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Decline in sex ratio at birth after Kobe earthquake

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We investigated the possible association between the Kobe earthquake (January 1995) and the sex ratio among live-born infants after the catastrophe. A significant decline in the sex ratio (0.501) of Hyogo Prefecture in October 1995 was observed 9 months after the Kobe earthquake as compared with an expected value of 0.516 in the period from January 1993 to January 1996 ($P = 0.04$; one-tailed). Simultaneously, a reduction in fertility of ~6% was also observed, compared with the month of October 2 years previously. Thus, the acute stress resulting from a great natural catastrophe can be a cause of a low sex ratio at birth 9 months later.

Key words: fertility/Kobe earthquake/sex ratio/stress

Introduction

It has been proposed that the newborn sex ratio may be a useful indicator of male reproductive hazard (James, 1997). A significant decline in the sex ratio at birth in recent decades has been reported from Denmark (Møller, 1996), England and Wales (Dickinson and Parker, 1996), USA and Canada (Allan *et al.*, 1996), the Netherlands (van der Pal-de Bruin *et al.*, 1997) and Germany (Bromen and Jöckel, 1997), and Sweden, Norway and Finland (Møller,1998). It is speculated that chronic exposure to environmental toxic agents of the male reproductive system could lead to low male:female ratios. Lyster (1974) also reported altered sex ratios after the London smog in 1952 and after the Brisbane flood in 1965. We have investigated whether acute stress caused by the Kobe earthquake (January 17, 1995) could alter the sex ratio 9 months later.

Materials and methods

We assessed the monthly numbers of males and females at birth in relevant periods around the time of the Kobe earthquake (January 17, 1995). The data were obtained from Hyogo Prefecture and from the published welfare statistics in Japan. The sex ratio was expressed as the male proportion, i.e. males/(males + females). The fertility in the population was described by the total numbers of births in the period 6–12 months after the earthquake (July 1995 to January 1996). For comparison, the corresponding months 2 years previously were used.

Statistical analysis of the sex ratio was performed using Fisher's exact test (one-tailed) comparing the numbers of males and females born in any given month with the numbers in the remainder of the period from January 1993 to January 1996. A significance level of $P < 0.05$ was chosen *a priori*.

Results

Supposing that intercourse occurred on the day of the earthquake, January 17, 1995, pregnancy term would be October 9, 1995. As shown in Figure 1, a prominent decline in the sex ratio (0.501) in Hyogo Prefecture was observed in October 1995. In the month of October 1995, 1971 males and 1961 females were born. In comparison with a value of 0.516, based on 82 130 males and 77 155 females in the period from January 1993 to January 1996, the reduction in sex ratio in October 1995 was statistically significant ($P = 0.04$; one-tailed). Moreover, a reduction in the population fertility of ~6 % was also observed, compared with the month of October 2 years previously (Figure 2).

The numbers of spontaneous abortions and preterm births from January 1995 to October 1995 did not change compared with the previous 2 years.

Discussion

Our data suggest that the sex ratio among newborn infants in Hyogo Prefecture 9 months after the Kobe earthquake decreased from its usual value of ~0.516 to a low value of 0.501. This corresponds to the reported sex ratio changes following the London smog and the Brisbane flood. In contrast to the latter two disasters, where the sex ratio changes appeared after ~320 days, the reduction was seen ~280 days after the earthquake. The reason for this difference is not known. This may have to do with the duration of the catastrophes: the duration of the smog and the flood was relatively long, while that of the earthquake was very short, ~20 s.

What caused such a decline in sex ratio and reduced fertility? It may be speculated that people directly or indirectly affected by the earthquake would have refrained from intercourse, and the resulting lower frequency of sexual intercourse in the population would expectedly lead to reduced fertility and a decline in sex ratio (James, 1976). However, we have previously demonstrated that the acute stress resulting from this earthquake could be a possible cause of reduced sperm motility (Fukuda *et al.*, 1996). The male partners of infertile couples in Hyogo Prefecture showed relatively normal semen quality, with a sperm concentration of $>30\times10^6$/ml and a motility of

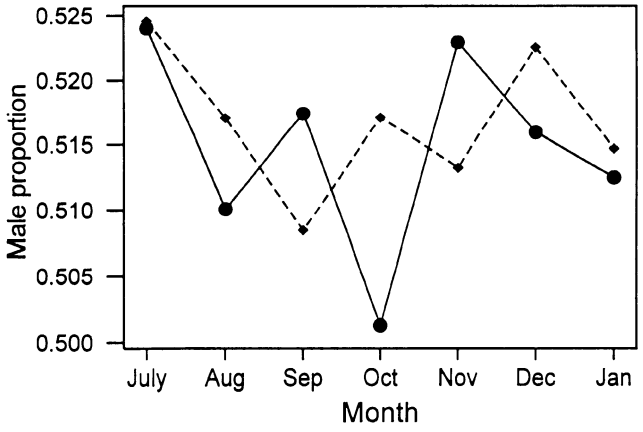

Figure 1. Male proportion among newborn infants in Hyogo Prefecture, Japan in the period from July 1995 to January 1996. For comparison the corresponding values for the preceding 2 years are indicated, combined (dashed line).

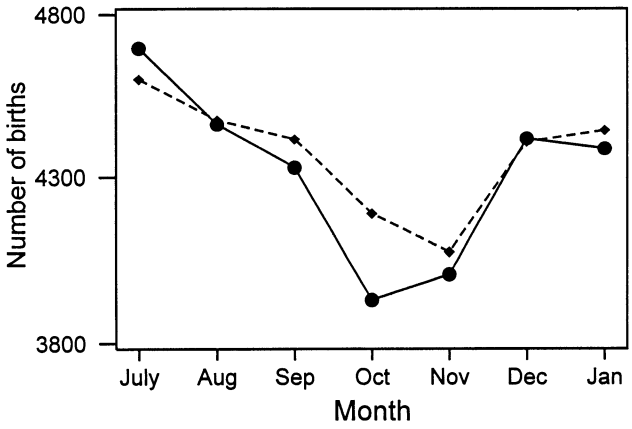

Figure 2. The fertility in the population as described by the total number of births per month in the period 6–12 months after the earthquake (July 1995 to January 1996). For comparison, the corresponding months 2 years previously (dashed line) were used.

>40% before the earthquake. Less than 1 month after the earthquake, the sperm motility was greatly reduced in men who had had their homes destroyed in the earthquake; the sperm motility was restored over a period of 2–9 months (Fukuda *et al.*, 1996). Therefore, our data suggest the possibility that the acute stress resulting from the Kobe earthquake may have affected the male population, leading to rapid decrease in sperm motility and associated responses 9 months later in terms of low fertility and low sex ratio among the newborn infants.

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