Original Article

Secular trends and latitude gradients in sex ratios at birth in Australia and New Zealand (1950-2010) demonstrate uncharacteristic homogeneity

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Abstract

Introduction: The male to female ratio of live births is expressed as the ratio of male live births divided by total live births (M/F). Although this would be more accurately abbreviated as M/T (male births divided by total births), it is widely (albeit technically incorrectly) abbreviated as M/F, and this will be used throughout. Globally, over the past four decades, this is expected to be 0.515, with a slight (1.5%) male excess. M/F exhibits an unexplained contrasting latitude gradient. More males are born towards the south of Europe, and the south of Asia, while more males are born toward the north in North American continent. M/F is also declining overall, in both of these continents. This study investigates secular trends and latitude gradients in M/F in Australia and New Zealand from a World Health Organization (WHO) dataset that includes the past sixty years.

Methods: Permission was obtained to source WHO datasets going back to 1950, following which Microsoft Excel was used to calculate M/F ratios. Australian and New Zealand data were available for the years 1950-2006 and 1950-2009 respectively**.** 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.

Results: There were 17035325 births for Australia and New Zealand during this period. M/F ratios ranged between 0.507-0.519. No latitude variations in M/F were found between Australia (9° to 44°) and New Zealand (29° to 53°). The overall M/F was 0.5134 - lower than the anticipated 0.515, with an estimated male birth deficit of 28009. Cycles of 30 years duration are apparent in the dataset but not at statistically significant levels.

Discussion: The lack of latitude gradient in this region is not unexpected as there is a wide latitude overlap between Australia and New Zealand. It has been hypothesised that M/F exhibits a 30 year cycle due to an unknown mechanism that negatively correlates M/F with the adult sex ratio at the time of conception.

Conclusion: The factor/s that are causing a decline in M/F ratios in Europe, North America and Asia are absent or not so strongly influential in Australasia.

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

Introduction

The male to female ratio of live births is expressed as the ratio of male live births divided by total live births (M/F). Globally, this is expected to be around 0.515, with a slight (1.5%) male excess.[1]

M/F exhibits a contrasting latitude gradient. More males are born towards the south of Europe and south of Asia, while more males are born toward the north in North American continent. This remains unexplained.[2] M/F is also declining overall in both continents.[3] This trend in M/F ratios may be important as the pregnant human female is more prone to spontaneously abort a male fetus than a female fetus if adverse environmental conditions are experienced.

These include warfare,[4] earthquakes,[5] environmental disasters,[6] and a plethora of other factors. For these reasons M/F has been proposed as a surrogate sentinel health indicator.[7]

This study investigates secular trends and latitude gradients in M/F in Australia and New Zealand, separately and jointly, from a World Health Organization (WHO) dataset that includes the past sixty years.

Methods

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. 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).[8,9]

The quadratic equations of Fleiss were used for exact calculations of 95% confidence intervals for ratios.[10] $p<0.05$ was taken as statistically significant.

Results

There were 17035325 births for Australia (1950-2006) and New Zealand (1950-2009). Overall, there were 8745183 male births and 8290142 female births (M/F 0.5134, 95% CL 0.5131-0.5136).

Five-year trends are shown in table 1 and figures 1 and 2. No significant secular trends overall were found in either country (Australia chi for trend=0.1, p=0.7, New Zealand chi for trend=3, p=0.9) and in the amalgamated male and female totals (chi for trend=0.04, p=0.8).

Visual inspection of the data showed declining and increasing trends in different time periods. Cycles of 30 years duration are apparent in the dataset but not at statistically significant levels but separate analysis of these eras also failed to show any significant trends (table 2).

No latitude variations were found between Australia (9° to 44°) and New Zealand (29° to 53°), and there were no significant differences. The overall M/F was 0.5134 (95% CI: 0.5131-0.5136), which is lower than that expected at 0.515. This resulted in an estimated male birth deficit of 28009 for the period studied.

Table 1: 5 year total live births and sex ratios at births, in 5 year intervals

Australia	1950-54	1955-59	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	Total
M	507666	559474	602835	598574	662359	584262	604746	632530	661109	646556	642904	268672	6971687
F	482364	530174	569396	567284	629335	552339	573130	600561	626131	613796	609521	254525	6608556
T	990030	1089648	1172231	1165858	1291694	1136601	1177876	1233091	1287240	1260352	1252425	523197	13580243
UCI	0.5138	0.5144	0.5152	0.5143	0.5136	0.5150	0.5143	0.5138	0.5145	0.5139	0.5142	0.5149	0.5136
M/F	0.5128	0.5134	0.5143	0.5134	0.5128	0.5140	0.5134	0.5130	0.5136	0.5130	0.5133	0.5135	0.5134
LCI	0.5118	0.5125	0.5134	0.5125	0.5119	0.5131	0.5125	0.5121	0.5127	0.5121	0.5125	0.5122	0.5131
New Zealand													
M	132380	150555	164561	157064	158816	137938	130133	141220	152185	145247	143631	159766	1773496
F	124925	142702	156024	149319	151129	131293	123251	134293	143537	137057	136997	151059	1681586
T	257305	293257	320585	306383	309945	269231	253384	275513	295722	282304	280628	310825	3455082
UCI	0.5164	0.5152	0.5150	0.5144	0.5142	0.5142	0.5155	0.5144	0.5164	0.5164	0.5137	0.5158	0.5138
M/F	0.5145	0.5134	0.5133	0.5126	0.5124	0.5123	0.5136	0.5126	0.5146	0.5145	0.5118	0.5140	0.5133
LCI	0.5126	0.5116	0.5116	0.5109	0.5106	0.5105	0.5116	0.5107	0.5128	0.5127	0.5100	0.5122	0.5128

Figure 1: Male:female ratio at birth for Australia (5 year totals)

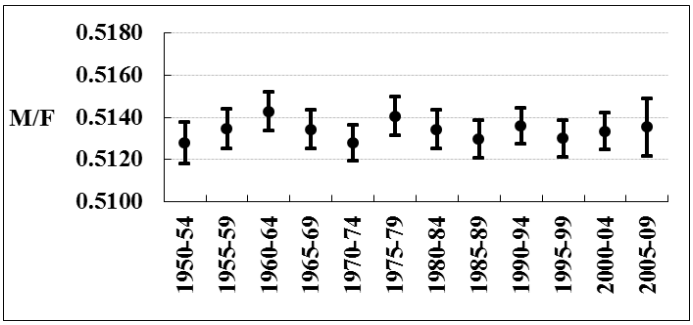

Figure 2: Male:female ratio at birth for New Zealand (5 year totals)

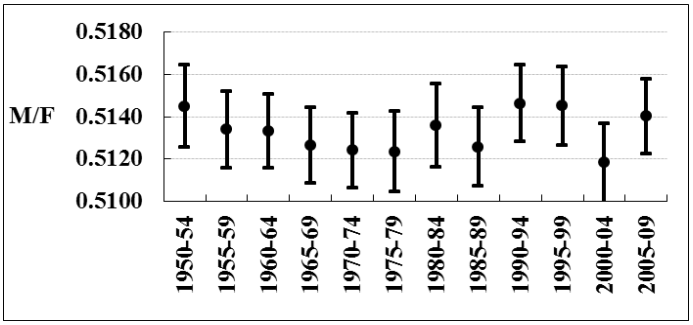

Table 2: Analysis of trends by era for Australia and New Zealand

Era	Chi for trend	p
Australia		
1950-1964	2.8	0.09
1965-1973	2.8	0.09
1973-1980	0.1	0.6
1980-1989	1.3	0.3
New Zealand		
1950-1979	3.4	0.06
1979-2000	2.8	0.09

Discussion

The lack of latitude gradient in this region is not unexpected as there is a wide latitude overlap between Australia (9° to 44°) and New Zealand (29° to 53°).

M/F appears to have been below the expected value for the period under study, with no significant secular trends and an overall male birth deficit.

It has been proposed that M/F exhibits a thirty year cycle due to an unknown homeostatic mechanism that negatively correlates M/F with the adult sex ratio at the time of conception, and cycles of this approximate duration are apparent in the dataset, albeit not at statistically significant levels.[11]

The lack of secular trends and the nonsignificance of the observed cycles may be due to the relatively smaller numbers involved in this study when compared with studies that embraced larger datasets, such as Europe or the North American continent.[2,3]

Asia is a close neighbor to Australasia. Interestingly, a study utilizing the same dataset and dealing with Asia over the same era (and encompassing 245938211 live births) showed an overall increasing trend in M/F ($p < 0.0001$). A latitude gradient was also present, with more boys being born in southern, warmer latitudes ($p < 0.0001$). There was also an overall deficit of 1351757 male births based on an anticipated M/F of 0.515.[12] The same latitude gradient was noted in Europe, with an excess of males in southern latitudes.[2] The present study is clearly in contrast with Asia and Europe.

Conclusion

The factor/s that are causing declining M/F ratios in Europe and North America and increasing M/F ratios in Asia appear to be absent or not so strongly influential in Australasia.

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