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Temporal trends of infant and birth outcomes in Minamata after severe methylmercury exposure☆

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ABSTRACT

Severe methylmercury poisoning occurred in Minamata and neighboring communities in Japan during the 1950s and 1960s, causing what is known as Minamata disease. Although an increase in stillbirths and a reduced male proportion at birth (i.e., reduced sex ratio) have been reported, no studies have evaluated the impact of exposure on an entire set of infant and birth outcomes. We therefore evaluated the temporal trends of these outcomes in the Minamata area from 1950 to 1974. We focused on the spontaneous/artificial stillbirth rate, crude fertility rate, male proportion at birth, male proportion among stillbirths, and infant mortality. We obtained the number of stillbirths, live births, and infant deaths in Minamata City and Kumamoto Prefecture (as a reference) from 1950 to 1974. After plotting annual figures for each outcome, we divided the study period into five intervals and compared them between Minamata City and Kumamoto Prefecture using the chi-squared test. We observed a slightly increased spontaneous stillbirth rate and decreased artificial stillbirth rate in Minamata City, followed by a reduced crude fertility rate. The crude fertility rates in Minamata City during the period 1955–1965 were significantly lower compared with those in Kumamoto Prefecture ($p < 0.001$). An increase in the male proportion among stillbirths was observed, corresponding to a reduction in the proportion of males at birth in the late 1950s. The impact on infant mortality was equivocal. These descriptive analyses demonstrate a severe regional impact of methylmercury exposure on a series of birth outcomes in the Minamata area.

1. Introduction

Severe methylmercury poisoning through consumption of contaminated seafood occurred in Minamata and neighboring communities in Japan during the 1950s and 1960s; the incident caused what is known as Minamata disease (Harada, 1995; Yorifuji et al., 2013a). The first patient was officially identified in May 1956, and many other patients were subsequently identified in the exposed areas. Affected individuals manifest neurological signs including paresthesia, ataxia, dysarthria, constriction of the visual field, and hearing difficulties. Moreover, a considerable number of children who were exposed to methylmercury *in utero* were born in exposed areas during the exposure period with conditions resembling cerebral palsy, known as congenital Minamata disease (Harada, 1978).

Aside from congenital Minamata disease, exposure to methylmercury *in utero* in the contaminated areas affected several birth outcomes. For example, Itai et al. observed an increased proportion of abnormal pregnancies (spontaneous abortion and stillbirths) in a contaminated area of Minamata City compared with a control area (in a different prefecture) during the exposure period (Itai et al., 2004). Moreover, reduced sex ratio at birth (i.e., reduced male proportion) was observed in Minamata City and neighboring communities during the period (Doi et al., 1985; Sakamoto et al., 2001; Yorifuji and Kashima, 2016), which is considered to be owing to a greater proportion of male stillbirths (Sakamoto et al.,

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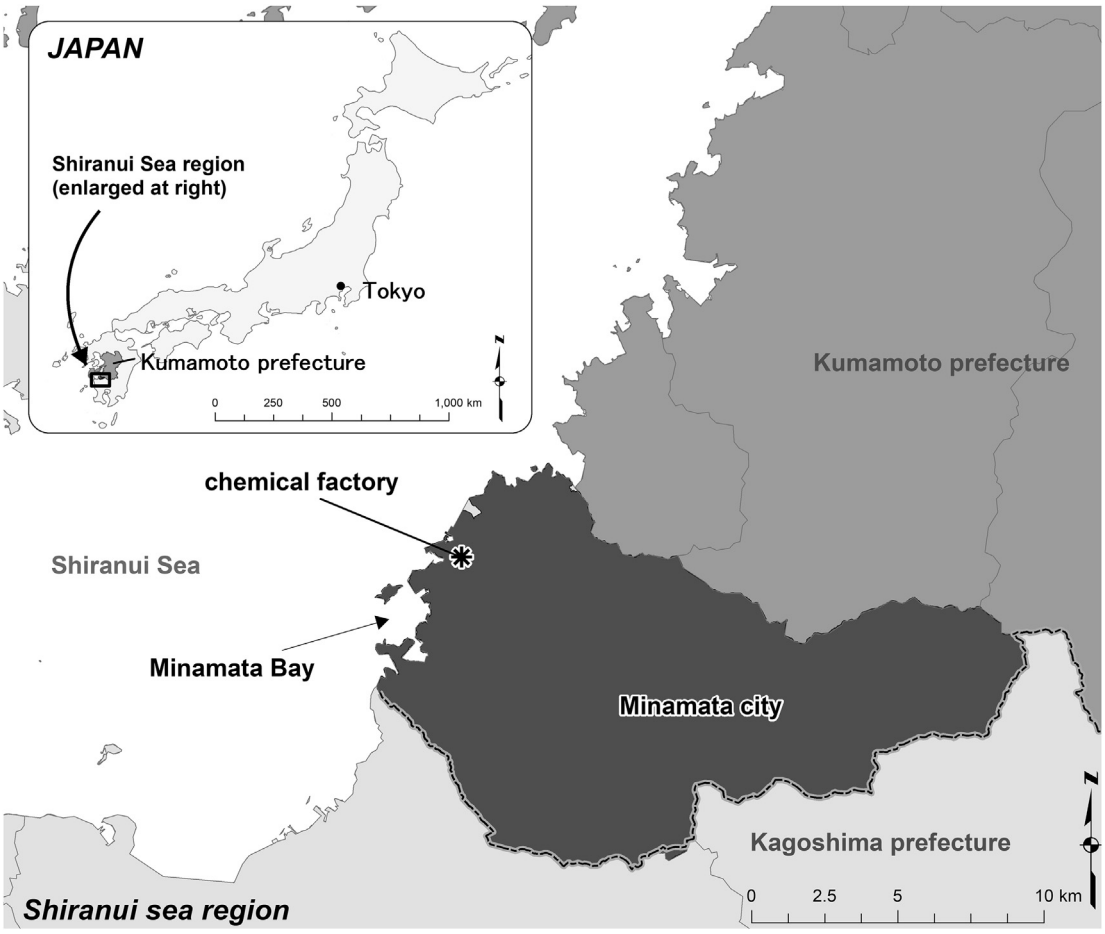

Fig. 1. Map of study area.

Table 1
Demographic characteristics of residents in Minamata City and Kumamoto Prefecture in 1960.

	Exposure area	Reference
	Minamata City	Kumamoto prefecture
	(n = 48,342)	(n = 1,856,192)
Age category, n (%)		
0–14 years old	17,339 (35.9)	629,548 (33.9)
15–59 years old	26,833 (55.5)	1,033,097 (55.7)
60 years old and over	4170 (8.6)	193,547 (10.4)
Women, n (%)	25,270 (52.3)	969,154 (52.2)
Women aged 15–44 years among all women, n (%)	11,163 (44.2)	421,221 (43.5)
Educational status (among residents aged 15 years old and over)		
Number of residents aged 15 years old and over, n	31,003	1,226,644
Residents who completed university, n (%)	418 (1.3)	14,724 (1.2)
Residents who completed high school or college, n (%)	2772 (8.9)	107,493 (8.8)
Industry classification (among workers aged 15 years old and over)		
Number of workers aged 15 years old and over, n	19,944	814,544
Primary (Farmer, fisherman, etc.), n (%)	6283 (31.5)	420,310 (51.6)
Secondary (Factory worker, etc.), n (%)	6510 (32.6)	133,923 (16.4)
Tertiary (Services, etc.), n (%)	7146 (35.8)	260,235 (31.9)
Unknown, n	5	76

Source: National census (1960).

2001). However, no studies thus far have evaluated the impact of exposure on an entire set of infant and birth outcomes (e.g., crude fertility rate or infant mortality rate) in the contaminated area.

We therefore conducted a descriptive study to evaluate temporal trends of infant and birth outcomes in the Minamata area from 1950 to 1974 and assessed how regional methylmercury exposure affected these outcomes.