

## CORRELATION OF INFECTION RATE OF INTESTINAL HELMINTHS IN JAPANESE INHABITING TROPICAL COUNTRIES WITH DEGREE OF POLLUTION OF DRINKING WATER<sup>1</sup>

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**Abstract:** Many Japanese inhabit tropical countries, and some of them are suffering from infectious diseases. In order to know the relationship between the prevalence of these diseases and the degree of faecal pollution of the drinking water, we have examined the drinking water in these countries of the world, and at the same time we have studied the infection rate of intestinal helminths of the Japanese who stayed 6 months or more in these countries.

In total over 300 samples of drinking water from countries of South East and South West Asia, Middle East, East Africa and Central and South America were tested with potassium permanganate consumed test, and number of coliform bacilli from the drinking water was counted after cultivation. Relatively high proportion of samples appeared to be polluted by faecal matters. Then, we checked parasite eggs in the stool samples of Japanese who used the water samples in the tropical countries actually. Eggs of *Ascaris lumbricoides*, *Trichuris trichiura*, *Taenia saginata* and *Clonorchis sinensis* were found among the Japanese. Infection rate of intestinal helminths was proved to be highest among Japanese in Indonesia, and the rate was followed by those of people in South West Asia, in East Africa and in Central and South America. The relationship between the infection rate of intestinal helminths and the degree of pollution of the drinking water was studied. Significant relationship was observed between the infection rate of intestinal parasites of the Japanese inhabitants and the rate of water containing 10<sup>3</sup> or more/ml of coliform and of total micro-organisms ( $r=0.957$ ). However, no relationship between the infection rate of *Enterobius vermicularis* among the Japanese children there and the degree of the pollution of drinking water was found.

### INTRODUCTION

At present time, over 440 thousand Japanese inhabit tropical countries, and

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the number of Japanese stayed in these countries is increasing, as the Japanese technical cooperation with the countries is improved. The diseases from which Japanese suffers in the tropical countries are infectious hepatitis, especially type A, amoebic as well as bacillary dysentery, typhoid fever, various kinds of intestinal helminthiasis and so on. These diseases are thought to be orally infected, and among sources of infection, the drinking water is considered to be most important as the main route of infection.

In 1968, we started to examine the drinking water from tap as well as deep-well at various places in Indonesia. Results were shown that the drinking water in Indonesia contained a large amount of micro-organisms. For example, *Escherichia coli* was found in more than 10% samples of the drinking water supplied by Jakarta city (Fujita, Ikeda and Matsumoto, 1974). The examination continued to be conducted by us from 1968 until recently, but no good progress in the results of the examination of drinking water was seen in the past 13 years (Fujita, Okuwaki, Ikeda, Tsukidate, Sugiyama and Iwami, 1980).

From 1979, we have newly opened inquiry of the drinking water in many tropical countries in the world including Indonesia. Results also revealed that comparatively large proportion of drinking water contained *E. coli*, and it was thought to be polluted by faeces and sewage. On the same time, we conducted the survey of the intestinal helminth infection rate among the Japanese who live in tropical countries and use the drinking water in these countries. The present paper describes the relationship between the infection rate of intestinal helminths among the Japanese and the degree of pollution of drinking water in the tropical developing countries.

#### MATERIALS AND METHODS

From April 1979 to December 1980, we have visited various tropical countries, as shown in Table 1, and collected samples from drinking water with cleansed containers, after washing them thoroughly with it. The drinking water from tap as well as deep-well was dropped with a sterilized pipet into MacConky and CLED agar (Uricult Set, Daiichi Kagaku, Co. Ltd. Tokyo) and cultivated according to the previous paper (Okuwaki, Fujita, Sugiyama, Yanai, Yutaka, Tsukidate and Asakura, in press). To determine the number of bacteria/ml of the sample, the density of colonies appearing on each of the slide was compared with the densities on the model chart, according to our previous paper (Fujita et al., 1980).

Potassium permanganate consumed test, total hardness and other chemical tests of drinking water were also carried out with Shibata 8052-05 type water gauge (Shibata Co. Ltd., Tokyo).

On the same time, we have collected stool samples from the Japanese who inhabited in tropical countries for at least over 6 months and were using the same water we tested for drinking. The stool samples were put into the containers with 10% formaline, and on our return to Japan, they were examined by Formaline-Ether (MGL) method whether the Japanese suffered from intestinal helminths. Especially the children staying in these countries were tested to determine the infection rate

of *E. vermicularis* by Scotch Tape method (Yoshida, 1977).

## RESULTS

### *Potassium permanganate consumed test of drinking water.*

The greatest danger associated with drinking water in tropical countries is that it has been contaminated by sewage or by human excrement. Therefore, we examined first the potassium permanganate consumed test which is regarded as the most important index among various kinds of chemical examinations in connection with these kinds of water pollution. In total, 383 samples of the drinking water from tropical countries of South-East and South-West Asia, Middle East, Africa and Central and South America were tested with potassium permanganate consumed test. When the drinking water showing over 10 mg per litre in the test was regarded as positive, the positive rate was shown in the left column of Table 1. The positive rates of the drinking water from Argentina, Venezuela and India were proved to be highest. The values of drinking water from Brazil, Taiwan, Iraq, Tanzania and Bolivia were found next to them.

### *Determination of the coliform group and the total content of micro-organisms from the drinking water.*

The organisms most commonly used as indicators of faecal pollution are *E. coli* and the coliform group. In order to know the degree of faecal pollution of the drinking water in tropical countries, we picked up the samples containing  $10^2$  or more per millilitre of coliform and of the total content of micro-organisms on the same time. Among 298 samples tested, the drinking water from Malagasy and Indonesia showed the highest degree of contamination with micro-organisms, and the values were followed by the samples from Tanzania, Ecuador, Panama, India and Mexico, as shown in the central column of Table 1. It is interesting that percentage of drinking water containing micro-organisms from Indonesia was astonishingly high, in spite of that the relatively low positive rate was found in the potassium permanganate consumed test, as already mentioned.

### *Total hardness of the drinking water.*

Total hardness of the drinking water was assayed, and results were indicated as (1) to (6) according to the degree of the hardness, as shown in the right column of Table 1. Relatively soft drinking water was available in areas of South-East Asia and Central America, while harder water was obtained from Middle East.

### *Infection rate of the intestinal helminths in Japanese inhabiting tropical countries.*

We have collected the stool samples from the Japanese who stayed 6 months or more in these tropical countries, and examined parasite eggs. Eggs of *A. lumbricoides*, *T. trichiura*, *T. saginata* and *C. sinensis* were found, and the infection rates of these intestinal helminths were calculated in Japanese inhabiting Indonesia, South-West Asia (India and Pakistan), Middle East (Qatar), East Africa and Central

Table 1 Examination of the drinking water from tropical countries (1979 to 1980)

Area	Name of country	Potassium* <sup>1</sup> permanganate consumed test (%)	Coliform* <sup>2</sup> bacillus (%)	Total hardness
South East Asia	Indonesia	6/74 ( 8.1)	53/74 (71.6)	(2)–(3)* <sup>3</sup>
	Philippine	5/13 (38.5)	N.T.* <sup>4</sup>	(1)–(3)
	Taiwan	4/7 (57.1)	N.T.	(1)
South West Asia	India	16/24 (66.7)	10/24 (41.7)	(3)–(6)
	Pakistan	6/17 (35.3)	1/17 ( 5.9)	(4)
	Bangladesh	0/2 ( 0.0)	0/2 ( 0.0)	(2)
Middle East	Iraq	3/6 (50.0)	N.T.	(6)
	Qatar	0/12 ( 0.0)	1/12 ( 8.3)	(5)
	Egypt	1/8 (12.5)	0/8 ( 0.0)	(4)–(5)
Africa	Kenya	10/34 (29.4)	3/16 (18.8)	(1)–(3)
	Zambia	0/9 ( 0.0)	0/9 ( 0.0)	(4)–(5)
	Tanzania	7/14 (50.0)	7/14 (50.0)	(1)–(2)
	Malagasy	1/7 (14.3)	6/7 (85.7)	(1)–(5)
	Mozambique	0/17 ( 0.0)	6/17 (35.3)	(1)–(2)
	Neigeria	0/2 ( 0.0)	N.T.	(2)–(3)
Central America	Mexico	4/29 (13.8)	12/29 (41.4)	(2)
	Panama	3/14 (21.4)	6/14 (42.9)	(1)
	Guatemala	0/4 ( 0.0)	1/4 (25.0)	(1)
	Trinidad	0/5 ( 0.0)	N.T.	(4)
South America	Venezuela	14/18 (77.8)	N.T.	(3)
	Colombia	3/8 (37.5)	3/8 (37.5)	(1)
	Ecuador	1/9 (11.1)	3/7 (42.9)	(1)
	Peru	4/13 (30.8)	5/13 (38.5)	(5)
	Chile	1/8 (12.5)	1/8 (12.5)	(5)
	Argentina	6/7 (85.7)	N.T.	(2)
	Paraguay	1/5 (20.0)	N.T.	(2)
	Bolivia	1/2 (50.0)	N.T.	(2)
	Brazil	9/15 (60.0)	3/15 (20.0)	(1)

\*<sup>1</sup> Number of samples showing 10 mg/l or more  
in the potassium permanganate consumed test

Number of total  
samples tested

\*<sup>2</sup> Number of samples showing 10<sup>2</sup>/ml or more  
of coliform bacilli and of total  
content of micro-organisms

Number of total  
samples tested

\*<sup>3</sup> (1) mean value of total hardness of below 50 mg/l (2) 50–100 mg/l (3) 100–150 mg/l  
(4) 150–250 mg/l (5) 250–350 mg/l (6) over 350 mg/l respectively

\*<sup>4</sup> N.T.: not tested

Table 2 Correlation of infection rate of intestinal helminths in Japanese inhabiting tropical countries with the degree of pollution of drinking water

Area	South East Asia (Indonesia)	South West Asia (India, Pakistan)	Middle East (Qatar)	East Africa	Central and South America
Number of stool samples tested	212	80	48	89	226
Number of parasite positive samples	17 (8.0%)	2 (2.5%)	0 (0.0%)	2 (2.2%)	3 (1.3%)
<i>Ascaris lumbricoides</i> * <sup>1</sup>	12 (5.7)	2 (2.5)	0	2 (2.2)	0
<i>Trichuris trichiura</i>	4 (1.9)	0	0	0	2 (0.8)
<i>Taenia saginata</i>	1 (0.5)	0	0	0	0
<i>Clonorchis sinensis</i>	0	0	0	0	1 (0.4)
Number of Scotch tape tested	48	91	N.T.* <sup>4</sup>	75	105
<i>Enterobius vermicularis</i>	4 (8.3%)	6 (6.6%)	N.T.	5 (6.7%)	7 (6.7%)
Number of drinking water tested	76	43	12	63	98
Potassium permanganate consumed test* <sup>2</sup>	6 (8.3%)	25 (58.1%)	0 (0.0%)	15 (23.8%)	25 (25.5%)
Coliform bacillus* <sup>3</sup>	53 (71.6)	11 (25.6)	1 (8.3)	22 (34.9)	34 (32.4)

\*<sup>1</sup> Number of stool samples having eggs of *A. lumbricoides*

\*<sup>2</sup> Number of drinking water showing 10 mg/l or more in the potassium permanganate consumed test

\*<sup>3</sup> Number of drinking water showing 10<sup>2</sup>/ml or more of coliform bacilli and of total content of micro-organisms

\*<sup>4</sup> N.T.: not tested

and South America. The Japanese we selected in each of tropical countries were composed of persons from the same environmental as well as economical status; they were members of the first class of manufacturing trading firms of Japan and their families. Also, there were almost no differences in sex ratio and age of persons composed among these areas except in the case of Qatar. As shown in Table 2, the infection rate of the intestinal helminths among the Japanese was found highest in Indonesia, and those of South-West Asia, of East Africa and of Central and South America followed it. The infection rate of the Japanese in Qatar of Middle East was proved to be null.

The infection rate of *E. vermicularis* was also examined with their children of these areas by Scotch Tape method. The infection rate was also highest among children in Indonesia, but the rate was not so different from those of the other areas, and the infection rates of South West Asia, East Africa and Central and South America showed same value, as shown in Table 2.

*Relationship between the infection rate of intestinal helminths among the Japanese and the degree of pollution of drinking water.*

In order to know relationship between the infection rate of intestinal helminths and the degree of pollution of drinking water, the potassium permanganate consumed test and the examination of number of coliform bacilli as well as total number of other micro-organisms were carried out and they were compared with the parasite infection rate of the Japanese who were using water for drinking actually in these tropical countries.

The positive rate of potassium permanganate consumed test and of water samples containing  $10^2$  or more/ml of coliform and of total content of micro-organisms were shown in the lower column of Table 2. Significant relationship was observed between the infection rate of intestinal parasites and the rate of water containing  $10^2$  or more/ml of coliform and total micro-organisms. Its correlation coefficient was  $r=0.957$ , as shown in Fig. 1. However, no relationship was observed between the infection rate of parasites and the positive rate of potassium permanganate consumed test. Then the relation between the infection rate of *E. vermicularis* and the degree of pollution of drinking water was examined, but no significant relationship was found between them.

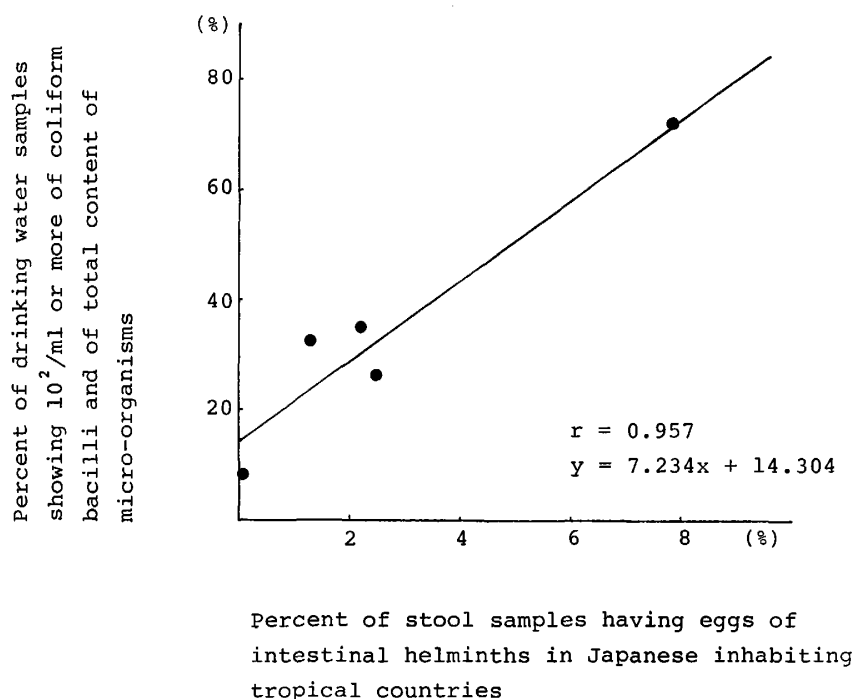


Figure 1 Correlation of infection rate of intestinal helminths in Japanese inhabiting tropical countries with the rate of drinking water samples having coliform bacilli.

## DISCUSSION

Water intended for human consumption must be free from organisms that may be a hazard to health. Some countries have established national standards of quality for drinking water and have achieved to get a certain degree of clean water (Takeuchi, 1980). Others, however, still lack official standards of quality (World Health Organization, 1971), and many tropical countries have no recognized methods for keeping good quality of drinking water. Our previous study for 13 years in Indonesia revealed that *E. coli* was always found in more than 10% sample of drinking water and the situation have never changed during these periods (Fujita et al., 1980).

On the other hand, outbreaks of water-borne diseases are still prevalent in these tropical countries and the Japanese inhabiting these countries are often suffering from these diseases. Some one says that they use water for drinking after boiling it completely, so the prevalence of diseases is not ascribed to the drinking water itself. However, it does not seem to be true. Present study clearly demonstrated that the Japanese who used the water containing coliform group for drinking were inclined to be infected with intestinal helminths. The result will suggest us that the drinking water still plays important parts in the prevalence of the water-borne diseases, even if people use the drinking water after boiling it completely.

At regional and international conferences sponsored by the World Health Organization, the problems of establishing standards of quality for safe and acceptable water supply in these countries have been discussed by groups of experienced hygienists and engineers. Outbreaks of water-borne diseases will be avoided through stricter control by the responsible health authorities of the quality of the water distributed for drinking purposes. If the drinking water continued to be kept free from faecal pollution in these countries, people in tropical countries including the Japanese inhabiting there would not contract these diseases.

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## 世界各地の発展途上国に在留する邦人の腸管寄生虫感染率と飲料水 水質検査成績との相関<sup>1</sup>

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世界各地の、いわゆる発展途上国に在留する邦人の数は著しく増加している。それと同時に、各地で A 型肝炎、腸チフスやアメーバ赤痢など重篤な経口感染症に罹患する邦人の数も増加している。我々は、その主な原因が飲料水の汚染にあると考え、世界各地の発展途上国の飲料水について、特に糞便汚染との関連について調査してきた。今回、飲料水の汚染と在留邦人の腸管内寄生虫感染率との関連について調べたので報告する。

我々は、1979年4月から1980年12月までの間に東南アジア、南西アジア、中近東、東アフリカおよび中南米の種々の国々を訪問し、飲料水を採取し、細菌学および化学的水質検査を行なった。

総数383検水について、まず過マンガン酸カリウム消費量が測定され、ついで一般細菌数および大腸菌群の数が調べられた。その結果、多かれ少なかれ、熱帯発展途上国の飲料水が糞便系汚染にさらされていることが判明した。

そこで、水質検査と同時にこれらの飲料水を利用している邦人について、彼らの腸管内寄生虫感染率を調査した。各地に6か月以上滞在している邦人の成人から小指頭大の糞便を採り、10%ホルマリン加バイアル瓶に入れて日本に持ち帰り、MGL 集卵法にて糞便内寄生虫卵を検出した。また邦人の子供達を対象に、セロファン2回法による蟯虫検査を施行した。

糞便からは主として蛔虫卵が見出され、その他鞭虫、無鉤条虫、肝吸虫などの卵が検出された。腸管内寄生虫感染率はインドネシア在留邦人に最も高く、次いで南西アジア、東アフリカ、中南米の順になり、中近東のカタールでは全員陰性となった。在留邦人のうちで、腸管寄生虫に感染している割合は、同地域の飲料水のうちで大腸菌群が検出された検水の割合と高い正の相関を示した。すなわち、大腸菌群の検出頻度の高い飲料水を使用している在留邦人ほど、腸管寄生虫に多く感染しており、両者の相関係数は  $r=0.957$  であった。しかし、糞便内寄生虫卵陽性率と飲料水の過マンガン酸カリウム消費量との間には相関関係は見出せなかった。また、在留邦人の子供を対象に施行した蟯虫卵の陽性率は飲料水の汚染とは全く無関係であった。

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