

Short Report

HIGHER PARENTAL PERCEPTIONS OF WEALTH ASSOCIATED WITH THE BIRTH OF MORE SONS IN AN AUSTRALIAN POPULATION

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Summary. Many industrialized nations are currently experiencing a decline in average secondary sex ratio (SSR) resulting in fewer boys being born relative to girls. While many potential factors may explain the decline in the birth of males relative to females, it seems most studies support the idea that male offspring are produced less often when environmental conditions are poor owing to males being more susceptible to loss in harsh environments. This study investigates the maternal factors that are associated with the sex of offspring in a cohort of the Australian population. It found that greater parental perceptions of wealth were significantly associated with an increase in the number of sons produced. These results suggest that male offspring are born at increased numbers to women with higher available resources, which may reflect the fact that male offspring are more vulnerable in poor environments.

The secondary sex ratio (SSR) in humans is a measure of boys born relative to girls and is considered to be at equilibrium at around 1.05 (i.e. that 105 males are born for every 100 females born). This is due to boys having higher mortality rates, thus an excess of males at birth is understood to lead to equity in adult sex ratios. Recently, however, many industrialized nations have reported a decline in SSR, meaning that fewer boys are being born relative to girls (Dickson & Parker, 1997; Dodds & Armson, 1997; James, 1998; Grech *et al.*, 2003; MacKenzie *et al.*, 2005; Hamilton & Rasmussen, 2010).

There are a wide range of factors that may cause a decline in the number of males born, including: technological changes, such as the use of fertility drugs; biological changes, such as reductions in sperm motility arising from exposure to war and disaster (Fukuda *et al.*, 1996, 1998; James, 2003; Bisioli, 2004); differing hormone levels in

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parents at the point of conception (Bisioli, 2004); environmental changes, particularly exposure to persistent environmental pollutants (James, 1998; MacKenzie *et al.*, 2005; Terrell *et al.*, 2011); and downward economic changes (Catalano, 2003). In addition, maternal condition is known to affect offspring sex. Women with high social status and good financial means have a greater number of sons (Grant & Yang, 2003; Cameron & Dalerum, 2009), while older mothers (over 35 years of age) are more likely to bear girls, potentially suggesting a response to the increased metabolic demands of male children (Dickson & Parker, 1997).

Whatever the cause, this evidence seems to suggest that more daughters are born under poor conditions, indicating male offspring *in utero* may be more vulnerable to environmental stresses than daughters. This may be due to the Y-chromosome making males more fragile and therefore a poorer investment in suboptimal environments. Further, as sons place a greater metabolic demand on the mother they may be more energetically costly to carry in lean environments (Helle *et al.*, 2009; Gray, 2010).

The Longitudinal Study of Australian Children (LSAC) is conducted in partnership between the Australian Government Department of Social Services, the Australian Institute of Family Studies and the Australian Bureau of Statistics (www.growingupinaustralia.gov.au). The LSAC study comprises a stratified, randomized nationwide sample of 10,000 children across two cohorts with data collected every two years. The response rates over subsequent waves have remained very high, with 80% responding in the 2012 survey. Using data from the B cohort of the LSAC study, which includes an initial sample of 5107 Australian children born between 2003 and 2004, this study aimed to determine what maternal factors are associated with offspring sex in an Australian population. Maternal variables tested included: use of Assisted Reproductive Technology (ART), maternal education level, household income, maternal age, maternal smoking, maternal marital status and parental perceptions of wealth (Table 1). Ethical clearance for the project was obtained from the ANU Human Ethics Research Committee (protocol number 2014/609).

Parental perceptions of wealth after birth were the only factor found to be significant ($n = 5099$, due to missing data; $\chi^2 = 8.919$; $df = 3$; $p = 0.03$). Where the principal carer indicated that they felt 'Poor' or 'Very poor' there was a decrease in the number of male children present in the LSAC sample. By contrast, where the principal carer reported that they felt 'Very comfortable' or 'Prosperous' there was an increase in the number of male children present in the LSAC sample.

Perceptions of wealth are likely to include factors such as education, employment stability, earning potential and support networks, and thus are more likely to account for both material assets and social context than a single measure of monetary income. Thus it seems that higher perceptions of wealth may relate to improved maternal condition and as such may exert a biological influence that promotes the conception and maintenance of male fetuses. This supports the reduction in male offspring seen following economic crises, where wealthy individuals have higher feelings of stress and angst (Jetton *et al.*, 2017), and thus probably have lower perceived ideas regarding their wealth.

Interestingly, in Australia, there is frequently a higher number of boys born relative to girls in the Australian Capital Territory compared with other states (Australian Bureau of Statistics, 2015). As this is also the state where women earn the highest national average

Table 1. Results of chi-square tests of independence for maternal factors associated with offspring sex using the Longitudinal Study of Australian Children (LSAC) dataset

Maternal factor	Female offspring	Male offspring	Total offspring	χ^2	df	<i>p</i> -value
Use of ART (<i>N</i> = 5102)						
Yes	155	146	301	2.825	2	0.244
No	2338	2463	4801			
Maternal education level (<i>N</i> = 3494)						
Diploma	244	254	498	0.357	5	0.996
Bachelor's degree	479	519	998			
Certificate	620	648	1268			
Graduate diploma	150	165	315			
Postgraduate degree	175	189	364			
Other	25	26	51			
Weekly household income (<i>N</i> = 4828) ^a						
<\$499	310	296	606	1.953	4	0.744
\$500–\$999	796	809	1605			
\$1000–\$1499	620	675	1295			
\$1500–1999	330	344	674			
>\$2000	318	330	648			
Maternal age (<i>N</i> = 5106)						
<20	51	68	119	8.661	4	0.070
20–29	845	911	1756			
30–39	1480	1470	2950			
>40	120	158	278			
Maternal smoking (<i>N</i> = 4239)						
Yes	346	363	709	0.047	1	0.829
No	1707	1823	3530			
Maternal marital status (<i>N</i> = 5107)						
Single parent	232	245	477	0.598	2	0.742
Two parents	2265	2365	4630			
Perceptions of wealth (<i>N</i> = 5099)						
Poor and very poor	102	70	172	8.919	3	0.030
Just getting along	844	867	1711			
Reasonably comfortable	1144	1218	2362			
Very comfortable and prosperous	402	452	854			

^aHousehold income categories reflect those used on the LSAC survey given to participants.

weekly salary, and have higher education levels (Australian Bureau of Statistics, 2013) they may perceive themselves to be wealthier and as a result have more sons.

The results from this study may thus reflect the fact that because male offspring are more sensitive to poor environmental conditions, they are likely to be produced at higher numbers in cohorts of women who perceive themselves to have higher available resources.

Acknowledgments

The authors would like to thank one anonymous reviewer and the Associate Editor for their helpful comments on previous versions of this manuscript. This paper uses unit record data from Growing Up in Australia, the Longitudinal Study of Australian Children. The study is conducted in partnership between the Department of Social Services (DSS), the Australian Institute of Family Studies (AIFS) and the Australian Bureau of Statistics (ABS). The findings and views reported in this paper are those of the authors and should not be attributed to DSS, AIFS or the ABS.

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