Department of Health

Birth Ratios in the United Kingdom

A report on gender ratios at birth in the UK

May 2013

Published to gov.uk, in PDF format only.

www.gov.uk/dh

Birth Ratios in the United Kingdom

A report on gender ratios at birth in the UK

Prepared by

Analytical Team, Department of Health

Birth Ratios in the United Kingdom

Purpose:

1. To report on the gender ratio at birth in the UK and investigate whether this varies by mothers' country of birth beyond the range that we would expect to see naturally occurring.

Key Results:

- The UK gender ratio is 105.1 male births to 100 female and is well within the normal boundaries for populations
- When broken down by the mothers' country of birth, no group is statistically different from the range that we would expect to see naturally occurring
- There are significant limitations in what these data can show. As there are small numbers of births for most groups, large differences in birth rates would be needed to identify ratios outside of the expected range.

Background:

2. A recent report by the Council of Europe Parliamentary Assembly suggested that member states should 'collect the ratio at birth, monitor its development and take prompt action to tackle possible imbalances' and 'encourage research on sex ratios at birth among specific communities'[1].

3. The gender ratio at birth is the subject of numerous academic articles, with general consensus that a male to female birth ratio of around 105 (male births per 100 female) is normal[2].

4. Evidence suggests a number of factors can influence the sex of a child. These include paternal and maternal age, coital rates, number of children and sex of previous children[3]. However, many consider ratios above 108 and below 103 as unlikely to occur naturally other than as a product of the random variability associated with small numbers of births[4].

Method:

---

[1] http://assembly.coe.int/Main.asp?link=/Documents/AdoptedText/ta11/ERES1829.htm

[2] Eberstadt, N. (2011) The Global War Against Baby Girls. The New Atlantis.

[3] Jacbosen, R. et al (1999). Natural variation in the human sex ratio. Human Reproduction vol.14 no.12.

[4] Eberstadt, N. (2011) The Global War Against Baby Girls. The New Atlantis

Hesketh, T. and Xing, Z W. (2006) Abnormal sex ratios in human populations: Causes and consequences. Proceedings of the National Academy of Sciences

James, W.H. (1987) The human sex ratio. Part 1: a review of the literature. Human Biology 59:721-5

5. This analysis has been quality assured by the Methodology Team at the Office for National Statistics. Details of the tests undertaken are set out at Annex A.

6. We have obtained data for each constituent country of the UK from the Office for National Statistics, General Registrations Office for Scotland and Northern Ireland Statistics and Research Agency. This dataset contains the number of male and female live births over the period 2007-2011. These data are broken down by both mothers' and fathers' country of birth.

7. These data are routinely collected from parents/guardians when births are registered. We believe there to be no substantial data quality issues, and any unidentified issues are likely to impact equally on male and female births.

8. Although both mothers' and fathers' country of birth are recorded, we report results for mothers' country of birth only, as fathers' country of birth is not always stated. It should also be noted that country of birth is different to ethnicity. Mothers' country of birth was used for this analysis as mothers' ethnicity is not recorded in birth data.

9. For many countries of birth, the sample of births is so small that we cannot draw meaningful conclusions. Therefore, we have pooled data from the last five years (2007-11) to increase the sample size. We excluded those countries with fewer than 100 births in this pooled dataset. This gives us a dataset comprising 3,971,879 live births to mothers from over 160 countries[5]. The majority of these births occurred in England and Wales (89%) and were to mothers born in England and Wales (66%).

10. Recorded birth ratios vary widely by mothers' country of birth. We tested how likely those recorded ratios were to have occurred by random variation alone. This was done in the first instance by testing whether the ratios were significantly different from the UK birth ratio. However, as highlighted, there are genetic and cultural factors which may also affect the birth ratios for mothers born in some countries. We therefore also tested whether any of the ratios were significantly above 108 males to every 100 females or significantly below 103 to 100. Ratios above 108 and below 103 were selected as they rarely occur at a national level[6].

---

[5] Note not all of these are UN recognised countries and the list includes former countries, eg Czechoslovakia.

[6] Eberstadt, N. (2011) The Global War Against Baby Girls. The New Atlantis

Hesketh, T. and Xing, Z W. (2006) Abnormal sex ratios in human populations: Causes and consequences. Proceedings of the National Academy of Sciences

James, W.H. (1987) The human sex ratio. Part 1: a review of the literature. Human Biology 59:721-5

United Nations Data Division.. Available at :
http://data.un.org/Data.aspx?q=sex+ratio+birth&d=PopDiv&f=variableID%3a52%3btimeID%3a113&c=2,4,6,7&s=_crEngNameOrderBy:asc,_timeEngNameOrderBy:desc,_varEngNameOrderBy:asc&v=1

Accessed November 2012

11. The test estimates whether the likelihood of a ratio occurring by chance is less than 5% - that is, the same as the chance of it occurring 1 in 20 times. However, as there are over 160 countries being tested, we would expect a ratio with that level of deviance to occur for several countries through random variation (specifically, 1 in 20 of the 169 tests). We could then be in the position of mistakenly stating that some groups have birth ratios which are so low/high that they are unlikely to happen naturally. Techniques have been devised to deal with this problem, known as the ‘multiple testing’ problem, details of which are given in the appendix.

12. It should be noted that a consequence and a limitation of using the techniques for multiple testing are that the groups being analysed will generally need to be large (ie have a high number of births) for relatively small differences in birth rates to be found to lie outside the expected range. Many of the groups defined by mothers' country of birth in this analysis are small and so would require large differences in birth rates to be identified as different from the expected range.

Results:

13. The data show that in 2011 there were 807,776 births registered in the UK. Consistent with the literature, the male to female ratio was 105.1 in 2011 and is consistently around 105 over the observed period and before.

Table 1: Gender ratio at birth (UK)

Year	M:F ratio
2007	105.6
2008	104.9
2009	105.2
2010	105.1
2011	105.1

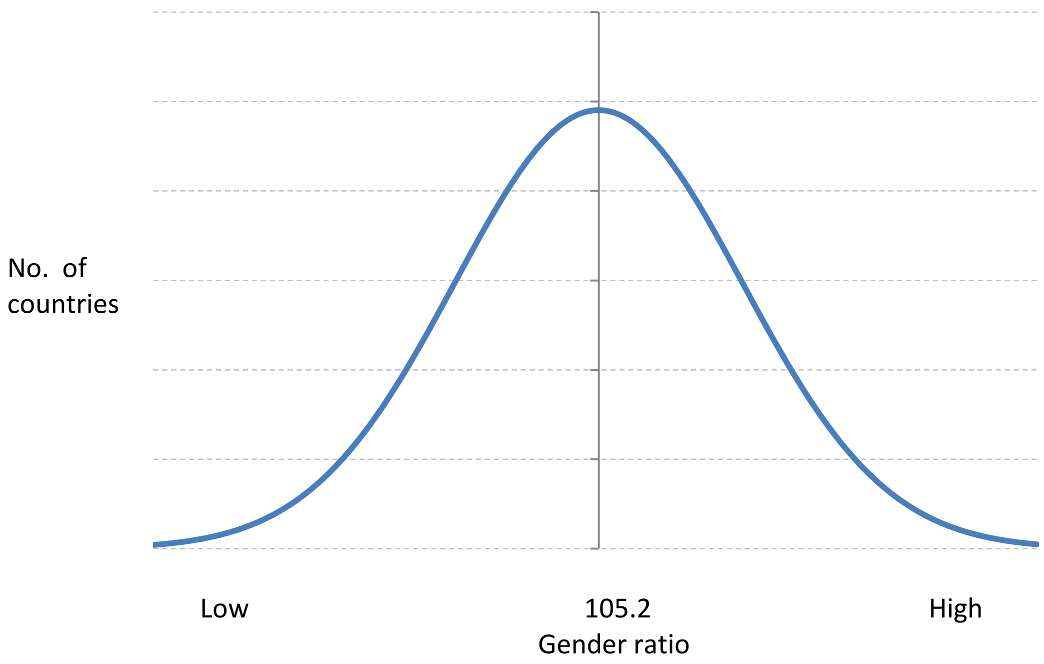
14. Gender ratios for national populations above 108 and below 103 are rare[6.] As has been mentioned, initial analysis was undertaken by DH which did not take into account the problems caused by multiple testing. A small number of countries had birth ratios that differed from the UK as a whole and potentially fell outside of the range considered possible without intervention. However, it was emphasised that this could be the result of natural variation and that further analysis was needed. This more comprehensive analysis has concluded that no group is statistically different from the range that we would expect to see naturally occurring.

15. The further analysis tested whether any countries of birth had a birth ratio significantly different from the figure of 105.1 for the UK as a whole. Only one country, Sri Lanka, was

found to have so. Mothers born in Sri Lanka have a birth ratio of 99.2, or 99 male children for every 100 female children.

16. Table 3 shows gender ratios for the countries analysed. The highest recorded ratio is found in mothers born in the USSR (although the USSR was formally dissolved in 1991, women are able to select the country of birth they most closely associate with). However, this result is not statistically significantly above 108 as this group has only 119 births and the lower the number of births the higher the chance of extreme ratios. There are a far higher number of births among mothers born in Russia and the Ukraine (which previously formed part of the USSR), and the ratios are much less extreme.

Figure 1: normal distribution



17. Figure 1 gives an example of the spread of ratios we would expect to see if the underlying ratio was the same for all groups. Natural variation means we expect to see a spread of ratios from high to low, with more grouped around the average than towards the lower and upper ends. It is analogous to tossing a coin 10 times, recording the results and repeating 169 times. If we do this we would expect 5 heads and 5 tails (ie a heads to tails ratio of 1) to occur more often than any other combination, but we would also expect other combinations.

18. It should be noted that the 10 countries in Table 2 have both over 10,000 births and recorded gender ratios either lower than 103 or higher than 108. However, there is still a strong probability that this is occurring by chance given the numbers involved are relatively small. None is statistically significantly above the UK birth ratio. In relation to Sri Lanka, while the birth ratio is statistically different from the UK as a whole, it is not statistically different to the 103 threshold for births of girls.

Table 2: Mothers' country of birth with recorded ratios above 108 and below 103

Below 103	**Above 108**
Bangladesh	Australia
Germany	China
Ghana	Philippines
Nigeria	
Somalia	
Sri Lanka	
Zimbabwe	

Summary:

1. None of the ratios split by mothers' country of birth is statistically different from the range that we expect naturally. Whilst there is a wide variation in ratios, there is insufficient evidence to conclude that this is not the result of cultural differences, genetic differences and random variation.

2. The statistical technique used to calculate whether groups are different from the natural range generally requires groups to be large to identify unexpected ratios. As populations for many of these groups are small, this database is unlikely to be able to ascertain cases of prenatal gender selection.

3. DH will repeat this analysis on an annual basis following publication of birth data by ONS.

Table3: UK birth ratios for mothers born in all countries (2007-2011)

Mother's country of birth	M:F ratio	Sample	Significantly below UK	Significantly above UK	Significantly different to common boundaries (103-108)
Afghanistan	105.4	13,373	×	×	×
Africa (NOS)	102.8	507	×	×	×
Albania	109.6	3,222	×	×	×
Algeria	103.8	5,588	×	×	×
Angola	99.6	2,972	×	×	×
Antigua and Barbuda	109.4	111	×	×	×
Argentina	111.4	1,152	×	×	×
Armenia	120.9	201	×	×	×
Asia (Except Middle East) (NOS)	95.8	423	×	×	×
Australia	108.8	12,315	×	×	×
Austria	102.8	789	×	×	×
Azerbaijan	103.2	380	×	×	×
Bahamas	114.4	208	×	×	×
Bahrain	114.9	374	×	×	×
Bangladesh	102.6	43,723	×	×	×
Barbados	111.6	383	×	×	×
Belarus	107.3	686	×	×	×
Belgium	101.0	2,199	×	×	×
Benin	124.5	110	×	×	×
Bermuda	113.6	220	×	×	×
Bolivia	105.0	619	×	×	×
Bosnia and Herzegovina	102.7	912	×	×	×

Mother's country of birth	M:F ratio	Sample	Significantly below UK	Significantly above UK	Significantly different to common boundaries (103-108)
Botswana	110.3	366	×	×	×
Brazil	110.6	6,959	×	×	×
Brunei	103.7	218	×	×	×
Bulgaria	102.6	4,714	×	×	×
Burma	123.2	558	×	×	×
Burundi	95.8	928	×	×	×
Cambodia	119.7	134	×	×	×
Cameroon	101.4	2,367	×	×	×
Canada	102.9	6,553	×	×	×
Canary Islands	109.6	109	×	×	×
Cape Verde	78.0	105	×	×	×
Channel Islands	119.3	1,362	×	×	×
Chile	105.7	574	×	×	×
China	109.0	17,246	×	×	×
China (Taiwan)	106.4	642	×	×	×
Colombia	109.7	2,368	×	×	×
Congo	106.1	7,500	×	×	×
Cote d'Ivoire	109.4	1,979	×	×	×
Croatia	119.8	743	×	×	×
Cuba	116.5	236	×	×	×
Cyprus	103.8	2,544	×	×	×
Czech Republic	108.3	6,204	×	×	×
Denmark	114.8	1,991	×	×	×
Djibouti	90.6	122	×	×	×

Mother's country of birth	M:F ratio	Sample	Significantly below UK	Significantly above UK	Significantly different to common boundaries (103-108)
Dominica	111.8	216	×	×	×
Dominican Republic	87.6	167	×	×	×
East Timor	95.2	328	×	×	×
Ecuador	110.4	1,075	×	×	×
Egypt	109.6	2,339	×	×	×
El Salvador	71.4	108	×	×	×
England	105.4	2,480,431	×	×	×
Eritrea	100.1	3,335	×	×	×
Estonia	109.3	925	×	×	×
Ethiopia	107.8	3,081	×	×	×
Fiji	98.4	984	×	×	×
Finland	103.8	1,390	×	×	×
France	104.3	12,894	×	×	×
Georgia	105.2	474	×	×	×
Germany	102.1	27,361	×	×	×
Ghana	100.4	18,098	×	×	×
Gibraltar	96.4	819	×	×	×
Greece	109.0	2,044	×	×	×
Grenada	116.4	290	×	×	×
Guinea	119.4	724	×	×	×
Guinea-Bissau	93.7	428	×	×	×
Guyana	122.5	881	×	×	×
Hong Kong	101.0	4,931	×	×	×
Hungary	103.9	4,113	×	×	×

Mother's country of birth	M:F ratio	Sample	Significantly below UK	Significantly above UK	Significantly different to common boundaries (103-108)
Iceland	119.1	195	×	×	×
India	105.4	67,525	×	×	×
Indonesia	100.9	1,077	×	×	×
Iran	106.0	4,961	×	×	×
Iraq	107.6	11,267	×	×	×
Ireland	103.0	20,315	×	×	×
Isle of Man	100.8	727	×	×	×
Israel	107.1	2,355	×	×	×
Italy	106.2	6,524	×	×	×
Jamaica	103.4	12,632	×	×	×
Japan	105.0	3,879	×	×	×
Jordan	112.6	742	×	×	×
Kazakhstan	103.7	556	×	×	×
Kenya	102.4	7,336	×	×	×
Korea (South)	111.5	1,430	×	×	×
Kosova	116.7	4,158	×	×	×
Kuwait	105.8	1,815	×	×	×
Kyrgyzstan	109.6	197	×	×	×
Latvia	104.7	6,977	×	×	×
Lebanon	106.3	2,205	×	×	×
Liberia	111.0	669	×	×	×
Libya	101.1	4,550	×	×	×
Lithuania	107.6	14,523	×	×	×
Luxembourg	111.1	114	×	×	×

Mother's country of birth	M:F ratio	Sample	Significantly below UK	Significantly above UK	Significantly different to common boundaries (103-108)
Macedonia	101.1	533	×	×	×
Malawi	97.0	2,037	×	×	×
Malaysia	106.3	5,084	×	×	×
Malta	90.6	829	×	×	×
Mauritius	106.9	3,164	×	×	×
Mexico	112.6	1,161	×	×	×
Moldova	125.4	728	×	×	×
Mongolia	94.9	462	×	×	×
Montserrat	105.1	568	×	×	×
Morocco	104.6	3,712	×	×	×
Mozambique	105.6	736	×	×	×
Namibia	106.4	481	×	×	×
Nepal	106.6	3,663	×	×	×
Netherlands	99.7	3,927	×	×	×
New Zealand	104.5	6,703	×	×	×
Nigeria	102.8	37,781	×	×	×
Northern Ireland	105.0	118,083	×	×	×
Norway	101.4	1,156	×	×	×
Not Stated	104.0	43,833	×	×	×
Oman	157.9	196	×	×	×
Pakistan	104.3	95,829	×	×	×
Palestine	124.1	390	×	×	×
Papua New Guinea	127.8	180	×	×	×
Peru	110.9	890	×	×	×

Mother's country of birth	M:F ratio	Sample	Significantly below UK	Significantly above UK	Significantly different to common boundaries (103-108)
Philippines	111.0	15,084	×	×	×
Poland	105.2	93,880	×	×	×
Portugal	102.8	8,428	×	×	×
Qatar	98.2	226	×	×	×
Romania	106.6	12,127	×	×	×
Russia	101.8	4,764	×	×	×
Rwanda	113.8	834	×	×	×
Sao Tome and Principe	114.2	227	×	×	×
Saudi Arabia	104.7	2,911	×	×	×
Scotland	105.0	263,522	×	×	×
Senegal	113.9	445	×	×	×
Serbia	112.3	760	×	×	×
Seychelles	106.5	256	×	×	×
Sierra Leone	97.6	3,687	×	×	×
Singapore	99.9	1,793	×	×	×
Slovakia	111.1	8,830	×	×	×
Slovenia	112.0	176	×	×	×
Somalia	102.3	29,086	×	×	×
South Africa	106.3	23,538	×	×	×
Spain	104.2	5,915	×	×	×
Sri Lanka	99.2	17,268	✓	×	×
St Helena and Dependencies	121.7	184	×	×	×
St Lucia	106.8	577	×	×	×

Mother's country of birth	M:F ratio	Sample	Significantly below UK	Significantly above UK	Significantly different to common boundaries (103-108)
St Vincent	100.6	355	×	×	×
Sudan	108.7	3,339	×	×	×
Swaziland	159.0	202	×	×	×
Sweden	109.2	3,295	×	×	×
Switzerland	106.9	1,467	×	×	×
Syria	118.8	1,455	×	×	×
Tanzania	100.3	2,486	×	×	×
Thailand	110.9	5,128	×	×	×
The Gambia	106.0	2,948	×	×	×
Togo	110.4	324	×	×	×
Trinidad and Tobago	102.8	1,689	×	×	×
Tunisia	109.9	760	×	×	×
Turkey	107.0	12,863	×	×	×
Turkmenistan	86.5	138	×	×	×
Uganda	103.5	4,962	×	×	×
Ukraine	102.1	3,197	×	×	×
Union of Soviet Socialist States	183.3	119	×	×	×
United Arab Emirates	103.0	1,334	×	×	×
United States	105.8	17,340	×	×	×
Uruguay	88.9	119	×	×	×
Uzbekistan	109.1	554	×	×	×
Venezuela	103.3	1,124	×	×	×
Vietnam	104.1	3,970	×	×	×

Mother's country of birth	**M:F ratio**	**Sample**	**Significantly below UK**	**Significantly above UK**	**Significantly different to common boundaries (103-108)**
Wales	105.6	150,097	×	×	×
Yemen	102.9	2,784	×	×	×
Yugoslavia	90.7	286	×	×	×
Zambia	106.3	3,198	×	×	×
Zimbabwe	100.7	15,597	×	×	×

Appendix

Bonferroni Correction

The Bonferroni correction is a multiple-comparison correction used when several dependent or independent statistical tests are being performed simultaneously (since while a given alpha value α may be appropriate for each individual comparison, it is not for the set of *all* comparisons). In order to avoid a lot of spurious positives, the alpha value needs to be lowered to account for the number of comparisons being performed.

The simplest and most conservative approach is the Bonferroni correction, which sets the alpha value for the entire *set* of n comparisons equal to α by taking the alpha value for *each* comparison equal to α/n. Explicitly, given n tests T_i for hypotheses H_i ($1 \le i \le n$) under the assumption H_0 that all hypotheses H_i are false, and if the individual test critical values are $\le \alpha/n$, then the experiment-wide critical value is $\le \alpha$. In equation form, if

$$P(T_i \text{ passes } | H_0) \le \frac{\quad}{n}$$

for $1 \le i \le n$, then

$$P(\text{some } T_i \text{ passes } | H_0) \le \alpha,$$

which follows from the Bonferroni inequalities.

Benjamini–Hochberg procedure

The *Benjamini–Hochberg procedure* (BH step-up procedure) controls the false discovery rate (at level α).[1] The procedure works as follows:

1. For a given α, find the largest k such that $P_{(k)} \le \frac{k}{m}\alpha.$
2. Then reject (i.e. declare positive discoveries) all $H_{(i)}$ for $i = 1, \ldots, k$.

The BH procedure is valid when the m tests are independent, and also in various scenarios of dependence.[11] It also satisfies the inequality:

$$E(Q) \le \frac{m_0}{m} q \le q$$

If an estimator of m_0 is inserted into the BH procedure, it is no longer guaranteed to achieve FDR control at the desired level.[3] Adjustments may be needed in the estimator and several modifications have been proposed.[20][21][22][23]

The BH procedure was proven to control the FDR in 1995 by Benjamini and Hochberg.[1] In 1986, R. J. Simes offered the same procedure as the "Simes procedure", in order to control the FWER in the weak sense (under the intersection null hypothesis).[24] In 1988, G. Hommel showed that it does not control the FWER in the strong sense.[25] Based on the Simes procedure, Yossi Hochberg discovered Hochberg's step-up procedure (1988) which does control the FWER in the strong sense.[26]

Note that the mean α for these m tests is $\frac{\alpha(m+1)}{2m}$ which could be used as a rough FDR, or RFDR, "α adjusted for m independent (or positively correlated, see below) tests". The RFDR calculation shown here provides a useful approximation and is not part of the Benjamini and Hochberg method; see AFDR below.