Identifying individual and departmental drivers of fetal deaths among Venezuelan and Colombian mothers in Colombia, 2017-2020

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Abstract

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Objectives:

This study aims to examine fetal death rates among Venezuelan migrants and Colombian nationals giving birth in Colombia between 2017 and 2020 and to identify individual and departmental drivers of fetal death among these groups and differences in their risk profiles to highlight key areas of future research and policy intervention.

Methods:

Drawing upon Colombia's vital records, existing literature, and other survey data sources, we conducted a descriptive analysis of fetal deaths, live births, and associated department-level characteristics. We further derived a series of logistic regressions to quantify the relationship between various indicators of interest and the likelihood of fetal death among Colombian and Venezuelan women combined and independently.

Results:

While Venezuelan women had statistically higher rates of fetal deaths than their Colombian counterparts, this disparity was reversed when accounting for various maternal and departmental characteristics. Among both Venezuelan and Colombian women, parity, maternal age, not having reported education data, and being in a department with a higher average number of prenatal visits were associated with

higher odds of fetal death, and being in departments with higher proportions of cesarean sections and gross domestic product per capita resulted in a lower likelihood of fetal death. While having any form of health insurance and lower levels of educational attainment were associated with lower odds of fetal death among Colombian women, these associations were found to be insignificant among Venezuelan women.

Conclusions:

To the best of our knowledge, the present study is the first attempt to examine patterns and drivers of fetal deaths in Colombia across the dimension of migration. Most keenly, we identified a need to lower barriers of access to health insurance for both Colombian women and Venezuelan women as a measure to combat fetal deaths in Colombia. Whether through improvements to the vital registration system or supplemental mixed-methods surveys, future efforts should serve to contextualize the present findings and clarify the mechanisms through which relevant indicators influence the likelihood of fetal deaths within both Colombian and Venezuelan populations.

Identifying individual and departmental drivers of fetal deaths among Venezuelan and Colombian mothers in Colombia, 2017-2020

Introduction

As of 2021, Venezuelans are estimated to make up roughly 3% of Colombia's population and 93% of the country's migrants.[1,2] The magnitude of this influx, driven by ongoing economic and political unrest in Venezuela, has posed a substantial challenge to Colombia's health systems and policies.[2–4] Despite integration policies that grant Venezuelan migrants access to public health insurance schemes, Venezuelan mothers in Colombia have been found to have lower health insurance coverage than their local counterparts, while surveys of Venezuelans in the country have found high rates of sexual- and gender-based violence and discrimination in medical settings that, in turn, dissuade healthcare seeking behaviors.[5–8] Despite the cultural and linguistic similarities between Venezuelan and Colombian women, these two groups also face distinct health challenges that have been largely overlooked in existing research.[9,10] Among limited available research, researchers have found, for example, that children born to Venezuelan migrants in Colombia are at a higher risk of low birth weights and more extreme low birth weights than their counterparts.[5,6]

Low birth weight, exposure to violence, and challenges accessing antenatal care have been associated with increased fetal and neonatal deaths in other settings.[11–15] While fetal deaths often have indeterminate causes, studies in Europe, North America, Australia, and the Middle East have found that migrant mothers, specifically, have higher fetal mortality rates than their local counterparts.[16–19] These disparities are likely attributable to a combination of differences in their exposure to the aforementioned risk factors and the stressors associated with migration.[16–19] Furthermore, progress on preventing stillbirths globally has not kept pace with reductions in early childhood mortality.[11,20] For the women who experience them, fetal deaths can mean complex and harmful mental health consequences and increased risk of cardiovascular disease.[21,22]

Despite knowledge of existing disparities in known risk factors for fetal mortality between Venezuelan and Colombian women in Colombia, there has been little research into the patterns of these fatalities between the two groups and associations with other drivers. The present study sets out to fill this gap in existing literature and examine whether the patterns in fetal deaths observed elsewhere between migrant and non-migrant populations are similarly present in Colombia amid the growing surge of Venezuelan migration. This study aims to quantify fetal death rates among Venezuelan migrants and Colombian nationals giving birth in Colombia between 2017 and 2020 and highlight key areas of future interventions and research to improve pregnancy outcomes for both Colombian nationals and the growing segment of Venezuelan migrants. We draw upon the country's vital records and other data sources to further identify individual and departmental drivers of fetal death and depict differences between the risk profiles of Venezuelan migrants giving birth in Colombia and those of their Colombian counterparts.

Methods

Vital Records

The study population is Venezuelan and Colombian women who experience a loss of pregnancy or live birth in Colombia during the four years spanning from 2017 through 2020 as identified through the fetal deaths and live births recorded by the Colombian National Department of Statistics (DANE).[23] DANE is responsible for de-duplicating, anonymizing and publishing microdata containing Colombia's birth and death records. These vital records have high rates of completeness and have been lauded for their high degree of data quality.[24,25] Despite some persistent gaps in coverage, these datasets represent the most comprehensive data available pertaining to live births and fetal deaths in Colombia.

Live births have been defined by DANE as births in which the child shows signs of life (including heartbeats, umbilical cord pulsations, or voluntary muscle movements) after separation from the mother.[23,26] Fetal deaths are defined as cases in which a fetus weighing 500 grams or more "does not breath or show any other signs of life" after separation from the mother.[23,26] It includes, but is not limited to, stillbirths, defined by the World Health Organization as fetal deaths at or after 20 weeks of gestation.[11] For births and fetal deaths captured, DANE also reports standardized variables, including maternal age,

gestational age, type of birth or separation from the mother, and maternal health insurance status, among others. Some variables, like number of prenatal visits and race/ethnicity of the baby, are only recorded for live births.

Fetal death and live birth data do not contain explicit details regarding maternal nationality. Instead, the data report on the mothers' "country of habitual residence." This variable has been used by previous researchers as a proxy for migrant status to examine disparities between the children of Venezuelan and Colombian mothers.[5,6] It follows the assumption that mothers who would identify Venezuela as their "country of habitual residence" are likely to be Venezuelan and to have migrated to Colombia relatively recently. For the purposes of the present analysis, women who report Venezuela as their "country of habitual residence" are coded as Venezuelan, while women who report Colombia as their "country of habitual residence" are deemed Colombian. A small number of mothers who report other countries as being their "country of habitual residence" are omitted from our population of interest and study sample. Our analysis is also restricted to semi-complete cases—records with no missing values in the variables of interest except for educational attainment. When relevant, all the available records are used to derive contextual departmental-level variables described below.

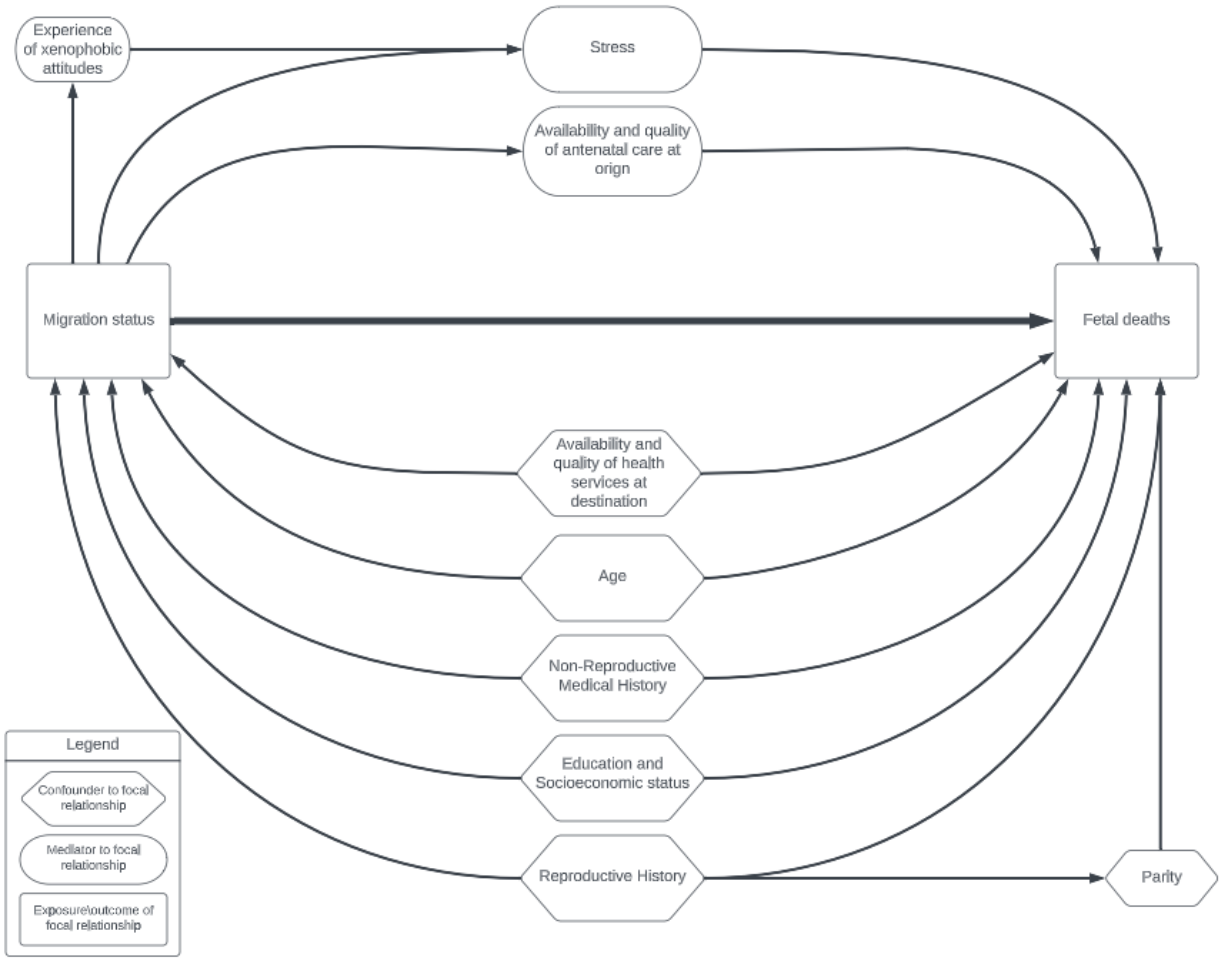
Supplementary Data Sources

Contextual department-level variables that could not be derived from the vital records were drawn from a range of other sources, including previously published departmental estimates of gross domestic product (GDP) per capita and tabulated data from the 2021 National Quality of Life survey.[27,28] Given that xenophobic experiences are known to be important factors in a migrant's health status and healthcare seeking behavior, we also drew upon the Colombian respondents of the 2020 Latinobarometer survey, a publicly available and anonymized public opinion survey.[29] Latinobarometer is a representative survey conducted annually in 18 Latin American countries, including Colombia. Details on sampling strategy and data collection methodology, including pandemic adjustments, can be found online.[29]

Directed Acyclic Graph

Given the breadth of available data and variability in existing literature regarding potential variables of interest, the research team drew upon a directed acyclic graph (DAG) to direct variable selection and model development (Figure 1). DAGs are a commonly used tool in epidemiology to identify and explore assumptions or hypotheses regarding the relationships between different variables and exposure and/or outcome of interest.[30] The variables, depicted as bins, are linked through arrows that depict the assumed direction of causal relationships. These arrows illustrate variables that are considered confounding or mediating of the primary relationship of interest, which in this case is the association between migrant status and likelihood of fetal death. The DAG for this analysis (Figure 1) depicts relationships observed in existing literature pertaining to the drivers of negative maternal health and birth outcomes, particularly among migrant populations globally.[11,16,31,32]

Figure 1. Directed acyclic graph depicting associations surrounding the focal relationship between migrant status and fetal deaths



Individual-level Variables

We aligned the available individual-level variables included in both the live birth and fetal death datasets with the relevant indicators of interest (Figure 1). Instances of fetal deaths were coded, per the definitions used by the DANE, as a binary variable whereupon all rows of fetal death data were considered cases contrary to rows of live birth data. The primary analysis was undertaken without restriction to gestational age in alignment with Colombia's categorization of fetal deaths and live births.

Maternal age

Maternal age was directly reported in the vital records as a categorical variable grouped into 5-year age bins ranging from 10 to 14 years old to 50 to 54 years old. Due to the small number of pregnant women over the age of 45 recorded in Colombia during these years, we aggregated the two oldest age groups into a single category of women 45 to 54 years old.

Socioeconomic status

While socioeconomic variables were not directly available across the birth and death records, we drew upon two related variables reported in both datasets: highest maternal educational grade completed and health insurance status. The highest completed education level was reported as a continuous variable ranging from zero (or less than a year of education) to over 13. Since educational attainment had the greatest degree of missingness of any relevant variable, this variable was grouped into a categorical variable to facilitate comparison of women with no education (zero completed years of education), some or complete primary school education (1-5 years of education), and at least some secondary school education (6 or more years of education) against those without a reported educational level. This approach, a deviation from our otherwise complete case analysis, allows us to leverage a greater number

of observations. We did not attempt to infer missing information given clear patterns of missingness that contraindicated most imputation strategies (Appendix Figure S1).

Maternal health insurance status was reported in the vital records as a categorical variable of no insurance, subsidized insurance, contributive insurance, special insurance, or insurance exception. Due to the very small number of observations in the latter two categories, they were aggregated into an "other" insurance category. In Colombia, all citizens who are employed are mandated to receive health insurance through contributions from themselves and their employers, deemed "contributive" insurance.[2] Those who are not employed or are members of vulnerable groups receive a public form of subsidized health insurance. In 2017, these insurance systems were made available to Venezuelan migrants with legal documentation, although enrollment in these health insurance systems remains varied.[2] While emergency healthcare services are available to all, Colombia's health insurance options, particularly for Venezuelan migrants and Colombian nationals, are crucially a reflection of an individual's socioeconomic status.

Reproductive and non-reproductive medical history

The data available does not contain details on individuals' personal medical history, including behavioral risk factors or existence of chronic diseases, highlighting a limitation and important factor that we cannot appropriately account for. Health insurance status as described above provides our best approximation of the women's ability to access primary health services to address pre-existing medical concerns but does not speak to the actual existence of such concerns.

We can derive women's parity, an important component of reproductive history, from the vital records. Parity was directly reported for each live birth. The number of prior live births and number of prior stillbirths were reported for each fetal death, allowing us to construct a continuous parity variable akin to that in the birth records by adding both numbers together.

Department-level Variables

Several potential variables of interest were best described at the departmental-level in the absence of detailed individual-level survey responses describing individual's experiences. Departments, including the capital district of Bogota, reflect important administrative units in Colombia that reflect geographic and political differences across the country.

Availability and quality of health care

While we do not have data pertaining to the availability and quality of health care services at the origin of individual migrant women, which is a factor that may inform a woman's likelihood of migrating away from a location and her likelihood of experiencing a pregnancy loss, we do have sufficient evidence to consider the characteristics of their destination. The average number of prenatal visits was derived as a single summary value for each department among all live births, regardless of whether their data were missing other variables. The average number of prenatal visits reflects both adequate availability and accessibility of prenatal care in a department. The rate of cesarean sections was also calculated as the proportion of all pregnancies (live births and fetal deaths) that end in cesarean sections. This rate is suggestive of the implementation and availability of medical interventions during birth. The gross domestic product (GDP) per capita in each department was extracted from previously published literature and used as a proxy for the overall socioeconomic condition and health care service availability in each department.[27]

Experience of xenophobic attitudes

From the Latinobarometer survey, we identified 10 relevant scale variables exploring xenophobic attitudes of the respondent out of over 200 total variables (Appendix Section 2.1). With a limited sample size of 1,200, of which 168 had some degree of missingness in the 10 relevant variables, we examined the correlation between non-missing. With missingness seemingly at random and some observed correlation between non-missing observations, we conducted multiple chained imputation for our 10 xenophobia variables using the 49 variables with no missing values. In the final imputed dataset, each variable was transformed into a binary in which xenophobic attitudes were expressed (1) or they were not (0). For each respondent, these binary variables were then summed to create an index scale ranging from 0 (no xenophobic attitudes were expressed) to 10 (the respondent only expressed xenophobic attitudes). We took the weighted average and standard deviation of the index for each department.

Statistical Analysis

Descriptive Analysis

We conducted a thorough descriptive analysis of fetal deaths, live births, and departmental-level indicators in Colombia during this period. We derived crude point estimates of the rate of fetal deaths per 10,000 live births stratified by department and maternal nationality, as well as the prevalence of fetal deaths for both groups nationally by year and across the entire four-year timespan. We produced summary statistics for the individual-level variables described above by maternal nationality and department to characterize the study population. Additionally, we depicted these statistics through visualizations that allowed us to compare spatial patterns in relevant department-level indicators throughout Colombia.

Logistic Regressions

To identify individual and departmental-level drivers of fetal deaths in Colombia among Venezuelan and Colombian mothers, we leveraged fixed effects and mixed effects logistic regression models. First, we conducted a univariate regression (Equation 1) with maternal nationality as the sole predictor variable to establish whether there was an observed relationship between migrant status and likelihood of experiencing a fetal death if no other variables are considered.

Equation 1:

$$Pr(Y_i = 1) = logit^{-1}(\beta_0 + \beta_1 C_i)$$

Y_i : The outcome of a pregnancy (1 = fetal death; 0 = live birth)

C_i : Country of origin of the mother

Next, we ran univariate regressions for each individual-level variable in which each, in turn, replaced maternal nationality (C_i) in Equation 1, while stratifying the analytical sample by maternal nationality to evaluate the association between each individual-level variable and the odds of experiencing a fetal death in each sub-population. We additionally ran a bivariate regression (Equation 2) with the entire sample for each individual-level variable with maternal nationality as the second predictor variable to examine how the relationship estimated through Equation 1 was modified when controlling for other characteristics.

Equation 2:

$$Pr(Y_i = 1) = logit^{-1}(\beta_0 + \beta_1 C_i + \beta_2 X_i)$$

Y_i : The outcome of a pregnancy (1 = fetal death; 0 = live birth)

C_i : Country of origin of the mother

X_i : Maternal characteristic of interest

Lastly, we constructed two fixed effects logistic regression, one with all the maternal characteristics as predictors and a second adding in the departmental-level confounders (Figure 1; Equation 4). We ran each of these models for the entire analytical sample, including maternal nationality as a predictor, and for samples stratified by country of origin. We conducted a separate mixed effects logistic regression adding a random intercept on department to Equation 3 to evaluate the degree to which variance in the odds of fetal death can be attributed to departmental-level characteristics, including those that are not measured.

Equation 3:

$$Pr(Y_i = 1) = logit^{-1}(\beta_0 + [\beta_1 C_i] + \beta_2 parity_i + \beta_3 maternal\ age_i + \beta_4\ education_i + \beta_5 health\ insurance_i)$$

Y_i : The outcome of a pregnancy (1 = fetal death; 0 = live birth)

C_i : Country of origin of the mother

Equation 4:

$$Pr(Y_i = 1) = logit^{-1}(\beta_0 + [\beta_1 C_i] + \beta_2 parity_i + \beta_3 maternal\ age_i + \beta_4\ education_i + \beta_5 health\ insurance_i + \beta_5 prenatal_d + \beta_5 cesarean\ sections_d + \beta_5 gdp\ per\ capita_d)$$

Y_i : The outcome of a pregnancy (1 = fetal death; 0 = live birth)

C_i : Country of origin of the mother

All parts of the analysis were conducted using R version 4.2.1. This study did not seek institutional review board approval because it relies solely on de-identified, free, publicly available datasets.[23,27–29] It involves no direct interaction with subjects, risk to the subjects, or identifiable private information. There was no effort made to try to re-identify the anonymized data, and it was used in accordance with the guidance described on the DANE website.[23] Related code can be found online, vital statistics can be found on the DANE website, opinion poll data can be found on the Latinobarometer website, and other supplemental data is available elsewhere online as cited.[23,27–29]

Results

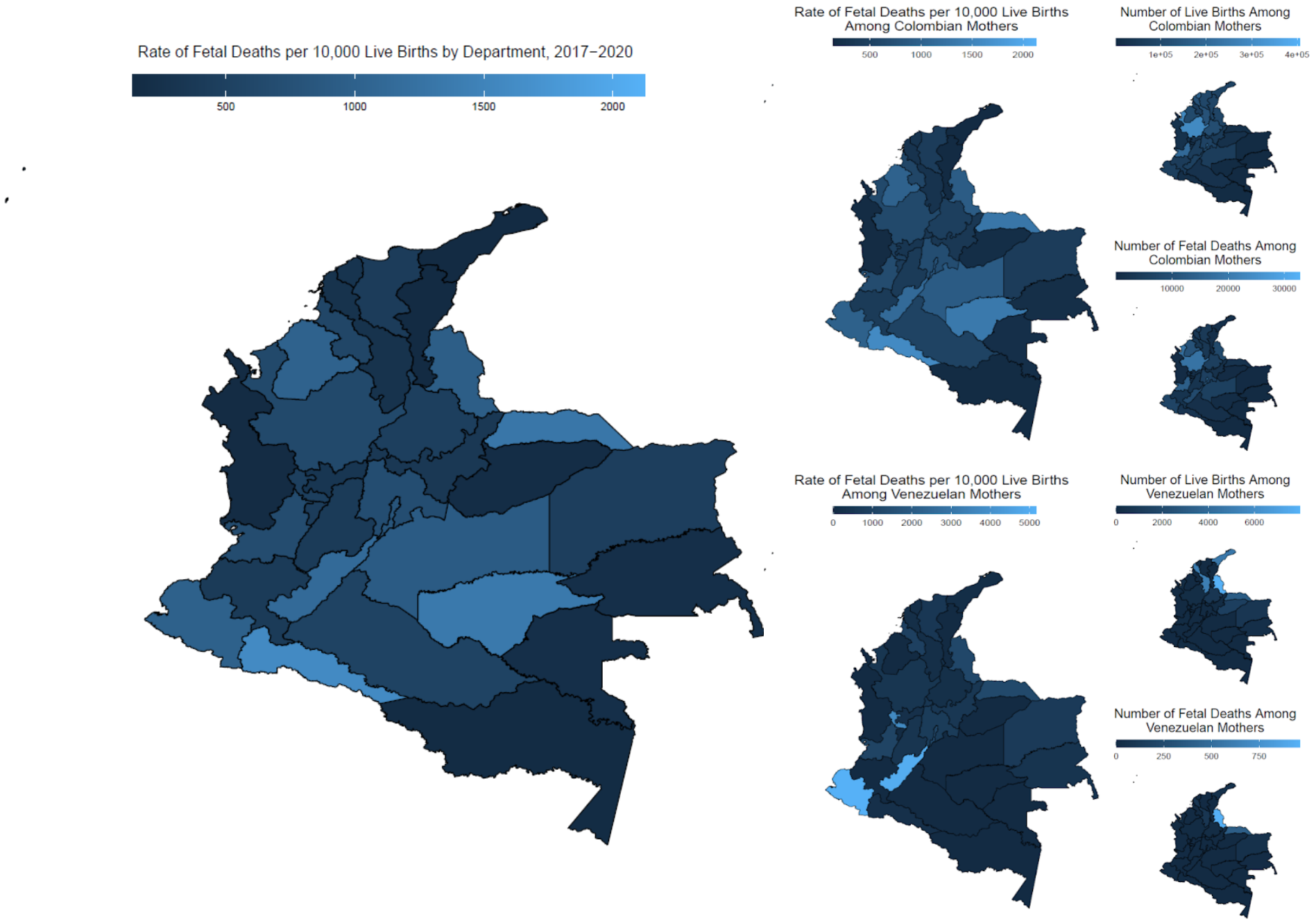
Landscape of fetal deaths in Colombia

In Colombia, there were 156,788 fetal deaths and 2,577,881 live births in 2017-2020 with an overall rate of fetal deaths of 608.20 per 10,000 live births. The vital records recorded 44,488 fetal deaths in 2017, 41,098 in 2018, 37,875 in 2019, and 33,327 in 2020. During the same time range, there were 656,704 live births in 2017, 649,115 in 2018, 642,660 in 2019, and 629,402 in 2020. These counts amounted to 677.44 fetal deaths per 10,000 live births in 2017, 633.14 in 2018, 589.35 in 2019, and 529.50 in 2020. Among Colombian women, there were 154,654 fetal deaths and 2,551,340 live births from 2017 to 2020. There were 1,774 fetal deaths and 26,095 live births among Venezuelan mothers and 360 fetal deaths and 446 live births among mothers of other countries. In other words, 2017-2020 saw a rate of 606.17 fetal deaths per 10,000 live births among Colombian mothers, 679.82 per 10,000 live births among Venezuelan mothers, and 966.29 per 10,000 live births among mothers of other countries nation-wide.

Among Colombian and Venezuelan women, there was substantial variation in the rate of fetal deaths per 10,000 live births across departments ranging from 140.52 fetal deaths per 10,000 live births in Cesar to 1,585.84 in Putumayo and 2,121.41 in el Archipielago de San Andres, Providencia y Santa Catalina (Figure 2; Appendix Section 1.2). El Archipielago de San Andres, Providencia y Santa Catalina, Putumayo, and Guaviare had the highest rates of reported fetal deaths per 10,000 live births among Colombian women (2,121.41, 1,589.56, and 1,343.11, respectively), while Narino, Huila, and Risaralda had markedly higher rates of fetal deaths among Venezuelan women (5,151.52, 5,000.00, and 3,750.00).

The extremely high rates in several departments among Venezuelan women were driven by very small numbers of reported deliveries (fetal deaths or live births; Appendix Section 1.2). Out of the 33 departments, five reported no deliveries by Venezuelan women, and only eight departments reported more than 500 deliveries by Venezuelan women. Of these, Casanare had the lowest rate of fetal deaths for Venezuelan women at 14.75 per 10,000 live births with only 2 reported fetal deaths and 1,356 live births. Only Bogota, Arauca, and Norte de Santander reported more than 100 fetal deaths among Venezuelan women with rates of 1,240.69, 1,261.67, and 1,209.00 fetal deaths per 10,000 live births, respectively. Among Colombian women, only Amazonas, Guainia, and Vaupes reported fewer than 100 fetal deaths, and these three departments also made up three-quarters of the four with the fewest number of reported live births. Amazonas was also included in the five departments with rates of fetal deaths lower than 200 per 10,000 live births to Colombian women, while only six departments had rates higher than 1,000 per 10,000 live births in this group.

Figure 2. Geographical distribution of the rates and counts of fetal deaths and live births in Colombia among Colombian and Venezuelan women



Demographic characteristics of study sample

Among the 2,733,863 potentially eligible observations of fetal deaths and live births from Venezuelan and Colombian mothers, 6,011 were missing data on their parity, health insurance status, and age and were, thus, excluded from the primary analytical sample. See Appendix Table S1 for more details on the characteristics of the women with these missing data. Table 1 provides further details on the demographic characteristics of the final sample of 2,727,852 Colombian and Venezuelan women used in the present analysis. Most of the women included in the sample were 20- to 24-year-olds, representing over a quarter of both the live births and fetal deaths (28.63% of Colombian women and 35.56% of Venezuelan women). Among Colombian women, the second largest age group of women was 25- to 29-year-olds (24.17%). For Venezuelan women, the second most represented age group was that of 15- to 19-year-olds (25.69%), reflecting an overall younger population of pregnant women. Despite these differences in the age distribution of both groups, the mean reported parity fell between two and three prior pregnancies across all segments of the sample (Table 1).

Over half of the women of both nationalities reported receiving at least some secondary schooling and fewer than 1.00% reported having less than one year of education. The distribution of secondary education, primary education, and no schooling was comparable across both Colombian and Venezuelan women. However, education was the variable with the largest degree of missing information across the entire dataset (Appendix Figure S1). This missingness particularly affected Venezuelan women who experienced fetal deaths, among which nearly a quarter were missing educational data. While Venezuelan women who had live births had a lower rate of missingness for educational data (11.02%), this was still several percentage points higher than that of Colombian women (4.08% for live births and 8.42% for fetal deaths). Differences in health insurance were also evident across both groups. Colombian women saw a much higher rate of health insurance coverage at 93.25%, including both subsidized and contributive insurance. Venezuelan women, on the other hand, had substantially lower health insurance coverage with less than 5% having any form of health insurance. This disparity persists despite Venezuelan migrants' expanded eligibility for subsidized and contributive insurance.[2]

Table 1. Demographic characteristics of analytical sample including Colombian and Venezuelan women with deliveries in Colombia, 2017-2020

		Colombian and Venezuelan women		Colombian women		Venezuelan women	
		Live births N (%)	Fetal deaths N (%)	Live births N (%)	Fetal deaths N (%)	Live births N (%)	Fetal deaths N (%)
N		2572415	155437	2546363	153665	26052	1772
Country of origin	Colombia	2546363 (98.99)	153665 (98.86)	N/A			
	Venezuela	26052 (1.01)	1772 (1.14)	N/A			
Maternal age	10-14 years old	20413 (0.79)	1528 (0.98)	20191 (0.79)	1516 (0.99)	222 (0.85)	12 (0.68)
	15-19 years old	480583 (18.68)	24105 (15.51)	473867 (18.61)	23674 (15.41)	6716 (25.78)	431 (24.32)
	20-24 years old	743523 (28.90)	39457 (25.38)	734185 (28.83)	38902 (25.32)	9338 (35.84)	555 (31.32)
	25-29 years old	623783 (24.25)	34820 (22.40)	618191 (24.28)	34411 (22.39)	5592 (21.46)	409 (23.08)
	30-34 years old	418224 (16.26)	26366 (16.96)	415563 (16.32)	26152 (17.02)	2661 (10.21)	214 (12.08)
	35-39 years old	225503 (8.77)	19640 (12.64)	224275 (8.81)	19541 (12.72)	1228 (4.71)	99 (5.59)
	40-44 years old	55793 (2.17)	8502 (5.47)	55525 (2.18)	8454 (5.50)	268 (1.03)	48 (2.71)
	45+ years old	4593 (0.18)	1019 (0.66)	4566 (0.18)	1015 (0.66)	27 (0.10)	4 (0.23)
Maternal education	None	26028 (1.01)	1045 (0.67)	25645 (1.01)	1027 (0.67)	383 (1.47)	18 (1.02)
	Some or all primary school	901958 (35.06)	44987 (28.94)	895624 (35.17)	44649 (29.06)	6334 (24.31)	338 (19.07)
	Some secondary school or more	1537773 (59.78)	96031 (61.78)	1521310 (59.74)	95050 (61.86)	16463 (63.19)	981 (55.36)

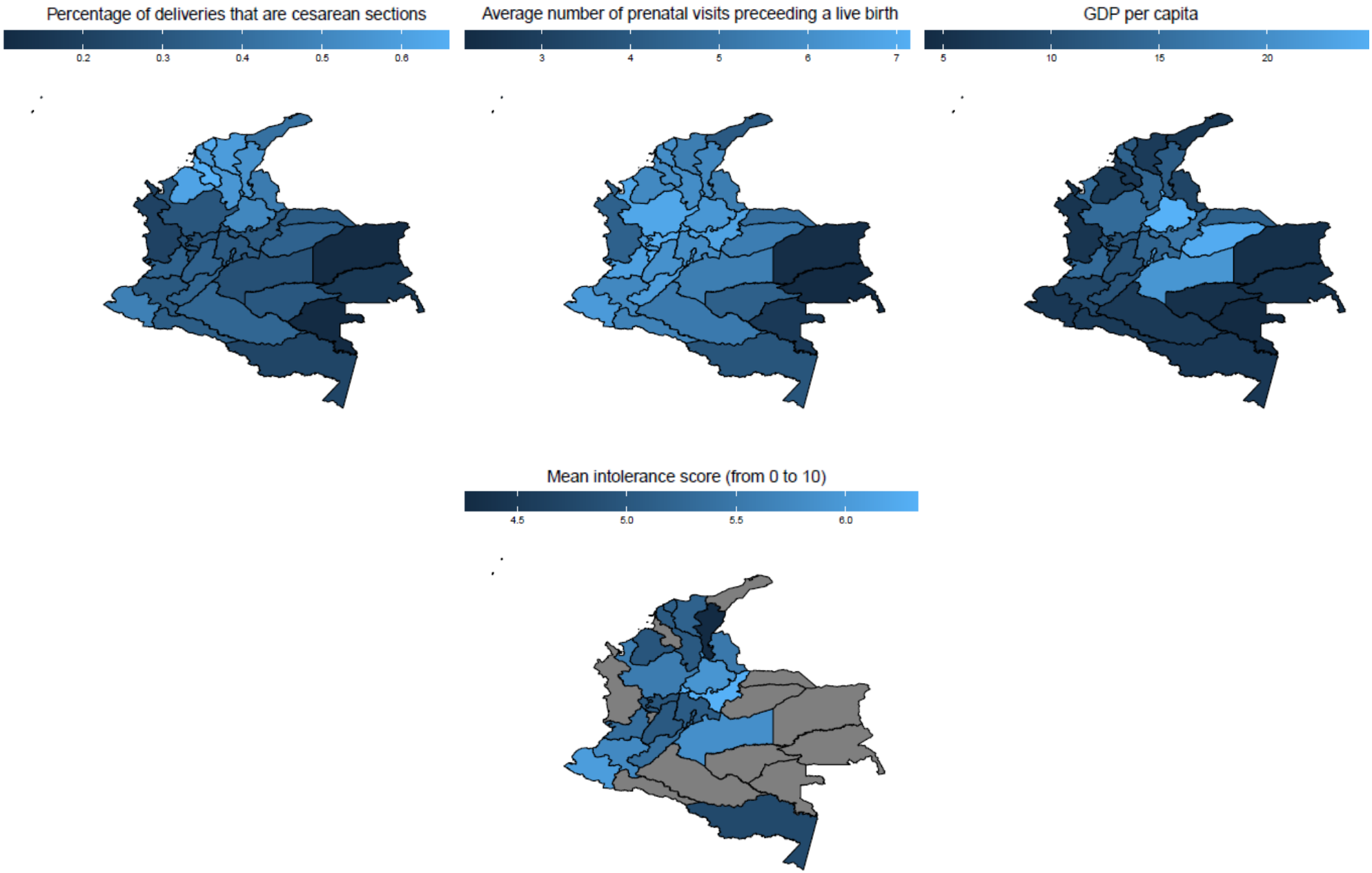
	Missing education data	106656 (4.15)	13374 (8.60)	103784 (4.08)	12939 (8.42)	2872 (11.02)	435 (24.55)
Health insurance	Not insured	191909 (7.46)	16990 (10.93)	166930 (6.56)	15293 (9.95)	24979 (95.88)	1697 (95.77)
	Other	55284 (2.15)	3406 (2.19)	55283 (2.17)	3405 (2.23)	1 (0.00)	1 (0.06)
	Subsidized	1358190 (52.80)	74392 (47.86)	1357192 (53.30)	74327 (48.37)	998 (3.83)	65 (3.67)
	Contributive	967032 (37.59)	60649 (39.02)	966958 (37.97)	60640 (39.46)	74 (0.28)	9 (0.51)
Parity Mean (SD)		2.07 (1.33)	2.41 (1.52)	2.07 (1.33)	2.41 (1.52)	2.43 (1.56)	2.70 (1.69)

Departmental characteristics of interest

Across all 2,734,669 deliveries that occurred in Colombia from 2017 through 2020, 42.44% (1,160,478/2,734,669) were reported to be cesarean sections. The proportion of deliveries in each department that were cesarean sections ranged from 66.93% in Sucre to 10.20% in Vaupes (Figure 3). The mean rate of cesarean sections across all departments was 373.50 per 1,000 deliveries (SD: 149.80 per 1,000), with a greater propensity for cesarean sections in northern departments that comprise the Caribbean region of the country (Figure 3). Among all live births in Colombia during the same period, the average number of prenatal visits was 6.11 (SD: 2.69; departmental range: 2.14-7.23; Figure 3). Departments in the Andina region tended to report higher mean number of prenatal visits overall, while those in the Amazonas and Orinoquia regions reported both fewer mean prenatal visits and lower proportions of cesarean sections than departments in other regions (Figure 3). Patterns of GDP per capita followed a less distinct regional pattern with Santander, Casanare, Bogota, and Meta reporting much higher GDP per capita than most of the other departments from 21.18 to 25.11. Inversely, Vaupes, Vichada, and Guaviare reported the lowest GDP per capita at 4.21, 5.07, and 5.22, respectively.

Drawing on the 1,200 Colombian Latinobarometer survey respondents, we derived a mean intolerance score for 20 out of the 33 departments. The weighted mean scores and their standard deviations for each department can be found in the Appendix Section 2.2. With a minimum score of 0 reflecting no xenophobic sentiment was expressed across any of the relevant survey questions and a maximum score of 10 being that only xenophobic sentiment was expressed, departments ranged from 4.26 (SD: 1.65) in Cesar to 6.33 (SD: 1.57) in Boyaca. Notably, Cesar is one of the departments bordering Venezuela. The other bordering department for which a mean intolerance score was derived, Norte de Santander, had a higher score at 5.51 (SD: 2.30). While this is a limited contextual measure of mean intolerance, we found that the departments with lower mean intolerance scores are correlated with those that reported lower rates of fetal deaths among Venezuelan mothers, however, there was no clear pattern observed when comparing intolerance scores with crude odds ratios for country of origin for each department (Appendix Section 2.2).

Figure 3. Geographic distribution of departmental-level health, economic, and social indicators of interest



Univariate and bivariate logistic regressions

Without controlling for any other maternal or departmental characteristics, we found that Venezuelan women who are pregnant in Colombia had a 13% (95% confidence interval [CI]: 7%-18%) higher odds of a fetal death than pregnant Colombian women (Table 2). When parity or maternal age were considered, pregnant Venezuelan women still consistently had significantly higher odds of experiencing a fetal death than their Colombian counterparts (OR: 1.06 [1.01-1.11] and 1.20 [1.14-1.26], respectively; Table 2). However, this risk is attenuated when controlling for maternal education whereupon country of origin no longer had a significant effect on the probability of fetal deaths (Table 2). When only health insurance status was controlled for, pregnant Venezuelan women were estimated to have 0.74 (0.72-0.80) times less likely to have a fetal death than their counterparts, with any of the three health insurance options (contributive, subsidized, and other) being similarly protective of fetal deaths relative to having no health insurance (Table 2). Given the large impact of controlling for health insurance, we evaluated the potential collinearity of health insurance and country of origin by estimating the variance inflation factor (VIF) but did not find them to be collinear factors (VIF: 1.10).

Among both Venezuelan women and Colombian women, increases in parity were associated with 1.10 (1.07-1.13) and 1.17 (1.17-1.17) times higher odds of fetal death without controlling for other factors. Similarly, Venezuelan and Colombian women, alike, who were above 25 years old had significantly higher odds of fetal deaths than women aged 20- to 24-year-olds (Table 2). Venezuelan women over the age of 45 were an exception, however, this group was particularly small (31/27,824; Table 1). For Venezuelan women, having completed all or some primary school or having completed no years of schooling were not significantly independently associated with the likelihood of fetal death when compared to women who had attended some secondary school or more (Table 2). Among Colombian women, these lower levels of schooling were estimated to reduce the odds of fetal deaths relative to some secondary school or more. However, missing data on their educational status was significantly associated with an increased odds of fetal deaths with estimated odds ratios of 2.54 (2.25-2.86) among only Venezuelan women and 2.00 (1.96-2.03) among only Colombian women, which highlights differential patterns in data completeness. When examining only health insurance status, there was insufficient evidence of an association with the odds of fetal deaths for Venezuelan women, while Colombian women with any of the three forms of health insurance saw between a 40% (39-41%) and 32% (30-47%) reduction in the odds of fetal death relative to the Colombian women with no health insurance (Table 2).

Table 2. Pooled and stratified bivariate and univariate model results for Colombian and Venezuelan women

		OR (95% CI)*	OR among Venezuelan women (95% CI)**	OR among Colombian women (95% CI) ***
Country of origin	Colombian	1.00 (reference)	N/A	N/A
	Venezuelan	1.13 (1.07-1.18)	N/A	N/A
Country of origin (Controlling for parity)	Colombian	1.00 (reference)	N/A	N/A
	Venezuelan	1.06 (1.01-1.11)	N/A	N/A
Parity		1.17 (1.17-1.17)	1.10 (1.07-1.13)	1.17 (1.17-1.17)

Country of origin (Controlling for maternal age)	Colombian	1.00 (reference)	N/A	N/A
	Venezuelan	1.20 (1.14-1.26)	N/A	N/A
Maternal age	45+ years old	4.19 (3.91-4.48)	2.49 (0.73-6.40)	4.20 (3.91-4.49)
	40-44 years old	2.88 (2.80-2.95)	3.01 (2.17-4.11)	2.87 (2.80-2.95)
	35-39 years old	1.64 (1.61-1.67)	1.36 (1.08-1.69)	1.64 (1.62-1.67)
	30-34 years old	1.19 (1.17-1.21)	1.35 (1.15-1.59)	1.19 (1.17-1.21)
	25-29 years old	1.05 (1.04-1.07)	1.23 (1.08-1.4)	1.05 (1.03-1.07)
	20-24 years old	1.00 (reference)	1.00 (reference)	1.00 (reference)
	15-19 years old	0.94 (0.93-0.96)	1.08 (0.95-1.23)	0.94 (0.93-0.96)
	10-14 years old	1.41 (1.34-1.49)	0.91 (0.48-1.56)	1.42 (1.34-1.49)
Country of origin (Controlling for maternal education)	Colombian	1.00 (reference)	N/A	N/A
	Venezuelan	1.03 (0.98-1.08)	N/A	N/A
Maternal education	Some secondary school or more	1.00 (reference)	1.00 (reference)	1.00 (reference)
	Attended some or all primary school	0.80 (0.79-0.81)	0.90 (0.79-1.02)	0.80 (0.79-0.81)
	Attended less than a year of school	0.64 (0.60-0.68)	0.79 (0.47-1.23)	0.64 (0.60-0.68)
	No education data reported	2.01 (1.97-2.05)	2.54 (2.25-2.86)	2.00 (1.96-2.03)
Country of origin (Controlling for health insurance status)	Colombian	1.00 (reference)	N/A	N/A
	Venezuelan	0.76 (0.72-0.8)	N/A	N/A
Health insurance status	No health insurance	1.00 (reference)	1.00 (reference)	1.00 (reference)
	Other health insurance	0.67 (0.65-0.70)	14.72 (0.58-372.34)	0.67 (0.65-0.70)
	Contributive health insurance	0.69 (0.67-0.70)	1.79 (0.83-3.39)	0.68 (0.67-0.70)
	Subsidized health insurance	0.60 (0.59-0.61)	0.96 (0.74-1.23)	0.60 (0.59-0.61)

OR: Odds ratio; CI: Confidence interval

*The OR for country of origin alone is estimated using Equation 1. All other ORs in this column are estimated using Equation 2 with both country of origin and the maternal characteristic of interest as fixed effects variables.

** The ORs in this column are estimated from a subset of data including only Venezuelan women and using a variation on Equation 1.

*** The ORs in this column are estimated from a subset of data including only Colombian women and using a variation on

Equation 1.

Multivariate regressions

When controlling for all potentially confounding individual-level drivers of fetal deaths, Venezuelan women were found to have 28% lower odds of fetal death than their Colombian counterparts (OR: 0.72 [0.68-0.75]; Appendix Table S5). The full results of the individual-level fixed effects model can be found in Appendix Section 4. Venezuelan women were found to have even lower odds of fetal death our inclusion of a random intercept on department, which identified department-level variance of 0.67 (Table 3). In an attempt to capture the sources of this department-level variance, we included a number of departmental-level characteristics in our full multivariate analysis. Upon the inclusion of these additional fixed effects departmental variables, Venezuelan women were found to have 16% (12-20%) lower odds of fetal death than their Colombian counterparts (Table 3).

On the contrary, increasing parity and having no educational data reported (relative to having attended some or all secondary school) contributed to increased odds of fetal deaths (Table 3). Maternal age was also significantly associated with increased odds of fetal deaths, which increased with every 5-year age grouping above 20-24 years old (Table 3). Relative to attending some or all secondary school, attending fewer years of schooling, both at the primary level and no schooling, were found to significantly reduce the odds of fetal deaths, deviating substantially from the relationship observed with having no educational data reported (Table 3). Having any form of health insurance was similarly found to significantly lower the odds of experiencing fetal deaths compared to the women who reported having no health insurance (Table 3). These maternal drivers are largely consistent with those associated with fetal deaths among only Colombian women (Table 3). When limiting our analysis to only Venezuelan women, we found that the associations between parity and lower educational attainment and the odds of fetal death remained consistent with those observed among the whole sample. However, health insurance status and some age groups were not significantly associated with fetal deaths in this group (Table 3).

We additionally found that when maternal characteristics are held constant, Colombian and Venezuelan women who delivered in departments with higher mean number of prenatal visits were more likely to experience fetal deaths (OR: 1.29 [1.28-1.30]; Table 3). The women who delivered in departments with a greater proportion of cesarean sections were less likely to experience fetal deaths than those with lower proportions of cesarean sections (OR: 0.57 [0.54-0.59]; Table 3). Across all women in the sample, the GDP per capita, as a proxy for socioeconomic opportunity and infrastructure, was not associated with the odds of fetal death (OR: 1.00 [0.99-1.00]; Table 3). However, Venezuelan women, specifically, who delivered in departments with greater GDP per capita were found to have significantly lower their likelihood of fetal deaths relative to other Venezuelan women in other departments (OR: 0.92 [0.91-0.94]; Table 3).

Table 3. Pooled and stratified multivariate model results of drivers of fetal deaths among Colombian and Venezuelan women

		Mixed effects model	Full fixed effects model		
Variable		OR (95% CI)[^]	OR (95% CI)[+]	OR among Venezuelan women (95% CI)[++]	OR among Colombian women (95% CI)[+++]
	Colombian	1.00 (reference)	1.00 (reference)	N/A	N/A

Country of origin	Venezuelan	0.64 (0.61-0.67)	0.84 (0.80-0.88)	N/A	N/A
Parity		1.14 (1.14-1.15)	1.13 (1.13-1.14)	1.10 (1.07-1.14)	1.13 (1.13-1.14)
Maternal age	45+ years old	3.29 (3.14-3.45)	3.26 (3.04-3.50)	2.20 (0.63-5.82)	3.27 (3.04-3.51)
	40-44 years old	2.31 (2.25-2.37)	2.36 (2.30-2.43)	2.48 (1.74-3.47)	2.36 (2.30-2.43)
	35-39 years old	1.44 (1.42-1.47)	1.47 (1.44-1.50)	1.1 (0.86-1.39)	1.47 (1.44-1.50)
	30-34 years old	1.11 (1.09-1.13)	1.12 (1.10-1.14)	1.21 (1.01-1.44)	1.12 (1.10-1.14)
	25-29 years old	1.02 (1.01-1.04)	1.02 (1.01-1.04)	1.18 (1.03-1.35)	1.02 (1.01-1.04)
	20-24 years old	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
	15-19 years old	1.02 (1.01-1.04)	1.02 (1.00-1.03)	1.20 (1.05-1.37)	1.01 (1.00-1.03)
	10-14 years old	1.70 (1.62-1.78)	1.71 (1.62-1.80)	1.11 (0.58-1.93)	1.72 (1.63-1.81)
Maternal education	Some secondary school or more	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
	Attended some or all primary school	0.71 (0.70-0.72)	0.71 (0.71-0.72)	0.85 (0.75-0.97)	0.71 (0.70-0.72)
	Attended less than a year of school	0.63 (0.60-0.66)	0.54 (0.50-0.57)	0.72 (0.43-1.14)	0.53 (0.50-0.57)
	No education data reported	2.9 (2.84-2.96)	2.19 (2.14-2.23)	2.34 (2.06-2.65)	2.18 (2.14-2.22)
Health insurance status	No health insurance	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
	Other health insurance	0.64 (0.62-0.67)	0.68 (0.65-0.71)	20.83 (0.81-535.97)	0.68 (0.65-0.70)
	Contributive health insurance	0.67 (0.66-0.68)	0.69 (0.68-0.71)	1.32 (0.59-2.63)	0.69 (0.68-0.71)
	Subsidized health insurance	0.57 (0.56-0.58)	0.6 (0.59-0.61)	0.9 (0.69-1.16)	0.6 (0.58-0.61)

Departmental average number of prenatal visits	N/A	1.29 (1.28-1.30)	2.18 (2.01-2.36)	1.29 (1.28-1.30)
Departmental proportion of c-section deliveries	N/A	0.57 (0.54-0.59)	$1.74x10^{-3}$ ($9.27x10^{-4}$-$3.29x10^{-3}$)	0.58 (0.56-0.61)
Departmental gross domestic product per capita	N/A	1.00 (0.99-1.00)	0.92 (0.91-0.94)	1.00 (1.00-1.00)
Random effects departmental-level variance	0.67	N/A		

OR: Odds ratio; CI: Confidence interval; c-section: cesarean section
[+] The ORs in this column are estimated using Equation 4 including country of origin as a fixed effects variable.
[++] The ORs in this column are estimated from a subset of data including only Venezuelan women and using Equation 4 without country of origin.
[+++] The ORs in this column are estimated from a subset of data including only Colombian women and using Equation 4 without country of origin.
[^] The ORs in this column are estimated from a variation of Equation 3 including both country of origin and a random intercept on department.

Sensitivity Analysis

Given risk factors for fetal death can differ at different stages of gestation, we conducted a sensitivity analysis by stratifying the sample by gestational age.[33] In this exploration, we estimated a crude odds ratio for country of origin and ran our full fixed-effect multivariate logistic regression (Equation 4) using only the observations reflecting full term deliveries at a gestation of 38 weeks or longer. Overall, the restriction in outcome definition resulted in slightly different odds ratios but largely affirmed the magnitude and direction of our observed associations apart from that for education. When restricting the data to only deaths and births that occurred at full term, we found that lower levels of maternal education increased the odds of fetal death relative to having completed some or all of secondary school across the entire sample (OR resulting from having some or all primary school: 1.12 [1.04-1.22]; OR from no schooling: 3.08 [2.57-3.67]). Having no educational data reported remained the most at-risk group relative to having completed some or all secondary school (OR: 3.76 [3.39-4.17]). The full results of this analysis can be found in the Appendix Table S6.

We also conducted a further sensitivity analysis to examine whether the effect of country of origin from our primary analysis differed among women who were not insured. Using a similar approach to that described above, we limited our dataset to only the observations from women who did not report having any form of health insurance. Among women with no health insurance, we found a crude odds ratio of 0.74 (0.70-0.78) for Venezuelan women relative to Colombian women (Appendix Table S7). The adjusted odds ratios affirmed the direction and relative strength of the associations observed in our primary analysis, including lower levels of maternal education resulting in lower odds of fetal death relative to some or all secondary school and the contrary for women who did not have reported educational data (Appendix Table S7). Like in our primary analysis, Venezuelan women in both sensitivity analyses were found to have lower odds of fetal death than their Colombian counterparts with adjusting for all relevant variables.

Discussion

This study reflects a comprehensive examination of fetal deaths in Colombia from 2017 through 2020 and goes a step further to quantify the relationships between fetal deaths and numerous individual-level and departmental-level characteristics. It presents how patterns in maternal and departmental traits

influence the likelihood of fetal death among pregnant Venezuelan women and Colombian women and sheds light on previously unexamined differences in the drivers of fetal deaths between the two groups. Across the four years of vital records, we found that Venezuelan and Colombian women in Colombia had an overall rate of 608.20 fetal deaths per 100,000 live births, amounting to 679.82 and 606.17 fetal deaths per 100,000 live births, respectively. Without adjusting for any other factors, Venezuelan women were statistically more likely to experience fetal deaths than their Colombian counterparts.

However, this disparity was attenuated and, in fact, reversed when accounting for health insurance status, maternal education, maternal age, and parity, as well as several departmental characteristics. Interestingly, these findings deviate from some existing literature regarding the risk of fetal death among migrant populations relative to their host communities. One systematic review of articles from 2000 through 2019 with no geographic restrictions identified eleven studies pertaining to stillbirths or miscarriages among refugee populations in Europe, North America, and the Middle East.[16] Ten of these eleven studies found that refugee women were more likely to experience stillbirths or miscarriages than nationals of the host country, while the eleventh did not report a significant difference.[16] The difference in findings may be attributable, in part, to the portion of unobserved fetal deaths that may not be captured in the vital records and could not be accounted for in our present analysis. However, our results remained largely consistent with the finding of excess risk when independently controlling for various maternal characteristics other than health insurance.

We consider that health insurance status, which differs substantially between the Colombian and Venezuelan women in our sample despite existing integration policies, reflects at a woman's socioeconomic status, as associated with migration, but it also affects care-seeking behavior during pregnancy. Consequently, unlike in other settings, health insurance status appears to drive an individual's risk of fetal death where policies are in place to allow migrants to receive public health insurance but where the barriers to accessing it remain high for both migrants and low-income non-migrants, as is the case in Colombia. Lowering the barriers to health insurance access, including by reducing bureaucratic demands and employment requirements, for the whole population, including Venezuelan migrants, would go far in reducing the overall burden of fetal deaths. Furthermore, our findings may reflect a phenomenon coined the "health migrant effect" in which individuals who are able to move away from their country of origin report a better baseline health status than the nationals in their host country. While there is inconsistent evidence of such a phenomenon, it may be applicable in this context given our inability to directly account for the prior existence of chronic or acute medical conditions that may affect a person's ability to migrant from Venezuela to Colombia and increase the risk of experiencing a fetal death.[31,34,35]

Across both Venezuelan and Colombian women, we found that parity and maternal age were associated with higher odds of fetal death, while delivering in a department with higher rates of cesarean sections and GDP per capita were associated with lower likelihood of fetal death. These drivers are consistent with those found in other studies examining harmful and protective risk factors of fetal deaths broadly without considering migration status.[11,31] For example, another study drawing upon Colombia's vital records from 1999 through 2008 focused solely on fetal deaths due to congenital anomalies, which were found to be responsible for 3.4% of fetal deaths during that time period.[26] It similarly found that older maternal ages resulted in increased risk of fetal death due to congenital anomalies, while a separate study focused only on a single hospital in Bogota identified a similar relationship between being above the age of 35 and fetal death as defined by our analysis.[26,36]

The risk profile of fetal deaths between the two groups did have some slight differences among other indicators. Colombian women with any form of health insurance and with lower levels of educational attainment were found to have lower odds of fetal death than Colombian women with no health insurance and with some secondary schooling or more. These associations were found to be insignificant among our sample of Venezuelan women. Contrary to our findings, previous literature has found that women lower educational attainment had greater risk of stillbirths relative to those with higher educational attainment.[11] One explanation for the differences in our findings is in our deviation from the WHO definition of stillbirths to align with that used by Colombia's DANE. Alternatively, the high degree of missingness in the education variable included in the vital records, and the higher odds of fetal death

among the women with missing education data across both Colombian and Venezuelan women, suggests that the segment of the population for which this data is missing is that most at-risk and may substantially influence our findings.

Furthermore, we did not find significant associations with many of our indicators and fetal death among Venezuelan women, in particular. While many of these findings may be attributable to small samples, it is also possible that there are additional factors that primarily affect Venezuelan women that we were unable to incorporate. For example, while we were limited in our ability to evaluate the direct association between fetal deaths and experiences of xenophobia, we did find evidence of xenophobic attitudes throughout the departments for which data was available. In a 2021 survey, researchers found high prevalence of discriminatory experiences among Venezuelan migrants along border departments at 53.6%, and an earlier 2018 survey reported that 27% were victims of xenophobic actions, including violence.[37] Discrimination by health providers can lead to both directly harmful health outcomes and, in the long term, distrust by migrants towards health services as a whole.[38] One report suggests that 17% of the Venezuelans in border departments who did seek out health care were refused care due to their status as a migrant, while 28% elected to not seek out care when they may have needed it because of their perception that they may be mistreated or disrespected at the health clinics due to their nationality.[7] This degree of mistrust observed in other studies and xenophobic attitudes identified above could contribute to women being unlikely to seek care during pregnancy and documentation of a fetal death that occurs outside of a healthcare setting, which in turn may affect the universe of Venezuelan fetal deaths captured in Colombia's vital records.

The findings of the present study must be considered within the context of several further limitations, particularly pertaining to the quality and availability of the underlying data. First, this analysis narrows in on differences in fetal death rates and drivers between Venezuelan migrants and Colombian nationals in Colombia, however, the country's vital records do not directly report on maternal nationality or other migration-related characteristics.[23] Instead, the women's reported "country of habitual residence" is used a proxy for their nationality and, by extension, their migrant status. This variable been previously applied in a similar manner to examine disparities in low birth weight and other health outcomes among children of Venezuelan and Colombian mothers in Colombia.[5,19] As the closest variable to maternal nationality, we presume that mothers who identify Venezuela as their "country of habitual residence" are likely to be Venezuelan and to have migrated to Colombia recently without fully integrating. Furthermore, since these mothers are likely to represent recent migrants, they are likely to have migrated during or closely prior to their pregnancy, which would suggest that any migration-related factors in their risk of fetal death would be more directly observable. However, the use of this proxy may obscure true patterns in fetal mortality rates and drivers among migrants by misassigning births and deaths from Venezuelan women who have more fully integrated to Colombian women. The paucity of migration-specific data also restricts the feasibility of extending the present analysis to other important migration factors, like legal status, time since arrival, and conditions at their location of origin. These factors and their relationship to maternal outcomes are important directions for future research with more comprehensive migration-related data than that which is currently available.

Lastly, our analysis found that pregnant women who were missing data on maternal educational attainment in their associated vital records were far more likely to have a fetal death than those with the information on their education filled in. These results were maintained regardless of the other characteristics that were controlled for and suggest that the women whose deliveries do not result in completed vital records (be it a comprehensive birth certificate or a full fetal death registration) represent a particularly vulnerable segment of the population. However, they also hint at the fact that the missingness in the dataset, as well as its overall completeness, may affect the generalizability of the results beyond the analytical sample. While Colombia's vital registry is estimated to have some of the highest completeness in the world, it may still fail to capture up to 10% of the country's births and deaths.[24,25] Births and deaths are also more likely to be missed if they occur outside of a healthcare system, and despite the country's attempts to fill in these gaps, 98.08% of the included deliveries in the present analysis occurred in healthcare settings.[39] The omissions from vital records may be particularly

affect counts of fetal deaths, which are infamously difficult to categorize and can take many different forms, and counts among Venezuelan women who may face additional barriers to care.[40]

Conclusion

To the best of our knowledge, the present study is the first attempt to examine patterns and drivers of fetal deaths in Colombia across the dimension of migration. While Venezuelan women in Colombia had higher rates of fetal deaths than Colombian women during the four-year study period, this observed disparity reflects differences in the maternal and departmental drivers of fetal deaths. Most keenly, the descriptive and regression analyses presented highlight the need to lower barriers of access to health insurance for both Colombian women and Venezuelan women as a measure to combat fetal deaths in Colombia. However, the data limitations identified throughout this study highlight the need for survey data linked to the observations of fetal deaths and live births with insights into the experiences of individual women accessing necessary care, navigating any mistreatment or xenophobia, and prior medical history. Whether through qualitative or quantitative measures, such insight could serve to contextualize the present findings and clarify the mechanisms through which relevant indicators influence the likelihood of fetal deaths within this growing population.

References

1. OECD. *International Migration Outlook 2021*. (OECD, 2021). doi:10.1787/29f23e9d-en.
2. Bowser, D. M., Agarwal-Harding, P., Sombrio, A. G., Shepard, D. S. & Harker Roa, A. Integrating Venezuelan Migrants into the Colombian Health System during COVID-19. *Health Systems & Reform* **8**, 2079448 (2022).
3. Fernández-Niño, J. A., Cubillos-Novella, A., Bojórquez, L. & Rodríguez, M. Recommendations for the response against COVID-19 in migratory contexts under a closed border: The case of Colombia. *Biomedica* **40**, 68–72 (2020).
4. Del Real, D. Seemingly inclusive liminal legality: the fragility and illegality production of Colombia's legalization programmes for Venezuelan migrants. *J Ethn Migr Stud* **48**, 3580–3601 (2022).
5. Guarnizo-Herreño, C. C. & Wehby, G. L. Health of Infants Born to Venezuelan Refugees in Colombia. *J Immigrant Minority Health* **23**, 222–231 (2021).
6. Garnica-Rosas, L., Granich-Armenta, A., Guerra y Guerra, G., Sánchez-Dominguez, M. & Lamadrid-Figueroa, H. Perinatal Outcomes Among Venezuelan Immigrants in Colombia: A Cross-Sectional Study. *J Immigrant Minority Health* **23**, 976–985 (2021).

7. Cubides, J.-C., Peiter, P. C., Garone, D. B. & Antierens, A. Human Mobility and Health: Exploring the Health Conditions of Venezuelan Migrants and Refugees in Colombia. *J Immigrant Minority Health* **24**, 1281–1287 (2022).
8. Calderón-Jaramillo, M., Parra-Romero, D., Forero-Martínez, L. J., Royo, M. & Rivillas-García, J. C. Migrant women and sexual and gender-based violence at the Colombia-Venezuela border: A qualitative study. *J Migr Health* **1–2**, 100003 (2020).
9. Vera Espinoza, M. *et al.* Towards a typology of social protection for migrants and refugees in Latin America during the COVID-19 pandemic. *Comp Migr Stud* **9**, 52 (2021).
10. Oberoi, P. *et al. International Migration, Health and Human Rights*. https://www.ohchr.org/sites/default/files/Documents/Issues/Migration/WHO_IOM_UNOHCHRPublication.pdf (2013).
11. McClure, E. M. *et al.* Stillbirth 2010–2018: a prospective, population-based, multi-country study from the Global Network. *Reproductive Health* **17**, (2020).
12. Pastor-Moreno, G., Ruiz-Pérez, I., Henares-Montiel, J. & Petrova, D. Intimate partner violence during pregnancy and risk of fetal and neonatal death: a meta-analysis with socioeconomic context indicators. *American Journal of Obstetrics & Gynecology* **222**, 123-133.e5 (2020).
13. Conde-Agudelo, A., Belizán, J. M. & Díaz-Rossello, J. L. Epidemiology of fetal death in Latin America. *Acta Obstet Gynecol Scand* **79**, 371–378 (2000).
14. Eshete, A., Alemu, A. & Zerfu, T. A. Magnitude and Risk of Dying among Low Birth Weight Neonates in Rural Ethiopia: A Community-Based Cross-Sectional Study. *International Journal of Pediatrics* **2019**, e9034952 (2019).
15. Vilanova, C. S. *et al.* The relationship between the different low birth weight strata of newborns with infant mortality and the influence of the main health determinants in the extreme south of Brazil. *Population Health Metrics* **17**, 15 (2019).
16. Harakow, H.-I., Hvidman, L., Wejse, C. & Eiset, A. H. Pregnancy complications among refugee women: A systematic review. *Acta Obstetricia et Gynecologica Scandinavica* **100**, 649–657 (2021).

17. Mozooni, M., Preen, D. B. & Pennell, C. E. The influence of acculturation on the risk of stillbirth in migrant women residing in Western Australia. *PLoS One* **15**, e0231106 (2020).
18. Gissler, M. *et al.* Stillbirths and infant deaths among migrants in industrialized countries. *Acta Obstetricia et Gynecologica Scandinavica* **88**, 134–148 (2009).
19. Bollini, P., Pampallona, S., Wanner, P. & Kupelnick, B. Pregnancy outcome of migrant women and integration policy: A systematic review of the international literature. *Social Science & Medicine* **68**, 452–461 (2009).
20. Global, regional, national, and selected subnational levels of stillbirths, neonatal, infant, and under-5 mortality, 1980–2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet* **388**, 1725–1774 (2016).
21. Sarwar, A. H. *et al.* History of Pregnancy Loss as a Risk Factor for Myocardial Infarction. *Cureus* **13**, e17288.
22. Cuenca, D. Pregnancy loss: Consequences for mental health. *Front Glob Womens Health* **3**, 1032212 (2023).
23. Microdatos - DANE. *Departamento Administrativo Nacional de Estadisticas - Archivo Nacional de Datos* https://microdatos.dane.gov.co/catalog/MICRODATOS.
24. Karlinsky, A. *International Completeness of Death Registration 2015-2019*. http://medrxiv.org/lookup/doi/10.1101/2021.08.12.21261978 (2021) doi:10.1101/2021.08.12.21261978.
25. Vos, T. *et al.* Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *The Lancet* **396**, 1204–1222 (2020).
26. Roncancio, C. P. *et al.* Trends and characteristics of fetal and neonatal mortality due to congenital anomalies, Colombia 1999–2008. *J Matern Fetal Neonatal Med* **31**, 1748–1755 (2018).
27. Peiró-Palomino, J., Prieto-Bustos, W. O. & Tortosa-Ausina, E. Regional income convergence in Colombia: population, space, and long-run dynamics. *Ann Reg Sci* **70**, 559–601 (2023).

28. DANE - Encuesta nacional de calidad de vida (ECV) 2021. https://www.dane.gov.co/index.php/estadisticas-por-tema/salud/calidad-de-vida-ecv/encuesta-nacional-de-calidad-de-vida-ecv-2021.
29. Latinobarometro. *Latinobarometro* https://www.latinobarometro.org/lat.jsp (2022).
30. Tennant, P. W. G. *et al.* Use of directed acyclic graphs (DAGs) to identify confounders in applied health research: review and recommendations. *Int J Epidemiol* **50**, 620–632 (2020).
31. Flenady, V. *et al.* Major risk factors for stillbirth in high-income countries: a systematic review and meta-analysis. *Lancet* **377**, 1331–1340 (2011).
32. Aminu, M. *et al.* Causes of and factors associated with stillbirth in low- and middle-income countries: a systematic literature review. *BJOG: An International Journal of Obstetrics & Gynaecology* **121**, 141–153 (2014).
33. Reeske, A., Kutschmann, M., Razum, O. & Spallek, J. Stillbirth differences according to regions of origin: an analysis of the German perinatal database, 2004-2007. *BMC pregnancy and childbirth* **11**, (2011).
34. Elshahat, S., Moffat, T. & Newbold, K. B. Understanding the Healthy Immigrant Effect in the Context of Mental Health Challenges: A Systematic Critical Review. *J Immigrant Minority Health* **24**, 1564–1579 (2022).
35. Flores, G. & Brotanek, J. The Healthy Immigrant Effect: A Greater Understanding Might Help Us Improve the Health of All Children. *Archives of Pediatrics & Adolescent Medicine* **159**, 295–297 (2005).
36. Molina-Giraldo, S., Solano-Montero, A. F., Gómez-Parra, S. R., Jl, R.-A. & E, A.-O. [Characterization of fetal deaths and associated factors in a high complexity hospital in a Latin American country]. *Ginecologia y obstetricia de Mexico* **82**, (2014).
37. Alarcon, R. D. *et al.* A Scoping Review of the Venezuelan Migration in Three South American Countries: Sociocultural and Mental Health Perspectives. *World Social Psychiatry* **4**, 13 (2022).

38. Agudelo-Suárez, A. A. *et al.* A metasynthesis of qualitative studies regarding opinions and perceptions about barriers and determinants of health services' accessibility in economic migrants. *BMC Health Serv Res* **12**, 461 (2012).
39. *Colombia*. https://www.vitalstrategies.org/wp-content/uploads/Vital-Strategies-CRVS-Colombia-English.pdf (2020).
40. Leisher, S. H. *et al.* Seeking order amidst chaos: a systematic review of classification systems for causes of stillbirth and neonatal death, 2009–2014. *BMC Pregnancy Childbirth* **16**, 295 (2016).