1. Introduction

Many pre-industrial societies regulated population size by resorting to infanticide and the mortal neglect of unwanted infants and children (Langer 1974; Harris and Ross 1987; Hrdy 1999; Hanlon 2016). These practices have traditionally targeted girls in India, China and Japan, among other countries characterised by strong patriarchal traditions that favour males (Sen 1990; Das Gupta 2003; Bhaskar and Gupta 2007; Drixler 2012; Gupta 2014). Although women's status in historical Europe was definitely more advantageous than in other parts of the world, Europe was not a gender-equal paradise and women were discriminated in many dimensions (Szoltysek et al. 2017; Carmichael and Rijpma 2017; Dilli et al. 2019). Son preference, affecting the propensity to have additional children, was indeed present in many regions in pre-industrial Europe (Kolk 2011; Manfredini et al. 2013, Sandström and Vikström 2015, Reher and Sandström 2015)[1].

There is, however, little evidence that European families neglected their female babies. Derosas and Tsuya (2010), for instance, found no clear pattern of female infanticide in the three samples that they were analysing: Casalguidi in Italy (1819-1859), Sart in Belgium (1812-1874) and Scania in Sweden (1829-1867). Summarising this view, Lynch (2011) argues that the household formation patterns, as well as cultural and religious values, prevented female infanticide in historical Europe. Several studies have though challenged this view and suggested that families resorted to female infanticide as a means of controlling the size and sex composition of their offspring in different regions and periods (Bechtold 2000; Hynes 2011; Hanlon 2016; Beltrán Tapia and Raftakis 2019)[2].

Relying on longitudinal micro data from a small rural region in North-eastern Spain between 1750 and 1950, this article evidences that discriminatory practices increased female at birth. Firstly, aggregate sex ratios obtained from baptismal records were exceptionally high, even during the 19th century when the quality of registration was very high. Secondly, the data shows that having no previous male siblings, a feature that could trigger discrimination in the presence of son preference, increased both the probability of male baptisms and female mortality around birth during this period. Taken together, these results strongly support the idea that these families were neglecting a significant fraction of their female babies in 19th-century Spain.

These findings seem to be concentrated at higher parities and among landless and semi-landless families which were subject to harsher economic conditions and therefore more likely to resort to extreme decisions under difficult circumstances. Crucially, the fact that the results are robust to employing data from birth and death registers rules out the possibility that under-registration explains this pattern: although female misreporting would bias sex ratios at birth upwards, it would have the opposite effect with mortality rates. Lastly, although these practices were definitely more important during the traditional demographic regime, discriminatory patterns affecting female mortality shortly after birth were still visible during the first decades of the 20th century, thus proving that son preference continued to be a strong cultural norm within these societies.

This article supports previous studies that challenged the idea that there were no missing girls in historical Europe (Beltrán Tapia and Gallego-Martínez 2017; Beltrán Tapia 2019). In

[1] See also Bohnert et al. (2012) for the US.

[2] Interestingly, Hynes (2011) and Hanlon (2016) consider that families could also target boys depending the circumstances. Another strand of the literature suggests that gender-discriminatory practices unduly increased female mortality during infancy and childhood via an unequal allocation of food, care and/or workload (Tabutin 1978; Johansson 1984; Pinnelli and Mancini 1997; Baten and Murray 2000; McNay et al. 2005; Horrell and Oxley 2016; Beltrán Tapia and Gallego-Martínez 2017; 2020; Beltrán Tapia 2019).

this regard, it shows that the high sex ratios in infancy and childhood found in previous studies are not driven by problems with the quality of the registers, but by female excess mortality. In addition, the micro-data used here sheds light on how these societies ended up showing unbalanced number of boys and girls by illustrating that an important fraction of these missing girls were neglected at birth. While the neglect of female babies was possibly a conscious family decision that affected a relatively small number of families under certain circumstances, our data cannot distinguish whether the death of infant girls was the result of direct female infanticide or more indirect forms of mortal neglect (starvartion, smothering, exposure, etc.)[3]. Given that anecdotal evidence hardly exists, it seems that families succeeded in disguising female infanticide as natural deaths.

Likewise, the finding that families neglected female infants suggests that these societies regulated the size and sex composition of their offspring despite the religious norms against it. The dominant view defends that the low number of children raised in European families was the result of different ways of reducing fertility. This could be achieved either indirectly via high age at marriage and a high singleness rate (Hajnal 1965; Wrigley and Schofield 1981), or directly by adjusting birth intervals or implementing fertility-stopping rules (Schofield 2000; Van Bavel 2004; Bengtsson and Dribe 2006; Reher and Sanz-Gimeno 2007; Marco-Gracia 2019; 2020)[4]. Our results imply that some sort of "death control" was also present (Langer 1974; Harris and Ross 1987; Hrdy 1999; Hanlon 2016; 2017). Resorting to infanticide could have been a drastic solution to regulate fertility, especially in already large families subject to economic stress. In this regard, girls entailed a larger burden to the household income because both the need to provide a dowry militated against girls and because there were less female waged labour opportunities (and worse paid)

The evidence provided here shows that families especially targeted girls, but boys could have undoubtedly fell victims of these practices as well. The fact that families somewhat increased the mortality of their children also has implications for our understanding of the demographic transition. The subsequent reduction of mortality rates would therefore partly respond to the relaxation of these practices. Likewise, many of these infanticides were never registered as births or deaths, thus indicating that fertility and mortality rates in pre-industrial Europe were higher than what it has been traditionally assumed.

Our findings are especially relevant because they take place in an area where nuclear households prevailed and inheritances were equally distributed among all children, regardless of their sex. Likewise, women maintained full control of the resources they brought to the marriage and were entitled to freely dispose of their patrimony through wills at their death (Jarque Martínez and Salas Ausens 2007, 126-127). Moreover, although it is true that women did not enjoy the same status in the labour market than men (lower salaries, less workdays, etc.), female waged labour was widespread and their contribution was crucial to sustain the household economy (Borderías et al. 2018; Germán Zubero 2009, Lana Berasain 2007). These features are not particularly related to patriarchal societies (Szoltysek et al. 2017), so the results open up the possibility of finding similar or even more extreme manifestations of son preference in other European regions.

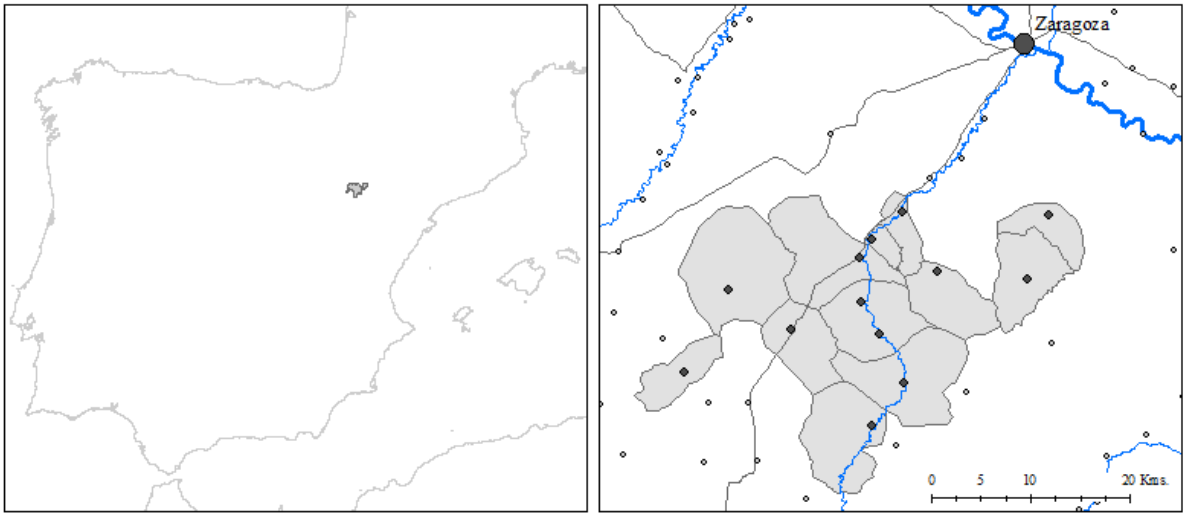
[3] See Langer (1972) for the different ways that families could dispose of unwanted children.

[4] See Van de Walle (1992) on the debate about whether an ideal family size existed before the demographic transition.

2. Data and historical background

This study focuses on a small rural area in Aragon, in North-Eastern Spain, that is located around 19-40 kilometres away from Zaragoza, the regional capital (see Map 1). This area, a combination of plains and foothills near the Huerva river, comprises 13 small municipalities[5]. Their total population was approximately 5,525 inhabitants in 1750, 8,315 in 1857 and 9,556 in 1950. The statistical analysis relies on the complete Church registers of these villages, whose records provide high-quality information on all baptisms, marriages and deaths that occurred between 1575 and 1999 (although the starting date varies by location; more details about the 'Alfamén and Middle Huerva Database' in Marco-Gracia 2017; 2019). Document 1 in the appendix offers an example of these registers. In total, this dataset contains information on 88,989 individuals (84,686 up to 1950), including name, sex, place and date of birth, parents' names and date of death, among others, thus permitting the reconstitution of the life history of these individuals and their families. This longitudinal dataset has also been complemented with information on occupation and literacy contained in population lists (1747-1830), population censuses (1857, 1860) and electoral rolls (1890-1955)[6]. Table A1 in the Appendix provides the number of observations by period, classified by sex, father's occupation and father's literacy.

Map 1. Area of study: Middle Huerva (Aragón, Spain)



Note: Dark dots refer to the localities studied here (except Zaragoza, the provincial capital) and the corresponding shaded areas to their municipal boundaries. Apart from rivers (in blue) and main roads (grey), the map also depicts neighbouring villages (white dots).

[5] The localities are: Alfamén, Aylés, Botorrita, Cosuenda, Jaulín, Longares, Mezalocha, Mozota, Muel, Torrecilla de Valmadrid, Tosos, Valmadrid, and Villanueva de Huerva.

[6] The information on father's occupation has been grouped into six categories: (1) day-labourers and small owners who were unable to make a living exclusively from their properties, (2) farmers with enough land to secure their livelihood, (3) sheep and goat shepherds, (4) artisans, (5) elites, mostly doctors, teachers and council representatives, and (6) other occupations, a heterogenous group including mule drivers, soldiers, low-skilled occupations working for the municipality, among other occupation that do not fit within the other groups. Due to the lack of information, data on occupations and literacy is missing for around one-third of the individuals. This scarcity is more important in the earlier periods and very low in the final years analysed here.

We should bear in mind however that registration quality greatly improved from 1750 onwards. Infant and child mortality rates before that date are too low, so under-registration of deaths is likely to be an issue. Although registration quality had been improving throughout the 18th century, the year 1774 was especially important: the priests in these villages received a pastoral visit conveying the orders from the Archbishop of Zaragoza. These mandates emphasized the importance of keeping accurate and detailed parish records[7]. We will therefore restrict most of our analysis to the period 1750-1950.

The area of study, 13 villages covering around 500 kms^2, hosted a population who mostly lived in nuclear households and was essentially devoted to agriculture (mostly wheat and some wine) and sheep grazing. Our records show that around 85 per cent of the male working population was engaged in the agricultural sector between 1800 and 1950. Average fertility was relatively stable around 6-7 children among complete families up to 1900 and declined rapidly thereafter following the demographic transition. Infant and child mortality rates were very high though and only around half of the children survived to their fifth birthday.

Mortality rates began to decline in the last third of the 19th century due to increasing living standards. The decline firstly benefited children in their late childhood and spread later to younger cohorts. Infants were the last one to join this trend and their survival chances only significantly increased from 1900 onwards when hygienic conditions and their mothers' health improved, an improvement that was especially visible during early childhood. Anthropometric evidence also indicates that standards of living were extremely low: the average male height was around 160 centimetres in mid-19th-century, well below their European counterparts or their fellow Spanish in other regions (Martínez-Carrión et al. 2016; Hatton and Bray 2020). In an area where most of the population enjoyed living standards close to subsistence levels, choices mattered and discriminatory practices could have had lethal consequences.

Although the quantitative information provided by the sources is exceptional, qualitative evidence on how parents treated their children is scarce or non-existent. Although the inheritance system prescribed that all property was divided equally among all children, son preference seems to have formed part of the shared norms in this area during the period of study. In this regard, Spanish women did not enjoy the same status as men: legally subordinated to their fathers and husbands, women were expected to remain within the domestic realm and those who did work in paid jobs received significantly lower wages (Camps 1998; Sarasúa 2002; Borderías et al. 2010; Borderías and Muñoz 2018).

The custom of the dowry was also something that militated against girls as plenty of studies have documented for regions in South and East Asia (Das Gupta et al. 2003; Bhalotra et al. 2020)[8]. Many state regulations frequently attempted to limit this practice in order to make it less onerous (Martín Rodríguez 1984, 264). Coherent with the state's interests in promoting fertility (so as to strengthen the nation with man and military power), the reason behind restricting the amount that parents had to pay their daughters to secure their marriages was mainly to facilitate weddings (and subsequently fertility). It however clearly implies that this practice was a burden for the families. The norm itself, consigned in the *Pragmática* of 1623 but alive during the period of study here, indicated that the costs associated with the dowry had detrimental consequences for families' estates because they sometimes had to borrow the money. In this regard, Harding (1984: 103) mentions that a farmer lost his family state in the late 19th century because it had to provide dowries for his eight daughters.

[7] While birth registers before that date only reported the name of the parents, they began to include that of grandparents. Death registers similarly now included the names of their relatives. Likewise, these records now reported not only where these people lived but also where they were born.

[8] See also Beltrán Tapia and Raftakis (2019) on the discriminatory effect of the dowry in 19th-century Greece.

Fertility decisions seemed to have indeed been related to the sex composition of the surviving children (Reher and Sanz-Gimeno 2007, Reher and Sandström 2015; Marco-Gracia forthcoming). Those families who did not have previous sons not only were more likely to continue bearing more children but also had shorter birth intervals, so fertility control strategies where used to control fertility and ensure at least a male heir. Reher and González-Quiñones (2003) also found that the probability of dying of daughters increased more than that of boys after the death of the mother, thus suggesting that son preference was stronger for fathers. It also appears that women were discriminated through an unequal allocation of resources within the household, both in terms of nutrition and educational investments (Sarasúa 2002; Borderías et al. 2014). As well as to the relative backwardness of this area, literacy rates also testify to how unequally parents treated boys and girls: while around 40 per cent of men were literate in 1860, less than 5 per cent of women were able to read and write. Next sections address whether these underlying attitudes towards boys and girls translated into their respective survival chances at birth.

3. Aggregate sex ratios at birth

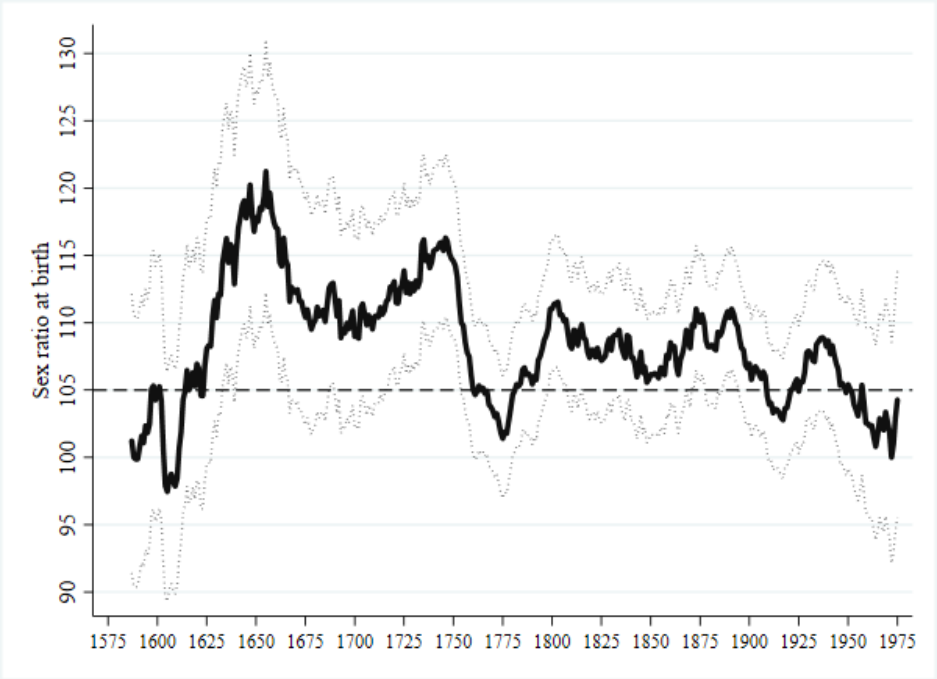
Baptism registers provide the name, sex, place and date of birth, parents' and godparents' names. Our records contain a total of 88,989 baptisms between 1575 and 1999. Although they are not birth registers, this information was registered quickly after birth because catholic beliefs stressed that if a child died without baptism, he or she could not enter heaven and ensure spiritual salvation (Hanlon 2016, 536; Minello et al. 2017). Our information confirms that new-borns were baptised within the same day that they were born from the late 18th century to the 1880s. The distance between birth and baptism increased in the following decades due to the decline in mortality rates and changing social and religious behaviour. Figure 1 plots sex ratios at baptism between 1575 and 1975. The number of boys per hundred girls remained exceptionally high between 1625 and 1750, averaging 113.5 (17,868 births). While the second half of the 18th century witnessed relatively balanced sex ratios at birth, these figures increased again during the 1790s and remained relatively high during the whole 19th century, and especially so in the 1800s and the 1860-1880s (reaching figures above 110 boys per hundred girls). The average sex ratio during the whole 19th century was 108.8, high enough to be statistically different from 105 at the 99 per cent confidence level (33,421 births; p-value=0.0006). Sex ratios became relatively normal from 1900 and remained so during the 20th century. As discussed in the previous section, registration quality greatly improved during the second half of the eighteenth century. Thus, our subsequent analysis will exclude the period before 1750. By doing so, we are adopting a conservative research strategy that disregards the most extreme sex ratio and therefore mitigates the possibility of finding spurious results.

Moreover, although we follow the literature in using 105, the "natural" sex ratio at birth, as our benchmark for comparison (Chao et al. 2019), the historical figure in absence of human manipulation might be slightly lower, thus making our findings even more significant. The probability of miscarriages is higher in high-mortality environments (Woods 2009). Given that the female survival advantage also exists in utero (Di Renzo et al. 2007; Dipietro and Voegtline 2017), more boys are expected to die before birth, thus pushing down the "natural" sex ratio at birth[9]. There is very little research on how this figure should look like in historical populations (Visaria 1967; Chahnazarian 1988), but modelling the evolution of sex ratios at birth over time

[9] The mechanisms behind the higher vulnerability of male foetuses are still largely unknown (Dipietro and Voegtline 2017). As well as in perinatal and neonatal mortality, the female biological advantage continues through infancy and childhood (Waldron 1998; Drevenstedt et al. 2008; United Nations 2011; Peacock et al. 2012; Peelen et al. 2017; Zarulli et al. 2018).

in Europe (1750-2015) using the Human Mortality Database yields an estimated figure close to 104 in high-mortality environments as those existing in 18th- and 19th-century Spain (see figure A1 in the Appendix)[10], thus making the figures observed here even more extreme. It is important to note that this historical estimate should be considered as a maximum threshold because it is based on observed sex ratios at birth, thus potentially including information from countries where female infants were being neglected[11].

Fig. 1. Sex ratios at baptism, 1575-1975



Note: 25-year moving average. Dotted lines represent the 95 per cent confidence interval. Source: AMHDB.

Although female under-registration could have been an issue before 1750, it is very unlikely that it explains the extreme figures observed during the 19th century. In this regard, baptism was free of charge, so there were no incentives to avoid registration[12]. It is possible though that families did not register a child if he or she died shortly after birth in order to avoid the funeral fee (or if these families thought that the child was going to die shortly). If this was the case, sex ratios at birth can be considered net of neonatal deaths. This potential issue however would not prevent detecting female infanticide and/or neglect. Due to the female biological advance, more boys would be expected to die during the first hours and therefore being under-reported. However, as mentioned before, religious beliefs powerfully dictated that children should be baptised as soon as possible, so it is very unlikely that new-borns went

[10] If under-registration of births was higher for girls in the past, this figure would be even lower because the sex ratios observed in the 18th and 19th centuries would be biased upwards.

[11] In this regard, sex ratios at birth in Mediterranean countries tend to be relatively high, especially in earlier periods. Unfortunately, the series for Eastern European countries do not usually allow looking at the period before 1950.

[12] In 1697, the synodal constitutions of the Archbishopric of Zaragoza established which ceremonies celebrated in the province were free and which ones involved paying a fee (and its amount). These constitutions were valid until 1943.

unregistered. Moreover, the distance between birth and baptism is very similar for boys and girls in all periods analysed here, thus suggesting that there were no sex differences baptismal patterns.

Importantly, during the Epiphany Mass, the first festivity of each year (January 6), the local priest read aloud all birth, marriage and death registers for the previous year to make sure every event was recorded[13].The priest consigned in the source that this reading was made during the *Misa Mayor*. Claims happened rarely, thus evidencing the high-quality of the records. When they were made, a register was added to the previous year's book. This procedure was also in the interest of the families because the existence of the Church register was required for many subsequent formalities (such as getting married, etc.). If under-registration is not likely, such extreme sex ratios can only occur if families were disposing of some of their female babies before getting baptised[14].

3. Individual characteristics and the probability of being born male

Analysing the individual-level information associated to each of these births allows shedding light on the behavioural nature behind these high sex ratios. Given that twins not only suffered extremely high mortality rates, but also generated an unexpected shock to the household resources that can distort our analysis, we have excluded from the analysis those children born in families who raised twins. Apart from mitigating unobserved heterogeneity, this approach allows us to unveil discriminatory practices taking place within ordinary families. The restricted sample contains 45,325 individuals born between 1750 and 1950. Table A2 in the appendix shows that this restriction hardly affects the socio-economic composition of our sample. If anything, the fraction of males is now lower, so excluding these children implies adopting a conservative research strategy because it reduces the likelihood of detecting practices that resulted in a higher number of male baptisms.

Table 1 reports the results of estimating a logit model assessing whether probability of being male at birth is related to different individual characteristics: birth parity, the number of children alive at the moment of birth and the sex composition of those previous children. Theoretically, the probability of being male or female at birth is independent of the sex of previous children. In this regard, panels A and B compare whether what matters is having no males or no females siblings alive at the moment of birth. While column (1) presents the baseline specification, column (2) adds a set of control variables: mother's age, father's occupation and literacy, and village and period fixed effects. Lastly, columns (3) to (6) repeat the analysis focusing on different parities. Table A3 in the appendix reports summary statistics of the variables employed here.

[13] The Epiphany celebrates the revelation that God is incarnated as Jesus Christ and is probably one of the most important Catholic celebrations, so all village gathered for the *Misa Mayor* (Major Mass). Our records indicate that this mechanism to correct potential errors in the records was at a place at least from the late 18th century.
[14] Differential-stopping rules do not affect societal sex ratios at birth (Basu and De Jong 2010, 523).

Table 1. Probability of being male at baptism, 1750-1900

	Dep. Variable: Probability of being male at birth					
PANEL A	All births		Parity 2	Parity 3	Parity 4	Parity 5+
	(1)	(2)	(3)	(4)	(5)	(6)
Children alive at birth	-0.005	-0.009	-0.059	0.020	0.146**	-0.044
	(0.010)	(0.026)	(0.114)	(0.118)	(0.064)	(0.031)
No males at birth	-0.003	0.055	-0.125	0.184	0.457***	-0.116
	(0.018)	(0.113)	(0.172)	(0.161)	(0.143)	(0.119)
Parity:						
Child order = 2	0.022	0.078				
	(0.028)	(0.072)				
Child order = 3	0.014	0.233***				
	(0.033)	(0.084)				
Child order = 4	0.041	0.235**				
	(0.057)	(0.104)				
Child order = 5+	0.013	0.188				
	(0.046)	(0.127)				
Controls	NO	YES	YES	YES	YES	YES
Observations	33,101	6,510	1,102	973	830	2,384
Pseudo R2	0.000	0.003	0.009	0.009	0.024	0.005
PANEL B	All births		Parity 2	Parity 3	Parity 4	Parity 5+
	(1)	(2)	(3)	(4)	(5)	(6)
Children alive at birth	0.001	-0.024	0.066	-0.073	0.001	-0.016
	(0.010)	(0.023)	(0.218)	(0.080)	(0.068)	(0.030)
No females at birth	0.033	-0.032	0.125	-0.111	-0.189	0.058
	(0.028)	(0.071)	(0.172)	(0.121)	(0.167)	(0.162)
Parity:						
Child order = 2	0.031	0.057				
	(0.029)	(0.065)				
Child order = 3	0.026	0.203***				
	(0.038)	(0.066)				
Child order = 4	0.054	0.200***				
	(0.060)	(0.048)				
Child order = 5+	0.021	0.164				
	(0.047)	(0.102)				
Controls	NO	YES	YES	YES	YES	YES
Observations	33,101	6,510	1,102	973	830	2,384
Pseudo R2	0.000	0.003	0.009	0.008	0.019	0.004

Coefficients estimated using a logit regression model. Robust standard errors in parentheses (clustered at the village level); *** p<0.01, ** p<0.05, * p<0.1; For simplicity, the intercept is not reported. Controls include mother's age, father's occupation, father's literacy, village and period fixed effects.

As shown in column (2), the probability of being male clearly increases with parity, especially for those children born third or fourth. This might be expected providing that perinatal and in utero mortality is mitigated in subsequent pregnancies and therefore especially

benefits boys that tend to die more when subject to tougher conditions[15]. Interestingly, when each parity is analysed independently, the probability of being a boy increases in parity 4 when there are no previous males alive, an effect that is not visible if there are no previous females alive (see how column 5 compares in panels A and B). It appears that the pressure to have a boy increased at high parities in those families that did not have any male descendant to the point to significantly alter the natural sex variability. In particular, at parity 4 and controlling for the other variables in the model, not having any boy alive increased the estimated probability of being male at birth from 50.9 to 61.8 per cent.

In order to further explore how these issues may have evolved over time, table 2 replicates the analysis for different periods (1750-1850, 1850-1900 and 1900-1950) and only focusing on those births happening at parity 4. The results show that the likelihood of having a son baptised significantly increased when there are no males in the family up to 1900. Having only girls however did not alter the sex ratio at birth during this period. This contrast is no longer visible after 1900 when having no male or female siblings does not affect the sex of the new baby. This implies that son preference was especially marked during the traditional demographic regime, a result that was also apparent when looking at crude sex ratios at birth (figure 1). The fact that this finding disappears in the early 20th century is compatible with a relaxation of cultural norms about the need of having male descendants. In this regard, improved living standards is likely to have mitigated economic constraints and the demographic transition towards lower fertility and mortality levels may have also altered parents' perceptions about their children's mortality and therefore their behaviour[16]. Likewise, the increasing availability of female labour opportunities, especially in the neighbouring Zaragoza, may have also affected the perceived relative value of girls.

Table 2. Probability of being male at baptism at parity 4 (by period), 1750-1950

	Dep. Variable: Probability of being male at birth (at parity=4)					
PANEL A	1750-1850		1850-1900		1900-1950	
	(1)	(2)	(3)	(4)	(7)	(8)
No males at birth	0.163*	0.759*	0.267***	0.371**	-0.282**	0.083
	(0.084)	(0.455)	(0.088)	(0.167)	(0.120)	(0.113)
Controls	YES	YES	YES	YES	YES	YES
Additional controls	NO	YES	NO	YES	NO	YES
Observations	2,402	163	1,618	677	1,407	749
Pseudo R2	0.007	0.081	0.008	0.025	0.009	0.013

	Dep. Variable: Probability of being male at birth (at parity=4)					
PANEL B	1750-1850		1850-1900		1900-1950	
	(1)	(2)	(3)	(4)	(7)	(8)
No females at birth	-0.051	-0.822	-0.090	-0.044	0.167	0.015
	(0.076)	(0.521)	(0.075)	(0.170)	(0.185)	(0.184)
Controls	YES	YES	YES	YES	YES	YES
Additional controls	NO	YES	NO	YES	NO	YES
Observations	2,402	163	1,618	677	1,407	749
Pseudo R2	0.006	0.089	0.006	0.021	0.008	0.013

[15] Notice that column (2) controls for mother's age, a dimension that would have the opposite effect. When mother's age is not included, in column (1), this effect is not visible, probably due to having two countervailing effects: while mother's age increases perinatal and in utero mortality, having several pregnancies decreases it.

[16] Although it has been argued that parental indifference to their infants was very common in high-mortality contexts (Ariès 1979; Zelizer 1985), Woods (2003) was highly sceptical about this hypothesis.

Coefficients estimated using a logit regression model. Robust standard errors in parentheses (clustered at the village level); *** p<0.01, ** p<0.05, * p<0.1; For simplicity, the intercept is not reported. The first set of controls include the number of children alive at birth, village and period fixed effects. The additional controls include mother's age and father's literacy.

Although splitting the analysis by occupation makes the results noisier due to reduced samples, it seems that female neglect around birth was concentrated among landless and semi-landless families. In this regard, table 3 shows that having no male offspring at parity 4 increases the probability of a male birth for the latter group but not for farmers[17]. These families were subject to harsher economic conditions and therefore more likely to resort to extreme decisions under difficult circumstances. Not only the expectation of having to provide a dowry militated against girls, but also labourers relied on the demand for waged agricultural labour and this clearly favoured males. In this regard, while the farmers' daughters could work on the family farm, it was difficult for landless families to find paid jobs for their daughters. This circumstance also made boys more attractive because they could better complement the family income.

Table 3. Probability of being male at baptism (at parity 4) by occupation, 1750-1900

Panel A	Dep. Variable: Probability of being male at birth (at parity=4)			
	Farmers		Labourers	
	(1)	(2)	(3)	(4)
No males at birth	0.121	0.027	0.481***	0.673***
	(0.263)	(0.306)	(0.134)	(0.222)
Controls	YES	YES	YES	YES
Additional controls	NO	YES	NO	YES
Observations	447	279	661	380
Pseudo R2	0.0131	0.0234	0.0269	0.0286

Panel A	Farmers		Labourers	
	(1)	(2)	(3)	(4)
No females at birth	-0.340	-0.190	-0.224	-0.239
	(0.306)	(0.372)	(0.152)	(0.295)
Controls	YES	YES	YES	YES
Additional controls	NO	YES	NO	YES
Observations	447	279	661	380
Pseudo R2	0.0162	0.0245	0.0218	0.0182

Coefficients estimated using a logit regression model. Robust standard errors in parentheses (clustered at the village level); *** p<0.01, ** p<0.05, * p<0.1; For simplicity, the intercept is not reported. The first set of controls includes the number of children alive at birth, village and period fixed effects. The additional controls include mother's age and father's literacy.

4. Mortal neglect of female babies from death records

The previous results linking the probability of being born male to individual characteristics support a behavioural explanation for the high sex ratios at birth found at the aggregate level.

[17] The size of the samples does not allow replicating the analysis on other occupational categories (shepherds, artisans, elites and/or other occupations).

Although anecdotal evidence on female infanticide is almost non-existent, the asymmetry between the number of male and female baptisms, especially at higher parities and in families of low socio-economic status with no previous male descendants, suggest that some families disguised female infanticide as natural deaths. As discussed before, registering a birth was free, so there were no incentives to under-report girls. Death registers, however, provide further evidence that baby girls were neglected, especially under certain circumstances. If under-registration systematically targeted girls, it would have affected both births and deaths around birth. The latter is actually more plausible because, unlike births, registering deaths imply paying a fee. In any case, if under-reporting would bias sex ratios at birth upwards, it would cause the opposite effect on deaths. Female deaths during the first hours and days would then be under-reported, thus providing more evidence of female infanticide or neglect.

In this regard, table 4 reports the results of estimating a logit model assessing whether the probability of dying during the first day of life was affected by the number of previous children alive and the sex composition of those children (controlling for other characteristics). Having no surviving brothers at birth had no effect on male mortality but significantly increased female mortality during the first day of life. This is extremely telling because they support the evidence provided previously regarding unbalanced sex ratios at birth. The number of girls dying shortly after birth is significantly higher when no other sons are alive, thus suggesting that some families were neglecting their new-born girls because they only wanted a boy. In particular, and according to the coefficient estimated in column (4), the probability of a girl dying during the first day shifts from 0.8 per cent when there was already at least one son in the family to 2.5 per cent when there is none. The distinct effect of the variables in the model, children alive at birth and parity, on male and female mortality around birth also suggests that the chance of survival was lower for baby girls, relative to boys, in already large families.

Table 4. Probability of dying during the first day of life (by sex), 1750-1900

	Dep. Variable: Probability of dying during the first day of life			
	Males		Females	
	(1)	(2)	(3)	(4)
Children alive at birth	0.009	0.089	-0.028	0.332***
	(0.065)	(0.151)	(0.101)	(0.129)
No males at Birth	-0.004	0.115	0.339***	1.064**
	(0.136)	(0.376)	(0.106)	(0.465)
Parity:				
Child order = 2	-0.515***	-1.068**	-0.733***	-0.816
	(0.160)	(0.438)	(0.118)	(0.541)
Child order = 3	-0.980***	-1.361**	-0.481**	-1.345*
	(0.207)	(0.573)	(0.228)	(0.744)
Child order = 4	-0.840***	-0.707	-0.882***	-0.397
	(0.133)	(0.584)	(0.289)	(0.648)
Child order = 5+	-0.726***	-1.365*	-0.462	-0.096
	(0.163)	(0.750)	(0.342)	(0.648)
Controls	YES	YES	YES	YES
Additional controls	NO	YES	NO	YES
Observations	13,659	3,008	13,109	2,681
Pseudo R2	0.026	0.061	0.026	0.068

Coefficients estimated using a logit regression model. Robust standard errors in parentheses (clustered at the village level); *** p<0.01, ** p<0.05, * p<0.1; For simplicity, the intercept is not reported. While the first set of controls include village and period fixed-effects, the additional controls include mother's age, father's occupation and father's literacy.

Likewise, table 5 in evidences that the probability that a baby girl died during the first day of life was higher in landless or semi-landless families with more children alive at birth, an effect that is not visible for boys despite that they should be theoretically weaker. The distinct effect of parity on male and female mortality around birth in these families also point in the same direction. Moreover, although the effect of having no male siblings on female mortality is not statistically significant, this is probably due to the reduced number of observations. The size of the coefficient is actually very similar to the one shown in Table A3, thus suggesting that this feature is likely to have increased female mortality rates (notice also the negative sign in the male columns). These results confirm those reported in the previous section on the probability of being born male. Families from low socio-economic status that relied on the demand for waged labour were subject to more strenuous circumstances and therefore more likely to be involved in this kind of practices. As well as the burden imposed by the dowry, the fact that boys were more easily employable in these agricultural markets also contributed to reducing the relative value of girls.

Table 5. Probability of dying around birth (by sex and father's occupation), 1750-1900

	Dep. Variable: Probability of dying during the first day of life							
	Farmers				Labourers			
	Males		Females		Males		Females	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Children alive at birth	-0.064	0.069	0.024	0.116	-0.007	-0.122	0.449**	0.768***
	(0.169)	(0.244)	(0.210)	(0.211)	(0.114)	(0.204)	(0.177)	(0.272)
No males at birth	-0.250	-0.211	-0.799	-0.177	-0.607*	-0.422	0.227	0.954
	(0.550)	(0.744)	(1.008)	(0.805)	(0.358)	(0.419)	(0.260)	(0.642)
Parity:								
= 2	-0.753**	-0.987*	-2.439***	-2.204*	-0.674**	-1.149*	-0.934	0.537
	(0.345)	(0.577)	(0.845)	(1.311)	(0.310)	(0.688)	(0.718)	(0.930)
= 3	-0.800*	-1.315**	-2.122**		-0.991**	-2.429*	-0.891	-0.230
	(0.435)	(0.571)	(1.032)		(0.478)	(1.247)	(0.690)	(0.755)
= 4	-0.836	-0.810	-2.435**	-1.102	-0.452	-0.812	-1.416	0.590
	(0.689)	(1.056)	(1.192)	(1.337)	(0.412)	(0.581)	(0.923)	(1.064)
= 5+	-0.942**	-1.151	-2.364***	-1.294	-0.841***	-1.956***	-1.437	0.292
	(0.464)	(1.147)	(0.810)	(1.452)	(0.211)	(0.588)	(1.072)	(1.478)
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Add. controls	NO	YES	NO	YES	NO	YES	NO	YES
Observations	1,624	1,036	1,553	772	2,210	1,307	2,041	1,209
Pseudo R2	0.0348	0.0720	0.1016	0.1213	0.0389	0.1079	0.0583	0.1186

Coefficients estimated using a logit regression model. Robust standard errors in parentheses (clustered at the village level); *** p<0.01, ** p<0.05, * p<0.1; For simplicity, the intercept is not reported. While the first set of controls include village and period fixed-effects, the additional controls include mothers age, father's occupation and father's literacy.

Lastly, table 6 explores whether these patterns are also visible during the first half of the 20th century. Although individual characteristics did no longer influenced the probability of being male during this period (as shown in table 3 in the previous section), this additional exercise shows that they continued influencing female mortality during the first day of life. On the one hand, having no male siblings clearly increased the probability that baby girls died shortly after birth. On the other hand, although the number of children alive no longer seems to increase female mortality, the effect of parity still shows a distinct discriminatory pattern. In this regard, while being born at higher parities reduce male mortality rates during the first day of life, that is not the case for females. Although less important than before the demographic

transition as aggregate sex ratios indicate, the neglect of female babies persisted during the first decades of the 20th century.

Table 6. Probability of dying around birth (by sex), 1900-1950

	Dep. Variable: Probability of dying during the first day of life			
	Males		Females	
	(1)	(2)	(3)	(4)
Children alive at birth	0.127	0.063	0.042	0.020
	(0.121)	(0.104)	(0.098)	(0.158)
No males at birth	0.092	-0.180	0.136	0.961**
	(0.201)	(0.290)	(0.376)	(0.451)
Parity:				
Child order = 2	-1.071***	-0.874	-0.150	-0.718
	(0.370)	(0.591)	(0.351)	(0.819)
Child order = 3	-1.618***	-3.102**	-0.868*	0.043
	(0.424)	(1.266)	(0.495)	(0.650)
Child order = 4	-1.194***	-1.561**	-0.673	0.338
	(0.383)	(0.660)	(0.633)	(0.724)
Child order = 5+	-1.527***	-1.927***	-0.638	-0.160
	(0.396)	(0.483)	(0.504)	(0.774)
Controls	YES	YES	YES	YES
Additional controls	NO	YES	NO	YES
Observations	3,724	1,952	3,344	1,547
Pseudo R2	0.0453	0.0824	0.0390	0.0764

Coefficients estimated using a logit regression model. Robust standard errors in parentheses (clustered at the village level); *** p<0.01, ** p<0.05, * p<0.1; For simplicity, the intercept is not reported. While the first set of controls include village and period fixed-effects, the additonal controls include mothers age, father's occupation and father's literacy.

5. Conclusion

Although documenting female infanticide in historical Europe has proved difficult, this article shows that the number of male baptisms in the study area was exceptionally high up to the early 20th century. In addition, individual-level info shows that the probability of male baptisms was significantly higher when there were no previous male siblings alive. Likewise, this same feature also increased female mortality rates around birth. Taken together, these findings strongly support the idea that a significant fraction of female babies were neglected or disposed away. Although there is hardly any anecdotal evidence on female infanticide, the highly unbalanced number of male and female baptisms and deaths during the first day of life, especially at certain parities and among landless and semi-landless families, suggest that some families disguised female infanticide as natural deaths. The mortal neglect of girls around birth was possibly a conscious family decision that affected a small number of families under certain circumstances. Apart from the need to provide dowries for their daughters, the fact that there existed less female waged labour opportunities also militated against girls. Although these practices were more visible during the period previous to the demographic transition, they persisted into the first decades of the 20th century, thus evidencing that son preference continued to be a strong cultural norm within these societies.

The sources are though silent regarding how these girls were missing. There were of course many ways of disposing of unwanted children and these crimes were easy to commit and difficult to prove (starvation, dehydration, strangulation, drugged to death; smothering, exposure to elements, etc.; Langer 1972, 96; Harris and Ross 1987, 5-6). In his *Elementa*

medicinae et chirurgiae forensis, written in Latin in 1781 (and translated into Spanish in 1796), Joseph Jakob von Plenk, a prestigious Austrian physician, devoted 18 pages to describe different ways of committing infanticide, many of them practically indistinguishable from natural deaths. Given the high rates of stillbirth and neonatal mortality, infant deaths within married couples did not raise the suspicion of civil or religious officials (Hynes 2011, 509; Hanlon 2016, 537). Anecdotal evidence from religious trials indicates that killing unwanted new-borns before baptising them was a "well-established" custom in Early Modern Aragon (Tausiet 2001)[18]. The same source also stresses that many infants died due to neglect in the form of inadequate feeding or lack of attention. The Catholic Church strongly condemned infanticide, so increasing the mortality of new-born girls through indirect methods, rather than directly killing them, sounds indeed plausible[19]. As well as the "quiet disposal" of babies, Wrigley (1966, 105) argues that families could have not striven enough to keep them alive especially during the crucial first hours of life. Exposing them at the entrance of the church or in other less visible places hoping that someone would take care of the baby was also a possibility and it is quite likely that many of these abandoned children did not survive and die of hunger or cold. Boys could undoubtedly fell victims of these practices as well, but the evidence provided here shows that families especially targeted girls.

This article challenges the notion that there were no missing girls in historical Europe, and therefore suggests that these families regulated the size and sex composition of their offspring despite the religious norms against it. These findings have important implications for our understanding of the traditional demographic regime and the subsequent transition to lower fertility and mortality rates. The low number of children raised in European families cannot be longer explained just resorting to different methods of reducing fertility either indirectly (age at marriage, fraction of singles) or directly (spacing, stopping). By increasing the mortality of their unwanted children, these families also adopted a "death control" (Harris and Ross 1987; Hanlon 2017). Resorting to infanticide or infant neglect was a complementary strategy to control fertility that allowed families to limit family size and adjust the sex-composition of their offspring according to their preferences in a context where son preference prevailed. The gradual disappearance of these practices would therefore partly contribute to explaining the decline in fertility and mortality that took place during the demographic transition would therefore partly respond to the relaxation of these practices. Likewise, the fact that many of these infanticides escaped from birth and death registers also indicates that fertility and mortality rates in pre-industrial Europe were higher than what it has been routinely assumed. This analysis, however, focuses on a small region in North-eastern Spain, so more research is needed to assess whether this behaviour was also shared in other European regions.

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[18] Mentioned in Hanlon (unpublished manuscript, 9-10). We are grateful to the author for sharing his working paper.

[19] It should be stress that the attitude of the Church towards infanticide was much more permissive in Early Modern Aragon and considered these crimes as involuntary homicides due to lack of attention providing it took place within the private sphere of the family (Tausiet 1998, 83).

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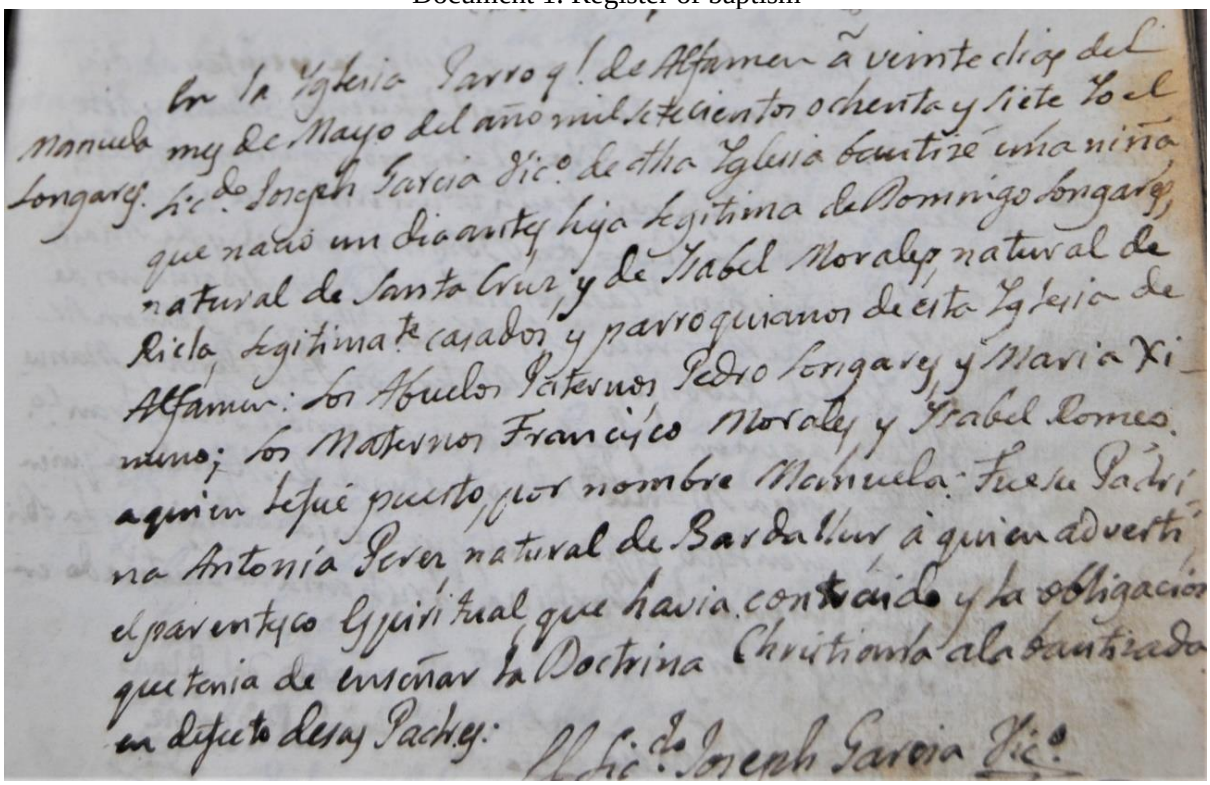
APPENDIX

Document 1. Register of baptism



Translation: At the parish church of Alfamén in May 20 (1787), I, the priest Joseph Garcia, vicar of this church, baptised a girl born the previous day. Daughter of Domingo Longares (born in Santa Cruz) and Isabel Morales (born in Ricla), legitimately married and parishioners of this church of Alfamén: granddaughter of Pedro Longares and María Ximeno on the father's side; and Francisco Morales and Isabel Romeo on the mother's. She was named Manuela. Her godmother was Antonia Pérez (born in Bardallur) who, in accordance to this spiritual relationship, has the obligation of teaching her the Christian doctrine in the absence of her parents.
Source: AMHDB.

Table A1. Frequency statistics (by year)

Sex									
	1550-99	1600-49	1650-99	1700-49	1750-99	1800-49	1850-99	1900-49	Total
Female	735	2,140	2,687	4,615	7,283	7,477	8,531	7,187	40,655
Male	744	2,329	3,047	5,214	7,688	8,104	9,309	7,596	44,031
Total	1,479	4,469	5,734	9,829	14,971	15,581	17,840	14,783	84,686

Father's occupation									
	1550-99	1600-49	1650-99	1700-49	1750-99	1800-49	1850-99	1900-49	Total
Artisans	45	51	17	15	67	389	859	596	2,039
Elites	18	21	40	28	21	27	112	134	401
Farmers	10	17	40	52	248	1,680	3,353	3,456	8,856
Labourers	10	10	0	3	265	1,441	4,663	4,352	10,744
Other	11	35	53	37	47	119	318	424	1,044
Shepherds	5	13	7	5	33	264	565	586	1,478
Missing	1,380	4,322	5,577	9,689	14,290	11,661	7,970	5,235	60,124
Total	1,479	4,469	5,734	9,829	14,971	15,581	17,840	14,783	84,686

Father's literacy									
	1550-99	1600-49	1650-99	1700-49	1750-99	1800-49	1850-99	1900-49	Total
Illiterate	0	10	0	9	50	1,996	6,166	2,800	11,031
Literate	5	3	9	9	32	606	3,879	6,431	10,974
Missing	1,474	4,456	5,725	9,811	14,889	12,979	7,795	5,552	62,681
Total	1,479	4,469	5,734	9,829	14,971	15,581	17,840	14,783	84,686

Source: AMHDB.

Fig. A1. Sex ratios at birth in Europe, 1750-2016

Source: Human Mortality Database. Coverage varies by country. Although the fitting line is estimated all the available data, the graph does not include the observations above 110 and below 100 so as to better visualize the trends. Excluding those observations from the estimation hardly alters the trend depicted here.

Table A2. Frequency statistics, 1750-1950

	Whole sample		Restricted sample	
Sex	Obs.	%	Obs.	%
Female	30,478	48,24	22,107	48,77
Male	32,697	51,76	23,218	51,23
Total	63,175	100,00	45,325	100,00
Period	Obs.	%	Obs.	%
1750-1799	14,971	23,70	9,691	21,38
1800-1849	15,581	24,66	10,009	22,08
1850-1899	17,840	28,24	13,104	28,91
1900-1949	14,783	23,40	12,521	27,62
Total	63,175	100,00	45,325	100,00
Father's occupation	Obs.	%	Obs.	%
Farmers	8,737	36,38	6,521	33,48
Labourers	10,721	44,64	8,983	46,12
Shepherds	1,448	2,29	1,246	6,40
Artisans	1,911	7,96	1,658	8,51
Elites	294	1,22	285	1,39
Other	908	3,78	783	4,02
Total	24,019	100,00	19,476	100,00
Father's literacy	Obs.	%	Obs.	%
Illiterate	11,012	50,15	8,301	47,91
Literate	10,948	49,85	9,027	52,09
Total	21,960	100,00	17,328	100,00

Note: The restricted sample excludes those individuals born in families who had twins.
Source: AMHDB.

Table A3. Summary statistics, 1750-1950

	Obs.	Mean	St. Dev.	Min	Max
	(1)	(2)	(3)	(4)	(5)
Sex (Male=1)	45,325	0.512	0.500	0	1
Dead during the first day of life	45,325	0.0152	0.122	0	1
Children alive at birth	45,325	1.560	1.715	0	14
No males at birth	45,325	0.526	0.499	0	1
No females at birth	45,325	0.538	0.499	0	1
Parity (birth order)	45,325	3.602	2.528	1	17
Mother's age	30,313	29.99	6.399	15.5	50.0
Father's literacy	17,328	0.521	0.500	0	1

Source: AMHDB.