Water source as a *Helicobacter pylori* transmission route: a 3-year follow-up study of Japanese children living in a unique district

Helicobacter pylori is associated with the pathogenesis of chronic gastritis, peptic ulcer disease and gastric cancer (Matysiak-Budnik & Megraud, 2006). It is thought that the acquisition of *H. pylori* infection occurs mainly during childhood (Sherman, 2004). Although an intrafamilial route has been suggested (Kivi & Tindberg, 2006), the major routes of transmission of *H. pylori* are poorly understood. There have been cases reported in which the intrafamilial route does not appear to apply. In 2002, we investigated *H. pylori* prevalence in 224 children (age range 0–6 years) in three districts in Miyagi prefecture, Japan (Fujimura *et al.*, 2004). The *H. pylori* prevalence rate in the children studied was 0% in district C. *H. pylori* prevalence rates in districts A and B were approximately equal to those in other reports from Japan (Kato *et al.*, 2003a). However, there were no reports of 0% prevalence rates such as found in district C. Therefore, we examined *H. pylori* prevalence 3 years later to determine whether the prevalence rate in the children of district C had changed.

From among the 51 children (age 3–5 years) investigated in district C in 2002, 40 children (age 6–8 years in the follow-up study) in 37 households, from whom informed consent was obtained, were re-examined in this study. *H. pylori* status was estimated using a stool antigen test (Premier Platinum HpSA; Meridian Bioscience) (Kato *et al.*, 2003b). According to the manufacturer's instructions, the results were divided into three groups for *H. pylori* infection: positive ($\text{OD}_{450/630} \geq 0.120$); negative (< 0.100); and indeterminate (0.100–0.199). Further, we studied *H. pylori* prevalence among the family members (the parents and siblings) who live together with the subject children. Informed consent was obtained from 24 of the 37 original households (64.9%). However, because agreement for obtaining stool samples was not obtained, the *H. pylori* status of the parents and siblings was assessed using a commercial ELISA kit

(URINELISA *H. pylori* antibody; Otsuka Pharmaceutical) to detect anti-*H. pylori* IgG antibodies (Miwa *et al.*, 1999).

The survey collected information regarding childcare and the living environment and included birthplace, feeding methods in infancy and the source of the household water.

All 40 children who were uninfected with *H. pylori* in 2002 remained *H. pylori*-negative at the 3-year follow-up. The *H. pylori* prevalence of their parents (mean age 38.9 years; range 27–51 years) was 35.4% (17/48). Among the 48 parents in 24 households, the prevalence rates of *H. pylori* for natives of district C and for people who had moved into the area from the outside were 37.5% (12/32) and 31.3% (5/16), respectively (Table 1). The mean age of the native parents who were infected with *H. pylori* was 40.8 years with a range of 35–51 years. Of the 24 households, at least one parent was infected in 14. Among these 14 households, the rates of infection of both parents, of the fathers, and of the mothers were 21.4% (3/14), 42.9% (6/14) and 35.7% (5/14), respectively. There were 14 households in which the subject had siblings; except for one family, none of the siblings were infected with *H. pylori* (Table 1). In the sole exception, the parents and both siblings were infected with *H. pylori*. These two siblings had not, as infants, been fed pre-chewed food by infected parents. However, another subject who was fed pre-chewed food by an infected mother was *H. pylori*-negative in a different household. There was no relationship between *H. pylori* infection and whether or not the subjects had received pre-chewed food during their infancy.

In a Japanese report, it has been shown that the infection rate of *H. pylori* was 8–10% at less than 10 years of age and was about 35% at 30–40 years (Asaka *et al.*, 1992). The *H. pylori* prevalence rate in parents in district C is almost in accord with that in another Japanese report (Kato *et al.*, 2003a). Although it is known that *H. pylori* is

acquired mainly during childhood, these results suggest that the living environment in district C where the parents spent their childhood 30–35 years ago was equivalent to that in other districts in Japan. District C with a population of 9000 is located in a rural area at the foot of a mountain range and is 10–20 km away from districts A and B. There are many reports pointing to drinking water as a transmission source for *H. pylori* (Bellack *et al.*, 2006; Fujimura *et al.*, 2004; Kikuchi & Dore, 2005). There are some reports that *H. pylori* DNA was detected in well water in Japan (Horiuchi *et al.*, 2001). In the three districts (A, B and C), all households used well water until 1975, and city water then became available. The source of water in districts A and B has been river water since 1975. However, in district C, groundwater from a layer deeper than that of general groundwater has been used as the water source. In a previous study, water samples were taken from three points (upper, middle and downstream reaches) along four rivers in the Tohoku region of Japan. We reported that *H. pylori* DNA was not detected in water samples from the upper reaches in the high mountains outside of the human biosphere but it was detected in the middle or lower reaches (Fujimura *et al.*, 2004). In the current study, the *H. pylori*-specific *ureA* gene was not detected in the groundwater of district C (data not shown). Since we failed to culture *H. pylori* from tap water and well water, the use of tap water derived from a water source which is not contaminated with *H. pylori* may account for the fact that no children living in district C were infected with *H. pylori*. In addition, the questionnaire results concerning feeding style in infancy, particularly feeding the child pre-chewed food, suggest that the possibility of *H. pylori* spreading via the intrafamilial route is low in this area. In Japan, the primary source of city-supplied water is rivers. There are extremely few cases like that of district C where spring water or groundwater from the high mountains is used as a source. Though the transmission source of *H. pylori* has not been

Table 1. Relationship between *H. pylori* status and the birthplace of parents and siblings of subject cases

Birthplace	<i>H. pylori</i> status	Father	Mother	Sibling*
District C	Positive	8	4	2†
	Negative	12	8	16
	Total	20	12	18
Other districts	Positive	1	4	—
	Negative	3	8	—
	Total	4	12	—

*—, None fitted the criteria.

†Two siblings and parents in only one family were infected with *H. pylori*.

clarified, *H. pylori* infection in children may be suppressed if drinking water is not of river water origin.

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