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REINFECTION AND INFECTION RATES OF ASCARIASIS IN RELATION TO SEASONAL VARIATION

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ABSTRACT

Preliminary stool examination of 320 primary school children for eggs of ascaris revealed a prevalence of 74.0%. Reinfection and infection rates were determined on a monthly basis with egg-positive subjects treated correspondingly. Due to dropouts of subjects, only 154 children completed the 12-month observation.

About 15% of children remained negative after treatment during one year but 85% got reinfected, with those reinfected only once being the highest then those reinfected twice, followed by those reinfected more than twice in year.

Of the 203 ascaris worms collected 69% were females and 31% were males with a sex ratio of 2.4 females to one male; 73% were mature and 27% were immature females; 70% were mature and 30% were immature males; mean number of worms per child was 2.6. The mean length and weight of female was 22.9 cm. and 3.6 gms., respectively while for males it was 16.1 cm. and 1.7 gm. respectively.

The graph showing amount of rainfall, reinfection and infection rates of ascariasis revealed the presence of two major peaks both in the reinfection and infection rates noted in December-January and May-June. Likewise, the rainfall also peaked twice namely in August and October. It appears that ascariasis re-infection or transmission is highest when rainfall is minimal and lowest when rainfall is at its highest peak.

Based on the peaks of reinfection and infection, it is suggested the school children be dewormed in June and in December each year for at least three years.

Introduction

In the Philippines, a number of researches have been done regarding reinfection and infection rates of soil-transmitted helminthiases particularly ascariasis (Garcia *et al.*, 1961; Jueco *et al.*, 1971; Cabrera, 1978). Studies along this line were done in order to determine the frequency of reinfection and the length of time required for such reinfection to take place. This factor of reinfection is a very important consideration in attempting to control soil-transmitted helminthiasis. From previous studies we learned that the higher the prevalence of ascariasis in a community, the faster is the rate of reinfection, probably because the soil is heavily polluted with human feces containing eggs of these helminths. We also learned that

children get reinfected with ascariasis faster than adults because of less consciousness regarding personal hygiene and sanitation and because of frequent contact with dirt and soil while playing. Finally, we learned that the significant rise in reinfection rates of ascariasis is approximately 4 months; for trichuris and hookworm around 2 months after treatment (Cabrera, 1978). Hence, in the control of soil-transmitted helminthiases in the Philippines, a periodic mass treatment of the population given every 4 months or 3 times a year for at least 3 years is being recommended (Cabrera *et al.*, 1982).

Insofar as seasonal variation and its relation to ascariasis transmission is concerned, we have not come across studies along this line in this country. It is for this reason that this study was started with the hope that after knowing the peaks of ascaris incidence we may want to modify our treatment schedule so as to coincide with the month of highest transmission of ascariasis. Although there are four types of rainfall in the Philippines, we have chosen type 1 rainfall for this particular project whereby approximately half of the year is dry and the other half is wet. Maybe later on we may want to do similar studies on an area with a different type of rainfall.

Materials and Methods

The methodology used here was patterned after that proposed by Dr. Akio Kobayashi, Jikei University, School of Medicine, Tokyo, Japan which was presented during the 4th APCO Parasitologist meeting last July 1982.

After preliminary consultation with the school authorities, we chose grades I and II primary school children of Epifanio delos Santos Elementary School at Pasay City as our subjects for this study. This school is located in an areas where people of low income group reside and where environmental sanitation is poor.

Inasmuch as this study will involve the giving of anthelmintics, we distributed letters of consent (through the teachers and pupils) for the parents to sign. Only those with signed letters were included in the list of study subjects to be treated.

A pre-treatment stool examination of the 320 children from grades I and II was done using formalin-ether for initial prevalence rate determination. After the stool survey was completed, we gave one 500 mg Flubendazole tablet each to only 308 children whose letters of consent were returned to us, irrespective of whether they were positive or negative for ascaris egg. This type of treatment is what is termed as "blanket treatment." Those with negative stools were included so that the subjects, who might have been infected with ascaris but still in their younger stages and therefore, incapable of laying eggs, would also be treated. A post-treatment stool examination was done two months after giving the anthelmintic because it takes at least two months and on the average 2.5 months for the female worms to mature and oviposit, hence, a reinfection occurring after the initial treatment can be detected only after 2 to 3 months maturation period (Kobayashi, 1983). It is

presumed that the anthelmintic used is also effective against immature worms except those migrating larvae in the lungs. In this way, the determination of re-infection rate will be more accurate.

The children were divided into two groups, i.e. those that were initially negative for eggs (Group A) and those initially positive for eggs but turned egg-negative by treatment (Group B) as revealed by the pre- and post-treatment stool examination. Both groups were the subjects of this investigation.

Every month thereafter for the next twelve months, stool examination was done on all subjects of both groups. Those that turned egg-positive from Group A were considered as "infection" while those that turned egg-positive from Group B were considered as "reinfection." All subjects that turned egg-positive were again treated. Hence, the idea is to keep the children free from ascaris infection so that eventually all those that turned egg-positive during the monthly stool examination can all be termed as "reinfections." On the day of treatment, the children were given three plastic bags each, into which they were instructed to defecate directly for three consecutive days or three consecutive bowel movements. Expelled worms were collected for number, sex, weight, size and maturity. One month after treatment, stool examination was again performed and the "turned egg-negative" subjects were again observed further as before while those found positive for eggs were again treated.

Reinfection and infection rates which were recorded monthly were determined by dividing the number of "turned egg-positive" subjects over the number of subjects examined. However, the estimation of the actual reinfection time (month) was determined by dating back about 3 months from the time of stool collection for examination inasmuch as the average pre-patent period of ascariasis is approximately 2.5 months (Kobayashi, 1983).

The amount of rainfall per month was obtained from the Philippine Weather Bureau for a period of 12 months and by plotting the amount of rainfall on a graph together with the reinfection and infection rates of ascariasis, we tried to establish the relationship, if any, of seasonal variation and incidence or transmission of ascariasis in the Philippines.

Results

The pre-treatment stool examination showed a prevalence rate of 74.0% for ascariasis. Due to dropouts among the study subjects, only 154 children were able to complete the 12 month observation period. The reinfection rate of ascariasis in relation to seasonal variation is shown in Table 1. There appear to be two major peaks in the reinfection rate, one in May-June and the other is in December-January. During these months the rainfall has either just started or is at its minimum. The highest amount of rainfall is in the months of August and October.

The infection rate in relation to seasonal variation is shown in Table 2. Just like in the reinfection table, there are also two major peaks and both peaks occur on the same months as in the reinfection when the amount of rainfall is minimal.

Table 1. Reinfection rate of ascariasis in relation to seasonal variation, Pasay City, Philippines, 1983

Month	*Ave. Amount of Rainfall**	*No. Exam.*	*No. (+)*	*% (+)*
February	TRACE	118	17	14.41
March	0.0 mm.	101	0	0.00
April	TRACE	94	3	3.19
May	10.0 mm.	84	19	22.62
June	87.8 mm.	66	12	18.18
July	220.1 mm.	52	7	13.46
August	233.0 mm.	45	8	17.77
September	182.8 mm.	38	2	5.26
October	270.8 mm.	36	1	2.77
November	23.4 mm.	35	6	17.14
December	2.0 mm.	29	8	27.58
January	4.4 mm.	21	6	28.57

*Data supplied by the Phil. Weather Bureau.

Table 2. Infection rate of ascariasis in relation to seasonal variation, Pasay City, Philippines, 1983

Month	*Ave. Amount of Rainfall**	*No. Exam.*	*No. (+)*	*% (+)*
February	TRACE	37	2	5.40
March	0.0 mm.	35	0	0.00
April	TRACE	35	3	8.57
May	10.0 mm.	31	4	12.90
June	87.8 mm.	26	8	30.76
July	220.1 mm.	17	1	5.88
August	233.0 mm.	15	2	13.33
September	182.8 mm.	13	2	15.38
October	270.8 mm.	11	0	0.00
November	23.4 mm.	11	1	9.10
December	2.0 mm.	10	2	20.00
January	4.4 mm.	7	2	28.60

*Data supplied by the Phil. Weather Bureau.

The graph showing rainfall, reinfection and infection rates of ascariasis is shown in Figure 1. It shows that there are two major peaks each, of the reinfection and infection rates of ascariasis among school children. The first peak is noted in May-June while the second peak is seen in December-January. On the other hand, the amount of rainfall has also two peaks, one in August and the other in October.

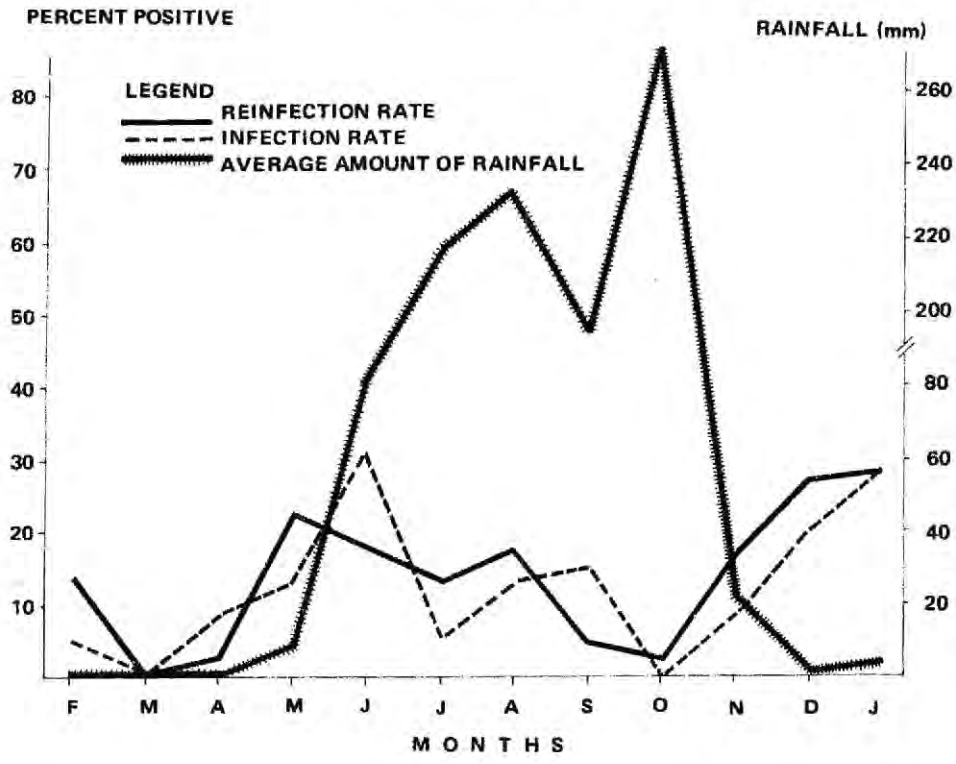

Figure 1. Reinfection and infection rate of ascariasis among children in relation to seasonal variation, Pasay City, Philippines, 1983.

The frequency of ascaris infections among school children is shown in Table 3. Among the subjects, 19.4% from group A and 13.9% from group B or a total of 15.2% remained negative during the 12-month observation. However, about 85% of subjects from both groups got reinfected with ascaris throughout the year as follows: 42.4% got infected only once, 29.5% were infected twice, 10.6% were infected three times and 2.3% were infected four times in a year. Comparing groups A and B with regard to the frequency of the infection, it showed that in the former, 80.6% of children acquired the infection during a year. On the other hand, in the latter group, 86.1% got the infection during a year, which might indicate that the infection occurs more frequently in the positive group than in the negative group. However, there is no statistically significant difference between the two groups as shown by the Z test.

The monthly collection of ascaris worms among school children after treatment is shown in Table 4. A total of 138 subjects were treated but only 78 of them

Table 3. Frequency of ascaris infections among school children, Pasay City, 1983

No. of Infection in One Year	*Group A (Initially Negative)*	*Group B (Initially Positive)*	*Total*
None	6 (19.4%)	14 (13.9%)	20 (15.2%)
1	14 (45.2%)	42 (41.6%)	56 (42.4%)
2	9 (29.0%)	30 (29.7%)	39 (29.5%)
3	1 (3.2%)	13 (12.9%)	14 (10.6%)
4	1 (3.2%)	2 (1.9%)	3 (2.3%)
Total	31 (100%)	101 (100%)	132 (100%)

Initial rate of ascaris infection – 74.0%.
Group A: subjects to be egg-negative on pre-treatment stool examination (negative group).
Group B: subjects found egg-positive but turned egg-negative by treatment (positive group).

Table 4. Ascaris worms collected among school children after monthly treatment, Pasay City, 1983

Month	*Number Treated*	*Number Submitted Specimen*	*Number of Worms Collected*	*Mean Number of Worms per Submitted Specimen*
February	19	9	39	4.3
March	0	0	0	0
April	0	0	0	0
May	15	6	18	3.0
June	15	8	23	2.9
July	8	7	19	2.7
August	10	3	6	2.0
September	17	7	19	2.7
October	10	7	14	2.0
November	16	10	20	2.0
December	10	10	19	1.9
January	18	11	26	2.4
Total	138	78	203	2.6

submitted specimens containing expelled ascaris worms. There were 203 worms which were collected from the 78 subjects with the monthly mean number of worms per specimen ranging from 2-4 worms; hence, the mean number of worms per child was 2.6.

The length and weight of the 203 ascaris worms collected are shown in Table 5. Of this number there were 140 females (69%) and 63 (31%) males or a sex ratio of 2.4 females for every one male. Among the female worms, 102 (73%) were mature and 38 (27%) were immature; among the male worms, 44 (70%) were mature and 19 (30%) were immature. These findings seem to indicate that the rate of maturation or development of both sexes are about the same. The mean length of mature and immature females are 22.9 cm. and 15.2 cm., respectively; while the mean length of mature and immature males are 16.1 cm. and 12.4 cm., respectively. The mean weight of mature and immature females are 3.6 gm. and 1.4 gm., respectively while mature and immature males are 1.7 gm. and 0.8 gm., respectively.

Table 5. Length and weight of 203 ascaris worms collected from treated children, Pasay City, 1983

Stage of Development and Sex	*Number of Worms*	*Mean Length (cm)*	*Mean Weight (gm)*
Mature:			
Male (15-31 cm)*	44	16.1	1.7
Female (20-35 cm)*	102	22.9	3.6
Immature:			
Male (<15 cm)	19	12.4	0.8
Female (<20 cm)	38	15.2	1.4
Total	203		

*According to Craig & Faust's Clinical Parasitology 8th Edition.

Discussion

When one relates reinfection and infection of ascariasis with the amount of rainfall for one whole year, it would appear that reinfection and infection rates are highest when the rainfall is minimal or just beginning. One will also note that both the reinfection and infection rates tend to follow the same trend. This is understandable because we initially applied blanket treatment on our subjects then we kept on treating those that "turned egg-positive" monthly for a period of 12 months. The presence, therefore, of migrating larvae and/or immature worms incapable of ovipositing eggs, among the initially negative group is out of the question. Figure 1 shows that during the peaks of the rainy season, ascaris reinfection and infection rates are low. This observed relationship in this country may be due to the flushing action of rain waters which tend to wash away the uppermost layer of the soil where eggs of ascaris at various stages of development are usually found.

Children who play with soil and dirt can possibly get their hands con-

taminated with infective eggs. During the rainy season, such child's play would result in muddy, grossly dirty hands. Thus, the children usually wash their hands with soap and water after playing in the mud. On the other hand, during the dry season, the same type of child's play would not result in noticeably dirty hands. Thus the children are not as conscious or concerned about washing their hands playing with the soil. Hence, they are more liable to acquire the infection through hand to mouth method.

In Figure 1, the first major peak of reinfection and infection is in May-June respectively while the second major peak is in December-January as detected by stool examination. However, the actual infection must have taken place in March for the May-June peak. The month of actual infection corresponds to the 3-month pre-patent period of ascariasis. It should be noted that March is shown to be a dry month. As aforementioned, the rise in reinfection and infection during the dry season, may be due to the decreased awareness of the children for washing their hands thoroughly after playing in the yard or garden. Other factors could include the fact that during the dry months, infective ascaris eggs could easily be carried with dust by strong gusts of wind disseminating them to practically any part of the environment.

On the other hand, the second major peak of reinfection and infection occurs in December-January, which means that the actual infection or reinfection occurred in September-October which are rainy months. Flood waters as previously stated may wash away the uppermost layer of soil in the yard close to the house and thus decrease the possibility of hand to mouth infection. However, these same flood waters may bring the upper layer of soil to low areas such as vegetable patches, which may then be contaminated with infective ascaris eggs, hence infection may occur particularly when vegetables are ingested raw.

On the frequency of ascaris infection among school children throughout a year, the number of those that got reinfected once was the largest, amounting to almost half of the total number of children. The next largest came from those reinfected twice in a year which was about one-third of the children. The sequence of reinfection frequency obtained in this study is similar to that obtained in Japan by Kobayashi in 1954, except for the higher percentages of the number of infections in our data. Whereas the data obtained in Japan showed the number of those that remained negative throughout the year was 34%, in the Philippines it was only 15%.

Based on the findings that two major peaks of infection of ascariasis occur among school children in areas in the Philippines with a type I rainfall, we suggest that anthelmintics against ascariasis be given twice a year. The first treatment should be in June at the start of classes and the second in December just before the children take their Christmas vacation. In this way, we strike at the time when ascaris worms are most abundant in the intestines of the host, hence eliminating as many worms as possible which are the sources of eggs. On the other hand, infection with the eggs already in the soil can be best avoided through improvement in personal hygiene and environmental sanitation.

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Gloria L. Enriquez, Discussant

Epidemiological studies on parasitic or infectious diseases (such as the paper presented here) are important for control purposes regardless of the methodology employed. Premised on these studies are the availability of information on the biology of the infectious or parasitic organism including, among others, their reproductive behaviour and their relationship with the host. As these seem to have been well documented for ascariasis, the present study has therefore logically made use of the information.

As with other soil-transmitted helminthiasis, the principal factors in maintaining endemicity of ascariasis are (1) favorable qualities of the soil and (2) habitual or frequent fecal contamination of the soil. Indeed, viable eggs that accumulate in the soil arise through the use of human excreta as fertilizers and through the promiscuous defecation by small children. The role of rainfall as a factor in transmission is limited mainly to (1) its providing essential moisture necessary for the development of the embryo to the motile, infective larva and (2) redistribution of eggs, both horizontally and vertically. Horizontal transport spreads the eggs over wide areas as it also concentrates the eggs in puddles. During and immediately after a heavy downpour (as it occurs quite normally at this time of the year), suspended in water are sand, coarse silt, medium-sized silt, ascaris eggs, fine silt and clay. In effect, the eggs whenever present are blanketed off from the sun's rays and dessication by the fine silt and clay even while they remain on the water surface that makes the eggs develop rapidly to the infective stage that are then easily available for infection and/or distribution to other location.

During the dry season, transmission of infection also occurs as shown in the present study. In fact the author's study in 1975 showed continuous transmission of ascaris infection throughout the year. Since the data for rainfall is available at the Weather Bureau, previous studies on infection rates could also be correlated to ascertain present findings. Moreover, granting that there are peaks of infection and reinfection, it seems that together with the rainfall a more important consideration is the children's exposure to infected soil, and people's habit of eating unwashed or uncooked food such as fruits and vegetables. For purposes of epidemiological data, these factors can be put together and analyzed accordingly. Indeed, it should provide definitive information as to the role of the amount of rainfall on the infection rates.

Although the present study has been limited only to transmission rates vis-a-vis the amount of rainfall, I am, however, confident that the author would have the answers or comments on the following observations:

1. Frequency of reinfection throughout the year was definitely highest for those children who get reinfected only once. Considering that the children's habit and the amount of rainfall remain the same during the period of study, could this condition be brought about by specific host-parasite relationship, such as the immune response of the host to the parasite? In this connection, are there

data to show when reinfection took place? Without treatment could the picture been different since the parasite does not multiply in the host and since it has a limited life span? Couldn't the self-cure phenomenon affect the incidence rates?

2. Since a child could have more than one worm at a time, are there data regarding the age of the worms collected per child? This may yet yield information on the host's behavior to subsequent exposure to the infective stage.
3. Epidemiologic data on ascariasis may be more significant if studies on parasite frequency is extended to the child's family. This will certainly provide significant information regarding the environmental sanitation and personal hygiene responsible for exposure to infection.
4. Ascaris pathogenesis seem to be directly related to the large number of infective larvae that find their way into the human host. In the present study, the children who harbored more than one (average of 4.3) did not seem to exhibit the effects of the infection. Otherwise, they would not be in school (For children don't really relish the idea of school and most parents would use the slightest discomfort to keep their kids at home). Indeed, reports have shown that the larval migration through the liver and lungs provokes no remarkable pathologic change or symptom unless the number of larvae is immense which under normal condition will occur as an exception rather than the rule. In addition, intestinal ascariasis tends to be well tolerated particularly if nutrient intake is adequate. Thus, while theoretically the parasite could be eradicated by periodic mass treatment if all worms were removed before they could reach full maturity, the logistics and cost of a large scale program makes it highly impractical particularly in our country where treatment schedule of 8-9 times a year is necessary. Considering all of the above conditions, control and ultimate eradication of the infection must depend largely on the universal use of sanitary facilities in all parts of the community. Mass treatment should go side by side with the proper dissemination of the information about the prevention of the infection.

Ruben L. Umaly, Discussant

I would like to congratulate Dr. Cabrera for his paper and to express my gratitude to the organizers for giving me this honor and for considering me as discussant.

I must confess that I felt nostalgic while I was reading the paper. As a Master of Public Health student more than twenty years ago at the Institute of Public Health, Prof. Trinita Cruz and I were enrolled in a graduate course in Helminthology under Dr. Cabrera and one of our special project was to determine the prevalence of ascariasis, trichoriasis and hookworm infection among Grades 1 to IV pupils of an elementary school in Manila. Part of our work must have been utilized in the 1961 paper cited in the literature. It saddens me a lot that inspite the supposed improvement of living conditions in this primate city Manila, the prevalence

of these parasitic diseases has not changed much. The saying that "Hindi ka Pilipino kung hindi ka nagkabulate kahit minsan" is still true and it is almost the end of the twentieth century!

If I get it right the major thesis of the paper is this: the supposed lower incidence of infection or reinfection during the rainy season is because the eggs on the soil are washed away and that when the hands of children are soiled with mud, they would have a greater tendency to wash their hands before eating than if it were soiled only by dust during dry season.

From Tables 1 and 2 and Figure 1 there was an attempt to show correlation behavior rate of infection and reinfection with amount of rainfall for each month. There were two peaks of infection and reinfection stated, namely May-June and December-January with values of 22.6 to 18.2 and 27.6 to 28.6% positives, respectively. The May-June positive stools are supposed to be due to infections or reinfections 3 months before, namely, February-March when there were low rainfall values. These observations support their thesis. However, the December-January high values of positive stools were due to infections during the months of September and October when the amount of rainfall were high and thus contradicting the first observation.

Just looking at Figure 1 and Tables 1 and 2 could mislead the reader for one automatically tends to correlate the stool examination with rainfall values of the same month when in reality the positive stool specimen is due to an infection or reinfection three months ago. Perhaps a readjusted value could be plotted showing the 3 months delay.

I was also curious to find out the number of stool negative children who were treated and who passed immature worms or all male worms. This would help evaluate the efficiency of a stool exam.

Although it is nice to have free drugs from pharmaceutical companies for drug efficiency testing, I think mass treatment even if timed with maximum infection is not the more effective solution to the problem of ascariasis. Considering that ascariasis is a self-limiting disease in that one gets cured even if one is not treated, use of expensive drugs should be discouraged. Perhaps niyog-niyogan may be substituted or even an overeating of pineapple could help sweep the worms from the intestine. Anyway, the worm builder of 3 is not very high.

Although I may sound bias for I used to belong to the Department of Governmental Sanitation, I think one can control ascariasis only by preventing the eggs from getting to the soil and that can be done by having sanitary toilets which everybody can use. There could be no substitute to intensive health education, construction and use of toilets and provision of water supply to the people rather than mass treatment!