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REVIEW

Epidemiological Aspects of Paragonimiasis in Korea

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Paragonimiasis has been recognized as a major public health problem in various parts of the Far East (Sadun, 1960), but apparently it is more serious in Korea than in any other country in the world (Kobayashi. 1918; 1919; 1921).

According to the references, several clinical studies and field surveys on paragonimiasis and the intermediate hosts of the paragonimus have been carried out since Mooda (1912; 1913) published his report, "Extrapulmonary paragonimiasis in Hai Joo Guhn, Whang Hai Do" in 1912 and 1913.

Kobayashi (1926) also reported that this infection is present in Korea not only in man and in some of the domestic animals such as cats, dogs and pigs, but also in tigers, leopards, foxes, wolves and wild cats.

His report that approximately 8 percent of 350,000 Koreans examined were positive for this fluke prompted his conclusion that paragonimiasis is one of the most important disease in Korea (Kobayashi, 1926). However, most of the past studies on paragonimiasis were mainly concerned with adults, but rarely with children.

Miller and Walker (1955) studied 227 infected prisoners of war from a roentgenographic stand-point in an attempt to delineate the radiographic features of this disease, in order to differentiate it from pulmonary tuberculosis, which is the leading cause of death in Korea.

Graumann et al. (1957) emphasized the clinical and public health importance of paragonimiasis in Korea and indicated that a larger number of individuals have extrapulmonary infections.

Sadun and Buck (1960) have recently done comprehensive studies on paragonimiasis in South Korea, including immuno-diagnostic, epidemiologic, clinical, roentgenologic and therapeutic studies.

Investigation of the fluke problem has been carried out by the WHO Survey Team (Walton et Chyu, 1959).

Theirs was the first attempt to make a nation-wide survey on the prevalence of both paragonimiasis and clonorchiasis by means of the skin test (intradermal reactor), with selected samplings (Walton & Chyu, 1959).

According to a recent survey (Walton & Chyu 1959), (Sadun et al. 1960), it is estimated that over a quarter million human infections occur in South Korea and approximately one million persons are infected in Japan (Miyasaki, Iwasak and Yogawa, 1958~1960).

Goizumi (1951) has mentioned about the food habit of consuming either boiled or burned crabs in Japan and the different custom of eating salted raw crabs in both Korea and Formosa. He also described an old custom of applying the juice of crushed crabs (potamon) for certain kinds of dermatitis and of drinking the juice for colds, coughs and as an

antipyretic.

There had been the peculiar custom of giving the juice of crushed crayfish or crabs for the treatment of measles in Korea, particularly in South Korea (Park and Song, 1959). However, such custom spread rapidly to other parts of Korea during the Korean war.

None of the references to investigations or studies in the past reported any close relationship between measles and paragonimiasis in Korean children.

While studying and surveying this infection during the past decade the author was particularly concerned with the mode of transmission of paragonimiasis among children in Korea. Because it was observed that many cases of this infection had a history of ingesting crayfish (crushed juice) as a means of modifying measles, it seemed important to investigate any correlation between the incidence of measles and the incidence of paragonimiasis (Park and Song, 1959; 1961).

a) Yearly Incidence (Table 1a): From January, 1953. to December, 1957, a total of 54 patients in the Pediatric Clinic were found to have paragonimiasis. This was a yearly average of 0.18% of the total number of out-patients. From January, 1958, to June 1962, a total of 245 patients were found with the disease, a yearly average incidence of 0.7 % giving a total average incidence of 0.41%. The distribution of all 299 cases of paragonimiasis by year is summarized in Table 1a.

During the years 1953 to 1957 diagnosis was made chiefly by the history and clinical findings (Park et al., 1959). On the other hand, the use of skin tests as a screening method (Yokogawa et al., 1955) for paragonimiasis (P.W.) and for clonorchiasis (C.S.) since 1958 is probably the reason for the higher incidence found. Since 1960 the number of paragonimiasis patients has diminished, a result to which health education and prevention have contributed greatly (Park et al., 1961). In general, paragonimiasis is most prevalent in rural areas, where the intermediate hosts are often consumed raw, and least prevalent in urban areas (Sadun and Buck, 1960).

Table 1a. Yearly incidence

Year	Total No. of Pts.	No. of Paragonimiasis Pts.	Percentage
1953	5,134	12	0.33%
1954	5,327	8	0.15%
1955	6,817	8	0.11%
1956	7,803	12	0.12%
1957	7,363	14	0.19%
1958	7,783	42	0.58%
1959	7,836	83	1.7 %
1960	8,370	56	0.68%
1961	9,240	47	0.50%
1962(6m)	6,376	17	0.26%
Total	72,049	299	0.41%

b) Geographical Distribution(Fig. Tab. 1b): Walton and Chyu (WHO Survey Team, 1959) made a nation-wide survey by skin tests (intradermal test) for P.W. and C.S. infection. According to their data, the prevalence of interdermal reactor to P.W. and C.S. antigen was highest in Chulla Nam-Do, with 16%; Kyungsang Nam-Do had 9%, Chulla Puk-Do 5 %, and Kyungsang Puk-Do had the lowest prevalence, 4%. However, in the age distribution for their data, the pre-school group was not included, and the samplings were imperfect in varying degree. There was great variation in prevalence even in the same province (Park et al., 1961; Sadun et al., 1960). The P.W. infectivity rate of crayfish in various localities is summarized in Table 2.

Whenever possible, the results of skin tests should be related to the clinical findings, to the radiologic evidence of the severity of infection and, epidemiologically, to the presence of infected fresh water crabs and crayfish locally (Kobayashi, 1926; Miyasaki, 1958~1960).

The purpose of this study was to evaluate the usefulness of the skin test for epidemiologic investigation and to gain information concerning the distribution of this disease in different localities.

For these purposes, it was decided to concentrate our studies on Kyung-Sang Puk-Do (Park et al., 1959, 1961).

Both clonorchiasis and paragonimiasis were endemic in this province (Hidomiya, 1951). Fresh-water fish infected with metacercariae of clonorchis sinensis have been found in the Nak Dong River and its

Table 15. Prevalence rates of dermal reactors to P. westermanii Antigens in different localities in Korea

Locality		Walton et Chyu		Park et al.		Sadun & Buck	
		No. of persones examined	Percent	No. of persons examined (children)	Percent	No. of persons examined	Percent
Kyung Kee	Kak Kyo Ri	225	4.0				
	Nung Kak	207	3.4				
	Byuk Jae	132	1.5				
Kang Won	Chun Chyun	441	7.0				
	Won Choo	412	1.7				
Chung Book	Cheung Choo	498	2.4				
	Bo Sa	279	7.2				
	Chung Choo	341	5.0				
	Pyung Am Ri			136	13.2		
Chung Nam	Boo Yu	426	29				
	Chun An	379	13				
	Peup Tongri			82	14.5		
	Yoon Nae Ri			280	8.5		
Kyung Book	An Dong	452	3.5				
	Yung Chun	325	4.6				
	Po Hang	345	4.9				
	Ha Yang			410	3.9		
	Taegu			560	5.0		
	Ku Ji Ri			240	7.5		
	Ta Sa Ri			202	8.9		
	Senk Jeuk Ri			256	20.2		
	Seun Nam			310	11.6		
	Yak Mok			186	25.5		
	Chung Song			300	44.5		
Kyung Nam	Ul San	400	7.5			405	4.0
	Milyang					413	7.6
	Taetijon					356	0.3
	Un Dong					580	27.2
Chen Book	Kae Chung	491	5.5				
	Chen Choo	509	5.4				
Chen Nam	Nam Pyung	394	6.1				
	Mok Po	378	17.1				
	Hae Nam	451	22.6				
Jae Choo	Kang Chungri					273	78
	Sogi Po					500	48.3
	Nam Wong Ri					200	12.6
	Sam Ka Ri					100	15.5
	Sing Hung Ri					100	12.7
	Naedodong					97	64.2

Table 2. Infectivity rate of crayfish in various areas in Korea

Area	Kyung-Nam Hapchun, Hae-In-Sa	Kyung-Buk Kong-San Myun, Tong Wha-Sa	Kyung-Buk Kachang Myung	Kyung-Buk, Taegu-City Anji Kae	Kyung-Buk Yung-Chun Eunhae-Sa	Kyung-Buk, Kimchun Chikji-Sa	Total
Total No.	258	546	158	248	463	123	1701
No. of Infect.	138	343	67	72	322	57	999
Percent Infected	53%	63%	43%	31%	69	46%	58%

tributaries, but crabs are extremely rare in this province.

Crayfish are found in mountain streams, but not in the Nak Dong River.

The infectivity rate (carrier rate) of paragonimus westermani in crayfish in various localities is summarized in Table 2.

According to another survey made by Lee (1958) in nine villages of Gen-Chang Country (Kyung-nam), 24% of the population showed positive skin tests for P.W.,

In our survey (Park et al., 1959; 1961), the highest incidence was 44.5% of those skin tested for P.W.; this was among school children living in the mountainous areas of both Chung Song and Young Yang (Kyung-Puk). By contrast, elementary school children living in the valley areas showed 12% positive skin tests, while children in the same age group in the city of Taegu showed only 3 to 5% positive skin tests. Therefore, it should be noted that the infectivity rate varies according to the areas where a differenct type of intermediate host is found.

In Kyungsang Puk-Do, the prevalence of P.W. infection was very low in four valley areas surveyed along the Naktong River and its tibutaries (from 3.9 to 9.5%), but there was a higher prevalence in such areas as Young Yang and Chung Song (44.5 %) and Yak-Mok (25.5%), where mountain streams with crayfish are found and heavily infected.

These observations emphasize the need to consider the habitat and the number and seasonal migratory behavior of infected crayfish, how they are ingested, the number of crayfish ingested and their carrier rate of P.W. (Miyasaki et al., 1958~1960; Park et al., 1961).

Fresh crabs are not so important an intermediate host in Kyungsang Puk-Do and parts of Choong Chung-Do.

c) Age Incidence (Table 3): The age factor, as well as the kinds of intermediate hosts in differenct localities, also plays an important part. As was suspected, there was a close relationship between measles and P.W. infection, the age incidence for P.W. always being parallel with that of measles and usually following measles by one year (Fig. 2a). There were three peak periods in the morbidity rate of paragonimiasis, including 24 cases in children from 6 to 7 years of age (Fig. 2a).

Table 3. Age & sex distribution of paragonimiasis (Table 3, Fig. 2b, 2c)

Age	1~2	2~3	3~4	4~5	5~6	6~7	7~8	8~9	9~10	10~11	11~12	12~13	13~14	14~15	Total	%
Male	4	12	15	12	19	18	20	16	12	11	10	19	13	9	192	64.2
Female	3	7	9	8	9	13	6	8	7	7	8	10	7	5	107	35.8
Total	27	19	24	20	28	31	26	24	19	18	18	29	20	14	299	

Table 4. Age and sex distribution of measles in paragonimiasis patients

Age	0~1	1~2	2~3	3~4	4~5	5~6	6~7	7~8	8~9	9~10	10~11	Total	Percent
Male	14	25	38	25	14	25	18	13	8	8	2	192	64.2%
Female	8	18	21	13	8	15	7	7	5	3	2	107	35.8%
Total	22	43	59	37	22	40	27	20	13	11	4	299	

Note the two peaks in the incidence of measles, the first from 1 to 4 years of age and the second from 5 to 6 years of age. The highest incidence was from 2 to 3 years of age. The peak for paragonimiasis infection, was about one year later than for measles.

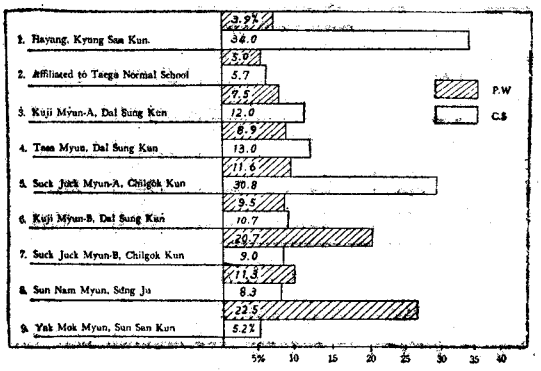

Fig. 1. Infectivity Rates (by skin test) of P. W. with C.S. in school children according to various areas.

The prevalence among males was higher in all age groups, possibly related to the fact that raw crabs are consumed frequently while drinking alcoholic beverages, which in Korea is done primarily by males. A lower prevalence was found in children of both sexes under 9 years of age.

Sudan (1960) thought that this probably was due to the fact that a young child is rarely fed raw crabs. The most rapid average increase in the rate of infection was observed to take place between 10 and 14 years of age. In both sexes, the prevalence increased up to the age group of 25 to 34, and decreased in older age groups (Sudan and Buck, 1960).

The paragonimiasis morbidity rate in adults was quite different from that of children, because of the different mode of infection. In adults, the infection results from the ingestion of raw crabs, which are found in endemic valley areas, rather than from raw crayfish as in the case of children. Therefore, it would seem that the age factors are related to both the type of intermediate host and to the geographical situation.

d) Sex Incidence (Table 3, Fig. 2b. 2c): As to sex, there were 192 male children, or 64.2%, and 107 female children, or 35.8%, found to have paragonimiasis. In other words, the male incidence was found to be almost twice that among females. (However, because of the cultural pattern—greater concern of parents for the health of male children—more male children than female were seen. Therefore, the greater incidence of P.W. among male children is not an entirely reliable conclusion.) Sadun (1960) had mentioned that males had a significantly higher prevalence rate than females, the ratio being 1.28 in Cheju-Do, 1.52 in Kyungsan Nam-Do. In Kyungsang Puk-Do, the prevalence of P.W. was very low in the three areas surveyed on the Naktong River and its tributaries (from 3.5 to 9.5%), whereas a higher prevalence was found in Young Yang and Chung Song (44.5%) and Yak-Mok Myun (25.5%) where mountain streams with crayfish are found (Park et al., 1959; 1961). These observations emphasize the need to consider the habitat and the number and seasonal migratory behavior of infected crayfish (crabs are not an important intermediate

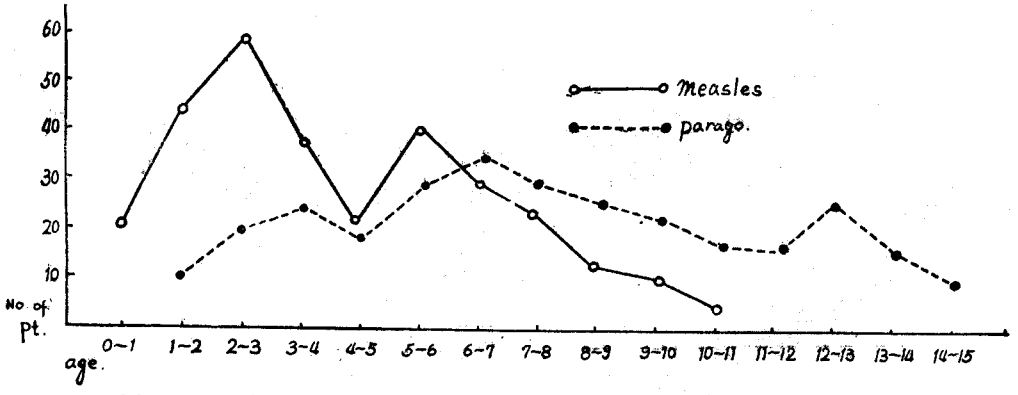

Fig. 2a. Relationship between measles and paragonimiasis in age incidence.

host in Kyung Sang Puk-Do) in evaluating the distribution of paragonimiasis.

e) Seasonal Incidence: Paragonimus infection closely followed measles, the highest number of cases being found in the spring, followed by summer, and then fall. In winter, the difficulty of catching crayfish could explain the lower incidence of paragonimus infection then.

Table 5. Seasonal prevalence of measles

	Spring Mar.-May	Summer June-Aug.	Autumn Sept.-Nov.	Winter Dec.-Feb.
No. of measle	165	86	15	33
percent	55%	29%	5%	11%
No. of children ingesting crayfish	171	107	15	6
Percent	57%	36%	5%	2%

f) Infectivity Rate Related to Measles (Table 6a): During the four-year period survey, the total number of measles cases studied was 2385. Of these, 692 cases, or 328%, had ingested crayfish, and of that number 297, or 24% became infected with paragonimus. However, none of the cases in the control group who had no history of ingesting crayfish for measles showed positive skin tests. The number of ingested crayfish per patient ranged from 1 to 19. The positive skin test for P.W. and C.S. in children in various areas is demonstrated in Fig. 1 and Table A. In general, the incidence of both diseases in the various locations was in converse relationship.

g) Source of Infection (Tables 6a & 6b): Of the 233 cases of paragonimiasis, 184 or 79%, were caused

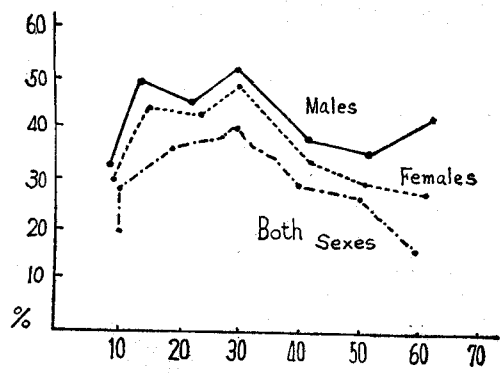

Fig. 2b. Age in years

Table 6a. Infectivity rate related to measles

No. of measles cases	No. of cases ingesting intermed. host	Positive skin test
2,385	692(32.8%)	297(42.9%)

Table 6b. Cause of infection and various tests (299 cases)

	No. of Pt. Crayfish ingested	No. of Pt. Crabs Ingested	No. of Pt. Unknown history	No. of Pt. Positive Ova in feces	No. of Pt. Positive Ova in sputum
Number	236	49	14	114	272
Percent	79%	16%	5%	38%	91%

by the ingestion of crabs; 37, or 16%, were caused by the ingestion crabs, and 12, or 5% were of unknown history. In children, the crayfish was far more frequently the source of infection than were crabs. In adults, the opposite was true.

h) Relation-ship between P.W. & C.S. Infection by age: The relationship between P.W. and C.S. skin tests in various localities is demonstrated in Figure 1. Geographical variation in the incidence of both diseases was quite significant. The higher incidence of P.W. infection was observed in mountainous areas, where crayfish were found; in contrast, a higher incidnece of liver fluke infection was found in valley areas, where crabs were found (Chyu, 1959). The age specific prevalence rate of interder-

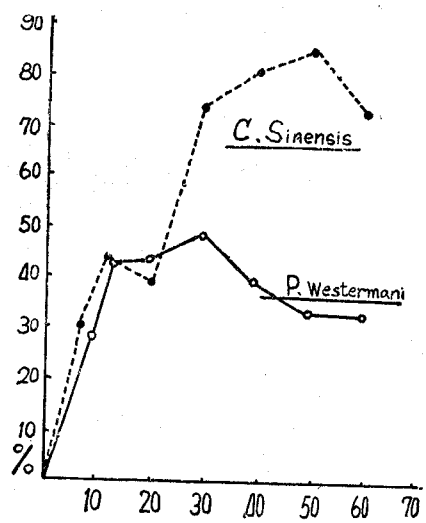

Fig. 2c. Age in years

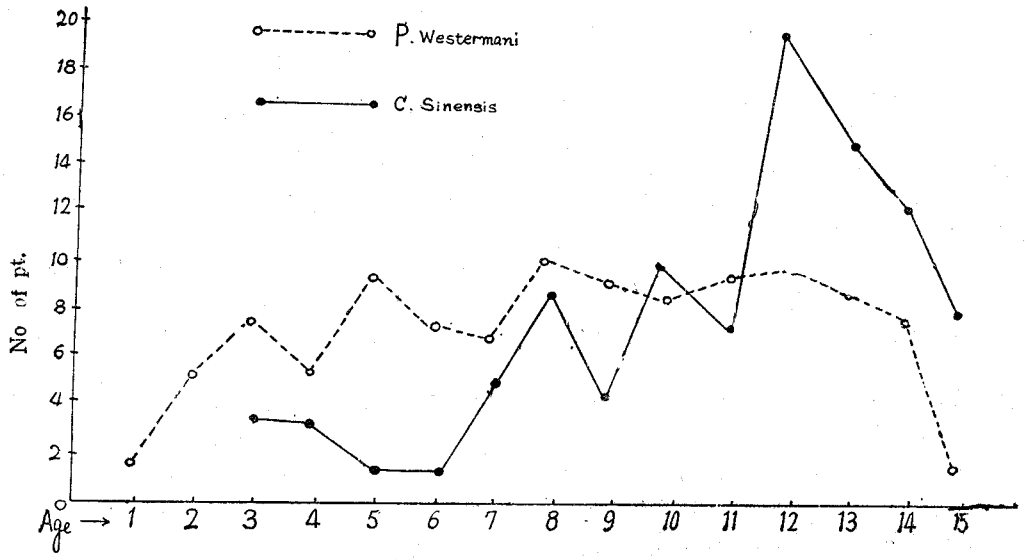

Fig. 3. Relationship between P.W. & C.S. skin tests by age morbidity rate of Parago. & Clonorch. by age (Dr. Park).

mal reactors to P.W. and C.S. in areas of high endemicity (Chejudo and Kyung Sang Nam Do) were compared by Sadun (1960). Fig. 2b Prevalence of dermal reactors to P. Westermani (826) and C. Senensis (363) antigens in relation to age among individuals in areas of high endemicity. (Dr. Sadun)

Whereas the percentage of reactors to P.W. increased up to the age 30 and then decreased, the percentage of reactors to C.S. continued to increase up to the age of 50, at which age 80% of the population tested was positive (Fig. 2A and 2B).

i) Skin Test for P.W. & C.S. Infection: Yokogawa (1955), recently developed an interdermal test using antigen made from the adult worm (1; 10,000), giving 95% correlation with known positivity in Japan. It is quite obvious, therefore, that the skin test is a simple and valuable tool which has helped immeasurably in the establishment of a diagnosis of P.W. and C.S.

j) X-ray Findings (Table 7): Routine X-rays of the chest were taken on cases with a positive skin test. Also, in a few suspicious cases with positive skin tests, X-rays were taken for unusual localization in such areas as the brain and other parts of the body (Tab. 7 & 8). Of 215 patients X-rayed in the survey, 48% showed cyst formation; 22% revealed increased bronchial markings; 16% showed pleural involvement, and 10% showed pneumonic infiltration. However, on films of the skull, focus with a tendency to calcify.

Table 7. X-ray findings (215 cases)

Areas	Number	Percent
Cyst formation	103	48%
Pleurisy & pleural thickening	34	16%
Pneumonic infiltration type	22	10%
Bronchial marking increased	47	22%
Brain (cyst formation)	14	4%

Table 8. Localization other than in lung parenchyma (52 cases)

1. Pleurisy with pleural thickening.....34 cases
2. Cerebral paragonimiasis .....16 cases
3. Skin and subcutaneous nodules..... 2 cases

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