

Population stress, civil unrest and the male to female ratio at birth in Chile, Argentina, Brazil, Australia and Finland

Abstract

Introduction

Male live births occur slightly in excess of female births but is influenced by a very large variety of factors. The ratio is remarkably stable but may exhibit sudden shifts in response to influences such as population stress. A World Health Organisation dataset comprising annual live births by year and country was analysed not only to pinpoint outlier values but also to attempt to identify historical causes for such outliers.

Methods

The WHO HFA (Health for All) mortality database was used to identify outlier M/F values. Data was analysed using chi tests and chi tests for trend. Comparison for years of interest were made against baselines of only up to five years before and after such years since M/F exhibits potentially confounding long-term secular variations.

Results

Chile

There was a significant difference in M/F between the period 1967-1971 and 1972 ($p < 0.0001$). There was a decline over 1972-1976 ($p < 0.0001$).

Argentina

Increases were noted in 1978, 1988 and 1994 ($p < 0.0001$).

Brazil

There was a sustained rise in M/F over the period 1990-1995 ($p < 0.0001$).

Australia

M/F rose sharply in 1956 ($p = 0.0008$).

Finland

There were increases in 1962 and 1971 ($p < 0.0001$).

Discussion

Stress has been shown to affect M/F. Almost all of the observed outliers were temporally associated with political events or political decisions that influenced the respective countries' economies. M/F ratios worldwide provide tantalising hints that even transient stress may influence this ratio, making it a sensitive indicator of overall population stress.

35 Key words

Civil Disorders

Sex Ratio

Dissent and Disputes

Birth Rate/*trends

Infant, Newborn

36

37 Introduction

38 Male live births occur slightly in excess of female births.(1) The ratio of male to female live
39 births (the secondary sex ratio) is generally expressed as the ratio of male live births divided
40 by total live births, and is usually (albeit technically incorrectly) abbreviated as M/F. This
41 abbreviation will be used. For humans, M/F is anticipated to approximate 0.515 but is
42 influenced by a very large variety of factors.(1,2)

43

44 It is believed that natural selection may have influenced the species such that pregnant
45 females who are stressed or are exposed to toxins are likelier to abort spontaneously if
46 gestating a male than if gestating a female foetus. This is in accordance with the Trivers-
47 Willard hypothesis and is based on the assumption that a male who reaches reproductive age
48 in good condition is expected to outreproduce a female in similar condition. Conversely, if
49 both are in poor condition, a female is expected to out-reproduce a male. This is because a
50 weak son would compete poorly with stronger males for the same cohort of females, thus
51 producing fewer offspring than a weak female daughter would.(3)

52

53 Pregnant women who are stressed or who are exposed to toxins have therefore developed
54 mechanisms that allow them to cull male fetuses that are least likely to eventually sire
55 grandchildren and thereby fail to propagate their genes. A population's M/F therefore falls
56 under such circumstances.

57

58 It has been demonstrated that certain political events reduce M/F, presumably due to
59 engendered within populations. This was clearly shown in the East part of Germany during a
60 severe recession shortly after the reunification of this country in 1990. The recession in this
61 part of the country was associated with a transient and significant drop in M/F.(4) Similarly,
62 it has been shown that M/F dropped sharply in Ireland in the last quarter of 2007 in relation to
63 the onset of the economic recession.(5)

64

65 Thus, political and economic turmoil within a country may also lead to population stress and
66 both may lower M/F. The analysis of a World Health Organisation (WHO) dataset
67 comprising annual live births by year and country has yielded several instances whereby M/F
68 dropped in temporal relation to political events, and some examples will be given. In Israel,
69 Egypt and Kuwait, significant M/F dips were shown to occur in relation to escalations of
70 conflicts and other political events in this region.(6)

71

72 In Cuba, significant short dips in M/F were found in association with American legislation
73 that facilitated mass Cuban emigration from repressive communist rule to the United
74 States.(7) In Malta, democratic elections were shown to reduce M/F but other political
75 nonelectoral events raised M/F.(8) And this same WHO database has also been used to
76 identify conflicts in the last 50 years and to show that many of these influenced M/F.(9)

77

78 This study analysed the same WHO dataset, pinpointed outlier values and also attempted to
79 identify historical causes for such outliers.

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82 **Methods**

83 ***Data sources***

84 The WHO HFA (Health for All) mortality database was used to identify outlier M/F values.

85 Outliers were arbitrarily defined as data points whose statistical significance (alpha) exceeded

86 0.001 (0.1%), a more rigorous value than the conventional value of 0.05 (5%). This was

87 deemed appropriate due to the large number of datapoints reviewed, in order to minimise the

88 risk of a type 1 error (error of the first kind) with the incorrect rejection of a true null

89 hypothesis, which in this case, was the assumption that there were no true outlier values.

90

91 ***Statistics***

92 Excel was used for data entry and analysis. The quadratic equations of Fleiss were used for

93 exact calculation of 95% confidence intervals for M/F ratios.(10) Chi tests were applied using

94 the Bio-Med-Stat Excel add-in for contingency tables. A simple chi test with Yates correction

95 was carried out on 2x2 tests. Chi test for trend (Cochran-Armitage test) was carried to test for

96 departure/s from linear trend (with one degree of freedom). (11)

97

98 Comparison for years of interest were made against baselines of only up to five years before

99 and after such years since M/F exhibits long-term secular variations,(12) the effects of which

100 this study strove to avoid.

101

102 A p value of ≤ 0.001 was taken to represent a statistically significant result.

103

Results

Chile

There was a significant difference in M/F between the period 1967-1971 (fig. 1) and the year 1972 ($p<0.0001$). The decline in M/F for the period 1972-1976 was also significant ($p<0.0001$).

Argentina

Outliers were noted in 1978, 1988 and 1994 (fig. 2). When compared to the previous and following two years for each instance, all three outliers were highly statistically significant ($p<0.0001$).

Brazil

This country showed a sustained rise in M/F over the period 1990-1995 (fig. 3 - $p<0.0001$).

Australia

There was a sharp rise in the Australian M/F in 1956 (fig. 4) and this was significantly higher than the previous and following 5 year periods ($p=0.0008$).

Finland

Annual M/F for Finland is shown in fig. 5. The increases in 1962 and 1971 were highly significant when compared to the aggregate of the previous and following two years for each event ($p<0.0001$).

Discussion

Stress has been shown to affect M/F, and even relatively mundane events may have significant effects. For example, it has recently been shown that the World Cup influences M/F in selected countries.(13)

Directly witnessing violent events such as involvement in short duration wars has been shown to depress M/F. For example, the very short war in Slovenia (26 June–7 July, 1991) reduced M/F to 0.504 in Slovenia and to 0.483 in Ljubljana, 6 to 9 months later.(14) Even terrorist events have been shown to exert an influence on M/F. The September 11 attacks on the United States depressed M/F not only in New York,(15) but also in California where the events were witnessed over the media.(16)

It has also been shown that such M/F dips may be quite sudden, occurring less than nine months after the event, and may last just a few months.(4,5,15)

Chile

In Chile, under President Allende, inflation had peaked at 463% in 1973, exacerbated by civil strife that included strikes (sometimes simultaneous) by the medical and teaching professions, students, truck owners and copper workers. The regime was overthrown in September 1973 by General Augusto Pinochet. While harshly repressive, the Junta's new economic policies rapidly resulted in the drop of inflation rates to double and single digits.(17)

Economic stress may be hypothesised as an explanation for the low M/F (circa 0.509) evidenced in 1970-1, and the improved economic situation after the coup may also have resulted in the higher M/F after 1972. This theory however does not explain the M/F rise to 0.518 in 1972, just before the coup, and the decline thereafter.

Argentina

In 1978, the 11th soccer World Cup was held in Argentina, and the country actually won. It is known that when coitus occurs at the beginning and end of the menstrual cycle, M/F is increased.(18) It is possible that exuberance leading to increased sexual activity toward the beginning and end of menstrual cycles may have resulted in the observed excess of male conceptions.(13)

However, the rise in 1978 also occurred during a time of turmoil, which included the so-called "Dirty War" waged by the military regime, an ideological program that attempted to eliminate the perceived social base for anti-government insurgency. This included the assassination of middle class students, intellectuals and labour organisers.(19) Theoretically, these events should have decreased M/F. It is possible that the positive effects on M/F by football outweighed the negative effects on M/F by violence.

The M/F rise in 1994 may have been caused by the governments change in policy to an embracement of neoliberalism, with the enactment of a fixed exchange rate 1991, the removal of protectionist barriers, the establishment of business regulations and privatisations. These measures stabilised the economy up to 1996, which went into decline thereafter.(19)

Brazil

An elected president took power in 1989 after years of military rule. This new administration actively battled hyperinflation which had peaked at 25% per month, and promoted free trade and programs of privatisation.(20) This may explain the rise in M/F in the 1990s.

Australia

In Australia, the 1950s were characterised by four elections, in 1951, 1954, 1955 and 1958. These were close run events, with $\leq 4\%$ points differences between elected and runner-up parties and $> 95\%$ turnout for elections. Moreover, the 1954 election was tainted by conspiracy theories of communist spy rings in Australia, fuelled by the Petrov Affair, wherein Vladimir Petrov, an attaché to the Soviet embassy in Canberra, defected to the West. He too claimed these spy rings existed. Since the 1951 Australian election had been contested over the issue of whether to make the Communist Party of Australia illegal, this claim appeared *prima facie* legitimate. This led to the incumbent government (the Liberal Party in coalition with the Country Party) writing to Vyacheslav Molotov, the Soviet Foreign Affairs Commissar, who assured him that no such rings existed, a declaration that was made public and helped win the election with the administration remaining in power, defeating the Labour Party. This defeat led to the “great split” of the Labour Party in 1955, with the Liberal/Country coalition remaining in power for the next seventeen years.(21) One wonders whether this turmoil may have influenced M/F, which spiked significantly in 1956.

Finland

During the Cold War, while officially claiming neutrality, Finland entered into the Finno-Soviet Pact of Friendship, Cooperation and Mutual Assistance (YYA Treaty). The Finnish leadership of the time leaned toward the Soviet Union but the country retained a Western European market economy.

At the end of October 1961, the Soviet Union sent a diplomatic note to the Finnish authorities, claiming that neo-Nazism and militarism in West Germany were a threat to both the USSR and Finland.(22) Two-stage presidential elections were held in this country in 1962 with an 81.5% turnout and these were deemed important by the populace for the future neutrality of Finland.(23) It is possible that the election result and the events leading up to it may have somehow increased M/F that year.

A demographic shift may have been responsible for the 1971 spike in M/F. When the so-called “baby boomers” entered the workforce in the late 1960s and early 1970s, the economy failed to generate jobs at a sufficiently high rate and hundreds of thousands of Finns emigrated to the more industrialized Sweden, with emigration peaking in 1969 and 1970, to the extent that the country’s population contracted.(24) It is likely that emigration from Finland was predominantly male, potentially producing a “marriage squeeze” for the remaining females. This may have, in some way, influenced M/F. However, it is not possible to test this hypothesis as the Population Statistics Department of Statistics Finland does not have emigration data divided by gender for this time period (Ms. Irma Pitkanen, Personal Communication).

In conclusion, M/F ratios worldwide provide tantalising hints that even transient stress may impinge on M/F, making this a sensitive indicator of overall population stress.(25)

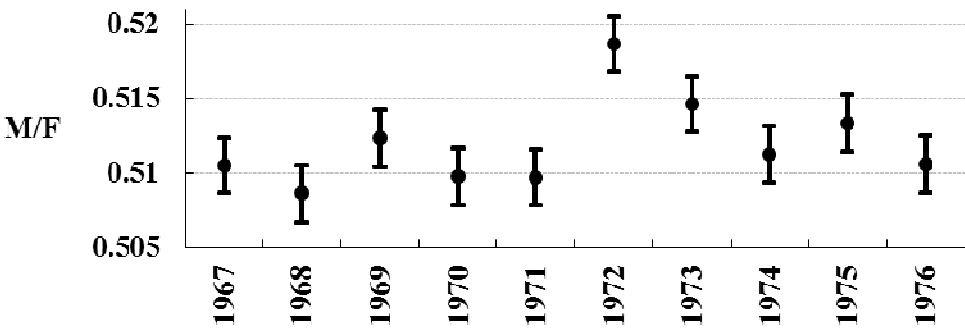
References

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. Trivers RL, Willard DE. Natural selection of parental ability to vary the sex ratio of offspring. *Science.* 1973;179:90-2.
4. Catalano RA. Sex ratios in the two Germanies: a test of the economic stress hypothesis. *Hum Reprod.* 2003;18:1972-5.
5. Grech V. Economic stress and the secondary sex ratio: Ireland, Iceland, Greece and Latvia. *Int J Trop Dis Health* – in press
6. Grech V. The effect of warfare on the secular trends in sex ratios at birth in Israel, Egypt, and Kuwait over the past 60 years. *Libyan J Med.* 2014;9:23448.doi: 10.3402/ljm.v9.23448.
7. 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* – in press.
8. Grech V. The male:female ratio at birth is depressed by Maltese parliamentary elections and increased by other non-electoral events. *Int J Trop Dis Health* 2014;4:1123-1131
9. Grech V. Conflicts in the last fifty years and subsequent effects on the male:female ratio at birth. *Int J Trop Dis Health* – in press.
10. Fleiss JL. Statistical methods for rates and proportions. New York: John Wiley and Sons, 1981:14-15 (2nd edition).
11. Sležák P. Microsoft Excel add-in for the statistical analysis of contingency tables. *Int J Innovation Educ Res* 2014;2:90-100.
12. Gini C. Sulla probabilita che termini di una serie erratica sieno tutti crescenti (o non decrescenti) ovvero tutti decrescenti (o non crescenti) con applicazioni ai rapporti dei sessi nascite umane in intervalli successivi e alle disposizioni dei sessi nelle fratellanze umane. *Metron* 1955;17:1-41.
13. Grech V. Soccer World Cup influences sex ratio at birth. *Eur J Sports Med* – in press
14. Zorn B, Sucur 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.
15. 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.
16. Catalano R, Bruckner T, Gould J, Eskenazi B, Anderson E. Sex ratios in California following the terrorist attacks of September 11, 2001. *Hum Reprod.* 2005;20:1221-7.
17. Corbo V. Reaching one-digit inflation: the Chilean experience. *J Applied Economics* 1998;1:123-163.
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. Ramos MA. Psychiatry, authoritarianism, and revolution: the politics of mental illness during military dictatorships in Argentina, 1966-1983. *Bull Hist Med.* 2013;87:250-78.
20. Mahmood Q, Muntaner C. Politics, class actors, and health sector reform in Brazil and Venezuela. *Glob Health Promot.* 2013;20:59-67.
21. McAllister I. Civic education and political knowledge in Australia. *Aust J Pol Sci.* 1998;33:7-23.
22. Vihavainen T. The Welfare Finland (Hyvinvointi-Suomi). In: Zetterberg S. et al., editors. *A Small Giant of the Finnish History.* Helsinki: WSOY; 2003. p. 840-842.
23. Pesonen P, Rantala O. Current election studies in Finland. *Scand Pol Studies* 1967;2:284-294.

- 275 24. Karisto A. Finnish baby boomers and the emergence of the third age. *Int J Ageing Later*
276 *Life*. 2007;2: 91-108.
277 25. Davis DL, Gottlieb MB, Stampnitzky JR. Reduced ratio of male to female births in
278 several industrial countries: a sentinel health indicator? *JAMA* 1998;279:1018-1023.
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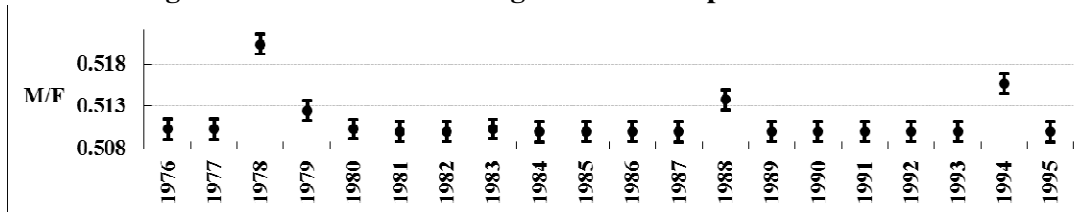
Figures

Figure 1: Annual M/F for Chile for the period 1967-1976.



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Figure 2: Annual M/F for Argentina for the period 1976-1995.

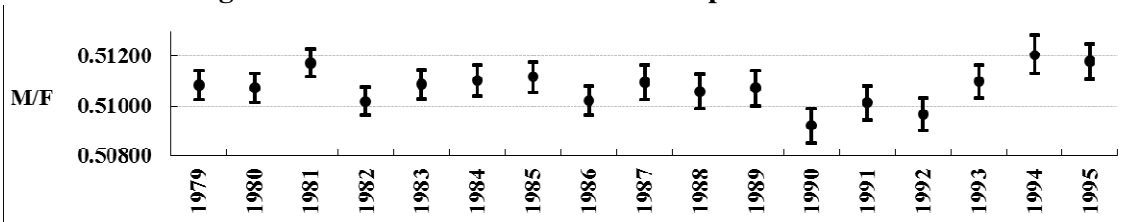


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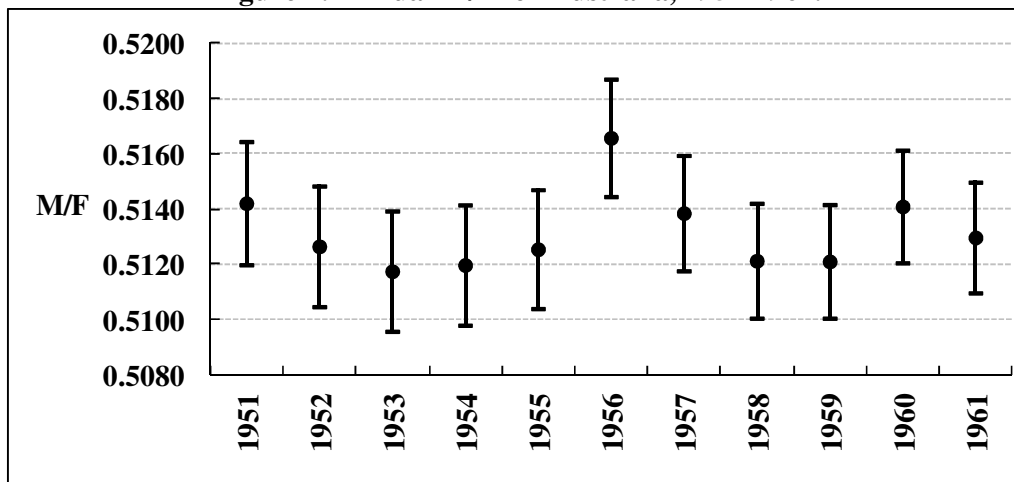
Figure 3: Annual M/F for Brazil for the period 1979-1995.



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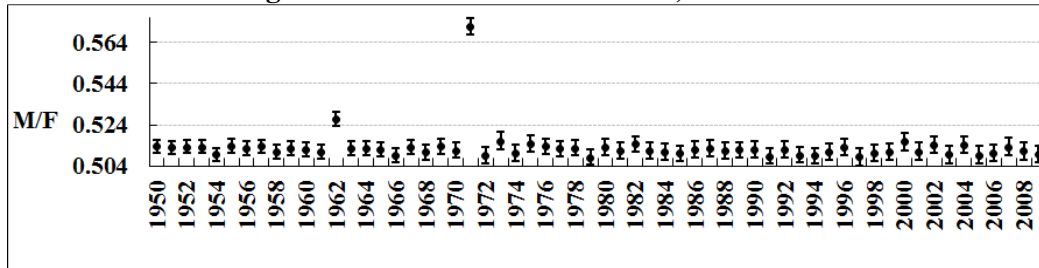
Figure 4: Annual M/F for Australia, 1951-1961.



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Figure 5: Annual M/F for Finland, 1950-2009



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