.S. (1979) Status
of *Ascaris lumbricoides* infection in a slum popula-
WHO (1981) Intestinal protozoan and helminthic
infections. Report of a WHO Scientific Group,