



Comparative analysis of knowledge on schistosomiasis japonica in the local people in the former endemic area in Yamanashi Prefecture, Japan: comparisons among the background of age and occupation

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ABSTRACT. Eradication of schistosomiasis japonica in Yamanashi Prefecture was officially declared in 1996, and all surveillance and health campaign were finished by the end of 2001. Schistosomiasis control had been carried out by strong collaboration among local Government, local people and academia, though which knowledge and experiences of the disease control were accumulated among the local people. It is 20th anniversary of the disease eradication in Yamanashi. We planned to analyze the current situation whether the local people still keep the knowledge of schistosomiasis or not. There was no more knowledge kept in the middle school students, to whom the local Government did not educate about schistosomiasis. Among adult individuals, elderly people who have experienced endemic condition still know about it at almost comparable level as in the past. However, younger people who learned it in the primary school but no experience of the disease transmission started losing the knowledge. Those situations of the adult local people were compared with the veterinarian group. It was confirmed that the veterinarian group had correct and proper knowledge of schistosomiasis japonica not only in elderly groups, but also in younger age group. Considering that methods for control and prevention of infectious diseases are common to some extent, their knowledge and experiences would be applicable for other infectious diseases in future. Therefore, the knowledge would be worth keeping in the local people. Taken together, individuals with specialty, such as veterinarians, are expected to play roles in public health for promotion of health and welfare.

KEY WORDS: health knowledge, questionnaire survey, schistosomiasis japonica, Yamanashi Prefecture

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Schistosomiasis japonica is a parasitic disease caused by the intravenous trematode, *Schistosoma japonicum*. In the life cycle of *S. japonicum*, intermediate snail hosts, *Oncomelania hupensis nosophora*, are needed for the parasite growth and maturation.

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Therefore, endemic areas are focal in which *Oncomelania* snails are breeding. Three major endemic foci were known in Japan; Kofu basin in Yamanashi Prefecture. Katayama area in Hiroshima and Okayama Prefectures, and Chikugo River area in Saga and Fukuoka Prefectures (Fig. 1). In the late 1960s, breeding intensity of *Oncomelania* snails in Katayama and Chikugo areas was gone, and subsequently, disease transmission had ceased in those areas [18]. On the other hand, the snail habitat areas still remained in Kofu basin, and human cases were reported in the late 1970s. Yamanashi Prefecture took intensive and comprehensive control measures against schistosomiasis including public and private sectors, and the disease eradication was officially declared in 1996. All control and surveillance activities had completed in 2001, after 5 years of follow-up activities [6, 9].

In the life cycle of *S. japonicum*, cercariae, the infective larvae, cattle, were released from *Oncomelania* snails, and they penetrate skin of the final hosts. Final host of *S. japonicum* is not only humans, but also other domestic and wild animals including cattle, pigs, goats, dogs and mice accept *S. japonicum*, indicating that schistosomiasis japonica is zoonotic. Pathogenesis of schistosomiasis japonica has been analyzed. Adult parasites in the mesenteric vein of the final host produce eggs, and they are embolized in capillary vessels, around which granulomatous inflammation is induced by the host immune system. In the chronic phase, various symptoms, such as liver fibrosis, portal hypertension and mucosal inflammation in intestine, are observed. As the advanced symptoms, fatal symptoms including colon cancer, hepatic cancer, epilepsy and esophageal varix were developed [2, 4, 5, 7, 17]. Those symptoms were known in the endemic areas; Katayama Note described hepatic symptoms in detail, and severe ascites was noted in a folk song in Yamanashi [6]. For treatment of schistosomiasis, praziquantel is now available with high efficacy, but only faint side effects [8, 12, 13, 19].

The last human case of schistosomiasis japonica was reported in 1977, and since then, all human cases in Japan were imported cases from endemic areas [7]. In Yamanashi Prefecture, there are still *Oncomelania* snails, however, disease transmission seems to be interrupted, which is only the success in schistosomiasis control in the world [6, 7, 9]. Strategies of schistosomiasis control have been established, and WHO recommends several approaches, such as case management, snail monitoring, environmental changes and health education [1, 14, 20]. It was before the clinical use of praziquantel when disease transmission ceased in Yamanashi, and therefore, case management was not the main component of schistosomiasis control in Japan [6]. It should be emphasized that individuals in endemic areas had correct knowledge of schistosomiasis and disease prevention, and the people were well mobilized to participate in the control activities. This was the most important factor for the success of disease eradication [3, 15]. There were big contributions from the scheme of school health, disease control campaign by the local Government and provision of information from medical and veterinary sectors.

When health education was distributed to local people at enough level, it is expected to keep the situation. Sustainability is the most important key word. Yamanashi Prefecture had repeatedly monitored the knowledge level of local people, both adults and students, about schistosomiasis and disease prevention [10, 11]. Although schistosomiasis is not likely re-emergent in Yamanashi Prefecture, there are many common components in schistosomiasis prevention tools with those for other infectious diseases. Knowledge and attitude for schistosomiasis control seem to be applicable for preventing other infectious diseases. It is, therefore, expected to keep knowledge of schistosomiasis, which was once distributed in local people continuously. In these 15 years, there has been no public health campaign and no school health education about schistosomiasis control. No systematic research has been done to uncover how is the situation of public health knowledge related to schistosomiasis in Yamanashi Prefecture.

In our present study, we analyzed public health knowledge related to schistosomiasis control kept in local people in the former endemic areas in Yamanashi. We tried to get information whether local people still keep correct knowledge even after these 15 years interval. We compared the changes in knowledge between now and 50 years ago, and compared the changes between different age groups, including people who experienced the disease endemicity or people who were educated at primary school but no experience of the disease endemicity. It was, furthermore, compared the situation of knowledge between group with and without scientific specialty. We collected information of knowledge level from veterinarians in Yamanashi, because of schistosomiasis japonica being zoonotic. Together with those, we discuss how deeply the blank period of 15 years influenced for keeping public health knowledge in local people, and consider about possible contribution of veterinarians for keeping disease control knowledge and attitude in the local people.

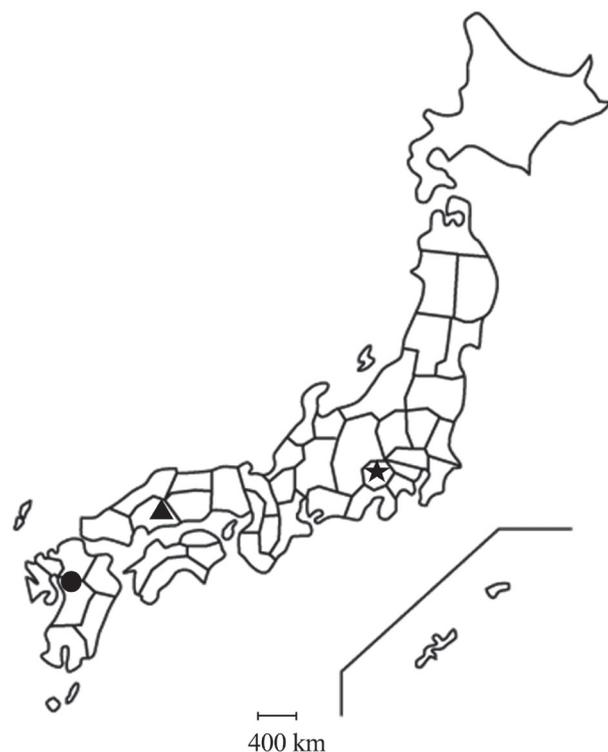
MATERIALS AND METHODS

Studied populations

We tested resident population in the former endemic areas of schistosomiasis japonica in Yamanashi Prefecture (Fig. 2). Four age groups were tested: (1) Middle school students (N=1,949), (2) General adults of age 20–39 years (Group A, N=62) who were students at the time of the declaration of disease eradication, with school education of schistosomiasis at primary schools, (3) General adults of age 40–54 (Group B, N=100) who were already matured at the declaration but with no experience of endemic condition of schistosomiasis, (4) Elderly age above >55 years (Group C, N=157) who experienced endemic condition of schistosomiasis. Apart from general adult individuals, we tested veterinarian population in Yamanashi (N=109), because schistosomiasis japonica is zoonotic and veterinarians were expected to have knowledge of schistosomiasis. Veterinarian group was also divided into 3 age groups: under <39 years (Group A', N=28), age between 40–54 years (Group B', N=36) and above 55 years (Group C', N=45) (Table 1).

Questionnaire study

We prepared two different questionnaire sheets, of which one was for middle school students and the other for adult population



- ★: Yamanashi Prefecture
- ▲: Katayama
- : Chikugo River area

Fig. 1. Indicating three major schistosomiasis endemic areas. (https://www.pref.yamanashi.jp/link/link_city.html confirmed 5th now, Accessed 13 December 2016).



Fig. 2. Map of the location of middle schools tested in this study. Each underlined number indicates cities and township where middle schools tested in this study were located. All those were former endemic areas of schistosomiasis japonica in Yamanashi Prefecture. No; 1: Kofu, 6: Nirasaki, 7: Minami Alps, 9: Kai, and 19: Showa. (<https://www.hp-sozai.net/link/c-map/g-map.05html>, Accessed 5 November 2016).

Table 1. Profiles of studied subjects tested in this study

Population	Age range (year)	N	Sex ratio ^{a)}
(1) Middle school	13–14	1,949	
(2) General adult population		319	1.10
Group A	20–39	62	1.21
Group B	40–54	100	0.79
Group C	55 above	157	1.31
(3) Veterinarian population		109	2.52
Group A'	20–39	28	1.33
Group B'	40–54	36	2.60
Group C'	55 above	45	4.99

Middle schools tested were located in cities of Kofu, Kai, Nirasaki, Minami Alps and Showa Township. ^{a)} Sex ratio = (male number) ÷ (female number).

including veterinarians (Table 1). Contents of each of two questionnaire sheets were almost the same as questionnaire sheets used in a previous study done by Yamanashi Prefecture [10, 11] (Tables 2 and 3). For middle school students, full agreement was obtained from the educational committee, school masters and parents. In this study, we tested middle schools located in Kofu, Kai, Nirasaki, Minami Alps and Showa, all of which are former endemic areas (Fig. 1b). For adult people, questionnaire sheets were distributed through health sector, regional leaders and social meetings. After getting informed consent from each person, questionnaire sheets were returned back. Questionnaire sheets for veterinarians were sent back to the Association of Veterinarians in Yamanashi with full informed consent. This study was approved by the ethical committee of Tokai Gakuin University (Approval Number: 2016-12) and the ethical committee of the Society of Comparative Integrative Medicine Japan (Approval Number: 28-001).

Table 2. Questionnaire for Junior high school students

No.	Question	Answer
1	Do you know in which parts schistosomiasis was endemic?	(Fill in the areas)
2	Did your relatives get infection?	Yes/ No/ No idea
3	Do you know the pathogen of schistosomiasis japonica? In case of Yes, please write name of the pathogen...	Yes/ No (<i>Schistosoma japonicum</i>)
4	Do you think that schistosomiasis was dangerous disease?	Yes/ No/ No idea
5	Do you know the root of infection?	Mouth/ Skin/ Blood/ others
6	Was schistosomiasis japonica zoonotic? In case of Yes, please write two reservoir animals....	Yes/ No/ No idea (ex. Cattle, mice,)
7	Do you know which organ schistosome infect? In case of Yes, please specify the name of organ....	Yes/ No (ex. Liver, Rectum,)
8	Is protective immunity induced against schistosome in infected hosts?	Yes/ No/ No idea
9	Do you know how schistosomiasis japonica is diagnosed?	Yes/ No
10	Do you know in which season schistosome infection occurs?	Spring/ Summer/ Autumn/ Winter/ All seasons
11	Do you know the vector of <i>Schistosoma japonicum</i> ? In case of Yes, please specify the vector.... How big is it?	Yes/ No (<i>Oncomelania</i> snails ...) 6–8/ 10–15/ >20 mm/ No idea
12	Do you know the site of infection of <i>S. japonicum</i> ?	Paddy field/ water canal/ The Kamanashi river, vegetable field, no idea
13	Do you know where the vector reside?	Paddy field/ Farm road, glass field, dry sand/ no idea
14	Concrete water ways were constructed in Yamanashi. Do you know the reason? In case of Yes, what was the reason?	Yes/ No (Snail control ...)
15	Do you think that schistosomiasis become endemic again in Yamanashi? In case of Yes, please specify the reason(s)...	Yes/ No/ No idea
16	Do you know in which year(s) schistosomiasis was eradicated in Yamanashi?	1960/ 1970/ 1980/1990/ 2000–/ No idea
17	Do you know in which year the Mayor of Yamanashi declared the disease eradication?	1960/ 1970/ 1980/ 1990/ 2000–/ No idea
18	Do you know how schistosomiasis japonica was eradicated in Yamanashi?	Health check/ Health education/ land-use change/ River bank/ bank/ construction/ medical development/ others
19	Do you know the number of schistosomiasis patients in the world?	0.2/ 2/ 20/ 200/ 2,000 million

Statistical analysis

Comparisons were made for various combinations. For middle school students, current student group was compared with students in 1960s [10, 11]. Among adult people, different age groups were compared about their knowledge of schistosomiasis. Chi-square analysis was done, and *P* value less than 0.05 was cut-off for significant difference. Along with statistical analysis, odds ratio was calculated to evaluate the strength of association. Odds ratio was calculated as follows: (% value in group (1)) / (% value in group (2)).

RESULTS

Analysis of middle school students

In total, 1,949 students joined the present study. The main purpose of the present study on middle school student was to compare knowledge of schistosomiasis between current students and students in the past time. Results of questionnaire studies in 1961 and 1975 are available [8, 13], and then, it was possible to know what changes occurred in these 50 years interval. As was anticipated, correct knowledge was almost lost in the current student group, while around 90% of middle school students in 1960s had correct knowledge about the pathogen, symptoms, root of infection and the intermediate snail, *Oncomelania* snails. Representative results are shown in Table 4. All such information is not kept in the current student group. Out of 5 former endemic areas, students from Showa township still keep a little bit more profound knowledge compared with students from other areas tested in this study. For example, knowledge about the intermediate snails, students from Showa were significantly better than students from other areas, and odds ratio compared with other areas were from 3.41 to 7.15 (*P*<0.05) (Table 5). Knowledge of schistosomiasis japonica was no more kept in middle school students in Yamanashi Prefecture, however, there were significant differences in some knowledge level among the location of middle schools.

Analysis of general adult population

General adult people were divided into 3 different age groups (Table 1). All groups experienced school education about

Table 3. Questionnaire for Adult/ Veterinarian population

No.	Question	Answer
1	Please specify your sex	Male or Female
2	How old are you?	<20/ 20–34/ 35–44/ 45–54/ 55 yr <
3	What is your occupation?	No working/ student/ office worker/ farmer/ merchant/ Government official/ others
4	How many years have you been living in the present area?	<10 yr/ 10–20 yr/ 20–30 yr/ 30 yr <
5	Do you know schistosomiasis japonica?	Mouth/ Skin/ Blood/ others
6	Do you know that schistosomiasis was endemic in Yamanashi? In case of Yes, how did you get such information.....	Yes/ No From relatives/ book reading/ school/ campaign by Yamanashi/ others
7	Do you know the root of infection?	Yes/ No
8	Do you know symptoms of schistosomiasis japonica? In case of Yes, please specify the symptoms....	Yes/ No
9	Do you know that safe/effective medicine is available now?	Yes/ No
10	Do you know how prevent the infection?	Yes/ No
11	Do you know that Yamanashi was the first area of successful disease eradication in the world?	Yes/ No
12	Do you know what control measures were taken in Yamanashi? In case of Yes, can you specify two measures?	Yes/ No (Education, Snail control)
13	Do you suppose that schistosomiasis is never re-emergent? In case of Yes, what was the reason(s) ?	Yes/ No/ No idea (vector snails are still there ...)
14	Do you think that Yamanashi Prefecture should continue surveillance even now? In case of Yes, please specify the reason(s)...	Yes/ No/ No idea Snails are still there/ parasite can be imported/ parasites might be still there/ others...
15	Have your relatives had infection of <i>Schistosoma japonicum</i> before?	Yes/ No
16	Do you have talk with your family about schistosomiasis within 5 years?	Yes/ No
17	Do you know that there is a special exhibition corner in Yamanashi Prefectural Museum?	Yes/ No
18	Are you concerning about emergent infectious diseases such as Influenza?	Yes/ No/ No idea
19	What is the most important factor for controlling communicable diseases?	Improved medical care/distributing information/ personal protection/ improvement of living environment/ knowledge/ legal regulation/ others
20	Do you think that the success in controlling schistosomiasis in Yamanashi can be applicable for controlling other endemic diseases in future?	Yes/ No/ No idea

schistosomiasis at the primary schools. When we checked sex ratio of 3 groups, Group B had slightly higher female ratio, but it was not big difference. We observed that knowledge of schistosomiasis was somehow age-dependent: elder group kept more correct knowledge than younger groups (Table 6). It should be noted that individuals of Group C had experiences of schistosomiasis. Other two groups, Groups A and B, did not have direct experiences, but people of Group B had already grown up when various anti-schistosomiasis activities and campaign were done by the local Government. For several questions, there were statistically significant differences between the Groups of A and B. Although younger group did not keep knowledge compared with the situation of elder group, individuals who answered “yes” to questions, correct answers were obtained about schistosomiasis, such as major symptoms and effective control measures. Currently, praziquantel is the first choice drug for treatment of schistosomiasis with high efficacy, however, it was not widely known even in Group C population (Table 6).

Study on Veterinarian group

Sex ratio of the veterinarian group shifted much to be male-dominant ($P < 0.01$), however, it seemed to be a general pattern in veterinarian groups in Japan. This group was also divided into 3 groups of the same age criteria made for the adult population study, and comparison was tested among different age groups of veterinarian population, and also compared between veterinarian and non-veterinarian populations. In the veterinarian groups, around 90% or more of individuals of all age groups knew the word of “schistosomiasis” and the root of infection, however, better understanding about other questions, such as the symptoms or preventing infection, was observed for the elder age group ($P < 0.05$) (Table 7). The better knowledge level in the elder group was probably due to their experiences of the disease, as was the case in general adult population. Comparisons were also made between veterinarian and general adult groups of the same age group. When we compared Group A vs A’ or Group B vs B’, better knowledge and understanding were observed in the veterinarian group (data not shown). However, it was observed that knowledge

Table 4. Comparisons of knowledge level of schistosomiasis japonica in middle school students of 50 years interval, 1960s and 2016

No.	Question	Students (%)	
		1960s (N=758)	2016 (N=1,949)
1	Do you know in which parts schistosomiasis was endemic?	NT	11.1
2	Did your relatives get infection?	30.2*	2.21*
3	Do you know the pathogen of schistosomiasis japonica?	83.9*	0.26*
4	Do you think that schistosomiasis was dangerous disease?	NT	38.3
5	Do you know the root of infection?	98.8*	24.1*
6	Do you know that schistosomiasis was endemic in Yamanashi?	NT	11.4
7	Do you know which organ schistosome infect?	95.5	4.00
8	Is protective immunity induced against schistosome in infected hosts?	NT	6.11
9	Do you know that safe/effective medicine is available now?	NT	5.34
10	Do you know in which season schistosome infection occurs?		
	Spring	8.31	5.64
	Summer	82.3	31.5
	Autumn	4.49	12.2
	Winter	NT	13.2
	All seasons	NT	65.4
11	Do you know the vector of <i>Schistosoma japonicum</i> ?	92.9*	2.15*
12	Do you know the site of infection of <i>S. japonicum</i> ?		
	paddy field	52.6	33.4
	water canal	29.0	32.3
	the Kamanashi river	1.85	19.2
	vegetable field	1.06	10.1
	no idea	NT	75.8
13	Do you know where the vector reside?	81.1*	24.6*
14	Concrete water ways were constructed in Yamanashi. Do you know the reason?	NT	8.72
15	Do you think that schistosomiasis becomes endemic again in Yamanashi?	NT	5.54
16	Do you know in which year(s) schistosomiasis was eradicated in Yamanashi?	NT	1960 2.36 1970 4.41 1980 4.41 1990 4.00 2000– 1.90
17	Do you know in which year the Mayor of Yamanashi Prefecture declared the disease eradication?	NT	1960 1.08 1970 1.90 1980 3.75 1990 5.18 2000– 2.98
18	Do you know how schistosomiasis japonica was eradicated in Yamanashi?	NT	Health check 17.2 Health education 14.2 Land-use change 22.4 River bank construction 27.3 Medical development/ others 35.3
19	Do you know the number of schistosomiasis patients in the world?	NT	0.2 million 15.0 2 million 19.5 20 million 16.3 200 million 15.6 2,000 million 11.2

* $P < 0.01$, 1960 vs. 2016. NT (not tested).

level about several questions of Group C was almost comparable to that of Group C', suggesting that the elder group of general adult population got high level of knowledge through their own experiences of schistosomiasis in endemic situations (Table 7).

Table 5. Difference in correct answer rate to question, “Do you know in which parts schistosomiasis was endemic?”, among places of middle schools located

Location	in 1961		in 2016				
	Minami Alps ^{a)} (N=403)	Kai ^{b)} (N=355)	Minami Alps (N=586)	Kai (N=466)	Nirasaki (N=256)	Kofu (N=143)	Showa (N=499)
Correct answer (%)	89.3	81.7	9.7	6.9	5.1	7.1	26.9*
Odds ratio vs. Showa			3.41	4.99	6.88	7.15	-

a) Minami Alps: Middle school in Hatta village, which is currently Minami Alps City, was tested in 1961 [9]. b) Kai: Middle school in Futaba town was tested in 1961 [9]. * $P < 0.05$ compared with students in other areas.

Table 6. Age-dependent knowledge level of schistosomiasis japonica in general adult groups

No.	Question	Group A	Group B	Group C	Odds ratio ^{a)}
5	Do you know schistosomiasis japonica?	30.6*	60.0*	85.4	15.4/ 4.53
6	Do you know that schistosomiasis Japonica was endemic in Yamanashi?	30.6*	57.0*	85.4	13.2/ 4.29
7	Do you know the root of infection?	27.4*	47.0*	77.8	9.87/ 4.20
8	Do you know symptoms of schistosomiasis japonica?	17.8*	26.0*	68.2	10.1/ 6.22
9	Do you know that safe/effective medicine is available now?	8.8**	18.0	19.7	2.82/ 1.13
10	Do you know how to prevent the infection?	11.3*	24.0*	45.2	10.1/ 4.06
11	Do you know that Yamanashi was the first area of successful disease eradication in the world?	12.9	25.0	64.3	12.6/ 5.61
12	Do you know what control measures were taken in Yamanashi?	9.7*	25.0*	42.7	7.00/ 4.14
13	Do you suppose that schistosomiasis is never re-emergent?	1.6*	14.0	21.0	4.63/ 2.36
14	Do you think that Yamanashi Prefecture should continue surveillance even now?	38.7	49.0	63.1	1.45/ 1.19
15	Have your relatives had infection of <i>Schistosoma japonicum</i> before?	1.6	10.0	27.4	22.7/ 3.50
16	Do you have talk with your family about schistosomiasis within 5 years?	4.8	10.0	10.2	0.17/ 0.01
17	Do you know that there is a special exhibition corner in Yamanashi Prefectural Museum?	14.5	23.0**	16.6	1.12/ 0.67
18	Are you concerning about emergent infectious diseases such as Influenza?	87.1	78.0	81.5	0.52/ 0.91
19	What is the most important factor for controlling communicable diseases?				
	Improved medical care	58.1	59.0	64.3	
	Distributing information	82.3	80.0	75.2	
	Personal protection	56.5	52.0	48.4	
	Improvement of living environment	29.0	24.0	35.7	
	Knowledge	48.4	54.0	49.0	
	Legal regulation	12.9	16.0	15.3	
20	Do you think that the success in controlling schistosomiasis in Yamanashi can be applicable for controlling other endemic diseases in future?	72.6	70.0	76.4	0.67/ 1.29

a) Odds ratio: (Group C vs. Group A) / (Group C vs. Group B). * $P < 0.01$ vs. Group C. ** $P < 0.05$ vs. Group C.

DISCUSSION

The year of 2016 is the 20th anniversary of the declaration of disease eradication of schistosomiasis japonica in Yamanashi Prefecture, Japan. During the days of schistosomiasis been in endemic situation, inhabitants in endemic areas sufficiently kept enough knowledge about schistosomiasis japonica including biology of the pathogen, the intermediate snail, root of infection and the way of disease prevention [10, 11]. All the knowledge had been gained through the public health campaign in the community and/or in school education, however, all those activities had been stopped in 2001. The present study was intended to uncover whether such public health knowledge is still kept or not after the blank of 15 years in the people of the former endemic areas. Yamanashi Prefecture is one of the exceptional areas in the world from where schistosomiasis was eradicated and the proper knowledge as their “intellectual property” in disease control had a big contribution for their success in controlling schistosomiasis.

In parallel with patient management and controlling intermediate snails, health education for disease prevention had been implicated by the local Government and academia peoples. Community people in Yamanashi were well mobilized and participated in control activities on their own willings. Primary schools were important places for health education for school children. However, no educational input has been given to school children since 2001.

It was interesting to note that there was a big difference in knowledge about schistosomiasis among middle school students in the mid/late 20th Century and in nowadays (Table 5). The middle school students in 50 years ago had almost accurate knowledge about schistosome and schistosomiasis. This might have been due to school education and communications in their communities

Table 7. Knowledge level of schistosomiasis in veterinarian group and comparisons with elder group in general adult population

No.	Question	Veterinarian (%)		General Adult (%)	
		Group A'	Group B'	Group C'	Group C
5	Do you know schistosomiasis japonica?	89.3	91.7	97.8	85.4
6	Do you know that schistosomiasis was endemic in Yamanashi?	53.6	88.9	91.1 *	85.4
7	Do you know the root of infection?	82.1	77.8	95.6	77.8
8	Do you know symptoms of schistosomiasis japonica?	46.4	63.9	88.9*	68.2
9	Do you know that safe/effective medicine is available now?	50.0	47.2	64.4 *	19.7
10	Do you know how to prevent the infection?	46.4	58.3	91.1 *	45.2
11	Do you know that Yamanashi was the first area of successful disease eradication in the world?	25.0	44.4	71.1	64.3
12	Do you know what control measures were taken in Yamanashi?	25.0	33.3	62.2	42.7
13	Do you suppose that schistosomiasis is never re-emergent?	0.0	13.9	15.6	21.0
14	Do you think that Yamanashi Prefecture should continue surveillance even now?	57.1	44.4	60.0	63.1
15	Have your relatives had infection of <i>Schistosoma japonicum</i> before?	0.0	0.0	18.0	27.4
16	Do you have talk with your family about schistosomiasis within 5 years?	10.7	5.6	17.8	10.2
17	Do you know that there is a special exhibition corner in Yamanashi Prefectural Museum?	14.3	22.2	22.2	16.6
18	Are you concerning about emergent infectious diseases such as Influenza?	82.1	80.6	93.3	81.5
19	What is the most important factor for controlling communicable diseases?				
	Improved medical care	50.0	44.0	55.6	64.3
	Distributing information	82.1	83.3	88.9	75.2
	Personal protection	71.4	44.4	31.1	48.4
	Improvement of living environment	21.4	25.0	35.6	35.7
	Knowledge	78.6	80.6	75.6	49.0
	Legal regulation	14.3	22.2	11.1	15.3
20	Do you think that the success in controlling schistosomiasis in Yamanashi can be applicable for controlling other endemic diseases in future?	89.3	66.7	84.4	76.4

* $P < 0.005$ for Group C' vs. Group A'.

to share the health knowledge in students in 1960s. On the other hand, as was suspected, middle school students in these days have only faint knowledge about schistosomiasis. This may be due to the lack of school education or no frequent communications with adult populations to share information or both.

Interesting results were observed in the testing in general adult population. Among three subpopulations, Groups A to C, Group C was composed of elder individuals above 55 years, who had experienced the endemic conditions of schistosomiasis japonica. When we compared the present results with those obtained 50 years ago, knowledge in Group C was well kept. Depth of knowledge of Group C was significantly higher than that of Group A and Group B for almost all questionnaire subjects. This suggests that not only education, but also experience of disease transmission might have been strong motivation to have knowledge of the disease. When we analyzed knowledge in Groups B and C, Group B had higher level of knowledge than Group A, possibly because that individuals of Group B were adult and could understand public health campaign in those days compared with individuals of Group A.

Importance of experiences seemed to be reflecting in the question #9, "Are safe and effective medicine are available?". For this question, there was not a big difference between Groups A and C. In Yamanashi, transmission of schistosomiasis had ceased before the appearance of praziquantel, and patients at that time in Yamanashi were treated with sodium tartate injection for 20 consecutive days, which was toxic in some cases and people in endemic areas were scared of it at that time. The answer of "No" in Group A might be reflecting innocent situation, however, answer of "No" in Group C was from their correct experiences.

In the present study, knowledge level of middle school students was almost around base line level, probably because of lack of education or of input of information about schistosomiasis. Is there place where middle school students could contact with the source of information in Yamanashi? There is a special exhibition corner of schistosomiasis japonica in Yamanashi Prefectural Museum [21], or memorial/historical sites related schistosomiasis are available in Yamanashi Prefecture [16]. If students visit those places, they can obtain knowledge about schistosomiasis. Among middle schools located in five cities/township, knowledge level of students from Showa township was higher than that of students of other areas. There was curriculum at primary school in Showa township in which students visit a memorial house of schistosomiasis control in Showa, and therefore, middle school students in Showa seem to keep knowledge about schistosomiasis control implemented in their community.

Although knowledge level in middle school students and young adult groups was lower than that in the elderly people group, it should be noted that the answer made by small number of those young people who answered "Yes" and described specified items in the questionnaire sheets was almost proper answers. This suggests that there are channels to keep knowledge about schistosomiasis in people of younger age.

Veterinarian group was also tested to compare with general adult population. Schistosomiasis japonica is a zoonosis, and therefore, disease burden is noted both in humans and domestic animals. It is, therefore, expected to keep knowledge on schistosomiasis japonica in medical doctors, co-medical personnel, and veterinarians. Because of their higher education as the background, veterinarian group had higher level of knowledge about schistosomiasis, and significant differences in knowledge level were observed between Group A and Group A', the same younger age groups of general and veterinary populations. As was observed for general adult population, elder age group had higher knowledge level even among veterinary groups. This seemed to be reflecting difference between with and without experiences of schistosomiasis. When we checked odds ratio for knowledge level between younger and elder age groups in the general adult population, we noticed that odds ratio observed for young and elder veterinarian groups was smaller, suggesting that the age-dependent difference in knowledge level seemed to be not so apparent in veterinarian groups. In the community, it seems likely that human communication among the similar age groups are easily constructed, and young veterinarians could be the source of information of schistosomiasis in the young adult population in Yamanashi. On the other hand, parasitology and parasitic diseases in recent medical education have no more intensive in Japan. Although it is also expected to have a role for keeping knowledge of schistosomiasis in medical doctors and co-medical personnel, it is possible not to keep enough knowledge in those people. More extensive research including medical doctors is now on going.

Together with those, results of our present study are summarized as follows. First, middle school students have almost completely lost knowledge about their previous endemic disease, schistosomiasis japonica, after the blank of 15 years during which no active campaign and education were provided by the local Government. On the other hand, elder age group kept enough knowledge even under the same situation. Younger age group, such as Groups A and B, were shown not to keep enough knowledge in spite of health education on schistosomiasis in their primary and/or middle school. This indicated that education alone is not enough to keep knowledge level, but actual experiences seem to give a big impact for individuals in former endemic areas.

It is controversial whether knowledge of inhabitants on schistosomiasis should be kept in Yamanashi. Schistosomiasis is a parasitic infection, for which no vaccine is available, but tools of prevention were already established. Knowledge is said to be "written vaccine", because no vaccine is available for parasitic diseases. Each person in endemic areas is expected to have proper knowledge and attitude about the endemic diseases to keep self-protection on their own responsibility. When we consider about endemic diseases, only a few infection roots are surely noticed and disease prevention methods are rather simple. In this sense, accumulated knowledge in the people, regardless of parasitic infections or viral infection, such as influenza, could be somehow benefit for future endemic diseases of other pathogens [14, 15]. The final question is what can be the source of information. In our present study, veterinarian population had high level of knowledge about schistosomiasis even in young-age population, and they can be the providers of health information including the experiences of schistosomiasis japonica to general population. Role of veterinarian group for keeping knowledge on schistosomiasis is expected.

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REFERENCES

1. Bergquist, R., Yang, G. J., Knopp, S., Utzinger, J. and Tanner, M. 2015. Surveillance and response: Tools and approaches for the elimination stage of neglected tropical diseases. *Acta Trop.* **141** Pt B: 229–234. [Medline] [CrossRef]
2. Hayashi, M. 1979. Clinical studies on cerebral schistosomiasis japonica in the Philippines. *Bull. Tokyo Med. Dent. Univ.* **26**: 287–297. [Medline]
3. Hollingsworth, T. D., Adams, E. R., Anderson, R. M., Atkins, K., Bartsch, S., Basáñez, M. G., Behrend, M., Blok, D. J., Chapman, L. A., Coffeng, L., Courtenay, O., Crump, R. E., de Vlas, S. J., Dobson, A., Dyson, L., Farkas, H., Galvani, A. P., Gambhir, M., Gurarie, D., Irvine, M. A., Jervis, S., Keeling, M. J., Kelly-Hope, L., King, C., Lee, B. Y., Le Rutte, E. A., Lietman, T. M., Ndeffo-Mbah, M., Medley, G. F., Michael, E., Pandey, A., Peterson, J. K., Pinsent, A., Porco, T. C., Richardus, J. H., Reimer, L., Rock, K. S., Singh, B. K., Stolk, W., Swaminathan, S., Torr, S. J., Townsend, J., Truscott, J., Walker, M., Zoueva A., NTD Modelling Consortium. 2015. Quantitative analyses and modelling to support achievement of the 2020 goals for nine neglected tropical diseases. *Parasit. Vectors* **8**: 630. [Medline] [CrossRef]
4. Inaba, Y. 1984. A cohort study on the causes of death in an endemic area of schistosomiasis japonica in Japan. *Ann. Acad. Med. Singapore* **13**: 142–148. [Medline]
5. Ishii, A. 1994. Infection with schistosomes (*Schistosoma haematobium*, *Schistosoma mansoni* and *Schistosoma japonicum*). *IARC Monogr. Eval. Carcinog. Risks Hum.* **61**: 45–119. [Medline]
6. Kajihara, N. and Hirayama, K. 2011. The war against a regional disease in Japan a History of the eradication of schistosomiasis japonica. *Trop. Med. Health* **39** Suppl 1: 3–44. [Medline]
7. Keenan, J. D., Hotez, P. J., Amza, A., Stoller, N. E., Gaynor, B. D., Porco, T. C. and Lietman, T. M. 2013. Elimination and eradication of neglected tropical diseases with mass drug administrations: a survey of experts. *PLoS Negl. Trop. Dis.* **7**: e2562. [Medline] [CrossRef]
8. Matsumoto, J. 2002. Adverse effects of praziquantel treatment of *Schistosoma japonicum* infection: involvement of host anaphylactic reactions induced by parasite antigen release. *Int. J. Parasitol.* **32**: 461–471. [Medline] [CrossRef]
9. Minai, M., Hosaka, Y. and Ohta, N. 2003. Historical view of schistosomiasis japonica in Japan: implementation and evaluation of disease-control strategies in Yamanashi Prefecture. *Parasitol. Int.* **52**: 321–326. [Medline] [CrossRef]
10. Minai, M., Inoue, T., Sunayama, A., Shimizu, E. and Kawakubo, M. 1975. Investigation about the knowledge of *Schistosoma japonicum*. *Yamanashi Prefecture of Hygiene Pollution Research Institute Annual Journal* **18**: 37–40 (in Japanese).
11. Ohta, H. 1961. Investigation about the knowledge of *Schistosoma japonicum*. *Yamanashi Prefecture of Hygiene Pollution Research Institute Annual*

- Journal* 4: 56–60 (in Japanese).
12. Ohta, N., Hosaka, Y., Minai, M., Hayashi, M. and Miki, Y. 1989. Disappearance of specific antibodies in patients with chronic schistosomiasis japonica by treatment with praziquantel. *Jpn. J. Med. Sci. Biol.* **42**: 31–38. [Medline] [CrossRef]
 13. Olliaro, P. L., Vaillant, M., Diawara, A., Coulibaly, J. T., Garba, A., Keiser, J., King, C. H., Knopp, S., Landouré, A., N’Goran, E. K., Raso, G., Scherrer, A. U., Sousa-Figueiredo, J. C., Stete, K., Zhou, X. N. and Utzinger, J. 2015. Toward measuring *Schistosoma* response to praziquantel treatment with appropriate descriptors of egg excretion. *PLoS Negl. Trop. Dis.* **9**: e0003821. [Medline] [CrossRef]
 14. Ross, A. G., Olveda, R. M. and Li, Y. 2015. An audacious goal: the elimination of schistosomiasis in our lifetime through mass drug administration. *Lancet* **385**: 2220–2221. [Medline] [CrossRef]
 15. Savioli, L., Fenwick, A., Rollinson, D., Albonico, M. and Ame, S. M. 2015. An achievable goal: control and elimination of schistosomiasis. *Lancet* **386**: 739. [Medline] [CrossRef]
 16. Sugiura, Memorial Museum in Showa Town; <http://www.sugiura-iin.com/> [in Japanese].
 17. Takemura, Y., Kikuchi, S. and Inaba, Y. 1998. Epidemiologic study of the relationship between schistosomiasis due to *Schistosoma japonicum* and liver cancer/cirrhosis. *Am. J. Trop. Med. Hyg.* **59**: 551–556. [Medline]
 18. Tanaka, H. and Tsuji, M. 1997. From discovery to eradication of schistosomiasis in Japan: 1847–1996. *Int. J. Parasitol.* **27**: 1465–1480. [Medline] [CrossRef]
 19. Wang, W., Dai, J. R., Li, H. J., Shen, X. H. and Liang, Y. S. 2012. The sensitivity of *Schistosoma japonicum* to praziquantel: a field evaluation in areas with low endemicity of China. *Am. J. Trop. Med. Hyg.* **86**: 834–836. [Medline] [CrossRef]
 20. WHO Schistosomiasis. Fact sheet N°115, 2015. <http://www.who.int/mediacentre/factsheets/fs115/en> [accessed 12 Decemer 2016].
 21. Yamanashi Prefectural Museum. http://www.museum.pref.yamanashi.jp/2nd_audio_guide/en/main-exhibit3/1/ [accessed 18 November 2016].