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Debate

ADAPTING TO DISASTER? A COMMENTARY ON HAMAMATSU *ET AL.* (2014) – A BRIEF REPLY

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We thank Hamamatsu *et al.* (2014) for their thoughtful and prompt response, as well as the additional analysis that they have provided. We agree that secondary sex ratio (SSR) declines are widely reported following periods of parental stress, with the role of both maternal uterine conditions and paternal sperm motility appearing relevant. For example, Fukuda *et al.* (1996) reported that, following the Kobe earthquake, sperm motility in previously healthy men declined, probably due to stress. Fukuda *et al.* (1998) suggested that this lowered motility might have resulted in the observed declines in both SSR and birth rate. Thus we agree with Hamamatsu *et al.* (2014) that the decline following the 3/11 disaster accords with this trend and, further, with theories of male fragility and the benefits of bearing female offspring in stochastic environments.

However, we suggest that both Fukuda *et al.* (1998) and Hamamatsu *et al.*'s (2014) findings may relate to an underlying trend in the fetal death sex ratio, which indicates that a greater loss of male fetuses, rather than changes to the primary sex ratio, might be the cause of the decline in the SSR. The fetal death sex ratio appears to be experiencing disruption, with the sex ratio of fetal deaths rising substantially in recent decades. This increase accords with growing earthquake frequency. Potentially, the relationship between a rising fetal death sex ratio and a falling SSR suggests that earthquake stress may alter fetal loss, rather than the primary sex ratio. Such an effect would accord with the work of Catalano & Brucker (2006), who suggested that altered SSRs might arise from a 'culled cohort' of male fetuses, rather than changes in conception ratios. We intend to study this possibility further in the future.

Causes of fluctuations in marriage rates are, of course, multifactorial. We agree that social and logistical factors, such as the tempo effect, will probably have influenced marriage rates. We thank Hamamatsu *et al.* (2014) for the additional analysis that they have provided. Understandably, Fukushima prefecture itself remains affected by the lasting impact of the disaster and substantial population displacement, but it is interesting to note that six prefectures, both affected and unaffected, now show evidence of elevated marriage rates.

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Other work has shown that marriage and birth rates durably increase in response to disaster or to the perceived threat of disaster (Cohan & Cole, 2002; Rodgers *et al*., 2005; Raschky & Wang, 2012). However, as Hamamatsu *et al*. (2014) rightly state, it is too soon to determine whether such an effect is occurring in this instance and whether a broader pattern might emerge.

Evolutionary explanations of contemporary behaviour are necessarily complex to determine empirically. Nevertheless, the effect of mortality threats in increasing reproduction (and thus increasing marriage as a social product of increased reproductive intent) is well supported by both empirical observation and evolutionary theory (Chisholm, 1999).

We look forward to future analysis of population trends in the affected regions which will be able to consider changes over the longer term.

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