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Inequities in Child Loss: Ethnicity and Maternal Bereavement in Colombia

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Abstract

Background: Offspring mortality, also known as parental bereavement, might play an important role in health and life expectancy. The death of a loved one increases the mortality risk of the bereaved, popularly understood as "dying of a broken heart". Demographic changes, particularly those related to child survival, have altered the age at which parents, particularly women, experience loss during their lives. We investigate how these changes have affected White-Mestizo, Indigenous, and Afro-descendant women in Colombian society.

Methods: We analysed births from the 2017 Colombian Vital Statistics and deaths from the national Census. We modelled child survival and death frequency using the matrix formulation of kinship network estimation. This framework considers kin for each sex and ethnic group within age-classified populations, with time-invariant rates (fixed mortality and fertility schedules).

Results: Three distinct offspring mortality patterns were identified. White-Mestizo women show the lowest probabilities of experiencing child loss, followed by Afro-descendant women, with Indigenous women presenting the highest probabilities. An Indigenous woman has, on average, 2.6 living children at the age of 45; but by the age of 90 this number declines to two. Afro-descendant women have a higher number of living children at age 45 (2.2) than White–Mestizo women (1.9). By age 90, however, both groups have the same average number of surviving children (1.7).

Conclusions: Marked ethnic differences in maternal bereavement reflect profound social inequalities, mirroring disparities typically observed between high- and low-income countries.

Contribution: This is the first national study to analyse maternal bereavement by ethnicity in Colombia, providing evidence to inform targeted interventions that address persistent health inequalities in marginalised populations.

Keywords: Maternal Bereavement, Ethnicity, Health Inequities, Child Mortality, .

1 Introduction

Child mortality is a powerful indicator of health and social inequalities, extensively used to measure disparities in healthcare access and living conditions (Palacios, 2018; Cramer, 1987; Garcia, 2020; Chivardi *et al.*, 2023). Beyond its value as an indicator, child mortality also functions as a critical determinant of health and social well-being, most directly by shaping maternal experiences of bereavement.

For decades, researchers have investigated whether the death of a loved one increases the mortality risk of the bereaved, popularly understood as "dying of a broken heart" (Doku *et al.*, 2020; Hendrickson, 2009; Stroebe *et al.*, 2007; Stroebe & Stroebe, 1993). More recently, demographic studies have increasingly incorporated child loss from the parental perspective, often referred to as *parental bereavement*, to describe population patterns and to analyse how the risk of losing a child has evolved over time in relation to maternal age and country of residence (Alburez-Gutierrez *et al.*, 2021; Smith-Greenaway *et al.*, 2021; Smith-Greenaway & Trinitapoli, 2020).

Empirical evidence demonstrates a marked decline in women's experience of child loss in recent decades (Kayode *et al.*, 2022; Ananth *et al.*, 2022; Hill *et al.*, 2012), largely attributable to advances in healthcare and medical science. But this decline has not occurred uniformly across populations. Significant inequities in parental bereavement persist, particularly among ethnic and racial groups (Rojas-Botero *et al.*, 2025; Rebouças *et al.*, 2022; Mena-Meléndez, 2020; Rice *et al.*, 2017). Additionally, little is known about how these persistent mortality differentials affect surviving parents from ethnic minority groups, specifically in relation to their probability of child loss, the ages at which such loss is most likely to occur, and how these patterns differ when compared with the White standard population.

In this article, we provide the first national-level estimates of maternal bereavement among Indigenous, Afro-descendant, and White-Mestizo women in Colombia. We generate measures of total fertility rates, the number of surviving children by mother's age and ethnicity, child mortality rates, parental life expectancy, and the probabilities of child loss across the life course.

Disparities in child loss across ethnic groups likely reflect underlying social inequalities and serve to exacerbate broader health and mortality differentials in multiple ways. First, child mortality directly reduces life expectancy, as it accounts for a greater number of years of

life lost. Second, it may adversely affect the health and longevity of surviving parents. Studies have shown that child loss increases the risk of parental mortality, particularly from circulatory diseases associated with elevated psychological stress (Chen *et al.*, 2021; Schorr *et al.*, 2016). Similar effects have been observed among widowed individuals, whose heightened mortality risk is often referred to as the *widowhood effect* (Elwert & Christakis, 2008; Hart *et al.*, 2007).

Systematic exposure to higher mortality rates among close relatives has therefore significant implications for health outcomes and life expectancy. Challenging life circumstances contribute to a cumulative deterioreting process over age (Lynch, 2003; DiPrete & Eirich, 2005; Green *et al.*, 2022). This cumulative burden of adverse life experiences over the lifespan, also known as "allostatic load", has proved to be a good predictor of early morbidity and mortality in older ages (Howard & Sparks, 2016; Moore *et al.*, 2022; Duru *et al.*, 2012; Akinyemiju *et al.*, 2020).

Maternal bereavement have been found more common in Adolescent mothers than in older ones (Finlay *et al.*, 2011). However, advanced maternal age has also been linked to adverse health outcomes, and shortened life expectancy in children (Jacobsson *et al.*, 2004; Liu *et al.*, 2011; Carslake *et al.*, 2019). Children born from mothers aged between 25-29 are the ones with lower mortality risk (Barclay & Myrskylä, 2018). Offspring mortality has also been found particularly higher in families with parental substance abuse of alcohol and drugs (Berg *et al.*, 2022), and in mothers with short lengths of time between pregnancies (Wendt *et al.*, 2012; Kozuki & Walker, 2013). Structural factors increasing probabilities of experiencing maternal bereavement were found in less educated mothers (Balaj *et al.*, 2021; Victoria *et al.*, 1992), deprived living conditions (Buitrago *et al.*, 2025; Alburez-Gutierrez *et al.*, 2021), rural areas, and racial descrimination (Mena-Meléndez, 2020; Palacios, 2018; Perreira & Telles, 2014). Country of residence and mother's birth cohort play a fundamental role in determining the mother's age for maternal bereavement.

For instance, women born in the middle of the past century or women born in the Global South have higher chances of experiencing child loss between ages 15 and 64. Conversely, women born in 2000 or in the Global North have a higher risk of child loss after age 65 when their children are already adults (Alburez-Gutierrez *et al.*, 2021).

Colombia presents a particular multi-ethnic context with profound health and social inequalities among the main ethnic groups: White-Mestizo, Afro-descendant and Indigenous populations (Rojas-Botero *et al.*, 2025; Dare *et al.*, 2019; Palacios, 2018; Telles *et al.*, 2015; Urrea-Giraldo *et al.*, 2015). Maternal mortality is five times higher for indigenous groups, and Afro-descendant mothers risk a 25 percent chance of losing an under-five child compared to White counterparts (Palacios, 2018; WHO, 2023). In general, Indigenous and afro-descendant populations tend to have lower life expectancy, poorer child and maternal health outcomes compared to White populations (Anderson *et al.*, 2016; Mesenburg *et al.*, 2018; Mena-Meléndez, 2020; Gatica-Domínguez *et al.*, 2020). Mortality and health inequalities based on race and ethnicity have been extensively documented (Anderson *et al.*, 2016; Mesenburg *et al.*, 2018; Mena-Meléndez, 2020; Gatica-Domínguez *et al.*, 2020). These inequities were evident during the COVID-19 pandemic when non-White groups exhibited higher exposure to infection (Nazroo & Becares, 2020; Gross *et al.*, 2020; Ogedegbe *et al.*, 2020). Quantifying exposure to maternal bereavement among Indigenous and Afro-descendant women reveals a novel dimension of health determinants that contributes to explaining profound ethnic disparities in mortality and life expectancy.

2 Ethnic Categories in the Colombian Context

There is much confusion about the understanding of race and ethnicity which has lead to the inappropriate use of this categories in health and social studies (Moubarac, 2013; Gravlee, 2009; Bhopal, 2004; Bhopal & Donaldson, 1998). Ethnicity should be understood

in this document as a collective identity with putative common ancestry that shares cultural symbols and social practices like language, religion, norms, and characteristics such as type of diet, living style, and kinship (Cornell & Hartmann, 2007; Bonilla-Silva, 1999; Wade, 1993).

Ethnic classification within Colombian national statistics is predicated on self-identification. Individuals may identify with one of five officially recognised ethnic categories: Indigenous, Black-Mulatto, Black-Caribbean, Black-Maroon, and Roma. To allow analysis to be conducted on groups of sufficient size, the Black ethnic categories were consolidated into a single "Afro-descendant" group in subsequent results, and the Roma population was omitted from the study due to its very small population size. For those who do not identify with any of the ethnic groups, the census provides the option 'Non-ethnic group'. This designation is conceptually problematic as it is fundamentally asymmetrical, treating the identity of the socioeconomically dominant group as a neutral baseline. Although the 'Non-ethnic group' category is diverse and encompasses a range of complex identities, its largest constituent groups can be broadly termed 'White' and 'Mestizo'. These include populations of European descent from countries such as Spain, Italy, and Germany (DANE, 2007; Hudson, 2010, p.86).

The categories 'White' and 'Mestizo' are not employed directly in the Colombian census or other official statistics, as they could be interpreted as racial classifications based exclusively on physical phenotype. For the purposes of this study, however, the term 'White-Mestizo' is adopted as a convenient label for this non-ethnic classification, thereby avoiding the use of the asymmetrical 'non-ethnic' descriptor. This term should be understood as a residual category that captures a variety of socially constructed identities. It encompasses individuals or households whose social practices, beliefs, language, and culture distinguish them from those of Indigenous peoples, Afro-descendants, and other legally recognised ethnic groups. It is further noted that members of this group typically use these

terms for self-identification, as documented by Wade (2001, p.855) and (2009, p.176).

3 Data

This study employs the 2017 Colombian National Vital Statistics, which include registered births and deaths, and the 2018 Colombian Census, which provides population counts and deaths reported for 2017. Fertility rates were estimated using the vital statistics data, while life tables were constructed from the 2018 Census, as it offers more accurate ethnic population counts and death records than other national datasets. Information on deaths by ethnic group and sex is presented in Table 1. The datasets used in this study are publicly available from the Colombian National Statistics Office (Departamento Administrativo Nacional de Estadística - DANE) at https://microdatos.dane.gov.co/index.php/catalog.

The national census and the birth and mortality records constitute the most complete demographic data sources in the country. However, they are not exempt from problems related to ethnic misclassification, under-registration, and coverage (Loja-Torres *et al.*, 2025; Urrego *et al.*, 2022).

The 2018 Census encountered coverage challenges that disproportionately affected the enumeration of the Afro-descendant population. Post-census correction methods estimated that $4,094,077$ individuals were not counted, including $1,688,936$ Afro-descendants. This undercount likely underestimates the total number of deaths among Afro-descendants. We assume, however, that the omission occurred proportionally across all age and sex groups, meaning the fundamental mortality patterns by age and sex remain largely unchanged. The total national population was estimated at $44,164,417$ inhabitants ($48,258,494$ after correction), of whom $2,982,224$ self-identified as Afro-descendant, $1,905,617$ as Indigenous, $2,649$ as Rom, and the remainder reported belonging to none of the available ethnic categories (see Table 1).

Table 1: Population Size and Reported Deaths by Ethnicity from 2018 Census

Ethnicity	Population		Deaths	
	Male	Female	Male	Female
Indigenous	951,215	954,402	8,182	6,358
Afro-descendants	1,454,135	1,528,089	11,647	8,520
White-Mestizo	18,833,585	19,844,756	115,947	88,758

4 Method

This study investigates ethnic disparities in parental bereavement across White-Mestizo, Afro-descendant, and Indigenous populations. We focus specifically on maternal bereavement due to data availability and the disproportionately detrimental impact of child loss on women compared to men (Alburez-Gutierrez *et al.*, 2021; Hendrickson, 2009; Schoumaker, 2019).

Our analysis estimates differences in maternal bereavement by sex of the child and examines the associated ethnic disparities. Ethnicity for newborns was reported by the mother. For deceased household members, whose ethnicity is not recorded in the census, we assign the ethnicity of the surviving household head.

To address under-registration problems, such as those related to births outside hospitals, principally in peripheral areas (Urrego *et al.*, 2022), we apply the Relational Gompertz model to estimate fertility rates (Moultrie, 2013). This method relates the trend of cumulative fertility to current levels, thereby correcting the estimated aggregate level of fertility. However, the model yields a fertility schedule with a lower incidence of teenage fertility and a higher concentration in the 20–24 age group. This derived structure does not align with fertility schedules observed in Colombia. Consequently, we retained the original age structure derived from Vital Statistics, as it reflects the reproductive behaviour of Colombian women more accurately. Finally, the resulting fertility rates by five-year age group

were graduated using a quadratic optimisation method (Grigoriev *et al.*, 2018), and a uniform distribution of deaths was assumed within each age group for the mortality analysis.

We model child survival and the frequency of child death using the matrix formulation of kinship networks Caswell (2022). This framework accounts for kin of both sexes within age-classified populations, assuming time-invariant rates (fixed mortality and fertility schedules). The survival matrix U contains the age-specific survival probabilities (vector p) on its sub-diagonal and zeros elsewhere. The fertility matrix F contains the age-specific fertility rates (vector f) in its first row and zeros elsewhere, while $e(x)$ denotes the unit vector for age x. For a female Focal, the number of living children by sex at her age $x+1$ comprises the survivors from the children at her age x plus a vector representing newborns.

$$\begin{aligned} a(x+1) &= Ua(x) + F(x)e(x) \\ a(0) &= a_0 \end{aligned} \tag{1}$$

Equation 1 represents the basic one-sex (female) kinship model. This shows that the number of surviving children, a, at age $x+1$ depends on the survival probabilities, U, at age x, plus the children resulting from fertility schedules, F, at different ages $e(x)$.

A key indicator in this work is the probability of losing a child at each age x. This represents the average risk across all living children and is obtained from the product of the column vector $(1-p)$ - the probability of death by age, taken from a life table- and the row-normalised vector $a(x)/|a(x)|$ - the proportion of living children by age when the focal individual is x. This is presented in Equation 2.

$$c(x) \quad = \quad (1-p(x))\,\frac{a(x)}{\|a(x)\|} \tag{2}$$

This probability (a scalar) is calculated for each age x and for each ethnic subgroup, under the assumption that a woman experiences that demographic regime throughout her life, and that her child does as well. We consistently analyse women rather than mothers, because the results from Caswell (2022) are expressed in expected counts and are not conditional on having at least one child. The nature of this indicator is similar to that of life expectancy or the total fertility rate: it is a period indicator that reflects the demographic transitions at that time and, in our case, the demographic gaps between the three different subgroups in Colombia for the year 2017.

5 Results

We estimate a Total Fertility Rate (TFR) of 2.9, 2.3, and 2.0 for Indigenous, Afro-descendant, and White-Mestizo women, respectively, with corresponding mean ages at childbearing of 26.0, 26.4, and 27.2 years. Life expectancy at birth for males was estimated at 63.8 years for Indigenous, 67.3 years for Afro-descendant, and 74.8 years for White-Mestizo populations; for females, the figures were 70.1, 76.1, and 82.3 years, respectively. Life expectancy is strongly influenced by infant mortality (q_0), which stands at 0.06, 0.03, and 0.02 for males, and 0.04, 0.02, and 0.016 for females, in the same population order. Additional details on how disparities in fertility and survival affect child availability and mortality risk are presented in Figure A1 in Appendix A.

The average number of living children by maternal age reveals clear ethnic stratification in fertility outcomes (Figure 1). The number increases monotonically until approximately age 45 for all groups, after which it declines due to offspring mortality. Indigenous women maintain the highest number of living children at nearly all ages, peaking at an average of 2.6. Afro-descendant women follow an intermediate trajectory, peaking at 2.2, while White-Mestizo women have the lowest, peaking at 1.9. However, by age 90, the averages

Figure 1: Living child for a woman based on 2018 rates, by ethnic group

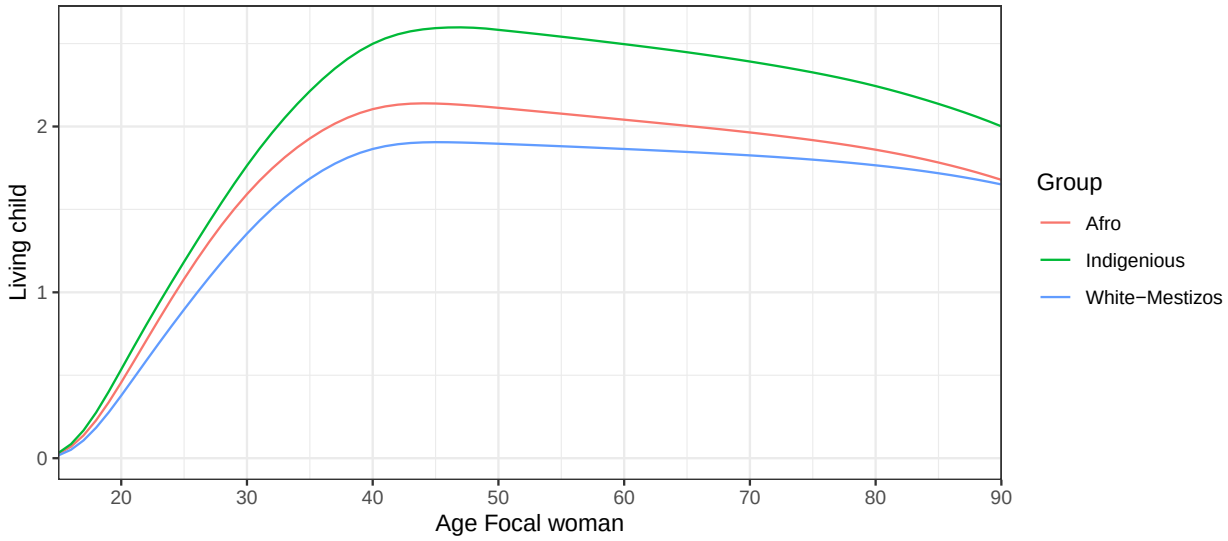


Figure 1 presents the number of surviving children by maternal age and ethnicity.

for Afro-descendant and White-Mestizo women converge at approximately 1.7, whereas Indigenous women retain slightly more (~ 2.0).

This pattern is explained by pronounced ethnic disparities in the cumulative probability of child loss (Figure 2). The figure presents the probability of child loss as a function of the focal woman's age. Contrary to the typical monotonically increasing cumulative probability observed in demographic data, this curve exhibits a distinct U-shaped pattern for all ethnic groups. The probability is highest for young mothers, declines to a minimum (inflection point) around age 35–40, and then increases again with advancing maternal age.

Clear gender-specific patterns emerge in the probability of child loss. For female child loss, ethnic differences are most pronounced around maternal age 45, when Indigenous women face a risk at least twice as high as that of White–Mestizo women. Notably, the probabilities for Afro-descendant and Indigenous women converge at older ages.

Patterns of male child loss are more complex. Ethnic differences are widest at around maternal age 40 and then narrow over time. However, between ages 45 and 60, when sons are approximately 20 to 28 years old (see Table 2), Afro-descendant mothers experience an in-

crease in child loss risk that surpasses that of Indigenous mothers. White–Mestizo mothers follow a similar trajectory, but at consistently lower levels.

Figure 2: Probability of Child Loss by Age of Mother and Ethnicity

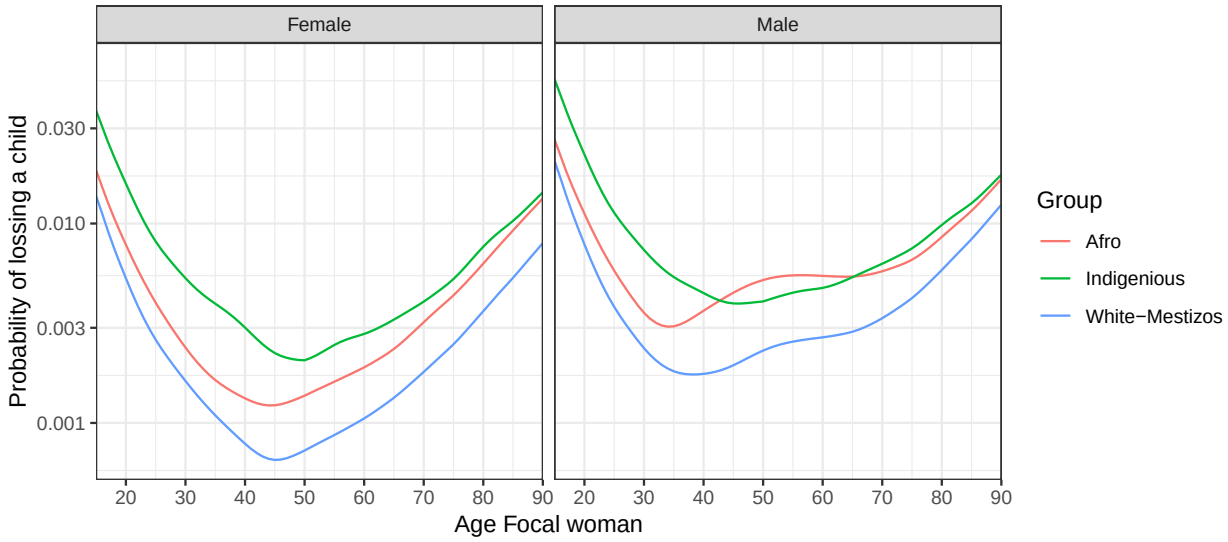


Figure 2 presents the probabilities of child loss by age of mothers and ethnicity.

Overall, the risk of a mother experiencing the death of a child is higher when that child is male. Indigenous women experience the highest cumulative risk of losing a child at nearly every age, followed by Afro-descendant women, while White-Mestizo women exhibit the lowest risk. The trajectories remain stratified, underscoring persistently higher lifetime exposure to offspring mortality among Indigenous and, to a lesser degree, Afro-descendant mothers. These patterns align with the age-specific child mortality rates presented in Figure A2, Appendix A.

Table 2 presents the mean age of mothers and children at the time of a child's death, alongside the corresponding number of surviving children. The findings reveal pronounced and persistent ethnic inequalities in both child mortality outcomes and maternal bereavement risk. Three principal results are evident. First, at very early maternal ages, Indigenous and Afro-descendant mothers exhibit consistently higher numbers of living children ($l(x)$) and an older average age at child death (AoD) relative to their White-Mestizo counter-

parts. A notable reversal in this pattern occurs later in the reproductive life course: from maternal age 40 for daughters and from age 35 for sons, White-Mestizo children, on average, survive to older ages than those from Indigenous and Afro-descendant backgrounds.

Second, the probability of child loss ($c(x)$) is uniformly higher for sons than for daughters across all ethnic groups and at nearly every maternal age, a trend that aligns with the pattern illustrated in Figure 2.

Finally, the intersection of ethnicity and a child's sex establishes a distinct risk gradient. The vulnerability is most acute for Indigenous mothers of sons, who face the highest probabilities of child loss ($c(x)$) during early motherhood. For instance, at maternal age 15, the probability of losing a son is 0.053 for Indigenous women, compared to 0.026 and 0.021 for Afro-descendant and White-Mestizo mothers respectively. However, this hierarchy shifts by mid-life; at maternal age 50, Afro-descendant women report the highest probability (0.005), followed by Indigenous (0.004) and then White-Mestizo mothers (0.002). Across the life span, White-Mestizo women consistently experience the lowest probabilities of child loss.

Table 2: Number of Surviving Children, Mean Age of Child Mortality, and Probabilities of Child Loss by Ethnicity and Age of Parents

	Indigenous			Afro-descendants			White-Mestizos		
Mother's Age	$l(x)$	AoD	$c(x)$	$l(x)$	AoD	$c(x)$	$l(x)$	AoD	$c(x)$
				Female					
15	0.016	0.032	0.037	0.013	0.028	0.019	0.008	0.015	0.014
20	0.270	0.557	0.016	0.229	0.467	0.008	0.189	0.377	0.005
25	0.599	1.212	0.008	0.544	1.128	0.004	0.450	0.986	0.003
30	0.893	2.065	0.005	0.801	2.242	0.002	0.680	1.892	0.002
35	1.121	4.617	0.004	0.972	5.147	0.002	0.847	4.272	0.001
40	1.268	8.523	0.003	1.065	10.996	0.001	0.938	9.764	0.001
45	1.320	15.058	0.002	1.089	19.011	0.001	0.962	18.422	0.001
50	1.320	22.900	0.002	1.085	24.972	0.001	0.960	24.670	0.001
55	1.306	28.890	0.002	1.077	29.692	0.002	0.956	29.493	0.001
60	1.289	33.723	0.003	1.067	34.677	0.002	0.952	34.591	0.001
65	1.270	38.917	0.003	1.057	40.097	0.002	0.946	40.008	0.001
70	1.247	44.158	0.004	1.043	45.768	0.003	0.939	45.458	0.002
75	1.219	49.626	0.005	1.024	50.847	0.004	0.930	50.628	0.002
80	1.182	55.489	0.008	0.998	56.108	0.006	0.916	55.954	0.004
85	1.132	60.104	0.010	0.962	61.132	0.009	0.897	60.979	0.005
90	1.067	64.969	0.014	0.911	65.953	0.013	0.869	65.995	0.008
				Male					
15	0.016	0.027	0.053	0.013	0.027	0.026	0.008	0.014	0.021
20	0.265	0.490	0.022	0.228	0.464	0.011	0.188	0.346	0.008
25	0.586	1.147	0.011	0.537	1.184	0.006	0.446	0.902	0.004
30	0.871	1.922	0.007	0.791	2.569	0.004	0.674	1.843	0.002
35	1.092	4.311	0.005	0.956	7.583	0.003	0.838	5.795	0.002
40	1.231	9.580	0.004	1.040	14.928	0.004	0.926	13.217	0.002
45	1.273	17.261	0.004	1.050	20.860	0.004	0.944	20.359	0.002
50	1.263	24.003	0.004	1.028	24.838	0.005	0.936	24.745	0.002
55	1.236	28.185	0.004	1.001	28.441	0.005	0.925	28.562	0.003
60	1.208	32.334	0.005	0.973	32.752	0.005	0.913	33.105	0.003
65	1.178	37.994	0.005	0.947	37.966	0.005	0.900	38.472	0.003
70	1.145	43.686	0.006	0.921	43.789	0.006	0.887	44.347	0.003
75	1.107	49.016	0.008	0.894	49.447	0.007	0.870	49.990	0.004
80	1.061	54.558	0.010	0.862	55.308	0.009	0.850	55.550	0.006
85	1.005	59.388	0.013	0.821	60.562	0.012	0.821	60.711	0.008
90	0.934	64.753	0.018	0.767	65.818	0.017	0.782	65.837	0.012

Number of living children ($l(x)$), mean age at child death (AoD), probability of child loss ($c(x)$) by mother's age, sex of the child, and ethnic group.

6 Discussion

The findings indicate that Indigenous and Afro-descendant women in Colombia experience significantly higher exposure to child mortality compared to White-Mestizo women. These disparities reflect persistent ethnic and social inequalities rooted in historical processes of marginalisation and exclusion. The structural disadvantages faced by Indigenous and Afro-descendant populations translate into limited access to healthcare services, precarious living conditions, and increased vulnerability to adverse health outcomes, all of which contribute to higher infant mortality rates.

The higher fertility observed among Indigenous women, which culminates in a greater number of living children during peak reproductive years, likely reflects both cultural norms and potential compensatory behaviours within high-mortality contexts. However, the subsequent decline in their number of living children after age 45, coupled with a sustained, elevated probability of child loss, reveals a heavy cumulative burden of bereavement.

The probability of child loss varies by maternal age, revealing distinct patterns across ethnic groups. Among Indigenous mothers, the highest risk of child mortality occurs at younger ages, which may be attributed to limited healthcare access, poor maternal health, and socioeconomic vulnerabilities that heighten risks during infancy. In contrast, Afro-descendant women experience the highest risk of child loss at age 40, when their children are adolescents and young adults. This pattern suggests that young Afro-descendants in poor urban areas face higher mortality rates due to violence, economic instability, and inadequate healthcare access during critical stages of development.

A critical finding is the convergence in the number of living sons between Afro-descendant and White-Mestizo women by very old age, despite their differing fertility trajectories. This suggests that the initially higher fertility of Afro-descendant women is effectively offset by higher cumulative child mortality. This represents a form of "demographic cross-

over," wherein White-Mestizo women ultimately end their lives with more surviving children. This statistical convergence masks a profound inequality in lived experience: to reach a similar number of living children in old age, Afro-descendant women must endure a significantly greater burden of child loss.

These disparities in child availability and mortality risk carry deep intergenerational implications. They directly influence potential sources of old-age support, the transmission of socioeconomic (dis)advantage, and the psychosocial well-being of mothers and wider communities. Therefore, the consistently diverging probability of child loss is not merely a neutral health indicator; it is a stark measure of cumulative disadvantage and intergenerational trauma, borne most heavily by Indigenous and, in a distinct pattern, Afro-descendant women.

In conclusion, ethnic identity in Colombia remains a powerful stratifier of demographic risk, structuring inequalities in both the creation and survival of kinship ties. Addressing these disparities requires targeted policies that go beyond general health improvements to specifically enhance child survival in Indigenous and Afro-descendant communities and address the underlying socioeconomic and structural determinants of these persistent gaps.

Structural racism constitutes a fundamental determinant of health inequality in Colombia. It operates through historical and systemic discrimination that has relegated Indigenous and Afro-descendant populations to entrenched socioeconomic marginalisation. This discrimination constrains access to education, stable employment, and quality healthcare, thereby directly shaping the demographic conditions that produce unequal mortality. Within this context, the elevated experience of maternal bereavement borne by Indigenous and Afro-descendant women is not an incidental disparity, but might constitute a serious contributor to the marked differences in morbidity and life expectancy observed between these groups and White-Mestizo women.

Public policies in Colombia must prioritise the reduction of ethnic-racial health inequali-

ties by directly confronting the structural racism underpinning elevated rates of maternal bereavement among Indigenous and Afro-descendant women. This requires implementing culturally competent healthcare programmes, co-designed with local communities and delivered by personnel trained in ethnic-specific contexts. Ensuring accessibility necessitates sustained investment in healthcare infrastructure within rural and marginalised regions. Crucially, these efforts must be integrated with broader anti-racist policies that address the social determinants of health, such as equitable access to quality education, fair employment, and secure housing. An intersectional approach is essential, as it recognises that Indigenous and Afro-descendant women face compounded vulnerabilities due to intersecting racism and gender discrimination.

7 Contributions

This study makes several novel and significant contributions to the demographic and public health literature on inequality in Colombia.

First, it represents the inaugural national analysis of maternal bereavement as a specific, human-centered indicator of deep-seated social and health inequalities among ethnic groups in Colombia. While prior research has documented disparities in aggregate mortality or fertility rates, this work shifts the analytical lens to the lived experience of mothers, quantifying their differential lifetime risk of enduring the death of a child. By framing child mortality through the outcome of maternal bereavement, we move beyond conventional health metrics to illuminate a profound dimension of intergenerational disadvantage and psychosocial burden that is unevenly distributed across the population.

Second, the analysis provides a detailed, intersectional mapping of bereavement risk. It elucidates how ethnicity, maternal age, and child's sex interact to create distinct gradients of vulnerability. A key finding is the non-monotonic, U-shaped trajectory of child loss

probability across the maternal life course, a pattern previously obscured in standard cumulative risk measures. We demonstrate that the highest risks occur not only in old age but also during adolescence and early adulthood, particularly for Indigenous and Afro-descendant mothers. Furthermore, we identify a critical demographic cross-over in later life, where the initial fertility advantage of Afro-descendant women is eroded by higher cumulative child mortality, leading to a convergence with—and eventual disadvantage relative to White-Mestizo women in terms of surviving children. This finding nuances the understanding of ethnic fertility differentials by highlighting their interaction with survival.

Third, methodologically, the study applies a state-of-the-art formal kinship demographic model to Colombian census data. This approach allows for the simultaneous estimation of child availability ($l(x)$), the mean age at child death (AoD), and the instantaneous probability of child loss ($c(x)$) under a consistent framework. By doing so, it integrates fertility and mortality schedules to produce a cohesive picture of kinship dynamics, offering a more holistic view of demographic disparity than analyses of single indicators.

Finally, the findings have direct implications for equity-focused policy and research. By pinpointing that Indigenous mothers of sons face the most acute risks in early adulthood and that Afro-descendant women carry a disproportionately high burden of loss in mid-life, the study provides evidence for targeted interventions. It argues that reducing ethnic inequalities in child survival is not only a public health imperative but also a crucial step toward mitigating intergenerational trauma and inequities in family support structures. This work establishes a baseline for monitoring progress toward health equity in Colombia and provides a replicable framework for assessing the human cost of mortality disparities in other multi-ethnic societies.

7.1 Future research

Further research is needed to deepen the understanding of child mortality exposure across different ethnic-racial contexts in Colombia. This includes exploring the long-term socioeconomic and health impacts of maternal bereavement, particularly its cumulative effect on maternal morbidity and life expectancy differentials between Indigenous, Afro-descendant, and White-Mestizo women. Additionally, incorporating the perspectives and lived experiences of Indigenous and Afro-descendant women in demographic research is crucial for developing culturally responsive and effective interventions. Future studies should also examine the intersection of ethnicity, gender, and socioeconomic status, employing longitudinal and mixed-methods designs to capture dynamic pathways of disadvantage and resilience. Such research must explicitly integrate racism as a measurable driver of bereavement risk, evaluating how structural and interpersonal discrimination shapes access to care, coping mechanisms, and health outcomes over the life course.

Future efforts can contribute to the development of policies and interventions that promote health equity and improve outcomes for all ethnic groups in Colombia. This includes refining maternal bereavement as a sentinel indicator of social inequality and a focal point for anti-racist public health strategy.

8 Limitations

This study is subject to several important limitations, primarily concerning data quality and methodological assumptions.

Firstly, the coverage error of the 2018 Census, which failed to enumerate an estimated 1.7 million Afro-descendant individuals, affected the number of reported deaths and births. However, it is assumed to be proportionally distributed across age and sex; it is therefore

unlikely to have significantly altered child mortality patterns between ethnic groups, and the observed differences in maternal bereavement remain valid.

Secondly, ethnic classification itself introduces potential measurement bias. For newborns, ethnicity is recorded based on maternal report, while for deceased persons, it is imputed from the ethnicity of surviving household members. However, this classification approach is associated with a low risk of misclassification error. According to 2018 Census data, in more ethnically diverse departments such as Valle del Cauca, multi-ethnic households constitute only 4.5% of the total, while in less diverse regions such as Antioquia, only 2.5% of households reported multiple ethnicities. This implies that Colombian households are generally ethnically homogeneous; consequently, parental ethnicity serves as a strong proxy for the ethnicity of other household members, minimising overall classification error.

Third. The study applies a period, matrix-based kinship model under the assumption of time-invariant fertility and mortality schedules. This synthetic cohort approach, while standard for cross-sectional analysis, projects current demographic rates over a hypothetical lifetime. It does not capture individual life-course trajectories, cohort effects, or future changes in mortality and fertility, which may affect the long-term experience of bereavement.

To correct for births under-registration, we applied the Relational Gompertz model but ultimately retained the original age structure from Vital Statistics, as the model's output did not align with observed Colombian fertility patterns, particularly underestimating adolescent fertility. This decision prioritizes structural accuracy but means our estimates may not be fully adjusted for under-reporting in certain age groups. Finally, the analysis assumes a uniform distribution of deaths within each five-year age group, which may smooth over more nuanced age-specific mortality risks.

fourth. The study focuses exclusively on maternal bereavement due to data constraints and the documented severe impact of child loss on mothers. Consequently, it does not ex-

amine the experience of paternal bereavement or the role of fathers, which represents a significant gap in understanding the full familial and psychosocial impact of child mortality. Additionally, while the model estimates the expected number and loss of children for all women, the results are presented as population averages and do not condition on parity, which may mask heterogeneity among mothers with different numbers of children.

In summary, while this study provides a robust period estimate of ethnic disparities in maternal bereavement risk, the findings should be interpreted as indicative of structural patterns under the 2018 demographic regime, rather than as precise predictions of individual experience.

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Consent to Participate

Consent to Participate declaration: not applicable.

Ethics Declaration

Ethics declaration: not applicable. The study is based exclusively on anonymised, publicly available secondary data.

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Data Declaration

The datasets analysed during the current study are publicly available from the Colombian National Statistics Office (Departamento Administrativo Nacional de Estadística—DANE) at https://microdatos.dane.gov.co/index.php/catalog

Authors' Contributions

J. L.-T. developed the study concept and wrote the main text of the manuscript. I.W. contributed to the data analysis and the presentation of results. R.A.U.P. also contributed to the data analysis and results. J.A. contributed to the interpretation of findings, as well as to the discussion and conclusions. All authors reviewed the manuscript and approved the final version.

Competing Interests

The authors declare that they have no competing interests.

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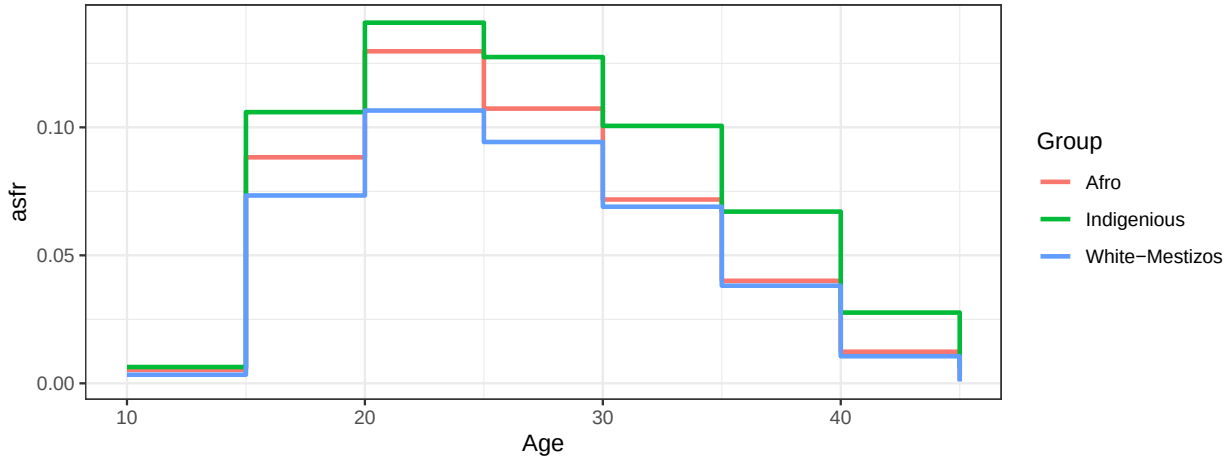
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A Appendix

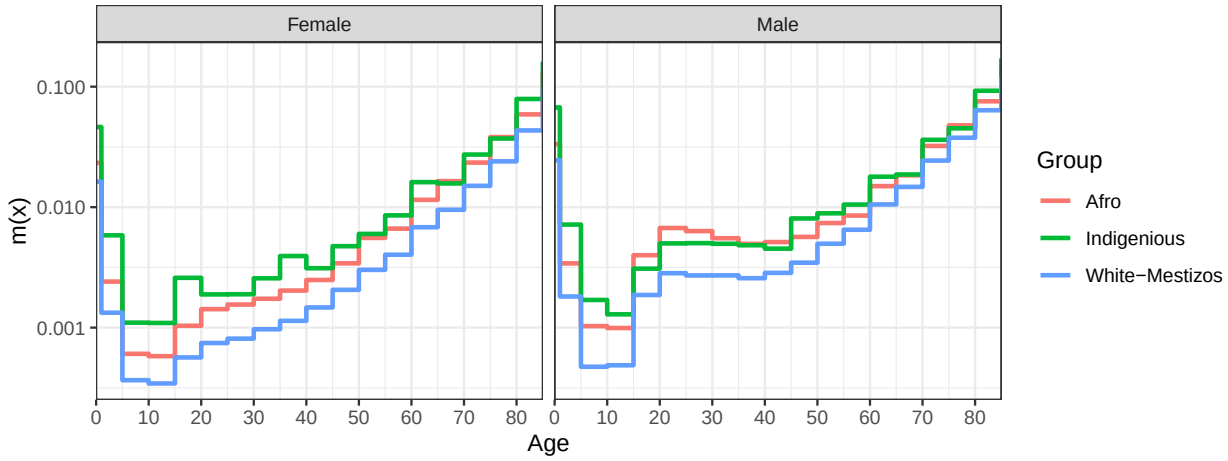
A.1 Mortality and Fertility Estimations in Indigenous, Afro-descendants, and White-Mestizos

Figure A1: Ethnic Variation in Fertility Rates and Maternal Age



Source: own results based on Colombian 2018 Census data.

Figure A2: Ethnic Disparities in Age-Specific Child Mortality



Source: own results based on Colombian 2018 Census data.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- FigureA1EthnicVariationinFertilityRatesandMaternalAge.pdf
- FigureA2EthnicDisparitiesinAgeSpecificChildMortality.pdf