

Original Article

The male to female ratio at birth following the Scottish Independence Referendum, September 2014

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Abstract

Introduction: Human male live births exceed female live births by approximately 3%. This sex ratio is conventionally expressed as M/F (male divided by total live births). Many factors have been implicated as influencing this ratio, such as stress. This phenomenon occurred following the Quebec sovereignty referendum of 1995. This study was carried out in order to ascertain whether the Scottish referendum of September 2014 had any effect on the M/F ratio in Scotland.

Methods: Monthly live births by gender for Scotland were obtained from Scottish Office of National Records for the period January 2004 to July 2015. They were analysed for any significant period changes as witnessed in Quebec in 1995.

Results: There were 661166 total births (338850 male and 322316 female births), with an overall M/F of 0.5125 (95% CI: 0.5113-0.5137). There were no changes in M/F in the first five months after the referendum. However, there was a non-significant rise in M/F toward the end of 2014 which continued during much of 2015. The rise in M/F reached its peak in May-June 2015, 8-9 months after the referendum (M/F 0.5199 compared to M/F of 0.5124 for aggregated May-June values 2004-14).

Discussion: There was no significant drop in M/F in the Scottish population in relation to the Scottish referendum. This may be due to a type 2 error since this study was less powered (12 times smaller) than the Quebec study. The non-significant rise may have potentially been caused by increased coital rates as observed after the birth of Prince William in 1982 and for Hong Kong in relation to Dragon years. It will be interesting to analyse the rest of the UK data when this becomes officially available.

Key words

Scotland, Sex Ratio, Birth Rate/*trends Infant, Newborn

Introduction

Human male live births exceed female live births by approximately 3%. This sex ratio is conventionally expressed as M/F, signifying male divided by total live births. Many factors have been implicated as influencing this ratio, such as stress from violent events¹ and toxins,² both of which tend to be associated with a reduction in the ratio three to five months after the event, potentially due to excessive male foetal losses in stressed and already pregnant women.³ This is in accordance with the Trivers-Willard hypothesis which theorises that natural selection has favoured females who are likelier to lose male foetuses when stressed.⁴

Even non-violent political events have been shown to be associated with a reduction in the ratio and this includes the Quebec referendum of 1995 proposing sovereignty from Canada.⁵ This study was carried out in order to ascertain whether the Scottish referendum of September 2015 was associated with any effect on the M/F ratio in Scotland.

Methods

Complete monthly live births by gender for England and Wales for 2015 and for the previous 10 years were not published and were not forthcoming from the UK Office for National Statistics. The equivalent data for the Scottish population for January 2004 to July 2015 were made available directly from Customer Services, National Records of Scotland, Ladywell House, Edinburgh (Ms. Rose Almond – personal

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communication) as an Excel spreadsheet, with the proviso that data for 2015 is still preliminary and unpublished.

Linear logistic regression was used in order to assess time trends in the occurrence of boys among live births, and to investigate whether there were changes in the trend functions after distinct events. Segmented regression (so-called “broken stick”) regression analysis was carried out. This involved considering the male proportion among all male (m) and female (f) births: $pm = m/(m+f)$. Important and useful parameters in this context are the sex odds: $SO = pm/(1 - pm) = m/f$, and the sex odds ratio (SOR), which is the ratio of two sex odds of interest, i.e. in exposed versus non-exposed populations. Dummy coding was used for single points in time and for time periods. The simple and parsimonious logistic model for a trend and a jump in 2006 has the following form (LB = live births):

$$\text{Boyst} \sim \text{Binomial}(\text{LB}t, \pi t):$$

$$\log \text{ odds}(\pi_1) = \text{intercept} + \alpha * t + \beta * d_{\text{timeperiod}}(t)$$

Statistical analyses were carried out with R 2.15.1, MATHEMATICA 8.0, and SAS 9.3 (SAS Institute Inc: SAS/STAT User’s Guide, Version 9.3. Cary NC: SAS Institute Inc; 2012). The quadratic equations of Fleiss were used for the calculation of 95% confidence intervals for ratios.⁶ A p value ≤ 0.05 was taken to represent a statistically significant result.

Results

This study analysed 661166 total births (338850 male and 322316 female births), with an overall M/F of 0.5125 (95% CI: 0.5113-0.5137). There were no changes in M/F three to five months after the referendum in September 2014. However, there was a non-significant rise in M/F in the following year with a peak in May-June 2015, i.e. 8-9 months after the referendum (figures 1 to 3). This can be seen when comparing May-June 2015 M/F (0.5199) with the aggregates for the same two months over the period 2004-2014 (0.5124: $p=ns$, figure 4).

Figure 1: Sex odds ratio (SOR) for Scotland January 2004-July 2015. Jump November 2014, $p=0.36$.

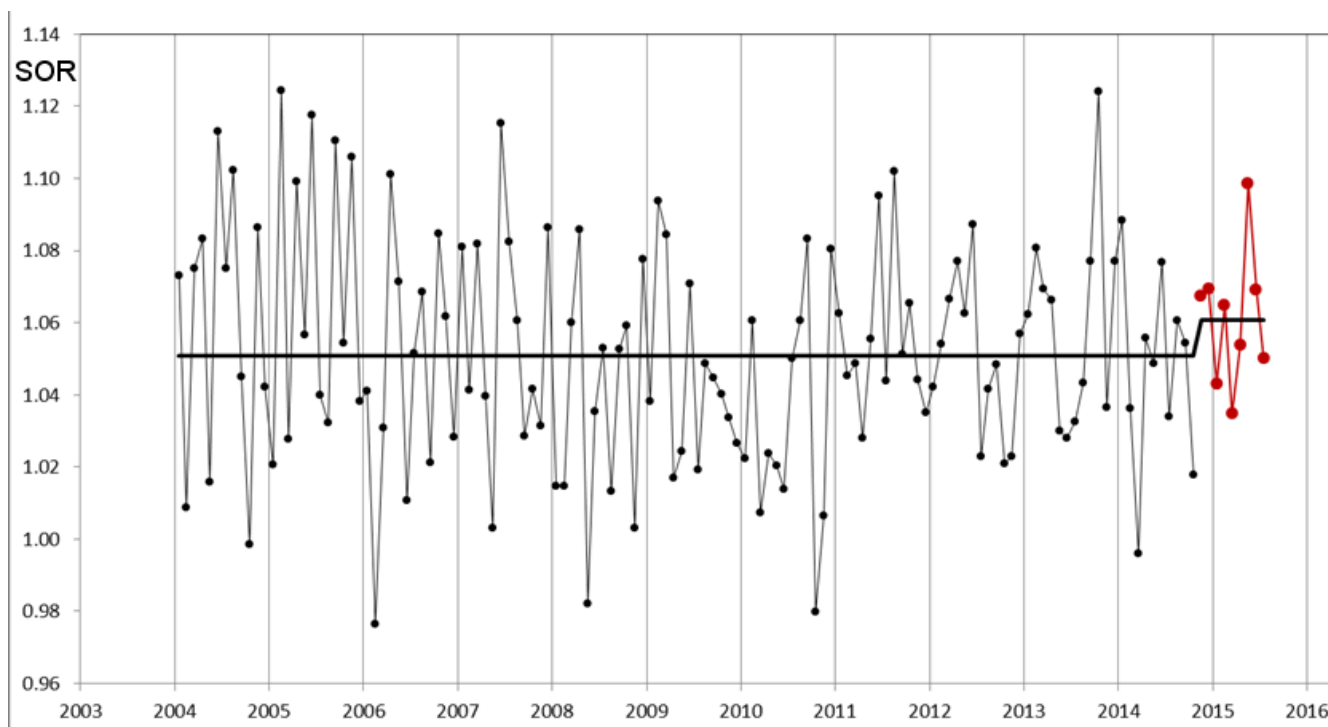


Figure 2: Sex odds ratio (SOR) for Scotland January 2004-July 2015. Jump December 2014, $p=0.43$.

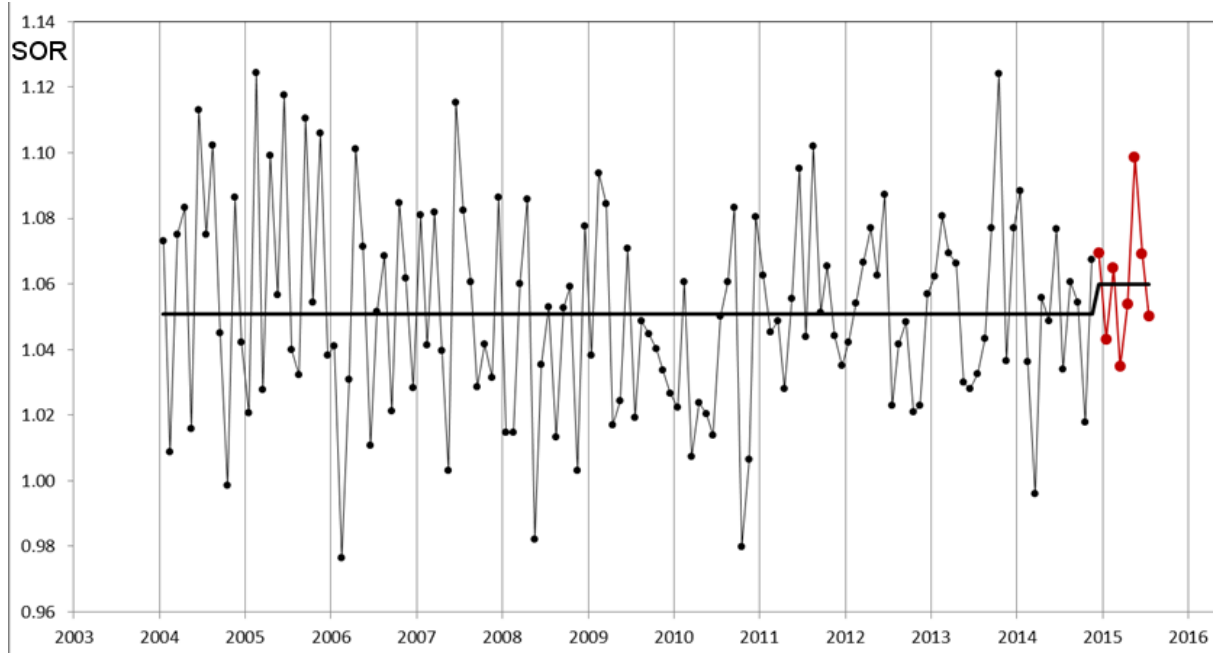


Figure 3: Sex odds ratio (SOR) for Scotland January 2004-July 2015. Jump January 2015, $p=0.53$.

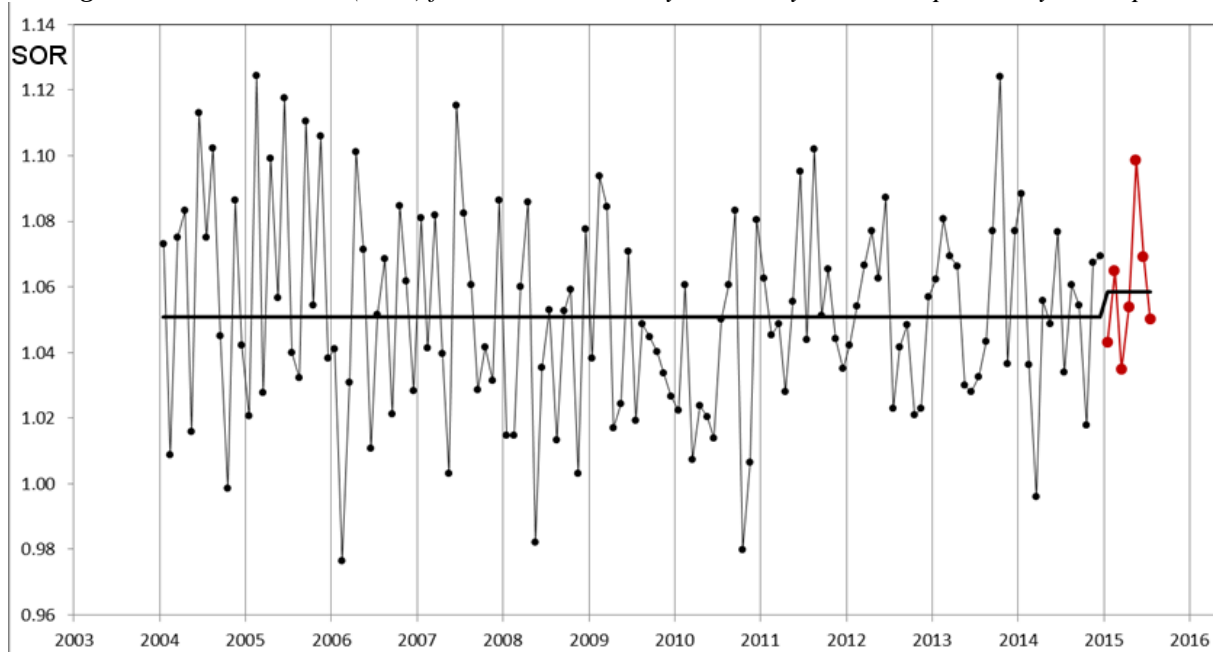
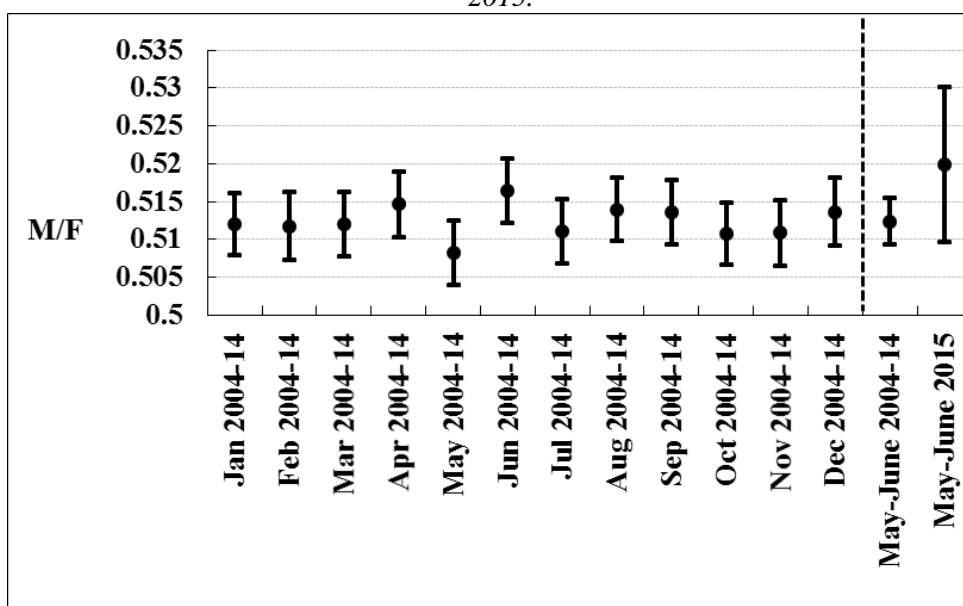


Figure 4: Monthly aggregate M/F for 2004-14, and for May-June aggregate for 2014-14 and May-June totals for 2015.



Discussion

This study failed to find a drop in M/F in relation to the Scottish referendum seeking secession from the Union. This is in contrast with the Quebec sovereignty referendum of 1995 which was associated with a drop in male births three months after referendum, followed by a rapid rise.⁵ This may be due to a type 2 error since this study was less powered, with a sample size 12 times smaller than the Quebec study which analysed 8099600 live births.⁵

The rise (albeit non-significant) may have potentially been caused by increased coital rates. M/F follows a U-shaped regression on cycle day of insemination, suggesting that female conceptions result most often from conceptions around ovulation, with male conceptions occurring more frequently at the beginning and end of the menstrual cycle.^{7,8} These findings have been confirmed by more recent meta-analysis.⁹ The rise in M/F in May-June 2015 may thus have been due to higher coital rates associated with the emotions linked to this particular event, transiently skewing M/F toward more male births.

This is not without precedent. It was recently shown that in the UK, M/F transiently rose in association with a Royal birth, that of Prince William in 1982. This event was associated with a sharp and significant rise in M/F in the following year only.¹⁰

These contentions are further reinforced by a recent study that showed that male births rose in Hong Kong in relation to Dragon years, since such years are considered auspicious for baby's births, in accordance with the Chinese Zodiac. The putative mechanism may be similar, with possible increased coital activity, since parents actively seek to conceive a child in Dragon years.¹¹

It will be interesting to analyse the rest of the UK data when this becomes officially available.

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References

- Catalano R, Bruckner T, Marks AR, Eskenazi B. Exogenous shocks to the human sex ratio: the case of September 11, 2001 in New York City. *Hum Reprod.* 2006;21:3127-31.
- James WH. The human sex ratio. Part 1: A review of the literature. *Hum Biol* 1987;59:721-752 Bruckner TA, Catalano R, Ahern J. Male fetal loss in the U.S. following the terrorist attacks of September 11, 2001. *BMC Public Health.* 2010;10:273.
- Trivers RL, Willard DE. Natural selection of parental ability to vary the sex ratio of offspring. *Science.* 1973;179:90-2.
- Grech V. The male:female ratio at birth was depressed in Québec by the sovereignty referendums. *Obstet Gynaecol Can* 2015;37:405-411.
- Fleiss JL. *Statistical methods for rates and proportions.* New York: John Wiley and Sons; 1981:14-15 (2nd edition).
- Guerrero R. Association of the type and time of insemination within the menstrual cycle with the human sex ratio at birth. *N Engl J Med.* 1974;291:1056-9.
- Harlap S. Gender of infants conceived on different days of the menstrual cycle. *N Engl J Med.* 1979;300:1445-8.
- Gray RH. Natural family planning and sex selection: fact or fiction? *Am J Obstet Gynecol.* 1991;165:1982-4.
- Grech V. Historic Royal events and the male to female ratio at birth in the United Kingdom. *Eur J Obstet Gynecol Reprod Biol.* 2015 May 30;191:57-61.
- Grech V. The influence of the Chinese zodiac on the male to female ratio at birth in Hong Kong. *J Chin Med Assoc.* 2015;78:287-91.