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THE 1976–1977 RUBELLA EPIDEMIC IN FUKUOKA CITY IN SOUTHERN JAPAN: EPIDEMIOLOGY AND INCIDENCES OF COMPLICATIONS AMONG 80,000 PERSONS WHO WERE SCHOOL CHILDREN AT 28 PRIMARY SCHOOLS AND THEIR FAMILY MEMBERS

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SUMMARY From 1975 to 1977, a nationwide rubella epidemic occurred in Japan. This epidemic provided the last chance for the observation of natural rubella and its epidemiology without the influence of mass-vaccination for rubella and before changes in the epidemic pattern of rubella in the 1980's in Japan. Epidemiological and clinical data were obtained by questionnaires on school children in 28 selected primary schools and their family members (a total of 80,221 persons) in Fukuoka in southern Japan during the 1976–1977 rubella epidemic. At the end of 1975 the rubella epidemic was mainly in the western part of Fukuoka city and then it spread to the eastern part. After a break during the summer of 1976, the epidemic restarted in 1977 mainly in the eastern part with few cases in the western part. Rubella was identified clinically in 14,322 cases (18%) during the 1976 epidemic, the incidences in various age groups being as follows: children of below 6 years of age, 28%; primary school children, 37%; junior and senior high school students, 30%; adults of 18 to 30 years of age, 8%; adults of over 30 years of age, 1%. The incidence in primary school children in 1977 was 18%.

Of the 14,322 cases of clinical rubella in 1976, 3 with encephalitis, 9 with purpura and 1,843 with joint complaints (pain and/or swelling of joints) were recorded. Rubella encephalitis was estimated to have occurred in 1 in 4,700 cases with clinical rubella, and purpura in 1 in 1,500 cases. The incidence of joint complaints was 13%, the incidences in age groups of below 6 years, 6–11 years, 12–17 years, 18–30 years and over 30 years being 7%, 10%, 14%, 28% and 37%, respectively, in

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males and 6%, 12%, 20%, 50% and 55%, respectively, in females.

INTRODUCTION

From 1975 to 1977, an epidemic of rubella occurred throughout the Japan Islands (Shishido et al., 1979). After this epidemic, the unique pattern of a 10 year cycle of epidemics in southern Japan tended to disappear, and rubella became endemic showing periodically increased incidence as in most other parts of the world (Ingalls et al., 1960; Ueda et al., 1983). Thus this rubella epidemic provided the last chance for investigations on natural rubella and its epidemiology before change in the epidemiological pattern of rubella and before the influence of the mass-vaccination program against rubella started in 1978 in southern Japan (Shishido et al. 1979; Ueda et al., 1983).

The incidences of the complications of rubella encephalitis and thrombocytopenic purpura reported so far were based on statistical analysis of cases of clinical rubella reported in Detroit (Margolis et al., 1943) and the morbidity rate observed in Pittsburgh (Beyer et al. 1965). A high incidence of joint complaints with natural rubella in children was reported in a rubella epidemic in Burmuda (Judelsohn and Wyll, 1973). However, there have been no confirmatory reports on the incidences of encephalitis and purpura in cases of clinical rubella, or on the incidences of joint complaints in children during natural rubella infection.

During the epidemic period from 1975 to 1977 in Fukuoka city, epidemiological and clinical data were obtained by questionnaires sent to 28 selected primary schools on the children and members of their families (a total number of 80,221 persons). This paper reports data on the epidemiology of rubella and the incidences of the complications in cases of clinical rubella.

BACKGROUND

Fukuoka city (population: 1,002,000 in 1975) is located at the northern part of Kyushu Island in southern Japan, which lies in the temperate zone. Rubella epidemics occurred in Fukuoka city and its environs in 1956–1958 and 1965–1969 (Fukuoka city in 1966). After two confirmed sporadic cases in December 1970, there were no more cases till the end of 1973. Subsequently small rubella epidemics occurred in Kitakyushu city in the spring of 1974, and in Kasuga and Onojo cities near Fukuoka city in the spring of 1975. Then at the end 1975, an extensive epidemic occurred starting in the western part of Fukuoka city. This epidemic ended in 1977, but sporadic or endemic cases of rubella continued to be reported till 1983 (Ueda, et al., 1983).

STUDY POPULATION AND METHODS

In Fukuoka city there were a total of 105 primary schools in 1976 (number of school children: 89, 397), and 28 of these schools cooperated in this investigation. There were 27,937 children in these 28 primary schools in 1976, or 31% of the total number of primary school children in Fukuoka city. Both these children and members of their families were studied in 1976 and the school children only in 1977.

Data were obtained by two questionnaires, which were sent home with the primary school children and filled out by the parents. The questionnaires contained questions concerning dates of the onset of a rubella rash, fever ($\geqq$37.5 C), lymphnode swelling, eye redness, catarrhal symptoms of the upper respiratory tract, and other complications (arthralgia, purpura and encephalitis).

The first questionnaires were sent in July 1976 to 21, 102 families of the pupils in the 28 primary schools to obtain information on the period from January 1975 to July 1976. Answers were obtained from 19,396 families (92%) giving information on 80,221 persons, i.e., 25,409 primary school children (91%) and 54,812 other members of their families. The second questionnaires were sent out in July

TABLE 1. *Study population and incidence of clinical rubella: Data on clinical rubella in primary school children and their family members in the 1976–1977 rubella epidemic were obtainable at 28 selected primary schools in Fukuoka city in southern Japan*

Age group (years)	Number of cases in 1976 study (Number of cases with clinical rubella : incidence)	Number of cases in 1977 study (Number of cases with clinical rubella : incidence)
≦5	7,907 (2,196 : 28%)	ND[a]
6–11 (primary school)	25,409 (9,515 : 37%)	26,076 (4,742 : 18%)
12–17 (junior and senior high school)	6,065 (1,832 : 30%)	ND
18–30	2,833 (232 : 8%)	ND
≧31	38,007 (547 : 1%)	ND
Total	80,221 (14,322 : 18%)	26,076 (4,742 : 18%)

[a] No data.

1977 to obtain data on the clinical rubella among 27,374 primary school children between August 1976 and July 1977, and answers were obtained about 26,076 children (95%) (Table 1).

Due to the great social interest in, and concern about rubella during the epidemic period from 1975–1977 in Japan, the clinical diagnoses of rubella during this epidemic period are considered to be reliable. Moreover, in a retrospective investigation on the relationship between clinical rubella and the rubella hemagglutination inhibition (HI) antibody titer, the rate of negative rubella HI antibody despite a clinical diagnosis of rubella was found to be below 3% (Kawakami and Takeuchi, 1978; Ueda et al., 1978).

RESULTS

1. *Epidemiology*

The incidences of clinical rubella in different age groups studied in the period from 1975 to 1977 are shown in Table 1. There were 14,322 cases (18%) of clinical rubella among the 80, 221 persons studied in the period from January 1975 to July 1976. The incidences in various age groups were as follows: children of below 6 years old, 28%; primary school children (6–11 years old), 37%; junior and senior high school students (12–17 years old), 30%; adults of 18 to 30 years old, 8%; and adults of over 30 years old, 1%. In the period from August 1976 to July 1977 the incidence of clinical rubella among primary school children was found to be 18%.

The epidemic curves for cases of rubella among primary school children in the western and eastern parts of Fukuoka city are shown in Fig. 1. The epidemic at the end of 1975 started in the western part and gradually spread to the eastern part. This epidemic reached a peak in the western part in April 1976, with 48% of the primary school children being infected, and in the eastern part in May to June 1976, with 21% of the children being infected. After an interruption in the summer of 1976, the epidemic restarted in the eastern part, where it reached a peak in March 1977, with 33% of the primary school children being infected. At this time, only 9% of the children in the western part were infected. The epidemic in Fukuoka city ceased in the summer of 1977.

2. *Clinical symptoms*

The incidences of various symptoms of rubella in different age groups of the 14,322 cases with clinical rubella are shown in Table 2. The incidences of the main symptoms were: fever (body temperature ≧37.5 C), 64%; lymphadenopathy, 37%; eye redness, 45%; cough and/or rhinorrhea, 2%. The

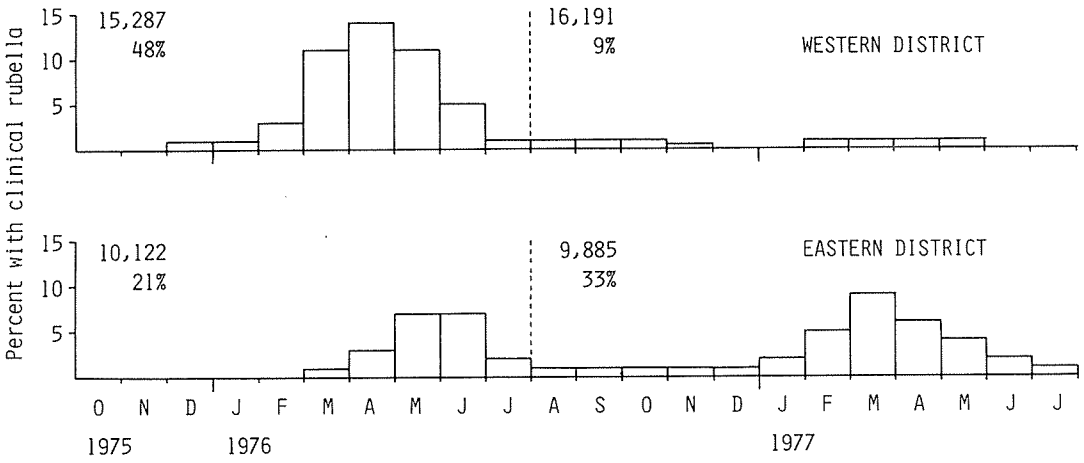

FIGURE 1. Epidemic curve of rubella cases in school children at 28 primary schools in Fukuoka city in souther n Japan in the 1976–1977 rubella epidemic. The monthly incidences of clinical rubella in the western and eastern districts indicate that the rubella epidemic started in the western district where it was greatest, and then gradually spread to the eastern district, in 1976. After an interruption in the summer of 1976, it restarted in the eastern district in 1977, where it was mainly concentrated. The epidemic ceased in the summer of 1977.

TABLE 2. *Symptoms of clinical rubella in 14,322 cases in school children and their family members in different age groups*

Age group (years)	Number of cases with clinical rubella rash	Fever (≧37.5 C)	Lymph-adenopathy	Eye redness	Cough and/or rhinorrhea
≦5	2,196	1,252 (57%)	725 (33%)	747 (34%)	44 (2%)
6-11	9,515	6,090 (64%)	3,330 (35%)	4,282 (45%)	190 (2%)
12-17	1,832	1,264 (69%)	769 (42%)	971 (53%)	36 (2%)
18-30	232	162 (70%)	116 (50%)	114 (49%)	2 (1%)
≧31	547	388 (71%)	268 (49%)	311 (55%)	11 (2%)
Total	14,322	9,156 (64%)	5,208 (37%)	6.415 (45%)	283 (2%)

incidences of symptoms were higher in older age groups.

3. *Complications*

The incidences of complications in different age groups of the 14,322 cases with clinical rubella are shown in Table 3.

Encephalitis: Three children (a 4-year-old boy, a 9-year-old girl, and an 11-year-old girl) showed encephalitic symptoms (convulsions and loss of consciousness). None of these patients had a past history of convulsions or epilepsy. One patient was admitted to the Kyushu University Hospital, and another the Fukuoka University Hospital, both with a diagnosis of encephalitis following rubella. The third patients was the daughter of a doctor of internal medicine, and her diagnosis was made clinically.

Purpura: Nine children (3 boys and 6 girls), all of less than 11 years old, had purpura. Detailed information on the purpura

TABLE 3. *Incidences of complications in 14,322 cases of clinical rubella in school children and their family members*

Age group (years)	Number of cases with clinical rubella (Male : Female)	Encephalitis	Purpura	Joint complaints (Male : Female)
≦5	2,196 (1,160 : 1,036)	1	1	142 (77 : 65)
		0.05%	0.05%	6.5% (6.6% : 6.3%)
6–11	9,515 (4,851 : 4,664)	2	8	1,037 (495 : 542)
		0.02%	0.08%	10.9% (10.2% : 11.6%)
12–17	1,832 (965 : 867)	0	0	307 (134 : 173)
				16.8% (13.9% : 20.0%)
18–30	232 (95 : 137)	0	0	95 (27 : 68)
				40.9% (28.4% : 49.6%)
≧31	547 (216 : 331)	0	0	262 (79 : 183)
				47.9% (36.6% : 55.3%)
Total	14,322 (7,287 : 7,035)	3	9	1,843 (812 : 1,031)
		0.02%	0.06%	12.9% (11.1% : 14.5%)

was obtained from the school nurses and/or parents of the children. Almost all purpura were pin-point size, but a few were more than 2–3 cm in diameter. In one case, thrombocytopenia was confirmed by a medical doctor.

Joint complaints: 1,843 cases (13%) suffered from joint complaints. The incidence increased with age, and in cases of over 18 years old, the incidence was higher in females than in males. The incidences of this complication in age groups of below 6 years, 6–11 years, 12–17 years, 18–30 years, and over 30 years were 7%, 10%, 14%, 28%, and 37%, respectively, in males, and 6%, 12%, 20%, 50%, and 55%, respectively, in females.

DISCUSSION

1. *Epidemiology*

The Japan archipelago is at a northern latitude of 25–45°, and is composed of four main islands (Hokkaido, Honshu, Shikoku, and Kyushu) and the Ryukyu Islands. Because it is long and narrow and extends through upon various climatic zones (cold, temperate, and subtropical), bio-meteorologically it is difficult to discuss the epidemiology of infectious diseases, especially rubella, in Japan as a whole. For example, differences between the epidemic patterns on the main islands and the Ryukyu Islands were observed in the nationwide rubella epidemic in 1965–1969 (Kono, 1969; Suto et al., 1971; Shishido and Ohtawara, 1976; Ueda et al., 1978; Shishido et al., 1979).

The rubella epidemic pattern in Japan was unique in that epidemics occurred in 1965–1969 and in 1975–1977, with intervals without endemics (Ueda et al., 1983). These nationwide rubella epidemics started with sporadic cases and gradually progressed to local epidemics, mainly among primary school children. The local epidemics spread from districts to districts and lasted about five years being interrupted during the summer. Thereafter, rubella disappeared from the whole Japan for about five years (Kono, 1969; Shishido and Ohtawara, 1976; Ueda, et al., 1978; Shishido et al., 1979; Ueda, et al., 1983).

The present study and our previous epidemiological and clinical studies on rubella based on laboratory investigations since 1965 (Ueda et al., 1983) indicated that in Fukuoka

city no children of under 9 years of age were found to have antibody to rubella after a 4–5 year period of free rubella endemics. The epidemic of rubella in the 1970's started among children in primary schools in the western part of the city at the end of 1975 and spreaded to the eastern part. There were differences in morbidity in different primary schools and an interruption during the summer, but the epidemic reached a peak in the spring of 1976. In this and the epidemic in 1977, a total of 55% of the primary school children were infected with clinical rubella within 2 years. Since the 1976–1977 rubella epidemic, sporadic and endemic cases of rubella have been reported, suggesting that the unique endemic pattern in southern Japan is changing in the 1980's (Ueda et al., 1983). Judging from these unique epidemiologic circumstances, this epidemiological investigation may be the last on natural rubella before change in the epidemiologic pattern and the influence of mass-vaccination against rubella.

Grayston et al. (1972) and Gale et al. (1972) examined the relation between the incidence of cases of rubella and the season in Taiwan in 1968, finding that the incidence was highest in Taipei with a peak in April and much lower in the central and southern regions of the island where the peaks were in May and June. This study on the epidemic in Fukuoka city in 1976 showed that the peak incidence in April in the western part was higher than that in May and June in eastern part.

In our seroepidemiologic investigation in Fukuoka city in 1978–1979, the incidence of rubella HI antibodies among children of 6 to 10 years old was found to be 57% (Ueda et al., 1983), which was approximately the same as the incidence of clinical rubella observed in this study. Previously 20% to 25% rates of subclinical rubella infection were reported (Green et al., 1965; Ueda et al., 1970). Thus the incidence of subclinical infection was probably not low in this rubella epidemic in Fukuoka city. However, the present study was made at selected schools that had relatively high attack rates and showed great interest on rubella.

The morbidities of rubella among other subjects than the primary school children in the 1976 epidemic were: below 6 years, 28%, 12–17 years, 30%, 18–30 years, 8%, and over 30 years, 1%. Since these data were obtained on other members of the families of the primary school children who were the targets of rubella infection, the actual mobidity rate in the general population, especially in preschool children and adults of child bearing age were probably much lower.

2. *Clinical symptoms*

The incidence of fever in rubella is variable. Krugman and Ward (1954) reported that 5 of 13 cases had body temperatures of 38.5 C, and Landrigan et al. (1974) observed incidence of fever of 74% in children and 47% in adolescents. In this study the incidences of fever, lymphadenopathy, eye redness and catarrhic symptoms among cases with clinical rubella rash were 64%, 37%, 45%, and 2%, respectively, and symptoms were severe in higher age groups.

3. *Incidence of complications*

Rubella encephalitis was estimated to have occurred in 1 in 6,600 cases of rubella in the Detroit epidemic in 1942 (Margolis et al., 1943) and in 1 in 4,000 cases in the Pittsburgh epidemic in 1964 (Kenny et al., 1965). The incidence in Detroit was calculated from data during the first half of 1942 in the Detroit area, where 14 cases of rubella encephalitis were found and 9,000 cases of rubella were reported, a number estimated as one-tenth of the total cases (Margolis et al., 1943). The incidence in Pittsburgh was also calculated from data for the first half of 1964 in the city of Pittsburgh and the surrounding Allegheny county, where 6 children with rubella encephalitis were hospitalized at the Children's Hospital of Pittsburgh and approximate 30,000 children of school age contracted rubella, judging from data supplied by school nurses

(Kenny et al., 1965). In the present study, 3 cases of rubella encephalitis were found among 14,322 cases of clinical rubella i.e., the ratio was 1: 4,700 cases of rubella, which is comparable with those in Detroit (Margolis et al., 1943) and Pittsburgh (Kenny et al., 1965).

Beyer et al. (1965) estimated the ratio of occurrence of purpura as 1: 3,000 in the Pittsburgh epidemic in 1964. This ratio was based on 11 cases of purpura (male 4; female 7) recorded at the Children's Hospital of Pittsburgh in 1964 and data showing that approximately 30,000 children of school age contracted rubella during the observation period. In this study the incidence of purpura was higher in females than in males, and the incidence ratio among the total cases with clinical rubella (1: 1,500) was a little higher than those reported previously, though it was evaluated by a different method.

Joint complaints in natural rubella are well-known in women (Fry et al., 1962; Chamber and Bywater, 1963; Brody et al., 1965; Judelsohn and Wyll, 1973). Various reports on rubella outbreaks have mentioned this complaint in children as well as adults. However, its incidence in children has been reported only by Judelsohn and Wyll (1973); in the rubella epidemic in Bermuda in 1971, they found that the over-all incidence was 42%, that in females being higher (female: 48% and male: 35%); the incidence was 26% in the prepubertal age group (under 13 years of age) and increased with age (73% in patients of 30 years and over) and the incidence in male adults (over age 20) was 52%. In this study the incidence of joint involvements was a little lower than that reported by Judelsohn and Wyll (1973). However, our findings support their observation of a higher frequency of joint complaints in children and in male adults than thought previously.

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