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A Epidemiological Investigation of A Dysentery Outbreak in A Primary School in Taichung City — A Preliminary Report

1. Introduction

Amebiasis and shigellosis are both reportable diseases. Both are transmitted by hand-to-mouth by water or foods contaminated by feces of infected persons[1-7]. Infection through direct contact is also important[2,8,10]. Infection may be asymptomatic, or manifested by diarrhea. In severe cases, death from dehydration may occur [9]. The protozoa may induce abscess in lung and brain [10,11]. In normal population groups, shigellosis attacks young children more [3,9,12]. Both diseases transmit in crowded places of poor sanitation such as mental hospitals, among homosexuals, and in prisons[11,12]. The world prevalence of amebiasis is around 10%[13]. In an institution for the mentally retarded in Japan, the prevalence was 12.6%[14]. Among homosexual men in the San Francisco Bay Area in USA, the prevalence was 28.6%[15]. In the present incident in a primary school in Taichung City, parents of these children are generally fairly affluent, the sanitary conditions of their homes are good, and yet a dysentery outbreak occurred. To understand the source of infection and the mode of transmission to prevent further spread of the disease, this epidemiological investigation was conducted.

2. Background Information

On 2 September 1993, two students of a primary school in Taichung City were taken to the Shuntien Hospital for the treatment of diarrhea. On 8 September, their fecal specimens were identified as Shigella Group D Type I infection by the Laboratory of the National Institute of Preventive Medicine stationed in the central part of the Island. On 10 September, four students of the school were confirmed amebiasis infection by the China Medical College Hospital.

The school is a Catholic church operated private primary school of 26 years old. Students come from all parts of Taichung City and neighboring counties and cities. There are 1,790 teachers and students: 1,708 students in 9 classes of the kindergarten, 3

classes each from grade 1 through grade 6, and one class for the mentally retarded. There are 66 teachers and other employees and 16 kitchen workers (including 4 janitors) The campus has a land area of 2,238 pings (around 8,000 m^2) and a floor area of 2,447 pings (10,000 m^2) (Figure 1).

Water used in the school comes from two sources (underground and tap water). Tap water is used for drinking, and underground water for washing. Drinking water for teachers and students comes from different systems: water fountain for students and boiled water for teachers.

With a few students whose lunches are delivered by parents, most students take the school lunch.

3. Materials and Methods

In September 1993, both clinical and laboratory information of students admitted to hospitals for the treatment of diarrhea was obtained from the medical records. All teachers and students of the school were interviewed with a questionnaire on 13 and 14 September. Absent students were interviewed through telephone. At the same time, the school environment was randomly inspected of the sources of the underground and tap water, sanitary conditions of the kitchen and toilets, the septic tank and the drinking water. Specimens of the underground water, tap water, utensils and water in the kitchen, and of the septic tank were collected for laboratory testings.

For amebiasis, fresh fecal specimens were collected for laboratory testings with formalin-ether sedimentation method and direct smear method dyed with MIF (merthiolate-iodine-formaldehyde) for identification. For shigellosis, specimens were collected through rectal swabbing, cultured in SS Agar or DHL Agar, and once suspected colonies appeared, they were shifted to TSI Agar, LIM or SIM Agar, or Christensen Citrate Agar for identification. Serological testings were conducted to identify the group and type.

At about 4 pm on 13 September and again at 2 pm on 14 September, 1,500 grams and 2,500 grams of red color agent No. 6 were poured to inspect the leakages of the underground water.

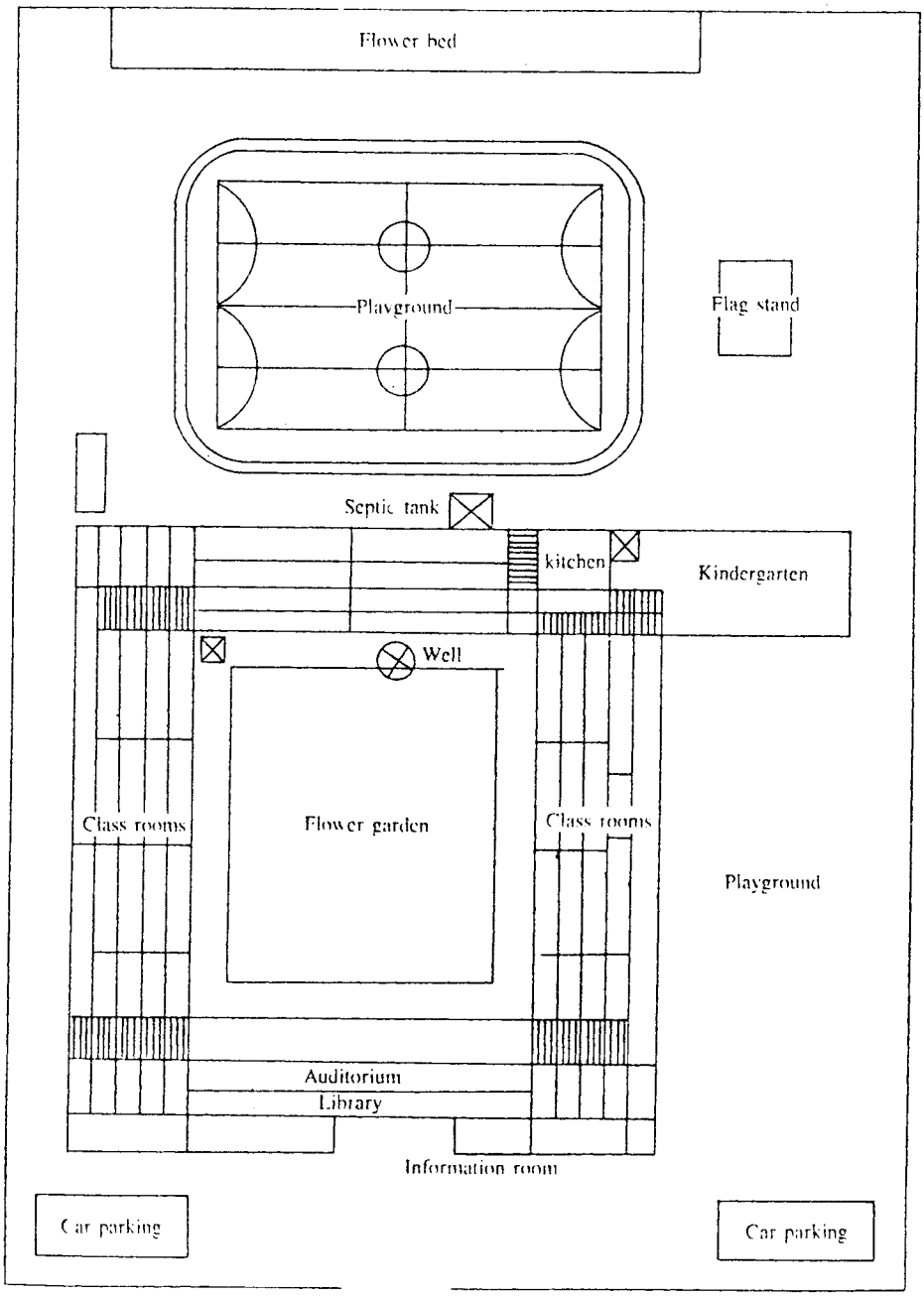
A case in the investigation was defined as: a student, teacher or employee of the school, who had developed one of the following symptoms during 15 August and 16 September 1993:

1) diarrhea with one of the following:
   (1) abdominal pain,
   (2) fever,
   (3) vomiting,
   (4) nausea.

2) constipation
3) blood in feces
4) pus in feces
5) mucus in feces

Returned questionnaires were tested with X^2-test

Figure 1. Plan of the Campus



4. Findings

1,541 copies of the questionnaire out of 1,790 students, teachers and employees of the school were collected, giving a return rate of 86.09%. Of them, 739 met the criteria of case. The total attack rate was 47.95%. 69.66% in kindergarten, 30.37% in the first grade, 39.78% in the second grade, 65.38% in the third grade, 42.08% in the fourth grade, 37.85% in the fifth grade, and 54.31% in the sixth grade, higher in the kindergarten, the third grade and the sixth grade (Table 1). The epidemiological curve of the 739 possible cases showed two peaks of onset on the 2nd and 9th September (Figure 2).

In 169 persons *Entamoeba histolytic* a were isolated. Of them, 144 are students, teachers and employees of the school, giving a positive rate of 8.04%. The rest 24 persons are family members of students (Table 2). 85 (59.03%) of the positive ones showed symptoms, 29 (20.14%) asymptomatic, and 30 failed to return the questionnaire (Table 3). Of the positive ones, 109 (75.69%) were trophozoites, 7 (4.86%) of cysts and 28 (19.44%) of mixed infection. In 111 persons *Shigella* were isolated. Of them, 100 are students, teachers and employees of the school, giving a positive rate of 5.59%, the rest 11 persons are family members of the students (Table 2). Of the positive ones, 66 (66.0%) showed symptoms, 11 (11.0%) asymptomatic, and 23 failed to return the questionnaire. 18 persons were infected with both amebiasis and shigellosis.

From the epidemic curves of confirmed cases, the curves for both amebiasis and shigellosis were similar (Figures 3, 4).

The symptom distributions of those who met the criteria of case and of the confirmed cases were generally similar (Tables 5, 6, 7). The major symptoms were diarrhea, abdominal pain and fever.

Laboratory testings of the drinking water showed a total bacterial colony 30 times higher than the normal value (Table 8). Laboratory testings of underground water, tap water and kitchen against *Shigella* all showed negative (Table 9).

Results of risk factor analysis showed that the water of the drinking fountain could be a statistically significant risk factor ($p<0.001$) at a relative odd ratio of 1.508 (Tables 10, 11). Incidence in persons washing hands frequently was significantly lower than persons washing occasionally ($p<0.05$) (Table 12). School lunch was found not related to the outbreak (Table 13). Table 14 gives the amount of tap water used by this school and the Kuang-Fu Primary School of Taichung City.

The filtration test by the red color agent No 6 showed 1.174 PPM of the agent at 9 am on 15 September The underground water was contaminated.

5. Discussion

Incidents of shigellosis transmitted by contaminated foods have been reported in many

countries[1-7], direct person-to-person contact is also an important factor[2,8]. This perhaps is related to the fact that a small amount of *Shigella* is enough to induce infection[16]. Amebiasis can be transmitted by drinking water contaminated by underground water[17], by contaminated vegetables or by infected food handlers[10] Analysis of the present incidence pointed to the water of the drinking fountain being a risk factor. Test of the water by the Environmental Protection Bureau also showed the number of bacteria in the water being 30 times more than the normal value. They all suggest the likelihood of the drinking fountain water being contaminated.

The filtration test showed that the underground water could have been contaminated by the sewage of the septic tank. Dyes have been used in other countries as indexes to test the pollution[3]. The number of students in the school in question was about two-thirds of that of the Kuang-Fu Primary School, and the amount of water consumed in this school was also two-thirds of that of the latter school. Students in the Kuang-Fu Primary School used both underground and tap wataer for drinking, students in the school in question must also used water of both sources for drinking. The polluted underground water transmitted the disease through water fountain. Some family members of students were also infected. This shows that person-to-person contact was also an important factor in this incident.

Of the 739 persons who met the criteria of case, *Shigella* was isolated in only 66. Partial reasons were that some of the cases took antibiotics before the specimens collection, and that some failed to submit specimens for laboratory testings.

Teachers had a lower attack rate. This could have been related to their immunity, susceptibility and drinking water from difference source.

For students, there were two peaks of onset of diseases on the 2nd and 9th September. When school began on 30 August (Monday), students could have contacted the water source and became infected. Disease set on after one to three days of incubation, and thus the first peak. After the weekend, they contacted the water source again on 6 September (Monday) and became infected to produce the second peak. From the incubation period, the infection was more likely to be shigellosis[9].

From the epidemic curve of the confirmed cases, curves for amebiasis and shigellosis were similar (Figures 3, 4). The two infections have different incubation periods. If cases were infected at the same time and showed symptoms, their curves would have not been the same [9,10]. For the following reasons, it was suspected that cases though were infected at the same time, but only shigellosis cases showed symptoms whereas amebiasis cases were asymptomatic, and hence the similar curves: (1) from the incubation period, the infection was more like shigellosis, (2) from the distribution of symptoms, the two infections had almost similar symptoms, (3) 90% of amebiasis infection are generally asymptomatic[21,22], (4) amebiasis cases were immediately medicated upon identification.

Between March and August 1993 in Taichung City, there were 5 amebiasis cases; in the same period in 1992, no cases were reported. This could indicate that amebiasis

was already spreading in Taichung City. The fact that the underground water was contaminated by the sewage of the septic tank, the infection of amebiasis could have started in the previous semester, for 90% amebiasis infection are generally asymptomatic[13,18], and that 10-20 students out of 1,708 had diarrhea should be considered normal. When the shigellosis infection in this semester produced symptoms, amebiasis was detected through laboratory testings. The epidemic curves thus gave curves of primarily symptoms of shigellosis.

Sufficient water sources for washing hands and foods are more important than the quality of water source[11,19,20]. This may explain why frequent hand-washers in the incident had a lower incidence.

The infectious agent in this incident was identified as *Shigella sonni*. Infection of this *Shigella* group in the developed countries is the highest among the four *Shigella* groups[12,21]. More infections in Taiwan in the recent years are also of this group. *Shigella* sonni can survive in water for more than 100 days[3], it was likely that the agent came from the septic tank to contaminate the water source.

The prevalence of amebiasis in the USA in the 1960's was 5-10%[21,23], in 1989 it went down to 1-4%[18-24]. In October 1993, in one survey of 1,122 students in a primary school in the central part of Taiwan found 11 amebiasis positive cases, giving an infection rate of 0.98%. The amebiasis infection rate of 8.04% in this outbreak was significantly higher than that of the control group.

6. Recommendations

1) Tap water should be used in the school. The well should be completely disinfected and closed for use.

2) That leakage of sewage from septic tank had contaminated the underground water is an established fact. That the tank had been used for long time is an important factor. It is imperative that the tank be completely disinfected and closed for use or repaired.

3) Health education on: washing hands with soap before meal and after toilet, and not drinking water directly from tap or underground water should be strengthened.

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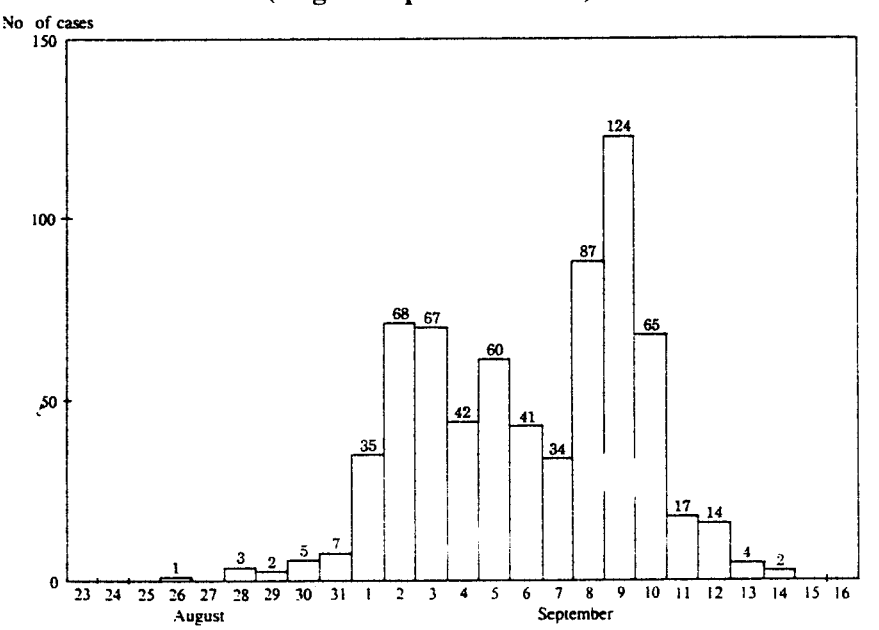
References:

1. Lee LA, Ostroff SM, McGee HB. An outbreak of shigellosis at an outdoor music festival. Am J Epidemiol 1991; 133: 608-615.
2. Black RE, Craun GF, Blake PA. Epidemiology of common-source outbreak of shigellosis in the United States, 1961-1975. Am J Epidemiol 1987; 108: 47-52.
3. Sorvillo FJ, Waterman SH, Vogt JK. Shigellosis associated with recreation water contact in Los Angeles County. Am J Trop Med Hyg 1988; 38: 613-617.
4. Hedberg CW, Levine WC, White KE. An international foodborne outbreak of shigellosis associated with a commercial airline. JAMA 1992; 268: 3208-3212.
5. Baine WB, Herron CA, Bridsonn K. Waterborne shigellosis at a public school. Am J Epidemiol 1975; 101: 323-332.
6. Rosenberg ML, Hazlet KK, Schaefer J. Shigellosis from swimming. JAMA 1986; 236: 1849-1852.
7. Makintubee S, Mallonee J, Istre GR. Shigellosis outbreak associated with swimming. Am J Public Health 1987; 77: 166-168.
8. Maratin DL, Gustafson TL, Pelosi JW. Contaminated produce — a common source for two outbreaks of *Shigella* gastroenteritis. Am J Epidemiol 1986, 124: 299-305.
9. Benenson AS. Control of Communicable Diseases in Man. An official report of the American Public Health Association 15th ed. Washington DC: American Public Health Association 1990; p.391-394.
10. Benenson AS. Control of communicable disease in man. An offical report of the American Public Health Association 15th ed. Washington DC: American Public Health Association 1990; p9-12.
11. A World Health Organization Meeting. Amebiasis and its control. Bulletin of the World Health Organization 1985; 63(3) :417-426.
12. Lee LA, Shapiro CN. Hyperendemic Shigellosis in the United States: A review of surveillance data for 1967-1988. J Infect Dis 1991; 164: 894-900.
13. Reed SL. Amebiasis: an update. Clin Infec Dis 1992; 14: 385-393.
14. Nagakura K, Tachibana H, Kaneda Y. Amebiasis in institutions for mentally retarded in Kanagawa Prefecture, Japan. Jpn J Med Sci Biol 1990; 43: 123-131.
15. Markell EK, Havens RF, Kuritsubo RA. Intestinal protozoa in homosexual men of the San Francisco Bay area: prevalence and correlates of infection. Am J Trop Med Hyg 1985; 33(2): 239-245.
16. DuPont HL, Levien MM, Hornick RB. Inoculum size in shigellosis and

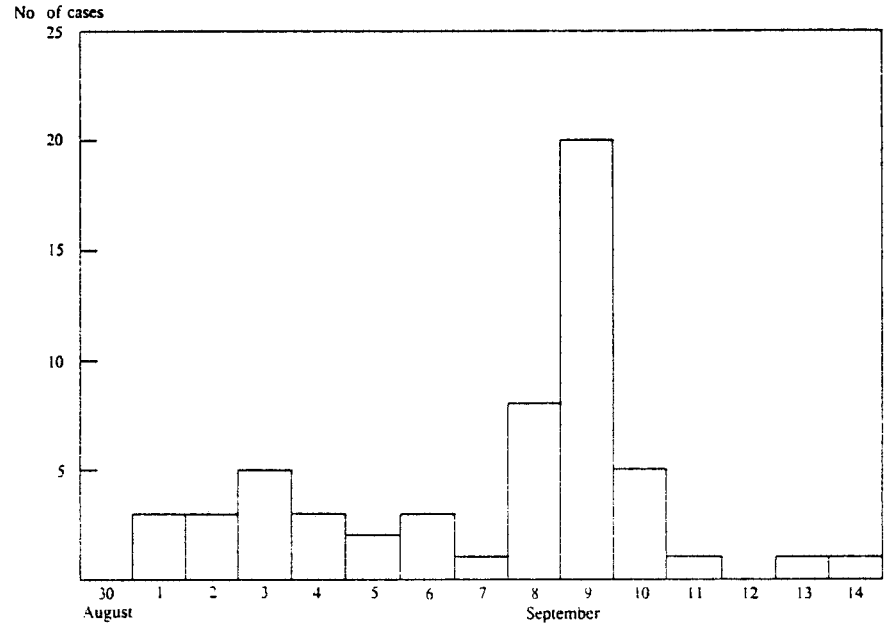
implications for expected mode of transmission. J Infect Dis 1989; 159: 1126-1128.
17. Holtan N. Amebiasis, the ancient scourage is still with us. Postgradmed. 1988; 83(3): 66-68, 72.
18. Widmer AF, Nettleman MD. Amebiasis. Infect Control Hosp Epidemiol 1991; 12: 735-739.
19. Black RE, Dykes AC and Anderson KE. Handwashing to prevent diarrhea in day-care centers. Am J Epidemiol 1981; 113: 445-451.
20. Khan MU. Interruption of shigellosis by hand washing. Trans R Soc Trop Med Hyg 1982; 76: 164-168.
21. Green MS, Block C, Cohen D, Slater PE. Four decades of shigellosis in Israel: Epidemiology of a growing public health problem. Rev Infect Dis 1991; 13: 248-253.
22. Krogstad DJ, Spencer HC, Healy GR. Amebiasis: epidemiologic studies in the United States, 1971-1974. Ann Inter Med 1978; 88: 89-97.
23. Burrows RB. Prevalence of amebiasis in the United States and Canada. Am J Trop Med Hyg 1961; 10: 172-184.
24. Sorvillo FJ, Leib L, Mascola L. Declining rates of amebiasis in Los Angeles County: a sentinel. Am J Public Health 1989; 79: 1563-1564.

Figure 2. Epidemic Curve of Shigellosis Outbreak in Taichung, Taiwan (August-September 1993)



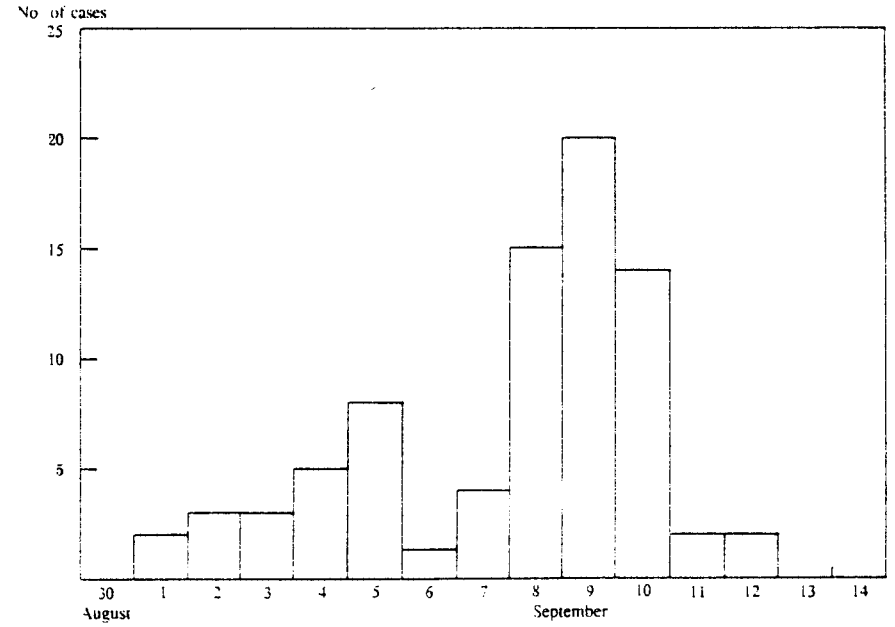
Note: 739 met the criteria of case; 61 failed to report date of onset.

Figure 3. Date of onset of Shigellosis Positives (August-September 1993)



Note: 100 were identified positive and with symptoms; 44 either asymptomatic, failed to return questionnaire or failed to report date of onset.

Figure 4. Date of Onset of Amebiasis Positives (August-September 1993)



Note 144 were identified positive and with symptoms, 65 either asymptomatic, failed to return questionnaire or failed to report date of onset

Table 1. No. of Questionnaire Returned by Class

Class	No. positive	No. negative	No. of returned questionnaire	Total	Collection rate (%)	Attack rate %
K-1	28	7	35	44	79.54	80.00
K-2	19	5	24	49	48.98	79.17
K-3	21	17	38	44	86.36	55.26
K-4	23	20	43	51	84.31	53.49
K-5	20	11	31	52	59.62	64.52
K-6	12	8	20	30	66.67	60.00
K-7	14	8	22	28	78.57	63.64
K-8	35	4	39	49	79.59	89.74
K-9	14	1	15	50	30.00	93.33
Subtotal	186	81	267	397	67.25	69.66
1-A	14	45	59	69	85.51	23.73
1-B	16	40	56	68	82.35	28.57
1-C	25	39	64	69	92.75	39.06
Subtotal	55	124	179	206	86.89	30.73
2-A	20	35	55	72	76.39	36.36
2-B	22	43	65	72	90.28	33.85
2-C	32	34	66	72	91.67	48.48
Subtotal	74	112	186	216	86.11	39.78
3-A	49	20	69	77	89.61	71.01
3-B	44	24	68	75	90.67	64.71
3-C	43	28	71	76	93.42	60.56
Subtotal	136	72	208	228	91.23	65.38
4-A	36	32	68	72	94.44	52.94
4-B	23	44	67	72	93.06	34.33
4-C	26	41	67	71	94.37	38.81
Subtotal	85	117	202	215	93.95	42.08

(to be continued)

Table 1. No. of Questionnaire Returned by Class (Continued)

Class	No. positive	No. negative	No. of returned questionnaire	Total	Collection rate (%)	Attack rate %
5-A	39	44	73	74	98.65	39.73
5-B	24	48	72	73	98.63	33.33
5-C	28	41	69	72	95.83	40.58
Subtotal	81	133	214	219	97.72	37.85
6-A	23	43	66	70	94.29	34.85
6-B	39	27	66	66	100.00	59.09
6-C	45	20	65	66	98.48	69.23
Subtotal	107	90	197	202	97.52	54.31
MR	8	16	24	25	96.00	33.33
Teachers	5	52	57	66	86.36	8.77
Worker	2	3	5	7	71.43	40.00
Janitor	0	2	2	9	22.22	0.00
Subtotal	7	57	64	82	74.39	11.48
Total	739	802	1,541	1,790	86.09	47.95

Table 2. Positive Rate of Confirmed Cases

Source of infection	No. infected	Total No.	Positive Rate
Entamoeba	144	1,790	8.04%
Shigella	100	1,790	5.59%

Table 3. Findings of Fecal Tests

Source of infection	No. (%) positive	No. (%) negative	Total
Shigella	66 (66.00)	11 (11.00)	100
Entamoeb	85 (59.03)	30 (20.83)	144

Note: Including 18 mixed infections

Table 4. Distribution of Amebiasis by Type

Type	No.	%
Trophozoite	109	75.69
Cyst	7	4.86
Mixed	28	19.44

Note: 144 were positive.

Table 5. Symptoms of Possible Cases

Symptom	No.	%
Diarrhea	706	95 53
Abdominal pain	631	85.39
Fever	597	80.76
Nausea	226	30.58
Vomiting	375	50 74
Constipation	189	25 58
Blood in feces	41	5 55
Pus in feces	26	3 52
Mucus in feces	148	20.23

Note· Total No of possible cases 739

Table 6. Symptoms of Confirmed *Shigellosis*

Symptom	No.	%
Diarrhea	69	89.61
Abdominal pain	55	71.43
Fever	61	79.22
Nausea	18	23.38
Vomiting	34	44.16
Constipation	19	24.68
Blood in feces	6	7.79
Pus in feces	8	10.39
Mucus in feces	21	27 27

Note: Of those who returned questionnaires, 77 were *Shigella* positive.

Table 7. Symptoms of Confirmed Amebiasis

Symptom	No.	%
Diarrhea	85	74.56
Abdominal pain	71	62.28
Fever	72	63.16
Nausea	24	21.05
Vomiting	44	38.60
Constipation	15	13.16
Blood in feces	5	4.39
Pus in feces	3	2.63
Mucus in feces	21	18.42

Note: Of those who returned questionnaires, 114 were *Entamoeba* positive.

Table 8. Laboratory Testings of Water by EPB on 14 September

Source	1F#	2F#	3F#	4F#	Oven	Standard
Total colony (CFU/mL)*	3.2×10^3	3.5×10^3	3.3×10^3	1.2×10^3	0	100
E-coli (MPN/100mL)**	0	0	0	0	0	6.0

EPB: Environmental Protection Bureau
* colony forming unit/mL
** most probable number/100 mL
# drink water on first second, third, fourth floor

Table 9. Laboratory Testings of Environmental Specimens

Specimens	8/Sep	9/Sep	11/Sep	12/Sep	14/Sep	15/Sep
Underground water 1	(−)					
Underground water 2	(−)					
Sewage output		(−)				
Kitchen water 1			(−)			
Kitchen water 2			(−)			
Hand-washing water 1			(−)			
Hand-washing water 2			(−)			
Warm drinking water 1			(−)			
Warm drinking water 2			(−)			
Tap water 1				(−)		
Tap water 2				(−)		
Ditch in kitchen					(−)	
Sewage in ditch					(−)	
Water for washing					(−)	
Chop-board						(−)
Large chop-board						(−)
Garbage can						(−)
Water trough						(−)

Table 10. Drinking Water and Its Infection

	Water brought	From fountain	Both	p value
Infected	224	207	299	0.000*
Not infected	375	160	224	

* X^2 test $p < 0.001$
Note: 249 questionnaire information not available; 52 no answer.

Table 11. Drinking Water and Its Infection

	Have drunk		Have not drunk		P value	RR**
	Ill	Not ill	Ill	Not ill		
Water fountain	207	160	224	375	0.000*	1.508
Water brought	224	375	207	160	0.000*	0.663

* X^2 test $p < 0.001$
** RR = relative risk
Note: 249 without questionnaire information; 52 no answer; 523 exposed to both not included.

Table 12. Hand-washing and Its Infection

	Frequently	Occasionally	Rarely	Never	P value
Ill	477	172	26	4	0.024*
Not ill	577	145	20	4	

* X^2 test $p<0.05$
Note: 249 without questionnaire information, 116 no answer

Table 13. School Lunch and Its Infection

	Have eaten		Have not eaten		P value
	Ill	Not ill	Ill	Not ill	
School lunch	722	741	2	1	0.491*

* X^2 test $p > 0.05$; 249 without questionnaire information, 75 no answer.

Table 14. Amount of Water Consumed

	No. of students	Jul	Aug	Sep	Oct	Nov	Dec
This school	1,790	109	16	45	261	1,870	2,823
Kuang-Fu Primary	3,130	150	21	31	178	181	159

Note: This school began use of tap water only in October; Kuang-Fu Primary School uses both tap and underground water for drinking.