



Original Article

The influence of the Chinese zodiac on the male-to-female ratio at birth in Hong Kong

Victor Grech*

Academic Department of Pediatrics, Mater Dei Hospital, Msida, Malta

Received July 17, 2014; accepted November 10, 2014

Abstract

Background: Secular trends have been found in the male–female ratio at birth (M/F: male births divided by total births) in various countries, and this ratio is anticipated to approximate 0.515. Births in Dragon years are considered auspicious. Fertility is known to have increased in Dragon years in Hong Kong. This study analyzed M/F with reference to Dragon years.

Methods: Annual national data for male and female live births in Hong Kong were obtained from the World Health Organization and analyzed with contingency Tables.

Results: There were 3,827,347 live births (1960–2009). Births declined steadily, then increased from 2004 in association with M/F. M/F was stable prior to this time, with spikes in 1975–1976, 1988, and 2000, associated with increases in births for these same years.

Conclusion: M/F follows a U-shaped regression on cycle day of insemination. Families attempting to conceive children during Dragon years may have increased coital rates, inadvertently skewing M/F in favor of a male excess.

Copyright © 2015 Elsevier Taiwan LLC and the Chinese Medical Association. All rights reserved.

Keywords: birth rate/trends; Hong Kong; infant; newborn; sex ratio

1. Introduction

In humans, sex is determined at conception. Males occur slightly in excess in a ratio that approximates 515 males to 485 females.^{1,2} This ratio is conventionally expressed as the ratio of male live births divided by total live births (M/F).

The reason for this discrepancy is uncertain but a large number of factors have been proposed.³ These include stress, which decreases M/F,⁴ and long-duration warfare (e.g., the World Wars), which increases M/F.⁵ The ratio may also exhibit slow secular changes.⁶

The Chinese zodiac (Shēngxiào, Chinese: 生肖) is annually related to different animals on the basis of a 12-year

cycle. These animals are the Dog, Dragon, Goat, Horse, Monkey, Ox, Pig, Rabbit, Rat, Rooster, Snake, and Tiger. Each animal has specific attributes, some of which may be desirable while some are not. The Chinese zodiac retains its popularity in various East Asian countries, including not only China and the Hong Kong Special Administrative Region of the People's Republic of China (henceforth referred to as Hong Kong) but also Vietnam, Korea, Taiwan, and Japan.⁷

This study identified secular trends in M/F in Hong Kong from a World Health Organization dataset that includes the past 50 years, with particular attention to the effect of the Chinese Zodiac on M/F in Hong Kong.

2. Methods

Annual male and female live births were obtained directly from the World Health Organization.

Conflicts of interest: The author declares that there are no conflicts of interest related to the subject matter or materials discussed in this article.

* Corresponding author. Dr. Victor Grech, Academic Department of Pediatrics, Medical School, Mater Dei Hospital, Msida, Malta.

E-mail address: victor.e.grech@gov.mt.

Excel was used for data entry, overall analysis, and charting. The quadratic equations of Fleiss were used for exact calculation of 95% confidence intervals for ratios.⁸ Chi tests as contingency tables and Chi tests for trend were used for annual male and female births. These were performed using the Bio-Med-Stat Excel add-in for contingency tables.⁹ This add-in is based on the original work by Cochran and Armitage (Dr. Peter Slezák, Institute of Normal and Pathological Physiology, Slovak Academy of Sciences, personal communication).^{10,11}

Years of interest were compared with years in close proximity in order to avoid the confounding effects of secular shifts in M/F that are known to occur over long time periods.⁶

SPSS version 22 (SPSS Inc., Chicago, IL, USA) was used to calculate Pearson correlations. A p value ≤ 0.05 was taken to represent a statistically significant result.

3. Results

There were 3,827,347 live births available for analysis over the period 1960–2009 (1,982,156 boys and 1,845,191 girls), with an overall M/F of 0.5184 [95% confidence limits (CL) 0.5179–0.5174].

Five-year live births and corresponding M/F are summarized in Table 1. M/F remained overall stable within a relatively narrow range except for a rise commencing in 2004. Similarly, there was a slow decline in the total number of births, which was reversed in 2004.

Inspection of annual data shows peaks in M/F in the years 1975–76, 1988, and 2000 (Fig. 1). These years exhibit the highest M/F in their respective preceding and following 5-year periods. M/F for the sum of 1975–76 was significantly higher than that for 1973–4 (Table 2). For 1988 and 2000, these M/F peaks were smaller, and when compared to adjacent years, were not higher at statistically significant levels. However, when the sum of these years was compared to the sums of their preceding and following years, a significantly higher M/F was found (Table 2). The peak M/F was associated with a rise in total births (Table 3).

The rise in M/F from 2003 to 2009 was statistically significant (x trend 57.0, $p < 0.001$). M/F prior to this period (1960–2003) was 0.5167 (95% CL 0.5172–0.5161).

For the period 1960–2009, there was a significant negative correlation between M/F and total births ($r = -0.31$, $p = 0.02$). When the period after the sharp rise in 2003 was eliminated, the correlation was even more significant

(excluding 2004–2009, $r = -0.51$, $p < 0.0001$; Fig. 1). For the period 2004–2009, M/F and total births paralleled each other.

4. Discussion

The Hong Kong dataset may be divided into two eras, with a watershed occurring around the year 2003. This is because after this period, M/F is skewed due an influx of mainland Chinese mothers and provides a clear example of how sex preference and national legislation may impact not only on countries in which such preferences exist and such legislation is enacted, but also on neighboring countries.

The increase in M/F in Hong Kong since 2003 has been linked to an increase in births due to mothers moving to Hong Kong from Mainland China in order to give birth, since this confers a variety of advantages.¹² This trend was encouraged by the *Right to Abode* legislation enacted that same year in Hong Kong, giving children born in Hong Kong an automatic right to live in Hong Kong.^{13,14}

The phenomenon is nontrivial and is so overwhelming that it almost precludes additional analyses. Indeed, the increase in Mainland Chinese mothers climbed from 16.2% in 2000 to 45.4 in 2009.¹³ This influx was of sufficient magnitude to reverse a previously declining trend in total births in Hong Kong, which had declined from 68,615 to 46,962 between 1995 and 2003, steeply climbing thereafter and exceeding 82,095 in 2009 (Fig. 1).¹² Mainland Chinese mothers delivering in Hong Kong were noted to have increased in all categories, including mothers residing legally in Hong Kong and those recorded as transient or illegal immigrants.¹² Interestingly, all the while, total births to Hong Kong mothers continued to decline.¹² It is for this reason that, for the period 2004–2009, M/F and total births paralleled each other.

Sex analysis of these births reinforces the contention that these trends are driven by extant family planning restrictions in Mainland China. For the period 2003–2007, M/F was significantly higher at all parities for Mainland Chinese mothers than for Hong Kong resident mothers.¹²

For the period 1960–2009, there was a significant negative correlation between M/F and total births, and this correlation was even stronger when the analysis was restricted to the era prior to 2003. This is an unexplained finding as extant studies have failed to reveal such a correlation.^{1,2}

Table 1
Five-year total live births and M/F for Hong Kong, 1960–2009.

	1960–1964	1965–1969	1970–1974	1975–1979	1980–1984	1985–1989	1990–1994	1995–1999	2000–2001	2005–2009
M	286,425	229,641	203,664	204,279	215,423	187,811	184,183	154,251	100,603	187,690
F	268,655	215,521	191,698	190,400	202,847	176,171	171,453	142,971	93,261	166,680
Total	555,080	445,162	395,362	394,679	418,270	363,982	355,636	297,222	193,864	354,370
UCI	0.51732	0.51733	0.51669	0.51914	0.51655	0.51761	0.51954	0.52077	0.52116	0.53129
M/F	0.51601	0.51586	0.51513	0.51758	0.51503	0.51599	0.51790	0.51898	0.51894	0.52964
LCI	0.51469	0.51439	0.51357	0.51602	0.51352	0.51436	0.51625	0.51718	0.51671	0.52800

F = female; LCI = lower confidence interval; M = male; UCI = upper confidence interval.

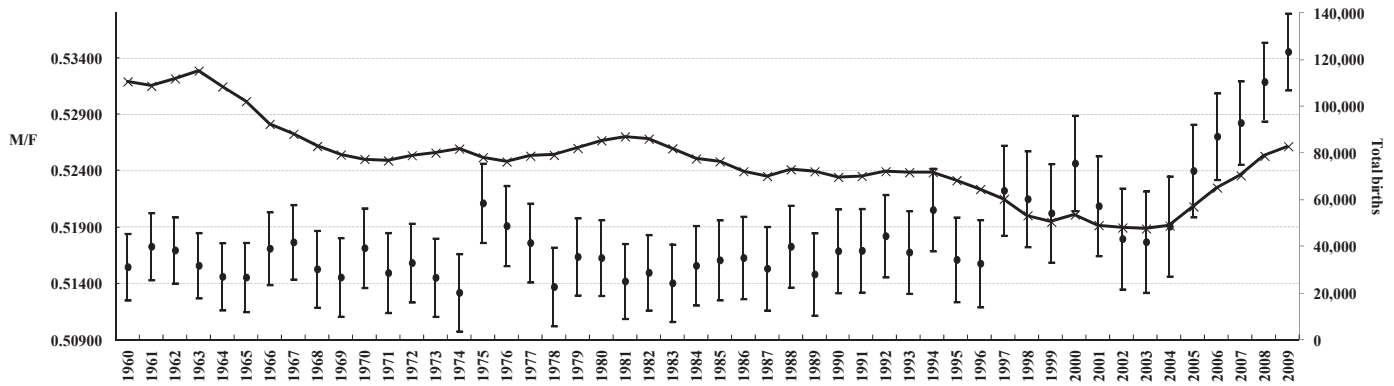


Fig. 1. Annual male/total births ratio (M/F) for Hong Kong, 1960–2009 (with 95% upper and lower confidence intervals) and total live births.

Religious beliefs have also been shown to exert their own specific influences. In Japan, for example, birth registration was introduced in 1872, becoming complete by 1948.^{15,16} Traditional belief in this country maintains that the birth year influences the individual's character and life, and that these influences are sex-specific.

The Japanese calendar comprises five cycles, each of 12 years, and each of these years is associated with a different symbolic animal. Any influences derived from these cycles will therefore repeat every 12 years. Indeed, M/F in Japan displays peaks in 1906 and 1966, followed by troughs. These 2 years are associated with the *Fire Horse*, and girls born in these years are said to be more likely to murder their husbands. This probably motivated parents who had girls in these years to misreport their dates of birth. Moreover, girls born in Tiger years (1914, 1926, 1938, 1950, 1962, and 1974) are said to be aggressive, and M/F was similarly distorted as a result, albeit at ever decreasing rates, probably as a result of fading superstition.^{15,16}

Chinese astrology dates back over 4000 years in China. The belief is that each person is a combination of three animals: the animal of one's birth year, the animal of one's birth month, and the animal of the time of the day one's birth. The Chinese zodiac has been shown to have had a significant influence in South Korea, where there is a belief that the year of the Horse is unfavorable for daughters, and hence, in these years, M/F increased significantly in association with decreased fertility.¹⁷

Table 2
Comparison of male-to female ratio in different cohorts.

	1973–1974	1975–1976	1988, 2000	1983–1987, 1989–1993, 1995–1999, 2001–2005
M	83,262	80,386	65,965	663,845
F	78,764	74,156	60,785	618,855
Total	162,026	154,542	126,750	1,282,700
UCI	0.5163	0.5226	0.5232	0.5184
M/F	0.5139	0.5202	0.5204	0.5175
LCI	0.5114	0.5177	0.5177	0.5167
x	12.5		3.9	
p	0.0004		0.049	

x tests for 1973–1974 versus 1975–1976, and for 1988 and 2000 versus 1983–1987, 1989–1993, 1995–1999, and 2001–2005.

F = female; LCI = lower confidence interval; M = male; UCI = upper confidence interval.

As has been mentioned, declining fertility has been noted in Hong Kong nationals, with a total fertility rate below the replacement level in 2000. However, short-run increases in fertility during Dragon years have been observed since the year of the Dragon is considered an auspicious time for births and marriages. This is not unexpected because, in Hong Kong, over 95% of the population are ethnic Chinese.⁷

This paper has shown that for Dragon years 1976, 1988, and 2000, there were increased births in association with a rise in M/F. This is consistent with known observations derived from the study of M/F. It has been shown that 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.^{18,19} These findings have been confirmed by recent meta-analyses.^{20,21}

This U-shaped regression is confirmed by the higher M/F that is found after the failure of rhythm methods of birth control since such failures would theoretically, on average, occur earlier or later in the menstrual cycle.¹

Thus, families attempting to conceive children during Dragon years may have increased coital rates, inadvertently skewing M/F in favor of a male excess. It is likely that no such spikes are visible prior to the 1970s due the unavailability of reliable contraception, making planning births in specific years difficult.⁷ This hypothesis is reinforced by the present study's analysis, in that increased coital rates should not only increase M/F but also birth numbers, as attested in Table 3, with normalization of M/F in non-Dragon years when birth

Table 3
Annual percentage change in live births in years of interest.

Year	1974	1975	1976	1977
Total births	80,147	81,879	78,200	76,342
Annual% change		2.2	-4.5	-2.4
Year	1987	1988	1989	
Total births	70,152	73,030	72,156	
Annual% change	—	4.1	-1.2	
Year	1999	2000	2001	
Total births	50,513	53,720	49,144	
Annual% change	—	6.3	-8.5	

numbers are lower. Further reinforcement is given by the finding that outside Dragon years, M/F was negatively associated with total births.

The factors that influence M/F are legion. Most factors reduce M/F, including: toxins, as was shown after the methyl mercury contamination of Minamata Bay in Japan in 1955–1959²² and the dioxin (2,3,7,8-tetrachlorodibenzo-p-dioxin) contamination of Seveso in Italy in 1976²³; stress due to various reasons such as contracting economies⁴; natural phenomena including earthquakes (for example after the Kobe event of 1995)²⁴; the London smog of 1952; and flooding in Australia.²⁵ Short-duration warfare also engenders sufficient stress to decrease M/F, as was shown during the Ten-Day war in Slovenia.²⁶ Terrorist attacks have also been shown to reduce M/F, as was demonstrated in New York after the September 11 attacks.²⁷

It has been speculated that all of these factors are in accordance with the Trivers–Willard hypothesis, which proposes that a man who reaches reproductive age in good condition is expected to out-reproduce a sister in similar condition. Conversely, if both are in poor condition, a woman is expected to out-reproduce a brother. This is because a weak son would compete poorly with stronger men for the same cohort of females, thus producing fewer offspring than a weak daughter would.²⁸ Natural selection has thus afforded women the option to influence M/F, in that pregnant women who are stressed and/or in poor condition spontaneously abort, providing an opportunity to become pregnant with a stronger male offspring or with a female offspring that is more likely to survive.²⁸

However, radiation²⁹ and long-duration warfare⁵ have been shown to increase M/F. The latter has been attributed to coital frequency. In times of war, an adult sex ratio imbalance prevails, with more males being away from their homes. This results in sexual excesses, “actions [that] were viewed as understandable responses to the *Frauenuberschuss*”, the excess supply of women.³⁰ It has been noted that in wartime, non-programmed copulation and high coital rates coexist, with more conceptions occurring early or late in the menstrual cycle, increasing M/F.³¹

Iatrogenic intervention may also interfere with M/F. Assisted reproductive technology permits the deliberate selection of sex by couples, as does the postconception sexing of fetuses. Due to the patriarchal nature of most human societies, the extermination of females is a far more common occurrence than the extermination of males. Male preference resulting in a higher proportion of males at all ages, particularly in Asia, has been attributed to the Confucian patriarchal tradition that is characterized by a strong son preference and female subordination.³²

This has led to the phenomenon of *rampant demographic masculinization*,³³ as evidenced by the dataset in the current study for the period after 2003. This phenomenon commenced as early as 1975 in China with the use of chorionic villous sampling,³⁴ and was facilitated, worldwide, by ultrasound technology.³⁵ This predominantly Asian phenomenon has led to claims that over a hundred million women are missing.³⁶

Although the study of M/F has resulted in the production of a large corpus of literature, new and unexpected findings continue to emerge, even from decades old datasets. These include, for example, the influence of USA-enacted legislation that facilitated the transfer of individuals from Cuba to the USA³⁷ and varying latitude gradients in M/F worldwide.³⁸

To the author's knowledge, this is the first time that changes in M/F have been linked with increased births (and probably increased coital rates) in Hong Kong due to the influence of traditional beliefs.

Acknowledgments

I wish to thank Mie Inoue and Gauden Galea from the World Health Organization for help in accessing the original datasets.

References

1. James WH. The human sex ratio. Part 1: A review of the literature. *Hum Biol* 1987;**59**:721–52.
2. James WH. The human sex ratio. Part 2: A hypothesis and a program of research. *Hum Biol* 1987;**59**:873–900.
3. James WH. Evidence that mammalian sex ratios at birth are partially controlled by parental hormone levels around the time of conception. *J Endocrinol* 2008;**198**:3–15.
4. Catalano RA. Sex ratios in the two Germanies: a test of the economic stress hypothesis. *Hum Reprod* 2003;**18**:1972–5.
5. Houdaille J. Le rapport de masculinité. *Pop Soc* 1973;**61**:1–3.
6. Gini C. The probability that the terms of a series increase (or do not decrease) or all decrease (or do not increase) with application to gender at birth in humans in successive time periods and on the gender likelihood in siblings. *Metron* 1955;**17**:1–41 [Article in Italian].
7. Yip PS, Lee J, Cheung YB. The influence of the Chinese zodiac on fertility in Hong Kong SAR. *Soc Sci Med* 2002;**55**:1803–12.
8. Fleiss JL. *Statistical methods for rates and proportions*. 2nd ed. New York: John Wiley and Sons; 1981. p. 14–5.
9. Slezák P, Bokes P, Námer P, Waczulíková I. Microsoft Excel add-in for the statistical analysis of contingency tables. *Int J Innovation Educ Res* 2014;**2**:90–100.
10. Cochran WG. Some methods for strengthening the common Chi-squared tests. *Biometrics* 1954;**10**:417–51.
11. Armitage P. Tests for linear trends in proportions and frequencies. *Biometrics* 1955;**11**:375–86.
12. Basten S, Verropoulou G. 45.4 SAR. Oxford Centre for Population Research Working Paper 2012;58:1–16.
13. Leung LS. The low-fertility problem in Hong Kong: do Mainlanders' births help to rejuvenate the low-fertility problem? *World Acad Science Engineer Tech* 2011;**7**:891–7.
14. Wong GY, Leung WC, Chin RK. Recent dramatic increase in the male-to-female sex ratio of babies born in Hong Kong. *J Perinat Med* 2010;**38**:209–13.
15. International Institute for Vital Registration and Statistics. *Vital statistics system in Japan*. Technical Report No. 2. Brussels: International Institute for Vital Registration and Statistics; 1979. 1982.
16. Ministry of Health and Welfare, Japan. *Vital statistics*, vol. 1; 1982.
17. Lee J, Paik M. Sex preferences and fertility in South Korea during the year of the Horse. *Demography* 2006;**43**:269–92.
18. 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.
19. Harlap S. Gender of infants conceived on different days of the menstrual cycle. *N Engl J Med* 1979;**300**:1445–8.

20. Gray RH. Natural family planning and sex selection: fact or fiction? *Am J Obstet Gynecol* 1991;**165**:1982–4.
21. James WH. Analysing data on the sex ratio of human births by cycle day of conception. *Hum Reprod* 2000;**15**:1206–8.
22. Sakamoto M, Nakano A, Akagi H. Declining Minamata male birth ratio associated with increased male fetal death due to heavy methylmercury pollution. *Environ Res* 2001;**87**:92–8.
23. Bertazzi PA, Bernucci I, Brambilla G, Consonni D, Pesatori AC. The Seveso studies on early and long-term effects of dioxin exposure: a review. *Environ Health Perspect* 1998;**106**(Suppl 2):625–33.
24. Fukuda M, Fukuda K, Shimizu T, Møller H. Decline in sex ratio at birth after Kobe earthquake. *Hum Reprod* 1998;**13**:2321–2.
25. Lyster WR. Altered sex ratio after the London smog of 1952 and the Brisbane flood of 1965. *J Obstet Gynaecol Br Commonw* 1974;**81**:626–31.
26. Zorn B, Sucer V, Stare J, Meden-Vrtovec H. Decline in sex ratio at birth after 10-day war in Slovenia: brief communication. *Hum Reprod* 2002;**17**:3173–7.
27. 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.
28. Trivers RL, Willard DE. Natural selection of parental ability to vary the sex ratio of offspring. *Science* 1973;**179**:90–2.
29. Scherb H, Voigt K. The human sex odds at birth after the atmospheric atomic bomb tests, after Chernobyl, and in the vicinity of nuclear facilities. *Environ Sci Pollut Res Int* 2011;**18**:697–707.
30. Moeller RG. *Protecting motherhood: women and the family in the politics of postwar West Germany*. Berkeley: University of California Press; 1993.
31. James WH. Time of fertilisation and sex of infants. *Lancet* 1980;**1**:1124–6.
32. Poston D, Zhang I. China's unbalanced sex ratio at birth: how many surplus boys have been born in China since the 1980s? In: Tucker J, Poston D, editors. *Gender policy and HIV in China: catalyzing policy change*. New York: Springer; 2009.
33. Attané I, Guilmoto C. *Watering the neighbour's garden: the growing demographic female deficit in Asia*. Paris: Committee for International Cooperation in National Research in Demography; 2007.
34. Warren MA. *Gendercide: The implications of sex selection*. New Jersey: Rowman & Allanheld; 1985.
35. Hull TH. Recent trends in sex ratios at birth in China. *Pop Dev Rev* 1990;**16**:63–83.
36. Sen A. Missing women. *BMJ* 1992;**304**:587–8.
37. Grech V. The influence of migration on secular trends in sex ratios at birth in Cuba in the past fifty years. *West Indian Med J* 2014;**63**:372–6.
38. Grech V, Savona-Ventura C, Vassallo-Agius P. Research pointers: unexplained differences in sex ratios at birth in Europe and North America. *BMJ* 2002;**324**:1010–1.