DEMOGRAPHIC DATA ON *SALMONELLA ENTERITIDIS* INFECTION IN THAILAND, 1990-1995

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Abstract. The data for the comprehensive analysis of *Salmonella enteritidis* infection was based on the information recorded in the request form submitted for *Salmonella* typing and the results of serotyping at the WHO National Salmonella and Shigella Center, Department of Medical Sciences, Ministry of Public Health, Thailand during 1990-1995. Fifty-one cases of *S. enteritidis* (SE) infection were confirmed in 1990. The morbidity being markedly increased each year from 1991 to 1995, with 105, 307, 471, 659 and 877 cases being identified, respectively. Among the isolates of *Salmonella* spp, SE was the most common serotype during 1993-1995. The cases were mostly predominant in Bangkok and then in southern, northeastern, central and northern regions, respectively. The morbidity rates per 100,000 population per year of SE infection in 1990-1995 were 0.09, 0.18, 0.53, 0.8, 1.11 and 1.47, respectively.

Analysis of the infection rate by sex and age demonstrated that the incidence in males was higher than in females. Adult patients were more frequently found than adolescent patients. The organism was found in feces, blood, pus, urine, cerebrospinal fluid and sputum, accounting for 41.7, 35.8, 5.5, 2.5, 1.7 and 0.4%, respectively. The average extraintestinal isolation index was 0.52.

INTRODUCTION

Salmonella enteritidis (SE) has been increasingly reported worldwide, especially in the American continents and Europe. During the period from 1979-1987, several countries in Asia including Thailand reported that SE was not common and ranked below the 15 top serovars of human isolates (Rodrigue *et al*, 1990). Most of the SE outbreaks were related to eggs (Mishu *et al*, 1994; Cox, 1995). Recently, Nakanishi *et al* (1992) reported that human infections in Japan due to SE had increased since 1989 and eggs were implicated in the outbreak. Likewise, a rising number of SE isolates from humans was also recorded in Hong Kong since 1989 (Wong *et al*, 1994). The organism was ranked third among the *Salmonella* serovars from extraintestinal sources (Wong *et al*, 1995).

Salmonellosis is considered as one of the major public health problems in Thailand. Changing of the serovars commonly isolated from humans has been observed. The most common serovars isolated during 1974-1975 were *S. typhi, S. derby, S. lexington* and *S. anatum*, from 1976-1982 were *S. krefeld, S. typhi, S. derby,* and *S. welterverden* and during 1983-1987 were *S. derby, S. welterverden, S. typhimurium* and *S. krefeld* (Jayanetra *et al*, 1990). A recent report noted that the three most common serovars found during 1988-1993 were not different from 1983-1987 (Bangtrakulnonth *et al*, 1995). SE infections were rare during 1972-1989 but increased markedly since 1989 (Bangtrakulnonth *et al*, 1993). Poultry meat was likely be the source of the infections (Kantana *et al*, 1995).

The purpose of this report is to present the demographic Thai data of the SE infection in humans from 1990 through 1995.

MATERIALS AND METHODS

Demographic data was based on the information recorded in the request form submitted to the WHO National Salmonella and Shigella Center, Department of Medical Sciences, Ministry of Public Health, for *Salmonella* typing received throughout the country during 1990-1995. Totally 26,073

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isolates were typed. Cultures were purified and biochemical tested using triple sugar iron agar and lysine indol motility agar. The cultures were then further examined using the slide agglutination technique with *Salmonella* polyvalent O antisera A-67 (O:2 - 0:67), A-1 (O:2-O:16) and groups B (O:4), C (O:7:O:8), D (O:9, O:9,46, O:9,46,27) and E (O:3,10:O:1,3,19), O-factor antisera, H-polyvalent and H-factor antisera (Kauffmann, 1966).

RESULTS

Incidence of *Salmonella* serovars and places of the SE infection

The average incidence of the 10 most common serovars found from 1990 through 1995 is shown in Fig 1. *S. derby* was the most common serovar and then *S. welterverden, S. enteritidis, S. anatum, S. typhimurium, S. agona,* S.I. 1, 4, 5, 12:I:-, *S. krefeld,*

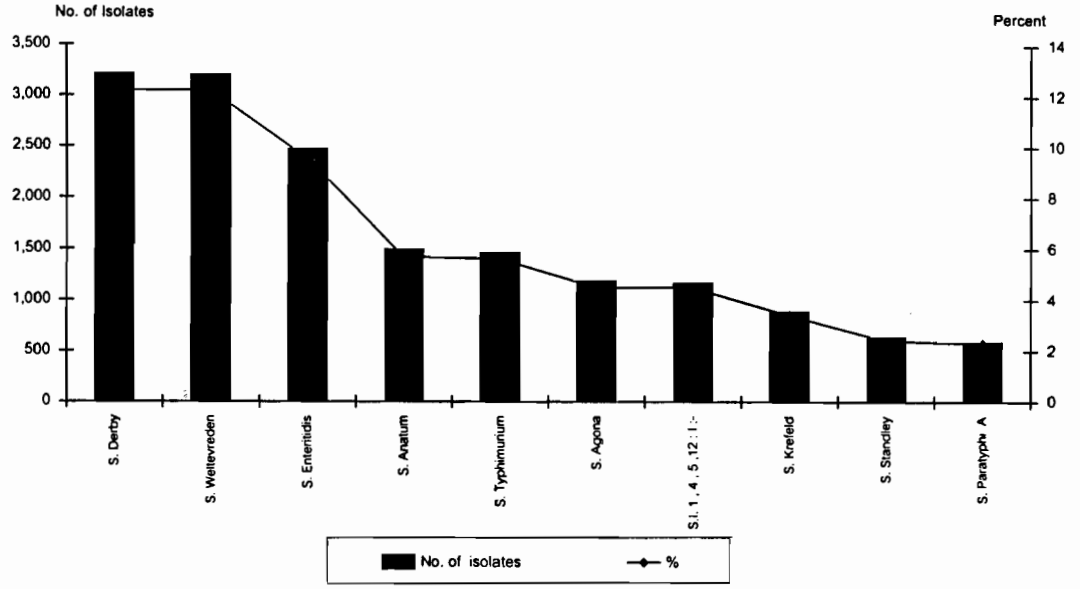

Fig 1–The average of the 10 commonest *Salmonella* isolated from human, during the 6 years period, 1990 - 1995.

Table 1

Number of cases and rate of infection of the ten most common *Salmonella* serovars during 1990-1995.

Serotype	1990	1991	1992	1993	1994	1995
S. derby	736/1.3*	539/0.94	343/0.59	368/0.63	650/1.09	576/0.96
S. welterverden	483/0.85	468/0.82	421/0.72	443/0.75	574/0.97	816/1.37
S. enteritidis	51/0.01	105/0.18	307/0.53	471/0.8	659/1.11	877/1.47
S. anatum	146/0.25	120/0.21	118/0.2	176/0.25	397/0.67	568/0.96
S. typhimurium	338/0.6	210/0.36	221/0.38	154/0.26	216/0.36	326/0.54
S. agona	262/0.46	225/0.39	130/0.22	118/0.2	215/0.36	236/6.39
S. I.1,4,5, 12:I:-	28/0.41	79/0.13	177/0.3	193/0.33	272/0.46	422/0.7
S. krefeld	147/0.26	217/0.38	108/0.18	149/0.25	129/0.21	135/0.22
S. stanley	74/0.13	92/0.16	70/0.12	64/0.1	147/0.24	186/0.31
S. paratyphi A	116/0.2	44/0.07	111/0.13	76/0.13	107/0.18	133/0.22
Total cases	3,839/6.8	3,648/6.4	3,065/5.3	3,284/5.62	5,770/9.8	6,644/11.7

* No. cases/rate of infection per 100,000 population.

S. standley and *S. paratyphi* A, accounting for 12.2, 12.2, 9.5, 5.7, 5.6, 4.5, 4.5, 3.4, 2.4 and 2.3%, respectively. Table 1 shows the range and rate of infection of the 10 most common serovars during the study period. *S. derby, S. welterverden* and *S. enteritidis* ranked first in 1990-1991, 1992 and 1993-1995, respectively. The rate of infection per 100,000 population of all salmonellosis in 1990-1995 was 6.8, 6.4, 5.3, 5.6, 9.8 and 11.2, respectively. SE infection increased markedly showing a rate of infection of 0.09, 0.18, 0.53, 0.8, 1.11 and 1.47 in 1990 to 1995, respectively. Cases were found dominantly in Bangkok but the rate in the northern region of the country is shown in Fig 2.

Age and sex of the patients

Totally, 2,470 cases of SE infection were confirmed. The incidence of cases analysed by age and sex is shown in Table 2. Seven hundred and twenty-seven cases, 29.4%, were adolescents (age uner 14 years) and the majority, 1,743 cases, 70.6% were adults (age over 15 years). Among the adolescent patients, 5.7, 2.5 and 21.5% were under 5, 6-14 years and unspecified age, (0-14 years), respectively. While 18, 2.3 and 50.3% of the adult patients were 15-60, over 60 years and unspecified age (over 15 years). The ratio of SE infection in male and female was 1.32:1, 1.76:1, 1.42:1, 1.51:1, 1.4:1 and 1.59:1 in 1990-1995, respectively. The average ratio of the infection in male and female was 1.5:1. Fig 3 shows the number of cases of SE infection in different regions. Adolescent patients were found to be fewer than adult patients in all regions. In the northern region, adolescent cases were not found but only 2 and 4 cases of adults were reported in 1993 and 1995, respectively.

Body sites of isolation

As shown in Table 3, 41.7 and 45.8%, of the isolates were from stools and extraintestinal sources, respectively. Eight hundred and eighty-four isolates (35.8%) out of 1,095 extraintestinal infections were isolated from blood. Table 4 demonstrates the sites of SE isolation in various age groups. Stool was the major source of the organism from adolescent patients. The extraintestinal isolation index (EII), as calculated according to Wong *et al* (1994), of the organism from adolescent patients, aged 0-5, 6-14 years, and unspecified age, was 0.22, 0.33 and 0.43, respectively. The EII of the isolates from the adult patients, age 15-60, > 60 years and unspecified age was 0.5, 0.56 and 0.62, respectively. The EII of all isolates was 0.52.

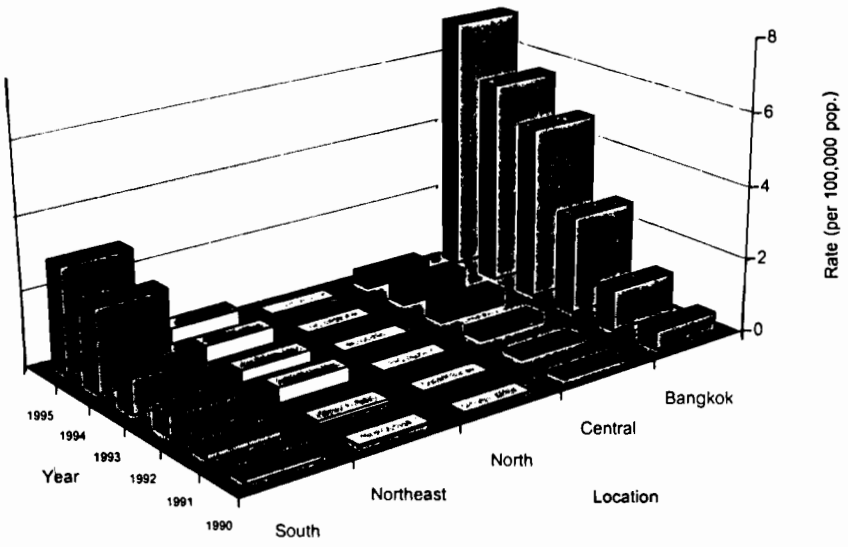

Fig 2–Rate of *Salmonella enteritidis* infection in various region of the country.

Table 2

Number of cases of *Salmonella enteritidis* infection in different age groups and sex.

Age (Year)	1990 (51)	1991 (105)	1992 (307)	1993 (471)	1994 (659)	1995 (877)	Total 2,470
Adolescents							
0-5	5:10*	2:8	3:7	21:14	19:14	25:12	75:65
6-14	-	4:3	9:3	11:6	10:5	3:8	37:25
Unspecify**	-	17:11	44:34	55:32	74:71	121:66	311:214
Subtotal	5:10	23:22	56:44	87:52	103:90	149:86	423:304
Adult							
15-60	6:4	15:8	33:36	69:46	65:28	57:78	245:200
> 60	-	1:0	6:3	14:8	12:5	3:4	36:20
Unspecify	18:8	28:8	85:44	113:82	204:152	330:170	778:469
Subtotal	24:12	44:16	124:83	196:136	281:185	390:252	1,059:684
Total	29:22	67:38	180:127	283:188	384:275	539:338	1,482:988

* No. of cases, male : female

** Age was not reported in the request form, 0-14 years for adolescent patients and > 15 years for adult patients

- no case

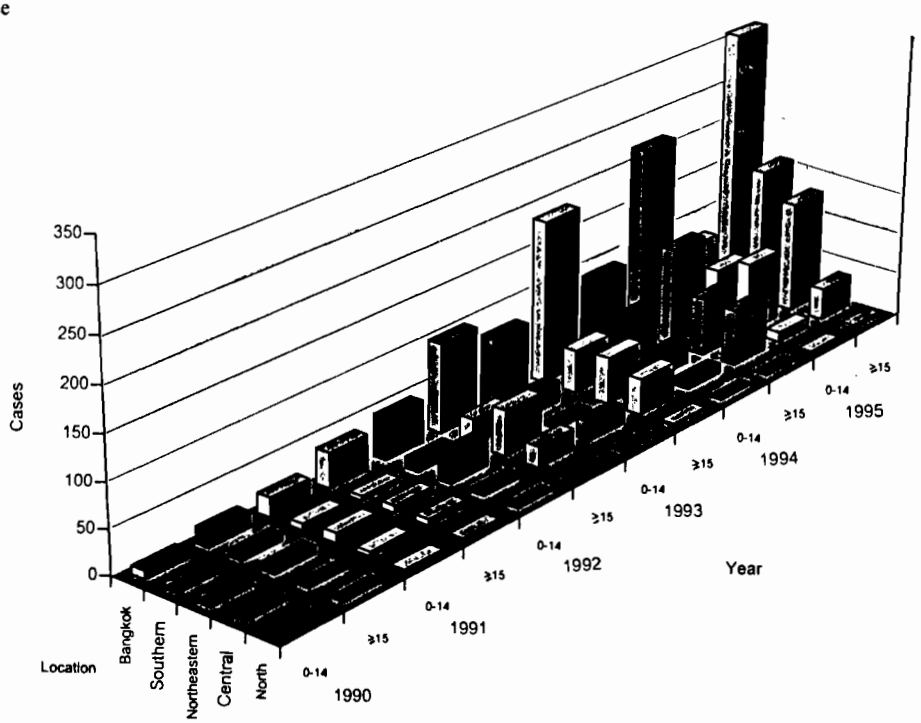

Fig 3–The frequency of *Salmonella enteritidis* infection in adolescent and adult patients, 1990-1995.

Table 3

Body sites of the isolation of *Salmonella enteritidis* from human 1990-1995.

Source	1990	1991	1992	1993	1994	1995	Total
Stool	17 (33.3)*	52 (49.5)	110 (35.8)	178 (37.8)	247 (37.4)	425 (48.4)	1,029 (41.7)
Blood	17 (33.3)	39 (37.2)	112 (36.5)	196 (41.6)	275 (41.7)	245 (28)	884 (35.8)
Pus	2 (3.9)	6 (5.7)	28 (9.1)	12 (2.5)	40 (6.1)	48 (5.4)	136 (5.5)
Urine	3 (5.9)	2 (1.9)	11 (3.6)	15 (3.2)	13 (2)	18 (2.1)	62 (2.5)
Sputum	0	0	0	2 (0.4)	5 (0.8)	2 (0.2)	9 (0.4)
CSF	1 (2)	0	6 (2)	7 (1.5)	13 (2)	14 (1.6)	41 (1.7)
Unknown	11 (21.6)	6 (5.7)	40 (13)	61 (13)	66 (10)	125 (14.3)	309 (12.5)
Total	51 (100)	105 (100)	307 (100)	471 (100)	659 (100)	877 (100)	2,470 (100)

* No. of isolates (%)

Table 4

Source of *S. enteritidis* isolated from various age groups.

Patient age (year)	Stool	Blood	EI	EII	Unknown*	Total
Adolescent						
< 5	97	20	7	0.22	16	140
6-14	36	16	2	0.33	8	62
Unspecify**	267	172	29	0.43	57	525
Adult						
15-60	206	162	43	0.5	34	445
> 60	24	21	10	0.56	1	56
Unspecify	399	493	157	0.62	193	1,242
Total	1,029	884	248	0.52	309	2,470

* Type of clinical material was not recorded

** Age was not reported in the request form, 0-14 for adolescent patient and > 15 for adult patients

EI = Extraintestinal isolation, pus, urine, sputum, cerebrospinal fluid

$$\text{EII} = \text{Extraintestinal isolation index}, \frac{\text{No. of isolates from extraintestinal source}}{\text{Total number of isolates from stool and EI}}$$

DISCUSSION

The reported cases of human salmonellosis during 1990-1995 varied. The morbidity rate per 100,000 population during the study period was varied from 5.3 in 1992 to 11.17 in 1995. A marked increase was seen in 1994 and 1995 showing the rate of 9.76 and 11.17, respectively. Most of the reported cases were sporadic and only one outbreak of salmonellosis was found during 1991-1992. (Chunsuttiwat *et al*, 1995). The present report revealed that the majority of the salmonellosis cases were not notified. Based on sentinel surveillance data about 1.1% of diarrheic cases were dued to *Salmonella* (Anonymous, 1996). Seven hundred thousand to 1,000,000 diarrheic cases were reported during 1990-1995 (Anonymous, 1997). Therefore, we estimated that salmonellosis cases would be 7,500 to 10,000 cases and the rate of

infection was 12 to 17 cases per 100,000 population. The estimated rate of infection was lower than the reports from Hong Kong, 40/100,000 (Wong *et al* 1994), England and Wales (60/100,000), and Scotland (58/100,000). (ACMSF, 1996). Our estimated cases may be low since the data was calculated from 1.1% of diarrheal cases which were due to *Salmonella*. Most of the previous reports found that 3-13% of dirrheal cases were caused by non-typhoidal Salmonellae (Jayanetra and Vorachit, 1981; Vibulbandhitkij *et al* 1982; Varavithya *et al*, 1990; Escheverria *et al*, 1989).

Changing of the first most common serovars was found. *S. derby, S. welterverden* and *S. enteritidis* were ranked first in 1990-1991, 1992 and 1993-1995, respectively. *S. enteritidis* obviously increased starting from 1990. During the same period an outbreak of *S. enteritidis* was also recorded in Hong Kong (Wong *et al*, 1995) and Japan (Nakanishi *et al*, 1992), while a pandemic of SE infection was reported since 1997 (Rodrigue *et al*, 1990).

SE infection was found dominantly in Bangkok (population ~ 5.5 million). The rate of infection was 0.5 in 1990 and increased to 7.05 in 1995, while the rate of infection in the southern (population 7.5 million), northeastern (20 million) central (13 million), and northern (11 million) regions during the study were 0.12-2.86, 0.05-0.46, 0.02-0.55, and 0-0.03, respectively. The reason for the difference in the SE infection among the different regions of the country is not well defined. It was unlikely that the infective organism was spread in a limited area, not the whole country, since SE was mostly isolated from chicken meat (Jernklinchan *et al*, 1994; Suthienkul *et al*, 1995) but the incidence was low in eggs (Saitanu *et al*, 1994). The isolates from poultry meat and humans were identical by random amplified polymorphic DNA technic (Kantana *et al*, 1995) and polymerase chain reaction (Saitanu *et al*, manuscript in preparation); this indicated that poultry meat was a major source of SE infection in humans in Thailand. This meant that the risk of exposure to SE was not different among the regions. Most reports from other parts of the world revealed that eggs were the most important source of the outbreaks of SE (Mishu *et al*, 1994; Rodrigue *et al*, 1990).

Analysis of the infections by age and sex showed that the infection rate in males was higher than in females in most of the age groups (Table 2). The number of cases in adolescent patients were markedly lower than in adult patients. This finding contradicted the incidence of other non-typhoidal salmonellosis reported by the others (Skirrow, 1987; Jayanetra and Vorachit, 1981; Wong *et al*, 1994).

The reason for the incidence was not clearly defined. The outbreak or sporadic cases of SE caused by food made from chickens was not investigated in Thailand. However, it should be kept in mind that the important source of infection was chicken meat which is not common food for the young and, particularly, not for infants. The dominant rate of infection in adults needs explanation. Although there is no direct evidence to define the incidence, we propose that the food-handling deficiencies, unproperly preparation, undercooked, inadequate holding temperature and cross-contamination of the food of chicken origin constituted a major risk factor. These would explain some of the adult cases.

It is worth noting that the majority of SE isolates were from extraintestinal sources (45.9%), while 41.7 and 12.5% were from stools and unknown sources, respectively (Table 3). The most common site of extraintestinal isolation was blood, accounting for 35.8%. When the extraintestinal isolation index was calculated, we found that our strains were highly invasive. The EII index of SE in Hong Kong was 0.18 (Wong *et al*, 1994), and of EI isolates in Israel was 3% (Sechter *et al*, 1991). However, when we analysed the EII index of the strains from adolescents excluding the adults, the strains from adolescent patients were of medium invasiveness, with an EII index of 0.22-0.42, while the strains from adult patients were highly invasive with the EII index varying from 0.5-0.62 (Table 4). An important difference in the body site of isolation between adolescent and adults patients requires explanation.

Recently, Thamlikitkul *et al* (1996) reported that among the 80 case of AIDS patients, age 16-81 years, who had bacteremia, *Salmonella* group D was the most common pathogen, accounting for 65%, then groups B (20%), A and C (7.5% each). Since SE is a serovar belonging to group D, the high incidence of SE from blood may be related to HIV infection. To eluciate the risk factor of extraintestinal infection of SE, the underlying disease due to non-typhoidal salmonellosis should be determined.

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