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ORIGINAL ARTICLE

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Disaster, demographics, and vulnerability: Interrogating the long-term effects of an extreme weather event

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Abstract

Climate risk events act on existing inequalities, causing unequal damage across social groups and showing that established vulnerability should be a key consideration in preventing and mitigating the consequences of weather extremes. The disastrous snowfalls that affected Asturias in Northern Spain in the winter of 1888 provide an intriguing and useful historical example of why such consideration is vital. This article is based on analysis of church records and population censuses of 22 mountain parishes over a 21-year period. It examines the long-term sociodemographic impacts of that weather event and reveals dramatic changes in fertility, mortality, and nuptiality. Marriages and births decreased by 67% in the 2 years following the snowstorms, when the highest levels of mortality were reached. The excess mortality especially affected those adults over 70, infants under 5, and, most notably, women. A livelihood crisis was at the base of these long-term effects. Those demographic impacts point to the event's severity and show that the repercussions of a disaster go far beyond deaths and material losses and are deeply rooted in social factors. These findings reinforce the idea that reconstructing old disastrous episodes is of great social and scientific interest now. That is because, as governments and others are progressively paying more attention to the possibilities of adaptation to global change, there is greater appreciation of the fact that delving into the long-term impacts of past natural disasters can guide our main future strategies.

KEYWORDS

demography, disaster, fertility, mortality, population change, social vulnerability

1 | INTRODUCTION

It is accepted that disasters have a clear spatial dimension and are therefore of interest in geographical scholarship. At the same time, historical perspectives are particularly important in understanding the causes and effects of rare disastrous events (Riede, 2017) and can reveal for study the morbidity and mortality associated with current disasters, crucial for developing comprehensive risk management and mitigation policies. Population changes

from disasters directly influence human occupation and resource consumption. In addition, they can significantly affect social development, cause declines in living standards, exacerbate inequality, and drive risky behaviours in interactions with the environment (Bidegain, 2013a). Furthermore, the impacts of certain events on the population produce changes that can hinder socioeconomic recovery after the disaster and even favour its recurrence (Bidegain, 2013b).

Usefully, there is increasing recognition of the importance in geography and other social sciences of the historical dimension of disasters: The literature on causation and consequences in the near and long-term has broadened to encompass economic (Boustan et al., 2020), geographical and geomorphological (Giacona et al., 2019; Huhtamaa et al., 2021; Stoffel et al., 2021; Williams et al., 2022), emotional (McKinnon & Cook, 2020), sociological and political variables (Jeffers, 2014, 2021; Nash et al., 2019; Van Bavel et al., 2020; Walshe et al., 2020).

However, despite the publication of historically informed research, few studies link historical disasters with the demographic impacts they could have caused, but they do exist. For example, Grattan et al. (2003, 2007) assessed the impact of the Laki fissure eruption of 1783 on human health and mortality, while Witham and Oppenheimer (2004) examined increased mortality linked to the same eruption in England. Lin (2010) associated natural disasters with a decrease in fertility in Italy between 1820 and 1962 and in Japan between 1671 and 1965. In the United States, Raker (2020) showed that severe tornadoes led to notable compositional changes in local population, and, in south-eastern Arabia, Petraglia et al. (2020) found ancient droughts corresponded with the decline of inland occupations and population movements. In Spain, studies also considered long-term effects of historical disasters (for example, Alberola–Romá, 2019; García-Hernández et al., 2019; García-Torres, 2017; Gil-Guirado, 2017), but only Cuadrat et al. (2016) delved specifically into their demographic impact, examining the effects of mid-seventeenth century droughts in the Central lands of the Ebro Valley, showing the event's correspondence with a sharp decline in the birth rate and a strong increase in mortality.

The disaster whose demographic impact is examined here occurred in the late nineteenth century in Northern Spain. Between mid-February and early April 1888, four heavy snowfalls caused significant material and personal damage throughout the entire area, although the greatest effects occurred in Asturias, one of the 17 autonomous communities that make up Spain. The snow cover depth up to 5 m in the highlands (with snowdrifts up to 9 m) caused great damage in the infrastructures and alterations to economic activities. The consequences for people included 42 direct fatalities and significant damage to properties: 1,000 buildings collapsed, and more than 19,000 domestic animals died. Those effects exceeded any other known disaster in Asturias. Isolation inside the region and from the rest of Spain lasted more than a month. To date, the impacts of the 1888 snowstorms have been explored in successive studies to determine the causes and repercussions of avalanches (García-Hernández, Ruiz-Fernández, & Pereira, 2017; García-Hernández, Ruiz-Fernández, Sánchez-Posada, et al., 2017, 2018) and landslides (García-Hernández, Ruiz-Fernández, Oliva, & Gallinar, 2018), the crisis's socio-political management (García-Hernández, 2019), impacts on fauna (García-Hernández et al., 2016), and the influence of inherited memories on current risk management (García-Hernández et al., 2019). Nevertheless, the *demographic* consequences of such a remarkable episode remain unexplored so far.

My starting hypothesis is that the 1888 snowstorms caused indirect impacts on demographic indicators such as mortality, nuptiality, and fertility. To that end, I document and critically analyse the long-term sociodemographic impact of 1888 snowstorms on the most affected areas, examining a sample comprising populations in 22 mountain parishes. In the process, I will, for years before and after the event, (a) reconstruct global mortality patterns; (b) examine ages of death; (c) examine the change in the number of marriages and births; (d) assess differences between female and male mortality; (e) examine de facto population changes (after the event); and (f) critically consider feasible causes explaining detected patterns and put them in the context of the currently available scientific information on impacts of natural hazards on fertility, morbidity, and mortality.

Key insights

This article argues for the worth of studying the effects on health and family planning of disaster-affected populations in the aftermath of a climate risk event. The Great Blizzard of 1888 had a notable effect on Spain's Asturian Mountain inhabitants: Mortality increased markedly in the 2 years following the disaster and was higher among females, especially the elderly and those under 5 years of age. Moreover, marriages and births fell by 67% in the same period. Confirmed demographic impacts show both the event's severity and its relationship to existing inequalities and vulnerabilities.

2 | MATERIALS AND METHODS

For the analysis, I used data from Asturian mountain parishes. Data were obtained from the parochial registers of burial, baptism and marriage, on deposit in the Diocesan Archive belonging to the Archdiocese of Oviedo. The church records belong to 22 parishes distributed in eight mountain municipalities: Cangas del Narcea, Somiedo, Tinéu, Quirós, Lena, Caso, Valle Altu de Peñamellera, and Peñamellera Baja (Figure 1). The selection has been guided by two criteria: (i) all selected parishes belong to councils in which personal injuries occurred during the snowfall, according to newspaper archives (data collected from 16 regional and national newspapers published between 10 February and 30 May 1888), and (ii) avoid spatial concentration, so that the selected sample is as representative as possible of the Asturian Mountain territory.

However, it should be noted that the selection was also highly conditioned by the lack of available files. In these parishes, the inconsistency of the ecclesiastical records is notable, and many of them were damaged or disappeared. On the other hand, three parishes of Lena, one of the most affected councils, were excluded because of strong demographic fluctuations in the study period arising from waves of immigration and subsequent changes in their populations. In summary, using the two criteria above, I selected the 22 parishes that offered the most reliable records and in which there were no discontinuities.

Table 1 shows which parishes have been used for each type of analysis, depending on their availability and degree of detail. Changes in 12 parishes in the numbers of deaths have been examined over a 21-year period (1878–1898, 10 years before, and 10 years after snowfalls). The study of deaths according to age and sex has been studied over an 11-year period (1883–1893, 5 years before, and 5 years after the snowfalls). The analysis was carried out using descriptive statistics with SAS University Edition software. On the other hand, the Spanish Population Census (Nomenclator) has been consulted to contextualise changes in mortality patterns, connecting them with those observed in the total population of the 22 parishes. The census immediately before the snowfall was conducted in 1887 and the next in 1900. Finally, the impact that the snowfalls could have caused on the number of marriages and births has been examined through the study of these two parameters in 15 parishes, over the 1886–1890 period (2 years before and 2 years after the snowfall).

3 | RESULTS

3.1 | Changes in the numbers of deaths

The year 1888 does not have a particularly high number of deaths compared with the rest of those that make up the period 1883–1893 (11 years). However, there is a considerable increase in mortality in the following 2 years, reaching the maximum number of deaths per year in the years 1889 and 1890 (Figure 2a). Likewise, in the period 1878–1898, those 2 years, 1889 and 1890, have a higher than usual mortality, since, again, the maximum values of a total of 21 years were reached (Figure 2b). Female mortality peaked the year after the snowfall, in 1889, while male mortality did so 2 years later, in 1890 (Figure 2c).

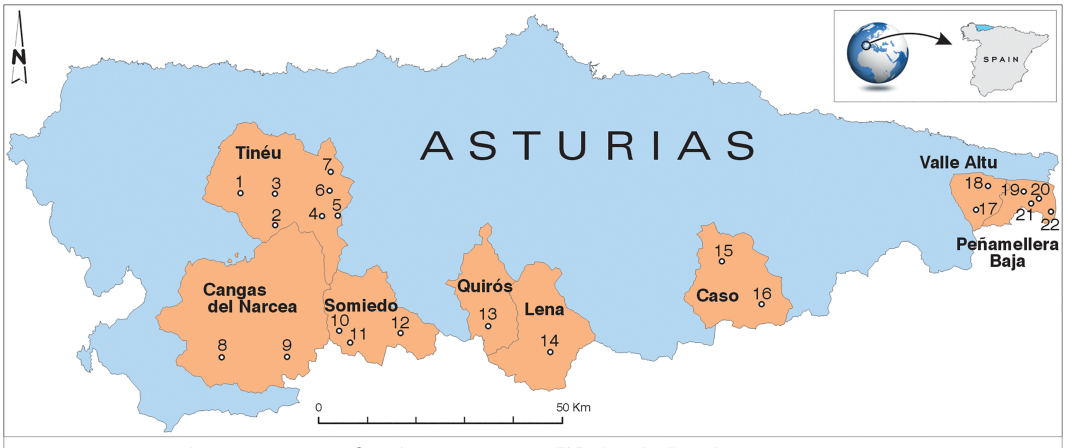

FIGURE 1 Asturian parishes selected for the analysis

TABLE 1 Data obtained from each source, depending on the parish and the study period

Parish	Municipality	Number of deaths 1883–1893 and 1878–1898	Deaths by sex/age 1883–1893	Population census 1887 and 1900	Number of marriages/ births 1886–1890
Arganza	Tinéu	x	x	x	x
Mirallo	Tinéu	x	x	x	
Bourres	Tinéu	x	x	x	
Santolaya	Tinéu				x
Brañallonga	Tinéu	x	x	x	
El Pedregal	Tinéu	x	x	x	x
La Preda	Tinéu	x	x	x	
Veiga de Rengos	C. Narcea				x
San Xulianu	C. Narcea				x
Villar de Vildas	Somiedo				x
Gúa	Somiedo				x
Veigas	Somiedo				x
Ricao	Quirós				x
Bueres	Caso	x	x	x	x
Tarna	Caso				x
Mier	El Valle Altu de Peñam.	x	x	x	
Alevia	El Valle Altu de Peñam.	x	x	x	x
Abandames	Peñam. Baja	x	x	x	x
Siejo	Peñam. Baja	x	x	x	
Tobes	Peñam. Baja	x	x	x	
Merodio	Peñam. Baja				x
Puente los Fierros	Lena				x

Source: own work.

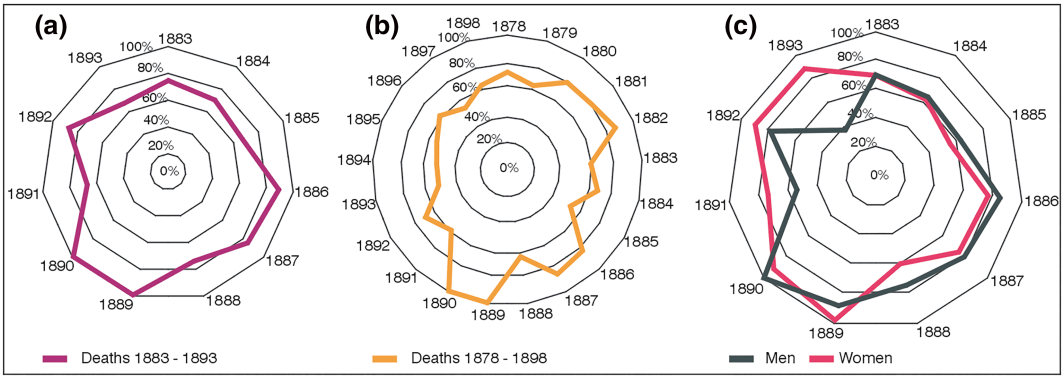

FIGURE 2 (a) Mortality pattern (males and females) in the periods 1883–1893 and (b) 1878–1898. (c) Mortality pattern differentiating males and females in the period 1883–1893

The year 1888 marks the start of a trend of increasing female mortality compared with male, leaving behind a period of synchrony (Figure 3). Starting in 1888, a gender gap opens in the mortality of examined parishes: The first sign of desynchronisation slightly favours male mortality, which, in 1889, returns to the previous figure. In contrast, in 1889 female mortality increased notably, surpassing that of males and achieving a record figure in the period of 11 years. In 1890, the figures come closer again, and, from there, the number of deaths of males undergoes a marked decrease until reaching the minimum in 1893, the last year of the series. Meanwhile, the number of deaths of females is constantly above that of males, establishing a greater distance between the two than that which existed prior to 1888.

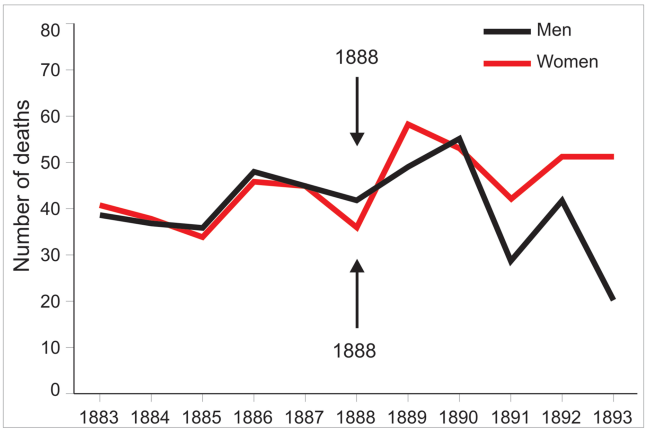

FIGURE 3 Number of deaths, by sex, in the period 1883–1893

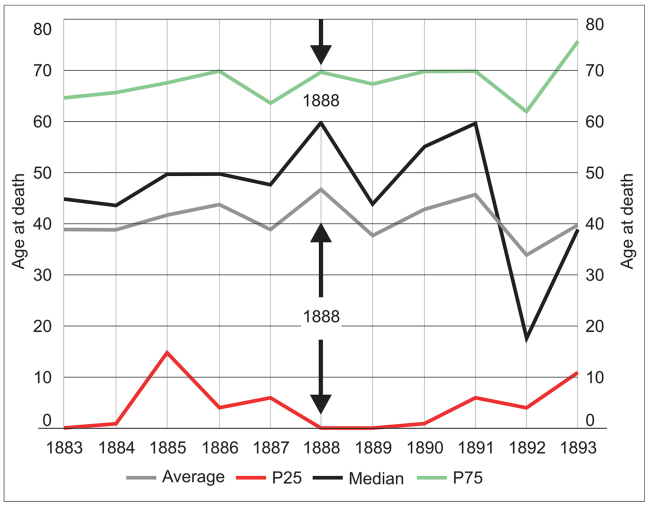

FIGURE 4 Measurements of position (average and percentiles) for the ages at death between 1883 and 1893

3.2 | Changes in ages at death

In the distribution of the ages at death, 1888 stands out as the year in which the measures of position reach the highest values as a whole (mean, median), and percentiles are farthest-out (Figure 4). In other words, 50% of the deceased were over 60 years old, with a significant concentration of deaths in the 60–70 age bracket (25% of deaths). In turn, 25% of the deceased were under 1 year of age, so 1888 is characterised as the year in which p25 and p75 are most distant.

Contrasting the distribution of the ages at death in the 5 years before the snowfall, and in the 5 years after (Figure 5), the previous finding is confirmed. In 1888, the median and mean age rose significantly, with a higher concentration of deaths in the 60- to 70-year-old range, and especially among those younger than one. Thus, 1888 was a year in which more deaths than usual occurred in those over 60 years (markedly between 60 and 70 years) and in children under 1 year of age. In the case of women, this concentration occurred in an even shorter range, since 25% of those who died in 1888 were neonates less than 1 month old. Regarding the differences between the 5 years before and after the snowfall, the ages at death are slightly differently distributed in females and males. In females, there is a decrease in

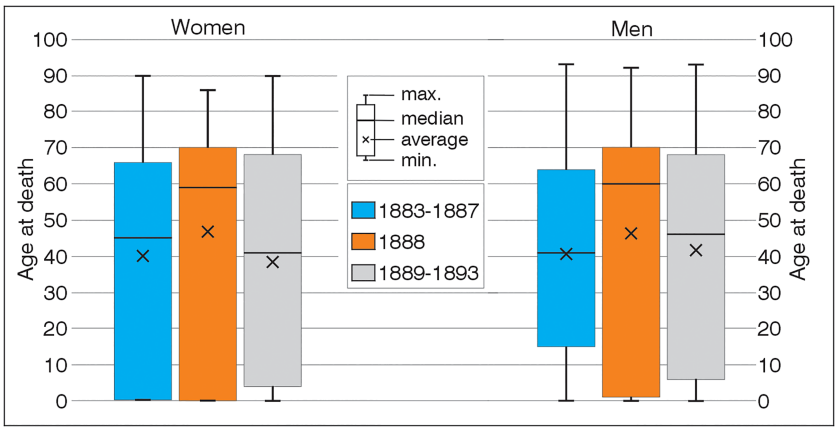

FIGURE 5 Distribution of the ages at death for females and males comparing the year 1888 with the 5 years before and after the snowstorms

the mean and median age (45 to 41 and 40.3 to 38.5), while in males, there is an increase in these values (40.7 to 41.7, and 41 to 46, respectively).

The age at death pyramid (Figure 6) shows the difference in the percentage of deaths of males and females, comparing the average for the 1883–1893 period with that of the 2 years after the snowfalls in which an increased mortality was detected (years 1889 and 1890). In the years 1889 and 1890, mortality was higher than usual in the first age cohort (0–4 years old) and in the 70–74 cohort. In both ranges, the difference is more noticeable in the case of women. In adulthood (15 to 65 years), there is a clear increase in the number of deaths of males in the 40–44 cohort. Male deaths also increased in cohorts 25–29 and 35–39. Instead, Figure 6 does not show an excessive increase in mortality of adult females, except in the cohort between 35 and 39 years old. In fact, examining the percentage of mortality represented by women of childbearing age (Figure 7) establishes that, before 1888, the relative mortality was higher than after this year. However, it should be noted that the mortality of females between 20 and 45 years old had experienced a steady decline (decreasing from 25% in 1884 to 12% in 1887) and then a rebound to 21% in 1889.

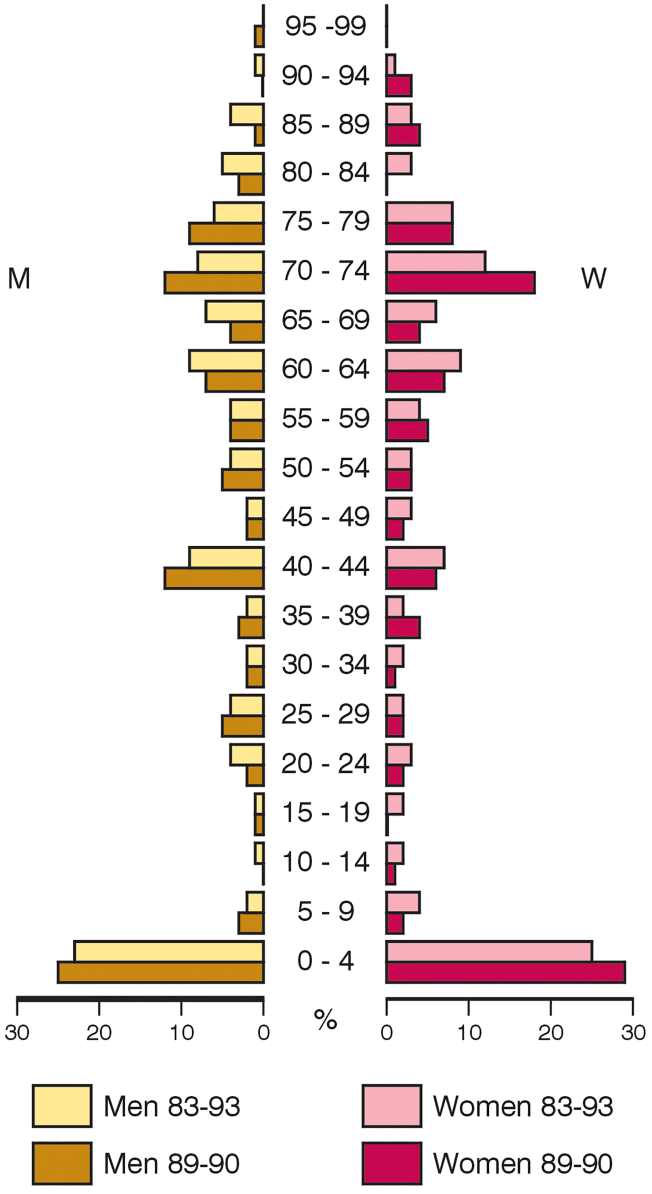

FIGURE 6 Percentage of deaths, by 5-year age cohorts, comparing the average for the 1883–1893 period with the average for the period 1889–1890

3.3 | Changes in the number of marriages and births

Annual numbers of marriages and births underwent outstanding change after 1888. Figure 8 shows the mean annual number of births and marriages by parish, comparing the mean values for the 2 years before the snowfall (1886 and 1887) with the 2 years after (1889 and 1890), and with the values of the year 1888. Births went from 38.6/year in the 2 years prior to the snowfalls to 13.1/year in 1888, dropping to 12.8 in the two subsequent years. In turn, marriages went from 9.1/year in 1886–87 to 2.1 in 1888, remaining at 3 the following 2 years. In both parameters, compared with the previous years, there was a decrease close to 67% in the 2 years following 1888 (66.7% in marriages and 66.9% in births).

3.4 | Changes in the population census

Finally, a clear reduction in the de facto population between 1887 and 1900 has been observed in 5 of the

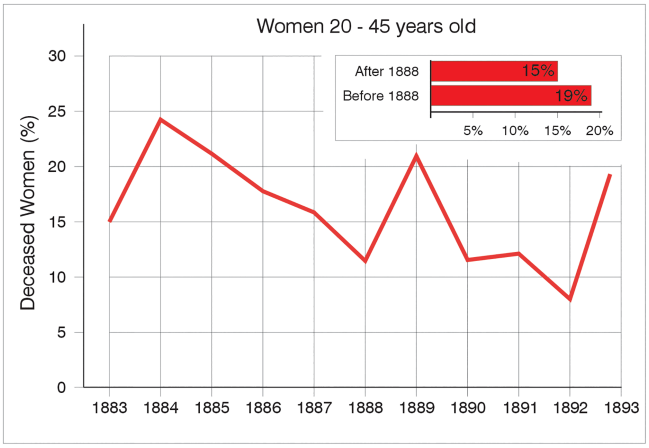

FIGURE 7 Percentage of deceased females of childbearing age (between 20 and 45 years old), between 1883 and 1893: by year, and comparing the 5 years before and after 1888

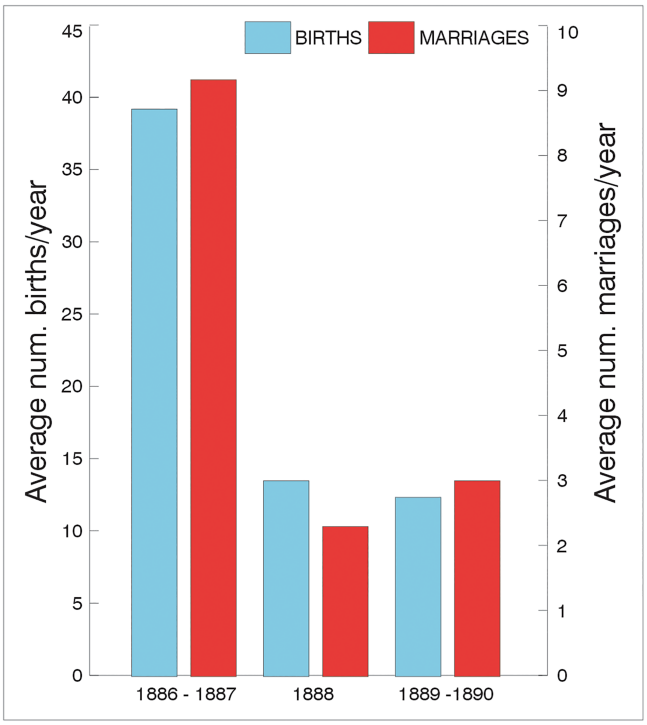

FIGURE 8 Changes in the mean annual number of marriages and births

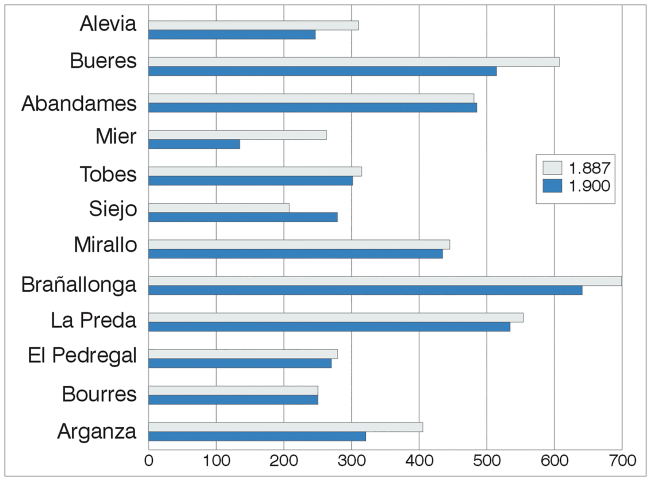

FIGURE 9 De facto population in examined parishes in 1887 and 1900 censuses

12 examined parishes—those parishes in which I carried out the analysis of mortality patterns (Table 1), although another 6 remained at similar figures (with a variation of less than 5%), and one increased its population (Figure 9). Altogether, the population of the studied parishes decreased by 6% between 1887 and 1900.

4 | DISCUSSION

4.1 | Near-term demographic effects

4.1.1 | Under-reported deaths in church records and apparently low levels of mortality in 1888

Journalistic chronicles and newspaper testimonies described situations compatible with an increase in poverty and starvation that affected the inhabitants of the Asturian mountain villages during and just after the snowstorms of 1888. In the subsequent the months, outbreaks of smallpox and respiratory diseases were reported. The newspapers contained statements such as the following: "In the villages there are many children affected by smallpox" (El Comercio newspaper, 02/29/1888) or "Smallpox causes deaths in the unfortunate town of Pajares" (El Carbayón newspaper, 03/02/1888) or:

> the number of deaths during these 2 months rises to that of the whole of last year, and the number of sick people increases every day. A part of the deaths has been caused by pneumonia. It was impossible to visit many of them, because of the depth of the snow. Today most of these unfortunates suffer from anaemia due to lack of food (...). (author translation, El Carbayón newspaper, 19/04/1888)

News about the effects of the typhus and smallpox epidemics following the snowfalls led to the mobilisation of resources even from Havana (Cuba), where many Asturians had emigrated in prior decades (Durán & Duany, 2015). Outbreaks of smallpox and other infectious diseases were frequent in the north of Spain until the last decades of the nineteenth century (Feo Parrondo, 2009) and often occurred in the aftermath of climate extremes and natural disasters such as plagues causing significant crop damage (Alberola & Olcina, 2009; García-Torres, 2017). Regard must also be paid to historical evidence that associates climatic events affecting agriculture with population declines (Santisteban et al., 2021). Thus, cold temperatures and the loss of goods and crops seem incompatible with low mortality in the 22 parishes, which has been verified in the results section. However, account must be taken of interruptions to daily routines in the highlands of Asturias between February and April 1888. In certain villages, isolation continued for several months after the snowstorms because of the effects of large avalanches, landslides, and floods—all of which affected infrastructures. Among such interrupted routines were funerals and burials. For

example, in the town of Veguellina, 4 days after the death of an 18-year-old girl, her body had not been removed from the house: "people are worried thinking about how take the corpse to the parish cemetery, since there is no one who dares to transport the coffin due to the great snow depth" (author translation, El Carbayón newspaper, 28/02/1888).

In fact, several deaths caused by snow avalanches were never recorded in the burial books, as no funerals had been held (García-Hernández, 2018, 2019). The inability of parish priests to move to places where their services were needed was a cause of underreporting of instances of deaths in the first months of the year. In Spanish church records, it is relatively common that deaths are underreported in exceptional conditions such as epidemics, climate extremes, war, and conflict, especially for females and children (Gozálvez Pérez & Martín-Serrano Rodríguez, 2016; Peral & Suárez-Guzmán, 2015). Under-representation in the number of victims and losses continues to occur in current disasters (Agyenim-Boateng & Oduro-Boateng, 2019; Cooper & Lapsley, 2019; Haynes et al., 2010; Mckeever & Hossain, 2021; Perkiss & Moerman, 2020). This factor explains the low number of deaths in a year in which, at least, a mortality similar to that of other years could be expected.

4.1.2 | Low temperatures and nutritional stress explain relative increases in mortality among the elderly and neonates

Compared with other years spanning 1883–1893, in 1888, there was a higher concentration of deaths among neonates under 1 month of age and among those over 60 years of age. Temporary nutritional stress can affect increases in mortality associated with infectious diseases, especially among children, the most vulnerable to malnutrition (Khan et al., 2017). Likewise, a relationship between maternal malnutritional status and increased neonatal mortality has been shown (Katona & Katona-Apte, 2008; Christian et al., 2015).

Several studies show an association between low temperatures and increased mortality (Analitis et al., 2008), with no evidence of differences by sex (Folkerts et al., 2021; Yoneyama et al., 2021). Thus, colder seasons tend to accumulate higher numbers of epidemic outbreaks and infectious respiratory diseases (Mäkinen et al., 2009), and winter storms are associated with increased rates of hospitalisation for respiratory and cardiovascular diseases, or for food and waterborne diseases (Lin et al., 2021). Low temperatures have a particular impact on those aged over 64 years, especially in rural and economically depressed areas (Grigorieva & Revich, 2021; Weilnhammer et al., 2021; Yoneyama et al., 2021) and on children under 5, who are very vulnerable to certain infectious diseases that occur more frequently in the coldest months (López et al., 2007). These effects of cold temperature have been observed in long-term studies in Spain (Carmona, Diaz, et al., 2016; Díaz et al., 2015). In the north of the country, temperatures below 2°C cause considerable increases in mortality across all age groups (Carmona, Díaz, et al., 2016). The cross-effect of both temporary nutritional stress and low temperatures on pregnant women would also cause specific effects on neonates (Derosas, 2009). Added to this outcome is evidence that connects natural disasters with increases in underweight and preterm babies (Harville et al., 2010; Tong et al., 2011; Xiong et al., 2008).

4.2 | Long-term demographic effects

4.2.1 | Decreases in the number of marriages and births

There is no unanimous agreement on the effects of natural disasters on births and marriages. Studies such as the one carried out on the demographic consequences of Hurricane Katrina (Hamilton et al., 2009), Red River floods in North Dakota (Tong et al., 2011), temperature and precipitation shocks from 1993 to 2015 in Indonesia (Sellers & Gray, 2019), droughts of the mid-seventeenth century in the Ebro Valley in Spain (Cuadrat et al., 2016), and the events that affected Japan and Italy during the nineteenth and twentieth centuries (Lin, 2010) point to a decrease in the number of births following the events. A decline in marriages was also observed in studies on the aftermath of major floods in Pakistan (Ahmed, 2018) or associated with the Covid-19 pandemic in the United States (Wagner et al., 2020).

On the contrary, following disasters, there are studies that find an increase in the number of births (Carta et al., 2012; Davis, 2017; Nandi et al., 2018; Nobles et al., 2015), marriages (Cicatiello et al., 2019; Xu & Feng, 2016), or in both of them (Cohan & Cole, 2002). Most such studies have linked those increases with a replacement fertility phenomenon or with the effects of the psychological impact—such as the need to make decisions and live intensely that follows the feeling of strong threat or loss. However, it seems that the increase usually occurs when the effects of events are minor, with the opposite occurring when disasters cause more severe material and personal damage (Cohan & Cole, 2002). The most apt example in this regard may be the consequences

of the 2011 Japan earthquake and tsunami, with its serious adverse effects on numbers of marriages and births (Hamamatsu et al., 2014). The ways in which the circumstances of 1888 affected the health of the inhabitants of the Asturian mountains could also explain such patterns. On the other hand, most of the aforementioned studies show that the effects of disasters on birth and marriage generally last no more than 1 year (Hamamatsu et al., 2014; Tong et al., 2011; Torche & Kleinhaus, 2012). Considering the decrease observed in the average annual number of marriages and births (−66.7 and −66.9%), and its prolongation for at least 2 years, the effects on marriage and birth can be considered indicators of the high severity of The Great Blizzard of 1888 in the Asturian mountains.

4.2.2 | Increase in mortality in the 2 years after the 1888 snowstorms

Results from this study show a notable increase in mortality in the 2 years after the snowstorms of 1888. In addition to acute nutritional stress in the first weeks, the snowstorms caused losses that could not be immediately repaired: damage to public and private property, loss of services, significant environmental damage, and loss of livelihoods. More than 1,000 buildings collapsed, almost 20,000 livestock died, essential working tools were lost, harvests were ruined, and there was serious damage to farmland. Moreover, damage to infrastructure caused significant difficulties for supplies and exchanges for many months after the events (García-Hernández et al., 2019). The situation thus had the potential to cause significant socioeconomic disruptions and health impacts in the long term.

Beyond temporary food stress, and particularly after natural disasters, chronic malnutrition has historically been related to an increase in mortality because of health problems such as gastrointestinal and respiratory infectious diseases (Keusch, 2003), an increase generally more prevalent in early childhood and especially among the elderly (Gombart et al., 2020; Rodriguez-Llanes et al., 2016). Citing one significant example, Adams et al. (2011) observed that more elderly people died than did those in any other age group in the first year after Hurricane Katrina in New Orleans, and, in the 10 years following the 2004 Indian Ocean tsunami, a higher risk of death was established for those aged 50 and older (Frankenberg et al., 2020).

This trend would largely explain the proportional increase in mortality in the 2 years following Spain's Great Blizzard in 1888: an increase in mortality which especially affected those under 5 and those over 70. But, from 1891 on, the annual number of deaths returned gradually to normal patterns of mortality. Without ruling out the possibility that food deficiencies and poverty were progressively mitigated, research related to physiological conservation and nutritional ecology suggests that certain behavioural and biological mechanisms underpin adaptation to changes in nutrient availability (Knott, 2005; Raubenheimer et al., 2012) and shows historical evidence for the importance of such mechanisms (Livi Bacci, 1990).

Finally, it is worth mentioning the possible influence of ineffective public responses. Disasters require organised responses by public administrations, including in relation to damage mitigation operations and work to reduce the probability of secondary damage (Steigenberger, 2016). However, research on the public response to snowfalls in 1888 in Asturias shows how the Spanish administration focused on restoring rail and road communications, did not develop any plan for rescue operations during the snowstorms, and offered little financial aid after the disaster: In the absence of governmental aid, the culture of neighbourhood solidarity in the mountain villages, very active until the twentieth century, underpinned the only emergency responses evident in the most affected areas (García-Hernández, 2019). However, as the demographic impact of the disaster shows, this social response failed to avoid the worst long-term consequences.

4.2.3 | Changes in female and male mortality patterns

One hypothesis is that, mostly the year after the disaster, the increase in female compared with male mortality was because of complications arising in pregnancy and childbirth. However, an increase in female mortality in childbearing ages has not been found, with the exception of those aged 35 to 39. Similarly, for three reasons, it is unlikely that male out-migration influenced the difference between the number of deaths of females and males in the years following the snowstorms. First, the increase in total mortality in 1889 and 1890 does not seem compatible with an important migratory movement that would have reduced demographic numbers in the studied parishes. Second, increases in male mortality have been observed in the young adult sector, in age cohorts in which migrations are usually undertaken (for example, between 25 and 29). Third, the revision of censuses puts paid to this hypothesis, since population decline was not significant enough nor did it affect all parishes, resulting in the accumulation of processes that extend for more than 10 years after the events.

In the case of the snowstorms of 1888, relative increases in female mortality particularly affected the most vulnerable: those over 70 and girls under 5 years of age. Increased mortality was also observable in elderly males and male children, although in less extreme ways. To explain the increase in female mortality, insights might be gained from recent studies on catastrophic events in rural areas in underdeveloped countries where disasters have an emphatic effect on existing discriminatory patterns, exacerbate challenges people have accessing and managing resources (Llorente-Marrón et al., 2020), and result in increased instances of violence against women (le Masson et al., 2016; Parkinson & Zara, 2013; Rao, 2020). These patterns existed in Spanish rural environments well into the twentieth century (García Martínez, 1990; Menéndez González, 2006; Pérez Álvarez, 2014), including in relation to female infanticide: Until the first half of the twentieth century, families resorted to this practice to shift sexual composition of their offspring and justified a preference towards sons on the grounds that, in the event of resource shortages, they could migrate out and send back remittances and could labour in more occupations in any case (Beltrán Tapia & Gallego-Martínez, 2020; Echavarri, 2021; Marco-Gracia & Beltrán Tapia, 2021). Neonatal discrimination produced excess female mortality in childhood even in rural societies whose traditions do not fully match those of more patriarchal societies (Beltrán & Marco-Gracia, 2021). Thus, natural disasters often have a higher long-term impact on female health, most notably in old age or in childhood, increasing the difference between male and female life expectancy (Doocy et al., 2013; Flanagan et al., 2011; Hoddinott, 2006; Sapir, 1993), as happened in Asturias during the aftermath of the snowstorms of 1888.

5 | CONCLUSION

Beyond the direct damage caused by snowstorms of 1888, this weather event caused significant damage to property and prolonged isolation for the populace of the Asturian mountains. Nutritional stress caused by the loss of the harvests and livelihoods, together with low temperatures, resulted in an increased incidence of infectious diseases. This outcome explains a higher concentration of mortality among newborns and the elderly in 1888, because they were also most vulnerable to infection. Food shortages led to a significant increase in mortality in the 2 years following the storms, when the highest number of deaths in the period 1878–1898 (10 years before and after 1888) was reached. The impact also extended to marriages and births, since in the 2 years following the snowfalls, there were marked decreases of −66.7% and −66.9%, respectively, a demographic outcome indicating a high-impact weather event. Moreover, in 1888, a gender gap opened in mortality: The increase in female mortality was produced from an excess in the mortality of women over 70 and girls under 5 years of age, and that pattern was particularly significant the year after the disaster, although differences continued to be important for at least 5 years. The exacerbation of certain discriminatory patterns that would already have been operating for females in rural Asturias could explain a decrease in the life expectancy of the most vulnerable women after the events of 1888.

The study of disasters caused by extreme weather events is a research area of growing interest. However, disaster assessments are potentially deceitful if they do not incorporate longer term effects on the population, and although more studies are emerging, there is a lack of historical evidence. The long-term demographic impact of the Great Blizzard of 1888 in Asturias constitutes a new high severity indicator that had been neglected in previous research. The most negative effects in the near- and long-term affected the segments in a previous physical and social vulnerability (the infants and the elderly), but especially women, widening the sex differences in mortality and causing an excess mortality among the younger and older women which would remain years after the risk event. With such historical insights, we can achieve a deeper understanding of the implications of disasters on demographic indicators, and the data can be useful both to assist current disaster research and to target action by policy-makers and local stakeholders.

CONFLICT OF INTEREST

The author declare that she has no known interests that could have influenced the work reported in this paper.

ETHICS STATEMENT

No approvals were required or morally appropriate.

DATA AVAILABILITY STATEMENT

The data provided belongs to institutions that do not accept public sharing, so no supporting data is available.

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