COMMUNITY CONTROL STUDIES ON *STRONGYLOIDES* INFECTION IN A MODEL ISLAND OF OKINAWA, JAPAN

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Abstract. The community control program for *Strongyloides* infection was conducted by fecal examination and subsequent treatment of the population on a model island (Kume Island) in Okinawa, Japan, for 5 years from 1993 to 1997. More than 1,200 persons, accounting for 17% to 20% of the persons subjected, received fecal examinations each year. The positive rate in 1993 was found to be 9.7% (133/1,374). The positive rate decreased to 6.5% (95/1,468) in 1994, then 4.8% (60/1,245) in 1995, 2.2% (27/1,225) in 1996 and 2.7% (33/1,217) in 1997 through treatment with albendazole or ivermectin on the positive persons detected each year. Among the positive persons detected after operation of the control program, more than 70% were newly detected persons who did not receive an examination in the previous year or were falsely-negative in the previous examination. The low enforcement of procuring fecal examinations, as well as low sensitivity of fecal examination, might have had an effect on the relatively gradual decrease in the prevalence rate, in spite of the high efficacy of the treatment. The results indicate that continuation of the control program for several years is needed to effectively reduce the prevalence of the parasitic infection in the community.

INTRODUCTION

Strongyloides stercoralis is a nematode parasite of man with a high prevalence in many tropical and subtropical countries (Genta, 1989; Liu and Weller, 1993). It is well known that the parasite can multiply within its host by internal autoinfection. The biological nature influences not only the clinical manifestation, such as fetal hyperinfection, but also the long-term persistence of the infection beyond its lifespan (Scowden *et al*, 1978; Mansfield *et al*, 1996).

Okinawa Prefecture, which occupies southernmost Japan, is the only prefecture in Japan located in the subtropical zone. Due to this geographical circumstance, the inhabitants of Okinawa have suffered in the past from many important parasitic diseases, such as malaria and filariasis. Although these parasitic diseases have already been completely eradicated in recent years, strongyloidiasis still remains as a serious public health problem in the prefecture because of its high prevalence among inhabitants (Sato, 1986; Asato *et al*, 1992) and also because of a high concomitance with immunosuppressive HTLV-1 (human T-lymphotropic virus type-1) infection (Nakada *et al*, 1984; Sato *et al*, 1990). In Okinawa, it has been known that the parasitic infection often progresses to a fatal disseminated infection under immunosuppressed conditions due to concomitant HTLV-1 infection (Nakada *et al*, 1987; Plumelle *et al*, 1993). Therefore, an effective control program to reduce the prevalence of the nematode should be conducted to prevent such a severe infection.

The purpose of the present study was to evaluate the effects and the problems of a community control program for *Strongyloides* infection conducted on a model island in Okinawa for 5 years.

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MATERIALS AND METHODS

Study area and population examined

Okinawa Prefecture, also referred as to the Ryukyu Islands, consists of about 60 small islands. One of the islands, Kume Island, located about 100 km east of Okinawa Island, was selected as a model

island in the present study. The island consists of two villages, Gushikawa and Nakazato. The control program was conducted in the villages for 5 years from 1993 to 1997. The total population in the island was 10,309 in 1992 and 7,200 adult persons over 20 years old were subjects in the present study. The numbers of persons who actually received the examination in each year were 1,374 in 1993, 1,468 in 1994, 1,245 in 1995, 1,225 in 1996 and 1,217 in 1997. These numbers of persons examined each year accounted for about 17% to 20% of persons registered for the study. Among the persons examined, more than 90% were over 40 years old. The number of females was greater than males in every year, showing a ratio 1:1.5 in total.

Stool examination

The stool examination was performed by fecal culture method using an agar plate (Arakaki *et al*, 1988). The method, recently developed in Okinawa, in which fecal samples (approximately 3.0 g) were placed on the center of the primary agar plate for bacterial culture and incubated at 28ºC for 3 days. After incubation, the surface of the agar plate was examined under a microscope to find motile larvae which emerged from the fecal mass on the plate. When found, the larvae were transferred to a glass slide and then identified morphologically, differing from those of hookworm and free-living *Rhabditis*. With this method, the unique alignment of bacterial colonies developed on the agar surface along the tracks of wandering larvae were an indicator of the presence of larvae. The method was known to be 2 to 3 times more sensitive in detecting chronic, low-level infection than other conventional methods, such as the Harada-Mori fecal culture or the fecal concentration (the formalin-ether concentration) (Sato *et al*, 1995; Salazar *et al*, 1995). For the above stool examination, two stool samples were collected from each person on 2 different days.

Treatment

The treatment of persons harboring the parasites was performed with albendazole in 1993 and with ivermectin since 1994. Albendazole (Zentel: Tianjin Smithkline and French Laboratories Ltd) was administered at a daily dose of 400 mg for 3 days and the same regimen was repeated once more at an interval of 2 weeks. In the case of ivermectin (Mectizan: Merck USA), a daily dose of 6.0 mg was administered once and it was repeated once 2 weeks after the first treatment.

The follow-up examinations were performed at 2 weeks, at 6 months and at one year after the treatment by the agar plate fecal culture method.

RESULTS

The results of the mass examination for each year are shown in Table 1. A total of 133 persons, accounting for 9.7%, were demonstrated to be positive for *Strongyloides* infection in the first year of the study. As shown in Table 2, 117 out of the 133 positive persons received treatment with albendazole and the cure rate estimated through the follow-up fecal examination was 75.7%. As a result of the treatment, the positive rate in the inhabitants decreased to 6.5% in 1994. Similarly, the positive rate decreased to 4.8% in 1995 and then reached 2.2% in 1996 after treatment with ivermectin. The subsequent rate in 1997, however, was 2.7% which did not differ from that in 1996. Also, when the transitional change in the positive rate was compared in each village, the positive rate did not change between 1993 and 1994 in Gushikawa village. Similarly, when the positive rate in Nakazato village was compared between 1994 and 1995, the prevalence (5.7%) in 1994 was also not different from that (5.5%) in 1995. To clarify the above results, the details of persons who were found harboring the parasites in each year are shown in Fig 1. In 1994, about half of the positive persons were newly detected among the persons who did not receive stool examinations in the previous year. The percentage of these persons decreased to 38% in the next year but represented about 35-45% of the positive persons in every subsequent year. Additionally, 22% of the positive persons in 1994 were also found to be newly positive persons who were determined to be false-negative in the previous examination. These persons also occupied about 20-40% of the persons positive in each year. As a result, as many as 70-80% of the positive persons were newly detected persons in each year. The persons who were not cured in the previous treatment occupied 22% of the positive subjects in 1994 but the ratio of these persons unsuccessfully treated decreased to 11-15% after treatment with ivermectin in the following years. The persons who did not receive treatment occupied 6.3% and 8.4% of the positive persons in 1994 and 1995, but the percentage of these persons increased to 15-22% in the following two years.

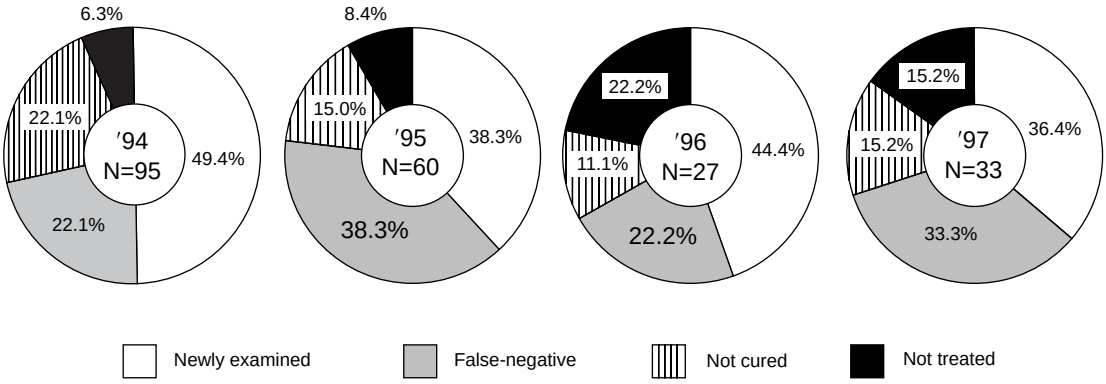

Fig 1–The details of 215 positive persons with *Strongyloides* infection on Kume Island from 1994 to 1997.

Table 1
Results of stool examination for *Strongyloides* infection among the inhabitants on Kume Island (1993-1997).

Area	Sex	No. positive/No. examined (Positive rate%)				
		1993	1994	1995	1996	1997
Gushikawa	Male	26/232 (11.2)	40/275 (14.5)	19/240 (7.9)	6/240 (2.5)	3/251 (1.2)
	Female	17/378 (4.5)	9/386 (2.3)	5/346 (1.4)	3/332 (0.9)	11/347 (3.1)
	Total	43/610 (7.5)	49/661 (7.4)	24/586 (4.1)	9/572 (1.6)	14/598 (2.3)
Nakazato	Male	60/300 (20.0)	27/296 (9.1)	25/239 (10.1)	12/261 (4.6)	14/242 (5.5)
	Female	30/465 (6.5)	19/511 (3.7)	11/420 (2.6)	6/392 (1.5)	5/377 (1.3)
	Total	90/764 (11.8)	46/807 (5.7)	36/659 (5.5)	18/653 (2.8)	19/619 (3.1)
Total		133/1,374 (9.7)	95/1,468 (6.5)	60/1,245 (4.8)	27/1,225 (2.2)	33/1,217 (2.7)

Table 2
Results of mass treatment for *Strongyloides* infection with albendazole and ivermectin.

Year	Treatment	No. positive	No. treated	No. followed	No. cured (%)
1993	Albendazole	133	117	111	84 (75.7)
1994	Ivermectin	95	67	65	62 (95.4)
1995	Ivermectin	60	40	37	36 (97.3)
1996	Ivermectin	27	13	11	10 (90.0)
1997	Ivermectin	33	27	24	22 (91.7)

DISCUSSION

There have been many epidemiological reports on the prevalence of *Strongyloides* infection in Okinawa, Japan. In the previous studies conducted by conventional examination methods, such as the Harada-Mori fecal culture method, the prevalence was estimated to be about 1.0 to 2.0%. However, it has became clear in recent studies, in which the sensitive agar plate culture method was applied to detect the infection, that the true prevalence rate is still as high as 10% or more in aged persons (Asato *et al*, 1992). In spite of high prevalence in the aged population, the infection is consistently rare in the younger population, under 30 years old. From the significant age inclination of the infection in modern Okinawa, it has been supposed that the inhabitants have no opportunity

to acquire the infection from the environment and that the majority of the patients are long-standing patients who acquired the infection in childhood which has persisted into adulthood (Sato, 1986). This epidemiological feature may also indicate that the prevalence of the parasitic infection would not decrease without operation of any control program even under improved sanitary conditions in which new infection from the environment is now almost negligible.

Due to its ability to replicate the life cycle in the host, the infection is known to be maintained for several decades, if not treated (Gill and Bell, 1979; Grove, 1980; Pelletier, 1984). In the present study, therefore, the authors conducted a mass control program by mass examination and subsequent mass treatment for 5 years. By the end of control program, the positive rate decreased from 9.7% to 2.2%. In an endemic area some control of prevalence rate could be achieved by chemotherapy but complete eradication was difficult even in a closed community without improvement of sanitary conditions (Jeffery, 1960; Banki *et al*, 1963; Yoeli *et al*, 1972, Arguedas *et al*, 1975). In the present study, the complete reduction of prevalence rate could not be achieved even though the control program operated for 5 years under a very sanitary environment. The efficacy of treatment may be an important factor influencing the effectiveness of the control program. In the present study, albendazole and ivermectin were used for the treatment of positive persons and as high as 75-97% of cure rates were obtained in each year. In spite of the high efficacy of the treatment, the decrease of prevalence rate by the present control program seemed to be relatively gradual, contrary to our expectations. There were times when the positive rate did not differ from that in the previous year. When the details of the positive persons in each year were determined, it was found that more than 70-80% of the positive persons were newly found to be harboring the parasite in each year.

The efficacy of the control program will greatly depend on the coverage of inhabitants receiving the examination. In Japan, the number of persons who receive such fecal examinations for parasitic infection has remarkably decreased as the prevalence of various parasitic infections has decreased significantly in recent years. Actually, the number of inhabitants who received the examination each year was about 17% to 20% of the total population, and almost a half of the persons were replaced by the persons who did not receive examinations in the previous year. Additionally, the low sensitivity of fecal examination in detecting chronic infection with the parasite might also be an important factor influencing the effect of such a community control program because the relatively large proportion of the positive persons were occupied by the persons in which the parasite was not detected in the previous examination. The low sensitivity of the examination, as well as low compulsion to receive fecal examinations, may be a major problem in these types of community control programs for *Strongyloides* infection in Japan. To resolve the problem, therefore, it may be important to continue these control programs for several years in a given community.

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