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# Assessing gender discrimination during infancy and childhood using twins: The case of rural Spain, 1750-1950

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## ABSTRACT

This article uncovers the existence of discriminatory practices in pre-industrial Spain by examining the fate of twins. The analysis of the complete parish registers of a small rural area (17 villages) shows that female twins were discriminated both at birth and during infancy and childhood. Not only the sex ratio of twins at baptism was extremely unbalanced, but discrimination continued throughout infancy and childhood and resulted in female excess mortality, despite that males are biologically more vulnerable. Although their extremely high mortality rates question the idea that twins constituted an exogenous shock to family decisions due to their impact of the family budget, studying twins helps shedding more light on discriminatory patterns because many families prioritised male twins to enhance their survival chances.

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## KEYWORDS

Twins; sex ratios; gender discrimination; infant and child mortality; health; female excess of mortality

## 1. Introduction

Historically, the birth of twins placed families under unexpected stress because it was not possible to know whether a woman had a multiple pregnancy before delivery. If both twins survived, the parents were faced with the difficulties of feeding and caring for two new children, along with the rest of their offspring, on a limited budget that a nuclear family with two parents and two children could barely support, especially outside the most developed areas of North-Western Europe (Clark et al., 2020). This unforeseen shock therefore offers an interesting context to delve deeper into how parental gender preferences may have affected the survival chances of their (unwanted) sons and daughters, especially bearing in mind that twins suffer lower birth weights and much higher mortality rates early in life (Botting et al., 1987; Imaizumi, 2001; Rydhström, 1990).

Given that son preference is a common feature of traditional societies where girls are considered of lesser value than boys (Williamson, 1976; Sen, 1990; Das Gupta et al., 2003), it is plausible to hypothesise that males were prioritised. In a context characterised by low standards of living and high mortality rates, discriminatory behaviour could in turn affect girls' health and their survival chances. Although a common occurrence in South East Asia and other developing societies, the prevailing view defends that there were hardly any

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'missing girls' in historical Europe (Derosas & Tsuya, 2010; Lynch, 2011). However, recent studies have shown the presence of high sex ratios and an excess mortality of girls compatible with the existence of missing girls, especially in some regions in Southern and Eastern Europe (Beltrán Tapia, 2019; Szoltysek et al., 2022; Beltrán Tapia & Gallego-Martínez, 2017; Beltrán Tapia and Raftakis, 2021). The latter argue that, in contexts characterised by strong son preference, some parents may have neglected their daughters around birth and/or during infancy and childhood.

Discrimination may have started at birth, especially if parents were expecting a boy. There are however no clear patterns of female infanticide in historical Europe (Derosas & Tsuya, 2010). Lynch (2011) argues that the cultural and religious values predominant in Europe, as well as household formation patterns, prevented female infanticide. Research on southern Europe nonetheless suggests that parents could have resorted to neglect as a mechanism to control the size and sex composition of their offspring (Bechtold, 2001; Hanlon, 2016; Hynes, 2011; Beltrán Tapia and Marco-Gracia, 2021). These authors argue that female neglect complemented other strategies (i.e. fertility-stopping rules or adjusting birth intervals) that helped achieving the desired family size and sex composition, especially in the period prior to the demographic transition (Bengtsson & Dribe, 2006; Marco-Gracia, 2021, 2021a; D. Reher & Sanz-Gimeno, 2007; Schofield, 2000; Van Bavel, 2004). This drastic solution to regulate fertility could have especially affected already large families subject to high degrees of economic stress and therefore affected a relatively small number of girls, especially if we consider that direct evidence of female infanticide is limited. The debate on the existence of female infanticide in some areas of historical Europe remains nonetheless a matter of empirical enquiry.

Alternatively, parents could have resorted to abandon their unwanted infants (Fuchs, 1984; Hunecke, 1991; Kertzer, 1993). Foundling hospitals were founded to save the lives of newborns, as well as the honor of single mothers that used them to hide their sins. Married couples, however, also made use of this option because most of these institutions accepted children anonymously, a phenomenon that was especially widespread during the 19<sup>th</sup> century. Although the available evidence for other European regions is not so clear-cut, more girls than boys were indeed abandoned in Italy and Russia but this preference declined over time and had practically disappeared by 1900 (Ransel 1988; Kertzer, 1993). For the case of Spain, while Revuelta-Eugercios (2012) does not find long-term sex imbalances in the number of admissions to the *inclusa* of Madrid, girls could have been more subject to abandonment in other regions (Blanco Villegas et al., 2002, p. 169; Pérez Moreda, 2005; Pérez Álvarez, 2009, p. 1087).

In addition to female neglect around birth, discrimination against girls may have occurred during infancy and childhood. An unequal allocation of food, care and/or workload could affect girls' net nutritional status and unduly increase female mortality rates as they grew up (Tabutin, 1978; Johansson, 1984; Pinnelli & Mancini, 1997; Baten & Murray, 2000; McNay et al., 2005; Horrell & Oxley, 2016; Beltrán Tapia et al., 2017, 2020). However, unveiling patterns of gender discrimination in infancy and childhood is especially challenging because males are biologically more vulnerable and their mortality rates are naturally higher, especially during the first year of life. This frailty was especially visible in the high-mortality environments that characterized pre-industrial Europe due to poor living conditions, lack of hygiene and the absence of public health systems (Beltrán Tapia, 2019).

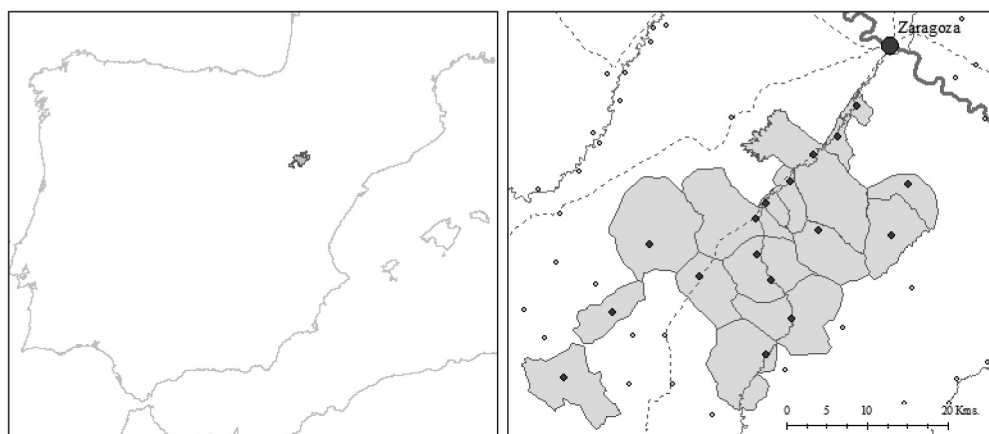
Relying on longitudinal micro data from a rural region in North-eastern Spain between 1750 and 1950 (1,840 twins, out of 70,148 births), this article evidences that female twins suffered higher mortality rates than their male counterparts both around birth and during the first years of life. On the one hand, twins exhibited extremely high sex ratios at baptism. The quality of the sources, the absence of sex differences in the interval between birth and baptism and the relative mortality rates during the first days of life suggest that some of these female babies could have been neglected or disposed away. In addition, despite their biological advantage (Drevenstedt et al., 2008; Waldron, 1998; Zarulli et al., 2018), female twins died in higher proportions than boys during the first years of life. Interestingly, female excess mortality is also evident during the breastfeeding period, a phenomenon that is very uncommon among singletons because single infants do not compete for resources during this period. As a result, the probability that both female twins survived to their 10<sup>th</sup> birthday was around half than that of male twins. Analysing twins is particularly relevant because they share genetic load as well as household characteristics. Therefore, this study can control for factors which are not accounted for in other studies relying on the whole population.

This article therefore supports previous studies that challenged the idea that there were no missing girls in historical Europe, especially in Southern and Eastern Europe. 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. In addition, son preference favoured discriminatory behaviour against female twins throughout infancy and childhood (either prioritising boys or neglecting girls), thus increasing their relative mortality rates.

## 2. Area of study, data and methods

This study focuses on a rural area in North-Eastern Spain located around 6–40 kilometres away from Zaragoza, the regional capital (see [Figure 1](#)). This area, a combination of plains and foothills near the Huerva river, comprises 17 small municipalities.<sup>1</sup> Their total population was approximately 7,050 inhabitants in 1750, 11,097 in 1857, 10,908 in 1857 and 12,162 in 1950. The analysis relies on the complete church registers of these villages, whose records provide high-quality information on all births, marriages and deaths that occurred between 1750 and 1950, thus allowing reconstituting their complete life histories. While the dataset contains information on 70,148 individuals, twins accounted for 1.3% of births in the study area: 342 pairs of mixed-sex twins, 313 pairs of male-twins and 265 pairs of female-twins.<sup>2</sup>

Given that we rely on local records, we do not have all the information on those individuals who migrated in/out of our study area. Children may have moved out with their families and died somewhere else, but we cannot observe their age of death. Similarly, an individual may have moved into our area of study, so we can have information on his/her death but not on his/her birth. The analysis of infant and child mortality is therefore restricted to those individuals for whom we have complete information. In this regard, we consider all observations for which we know both their birth and age of death. In addition, we also consider those who married and therefore were alive during their infancy and childhood.<sup>3</sup> Given that migration was predominantly male, we are excluding a larger proportion of males.<sup>4</sup>



**Figure 1.** Area of study: Middle huera (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 grey) and main roads (dotted lines), the map also depicts neighbouring villages (white dots).

The area of study, covering around 500 squared kilometres, hosted a population whose members mostly lived in nuclear households and were essentially engaged in agriculture (mostly wheat and some wine) and sheep grazing. Our records show that around 85% of the male working population was engaged in the agricultural sector between 1800 and 1900. Average marital fertility was relatively high and stable around 6–7 up to late 19<sup>th</sup>- and early 20<sup>th</sup>-century. High infant and child mortality rates however implied that only around half of the children survived to their tenth birthday. Mortality rates began declining consistently in the last third of the 19<sup>th</sup> century due to improving living standards. In addition, improvements in public health, which mainly benefited the cities, may also have had a positive impact on the villages (Harris & Helgertz, 2019; Szreter, 1988). The decline first benefited children in their late childhood and spread later to younger cohorts. Anthropometric evidence also indicates that standards of living were low: the average male height was around 160 centimetres in mid-19<sup>th</sup>-century (Marco-Gracia & Puche, 2021), below the stature of their European counterparts or their fellow Spaniards in other regions of the country (Hatton & Bray, 2010; Martínez-Carrión et al., 2016).

In an area where most of the population enjoyed living standards close to subsistence levels, household allocative choices mattered, and discriminatory practices could have had lethal consequences. As in other historical contexts where agriculture was the main economic activity (Alesina et al., 2013; Giuliano, 2018), Spanish women did not enjoy the same status as men: legally subordinated to their fathers and husbands, they were expected to remain within the domestic realm and those who did work in paid jobs received significantly lower wages (Borderías & Muñoz, 2018; Borderías et al., 2010; Camps, 1998; Sarasúa, 2002). As well as less able to provide monetary income to the household, girls had to provide a dowry for their marriage and inheritance practices tended to favour male heirs.<sup>5</sup> Economic considerations alone could therefore justify potential son preference. It is indeed likely that girls' inferior status could have resulted in an unequal allocation of resources within the household, both in terms of nutrition and

educational investments (Borderías et al., 2014; Sarasúa, 2002). Literacy rates, for instance, clearly show that parents invested differently in boys' and girls' education in the area of study: while around 40% of men were literate in 1860, less than 5% of women were able to read and write.<sup>6</sup>

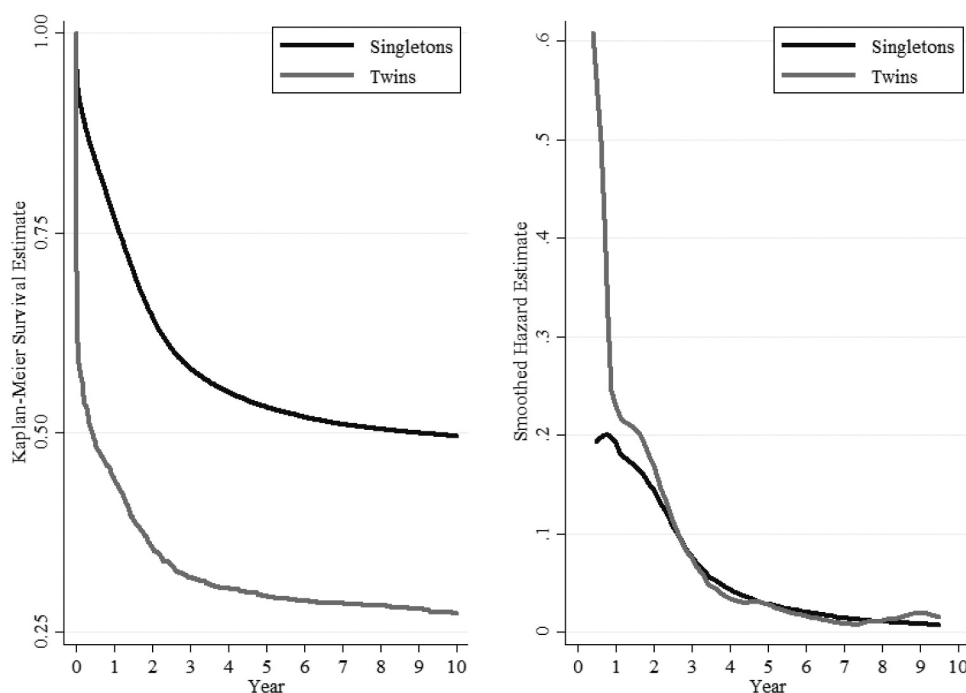
Methodologically speaking, this article relies on descriptive statistics to analyse both sex ratios at birth and mortality rates at different ages. In addition, we have used survival and hazard estimates to investigate statistical differences in survival and death rates between twins and singletons, mixed-sex twins and same-sex twins. In this regard, while survival estimates depict the cumulative difference in their survival rates, the hazard estimates allow identifying the ages when their mortality rates differed most. The analysis focuses on the period prior to the onset of the fertility transition (between 1750 and 1900) in order to avoid the noise associated with changes in fertility patterns. In fact, previous studies show that discriminatory patterns towards girls were less visible in our study area in the early twentieth century (Marco-Gracia & Beltrán Tapia, 2021; Beltrán Tapia and Marco-Gracia, 2021). As mentioned above, analysing twins is especially interesting because they provide a natural experiment that allows to hold genetic and household characteristics fixed. In addition, due to their higher fragility at birth, as well as for the competition for family resources that multiple births entailed, twins offer a promising window to delve deeper into how parents treated their sons and daughters. Considered together, these analyses offer a new perspective on how gender-discriminatory patterns affected the fate of this particularly vulnerable population.

### 3. Twins in historical perspective

Twins are a small proportion of births, approximately between 1 and 1.5% of all live births according to available records in Western Europe (Jacobsen et al., 1999; Pison & Couvert, 2004; Pison & D'Addato, 2006). In our sample, they represent 1.3% of all births and the probability of delivering twins increased with maternal age and parity: while in parity 1, only 0.6% of births correspond to twins born alive, the rate of twins increased to 1.3, 1.4 and 1.6% in parities 2, 3 and 4 and reached 1.8% in higher parities. This is consistent with other studies that associate this phenomenon with the higher risk of intrauterine death in multiple births among primiparas (Botting et al., 1987; Pison & D'Addato, 2006).

Twins have higher perinatal, neonatal and infant mortality. In contexts of low (near-subsistence) living standards, twins are generally born with lower average birth weights and higher risks of death (Botting et al., 1987; Imaizumi, 2001; Rydhström, 1990). In fact, a system of breastfeeding relief (*Socorro de lactancia*) was set up in urban maternity homes to help mothers of twins to breastfeed both babies at least since the mid-nineteenth century, in an attempt to combat the high mortality associated with low birth weight and weakness (Sánchez Lecha, 2020). However, in rural settings, such as the one analysed in this study, there were no public options to combat their higher mortality.

Our study dramatically confirms the gloomy perspectives of twins in pre-industrial rural Spain. Figure 2 compares the survival and hazard estimates of twins and singletons until they reached their 10<sup>th</sup> birthday between 1750 and 1900. Twins suffered a much higher mortality rate than singletons and this difference mostly originated during the first weeks of life (for the mortality rate of twins during the first week by day and sex see Table A1 in the Appendix). The mortality of twins was 10 times higher than that of singletons during



**Figure 2.** Survival and hazard estimates of twins and singletons, 1750–1900. Note: The left and right panel shows the survival and hazard estimates, respectively. Source: AMHDB.

the first hours of life and more than 40% of the twins had already died before the first month, a figure that reached around 50% before their first birthday. Less than 30% of twins survived to turn 10, which means that the probability that both twins survived their childhood was extremely low (around ten per cent).

Moreover, the timing of birth of twins and the number of siblings alive seems to have been a decisive factor in their chances of surviving to the first year of life in our area of study (the evolution of the number of siblings also serves as an indirect proxy for the evolution of the mother's age). As we can see, in [Table 1](#), the highest infant mortality rates were found among individuals who did not have any living siblings and who were possibly born in the early years of their parents' marriage. While more than 50% of twins with no living siblings died, this figure was only about 17% for singletons. These mortality rates decreased as the number of living siblings increased and as the years of parental marriage progressed: among those with four living siblings at the moment of birth, the percentage of dying during the first year of life decreased to about 35 and 15% for twins and singletons, respectively. The reduced risk of dying was probably the consequence of a combination of factors. On the one hand, the number of living siblings can be both an indicator of the reproductive success and parental care of a given family and a proxy for the number of people in the nuclear family household who could help caring to the many needs of twins. On the other hand, the number of living siblings was linked to the stage of the marriage.

**Table 1.** Differences in mortality by number of living children, 1750–1900. Percentage of children who died during the first year of life by number of siblings alive and condition (twins vs. singletons).

Number of siblings alive	Twins		Single children	
	Male	Female	Male	Female
0	50,6	50,9	18,3	15,9
1	46,8	47,1	17	14,3
2	40,3	42,7	16,7	14,5
3	39,8	39,7	17,2	13,9
4	31,6	39,1	15,4	14,4
5	45,8	36,8	16,4	16,2
6	25	36,7	15,2	15,2
7	33,3	10,5	16,4	15,8
8	10	11,1	15,2	13,9

Note: For the number of observations see Appendix Table A2.  
Source: AMHDB.

It is during the first years of marriage when families suffered the greatest economic stress due to the costs associated to setting up a new household. Families in later stages of the reproductive cycle were not only better off, but they were also more experienced and knowledgeable about childcare.

The arrival of twins in the family supposed a major shock in a context of low living standards (Clark et al., 2020). Our data, however, shows that twins had very little chance of survival, so this shock was just temporary for most families: the impact of twins was similar to the birth of a healthy child since in the cases where one of the twins survived, the other one most often died in the first weeks of life. In fact, as can be seen in Appendix Table A3, among the twins who survived beyond 5 years, 46% of the twins had the first twin dying within the first week of life and 72% within the first month of life. Although twins cannot therefore have exerted a large shock to the family budget in the long term, they nonetheless constituted a major shock in the short term, at least during the time when both of them were alive, and this consequently affected their survival chances, thus making it an ideal setting to study whether parents may have treated males and females differently. Next section thus studies whether gender discrimination affected the survival prospects of male and female twins (1) around birth and (2) during infancy and childhood.

#### 4. Gender discrimination around birth

Recent studies based on large samples have found that the sex ratio at birth of twins is slightly lower than that of society as a whole (e.g., Jacobsen et al., 1999). This is consistent with twins suffering greater vulnerability in utero, which in turn especially affect male foetuses (Dipietro and Voegtline, 2017; Di Renzo et al., 2007). As we can observe in

**Table 2.** Number of observations and sex ratios at baptism, 1750–1950.

	Males	Females	Total	Sex Ratio
All twins	968	872	1,840	111.0
Same-sex twins	626	530	1,156	118.1
Mixed-sex twins	342	342	684	100.0

Source: AMHDB.



**Table 2**, our database contains information on 1,840 twins born between 1750 and 1950 (968 males and 872 females), which yields a sex ratio at baptism of 111.0 boys per hundred girls. This sex ratio was especially high for the period 1801–1850 when it reached a ratio of 117.5, being more moderate in the rest of the decades. These figures, however, do not fully reflect the distorted number of boys and girls because mixed-sex twins cannot, by definition, alter the sex ratio (37.2% of our sample is composed of mixed-sex twins). If we only focus on same-sex twins, the sex ratio at baptism jumps up to 118.1, a number that is statistically different from the commonly-used benchmark of 105 (Chao et al., 2019), despite the relatively small sample size ( $p$ -value = 0.0246).

Moreover, the 105 benchmark is possibly too high because, as mentioned above, the sex ratio of twins is lower than that of singletons due to the greater vulnerability of male twins (Jacobsen et al., 1999; Pison & Couvert, 2004; Pison & D’Addato, 2006),<sup>7</sup> an important factor given the higher probability of miscarriage existing in the high-mortality conditions of pre-industrial Europe (Woods, 2009). Moreover, we should bear in mind that we are considering sex ratios at baptism and, although most infants were baptised right after birth,<sup>8</sup> our sample does not include those who died before baptism and went unregistered in the parish archives. Parents, for instance, may have practised a private ceremony without the knowledge of the parish priest if they thought that their child was going to die. As a result, and given that males were more vulnerable, a lower sex ratio (even below 103–104) is probably a better reflection of what the ‘natural’ benchmark at baptised twins should look like in pre-industrial Europe (Beltrán Tapia & Marco-Gracia, 2021).

**Table 3** reports the sex ratio of children in families who gave birth to twins classified in 50-year subperiods. The results show that the number of males was relatively high, especially in the second half of the 18<sup>th</sup> century. Even if we disregard those extreme sex ratios, the figures for the 19<sup>th</sup> century show around 5 more boys (per hundred girls) than what should be expected. These figures were also higher than those reported for all births during the 19<sup>th</sup> century, which similarly suggest that parents were also neglecting a fraction of female singletons (108.8; Beltrán Tapia & Marco-Gracia, 2021, p. 8). The sex ratio at baptisms during the first half of the 20<sup>th</sup> century is however not as unbalanced. These results confirm the high sex ratios among twins found in the study area and suggest that families either underreported twin girls at birth (or misidentified girls as boys) or neglect them to the point of reducing their survival chances around birth.

Even though baptism was free, it is plausible that female under-registration may explain why we observe more male twins baptised. If families thought that a child might die (due to congenital weakness), they might have not registered it in order to avoid funeral costs. This is not likely though because baptising children was especially important to save their alms. Moreover, there are no differences in baptism patterns (the gap between birth and baptisms) between boys and girls in the study area, thus further

**Table 3.** Sex ratio of children in families giving birth to twins, 1750–1950.

	1750–1799	1800–1849	1850–1899	1900–1950
Families with twins	114.6	111.4	110.9	108.3
Number of families	195	210	246	214

Source: AMHDB.

suggesting that under-registration is not likely to be an issue here. As explained in the previous section, there are a few cases where the priests assigned sex to the newborn but whose name is unknown (93). Excluding these cases still leaves a sex ratio at baptism of 114.2. Although we cannot observe what actually happened to those “missing” female twins, it is plausible that some families discarded them at birth. In this regard, the family could get rid of an unwanted newborn (the girl) and register the birth of a single baby. The existence of neglect at birth has also been documented in the case of female singletons in our area of study (Beltrán Tapia and Marco-Gracia, 2021), so it is not surprising that female twins also suffered that fate given the extra pressure they exerted on families. The sex ratio of twins born into landless families exhibited even more extreme figures (a sex ratio at baptism of 160; out of 182 children), thus suggesting that resource constraints were an important factor driving these results. Although it is true that reducing the sample into smaller groups leaves more room for random noise, this result is still statistically higher than 105 ( $p$ -value = 0.0032). It is plausible that female neglect around birth took the form of abandonment. Given that twins only constituted a small fraction of all births, the exposure of more female twins would hardly alter the sex ratio of children admitted to the nearby foundling hospital of Zaragoza, especially considering that many children never reached these institutions alive.

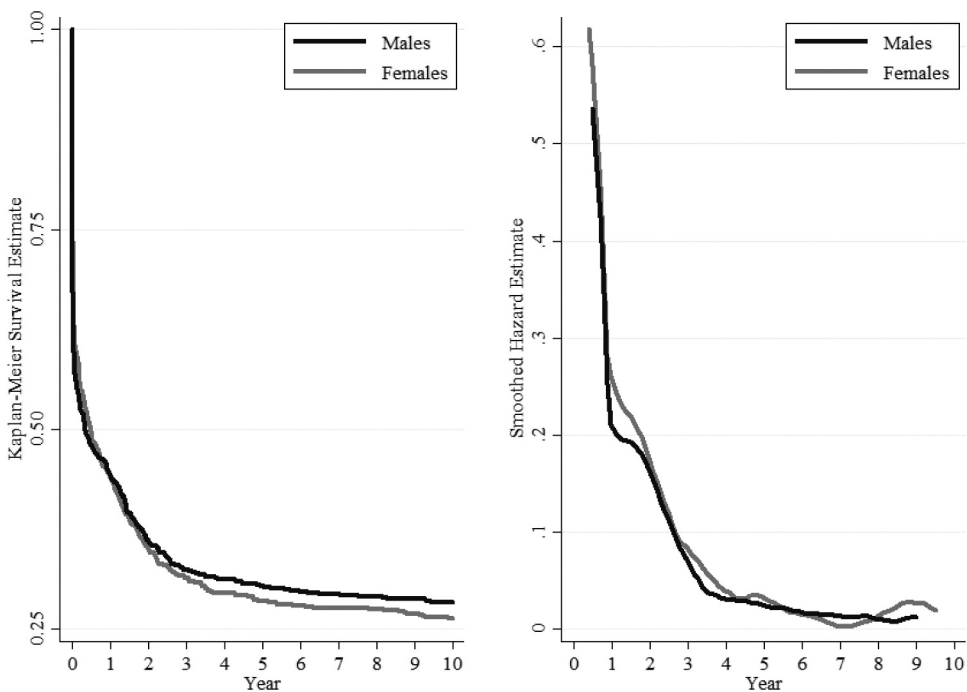
An alternative way of exploring neglect around birth is to analyse those who died right after birth. In this case, female under-registration would actually bias the results in the opposite direction, so this analysis could be considered a minimum threshold of gender discrimination. The problem with this approach is that, due to the female biological advantage, more boys are going to die for natural reasons and it is unclear what the benchmark for comparison is. The death registers from our case study indicate that 132 of our twins (7.2%) died during the first day of life and this figure had reached 367 (19.9%) by the end of the first week. More male twins were dying during the first days of life due to their greater vulnerability but female mortality rates became higher from day 6 onwards. Although selection is likely playing a role in this process, the female biological advantage is usually visible during the first years of life, so these results are at odds with what we know about sex-specific mortality rates early in life. Although the mortality rates of same-sex twins are higher than those of mixed twins (see [Figure A1](#) in the Appendix), they present similar patterns for males and females: males suffered a higher toll during the first five days but the pattern reverses from then onwards. As mentioned before, some twins were born dead or died right after birth and were registered as males or females but without a name. Excluding these observations from the analysis especially reduces the male mortality rate during the first day (see [Figure A2](#) in the Appendix). This is consistent with the male frailty but it may also suggest that some sort of gender discrimination may have increased the male survival rates and/or reduced the female ones.

These findings should be interpreted jointly with those obtained using sex ratios at baptism. If female under-registration is an issue, our results either over- or infra-estimate female neglect depending whether we are relying on baptismal or death registers. Taken together and bearing in mind the female biological advantage, these results suggest that behavioural decisions were acting against the survival of female twins right after birth. The birth of several children at the same time may have allowed parents to make

decisions about investing in these children (and thus their survival) based on their health status, family socio-economic status, existing gender preferences and previous experience. In this regard, twin baby girls seem to have been negatively affected by society's values and prevailing discriminatory behaviour.

## 5. Discrimination during infancy and childhood

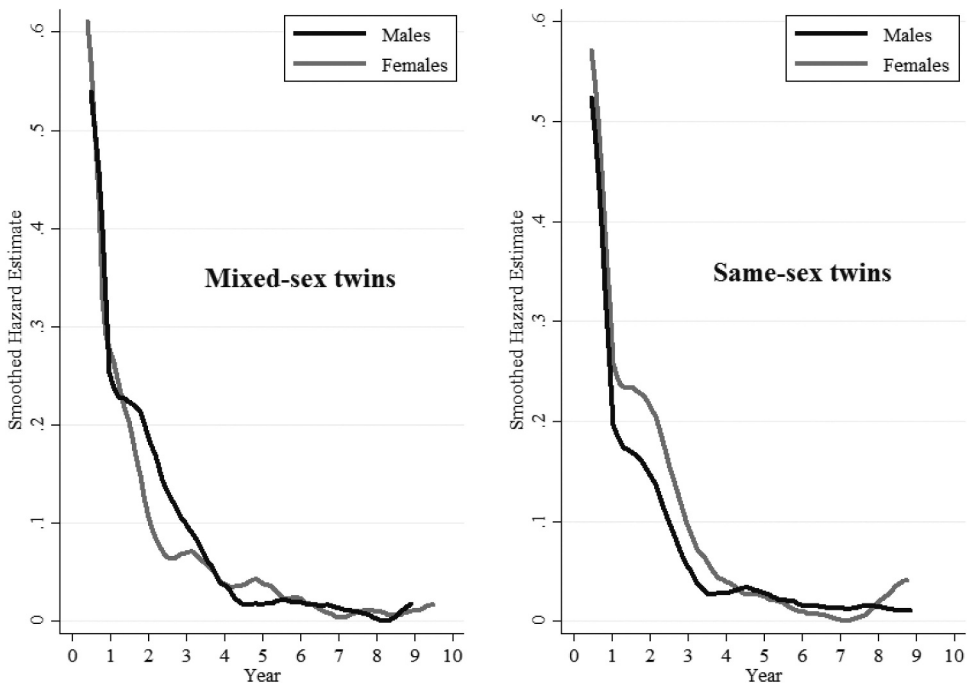
As noted above, international studies point to a much higher mortality of twins compared to singletons during the neonatal period but also later in life (at least during the first five years of life). As already shown in [Figure 2](#), this is also the case in our area of study, at least until children reached their third birthday. Gender-discriminatory practices may have also affected the survival chances of male and female twins during this period. In contexts of near-subsistence living standards and high infant mortality rates, a preference for boys linked to an unequal gender distribution of family resources may have favoured boys' health and/or impaired girls' (Marco-Gracia & Beltrán Tapia, 2021). Again, the female biological advantage may make it difficult to find differential mortality patterns because boys are weaker and their mortality tends to be higher in the first year of life, a pattern that is especially visible in the high-mortality setting that characterised pre-industrial Europe (Knodel, 1988; Drevenstedt et al., 2008; Waldron, 1998; Zarulli et al., 2018).<sup>9</sup> Consistent with results on singletons, most studies find that the highest mortality among twins was among boys (Botting et al., 1987; Imaizumi, 2001; Rydhström, 1990).



**Figure 3.** Survival and hazard estimates of male and female twins, 1750–1900.

In our area of study, however, the odds of survival were lower for female twins (see, [Figure 3](#) depicting survival and hazard estimates of male and female twins between 1750 and 1900). Despite their biological advantage, twin girls were especially at risk during the first months of life and again during their second and fourth year. Mortality patterns only tended to even out after the age of 5, when more than 50% of all twins born had died and there were hardly any twin pairs with both members alive. The excess mortality of twin girls was thus especially evident during infancy and early childhood. It should be stressed that, although the gap was not as large as during early childhood, the mortality of female twins exceeded that of boys also during the first year of life when the female biological advantage should be most visible. This finding is especially telling because, in contrast to singletons, twin infants do compete for their mother's milk during the breastfeeding period. Similar results penalising females have been found in countries where there is a strong preference for boys ([Jayachandran, 2017](#); [Kashyap & Behrman, 2020](#)).

Given that there might be differences in how parents treated their twins depending on whether they were mixed- or same-sex twins, the analysis has also been carried out separately. Although the female penalty during the first months of life is similar in both groups, early childhood was particularly lethal for pairs of female twins ([Figure 4](#); [Figure A3](#) in the Appendix focus on the first 5 years, so as to make these trends more visible). In mixed-sex twins, however, it was male twins who slightly were more at risk. The latter is expected due to frailty but complex selection effects might be playing a role here because the probability that both twins were alive to celebrate their first birthday was small, so this results might be influenced by the sex of the twin that died first (and the timing of the death).



**Figure 4.** Smoothed hazard estimates, mixed- and same-sex twins (age 0–10), 1750–1900.

Summing up, twins suffered extremely high mortality rates and their chances of surviving to adulthood were very low. In our study area, only 10.2% of twin pairs survived to 10 years of age. These results are obviously closely related to twins' congenital weakness at birth and the lack of medical advances, but are also affected by parental behaviour in relation to their sex preferences. Despite their biological advantage, female twins were at an even higher risk: while 13.0% of the male-twin pairs survived, only 6.1% of the female twins survived. In the case of mixed-sex twins, when one of the two children survived to ten years of age, we found that in almost 55% of the cases the survivor (10 or more years) was the male twin. These results are at odds with the well-known greater male frailty, especially early in life. The distribution of resources and family care thus clearly affected the sex-specific survival chances of twins in our area of study.

The reduction of infant and child mortality during the second half of the nineteenth century and especially in the early twentieth century increased survival rates for all children, including twins. In fact, the chances of both twins surviving rose from less than 10% throughout the nineteenth century to over 20% in the first quarter of the twentieth century. Although the small number of twins born in the early twentieth century prevents us from drawing strong conclusions, it seems that gender differences in mortality also decreased, thus suggesting that the fertility transition, as well as the associated improvements in living standards, especially benefited female twins.

## 6. Conclusion

This article shows that gender-discriminatory practices negatively affected the survival chances of female twins both around birth, infancy and early childhood in a Spanish rural area between 1750 and 1950. On the one hand, the sex ratio of twins at baptism was exceptionally high, at least until 1900 when it began declining. Although we cannot completely rule out the possibility of female under-registration, the quality of the sources, the absence of sex differences in the time between birth and baptism and the mortality rates during the first days of life suggest that some of these female babies could have been neglected or disposed away. A recent study also argues parental behaviour may have affected the mortality rates of female singletons around birth in the same area of study (Beltrán Tapia and Marco-Gracia, 2021).

On the other hand, mortality patterns by sex also confirm an excess mortality of twin girls, a phenomenon which was mostly concentrated during the first three years of life. Again, this female excess mortality contrast to what it should be expected due to the greater male vulnerability but confirms previous research on singletons in the same study area showing that parents clearly prioritised boys, especially from weaning onwards (Marco-Gracia & Beltrán Tapia, 2021). Interestingly, the results reported here indicate that the mortality of females twins exceeded that of boys also during the breastfeeding period when male frailty is most visible. This is especially relevant because, contrary to singletons, twin infants do compete for their mother's milk. It seems then that families with twins made additional efforts to ensure the survival of their male offspring in response to their especially difficult circumstances: parents were aware of the high mortality rates that twins suffered and therefore prioritised boys.

This behaviour reflects the perceived value that boys and girls had in many rural areas in pre-industrial Spain. Not only inheritance patterns somewhat privileged males, but girls also had fewer employment opportunities, received lower wages and had to provide a dowry at marriage. Son preference was therefore firmly rooted in the relative benefits and costs of raising sons and daughters. In resource-constrained families living in a high-mortality context, parents had to make difficult choices that favoured boys in terms of the allocation of food and/or care and therefore acted against the survival chances of girls. The general reduction in discriminatory practices experienced in the early twentieth century probably resulted from a combination of factors. On the one hand, improvements in living standards may have reduced the need for discrimination or, at least, made it less visible due to higher survival rates. On the other hand, the spread of knowledge about fertility control allowed parents to readjust family size and therefore adapt it to the available resources. Lastly, not only the expansion of labour opportunities for women could have altered the perceived relative value of sons and daughters, but general increases in living standards and longevity may have affected parents' attitudes towards infant welfare and/or the desire to have daughters to care for them in old age.

These results confirm that gender discrimination was the most important explanation for high sex ratios in rural Spain (Beltrán Tapia & Gallego-Martínez, 2017, 2020). They also seem to confirm the existence of practices close to infanticide or neglect in the care of girls in this area, strongly affecting twin girls. Our study has focused on a group of individuals (twins) who could particularly suffer from discrimination due to the shock they could represent in a small Spanish agricultural area. Our results also confirm that twins suffered especially from family resource allocation decisions (Tabutin, 1978; Johansson, 1984; Alter et al., 2004; Beltrán Tapia, 2019). However, further studies are needed to better understand how family behaviour affected the health and survival of their sons and daughters.

## Notes

1. The studied localities are: Alfamén, Aylés, Botorrita, Cadrete, Codos, Cosuenda, Cuarte de Huerva, Jaulín, Longares, María de Huerva, Mezalocha, Mozota, Muel, Torrecilla de Valmadrid, Tosos, Valmadrid, and Villanueva de Huerva.
2. According to our records, there was one twin birth for every 75 singleton births. This is clearly lower than the figure proposed in Hellin's law of 89 (Hellin, 1895). It has been shown, however, that there are differences in this rate depending on the region and period of study (Fellman and Eriksson, 2009), due to various environmental and even genetic factors.
3. Individuals who were born in the study area but migrated with their families as children have not been included in the analysis. We have no reason to believe that these families could be biased in their results since entire families, including male and female children, were migrating.
4. The results reported here, in any case, remain virtually identical if we consider that individuals with no recorded date of death reached adulthood.
5. The available evidence suggests that although inheritance norms benefited all children similarly regardless of sex, sons were nonetheless prioritised to some extent (Jarque Martínez & Salas Auséns, 2007). The dowry system meant that they were part of the daughters' inheritance. The size and composition of these dowries varied according to the economic possibilities of the parents (thus ranging from real estate to a limited set of household goods).

6. Literacy rates in the study area increased rapidly after the 1857 Education Act (known as the Moyano Act). By the early 20<sup>th</sup> century, the percentage of boys and girls who got literate was around 85 and 70%, respectively.
7. The lower sex ratios for multiple births than for the general population could be a reflection that the higher risk of miscarriage in twin boys increases in intensity in the case of multiple births (Dipietro and Voegtline, 2017; Jacobsen et al., 1999; Di Renzo et al., 2007). According to microdata from the INE, in Spain between 1975 and 1995, the sex ratio at birth of twins was actually 101.3 (from 173,652 twins), and even lower in higher-order deliveries (triplets or more).
8. Infants were baptised during the same day of birth or the day after if there were born in the evening.
9. On infant and child mortality in Spain, see, Gómez Redondo (1992), Dopico and Reher (1998), Cussó and Nicolau (2000), and David S. Reher and Sanz-Gimeno (2004), and Enrique et al. (2015) and Pérez Moreda et al. (2015).

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## References

- Alesina, A., Giuliano, P., & Nunn, N. (2013). On the origins of gender roles: Women and the plough. *The Quarterly Journal of Economics*, 128(2), 469–530. <https://doi.org/10.1093/qje/qjt005>
- Alter, G., Derosas, R., Nystedt, P. (2004). "Gender Differences in Mortality." In *Life Under Pressure: Mortality and Living Standards in Europe and Asia, 1700–1900*, edited by Bengtsson, T., Campbell, C. & Lee, J.Z. pp. 327– 358. Cambridge, MA: MIT Press.
- Baten, J., & Murray, J. E. (2000). Heights of men and women in 19th-century Bavaria: Economic, nutritional and disease influences. *Explorations in Economic History*, 37(4), 351–369. <https://doi.org/10.1006/exeh.2000.0743>
- Bechtold, B. H. (2001). Infanticide in nineteenth-century France: A quantitative interpretation. *Review of Radical Political Economy*, 33(2), 165–187. <https://doi.org/10.1177/048661340103300202>
- Beltrán Tapia, Francisco J., & Gallego-Martínez, D., (2017). Where are the missing girls? Gender discrimination in 19th-century Spain. *Explorations in Economic History*, 66, 117–126 <https://doi.org/10.1016/j.eeh.2017.08.004>



- Beltrán Tapia, F. J. (2019). "Sex ratios and missing girls in late-19th-century Europe," EHES Working Paper. European Historical Economics Association. 160.
- Beltrán Tapia, Francisco J., & Raftakis, M., (2019). Sex ratios and gender discrimination in Modern Greece. *Population Studies*.
- Beltrán Tapia, Francisco J., & Gallego-Martínez, D., (2020). What explains the missing girls in 19th-century Spain? *Economic History Review*, 73(1), 59–77 <https://doi.org/10.1111/ehr.12772>
- Beltrán Tapia, Francisco J., & Marco-Gracia, F. J., (2021). Death, sex and fertility: Female infanticide in rural Spain, 1750–1950. *European Review of Economic History*.
- Bengtsson, T., & Dribe, M. (2006). Deliberate Control in a Natural Fertility Population: Southern Sweden, 1766–1864. *Demography*, 43(4), 727–746. <https://doi.org/10.1353/dem.2006.0030>
- Blanco Villegas, M. J., Rodríguez Otero, H., Sánchez Compadre, E., Caro Dobón, L., & López Martínez, B. (2002). Exposición y muerte de los niños acogidos en la Casa Cuna de Ponferrada entre los años 1850–1932 (León, España). *Revista de Demografía Histórica*, 20(2), 163–184 <https://www.adeh.org/revista/2002,%20/Rodriguez%20Otero%20p.163-184.pdf> .
- Borderías, C., & Muñoz, L. (2018). ¿Quién lleva el pan a casa en la España de 1924? Trabajo y economías familiares de jornaleros y pescadores en Cataluña y Galicia. *Revista de historia industrial*, 74, 77–106 <https://doi.org/10.1344/rhi.v27i74.19921> .
- Borderías, C., Pérez-Fuentes, P., & Carmen, S. (2010). Gender inequalities in family consumption: Spain 1850–1930. In T. Addabbo, M.-P. Arrizabalaga, & A. Owens (Eds.), *Gender Inequalities, Households and the Production of Well-Being in Modern Europe* (pp. 179–196). Routledge.
- Borderías, C., Pérez-Fuentes, P., & Carmen, S. (2014). La desigualdad en el consumo familiar. Diferencias de género en la España contemporánea (1850–1930). *Areas*, 33, 105–120 <https://revistas.um.es/areas/article/view/216071/170181> .
- Botting, B. J., McDonalds Davies, I., & MacFarlane, A. J. (1987). Recent trends in the incidence of multiple births and associated mortality. *Archives of Disease in Childhood*, 62(9), 941–950. <https://doi.org/10.1136/adc.62.9.941>
- Camps, E. (1998). Transitions in women's and children's work patterns and implications for the study of family income and household structure: A case study from the Catalan textile sector (1850–1925). *The History of the Family*, 3(2), 137–153. [https://doi.org/10.1016/S1081-602X\(99\)80239-5](https://doi.org/10.1016/S1081-602X(99)80239-5)
- Chao, F., Gerland, P., Cook, A. R., & Alkema, L. (2019). Systematic assessment of the sex ratio at birth for all countries and estimation of national imbalances and regional reference levels. *Proceedings of the National Academy of Sciences*, 116(19), 9303–9311. <https://doi.org/10.1073/pnas.1812593116>
- Clark, G., Cummins, N., & Curtis, M. (2020). Twins Support the Absence of Parity-Dependent Fertility Control in Pretransition Populations. *Demography*, 57(4), 1571–1595. <https://doi.org/10.1007/s13524-020-00898-0>
- Cussó, X., & Nicolau, R. (2000). La mortalidad antes de entrar en la vida active en España. Comparaciones regionales e internacionales, 1860–1960. *Revista de Historia Económica*, 18(3), 525–551. <https://doi.org/10.1017/S0212610900008727>
- Derosas, R., Tsuya, N. O, Feng, W., Alter, G., Lee, J.Z. (2010). Child control as a reproductive strategy. In N. O. Tsuya et al. (Eds.), *Prudence and Pressure: Reproduction and Human Agency in Europe and Asia, 1700–1900* (pp. 129–155). Cambridge University Press.
- Di Renzo, G. C., Rosati, A., Sarti, R. D., Cruciani, L., & Cutuli. (2007). Does fetal sex affect pregnancy outcome? *Gender Medicine*, 4(1), 19–30. [https://doi.org/10.1016/S1550-8579\(07\)80004-0](https://doi.org/10.1016/S1550-8579(07)80004-0)
- Dipietro and Voegtline. (2017). The gestational foundation of sex differences in development and vulnerability. *Neuroscience*, 342(7), 4–20. <https://doi.org/10.1016/j.neuroscience.2015.07.068>
- Dopico, F., & Reher, D. S. (1998). *El declive de la mortalidad en España, 1860–1930*. Asociación de Demografía Histórica.
- Drevenstedt, G. L., Crimmins, E. M., & Vasunilashorn, S. (2008). "The rise and fall of excess male infant mortality," *Proceedings of the US National Academy of Sciences* 105(13): 5016–5021. <https://doi.org/10.1073/pnas.0800221105>



- Enrique, L. A., Sanz, J. U. B., & Sánchez, Á. L. V. (2015). ¿Pasó de largo por la España interior la primera fase de la transición demográfica? La mortalidad en Ávila y Guadalajara, 1700-1895. *Investigaciones de Historia Económica*, 11(2), 69–79. <https://doi.org/10.1016/j.ihe.2014.05.001>
- Fellman, J., & Eriksson, A. W. (2009). On the history of Hellin's law. *Twin Research and Human Genetics*, 12(2), 183–190. <https://doi.org/10.1375/twin.12.2.183>
- Fuchs, R. (1984). *Abandoned children: Foundlings and child welfare in nineteenth century France*. SUNY Press.
- Giuliano, P. (2018). Gender: A historical perspective. In S. L. Averett, L. M. Argys, & S. D. Hoffman (Eds.), *Oxford Handbook on the Economics of Women*. Oxford University Press, 1–32 .
- Gómez Redondo, R. (1992). *La mortalidad infantil española en el siglo XX*. Siglo XXI.
- Gupta, D., Monica, J. Z., Bohua, L., Zhenming, X., Chung, W., & Hwa-Ok, B. (2003). Why is son preference so persistent in East and South Asia? A cross-country study of China, India and the Republic of Korea. *Journal of Development Studies*, 40(2), 153–187. <https://doi.org/10.1596/1813-9450-2942>
- Hanlon, G. (2016). Routine infanticide in the West, 1500-1800. *History Compass*, 14(11), 535–548. <https://doi.org/10.1111/hic3.12361>
- Harris, B., & Helgertz, J. (2019). Urban sanitation and the decline of mortality. *The History of the Family*, 24(2), 207–226. <https://doi.org/10.1080/1081602X.2019.1605923>
- Hatton, T. J., & Bray, B. E. (2010). Long run trends in the heights of European men, 19th-20th centuries. *Economics & Human Biology*, 8(3), 405–413. <https://doi.org/10.1016/j.ehb.2010.03.001>
- Hellin, D. (1895). *Die Ursache der Multiparität der uniparen Tiere überhaupt und der Zwillingsschwangerschaft beim Menschen insbesondere*. München: Seitz und Schauer.
- Horrell, S., & Oxley, D. (2016). Gender bias in 19th century England: Evidence from factory children. *Economics & Human Biology*, 133, 47–64. <https://doi.org/10.1016/j.ehb.2016.03.006>
- Hunecke, V. (1991). Intensità e fluttuazioni degli abbandoni del XV al XIX secolo. In P. Boutrey (Ed.), *Enfance abandonnée et société en Europe, XIV-XIX siècle* (pp. 27–72). Ecole Française de Rome.
- Hynes, L. (2011). Routine Infanticide by Married Couples? An Assessment of Baptismal Records from Seventeenth<sup>th</sup> Century Parma. *Journal of Early Modern History*, 15(6), 507–530. <https://doi.org/10.1163/157006511X600828>
- Imaizumi, Y. (2001). *Infant mortality rates in single, twin and triplet births*. and influencing factors in Japan, 1995-1998.
- Jacobsen, R., Moller, H., & Mouritsen, A. (1999). Natural variation in the human sex ratio. *Human Reproduction*, 14(12), 3120–3125. <https://doi.org/10.1093/humrep/14.12.3120>
- Jarque Martínez, E., & Salas Auséns, J.A. (2007). *La vida en la historia de Cosuenda. Siglos XVI-XIX*. Institución Fernando el Católico.
- Jayachandran, S. (2017). Fertility Decline and Missing Women. *American Economic Journal: Applied Economics*, 9(1), 118–139. <https://doi.org/10.1257/app.20150576>
- Johan, Fellman, Aldur W, Eriksson. (2009). "Statistical analyses of Hellin's law". *Twin Research and Human Genetics*. Australia. 12(2): 191–200. doi:10.1375/twin.12.2.191
- Johansson, S. R. (1984). Deferred infanticide: Excess female mortality during childhood. In G. Hausfater & S. B. Hrdy (Eds.), *Infanticide: Comparative and Evolutionary Perspectives* (pp. 463–485). Aldine.
- Kashyap, R., & Behrman, J. (2020). "Gender discrimination and Excess Female Under-5 Mortality in India. A New Perspective Using Mixed-Sex Twins. *Demography*, 57, 2143–2167. <https://doi.org/10.1007/s13524-020-00909-0>
- Kertzer, D. (1993). *Sacrificed for honor. Italian infant abandonment and the politics of reproductive control*. Beacon Press.
- Knodel, J. E. (1988). *Demographic Behavior in the Past: A Study of Fourteen German Village Populations in the Eighteenth and Nineteenth Centuries*. New York: Cambridge University Press.
- Lynch, K. A. (2011). Why weren't (many) European women "missing"? *The History of the Family* 16: 250-266, 16(3), 250–266. <https://doi.org/10.1016/j.hisfam.2011.02.001>

- Marco-Gracia, F. J. (2021). Fertility control due to short-term economic stress in rural Aragón (Spain), 1801-1909. *Revista de Historia Económica – Iberian and Latin American Journal of Economic History, On-line*, 39(1), 129–155 . <https://doi.org/10.1017/S0212610919000144>
- Marco-Gracia, F. J. (2021a). Adapting family size and composition: Childhood mortality and human agency in fertility decisions in rural Spain, 1750-1949. *Journal of Interdisciplinary History*, 51(4), 509–531. [https://doi.org/10.1162/jinh\\_a\\_01626](https://doi.org/10.1162/jinh_a_01626)
- Marco-Gracia, F. J. (2021b). Like Father, Like Son “: The Importance of Fathers in Nineteenth- and Twentieth-century Rural Spain. *Journal of Family History, On-line*, 46(4), 483–501. <https://doi.org/10.1177/0363199020986815>
- Marco-Gracia, F.J., & Beltrán Tapia, F.J. (2021). Son preference, gender discrimination and missing girls in rural Spain, 1750-1950. *Population and Development Review*, 47(3), 665–687.
- Marco-Gracia, F. J., & Puche, J. (2021). The association between male height and lifespan in rural Spain, 1750–1949. *Economics and Human Biology*, 43. <https://doi.org/10.1016/j.ehb.2021.101022>
- Martínez-Carrión, J., Miguel, A., Cámara, D., & Pedro María, P.-C. (2016). Parámetros antropométricos de los reclutas españoles antes de la transición nutricional. Análisis de las desigualdades territoriales (1858–1913). *Nutrición Hospitalaria*, 33(6), 1477–1486. <https://doi.org/10.20960/nh.169>
- McNay, K., Humphries, J., & Klasen, S. (2005). Excess female mortality in Nineteenth-century England and Wales. *Social Science History*, 29(4), 649–681. <https://doi.org/10.1017/S0145553200013341>
- Moreda, P., Vicente, D. R., & Sanz-Gimeno, A. (2015). *La conquista de la salud. Mortalidad y modernización en la España contemporánea*. Marcial Pons Historia.
- Pérez Álvarez, M. J. (2009). La otra infancia en León en el Antiguo Régimen: Los niños expósitos. In J. J. Bravo Caro & J. Sanz Sampelayo (Eds.), *Población y grupos sociales en el Antiguo Régimen, vol. II (Imagraf Impresores: Málaga)*, Universidad de Málaga, (pp. 1077–1095).
- Pérez Moreda, V. (2005). *La infancia abandonada en España, siglos XVI-XX (Real Academia de la Historia)*, Madrid: Real Academia de la Historia.
- Pinnelli, A., & Mancini, P. (1997). Gender mortality differences from birth to puberty in Italy 1887–1940. In C. A. Corsini & P. P. Viazzo (Eds.), *The decline of infant and child mortality. The European experience: 1750–1990* (pp. 73–93). Martinus Nijhoff Publishers.
- Pison, G., & Couvert, N. (2004). The Frequency of Twin Births in France. The Triple Influence of Biology. *Medicine and Family Behaviour. Population (English Edition)*, 59(6), 765–794. <https://doi.org/10.3917/pope.406.0765> .
- Pison, G., & D’Addato, A. V. (2006). Frequency of Twin Births in Developed Countries. *Twin Research and Human Genetics*, 9(2), 250–259. <https://doi.org/10.1375/twin.9.2.250>
- Ransel, D. L. (1988). *Mothers of misery: Child abandonment in Russia*. PUP.
- Reher, D. S., & Sanz-Gimeno, A. (2004). Childhood mortality patterns in Spain before and during the demographic transition: In search of new dimensions. In M. Breschi & L. Pozzi (Eds.), *The determinants of infant and child mortality in past European populations* (pp. 19–42). Forum.
- Reher, D., & Sanz-Gimeno, A. (2007). Rethinking Historical Reproductive Change: Insights from Longitudinal Data for a Spanish Town. *Population and Development Review*, 33(4), 703–727. <https://doi.org/10.1111/j.1728-4457.2007.00194.x>
- Revuelta-Eugercios, B. (2012). Releasing Mother’s Burdens: Child Abandonment and Retrieval in Madrid, 1890–1935. *Journal of Interdisciplinary History*, 42(4), 645–672. [https://doi.org/10.1162/JINH\\_a\\_00308](https://doi.org/10.1162/JINH_a_00308)
- Rydhrström, H. (1990). “The Effect of Maternal Age, Parity and Sex of the Twins on Twin Perinatal Mortality. A Population Based Study. *Acta Geniticae Medicae Et Gemellologiae: Twin Research*, 39(3), 408–409. <https://doi.org/10.1017/S0001566000005341> .
- Sánchez Lecha, A. (2020). *Madres e hijos. Historia de la maternidad e incluso provincial de Zaragoza. Siglos XIX y XX (Institución Fernando el Católico)*.
- Sarasúa, C. (2002). El acceso de niños y niñas a los recursos educativos en la España rural del siglo XIX. In J. M. Martínez-Carrión (Ed.), *El nivel de vida en la España rural, siglos XVIII–XX* (pp. 549–612). Universidad de Alicante.

- Schofield, R. (2000). Short-run and secular demographic response to fluctuations in the standard of living in England. In T. Bengtsson & O. Saito (Eds.), *Population and Economy: From Hunger to Modern Economic Growth* (pp. 49–71). Oxford University Press.
- Sen, A. (1990). More than 100 million women are missing. *New York Rev. Books*, 37(20), 61–66.
- Szolysek, M., Ogorek, B., Gruber, S., & Beltrán Tapia, F. J. (2022). Inferring “missing girls” from child sex ratios in historical census data. *Historical Methods: A Journal of Quantitative and Interdisciplinary History*. <https://doi.org/10.1080/01615440.2021.2014377>.
- Szreter, S. (1988). The Importance of Social Intervention in Britain’s Mortality Decline ca. 1850–1914: A Re-interpretation of the Role of Public Health. *Social History of Medicine*, 1(1), 1–37. <https://doi.org/10.1093/shm/1.1.1>
- Tabutin, D. (1978). La surmortalité féminine en Europe avant 1940. *Population*, 33(1), 121–147. <https://doi.org/10.2307/1531720>
- Van Bavel, J. (2004). Deliberate Birth Spacing before the Fertility Transition in Europe: Evidence from Nineteenth-Century Belgium. *Population Studies*, 58(1), 95–107. <https://doi.org/10.1080/0032472032000167706>
- Waldron, I. (1998). Sex differences in infant and early childhood mortality: Major causes of death and possible biological causes. In I. Waldron (Ed.), *Too young to die: Genes or gender* (pp. 64–83). United Nations.
- Williamson, N. E. (1976). *Sons or daughters: A cross-cultural survey of parental preferences*. Sage.
- Woods, R. 2009. *Death before birth: Fetal health and mortality in historical perspective*. Oxford: Oxford University Press.
- Zarulli, V., Barthold Jones, J. A., Oksuzyan, A., Lindahl-Jacobsen, R., Christensen, K., & Vaupel, J. W. (2018). Women live longer than men even during severe famine and epidemics. *Proceeding of the National Academy of Sciences*, 115(4), E832–E840. <https://doi.org/10.1073/pnas.1701535115>

## Appendix

**Table A1** Mortality rate of twins during the first week (by day and sex), 1750–1950. Excluding Nonatos.

	1	2	3	4	5	6	7
Females	1.90	2.79	3.12	1.80	2.62	2.02	2.47
	841	825	802	777	763	743	728
Males	3.21	4.11	4.52	3.61	2.97	1.33	0.81
	906	877	841	803	774	751	741
Total	2.56	3.47	3.83	2.72	2.80	1.67	1.63
	1,747	1,702	1,643	1,580	1,537	1,494	1,469

Source: AMHDB.

**Table A2** Differences in mortality by number of living children, 1750–1900. Number of observations by categories (see, Table A2).

Number of siblings alive	Twins		Single children	
	Male	Female	Male	Female
0	142	110	10,495	9,906
1	255	205	8,155	7,648
2	195	195	6,226	5,992
3	153	135	4,377	4,082
4	104	94	2,736	2,578
5	55	60	1,590	1,499
6	27	43	829	788
7	20	17	425	357
8	11	6	184	159

Source: AMHDB.

**Table A3** Age at death of first twins (distributed in percentages) in the case of second twins surviving beyond 5 years, 1750–1950.

0–6 days	7–30 days	1–5 months	6–11 months	1 year	2 years	3–4 years
23.0%	12.7%	20.6%	11.9%	17.4%	7.2%	7.2%

Note: This information is available for 126 surviving twins.

Source: AMHDB.

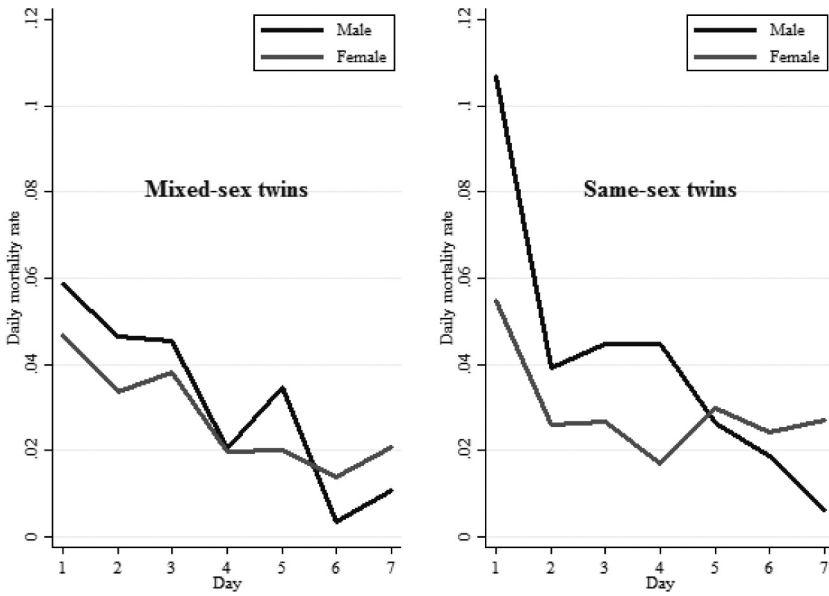


Figure A1. Daily mortality rates during the first week, by day, sex and type of twin

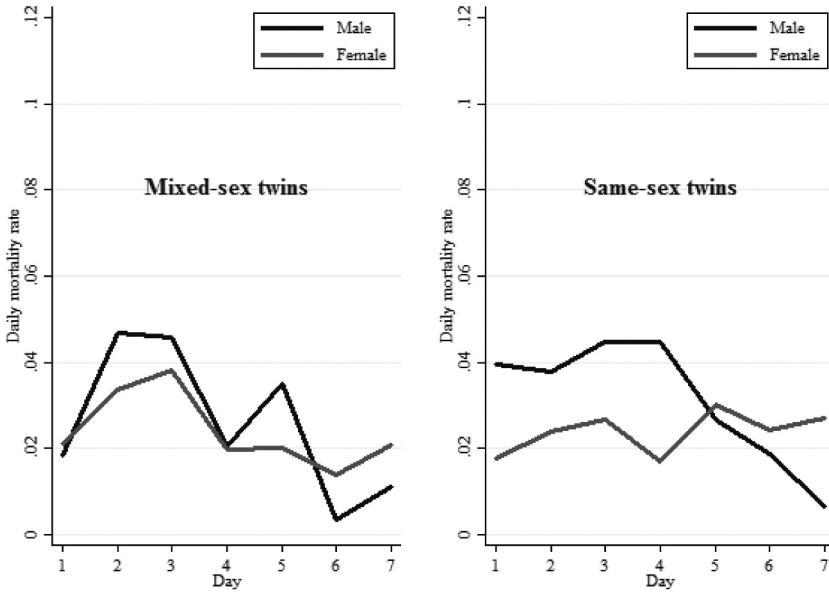
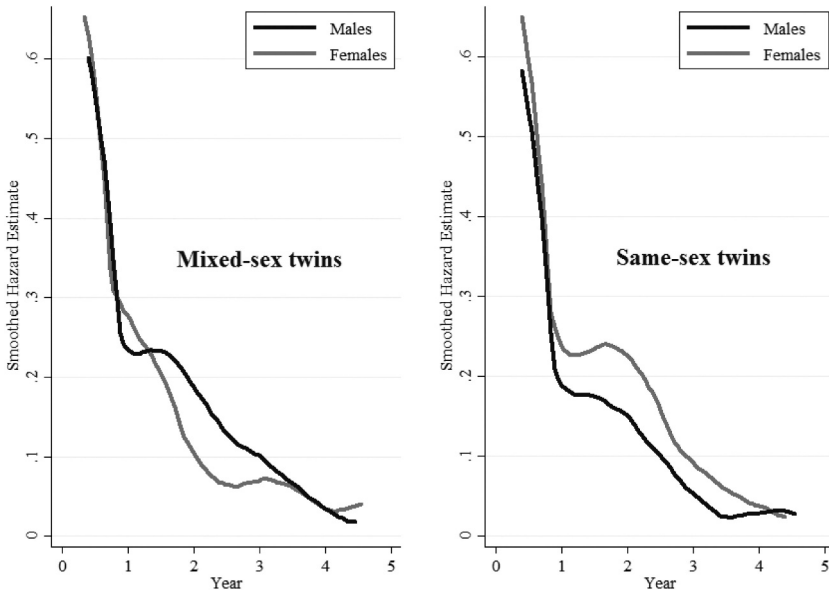


Figure A2. Daily mortality rates during the first week, excluding nonatos



**Figure A3.** Smoothed hazard estimates, mixed- and same-sex twins (age 0–5), 1750–1950