Missing girls among deliveries from Indian and Chinese mothers in Spain 2007–2015.

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ABSTRACT:

Deliveries from Indian and Chinese mothers present a higher than expected male:female ratio in their own countries, in northern Europe, EEUU and Canada. No studies have been carried out in southern European countries. We explored whether the high male-to-female ratio common in Indian and Chinese communities, also exists among families from those regions who live in Spain. For that purpose we designed a cross-sectional population-based study containing data on 3,133,908 singleton live births registered in the Spanish Vital Statistics Registry during the period 2007-2015. The ratio of male:female births by area of origin was calculated using binary intercept-only logistic regression models without reference category for the whole sample of births and taking into account a possible effect modification of birth order and sex of the previous males. Interaction effects of sociodemographic mothers' and fathers' characteristics was also assessed. In Spain, the ratio male:female is higher than expected for Indian-born mothers, especially for deliveries from mothers with no previous male births and, to a lesser extent, for Chinese-born women, specifically for third or higher order births and slightly influenced by the sex of the previous births. Therefore, the increased sex male:female ratio observed in other countries among Indian and Chinese mothers is also observed in Spain. This reinforces the notion that culture and values of the country of origin are more influential than the country of residence.

Keywords: Sex ratio; Male:Female ratio; Missing girls; Chinese mothers; Indian Mothers.

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Introduction

The Sex Ratio, a demographic indicator consistent across populations, usually varies between 1.03 and 1.07 males per female, is largely independent of birth order and the sex of previous siblings, and may fluctuate somewhat among different ethnic groups [1-15].

The association of altered sex ratio with many epidemiological and biological factors such as father's occupation [16], hepatitis B virus [17], parental periconceptional smoking [18], parental hormonal levels [19], time to pregnancy [20] and caloric availability [21] has been vaguely explored in the last years. Even if some results claim a possible association [17-21], their strength and reproducibility are weak. Additionally, whether or not these factors are taken into account, the sharp decrease in female births in countries from South and East Asia regions such as India [22] and China [23] is too pronounced to arise only from biological variation. In these countries, where there is a traditional preference for sons [1-7, 14, 15, 24-26], sex selection through selective abortions or female infanticides has been proposed as possible explanation for this imbalance [12, 27, 28].

The incentives for gender selection depend not only on gender preferences but also on the number and sex of children already born [7]. The use of higher parity and conditional-upon-previous-gender boy-birth percentages has been considered in some previous studies of Asian countries [22, 29]. In India, a large study showed a sharp increase in the male:female ratio among second order births when the firstborn was a girl, and no substantial increase when the firstborn[13] was a boy [28].

There is some evidence that these patterns are also present among Asian immigrants in developed countries such as US, Canada, England and Norway [5, 7-9, 13, 27, 30], even for second generation Asian migrants [31]. A relatively recent study [27] found that the likelihood of male births to India-born mothers in the United Kingdom had an overall upward trend since the 1980s and was considerably higher at third and later births after 1990.

Not all studies have taken into account the possible modification effect of mother's characteristics such as age, educational level, profession or parity and most of the studies conducted in developed countries have taken place in Anglo-Saxon countries. However, to our knowledge, no studies have addressed the imbalance in the sex ratio among Asian immigrants in countries of Southern Europe where the reception of immigrants is recent and have experienced a more difficult economic situation than the US, Canada and Northern Europe through the period 2007-2015 [30]. There may also be different self-selection. Those heading to English-speaking countries might be different (more traditional, many having relatives from previous generations – a more mature diaspora) than those going to Southern Europe.

Thus, the aim of the present study was to determine whether the high male-to-female ratio common in Indian and Chinese communities, also exists among families from those regions who live in Spain, and whether the imbalance increases with parity and sex of the previous children.

MATERIALS AND METHODS:

Study population

In Spain, registration of newborns is mandatory for all births occurring in the country, regardless of the mother's nationality. For the present study data on all births registered in the Spanish Vital Statistics Registry during the period 2005-2015 were used. Data included: mothers identification number, sex of the newborn (male, female), number of previous live births and mother's nationality for the period 2005-2006 or mother area of birth from 2007 onwards (Native, East Europe, Rest of Europe, Latin America, North Africa, Sub-Saharan Africa, North America and Oceania, India, China and Rest of Asia) among other information. Some other variables that were used to describe the sample and assess possible confounding effects and interactions were year of delivery (2005-2015), birth weight (≤1500grs, 1501-2499grs, ≥2500grs), gestational age (≤32, 33-36, >36), mother's and father's age (<20, 20-34, ≥35), educational level (primary, secondary, university or more) and occupation (non-manual, manual, does not work, non-classified), mother's marital status (married, non-married) and father's nationality/area of birth. Initially all singleton live births over 23 weeks of gestational age that survived more than 24 hours and reported the information on the mother's nationality/area of birth were selected (*Figure 1*).

Statistical analyses

Data on the number of previous live births for these deliveries was used to calculate the birth order that was grouped afterwards in three categories: 1st delivery; 2nd delivery; and ≥3rd delivery. The sex of the previous deliveries was obtained by linking the mothers' registries of previous years and grouped in three categories: 1st delivery, >1st delivery with no previous males; and >1st delivery with, at least, one previous male.

As indicated before, birth records collected different information on mother's origin for the period 2005-2006 (mother's nationality) than for the period 2007 onwards (mother area of birth). In order to have a uniform and precise definition of mother's area of origin, only mothers that gave birth from 2007 onwards were kept for the subsequent analyses. Characteristics of births and mothers of selected singleton live births over 23 weeks of gestational age that survived more than 24 hours, occurred between 2007 and 2015 and with information on the mother's nationality were described using number of births and percentage of males in each of their categories for the whole sample and by mother's area of origin (*Table 1*). The ratio of male:female births is a specific example of the odds [$P_{\text{male}}/(1 - P_{\text{male}})$] since it represents the proportion of males divided by the proportion of females. This ratio can be calculated with this very same formula within groups of mothers' area of origin by restricting the calculations to the data on sex from the births occurred in these groups. The 95% confidence intervals can be calculated using the formula of the 95%CI for a proportion. However, a more straight forward method to carry out these calculations will be, as some authors previously did [12, 13], to adjust a binary logistic regression model, including sex as the dependent variable and the area of mothers' origin as the main exposure keeping all levels of the variable (no basal category) and dropping the constant (see supplementary material I for more information on this method). Additionally, this modelling also allows to explore a possible modification effect of multiple external variables in a regression model (see supplementary material I). We did not consider mother's marital status, mother's and father's age, educational level and profession, and father's area of origin as potential confounders because their association with the male to female ratio has not been proved in the literature nor can be explained biologically. However, the possible effect modification of mothers' age, profession, educational level and marital status in the ratio of male:female births by area of origin was assessed including an interaction term between these variables and mother's area of origin for the whole sample (sex selection might be more likely among mothers married, older, less educated or with less specialized occupations). The final models were used to report the effect of mothers' nationality in the total male:female ratio with the corresponding 95% confidence intervals (*Table 2*). A possible effect modification of birth order (*Table 3*) and sex of the previous males (*Table 4*) was explored including in the models an interaction term between these variables and mother's area of origin.

All the statistical analyses were performed with Stata 14 assuming a confidence level of 95%.

RESULTS:

Data selection

For the period of 2005-2015, 5,038,435 births were registered in the Spanish Vital Statistics Registry. Initially 17,727 births born dead or that survived less than 24 hours, 183 births occurred in or before the 23rd week of gestation, 103,260 multiple births and 16,098 registries in which the nationality/area of origin of the mother was missing were excluded. For the subsequent analysis different exclusion criteria were followed. The analyses of the total effect of mother's nationality in the male:female ratio and the analysis by birth other were carried out with the 3,989,985 remaining births after excluding 911,182 that occurred before 2007. For the analysis of the effect of mother's nationality in male:female ratio by sex of the previous birth the analyses were performed over 3,133,908 births after the exclusion of 1,237,681 mothers that had at least one previous live birth occurred before 2005 (and therefore not registered in our databases), 16,735 mothers that reported one or more multiple births and 512,842 births occurred before 2007 (*Figure 1*).

Bivariate results

The bivariate analyses showed a possible effect of mothers' nationality in the ratio of male:female births for the period under study. This might be related with the noticeable higher percentage of male births from Indian-born mothers (54.7%) in comparison with the rest of the areas of origin (percentage of male births between 51.2%-52.0%). As for the births characteristics, the proportion of males seemed to be smaller among low birth weight deliveries but bigger among preterm births. No important differences in these percentages were observed by mother's profession, marital status, mother's age or education (*Table 1*).

Regression results

Since no interaction effects were observed with mother's characteristics, the crude male:female ratio and 95% confidence intervals were reported for all births (*Table 2*), by birth order (*Table 3*) and by sex of the previous births (*Table 4*). Taking into account that the common male:female ratio is between 1.03 and 1.07, our results showed an important alteration of this ratio among Indian-born mothers with a male:female ratio (95%CI) of 1.21 (1.14;1.28) for all births (*Table 2*). The ratio increased exponentially for the second 1.29 (1.17;1.42) and 3^{rd} or posterior deliveries 2.13 (1.68;2.72) (*Table 3*). The effect, when taking into account the sex of the previous births (*Table 4*), was restricted to deliveries from mothers whose all previous live born were females (male:female ratio (95%CI) = 1.51(1.23;1.87)). Another noteworthy result is the increased male:female ratio observed for Chinese-born women for 3^{rd} or posterior births (male:female ratio (95%CI) = 1.18(1.12;1.25) (*Table 3*) and only for mothers whose all previous live births were females (male:female ratio (95%CI) = 1.10(1.03;1.18)) (*Table 4*). Despite of not being considerably different from the common values, the ratio among North African women was slightly increased, but did not show a particular increase for higher order births independently of the sex of the previous deliveries (*Tables 2-4*).

DISCUSSION:

Our results indicate that, in Spain, the ratio male:female is higher than expected for Indian-born mothers, especially for deliveries from mothers with no previous male births and, to a lesser extent, for Chinese-born women, specifically for third or higher order births and slightly influenced by the sex of the previous births.

Our findings agree with those of previous studies carried out in India [22, 28] and China [6], and also in several European [27] and North American [1, 7-13] countries where, in women of Asian origin [8, 9] and more concretely among Indian [1, 5, 7, 10-13, 22, 27, 28] and Chinese [6, 7, 11-13], the sex ratio was higher than the ratio observed for other immigrant and native groups. Some of these studies also support our findings of a stronger sex-ratio modification among Indian than among Chinese women [10-13]. Few of them explored the effect of mothers' origin in the sex-ratio by birth order [5, 6, 10, 11, 13, 27] and even fewer took into account the sex of the previous births [8, 9, 12, 22]. The results previously published, in accordance with our results, provide evidence for a stronger sex-ratio modification for higher order births among Indians [5, 10, 11, 13] and, to a lesser extent, among Chinese [6, 9-11] that is especially noticeable for the second or higher order births with no previous females among Indian [9, 12, 22].

As stated in the introduction, the magnitude of the ratio can hardly be attributed to biological reasons. The hypothesis of a differential occurrence of stillbirths by area of origin in favour of males (more stillbirths among female foetuses from Indian or Chinese mothers which would translate into more male live births) is also unlikely. According to our data (not shown), for the period 2007-2015, Indian mothers had 31 stillbirths (39% females and 61% males) out of 4821 total births and Chinese women had 73 stillbirths (53% females and 47% males) out of 36063. The low proportion of stillbirths is unlikely to have an effect on our final estimates of sex ratio and, even if it would do, the data indicates that the difference in the occurrence of stillbirths is the opposite to the expected to explain our results (higher proportion of stillbirths among males from Indian mothers which would reflect in more female births, altering the sex ratio in the opposite direction to our results). Thus, the most likely explanation is sex selection. The reasons for such selection may stem from strong cultural gender biases that remain with immigrants who come to Spain. In China, sex-selection is mainly attributed to political reasons, with some areas limiting to one the number of children that families can have, inclining sex selection in favour of males. Some residual effects of such policies together with some cultural background might accompany Chinese families abroad, which could be responsible for the slightly altered sex ratio observed for this group of immigrants. However, in India, sex-selection is fully attributed to rooted cultural reasons that remain across borders. Parents from Indian females should provide a dowry that male families receive when couples get married. The obvious economic reasons together with cultural consideration of women as a weaker and less valuable part of society, whose social value resides in her capability to procreate, might be behind the more pronounced alteration of sex ratio observed for this group of immigrants in their own countries and also in Spain.

The most likely mechanism for sex-selection is sex-selective abortions. Most of the literature on altered sex-ratio among Asian women consider sex-selective abortions as the main reason to explain the altered sex ratio in favour of males [1, 5-13, 22, 27, 28]. Jha et al.[28] estimated, in a relatively recent publication that the number of selective abortions have increased in India from 2 million in 1980 to 6 million in the 2000s. In Spain, most pregnant women find out their baby's sex during their mid-pregnancy ultrasound, usually between 16 and 20 weeks (or around week 14-18 by amniocentesis). Despite that legal regulation in Spain only allows abortions during the first 14 weeks of pregnancy, the percentage of abortions carried out in Spain after 14 weeks (when women may already know the sex) was 6.17 in the last year of our study[32]. It would be of interest to have direct evidence on the incidence of abortions among Indian and Chinese women in Spain. Regrettably, available data on abortions do not report the specific country of birth of the parents. Nevertheless, indirect evidence by region of origin, based on our elaboration of data from voluntary termination of pregnancy (*Supplementary Table*

1) supplied by the Ministry of Health [32-39] and available data on births shows that the ratio of abortions per live single births is considerably higher for Asian (47% of voluntary abortions per 100 single live births in 2015) than for Spanish women (18% of voluntary abortions per 100 single live births in 2015).

The possible limitations and concerns about the data used for this study have been carefully considered and addressed. On the one hand, the estimation of the sex ratio by birth order for the whole sample and by sex of the previous births, assumes that the newborns from previous births are still alive, which might not always be true. In order to reduce this source of error, all births that occurred at or before the 23rd gestational week were excluded due to their low viability [40]. As for the remaining error, in Spain, the estimated infant mortality (0-1 year) rate has decreased gradually from 4.02 deaths/1000 births in 1990 to 3.07/1000 births in 2015. Therefore, in the worst case scenario only 7431 infants of 1,857,808 reported previous births will be dead before one year. Even adding up to these figures, the 31,297 deaths occurred in infants of ages 1 to 15 from 1990 to 2014, the total percentage of deaths in previous live births represents a very conservative estimation of 0.021% deaths of the total prior deliveries [41], which is unlikely to have an important impact in the final estimations.

Additionally, some concerns might arise from the suspicion of lower registration rate of births from non-Spanish mothers. However, some previous studies exploring the quality of data used to calculate reproductive and perinatal health indicators in native and migrant populations in some areas of Spain have demonstrated the rigor of these registries. The estimated under registration of births from immigrant mothers is very low (2-3%) and comes mainly from Latin-American, East-European and sub-Saharan women [42].

Furthermore, as explained in the methods section, for the calculation of the sex of previous live births, only deliveries from mothers that had all their children in the period 2005-2015 were included, ensuring that no information on previous live births was missing, especially for mothers from foreign countries that might had previous deliveries in their country of origin.

Finally, some sensitivity analyses were carried out. The potential effect modification of some mother's characteristics in the ratio of male:female births by area of origin was explored and no interaction was found. The same analyses presented here were also performed using father's area of origin and couple area of origin classified as no Indian/Chinese parents; both Indian; both Chinese; only mother Indian; only father Indian; only mother Chinese and only father Chinese. Similar results were obtained for Indian and Chinese-born fathers and for both Indian and both Chinese couples to the reported here for Indian and Chinese-born mothers (data not shown). This is greatly explained by the fact that, for the different analyses carried out, 85-93% of births from Indian-born mothers have Indian-born fathers and 94-97% of births from Chinese-born mothers have Chinese-born fathers.

This is the first study exploring a possible sex-ratio alteration for some immigrant groups in a country of Southern Europe. Our results show a similar pattern in sex ratio among Indian and Chinese immigrant women to that observed in their own countries or in countries from North Europe or North America. This reinforces the notion that the culture and values of the country of origin is more influential than the country of residence.

AUTHORS' ROLES / CONFLICT OF INTEREST

Adela Castelló: Analysis and interpretation of the data, drafting of the manuscript and final approval of the version to be published.

Marcelo Urquia: Conception and design of the work, critically revising the manuscript for important intellectual content and final approval of the version to be published.

M. Angeles Rodríguez-Arenas: Conception and design of the work, critically revising the manuscript for important intellectual content and final approval of the version to be published.

Francisco Bolúmar: Conception and design of the work, acquisition and interpretation of the data, drafting of the manuscript and final approval of the version to be published.

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Fig. 1 Flow chart displaying the selection process of births included in the final analyses for the whole sample and stratifying by birth order and sex of the previous births

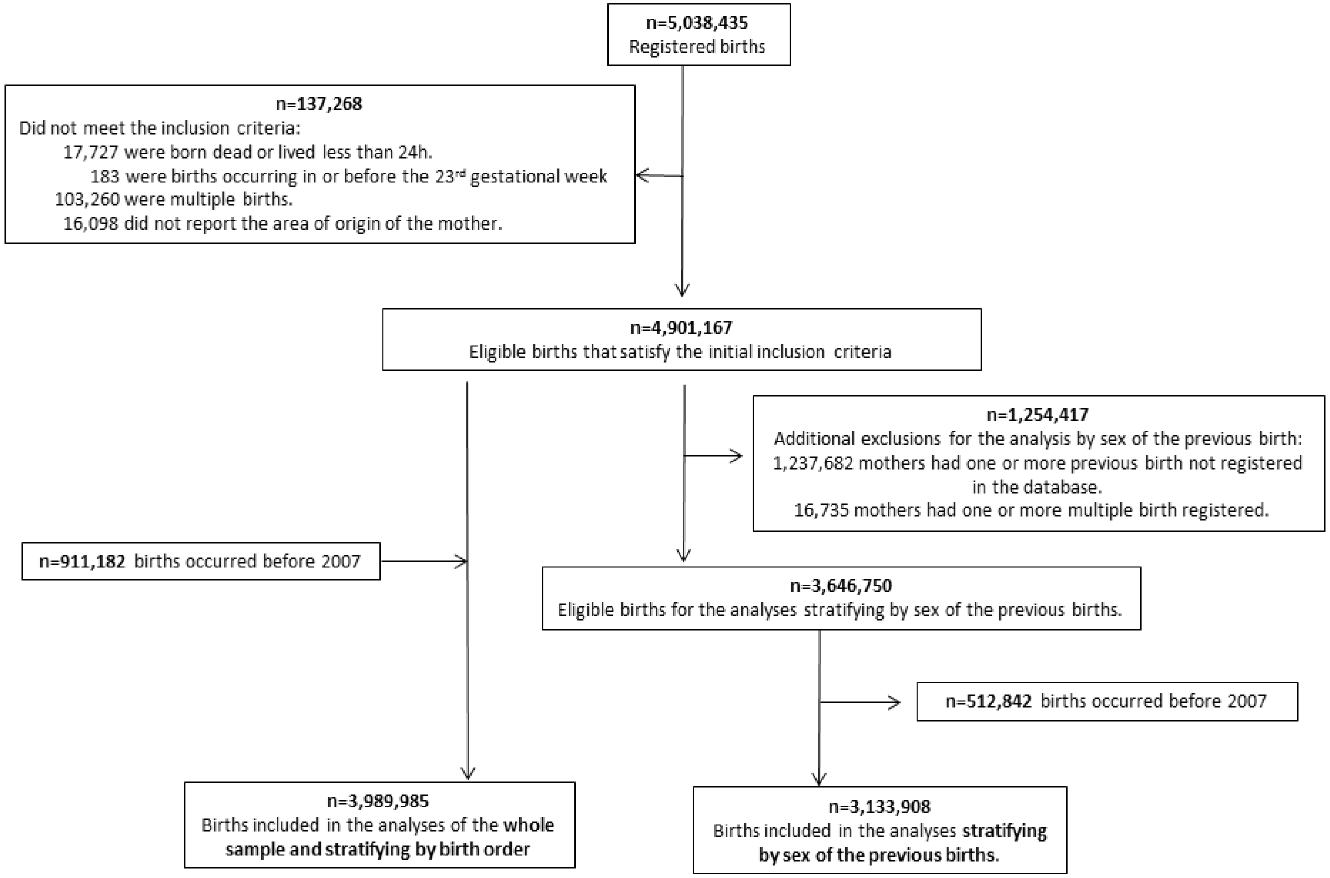

TABLE 1: Description of births' and mothers' characteristics and percentage of male births by mother's area of origin.

	All		**Native**		**East Europe**		**Rest of Europe**		**Latin America**		**North Africa**		**Sub-Saharan Africa**		**North America & Oceania**		**India**		**China**		**Rest of Asia**	
n	3,989,985		3,224,399		157,541		58,383		238,888		211,269		38,175		3,204		4,721		35,605		17,800	
% of all births			81.8		4.0		1.5		6.0		5.3		1.0		0.1		0.1		0.9		0.5	
% of males			51.6[a]		51.8[a]		51.2[a]		51.5[a]		52.0[a]		51.4[a]		51.7[a]		54.7[a]		51.8[a]		51.8[a]	
	n (%)	**% Males**	**n (%)**	**% Males**	**n (%)**	**% Males**	**n (%)**	**% Males**	**n (%)**	**% Males**	**n (%)**	**% Males**	**n (%)**	**% Males**	**n (%)**	**% Males**	**n (%)**	**% Males**	**n (%)**	**% Males**	**n (%)**	**% Males**
Year of Delivery																						
2007	470,566	51.6	381,918	51.7	17,667	51.6	6,782	50.5	34,578	51.2	20,229	52.0	3,867	50.2	333	52.0	313	50.8	3,621	50.8	1,258	53.5
2008	496,693	51.7	394,084	51.7	20,510	51.8	7,514	51.8	37,671	51.5	25,630	51.7	4,626	52.8	399	48.9	401	56.1	4,413	51.1	1,445	52.6
2009	471,290	51.8	374,319	51.8	18,193	51.7	7,331	51.7	33,336	51.9	26,144	52.1	4,962	52.1	311	52.4	497	53.5	4,645	51.4	1,552	53.3
2010	463,560	51.6	369,090	51.5	18,521	51.8	6,861	51.6	29,650	51.6	27,311	52.0	4,746	52.0	377	51.2	612	55.1	4,415	52.1	1,977	54.3
2011	449,151	51.6	362,488	51.6	17,406	51.4	6,349	51.5	26,083	51.6	24,586	51.8	4,391	50.1	347	52.2	573	55.5	4,464	51.7	2,464	50.6
2012	431,547	51.6	349,537	51.6	16,927	52.3	6,166	50.6	24,064	51.0	23,125	52.4	4,199	50.4	370	49.5	546	50.7	4,265	52.3	2,348	49.4
2013	404,507	51.5	330,582	51.6	15,677	51.1	5,810	49.9	20,338	51.6	21,891	51.6	3,660	50.7	333	53.5	576	55.6	3,425	52.8	2,215	51.3
2014	404,787	51.7	333,904	51.6	16,207	52.4	5,632	51.1	17,154	51.5	21,225	52.6	3,846	51.3	386	50.8	587	57.2	3,569	51.8	2,277	50.9
2015	397,884	51.6	328,477	51.5	16,433	51.9	5,938	51.9	16,014	51.6	21,128	51.7	3,878	52.2	348	56.0	616	56.2	2,788	53.0	2,264	52.0
Birth Order																						
1st alive birth	2,132,177	51.6	1,748,457	51.6	95,140	51.9	32,859	51.3	121,044	51.6	89,843	52.1	14,774	51.6	1,837	51.2	2,712	52.2	16,958 (47.6)	51.0	8,553	51.9
2nd alive birth	1,453,061	51.6	1,200,741	51.6	50,058	51.6	19,194	51.1	79,099	51.5	69,899	51.7	12,060	50.8	948	51.8	1,708	56.3	13,973	52.0	5,381	51.9
3rd alive birth	404,747	51.7	275,201	51.7	12,343	51.8	6,330	50.9	38,745	51.2	51,527	52.1	11,341	51.6	419)	53.7	301	68.1	4,674	54.2	3,866	51.3
Birth Weight																						
<=1500grs	25,245 (0.6)	51.7[a]	19,765	51.8	1,362	52.0	344	48.5	1,829	51.8	1,175	51.5	408	51.5	21	42.9	55	52.7	137	46.0	149	49.0
1501-2499grs	198,157	46.3[a]	166,804	46.2	7,383	46.6	2,676	46.6	9,359	47.1	7,254	46.5	1,996	45.3	124)	46.8	365	52.6	996	48.0	1,200	48.3
≥2500grs	3,570,131	51.9[a]	2,921,741	51.9	135,909	52.1	52,566	51.4	206,563	51.7	174,703	52.1	29,884	51.8	2,840	51.9	3,680	55.4	29,300	52.1	12,945	52.1
Unknown	196,452	51.8[a]	116,089	51.7	12,887	51.9	2,797	51.5	21,137	51.7	28,137	52.4	5,887	51.2	219	53.0	621	52.5	5,172	51.5	3,506	51.8
Gestational age																						
<=32 weeks	32,249	55.0[a]	24,906	55.3	1,882	53.6	437	55.1	2,651	53.6	1,444	54.9	484	51.0	24	45.8	49	57.1	217	54.4	155	58.1
33-36 weeks	159,942	55.4[a]	130,550	55.7	7,115	54.5	2,176	55.2	10,384	54.5	6,306	53.7	1,335	50.2	108	58.3	233	56.7	955	54.0	780	57.3
>36 weeks	3,093,166	51.4[a]	2,569,462	51.3	113,182	51.5	47,482	50.8	180,312	51.3	125,606	51.9	22,325	51.4	2,456	51.7	2,720	54.3	19,556	51.8	10,065	51.4
Unknown	704,628	51.8[a]	499,481	51.8	35,362	51.9	8,288	52.2	45,541	51.7	77,913	51.8	14,031	51.5	616	50.8	1,719	55.1	14,877	51.7	6,800	51.5

Mother's age																						
<20	98,579	52.0[a]	65,747	51.9	8,732	52.5	1,214	53.5	13,264	52.0	7,881	51.8	884	49.3	31	45.2	36	44.4	513	49.1	277	54.2
20-34	2,662,892	51.7[a]	2,075,692	51.7	128,027	51.8	37,514	51.1	179,206	51.6	162,594	52.1	29,639	51.5	2,074	51.3	4,197	54.8	30,377	51.7	13,572	51.6
>=35	1,228,514	51.4[a]	1,082,960	51.4	20,782	51.7	19,655	51.2	46,418	51.1	40,794	51.5	7,652	51.1	1,099	52.7	488	54.5	4,715	53.1	3,951	52.0
Mother's profession																						
Non Manual	1,799,951	51.6	1,661,354	51.6	30,745	52.0	29,196	51.0	42,540	51.4	21,472	52.4	5,274	50.9	1,717	52.2	434	57.4	4,931	53.2	2,288	51.6
Manual	997,381	51.6	784,759	51.6	55,921	51.9	13,408	51.6	65,969	51.5	44,467	51.9	10,767	52.1		47.0	754	55.8	17,900	51.3	3,038	50.9
Doesn't work	911,943	51.7	600,610	51.7	53,813	51.5	11,042	51.0	103,267	51.5	110,494	52.0	15,360	50.8	836	52.0	2,308	53.9	6,440	52.6	7,773	51.9
Non Classified	68,990	51.9	49,953	52.0	4,313	51.3	1,193	51.4	6,646	52.2	4,601	52.3	977	46.3	37	54.1	45	40.0	986	52.6	239	53.1
Unknown	211,720	51.7	127,723	51.7	12,749	52.1	3,544	51.6	20,466	51.4	30,235	51.6	5,797	52.8	216	55.1	1,180	55.3	5,348	51.2	4,462	52.2
Mother's education																						
Primary	1,408,059	51.7[a]	980,225	51.7	76,561	51.8	14,926	51.7	119,458	51.5	158,858	52.0	24,639	51.1	331	49.8	2,590	53.9	21,780	51.7	8,691	51.0
Secondary	1,066,355	51.5[a]	916,664	51.5	39,522	51.6	15,498	50.9	66,056	51.4	16,420	52.3	4,422	51.4	613	54.8	713	55.7	3,672	50.8	2,775	52.1
University or More	1,239,937	51.6[a]	1,154,432	51.6	20,384	52.2	23,199	50.9	27,598	51.5	7,531	51.2	1,408	52.6	1,912	50.8	397	58.2	1,357	52.3	1,719	53.8
Missing	275,634	51.8[a]	173,078	51.7	21,074	51.7	4,760	52.2	25,776	51.7	28,460	52.0	7,706	52.1	348	52.9	1,021	54.8	8,796	52.5	4,615	52.2
Married																						
Yes	2,492,156	51.6	2,041,229	51.6	83,351	51.9	27,248	50.9	97,735	51.4	177,677	52.0	21,573	51.5	2,693	51.6	3,985	55.1	22,428	52.2	14,237	51.4
No	1,497,829	51.6	1,183,170	51.6	74,190	51.7	31,135	51.5	141,153	51.6	33,592	52.1	16,602	51.1	511	52.4	736	53.0	13,177	51.3	3,563	53.2

[a] Statistically significant differences in the percentage of male births across categories with p-values<0.05 calculated with chi-squared test.

TABLE 2: Male:Female ratios of singleton live births in Spain from 2007 to 2015 by mother's area of birth.

	ALL		
	n=3,989,985		
	Females	**Males**	
n	1929731	2060254	
% of all births	48.4	51.6	
Mother's area of birth	**n(%)**	**n(%)**	**Male:Female Ratio (95%CI)**
Native	1,560,004 (48.4)	1,664,395(51.6)	1.07 (1.06;1.07)
East Europe	75,957 (48.2)	81,584(51.8)	1.07 (1.06;1.08)
Rest of Europe	28,489 (48.8)	29,894(51.2)	1.05 (1.03;1.07)
Latin America	115,842 (48.5)	123,046(51.5)	1.06 (1.05;1.07)
North Africa	101,452 (48)	109,817(52)	1.08 (1.07;1.09)
Sub-Saharan Africa	18,568 (48.6)	19,607(51.4)	1.06 (1.03;1.08)
North America and Oceania	1,547 (48.3)	1,657(51.7)	1.07 (1.00;1.15)
India	2,137 (45.3)	2,584(54.7)	1.21 (1.14;1.28)
China	17,150 (48.2)	18,455(51.8)	1.08 (1.05;1.10)
Rest of Asia	8,585 (48.2)	9,215(51.8)	1.07 (1.04;1.11)

TABLE 3: Male:Female ratios of singleton live births in Spain from 2007 to 2015 by mother's country of birth stratified by maternal parity.

	1st Birth			2nd Birth			+3rd Birth		
	n(%)=2,132,177 (53.4)			**n(%)**=1,453,061 (36.4)			**n(%)**=404,747(10.1)		
	Females	**Males**		**Females**	**Males**		**Females**	**Males**	
n	1,031,504	1,100,673		702,843	750,218		195,384	209,363	
% of all births	48.4	51.6		48.4	51.6		48.3	51.7	
Mother's area of birth	**n(%)**	**n(%)**	**Male:Female Ratio (95%CI)**	**n(%)**	**n(%)**	**Male:Female Ratio (95%CI)**	**n(%)**	**n(%)**	**Male:Female Ratio (95%CI)**
Native	846,361 (48.4)	902,096 (51.6)	1.07 (1.06;1.07)	580,703 (48.4)	620,038 (51.6)	1.07 (1.06;1.07)	132,940 (48.3)	142,261 (51.7)	1.07 (1.06;1.08)
East Europe	45,780 (48.1)	49,360 (51.9)	1.08 (1.06;1.09)	24,226 (48.4)	25,832 (51.6)	1.07 (1.05;1.09)	5,951 (48.2)	6,392 (51.8)	1.07 (1.04;1.11)
Rest of Europe	15,989 (48.7)	16,870 (51.3)	1.06 (1.03;1.08)	9,394 (48.9)	9,800 (51.1)	1.04 (1.01;1.07)	3,106 (49.1)	3,224 (50.9)	1.04 (0.99;1.09)
Latin America	58,587 (48.4)	62,457 (51.6)	1.07 (1.05;1.08)	38,366 (48.5)	40,733 (51.5)	1.06 (1.05;1.08)	18,889 (48.8)	19,856 (51.2)	1.05 (1.03;1.07)
North Africa	43,025 (47.9)	46,818 (52.1)	1.09 (1.07;1.10)	33,732 (48.3)	36,167 (51.7)	1.07 (1.06;1.09)	24,695 (47.9)	26,832 (52.1)	1.09 (1.07;1.11)
Sub-Saharan Africa	7,152 (48.4)	7,622 (51.6)	1.07 (1.03;1.10)	5,928 (49.2)	6,132 (50.8)	1.03 (1.00;1.07)	5,488 (48.4)	5,853 (51.6)	1.07 (1.03;1.11)
North America and Oceania	896 (48.8)	941 (51.2)	1.05 (0.96;1.15)	457 (48.2)	491 (51.8)	1.07 (0.95;1.22)	194 (46.3)	225 (53.7)	1.16 (0.96;1.41)
India	1,295 (47.8)	1,417 (52.2)	1.09 (1.01;1.18)	746 (43.7)	962 (56.3)	1.29 (1.17;1.42)	96 (31.9)	205 (68.1)	2.13 (1.68;2.72)
China	8,303 (49.0)	8,655 (51.0)	1.04 (1.01;1.07)	6,704 (48.0)	7,269 (52.0)	1.08 (1.05;1.12)	2,143 (45.8)	2,531 (54.2)	1.18 (1.12;1.25)
Rest of Asia	4,116 (48.1)	4,437 (51.9)	1.08 (1.03;1.12)	2,587 (48.1)	2,794 (51.9)	1.08 (1.02;1.14)	1,882 (48.7)	1,984 (51.3)	1.05 (0.99;1.12)

TABLE 4: Male:Female ratios of singleton live births in Spain from 2007 to 2015 by mother's country of birth and stratified by sex of the previous births.

	1st Delivery			**>1st Delivery: No previous Males**			**>1st Delivery: +1 Previous male**		
	n(%)=2,110,879(67.4)			**n(%)**=468,513(14.9)			**n(%)**=554,516(17.7)		
	Females	**Males**		**Females**	**Males**		**Females**	**Males**	
n	1,021,259	1,089,620		227,735	240,778		266,214	209,363	
% of all births	48.4	51.6		48.6	51.4		48.0	51.7	
Mother's area of birth	**n(%)**	**n(%)**	**Male:Female Ratio (95%CI)**	**n(%)**	**n(%)**	**Male:Female Ratio (95%CI)**	**n(%)**	**n(%)**	**Male:Female Ratio (95%CI)**
Native Born	839,160 (48.4)	894,157 (51.6)	1.07 (1.06;1.07)	202,705 (48.6)	214,285 (51.4)	1.06 (1.05;1.06)	236,875 (48)	256,345 (52)	1.08 (1.08;1.09)
Eastern Europe	45,499 (48.1)	49,071 (51.9)	1.08 (1.06;1.09)	4,448 (49.3)	4,583 (50.7)	1.03 (0.99;1.07)	4,955 (48)	5,373 (52)	1.08 (1.04;1.13)
Rest of Europe	15,865 (48.6)	16,750 (51.4)	1.06 (1.03;1.08)	2,223 (49.5)	2,272 (50.5)	1.02 (0.96;1.08)	2,470 (48)	2,681 (52)	1.09 (1.03;1.15)
Latin America and Car	58,053 (48.4)	61,914 (51.6)	1.07 (1.05;1.08)	5,330 (48.4)	5,673 (51.6)	1.06 (1.03;1.10)	6,204 (47.7)	6,790 (52.3)	1.09 (1.06;1.13)
North Africa	41,592 (47.9)	45,305 (52.1)	1.09 (1.07;1.10)	9,340 (48.5)	9,898 (51.5)	1.06 (1.03;1.09)	11,484 (47.5)	12,700 (52.5)	1.11 (1.08;1.13)
Sub-Saharan Africa	6,836 (48.5)	7,260 (51.5)	1.06 (1.03;1.10)	1,191 (47.6)	1,310 (52.4)	1.10 (1.02;1.19)	1,575 (48.9)	1,646 (51.1)	1.05 (0.98;1.12)
North America and Oceania	889 (48.8)	932 (51.2)	1.05 (0.96;1.15)	129 (52.4)	117 (47.6)	0.91 (0.71;1.16)	108 (48.2)	116 (51.8)	1.07 (0.83;1.40)
India	1,278 (47.5)	1,410 (52.5)	1.10 (1.02;1.19)	144 (39.8)	218 (60.2)	1.51 (1.23;1.87)	137 (46.4)	158 (53.6)	1.15 (0.92;1.45)
China	8,107 (48.8)	8,505 (51.2)	1.05 (1.02;1.08)	1,651 (47.6)	1,817 (52.4)	1.10 (1.03;1.18)	1,732 (49.3)	1,780 (50.7)	1.03 (0.96;1.10)
Rest of Asia	3,980 (48)	4,316 (52.0)	1.08 (1.04;1.13)	574 (48.7)	605 (51.3)	1.05 (0.94;1.18)	674 (48.6)	713 (51.4)	1.06 (0.95;1.18)