

Newborn's Well-Being within War Context in Colombia

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A mi madre, quién en medio de todo logró protegerme cuando más lo necesité.

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Abstract in English

Prior to the 2016 Havana Peace Agreement, Colombia struggled with 70 years of violence stemming from an armed conflict involving the military, guerrillas and paramilitaries, which had a profound impact on civilians, including pregnant women. While the existing literature addresses the causes of armed conflict, its specific impact on pregnant women and neonatal health remains unclear. This thesis presents four papers that address three different health dimensions of neonatal well-being. All papers are inspired by Urie Bronfenbrenner's ecological theory. The first paper examines the impact of the 2002 peak in violence on newborn weight, controlling for maternal education and regional socio-economic indicators for 24 regions. The second paper examines the odds of being born preterm during the 2002 violence peak, scoping in maternal university education for 32 regions. The third paper examines the odds of experiencing a stillbirth, miscarriage or early loss in 2002, controlling exploring the protective effect of maternal university education. The fourth paper examines the impact of regional violence between 1998 and 2007 and the effect of maternal university education on the odds of being born alive. By analysing the National Health Statistics Surveys and the National Centre of Historical Memory databases, the study shows that mothers with university education were consistently more likely to give birth to babies with favourable outcomes. Overall to being born alive and with higher weight. However, these mothers experienced increased vulnerability in the most affected regions. This compromised their ability to protect the dyad, particularly in the most violent year of

the period analyses, and specifically in terms of the likelihood of preterm birth, 2002.

Resumen

Antes del Acuerdo de Paz de La Habana en 2016, Colombia enfrentó 70 años de violencia derivada de un conflicto armado que involucraba al ejército, guerrillas y paramilitares, y que tuvo un impacto profundo en la población civil, incluyendo a mujeres embarazadas. Aunque la literatura existente aborda las causas del conflicto armado, su impacto específico en mujeres embarazadas y la salud neonatal aún no está claro. Esta tesis presenta cuatro documentos que abordan tres dimensiones diferentes de la salud neonatal, todos inspirados en la teoría ecológica de Urie Bonfenbrenner. El primer documento examina el impacto del pico de violencia en 2002 en el peso de los recién nacidos, controlando la educación materna e indicadores socioeconómicos regionales para 24 regiones. El segundo documento examina las probabilidades de nacer prematuro durante el pico de violencia en 2002, focalizando en la educación universitaria materna para 32 regiones. El tercer documento examina las probabilidades de experimentar un nacimiento sin vida, un aborto espontáneo o una pérdida temprana en 2002, explorando el efecto protector de la educación universitaria materna. El cuarto documento examina el impacto de la violencia regional entre 1998 y 2007 y el efecto de la educación universitaria materna en las probabilidades de nacer con vida. Al analizar las Encuestas Nacionales de Estadísticas de Salud y las bases de datos del Centro Nacional de Memoria Histórica, el

estudio muestra que las madres con educación universitaria tenían consistentemente más probabilidades de dar a luz a bebés con resultados favorables, en general, al nacer con vida y con un peso mayor. Sin embargo, estas madres experimentaron una mayor vulnerabilidad en las regiones más afectadas, comprometiendo su capacidad para proteger a la diada, especialmente en el año más violento del período analizado, y específicamente en términos de la probabilidad de nacer prematuramente, en 2002

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CHAPTER 1

GENERAL INTRODUCTION

1.1 Presentation

This thesis addresses a critical gap in empirical evidence on the protective effects of university education for pregnant women living in violent environments, particularly during the Colombian armed conflict from 1998 to 2007. The scarcity of such evidence highlights the need to understand how maternal university education interacts with the complex dynamics of armed conflict and its impact on neonatal well-being, particularly on health dimensions such as birth weight, gestational age and live birth.

Building on existing knowledge, it was found that women who had a university education and successfully completed it before giving birth were better equipped to have healthier pregnancies, resulting in higher levels of well-being for their newborns. Even if they were not able to complete their education, they were better able to protect the dyad. However, the contribution of this paper is to explore the modifying effects of violence in war-torn contexts on the protective influence of maternal university education. Thus, when regions are highly affected by regional violence, the likelihood of protecting the dyad in terms of gestational time decreases for all mothers, regardless of their level of education, even if it is university education.

The research presented in this thesis shows that despite the generally protective effect of maternal university education on newborn well-being, this effect is modified in the presence of violence. Specifically, in the Colombian context from 1998 to 2007,

characterised by the urbanisation of the conflict and a peak of violence in 2002, violence modifies and reduces the protective effect of maternal university education making all women vulnerable to contextual violence. This reality highlights the complex relationship between education, conflict and newborn outcomes. It also highlights the challenges faced by pregnant women in difficult situations. It is therefore important to consider the initial regional conditions before assessing neonatal and maternal well-being.

1.2 Understanding Colombian Armed Conflict

1.2.1 The most violent period, 1998 - 2007

The decade spanning from 1998 to 2007 stands as a somber chapter in Colombia's history, marking the country's most tumultuous and violent period within the past six decades of armed conflict (Echandía, 2019). The zenith of this distressing era manifested between 1998 and 2002, having its peak in 2002, unleashing widespread repercussions on the lives of individuals, even extending to the most vulnerable – (pregnant women/newborn) dyads. Regions including Caquetá, Casanare, Cesar, Meta, Antioquia, Guaviare, Putumayo, La Guajira, Norte de Santander, Arauca, Chocó, Magdalena, and Vaupés bore the brunt of this violence, as evident in the staggering toll of human casualties resulting from a spectrum of atrocities, ranging from landmines and forced displacement to terrorist attacks, targeted assassinations, child recruitment, kidnappings, assaults on public infrastructure and

civilian populations, sexual violence, military engagements, and massacres (Echandía, 2006; Echandía 2019; Echandía & Cabrera, 2022). This, is also documented within the reports and databases from the National Center of Historic Memory (1998 - 2013).

Figure 1.
CAC Categorization between 1998 and 2007

Year / Period	Escenario
1998 - 2002	Upward trend of rural violence and expansion of the Strategic military FARC ‘s plan. Peace negotiation failure during Pastran’s government. Strength of the National Military forcer through the “Colombian Plan” policy
2002	Peak of violence, the most violent year in the last decades of the CAC.
2003 - 2007	“Policy of Democratic Security” during Uribe’s government. Strong militar strategy to face the expansion of the FARC. Urbanization of the CAC. Peace agreement with the AUC.

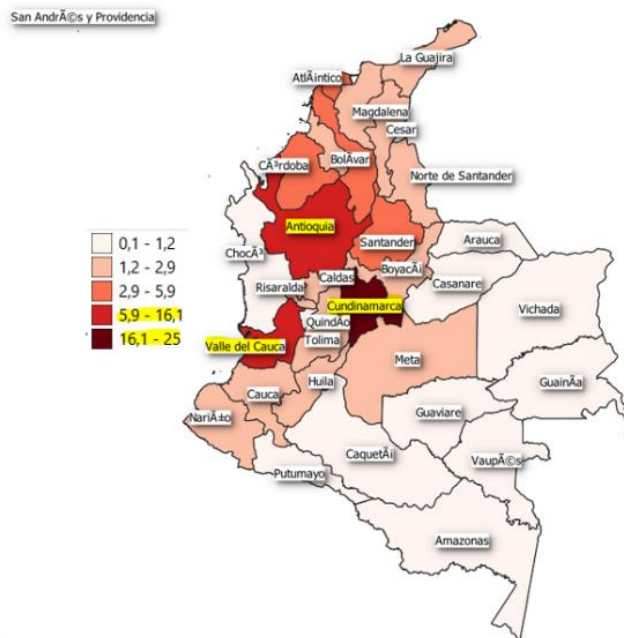
Source: Own elaboration 2023

Figure 1 presents a classification of the periods of analysis of the Colombian Armed Conflict escenario based on the level of violence documented in the databases of the National Centre for Historic Memory and complemented to information of the Multitemporal Data Platform of the Armed Conflict Monitoring Project in Colombia, Center for Research and Special Projects (CIPE), Externado University of Colombia.

An illustrative case of the detrimental scenario for pregnant women amid the Colombian Armed Conflict (CAC), where violence instilled fear leading to stress, is evident in Antioquia. This is because the leading violent trend within the region and the urbanization process of war and violence in Medellín and its metropolitan area. When contrasting to health science, pregnant women in such contexts are more prone to an overproduction of cortisol, the hormone responsible for fetal maturation (Braithwaite et al., 2016; Urizar et al., 2019) .

When reviewing the trend of other newborn outputs (low birth weight and preterm rates) in Colombia, Cundinamarca, which includes the capital city of Bogotá, was the most affected region in terms of preterm births between 1998 and 2007 (Echandía, 2019). As shown in Figure 2, between 16.1% and 25% of newborns were born before 37 weeks of gestation. Notably, Antioquia and Valle del Cauca emerged as the second most affected regions in this regard. We draw attention to the correlation that the regions most impacted by violence, specifically Antioquia, and the two "refugee" regions of Cundinamarca-Bogotá and Valle del Cauca, exhibited the highest percentages of preterm births between 1998 and 2007 (NHSS, 1998 - 2007).

Figure 2
Regional percentages of preterm newborns (under completed 37 weeks) between 1998 and 2007



Source: Own elaboration based on the 2002 National Health Statistics Survey, 2012 Poverty Mission, and National Centre of Historic Memory databases.

Figure 3 illustrates key data related to neonatal health and the well-being of newborns. Over the period from 1998 to 2007, various trends were observed, among which was a marginal 0.42% rise in births among young women under 19 years old (NHSS, 1998 - 2007). Concurrently, women with a basic educational level experienced a decrease of 14.45%, while those completing university education saw an increase of 2.48% (NHSS, 1998 - 2007). Examining newborn outcomes, the preterm birth rate rose by 5.47% (NHSS, 1998 - 2007). In urban areas, the rate of low birth weight (LBW) decreased by 1.57%, contrasting with a similar percentage

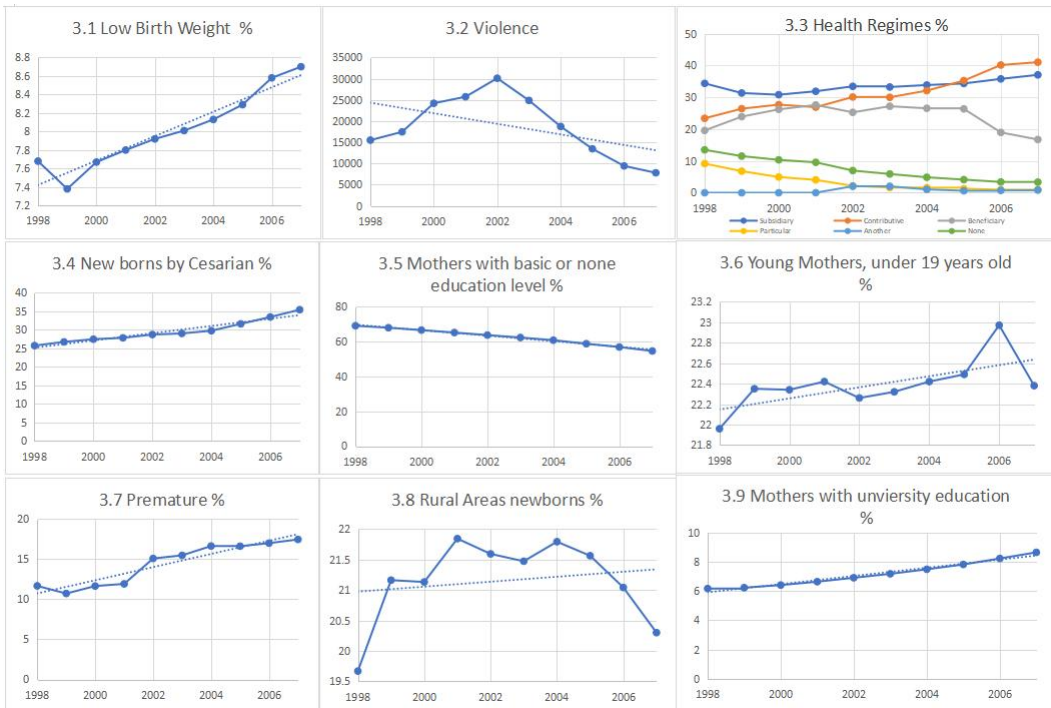
increase in rural areas (NHSS, 1998 - 2007). Among the surveyed women during this period, 58.26% were unemployed, while 34.57% were employed (NHSS, 1998 - 2007). Notably, women under the "subsidiary healthcare regime" were identified as lacking employment (NHSS, 1998 - 2007). According to Law No. 100, the "healthcare regime" categorizes health insurance types within the social protection system, including contributors (working mothers contributing to the system), beneficiaries (non-working mothers benefiting from a spouse or parents), subsidiaries (mothers earning less than the legal minimum wage or without a job), particulars (mothers with private insurance), and others (mothers with no or alternative health insurance).

On a different note, an analysis of the frequency of violent acts reveals a peak in 2002, coinciding with a notable increase in preterm births nationwide (National Centre of Historic Memory, 1998 - 20013). Similarly, there was a 1.2% rise in the national LBW rate during this period as shown in Figure 2 (NHSS, 1998 - 2007). It presents a group of charts relevant for newborn's well-being and a chart considering the average of violent acts at national level by year during the period of analysis.

Looking at neonatal health outcomes in terms of weight, Figure 3.1 shows an increasing trend in the proportion of newborns under 2500 grams born between 1998 and 2007, starting in 2002. Similarly, Figure 3.6 shows an increasing trend in the proportion of preterm births, with a jump of almost 5% in 2002 compared with 2001.

These adverse neonatal health outcomes occurred precisely when violence was at its peak, as shown in Figure 3.2.

Figure 3
Newborns' output trends and relevant figures from 1998 to 2007



Source: Own elaboration based on the 2002 - 2007 National Health Statistics Surveys

We observed a significant rise in the proportion of mothers giving birth who were affiliated with the subsidiary health system, as illustrated in Figure 3.3. This group comprised women who were either unemployed or earned less than one legal minimum wage per month, lacked contributions from a family member to their health insurance, thus not qualifying for the beneficiary regime, or were engaged in informal work.

As Figure 3.3 shows, between 1998 and 2007, the percentage of women giving birth under the Subsidiary healthcare regime surged from 23.39% to 41.03%. In contrast, those covered by the Contributory healthcare regime (women working in the formal sector) experienced a marginal increase from 34.37% in 1998 to 37.05% in 2007 (NHSS, 1998 - 2007). Conversely, there was a decline of 2.8% in the Beneficiary regime, 8.1% in the Particular regime, and 10% in those without any healthcare regime during the same period. Additionally, the proportion of women giving birth belonging to Another healthcare regime rose by 0.85% from 1998 to 2007.

With regard to maternal education, we observe an increasing trend for mothers with university education, Figure 3.9, while we observe a decreasing trend for women with primary education and no education who have a baby, Figure 3.5. Caesarean section, Figure 3.4, mothers under the age of 19, Figure 3.6, and the percentage of babies born in rural areas show an increasing trend between 1998 and 2007.

Given the central role of prenatal well-being in shaping human capital development and overall well-being, there is an imperative for governments, academia and societies to prioritize research and interventions aimed at improving these critical scenarios, especially in the presence of the twin specters of war and social inequalities, as is happening in other parts of the world such as Afghanistan, Iraq, Congo, Palestine, Ukraine, Sudan and others.

Thus, the present work, which consists of four papers (one already published, three others in the peer-review process), embarks on a rigorous quest to provide compelling evidence to the scientific community and beyond to elucidate the complex effects of violence associated with armed conflict, war and violence on the nascent well-being of newborns. To do this, however, we must first understand the wave of violence associated with armed conflict.

1.2.2 The uprising of violence (1998 - 2002)

Between 1998 and 2002, the ELN' (Ejercito de Liberación Nacional) northwestern war front was the most active guerrilla organization within Antioquia. Its most important source of financing derived from gold exploitation in Bajo Cauca (Lower Cauca), where it had Compañero Tomás (Comrade Tomás) and José Antonio Galán fronts (Echandía, 2006; Echandía 2019; Echandía & Cabrera, 2022). It also had a presence in Magdalena Medio (Middle Magdalena), through Carlos Alirio Buitrago, María Cano and Bernardo López Arroyabe fronts. In mountainous area were located Héroes y Mártires de Anorí, Capitán Mauricio and Ernesto "Che" Guevara fronts (Echandía, 2006; Echandía 2019; Echandía & Cabrera, 2022). The regional Luis Fernando Giraldo front was located in Medellín city (Echandía, 2019). Between 2000 and 2001, the ELN carried out highest number of armed actions recorded throughout its history, mainly represented by sabotages that sought to pressure demilitarization of an area to start a peace process with Pastrana Government (Echandía & Cabrea, 2017). Additionally, from 1997 onwards, with the creation of the United Self-Defense Forces of

Colombia (AUC), various regional groups including the Peasant Self-Defense Forces of Córdoba and Urabá, the Magdalena Medio, and the Eastern Plains joined forces to form the AUC (Echandía, 2019; Echandía & Cabrera 2017). In practice, it was a federation of regional groups that presented themselves under the banner of the AUC, creating the appearance of a unified organization with a national plan, regional coordination of military operations, and a programmatic agenda (Cubides, 2005). Antioquia, was a microcosm of this national chaos, became a crucible for the confluence of paramilitary groups, guerrillas, drug cartels, criminal factions, and military forces (Echandía, 2019). During this period, the AUC experienced an unprecedented territorial expansion, seeking to control the population by assassinating alleged sympathizers of the insurgency and systematically resorting to terror tactics (Echandía & Cabrera, 2017). This rapid territorial expansion was mainly driven by the pursuit of greater profits from drug trafficking, coinciding with the strengthening of the guerrilla groups and the increase in violence in the country starting for Antioquia (Echandía, 2019). Among the leaders of these structures were "Don Berna," "Doble Cero," "Cuco Vanoy," "Ramón Isaza," and others. The Central Bolívar Block (BCB) emerged later, and its acronym was officially recognized only in the year 2000 (Arias & Prieto, 2011). The BCB, which brought together a set of structures that did not align with the AUC, was divided into zones and blocs (Echandía, 2019; Cubides, 2005). Although the paramilitary groups primarily operated in strategic areas related to drug trafficking, such as cultivation zones, processing centers, corridors, and shipping areas,

they also had an impact on other scenarios. In the case of Medellín and the Aburrá Valley, while it is true that they acted to limit the capacity of the guerrillas, the so-called Cacique Nutibara and Metro blocks ended up in conflict over control of different sectors of the city (Echandía & Cabrera, 2017). The AUC also made incursions into flat areas or areas with dynamic economies, which were besieged by the guerrillas, such as the Magdalena Medio and the Eastern region of Antioquia. Additionally, they exerted pressure in the mountainous region and the western part of Antioquia (Escobedo, 2011; Cubides, 2005).

The strategic value of the Eastern region of Antioquia is the backdrop of the confrontation between guerrillas and self-defense groups and the high intensity of the conflict between 1998 and 2002 (Echandía, 2019). Undoubtedly, the armed dispute is related to expectations regarding the appropriation and utilization of the enormous potential offered by the regional scenario (Echandía, 2019; Echandía & Cabrera, 2017). The strategic importance of this region stems from the road infrastructure that connects Bogotá with the Atlantic and Pacific coasts, as well as the eastern and western parts of the country (Echandía, 2019). Since the 1970s, the regional scenario has gained economic significance with the construction of the Medellín-Bogotá highway, the San Carlos 1 and 2, Jaguas and Calderas dams, and the extension of power transmission lines (Echandía, 2006). The actions of the competing actors for territorial control were directed against unarmed civilians, generating a critical situation reflected, among other indicators, in the high

homicide rate (Echandía, 2019). Furthermore, the high intensity of the armed conflict is a result of the FARC's goal to prevent the paramilitary groups from gaining control over the Medellín-Bogotá route, for which they carried out dozens of assaults and mass kidnappings at illegal checkpoints. (Presidential Program on Human Rights and International Humanitarian Law, 2004).

On the other hand, between 1998 and 2002, the guerrilla in Colombia had a dizzying territorial expansion, which allowed it to have a device through which it surrounded the main political-administrative centers of the country, without reducing its presence in oil, mining, illicit crop and agricultural areas (Echandía, 2006). For their part, the paramilitary groups sought their recognition as protagonists of the conflict and recorded the strongest territorial expansion amid a sharp escalation of violence (Echandía, 2019). At that time in Colombia, the Pastrana Government was advancing peace negotiations with the FARC (Fuerzas Armadas Revolucionarias de Colombia), the public force began to regain the initiative thanks to the increase in mobility and the greater capacity for air reaction (Echandía & Cabrera, 2017). During the Pastrana Government (1998-2002), the military forces underwent a process of profound change, in the institutional, doctrinal and technological fields, which resulted in the professionalization of the Army, the adaptation of military doctrine to the realities of confrontation, greater effectiveness in planning and conducting operations, adopting a proactive, offensive and mobile operational concept, and improving intelligence, technology and command, control and

communications structures (Echandía & Cabrera, 2017). Between 1998 and 2002, the changes in the military capacities of the State were expressed in the sustained increase of combats with irregular groups (Echandía, 2006; Cubides, 2005; Escobedo, 2011).

1.2.3 The most violent year, 2002

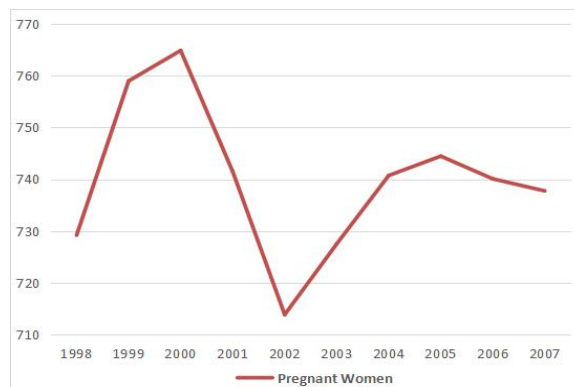
The breakdown of the peace process between the Pastrana government and the FARC in February 2002 led to the greatest escalation of armed conflict in the country (Echandía, 2006). In the areas the guerrillas invaded, the armed structures did not match the development or firepower of those created in the 1960s and 1970s (Echandía, 2006). Although the armed activity of the new structures was limited, the expansion of the guerrillas towards urban centres and their interest in municipalities with a higher level of development reveals a strategic purpose (Echandía, 2019). In the case of Valle de Aburrá, and Medellín in particular, the guerrillas managed to establish themselves in most of the entrances, and although they failed in their objective to control Comuna Trece (Thirteenth Municipality) in 2002, the militias managed to have influence in peripheral neighborhoods (Echandía & Cabrera, 2017).

In the struggle for territorial control, the FARC structures have resorted to terrorist practices similar to those of paramilitary groups and are therefore also responsible for the significant deterioration in the conflict (Echandía & Cabrera, 2022). It should be noted that, although the perpetrators of most of the murders committed by organised actors are unknown, the correspondence between the

intensity of the killings and the moments when paramilitary groups become more prominent demonstrates the predominant role of this actor. In fact, the guerrillas contribute to the increase in massacres after the paramilitaries, who are the main culprits in the escalation of violence between 1999 and 2001 (Echandía, 2006; Escobedo 2011).

As a result of this escalation in violence, the most violent year in Colombia's nearly six decades of armed conflict represent a reduction in registered and/or informed births, as shown in Figure 4. Across the 33 regions, including Bogotá, there was a significant drop in the number of births in 2002, with some 30,000 fewer births than in 2001. And on average there were 15,000 fewer births than in other years, as Figure 4 shows. Therefore, 2002 represented the nadir for newborn registrations in Colombia, according to data reported and recorded by health system institutions. It's important to note that this analysis does not account for international migration rates or changes in individual perceptions regarding childbearing.

Figure 4.
Pregnant women in hundred of thousands between 1998 and 2007



Source: Own elaboration from NHSS 1998 - 2007

1.2.4 The Uribe's first government (2002 - 2006)

The downward trend in massacres since 2003 is related to the behavior of paramilitary groups who, after achieving consolidation in vast territories as part of the demobilizations carried out during the first Uribe Vélez administration (2002 - 2006), cease to resort to this practice (Echandía, 2019). In these scenarios, the absence or decline in the recording of massacres does not indicate an improvement or positive evolution of the situation; on the contrary, it may indicate the de facto hegemony of an armed actor (Echandía & Cabrera, 2017). This was evident in the urbanization of armed conflict dynamics between 2002 and 2007, which significantly affected pregnant women, particularly those residing in Antioquia and across Colombia (Echandía, 2019). Consequently, it had a detrimental impact on the well-being of newborns.

This volatile amalgamation triggered an expansive tapestry of violence that traversed the nation, leaving an indelible imprint in Colombian people starting right from the womb (Duque, 2017). The ramifications of these illicit actors, wielding multifaceted control strategies, resonated deeply within national and subnational institutions, households, families, and individuals, permeating across diverse strata. In some cases modding the shield protector factors of maternal university education or social protection system (Mera, 2023).

Against this backdrop, a chorus of scholars and international development bodies echoes a unanimous sentiment – armed conflict

contexts exert a pernicious impact on the evolution of social and human capital (Squibb, 2020; Akhtar et al., 2019; Braveman & Gottlieb, 2014; Duque, 2017; Penn & Lloyd, 2011; Arias et al., 2009; Mendez & Huaynoca, 2005; Pómez et al., 2011). The inherent disruptive dynamics of such environments, enfolding both geographic territories and interpersonal dyads, beget catastrophic consequences for early-life conditions, most notably the health of newborns (Mera, 2023). In settings where violence and social disparities intersect, such as Colombia in 2002, the vulnerability of dyads to multifaceted deprivation becomes acutely magnified. The imprint of these adverse early-life contexts ripples beyond individual lives, leaving an enduring mark on the very fabric of societies moreover when violent contexts last for various years, such as the period between 1998 to 2007 (Duque, 2017).

1.3 Newborns well-being

As an approximation of neonatal well-being we integrate three key health dimensions measured at birth: weight, gestational age and the vital outcome of being born alive. These neonatal health dimensions will be our dependent variables, and in each paper we will assess the impact of regional violence on each of these critical health dimensions for neonatal and early childhood well-being. We have chosen these dimensions based on available data and recommendations from world health organisations, as well as previous health research studies on neonatal health.

Figure 5.
Neonatal health dimensions

Health Dimension	Definition (WHO)
Low Birth Weight (LBW)	A condition in health science, defined by the World Health Organization, where birth weight is under 2500 grams.
Preterm Births (PTB)	Identified in health science, according to the World Health Organization, as births occurring before 37 completed weeks of gestational time.
Stillbirths, miscarriages and early losses (SB - MC)	In the realm of health science, stillbirths are defined as the loss of a fetus after 28 weeks of gestational time. Miscarriages encompass losses under 28 weeks and above 20 weeks, while early losses specifically refer to those occurring before 20 weeks of gestation

Source: Own elaboration WTO information 2023

1.4 Maternal education and stress management

Maternal university education have been linked to early childhood well-being considering different factor such as women empowerment, antenatal medical control attendances, antenatal nutrition, purchase power, general knowledge and stress management. As the scientific literature suggests, higher educational levels indirectly increase birth weight means (Ruiz et al., 2015). However, more complex interactions in terms of violence and demographics features also likely affect birth outcomes (Mocan, Raschke, & Unel, 2015). Aside from that, researchers (Gage, Fang, O'Neill, & DiRienzo, 2013) have presented scientific evidence regarding the positive but indirect association between maternal

educational profile and birth weight. Qualitative difference in dietary requirements during early and late pregnancy are likely related to parents' knowledge of proper nurturing habits (Muthayya, 2009). Parents need to be aware that the micro-nutrients, calories and proteins required in the initial period of formation are different to those during the final stage; this fact focuses attention on a healthier in-utero life that guarantees newborns a healthy start. This level of awareness is likely correlated to a higher parental educational profile.

The implications of being pregnant involve responsible care habits that might not be important for pregnant women attempting to avoid violence and adversity while simultaneously experiencing stress due to educational and health deprivation. In addition, unobserved variables such as individual capacities, cultural backgrounds, occupation, and life stories, reinforce the roles within the household and determine outcomes in terms of deprivation. Other demographics scholars (McLanahan & Percheski, 2008) have stated that families are the basic institution for raising children and play an essential role in shaping children's life options. Several investigations state that family structure (size and composition) is an important mechanism in the reproduction of poverty and inequality (Biblarz, Raftery, & Bucur, 1997; McLanahan & Percheski, 2008; Waldfogel, Craigie, & Brooks-Gunn, 2010). Hence, exploring familial demographic features such as family composition and parental education, I expect to ascertain to what

extent this statement applies in terms of offspring outcomes, paying particular attention to mothers' educational levels.

1.5 Research Aims

The whole thesis was inspired by Urie Bronfenbrenner's ecological theory of human development and the need to explore potentially paradoxical relationships between maternal educational attainment and neonatal well-being in war contexts. Therefore, each paper within this thesis contributes a unique quantitative perspective, using one of the key dimensions of neonatal health as the dependent variable, and weaving a tapestry of evidence that reveals the intricate interplay between maternal university education, armed conflict dynamics and newborn well-being. Taken together, the four papers aim to shed light on this multifaceted relationship, while also illuminating the elusive shield that maternal education can provide amidst the tumultuous landscapes of conflict.

The first paper aims to examine the relationship between newborn well-being and regional violence, as well as the interaction effect between maternal education level and regional violence for 24 regions. The aim was to analyse the potential protective effect of maternal education across the dyad. This paper uses a triad of ordinary least squares (OLS) models, with newborn weight in grams as the dependent variable, and meticulously uses the 2002 National Health Statistics Survey (NHSS) datasets to disentangle the proximate processes at play.

The second paper aims to disentangle the relationship between regional violence and maternal university education in affecting the odds of being born preterm. Therefore we computed the likelihood of preterm birth considering regional levels of violence for 33 regions, including the capital city of Bogotá. This investigation includes a detailed examination of the interaction effect between maternal university education and regional violence, with the aim of identifying the moderating effect of education on the adverse outcomes associated with violence. Using logistic regression with preterm birth (defined as less than 37 completed weeks' gestation) as the dependent variable, this paper empirically uses data from the 2002 National Health Statistics Surveys (NHSS) and the National Centre of Historical Memory (NCHM) on acts of violence. The main focus is to examine how maternal university education acts as a moderating factor, mitigating the adverse effects of violence on the likelihood of preterm birth.

The third paper aims to explore the effect of violence on the losses during pregnancy. It continues to focus on the key year 2002, nevertheless uses a different database in the NHSS, the one for babies lost in 2002. We use a multilevel logistic model to estimate the odds of experiencing a stillbirth, miscarriage or abortion, controlling for the interaction between regional violence and maternal tertiary education, for 33 regions. This paper also calculates the odds of experiencing a violent or unexplained loss as a function of regional violence and maternal tertiary education. It examines the nuanced interaction between regional violence and the

protective effect of maternal tertiary education on stillbirths and miscarriages and violent or unexplained losses at the regional level (33 regions). Our detailed examination of events in 2002 is justified by the pronounced peak in violence in that year and the notable decline in births compared to other years in the period 1998-2007. For this paper, we improve our regional indicator of violence by calculating the number of victims of each of the 11 categories of violence, taking into account the regional population.

Finally, the fourth paper aims to assess the impact of violence on neonatal survival using a difference-in-differences methodology. This involves a comprehensive analysis of the NHSS data on live births and deaths from 1998 to 2007. In this final paper, we focus on analyzing the impact of regional violence on the probability of being born alive. Consistent with previous papers, we examine in detail the interaction between this regional violence and maternal university education for the 33 regions.

1.6 Main Contributions

The four papers significantly contribute to existing literature by unraveling the hidden dimensions of armed conflict's impact on maternal and newborn health. Over all in the case of Colombia the detrimental effect of the Policy of Democratic Security deployed by the Uribe's government between 2002 and 2008 and the peak of violence experienced in 2002.

In addition, the synthesis of findings advances our understanding of the multifaceted relationships between violence, maternal university education, and health neonatal outcomes, providing a foundation for future research in terms of demographic and policy factors involved in war contexts. To my knowledge this has not been made, not in Colombia nor in other contexts.

Furthermore, the implementation of different regression models, the use and merging different data bases, as well as the construction of a regional violent index is other leverage the methodological approach to assess the regional impact of violence over newborn's well-being.

Similarly, it makes an important contribution to understanding the protective effect of maternal tertiary education on neonatal outcomes (low birth weight, preterm births and stillbirths, miscarriages and early losses, and violent or unknown losses during pregnancy), particularly in turbulent contexts. To my knowledge, this has never been assessed and, more importantly, some previous health research (Ramos Jaraba et al., 2020) has found a paradoxical association between maternal university education and newborn weight and the likelihood of preterm birth. According to our results, this is due to different regional factors that are likely to influence antenatal well-being, higher levels of stress that specifically affect the odds of preterm birth, regardless of education level.

Nevertheless, we have demonstrated the existence of a protective effect, showing that mothers with a university education have a protective effect on live births and the prevention of violent or unexplained losses, highlighting the importance of education in mitigating the impact of conflict on maternal and newborn well-being and be considered as proxy of social class. In addition, the second, third and fourth papers further explore the complex dynamics by examining the moderating effect of violence on the protective role of maternal higher education, particularly in its paradoxical relationship with preterm birth. This study uncovers a complex interaction that illustrates how regional violence modifies the protective effect of maternal university education on the dyad, providing nuanced insights into the contextual challenges faced by pregnant women in conflict-prone regions.

Finally and despite the recent surge in interest and growing scientific inquiries in this field, the research strategically hones in on a singular factor that persists as an enigma in its protective capacity within the dyad – the educational level of mothers, placing particular emphasis on university education. The primary goal was accomplish, which was to enhance our comprehension of the regional and maternal demographic factors influencing early-life well-being, examining them through sociological, socioeconomic, and health dimensions, all while maintaining a keen awareness of the crucible of war.

CHAPTER 2

Exploring Maternal Education Effect on Birth Weight during the peak of violence

2.1 Abstract

Objective: This translational scientific paper enhances the sociological understanding of the regional mechanisms influencing newborn weight. We applied Bronfenbrenner's ecological theory and an empirical approach to elucidate the diminishing effect of violence and the protective role of mothers' university education.

Background: The year 2002 marked the peak of violence in the last 60 years of the Colombian Armed Conflict (CAC), with a surge in violent acts and victims. Building on empirical sociological research highlighting the detrimental effects of armed conflict on newborn weight, we delve deeper into exploring the protective effect of maternal education during pregnancy.

Method: We categorized regions based on violence levels and integrated regional macroeconomic data with maternal demographic features. Employing linear regression modeling, we framed observable interactions and moderation effects to predict the impact on newborn weight, thereby assessing the protective effect of maternal university education.

Results: This transversal study reveal that mothers with university education were more likely to shield the dyad and increase newborn weight by approximately 53 grams. Moreover, mothers with higher education levels demonstrated a greater ability to moderate the impact of regional violence, potentially enhancing the likelihood of achieving a healthy weight.

Conclusion: We identified a shielding/moderation effect of maternal education on newborn weight during the in-utero period, particularly in toxic contexts.

Implications: By leveraging Ulrich Bronfenbrenner's "ecological approach theory," we underscore the significance of proximate processes and contribute evidence to the existing literature on demographic factors influencing newborn weight. This study addresses a well-defined research gap concerning the protective effect of maternal education in highly violent contexts

Keywords: Violence, low birth weight and maternal education.

2.2 Introduction

Scholars and policymakers agree that armed conflict and social inequality are major threats to the well-being of children, the lives of individuals and the overall development of societies. While maternal education is widely recognized as a driver of early childhood well-being, the impact of concurrent factors such as inequalities, regional disparities, regional violence and forced displacement remains unclear. Consistent with these findings, in Colombia the databases of the National Centre for Historical Memory showed a peak in violence in 2002 within the 60-year armed conflict. In particular, Antioquia, the most affected region of Colombia at the time, had the second highest percentage of newborns under 2,500 grams (14.84%) in the country, after Bogotá (a less affected region and the country's capital) with 24.53%. Conversely, regions not affected by armed conflict, such as the San Andrés Islands and Amazonas, had the lowest rates, 0.15% and 0.13% respectively. However, taking into account the sample size, Bogotá and Antioquia represented 16.45% and 13.37% respectively. Focusing on the rate of underweight newborns in each region, Bogotá continued to lead with 11.43%, followed by Chocó (one of the regions most affected by poverty [54.2%] and indigence [23.18%]) with 9.15%, and Antioquia with 8.65%. Similarly, Antioquia had the highest percentage of uneducated mothers giving birth to underweight children (21.86%), followed by Valle del Cauca (7.54%) and Bogotá (7.20%).

This study examines the role of maternal education in preventing

children from reaching the recommended birth weight in fragile, violent contexts. It examines the regional structure of the 2002 National Health Survey theoretically and empirically, using three ordinary least squares (OLS) models for four system variables rooted in Bronfenbrenner's ecological theory. The study focuses on the proximate processes highlighted by Bronfenbrenner and examines the potential moderating effect of maternal university education in violent regional environments characterized by violence and social inequality. In line with Bronfenbrenner's findings, the study highlights the importance of proximate processes within a dyad, such as the mother's level of education or marital status. The results suggest that regional low birth weight rates were influenced by the combination of high unemployment in refugee cities (such as Bogotá), which reduced the shielding effect of more educated mothers in less affected regions. However, when the interaction effect between macro and micro system variables (regional violence and maternal tertiary education) is taken into account, the protection/shielding effect becomes clear.

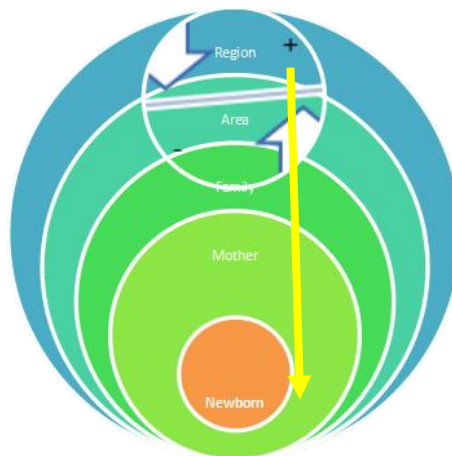
Despite utilizing data from 2002, this study retains its relevance due to the limited scientific evidence concerning the protective impact of maternal education in fragile and conflict-affected environments like Colombia in that year. Moreover, despite the prevailing violence during the period, Colombia has demonstrated ongoing advancements in infant mortality rates, life expectancy, and other health metrics. Additionally, violence levels have shown a decline compared to those recorded in 2002.

2.3 Theoretical framework

2.3.1 Bronfenbrenner's ecological theory

Existing scientific literature on maternal social psychology in armed conflict contexts often emphasizes the impact of proximate processes on newborn outcomes. Given the complex and interconnected nature of phenomena such as violence and inequality, our research, guided by Bronfenbrenner's ecological theory, explores the relationships between variables situated within systems such as education and violence. The theoretical framework we adopt is consistent with Bronfenbrenner's conception of multi-system environments in which dyadic experiences influence dyadic experiences. Figure 1 provides a visual representation of the concentric relationship between the sites in our theoretical approach.

Figure 1.
Theoretical Framework



Source: Own elaboration based on Bronfenbrenner's Ecological Framework

Bronfenbrenner's theory of the ecology of human development (Bronfenbrenner, 1979) provides a conceptual framework that allows researchers to break down a multifaceted problem into four distinct systems of analysis: i) the microsystem, ii) the mesosystem, iii) the exosystem, and iv) the macrosystem. At the heart of ecological systems theory is the microsystem. This level encapsulates the intricate interactions within the immediate environment and defines the proximate processes that shape the dynamics of a dyad. Moving outwards, the mesosystem encompasses other complex settings in which one or both parents are involved, such as the workplace or a social circle, and extends beyond a single location. The exosystem extends the scope across settings to include events that parents may not be directly involved in but are affected by, such as a sibling's school class. Finally, the macrosystem encompasses overarching social institutions that manifest themselves in a complex, nested system and embody widespread patterns of social behaviour, such as violence or stress.

2.3.1.1 Interaction between settlements

In Bronfenbrenner's (1979) conceptualisation, the environment that shapes children's experiences includes both the physical space or place and the complex interactions between families and individuals that coexist within that space, as well as the interplay between these different settings (Bronfenbrenner, 1979). The interrelationship between these levels and the behaviors associated with them is crucial in delineating specific maternal roles that are capable of initiating changes in a child's human development. These influential

events unfold within a particular context and setting (Bronfenbrenner, 1979). For example, as Bronfenbrenner (1979; p. 24) notes, 'changes in maternity ward practices that affect the relationship between mother and newborn may have effects that are still detectable five years later'. At the macro level, the impact of economic or armed conflict crises on children's human development in terms of deprivation is another example, with the literature suggesting that these effects may vary depending on the gestational age of the mother's exposure to the challenging event (Duque, 2017; Ramos Jaraba et al., 2019).

2.3.1.2 The dyad and the N+2 systems

Bronfenbrenner (1979) posited that each parent interacts in multiple settings, but the 'dyad' is a two-person system of analysis. This concept can be applied to a pregnant woman, considering that during pregnancy other lives develop in a multi-dimensional way, entirely dependent on the mother's will and interactions. In the context of pregnancy, the dyad may include an additional participant. The dyad therefore refers to the pregnant mother and the developing human being in utero. However, what matters in terms of behaviour and development is the environment as perceived, rather than its existence in 'objective reality' (Bronfenbrenner, 1979). As one member of the dyad develops, so do the others - in the context of pregnancy. This principle applies to all caregivers, leading Bronfenbrenner to call it the N + 2 system. For the pregnancy period, we operationalised the N + 2 system as pregnant women interacting in two different systems or with two

caregivers. This implies that the dyad is constituted by a pregnant woman with the existence of triads, treads and larger interpersonal structures (Bronfenbrenner, 1979). Similarly, the triadic principle applies to the relationship between settings, where other individuals are not yet considered to be caregivers unless they are designated as such by a doctor or other health or nutrition professional.

2.3.2 Proximate processes

Scientists have found a strong association between birth weight and neonatal mortality (Denham, Schell, Gallo, & Stark, 2001; Kallan, 1993; SM, 1997; Mosley and Chen, 1984). Sociological research further highlights the consistent correlation between socioeconomic level and neonatal mortality, suggesting a mediating factor of in utero deprivation (Gage et al., 2013). These findings are consistent with Mosely and Chen's 'proximate determinants' model of infant and child mortality (Mosley & Chen, 2003), which posits that maternal socioeconomic conditions affect maternal nutrition during pregnancy, which subsequently affects birth weight and neonatal mortality. The proximate determinants of maternal socioeconomic context are likely to influence neonatal health, taking into account factors such as gestational age or maternal in-utero interactions.

The study also highlights the role of maternal education, showing that the average level of maternal education affects the birth weight distribution by influencing both the mean newborn weight and the standard deviation of the birth weight distribution (Gage et al.,

2013). Categorising US mothers by ethnicity and stratifying them based on the binary classification of maternal education level as a proxy for socioeconomic status, the study shows that overall birth outcomes improve significantly with higher maternal education across all populations. Their logistic regression model shows a general decline in mortality with increasing education. However, it's worth noting that, according to Gage et al. (2013), some ethnic populations show an insignificant relationship between maternal education level and birth weight distribution. The reasons for this lack of effect on birth weight in certain populations despite increasing maternal education remain unclear.

2.3.2.1 Maternal Education and antenatal well-being

As suggested by the scientific literature, higher levels of education are indirectly associated with higher birth weight (Ruiz et al., 2015). However, more complex interactions involving violence and demographic factors are likely to influence birth outcomes (Agustine et al., 2014; Mocan et al., 2015) and reduce the protective effect of education (Ramos Jaraba et al., 2020). In addition, researchers (Gang et al., 2013) have provided scientific evidence of a positive but indirect association between maternal educational profile and birth weight. Researchers have also highlighted qualitative differences in stress levels and dietary habits during early and late pregnancy, which are associated with parents' knowledge of good feeding practices (Muthayya, 2009) and participation in antenatal education programmes (Hong et al., 2021).

For example, the literature suggests that mothers should be aware that the micronutrients, calories and proteins needed in the early stages of development are different from those needed in later stages. This focus on a healthier in utero life may contribute to a healthier start for newborns (Hong et al., 2021). This increased awareness may be correlated with a higher parental education profile or level.

On the other hand, the implications of pregnancy involve responsible care habits, which may be of secondary importance for pregnant women attempting to avoid violence and adversity while simultaneously experiencing stress due to educational and health deprivation because of their ethnic background (Gonzalez, 2002).

2.3.2.2 Family structure

Other demographers (McLanahan et al., 2008) argue that the family is the primary institution for child rearing and plays a crucial role in shaping children's life options. In addition, much research highlights the importance of family structure, including its size and composition, in combating poverty and inequality (Biblarz et al., 2010). Moreover, the sociological literature identifies marital status as a key factor influencing human development within families. It suggests that children raised in single-mother and cohabiting families may have poorer social and cognitive skills than those raised in married-couple families (Entringer et al., 2010; Waldfogel et al., 2010).

2.3.3 War and early well-being

Scholars and researchers have extensively documented the detrimental effects of adversity on reproductive outcomes (Akhtar, 2019; Mc Elroy et al., 2014; McEniry et al., 2018; Penn et al., 2010; Shonkoff et al., 2012; Van den Bergh et al., 2017). The prevalence of violent dynamics that shape human geography and territories (Castro Torres et al., 2019; Duque, 2017; Echandía Castilla, 2006, 2019) results in thousands of children being born in disadvantaged circumstances. However, the specific stressors or factors driving these inequalities in different regions, their interplay and their impact on human development during pregnancy remain unclear.

2.3.3.1 Armed conflict and early well-being

Families and entire communities have become targets of violence, victims of fear and stress in fragile contexts (Arias Nieto et al., 2009). In particular, the positive correlation between fertility and armed conflict (Castro Torres et al., 2019) suggests a growing deprivation that begins in the womb of women living in the most conflict-affected regions due to potential incidents of rape and violence (Castro Torres et al., 2019). However, it is crucial to recognise that rape is a heinous tragedy that is never the victim's fault. If a woman chooses to continue with a pregnancy resulting from rape, the policy network should provide supportive services to help her cope with this trauma and minimise its impact on the child. Therefore, in the context of violence manifested in rape,

pregnancies require a different approach and treatment beyond the conventional developmental process.

Despite this, compelling evidence strongly suggests that during the prenatal period, mothers living in municipalities and towns exposed to prolonged violent dynamics are likely to transmit trauma and deprivation to their newborns and children, potentially causing neurological and anthropomorphic delays (Ramos et al., 2019; Duque, 2017). However, this transmission could be addressed if pregnant women are educated on how to cope with stressful situations and have access to antenatal care. A study (Urizar et al., 2019) has shown that antenatal cognitive-behavioural stress management (CBSM) interventions are likely to improve stress outcomes in low-income pregnant women and potentially improve infant health outcomes in the short and long term.

2.4 Hypotheses

1. Environmental factors at the macrosystem/regional level, which include regional violence, regional poverty rate and regional unemployment rate, are expected to have a negative association with the regional rate of newborn weight.
2. Proximate characteristics within the mesosystem/family, such as having both parents, are expected to have a positive and significant association with newborn weight.

3. Maternal education is expected to act as a moderating shield, attenuating the effect of regional violence on newborn weight.

2.5 Data

This study is based on secondary data from the 2002 National Health Statistics Survey of Colombia (NHSS), a cross-sectional survey conducted annually since 1998 by the country's National Statistics Department (DANE). The NHSS, which covers a sample of 33 regions including Bogotá, aims to collect information on specific events in people's lives, with a particular focus on newborns and their mothers. In addition, the survey provides insights into the family characteristics of newborns based on geographic location. The data collection process follows formats designed according to international standards and the demographic characteristics of the country, involving sub-national entities and health dependencies. The survey is randomized according to international standards and rigorous statistical quality control.

The 2002 NHSS collected data from 33 regions, including Bogotá, representing 700,455 families and newborn/mother/father characteristics. For this study, however, we focused on data from only 24 regions, resulting in a sample size of 678,479. In addition, we used databases from the National Centre of Historical Memory (NCHM), a government body responsible for collecting, recording and researching all matters related to the Colombian armed conflict, including information on acts of violence in 2002. We also included data from the 2012 Poverty Mission, a government strategy to

combat poverty, which tracks regional poverty and unemployment rates. In addition, data on forced displacement for 2002 were obtained from the National Information System of the National Victims Unit, a government body that supports the victim population and collects data on victimisation events such as forced displacement rates. The use of multiple datasets allowed us to control for different system variables and proximate processes related to newborn weight.

2.6 Methods

First, using the databases of the National Centre of Historical Memory (NCHM), we measured the regional level of violence by assessing the frequency of violent acts related to the Colombian armed conflict between 2001 and 2002. These acts included various events such as kidnappings, the use of explosive landmines, selective assassinations, massacres, damage to public property, attacks on the population, civilian deaths due to armed actions and terrorist attacks (see Tables 2, 3 and 4). In particular, we gave more weight to massacres, attacks on the population and civilian deaths due to armed actions, in line with previous research highlighting the importance of studying such acts (Aarssen L. et al., 2016).

We then obtained control macro/regional variables such as regional poverty, unemployment and displacement. Data on these variables were obtained from the Poverty Mission's databases and the National Victims Unit's information system. Once all the macroeconomic variables were obtained, they were integrated with

the data obtained from the NHSS 2002 to form a new regional cluster of variables (violence, poverty, unemployment and displacement). Three ordinary least squares (OLS) models were then run. The dependent variable was operationalised as an approximation of the well-being of newborns in terms of health (Krywko et al., 1971), with the response variable Y being a continuous variable measured in grams reflecting the weight of newborns.

In parallel, the central independent and explanatory variables in our research were the regional level of violence and the mother's level of education. To fully capture the potential impact of macrosystem/regional variables, we controlled for other regional socioeconomic factors such as unemployment, poverty and displacement. We also included medical variables such as gestational age, sex and antenatal care received, and demographic control variables such as maternal age, marital status, number of siblings, number of deceased siblings and healthcare insurance regimes or healthcare schemes.

General Model.

$$Y_{ij} = \beta_0 + \beta_1(RV_j) + \beta_2(MEL_{ij}) + \beta_3(RV_j \times MEL_{ij}) + \beta_4(RU_j) + \beta_5(RP_j) + \beta_6(RD_j) + \beta_7(\text{area of housing } ij) + \beta_8 \dots \mathbf{n}(\text{medical and demographic controls}) + \varepsilon$$

The previous equation frames the environmental systems of Bronfenbrenner's theory. We have included macrosystem,

exosystem, mesosystem and microsystem variables. In this general OLS model, Y is the weight of newborn i living in region j at birth. The first component of the model, β_0 , is the intercept. β_1 is the correlation coefficient of the regional violence variable. β_2 is the coefficient on the maternal education variable. β_3 is the coefficient of the interaction between regional violence and maternal education. β_4 to β_6 are the coefficients of macro/regional control variables such as unemployment, poverty and displacement. β_7 is the coefficient of the exosystem control variable housing area (urban, rural and rural dispersed). In order to better assess the shielding effect of the mother's educational level, we consider the β_8 to β_n coefficients for all the mother's demographic and medical control variables. Finally, ε is the random error at the regional level, which includes the unobservable effects associated with the current observation of the data. We estimated some variances within the model using the robust technique of Hubber and White. This will be explained in more detail later. Below is the order of the models considered in the analysis:

1. **OLS 1** Macrosystem / regional variables
2. **OLS 2** Macrosystem, meso, and microsystem sociodemographic mother's and family variables
3. **General** (OLS 2 + macro and microsystem variables interaction +meso -and exosystem/area of housing and sociodemographic variables controls)

In our initial analysis, we categorised different regions of Colombia according to different levels of regional violence, taking into account the frequency of violent acts in each region. Two regions, Bogotá (a low-affected city and the capital) and Antioquia (the most-affected region), were treated uniquely because of their particular characteristics. Bogotá was identified as a unique urban region because of its unique urban demographic conditions and its status as a refugee city. Similarly, Antioquia was identified as a distinct region because it was the most severely affected. Together, these regions accounted for almost 30% of the sample. With the exception of Bogotá and Antioquia, the remaining regions were grouped into categories based on regional violence, with each category including more than one region.

For specific observations, we coded newborns' weight as a dichotomous variable, with (0) indicating underweight and (1) representing the minimum medically recommended weight for a newborn over eight weeks of gestation. The threshold defining a newborn as underweight was set at 2,499 grams, aligning with the standards established by the World Health Organization. Meanwhile, the threshold for the mean national weight was approximately 600 grams.

2.7 Descriptive analysis

In a broader context, a descriptive analysis reveals that Antioquia accounted for the highest proportion of the examined acts of

violence, totaling 42.74%. It was followed by Norte de Santander (14.73%), Cauca (13.75%), Caquetá (12.26%), and Bolivar (12.06%). These findings underscore the prevalence of violence in Antioquia compared to other regions in Colombia. Additionally, regions characterized by high levels of poverty, indigence, and a substantial negative displacement gap—indicating families becoming refugees—include Bogotá, Córdoba, Huila, Risaralda, Quindío, Valle del Cauca, and Atlántico. Table 1 shows the national birth frequencies for the family demographic features.

Table 1
Newborn's Weight, 2002: Descriptive Statistics (n = 700,455; 33 regions)

Demographic features	Newborn %	Mean weight grams	Standard Deviation
Marital Status			
Single mother	16.15	3117.4	1.657
Married	25.30	3212.3	1.312
Widow	0.35	3226.1	10.999
Cohabiting	57.61	3201.1	0.868
Separated/divorced	0.60	3185.5	8.546
Number of living children			
One	38.41	3134.3	1.008
Two or more	61.59	3207.2	1.206
Number of deceased children			
None	78.43	3192.2	0.716
One or more	17.40	3214.6	1.854
Healthcare regime			
Contributor	33.62	3181.9	1.111
Subsidiary	30.08	3199.5	1.182
Beneficiary	25.15	3199.3	1.271
Particular	2.13	3188.1	5.716
Other	2.72	3157	4.180
Mother's education level			
None or basic	17.97	3209.9	1.62
Primary school	15.56	3208.1	1.64
Incomplete high school	29.11	3176.2	1.21
Complete high school	24.98	3188.5	1.31

Incomplete University	4.47	3176	3.1
Complete University	6.91	3182.1	2.5

Source: Own elaboration based on the 2002 National Health Statistics Survey
*** The percentages of missing information were not taken into account.**

Table 1 illustrates that in 2002, 700,455 women gave birth across the 33 regions. Exploring the socioeconomic profile of these mothers, the average age was 25.19 years. Marital status distribution revealed that 16.15% of mothers were single, 25.3% were married, and 0.95% were either widowed or divorced. Cohabiting couples constituted the predominant family structure, representing 57.61% of the sample. Notably, single mothers had the lowest mean birth weight at 3,117.4 grams compared to other marital status categories.

Upon examining mothers with deceased sons or daughters, newborns from mothers with no deceased children exhibited a higher mean weight (3,214.6 grams) compared to those with deceased children (3,192.2 grams). Similarly, newborns with more than one sibling had a higher mean weight (3,207.2 grams) than those with only one sibling (3,134.3 grams).

With regard to the health system, employed mothers represented 33.62% in the contributory system. Those in the subsidiary system, indicating a lack of income, represented 30.08% of the sample. Regarding the educational level of the mothers, 6.91% of the women had a university education, while 17.97% had no or incomplete primary education.

Looking at the relationship between regional violence and maternal education (Table 2) among women with LBW babies (under 2500 grams), a striking pattern emerges. The most affected regions are less likely to have highly educated women with LBW babies. However, the least affected regions are also less likely to have women with LBW babies with low levels of education. Bogotá (least affected) had the highest percentage of university educated women with LBW babies (12.31%), followed by San Andres Islands and Amazonas (not affected). Antioquia (most affected) had the highest percentage of women with no or incomplete primary education giving birth to LBW babies (21.67%). It is noticeable that in the group of regions with lower levels of violence, a higher percentage of women with incomplete and complete secondary education gave birth to LBW babies. A detailed breakdown of these figures is given in Table 2.

Table 2
Newborn's Underweight Percentages by Mother's Educational Level and Regional Violence Groups: Descriptive Statistics (n = 700,455, 32 regions)

Regional Violence Group by Level	Mother's Educational Level						Total
	None or Incomplete Primary	Complete Primary School	Incomplete High School	Complete High School	Incomplete University	University	
Not affected	15.11	14.39	35.97	17.99	7.19	9.35	100
Scarcely affected	19.04	14.56	30.41	25.57	4.03	6.40	100
Low affected	6.76	11.18	32.1	30.25	7.39	12.31	100
Mid to low affected	21.45	17.24	29.55	21.78	4.64	5.35	100

Mid affected	19.37	15.98	31.23	24.18	3.77	5.47	100
Mid to high affected	19.69	20.18	28.61	22.61	4.26	4.65	100
Highly affected	21.35	18.22	28.37	21.49	4.38	6.19	100
Most affected	21.67	15.64	30.44	24.51	2.72	5.02	100

Source: Own elaboration based on the 2002 National Health Statistics Survey
*** The percentages of missing information were not taken into account.**

In our initial analysis (Table 2), we categorized different regions of Colombia based on the varying levels of regional violence. Two regions, Bogotá (a city with low-affected status and the national capital) and Antioquia (the most affected region), were treated separately due to their unique characteristics, comprising nearly 30% of the sample. All other regions, excluding Bogotá and Antioquia, were grouped into categories based on regional violence, each encompassing multiple regions. For this certain observation, we coded newborn weight as a dichotomous variable, with (1) indicating underweight and (0) denoting the minimum medically recommended weight for a newborn over 2,499 grams of weight. The threshold for defining a newborn as underweight was set at 2,499 grams, following World Health Organization standards.

In 2002, 17.13% of our sample, or 120,009 women, did not attend pre-school or complete primary school. A total of 16.56% (110,590) completed primary education. Of these, 29.11% (194,427) did not complete secondary education and 24.98% (166,807) did. Meanwhile, 6.91% (46,133) had the opportunity to complete university education, while 4.47% (29,850) did not.

Considering the 24 regions selected for our statistical analysis based on the regional economic data available we now present Table 3. It presents a broader descriptive analysis showing that 42.99% of the violence we studied occurred in Antioquia, followed by Norte de Santander (15.67%), Cauca (14.68%), Caquetá (13.18%) and Bolívar (12.85%). This highlights the results for the less affected regions of Colombia in terms of violence, with high levels of poverty, indigence and negative displacement - meaning that families have become refugees - in regions such as Bogotá, Córdoba, Huila, Risaralda, Quindío, Valle del Cauca and Atlántico.

Table 3
Regional Level of Socioeconomic and Armed Conflict Violence:
Descriptive Features (24 Regions)

Region	Violence Category	Violence %	Unemp %	Pov %	Indigence %	Regional displacement gap (families)
Antioquia	8	45.99	15.7	33.7	8.68	9,761
Norte de Santander	7	15.67	14	47.1	10.09	1,466
Cauca	7	14.68	10.5	49.3	19.66	1,634
Caquetá	7	13.18	8.1	42.7	14.63	4,408
Bolívar	7	12.85	11.1	42.3	9.1	4,578
Santander	7	11.53	16.1	29.6	6.51	-1,149
Nariño	7	8.28	15.2	40.1	10.38	-792
Cundinamarca	7	8.30	18.9	44.2	16.59	2,456
César	7	8.16	9.8	53.4	14.75	3,721
Tolima	7	7.93	17.8	35	8.43	3,155
Meta	7	7.79	11.8	30.7	7.32	960
Huila	6	6.33	21.2	64.1	31.89	-1,065
Sucre	6	5.61	8.5	58.3	20.17	-91
Valle del Cauca	6	5.03	15.3	29.9	6.03	-3,347

Caldas	6	4.34	16.4	33.4	7.38	3,098
Chocó	5	3.50	7.4	54.2	23.18	3,396
Magdalena	5	3.04	11.4	54	16.71	6,566
La Guajira	5	2.46	8.3	52.5	16.36	496
Boyacá	5	2.48	15.4	61.4	35.09	51
Quindío	4	1.66	19.7	41.9	11.94	-1,017
Córdoba	4	1.48	16.4	44.6	10.85	-106
Risaralda	4	1.49	16.5	27	3.96	-1,194
Bogotá D.C.	3	1.45	18.2	26.5	5.92	-13,109
Atlántico	2	1.21	15.1	38.8	7.62	-6,386

Source: Own elaboration based on the databases of the 2012 Poverty Mission, the National Centre of Historic Memory, and the Information System of the national Victims Unit

* Violence was estimated as a regional percentage of acts of violence occurred in 2001 and 2002, including target assassinations, explosive land mine use, kidnappings, massacres, terrorist attacks, damage of public goods, population attacks, civilian death by armed actions, and terrorist attacks. Extracted from the National Centre of Historic Memory databases.

** Unemployment refers to the regional rate of people economically active and without job in 2002. Extracted from the databases of the 2012 Poverty Mission (National Statistics Department)

*** Poverty refers to the regional rate of families who were suffering from monetary poverty in 2002. Extracted from the databases of the 2012 Poverty Mission (National Statistics Department)

**** Indigence refers to the regional rate of families suffering from a lack of income to access to the basic basket in 2002. Extracted from the databases of the 2012 Poverty Mission (National Statistics Department)

***** Regional displacement gap was estimated considering the difference between migrants and immigrants' families for each region in 2002. Extracted from the databases of the national Victims Unit.

2.8 Results

In this section, we present the outcomes derived from our primary explanatory and regional control variables within the three robust OLS models. The Ordinary Least Squares (OLS) model is a statistical method used to estimate the parameters of a linear regression model. In this model, the goal is to find the line (or hyperplane in higher dimensions) that best fits the observed data

points by minimizing the sum of the squared differences between the observed values and the values predicted by the model. Their interpretations provide insights into the relationships between the independent and newborns weight. Each coefficient represents the change in newborns weight (grams) associated with a one-unit change in the corresponding independent variable, holding all other variables constant.

Table 4
Summary of Simple Regression Analyses for Variables Predicting a Newborn's Weight, Colombia 2002. n = 489,635

Multi-system Socioeconomic, demographic, and Medical Variables	Newborn's Weight Correlation Coefficients and SD Results by Model				
	<u>Model 1</u> Macro	<u>Model 2</u> Macro and Meso	<u>Model 3</u> General Model	Variation (General-Macro)	Variation (General - Macro and Meso)
Gestational time	510.19*** (1.54)	481.81*** (1.71)	481.52*** (1.72)	-28.67 0.18	0.29 0.01
Sex (girls)	-106.46*** (1.22)	-107.14*** (1.33)	-107.23*** (1.33)	-0.23 0.10	-0.09 0
Regional Stressors					
Regional Violence	-4.42*** (0.076)	-4.39*** (0.083)	-3.88*** (0.126)	-0.54 0.05	-0.51 0.043
Regional Unemployment	-0.99*** (0.23)	-0.92*** (0.26)	-0.506** (0.269)	0.484 0.039	0.576 0.004
Regional Poverty	-0.467*** (0.077)	-0.327*** (0.083)	-0.249*** (0.083)	0.218 0.006	0.103 0
Regional Displacement	0.012*** (0.000)	0.013*** (0.000)	0.013*** (0.000)	0.001 0	0 0
Mother's Educational Level					
None or incomplete primary school (1)	Base line	Base line	Base line		
Complete primary school (2)	7.00*** (2.14)	16.79*** (2.4)	19.14*** (3.17)	12.14 1.13	2.35 0.780
Incomplete high school (3)	-7.00*** (1.89)	17.9*** (2.17)	23.05*** (2.85)	16.05 0.964	5.15 0.676
Complete high school (4)	9.18***	35.32***	42.158***	32.978	4.2999

	(1.94)	(2.37)	(3.029)	1.089	0.6459
Incomplete university (5)	16.30***	48.78***	52.93***	36.63	10,78
	(3.23)	(3.76)	(4.61)	1.382	0.857
Complete university level (6)	34.84***	47.72***	54.45***	19.61	6.73
	(2.76)	(3.46)	(4.17)	1.413	0.712
Healthcare Regime					
Contributor	Base line	Base line	Base line		
Subsidiary		-5.33***	-3.23*		2.1
		(1.85)	(1.87)		0.02
Beneficiary		6.42***	8.00***		2.42
		(1.94)	(1.95)		0.01
Particular		-9.8***	-8.27		-1.53
		(6.5)	(6.6)		0.01
Other healthcare regime		6.46	6.109		-0.351
		(4.19)	(4.21)		0.0205
Family Demographic Features					
Single	Base line	Base line	Base line		Base line
Married		38.02***	39.47***		1.45
		(2.27)	(2.28)		0.01
Widow		34.40***	32.34***		-2.06
		(11.8)	(11.83)		0.03
Cohabiting couple		29.19***	29.692***		0.5687
		(1.92)	(1.93)		0.01
Separate or divorced		12.91	10.90		-2
		(8.98)	(9.03)		1.1
Mother's age		-0.03	0.049		0.2014
		(0.13)	(0.13)		0
Number of siblings		39.45***	39.37***		0.08
		(0.68)	(0.69)		0.001
Deceased sons		-1.73	-2.10		-0.37
		(1.41)	(1.41)		0
Antenatal medical controls		8.69***	8.53***		-0.16
		(0.281)	(0.283)		0.002
Regional Violence and Mother Educational Level					
Interaction educational level (1) with regional violence	Base line	Base line	Base line		
Interaction educational level (2) with regional violence				-0.231	
				(0.161)	
Interaction educational level (3) with regional violence				-0.732***	

			(0.139)
Interaction educational level (4) with regional violence			-0.995***
			(0.143)
Interaction educational level (5) with regional violence			-0.737***
			(0.274)
Interaction educational level (6) with regional violence			-1.043***
			(0.220)
Area of housing			
Urban Area	Base line	Base line	Base line
Rural Area			-20.637***
			(2.588)
Constant	1,472.87***	1,407.1***	1,399.7***
	(8.26)	(9.70)	(9.823)
Observations	608,191	489,632	489,635

***Source: Own elaboration based on the 2002 National Health Statistics Survey, 2012 Poverty Mission, and National Centre of Historic Memory databases**

***Standard errors in parentheses**
***** $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$**

***General Model, F value = Prob > F = 0.0000**
R value = R-squared = 0.7656

***The reduction in the value of n does not represent a geographical bias, but rather to the exclusion of cases due to missing information regarding other independent variables. This exclusion is done to ensure the integrity and reliability of the model results. It's important to note that the lack of information on certain variables can distort the model results, as it affects the model's ability to adequately capture and explain variability in the data. Therefore, excluding cases with missing data is a standard procedure in statistical analysis to ensure the validity of the results.**

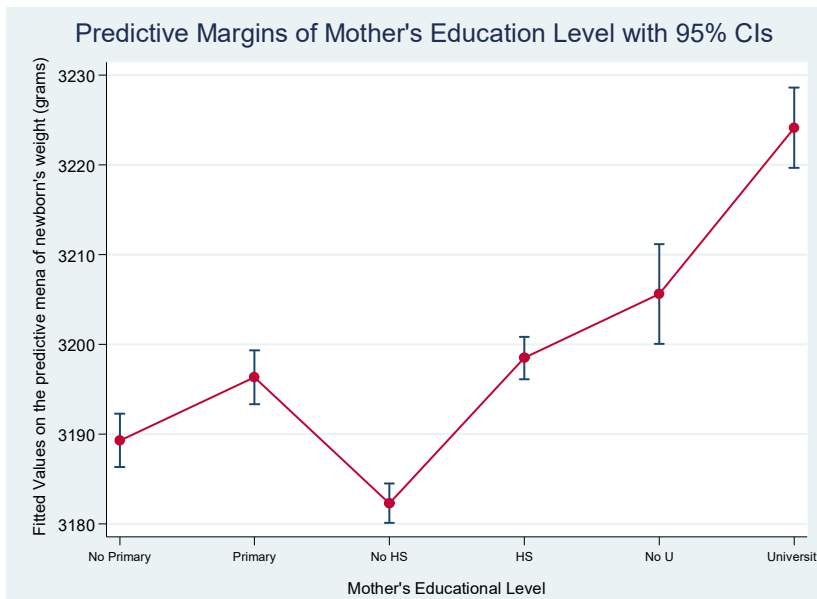
In the last two columns of Table 4 we have estimated the differences between the general model and each of the other two models. The third column of the general model gives an approximation of the variation in the model coefficients after incorporating the two-system interaction.

Hypothesis 1, concerning the impact of violence at the macro/regional level, was tested in Model 1 of Table 4. We

observed a significant negative correlation between birth weight and macro/regional environmental factors such as regional violence (-4.42 grams), regional poverty rate (-0.467 grams) and regional unemployment rate (-0.99 grams). Conversely, the number of regional displaced families showed a positive correlation with the outcome (0.012 grams). Proximate processes, such as the educational level of the mother, had a positive effect on the fitted values of the first model.

Figure 2 shows the results for the fitted values of OLS 1 taking into account the six levels of maternal education. For mothers with a university degree, the correlation coefficient was 34.84, the highest of the three levels. The figure also shows a decrease in the correlation coefficient for mothers who did not finish high school (-7).

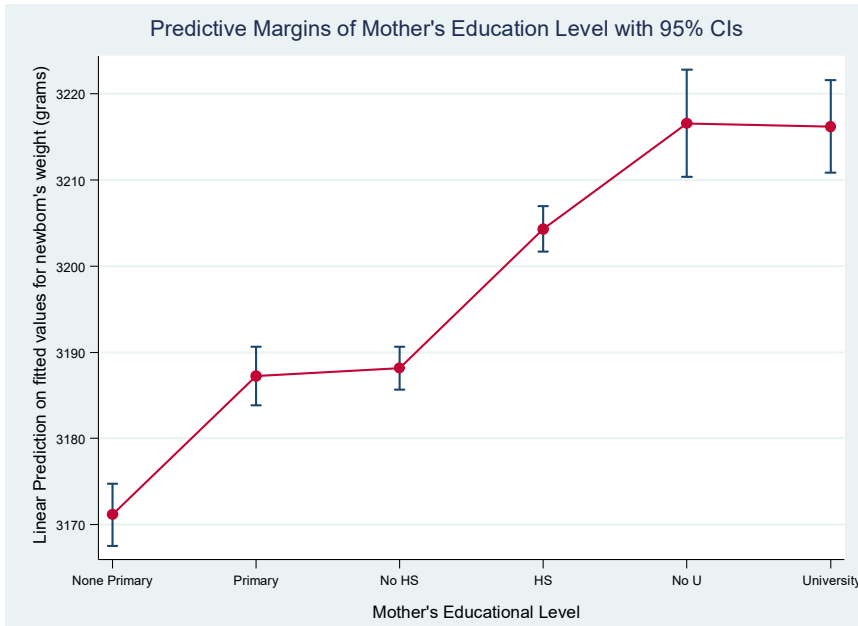
Figure 2
Newborn's weight by Mother's educational level on fitted values.
Model OLS 1 (Macrosystem variables)



Source: Own elaboration based on the 2002 National Health Statistics Survey, 2012 Poverty Mission, and National Centre of Historic Memory databases

Hypothesis 2, concerning the effect of proximate processes at the mesosystem/family level, was examined in Model 2 of Table 4. Both having siblings and having both parents were positively and significantly correlated with newborn weight. The same was true for mothers with tertiary education. This association is evident when controlling for medical variables such as gestational age, antenatal care received and sex, as well as other demographic controls such as maternal age and healthcare regimes.

Figure 3
Newborn's weight by Mothers' Education Level on fitted values.
Model OLS 2 (Mesosystem variables)



Source: Own elaboration based on the 2002 National Health Statistics Survey, 2012 Poverty Mission, and National Centre of Historic Memory databases

Figure 3 illustrates the marginal effect of maternal educational attainment, taking into account the macrosystem and mesosystem variables and controlling for medical characteristics. The figure highlights the larger effect of mothers who have not completed tertiary education (48.78 grams) compared to those who have completed tertiary education (47.72 grams).

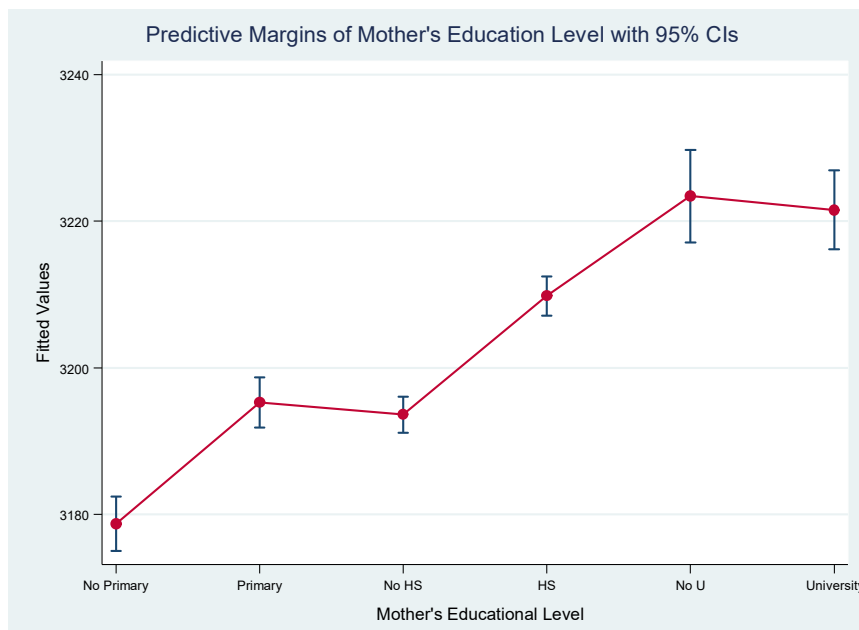
Other proximate processes at the mesosystem/family level, such as having siblings (38.45 grams), having both parents (married, 38.02 grams), and living together (29.19 grams), were also positively and

significantly correlated with newborn weight. We controlled for medical variables such as gestational age, antenatal care received, and sex, as well as other demographic controls such as maternal age and healthcare regime.

Hypothesis 3, concerning the moderating effect of maternal education on regional violence, was tested in the general model of Table 4, as well as Table 4.1. When considering the interactions between maternal education level and regional violence levels, the coefficient for maternal education level showed a stronger correlation with newborn weight than the correlation coefficients in the previous models (Models 1 and 2), which considered only two system/level variables and no interactions. These interactions between systems (macro-micro) remained when controlling for medical and demographic variables. Maternal education therefore appears to act as a moderating shield against regional violence.

Figure 4 illustrates the effect of violence on the mother's university education, which makes her less able to use her level of education and skills to protect the dyad when the level of violence is low. However, as the level of violence increases, she is likely to be more affected than women with lower levels of education.

Figure 4
Newborn's weight by Mothers' Education Level on fitted values.
Model OLS 3 (General Model)



Source: Own elaboration based on the 2002 National Health Statistics Survey, 2012 Poverty Mission, and National Centre of Historic Memory databases

Figure 4 also shows the average marginal effects of maternal education on the fitted values of the general model for newborn weight. In particular, it highlights a central moderating effect arising from the estimated interaction between maternal education level and regional violence, which reduces the marginal effect of maternal education level. Specifically, the coefficient for mothers with a university degree was 54.45, while the coefficient for mothers with an incomplete university degree was 52.93. This suggests that mothers with a university degree were more likely to be significantly affected by the regional level of violence, exceeding the effect observed for women with other levels of education.

Highlighting the differences between the coefficients of the general model and the macro-meso model highlights the benefits for the mother's level of education when regional violence is low. On the other hand, there was an increase for mothers who had not completed university education. Mothers with a higher level of education had the highest coefficient difference compared to other family demographic variables, even among those who did not complete their university education. In all three OLS models, the association between maternal education and birth weight was significant and positive.

As evident in the general model, all the interaction coefficients between the two-system variables (regional level of violence and mother's educational level) were significant and negatively correlated. Notably, the highest negative coefficient corresponded to mothers who completed their university education (-0.947 grams) with a standard deviation (SD) of 0.222 grams.

We suggest that the negative correlation between mother's educational level and regional violence points out that the higher the mother's educational level, the lower the interaction coefficient, and thus, the higher the negative impact on the newborn's weight. As suggested before, regional violence is reducing the shield effect of maternal education. Nevertheless, those mothers with higher levels of education are still more prone to increase their newborn's weight. We estimated the total moderation effect in the general model.

Table 4.1
Moderation effect estimation between Macro and Meso variables

Regional Violence and Mother Educational Level	General Model	Shield Effect	Violence Effect
Interaction educational level (1) with regional violence	base	base	base
Interaction educational level (2) with regional violence	-0.231 (0.161)	19.14 (3,017)	18,909
Interaction educational level (3) with regional violence	-0.732*** (0.139)	23.05 (2.85)	22.318
Interaction educational level (4) with regional violence	-0.995*** (0.143)	42.158 (3.02)	41.163***
Interaction educational level (5) with regional violence	-0.737** (0.274)	52.93 (4.61)	52.193***
Interaction educational level (6) with regional violence	-1.043*** (0.220)	54.45 (4.17)	53.407***

Standard errors in parentheses - * $p < 0.05$, ** $p < 0.01$, * $p < 0.001$**
Source: Own elaboration based on the 2002 National Health Statistics Survey, 2012 Poverty Mission, and National Centre of Historic Memory databases

As Table 4.1 shows, to estimate the moderating effect of mother’s educational level, we computed the interaction coefficient to the correlational coefficient of mother’s educational level. As previously mentioned, we highlighted the coefficients of mothers who did not complete their university education (52.93 grams) and those who completed their university education (54.45 grams). However, the SD values were also high at 4.61 grams and 4.17 grams, respectively. Still, the most affected were those mothers with university education with an interaction coefficient of -1.043 grams followed by those with complete high school (-0.995 grams).

2.9 Discussion

In 2002, the heightened violence resulting from the Colombian armed conflict, particularly in the most affected regions, raised concerns about the potential transmission of stress-related adversities from mothers to their newborns during pregnancy. This intricate process is contingent upon the interactions within

settlements and dyads. Our findings are consistent with previous municipality level findings by (Rodríguez, 2022) who provide evidence of the negative impact of exposure to violence in early pregnancy on newborn weight and how this effect is mitigated by maternal education level (Rodríguez, 2022).

Drawing on the framework provided by Bronfenbrenner's ecological theory (Bronfenbrenner, 1979), we were able to construct and validate a quantitative empirical strategy to demonstrate the protective role of maternal education level, adding evidence at the regional level to previous studies (Ramos Jaraba et al., 2019; Rodríguez, 2022). This strategy aimed to estimate the moderating effect of regional violence on newborn weight, revealing the nuanced interaction with maternal educational level. Revealing this interaction highlights the latent moderating effect of maternal education in mitigating the adverse effects of regional armed conflict violence on newborn well-being, aligning with previous findings for the Colombian case (Rodríguez, 2022).

At the same time, 'ecological transitions' (Bronfenbrenner, 1979) brought about by violence and inequality, such as forced displacement or unemployment, can lead to changes in maternal roles and attitudes. According to Bronfenbrenner (1979), these transitions influence the developmental trajectories of children during pregnancy. Regional violence and forced displacement contribute to maternal and family stress and promote maladaptive, toxic or inappropriate family behaviour, particularly in the context

of lower levels of education and precarious healthcare services, as in Colombia (Bernal et al., 2024).

On the other hand, a study by Calam (2017) found that higher levels of intrafamily violence in Afghanistan were associated with contextual violence and predicted poorer childhood outcomes. Similarly, a municipal-level study conducted for Rodríguez (2022) in Colombia, found that mothers exposed to higher levels of violence were more likely to engage in potentially harmful behaviour during pregnancy. Thus, developmental changes experienced by one member of a dyad (the pregnant woman) are likely to be reflected in the other. Therefore, there is evidence to support the relevance of Bronfenbrenner's call for co-development in supporting the need to elicit appropriate parental responses due to their role in shaping the well-being of newborns. A notable aspect of our analysis is the incorporation of Bronfenbrenner's dyad + N approach, which facilitates interactions between system variables. In this context, the microsystem encapsulates a pattern of activities, roles and interpersonal relationships experienced by the developing person (the mother). At the same time, through the mother, the developing person experiences the unique characteristics of each environment, emphasizing the complex interdependence of physical and material factors in the developmental process (Bronfenbrenner, 1979).

Furthermore, when examining the interaction between maternal education and municipal violence, our results confirm that maternal

education acts as a moderator that mitigates the negative effects of violence and social inequality, in line with recent findings by Rodríguez (2022).

CHAPTER 3

Exploring the Educational Paradox on Preterm Births

3.1 Abstract

Globally, the focus on preterm birth (PTB) has become central for health and social scientists investigating neonatal well-being in the context of antenatal conditions. Emerging evidence highlights violence and socioeconomic factors as potential stressors during pregnancy, yet limited attention has been paid to the role of maternal education in these diverse and violent contexts where preterm births persist. Drawing on Bronfenbrenner's bioecological theory, we empirically examine the protective influence of maternal education on the likelihood of PTB, shedding light on its nuanced role. We use logistic regression models to analyse the odds of PTB using data from the 2002 National Health Statistics Surveys (NHSS), the National Centre of Historical Memory (NCHM) and the Poverty Mission of 2012. The results show that women with university education were more likely to give birth to PTB babies (gestational age less than 37 completed weeks) than women without such education. Interestingly, when the interaction between regional violence and maternal university education is examined, the effect is attenuated, especially for women who were capable to pursue any level of university education. The most affected region in terms of PTB odds was the most violent region of Antioquia.

Keywords: Preterm birth, low birth weight, fragile contexts, and higher maternal education.

3.2 Introduction

According to the World Health Organization (WHO), preterm birth (PTB) is widely recognized as a major causal factor in the loss of births and early childhood, approximately 15 million every year (WHO, 2018). The scientific community recognizes armed conflict and inequality as threatening factors to pregnancy, early childhood well-being and people's biographies (Castro Torres & Urdinola, 2019; Duque, 2017; Hong et al., 2021; Lee, 2014; Mendoza Tascón et al., 2016; Ramos Jaraba et al., 2020; Stonkoff et al., 2012).

Framed by Bronfenbrenner's ecological theory and approached empirically through a logistic modelling technique, we test the likelihood of PTB, controlling for regional violence and maternal demographic characteristics, in terms of their correlation coefficient with PTB (see Figure 1 in Chapter 1 the most important dimensions in neonatal and early losses according to the WHO). We focus on maternal university education and investigate the paradoxical evidence previously reported for Colombia (Márquez-Beltrán, Vargas-Hernández, Quiroga-Villalobos, & Pinzón-Villate, 2013; Ramos Jaraba et al., 2020). Our aim is to test whether pregnant women with higher levels of education are better prepared to have a healthy pregnancy and give birth at 37 completed weeks of pregnancy in vulnerable circumstances in the regional context of Colombia during the year of peak violence, 2002.

3.3 Theoretical framework

3.3.1 Bronfenbrenner's ecological theory

The complex scenarios, such as the one in Colombia in 2002, highlight the combination of more than two critical phenomena in terms of early childhood well-being. The interaction between pregnant women and the environment must also be taken into account. Therefore, the paper approaches this issue by applying Bronfenbrenner's ecological systems theory to child development during pregnancy. It is important to note that ecological models have been used to develop models where ethnographic, descriptive/correlational and quasi-experimental aim to capture the effects across childhood, nested in different systems of social interaction.

Bronfenbrenner's revised theory of the 'bio-ecological model' in 1994 placed more emphasis on immediate external interactions or proximate determinants (Bronfenbrenner, 1994). However, noting that Bronfenbrenner's reference to childhood did not deeply consider the in-utero period, this paper translates his theory to the pregnancy stage and too fragile environments. Therefore, based on Bronfenbrenner's systems theoretical approach, we build on family theories and pregnancy well-being from sociological, neuroscientific and medical perspectives. Although not all the complexities surrounding prenatal well-being have been included in the statistical model, all the literature has helped to illustrate and flow the interrelated mechanisms behind human well-being from

the womb, where mother and daughter/son depend on an interaction at multiple systems, but certainly at each place and event with specific environmental conditions.

Bronfenbrenner's bio-ecological theory drew on the various interactions that pregnant women had to experience in different spheres of society and in their own lives during pregnancy. In addition, Bronfenbrenner highlighted the impact on the dyad of what he defined as ecological transitions. This allows us to look beyond individual development and consider wider influences and the ecology of development, understood as the complex and interconnected multisystem of the fetal environment or dyad + N interactions.

The Ecology of Human Development Theory (Bronfenbrenner, 1979) allows researchers to consider dividing the complex issue into four systems of analysis: i) the microsystem, ii) the mesosystem, iii) the exosystem, and iv) the macrosystem. The microsystem is the main level of ecological systems theory ("Ecological Systems Theory: Exploring the Development of the Theoretical Framework as Conceived by Bronfenbrenner", 2020). The complexity of interactions within the immediate environment is the microsystem. The mesosystem is any other complex setting in which one or both parents interact, such as work or a group of friends. They occur beyond a single setting. The exosystem looks across settings and considers events that parents may not attend but are affected by. For example, a school class attended by another

sibling. Finally, the macrosystem takes into account the common social institutions that manifest themselves in the interconnected and complex system. For example, generalized patterns of social behaviour such as violence or poverty, unemployment or forced displacement. However, as Bronfenbrenner (1979) noted, we seem to be on familiar ground. "The ecological environment is conceived as a series of nested structures, each nested within the next, like a set of Russian dolls. At the innermost level is the immediate environment, which contains the developing person" (Bronfenbrenner, 1979, p. 24).

3.2.2 Preterm births in social and health science

Preliminary research conducted in Colombia has provided evidence of the impact of violence on neonatal outcomes in municipalities with high levels of victimisation compared to those with low levels (Ramos Jaraba et al., 2020; Ramos Jaraba et al., 2019; Márquez-Beltrán et al., 2013; José Hernando & Liliana, 2011). Some notable findings were the low number of cesarean deliveries and women who were able to attend four or more antenatal medical check-ups in the more affected municipalities (Ramos Jaraba et al., 2020). Evidence suggests that the municipalities most affected by the armed conflict exacerbated the effects of violence on pregnant women (Duque, 2017; José Hernando & Liliana, 2011). The same studies found that fetuses exposed to massacres in the womb are more vulnerable to family violence and deprivation, which can lead to lower levels of physical and cognitive development in childhood

(Duque, 2017), as well as poorer birth outcomes such as low birth weight (Mera, 2023) and preterm birth (Márquez-Beltrán et al., 2013; Ramos Jaraba et al., 2020).

Another medical study conducted between 2010 and 2015 in Buga, Colombia, identified the following determinants associated with prematurity: ethnicity (indigenous Afro-Colombian or Mulato), number of antenatal visits equal to or less than six, gestational age less than two years, multiple pregnancies, pre-eclampsia, and other medical factors such as drug or alcohol use (Mendoza Tascón et al., 2016). The study concluded that prematurity is the result of a complex network of individual, social, cultural and gestational determinants that interact within social and political networks beyond the healthcare system. Nevertheless, in the Colombian case, distress pregnancy is correlated with ethnicity (Mendoza Tascón et al., 2016).

Complementary population studies in Brazil have shown that the five most important variables in predicting the week of delivery are: the number of previous cesarean deliveries, the number of antenatal visits attended, the mother's age, the availability of ultrasound in the healthcare system or care network, and the proportion of primary care visits in the community (Rocha et al., 20-21).

3.3.3 Maternal educational profile and stress management

Researchers have noted a qualitative difference in stress levels and eating habits during early and late pregnancy, which has been linked to parents' knowledge of proper feeding practices (Muthayya, 2009) and antenatal education programmes (Hong et al., 2021). For example, the literature suggests that mothers need to be aware that the micronutrients, calories and proteins required in the early stages of development are different from those required in the late stages; this point focuses attention on a healthier life in the womb, which could help newborns get off to a healthier start (Hong et al., 2021). We suggest that this level of awareness may be correlated with a higher parental educational profile or higher educational attainment. This would explain the protective effect of education during pregnancy on this dietary component. However, previous research shows that women with a university degree have a higher risk of giving birth to a PTB (Márquez-Beltrán et al., 2013; Ramos Jaraba et al., 2020).

According to (Ramos Jaraba et al., 2020), between 2005 and 2009, women who were educated and had a university degree were more likely to have PTB. The medical explanation provided by (Ramos Jaraba et al., 2020) is that women's age increases the likelihood of having a university degree and may be associated with higher obstetric risks than younger women due to their age. Similarly, the association between mothers with higher levels of education and higher consumption of folic acid and iron[Medical research has documented that supplementation with folic acid and iron during

pregnancy could prevent complications in the mother-child dyad. However, as argued by Ramos (2020), the use of folic acid for more than 11 weeks of pregnancy was associated with PTB and the use of folic acid for more than 11 weeks was associated with PTB]. (Ramos Jaraba et al., 2020).

From a sociological and health perspective, it is not clear why pregnant women with a university education might be more prone to PTB than other pregnant women with basic or intermediate education (Márquez-Beltrán et al., 2013; Ramos Jaraba et al., 2020). One of these medical and population studies analyzed 14,520 women included in the 2010 Demographic Health Survey and, using bivariate analyses, binomial regression and stratified models by age, showed a negative and significant association between higher education levels and preterm birth rates (Ramos Jaraba et al., 2020).

However, given the significant privatization of the higher education system and the increasing enrollment of women in tertiary education, it's reasonable to explore the potential correlation between high levels of student debt and increased stress levels, particularly in a country where the unemployment rate hovered around 24%, as reported by the Poverty Mission. This leads us to ponder whether women pursuing university degrees faced heightened challenges in fragile economic contexts during 2002, potentially impacting their well-being and stress levels. Consequently, we might anticipate elevated stress levels among

pregnant women who were either students or recent graduates, potentially contributing to earlier-than-expected childbirth. Regrettably, our regression models lack specific data on student debt levels, limiting our ability to explore this aspect further.

Empirical research on this issue requires that other unobserved variables that may be correlated with educational attainment, such as other mothers' skills, family income, student debt, cultural and ethnic background, medical background, occupation and life history, reinforce their role within the household and may be correlated with pregnancy outcomes.

3.3.4 War, conflict and early well-being

Several scholars and researchers have demonstrated the detrimental effects of adversity on reproductive outcomes (Akhta, 2019; Mc Elroy & Hevey, 2014; McEniry, Samper-Ternent, Flórez, & Cano-Gutierrez, 2018; Penn & Lloyd, 2010; Shonkoff et al., 2012; Van den Bergh et al., 2017). Furthermore, due to the prevalence of violent dynamics affecting human geography and territories (Castro Torres & Urdinola, 2019; Duque, 2017; Echandía Castilla, 2006, 2019), thousands of children are born in a disadvantaged position.

Therefore, defining the Colombian context as fragile leads us to the negative effects of human development due to the coexistence of violence and social inequality (Echandía Castilla, 2006). As scholars point out, access to basic healthcare and university education remains a national debt (Pacheco, 2020). More importantly, the respect for children's rights and the development of

their capabilities decrease in these fragile contexts¹ (José Hernando & Liliana, 2011). Moreover, in these fragile contexts, families and entire communities have become targets of violence and victims of inequality (Arias Nieto, Suescun Mutis, Mercer, Bonati, & Choonara, 2009). For example, the positive correlation between fertility and armed conflict (Castro Torres & Urdinola, 2019) suggests that for those living in the most affected regions, deprivation increases from the womb as a result of potential rape and violence (Castro Torres & Urdinola, 2019). The evidence strongly suggests that mothers living in communities and cities with prolonged exposure to violent dynamics and social inequality may transmit trauma and deprivation to their children during the prenatal period, causing neurological and anthropomorphic delays. However, this transmission could be countered if pregnant women were taught how to cope with stressful situations and had access to antenatal care. As shown by (Urizar, Yim, Rodriguez, & Schetter, 2019), antenatal cognitive-behavioural stress management (CBSM) interventions are likely to improve stress outcomes in low-income pregnant women and perhaps infant health outcomes in the short and long term.

Referring to the differentiation of violence between regions, new players joined the conflict in the 80s and 90s, such as drug cartels and different paramilitary groups, which escalated (Venegas Luque,

¹ According to the Red Cross the definition of conflict refers to “Prolonged armed confrontation between governmental armed forces and one or more-armed groups or between those groups, that surge within the territory of a state part of the Geneva Agreements. The armed confrontation must reach a minimum level of intensity, and the parts involved must have a minimum of organization” (Red Cross International Committee, 2008).

Gutierrez Velasco, & Caicedo Cardeñosa, 2017). Armed groups changed their financial strategies and targeted the population, including women and children (Echandía, 2006). The increase in violence, which manifested itself in massacres, selective killings, disappearances, forced displacements, sexual harassment, anti-personnel mines, child recruitment and numerous acts of violence against the population, was concentrated in certain areas, areas of strategic geographical value for them (Echandía, 2006). According to Echandía (2006), the location of the groups correlates with the drug industry and its concentration of illegal activities in these areas (e.g. trafficking and control). In addition, the motivations, ideological perspectives, socio-economic conditions and tactical formation of the groups vary (Sanín, 2008). For example, paramilitary and guerrilla groups differ in their demographic characteristics and income motivations (Echandía Castilla, 2019), in the socialisation process within the groups, and in the reasons for and nature of demobilization in the reintegration process (Sanín, 2008). In the case of paramilitary groups, their formation is linked to landowners, drug traffickers, the military and political acquiescence (Romero, 2003). In 1997, these groups formed the Autodefensas Unidas de Colombia (AUC). In the years that followed, they were responsible for massacres and crimes against humanity (Echandía Castilla, 2006). After their demobilization in 2006, organized crime, neo-paramilitary groups and gangs took over the illegal drug trade and other sources of funding such as urbanizing the violence (Echandía & Cabrera, 2022).

In 2002, Colombia experienced the highest peak of violence in the past forty years of armed conflict, at a time when the population was suffering from a macroeconomic crisis with high levels of poverty and unemployment (NCHM, 2013; Poverty Mission, 2012). According to the National Health Statistics Surveys of 2002 (NHSS), within this highest peak of violence embedded in 60 years of armed conflict (NCHM, 2013), Antioquia (the Colombian region most affected by violence and the second most prosperous region) had the second highest percentage of PTB (15.96%). A different case is Bogotá (the least affected region and the most urbanized and prosperous city/region in the country, with the highest number of mothers with a university degree), which had the highest percentage of PTB (19.41%). At the national level, Antioquia had the highest percentage of mothers with no education giving birth to PTB (24.09%), followed by Valle del Cauca (6.36%) and La Guajira (5.56%). However, the islands of San Andrés, a region not affected by the armed conflict, have a high rate of PTB, around 20%.

3.4 Hypotheses

(Armed conflict). Levels of violence vary by region and are significantly correlated with the odds of PTB. High levels of violence are associated with higher odds of PTB, but there are unobserved regional factors other than violence that affect PTB, as in the case of Bogotá.

(Women's educational puzzle). Premature births are increasing in the context of a significant mismatch between the economic reality

of the region (unemployment and social inequality) and the proportion of mothers with higher levels of education who are unemployed, regardless of the impact of the armed conflict.

(Resilience of mothers with university level). Despite the high rates of preterm birth among women with full or some university education living in regions with low levels of violence and medium levels of unemployment, such as Bogotá, at the individual level maternal education remains a protective factor for newborn well-being. In low and medium conflict contexts, women with some university education are better able to mitigate the negative effects of armed conflict violence and increase the likelihood of full-term birth.

3.5 Data

As mentioned above, the paper uses secondary data sources from the 2002 National Health Statistics Surveys (NHSS), a cross-sectional survey conducted annually since 1998. It has been used extensively to examine the main characteristics of key events in neonatal and women's health. The 2002 NHSS covers a sample of 33 regions, including Bogotá. It includes data on 700,455 families and on the characteristics of newborns/mothers. The NHSS has been conducted for the National Statistics Department of Colombia (DANE). The main purpose of the survey is to collect demographic information on the giving birth event. The survey also provides information on living conditions by geographical location. The data

collection is based on formats designed according to international standards and the characteristics of the country. The process involves subnational entities and subnational healthcare dependencies. Once the “vital register” for each new-born is generated within each region, the information is collected by the DANE. Lined up with international standards the Survey is randomized and pass for a rigor's statistical quality control. Even though there are more recent NHSS, the 2002 was selected under previous considerations regarding violence and high levels of poverty, unemployment, forced displacement and indigence in that year. This, make the specific scenario for our natural experiment. We asses 24 regions of the 33 entitled in the NHSS considering the control regional variables availability. Those such as unemployment rate, poverty rate, indigence rate and displaced families. Those regional rates control variables were obtained from the Poverty Mission of 2012.

3.6 Methods

In order to estimate the level of violence, we constructed a violence indicator that was the result of calculating the average of violent acts by category within the National Centre of Historical Memory (NCHM) databases. These categories include acts of war, abductions, landmines, selective killings, massacres, damage to public property, attacks on the population, civilian deaths caused by armed actions, sexual harassment, enforced disappearances, children in war and terrorist attacks. It is important to note that all actions carry the same weight. We have grouped the regions into

four categories: i) not/lowly affected, ii) Bogotá, iii) low/moderate affected, and iv) Anqioquía.

Our response variable Y will be a dichotomous variable measured in weeks, gestational age (1 = less than 37 completed weeks and 0 = more than 37 completed weeks). The critical independent and explanatory variables of our research are the regional level of violence and the mother's level of education and their interaction coefficient. We also control for other regional socio-economic variables, such as unemployment, poverty, displacement and indigence, in order to better observe the potential effect of macrosystem/regional interaction variables. We also control for medical variables such as gender, age and antenatal care received. Other demographic control variables such as mother's age, status, number of siblings, number of deceased siblings and healthcare system were included.

$$Y_{ij} = \beta_0 + \beta_1(RV_{ij}) + \beta_2(MEL_{ij}) + \beta_3(RV_{ij} \times MEL_{ij}) + \beta_4(\text{Area of Housing } ij) + \beta_5 \dots \mathbf{n}(\text{Medical \& Sociodemographic controls}) + \varepsilon$$

The previous equation frames the environmental systems of Brofenbrenner's theory and scopes the empirical analysis, instrumentalising the interaction between a macro-system and a micro-system variable. In this general logistic model, Y is the PTB of newborn i living in region j. The first component of the model is β_0 , which is the intercept. The β_1 is the correlation coefficient for the regional violence variable, which will be a cluster of regions

grouped by their level of violence. We separate Bogotá and Antioquia due to their representativeness within the survey and their different economic conditions compared to the other regions. β_2 is the correlation coefficient for the variable of the mother's level of education, which indicates whether she has a university education or not. β_3 is the correlation coefficient for the interaction between the regional level of violence and the level of maternal tertiary education. The β_4 is the calculation of the standard deviation when clustering women by area of residence (urban or rural and rural dispersed). We also weight for the regional population in the survey. In order to better assess the shielding effect of the mother's educational level, from β_8 to β_n we consider correlation coefficients for all mothers, demographic and medical control variables, including the mother's age and her healthcare regime / insurance, which in the Colombian case is an approximation of her socio-economic strata and work situation. Finally, ε is the random error at the regional level, which includes the unobservable effects related to the differentiation with the current observation of the data.

3.7 Results

The results are presented for the two logistic regression models. The logistic regression, odds of ratio, model the probability of a being born preterm based on the independent variables. Model 1 presents the logistic regression results considering all system variables but without estimating the interaction effect between regional violence and mother's education level. Model 2 includes the interaction effect between those two variables. We also present all the

variables' standard deviations and p values. It is essential to mention that both logistic regression models are weighted for region of housing, and we adjusted the standard error for the of area housing (urban or rural/rural dispersed). Likewise, we ran significant test for the comparison of moderation effect differences for mothers with university level within the same region and between regions. Hence, the models are well defined and fitted considering the Bronfenbrenner's ecological systems as well as the interaction between two system variables.

Table 1
Logistic regression results (odds ratio) for predicting the likelihood of preterm birth: Colombia, 2002 (n = 494,629)

Demographic, medical and regional features	Model 1	Model 2
Gender		
Boy	Base line	Base line
Girl	-0.944***, (0.005)	-0.944***, (0.005)
Antenatal medical controls attended	-0.80***, (0.008)	-0.80***, (0.008)
Regional Violence		
No/scarcely affected	Base line	Base line
Bogotá	1.104, (0.099)	1.110, (0.100)
Low/Mid affected	-0.979, (0.029)	-0.984, (0.0300)
Antioquia	1.381**, (0.167)	1.384***, (0.167)
Regional Unemployment	1.005***, (0.001)	1.005***, (0.001)
Regional Poverty	-0.999, (0.002)	-0.999, (0.002)
Regional Displacement	-0.999, (0.00001)	-0.999, (0.00001)
Regional Indigence	-0.996***, (0.001)	-0.996***, (0.001)
Mother's Education Level		
No University	Base line	Base line
Complete university	1.128***, (0.007)	1.207***, (0.012)
Mother's Age		
< 20	Base line	Base line
20 - 29	-0.876***, (0.0059)	-0.875***, (0.004)
30 - 39	-1.019, (0.014)	1.019, (0.014)
> 39	1.308***, (0.045)	1.308***, (0.045)

Marital Status		
Single	Base line	Base line
Married or Cohabiting	-0.941***, (0.013)	-0.941***, (0.013)
Widow/Divorced/Separate	-0.919, (0.053)	-0.919, (0.053)
healthcare regime		
Contributor	Base line	Base line
Subsidiary	-0.867***, (0.037)	-0.867***, (0.037)
Beneficiary	-0.807***, (0.0202)	-0.807***, (0.020)
Particular	1.026, (0.0715)	1.026, (0.071)
Other	1.104***, (0.007)	1.104***, (0.007)
Number of siblings	-0.936***, (0.012)	-0.936***, (0.012)
Deceased sons/daughters	1.108***, (0.007)	1.108***, (0.007)
Interaction Violence and Mother's Education		
Not affected regions		Base line
Bogotá - Complete university		-0.930*, (0.013)
Mid affected - Complete university		-0.924***, (0.004)
Antioquia - Complete university		-0.968***, (0.010)
Constant	-0.344***, (0.053)	-0.343***, (0.053)
Observations	494,629	494,629

*Own elaboration based of the National Health Statistics Survey of 2002, Poverty Mission 2012, and National Centre of Historic Memory databases

*Coefficients Standard errors in parentheses - Significance,

*** p<0.01, ** p<0.05, * p<0.1

*Prob > chi2 = 0.0000

R2 = 0.6545

*Note: controls variables are Gender, healthcare regime, Marital Status, Medical control attended, labor Typology, Number of living children and number of deceased children. Also, regional macro socioeconomic indicators: poverty, unemployment, and displacement.

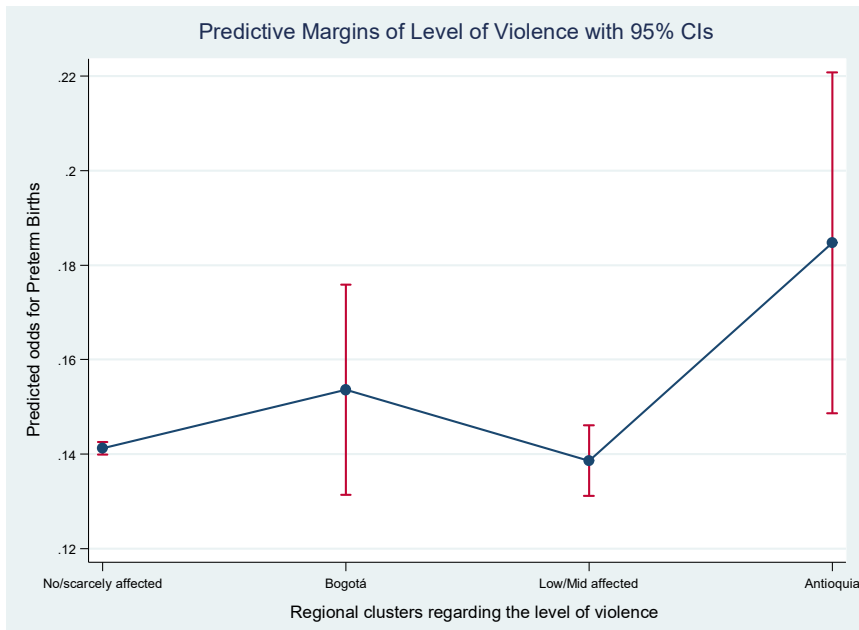
*The reduction in the value of n does not represent a geographical bias, but rather to the exclusion of cases due to missing information regarding other independent variables. This exclusion is done to ensure the integrity and reliability of the model results. It's important to note that the lack of information on certain variables can distort the model results, as it affects the model's ability to adequately capture and explain variability in the data. Therefore, excluding cases with missing data is a standard procedure in statistical analysis to ensure the validity of the results.

Armed conflict violence was associated with the preterm births (PTB) odds in Colombia in 2002. Without estimating the interaction effect, only Bogotá, a low affected region, and Antioquia, the most affected region, were more prone to preterm births than the other two clusters, of regional violence. In the case of Bogotá, violence is positive correlated to the PTB odds, but the result is not significant whereas Antioquia shows an odds of ratio of 1.38 and a p value of

(0.081). Other regional variables also increase PTB odds, such as regional unemployment rate (OR: 1.005). For instance, for a woman housing in regions low affected by violence as Huila. with 64.12% (Table 1 Chapter 2) of poverty, 21.1% of unemployment, and 31.89% of indigence, had 40% less odds to PTB than women living in Antioquia. Even women residing in Bogotá had approximately 25% lower odds compared to those in Antioquia. This phenomenon could be attributed to women's mobility between regions and cities in search of improved healthcare services or job prospects.

Figure 1 illustrates the results for the regional clusters of violence highlighting the harmful effect on the odds of PTB for Antioquia.

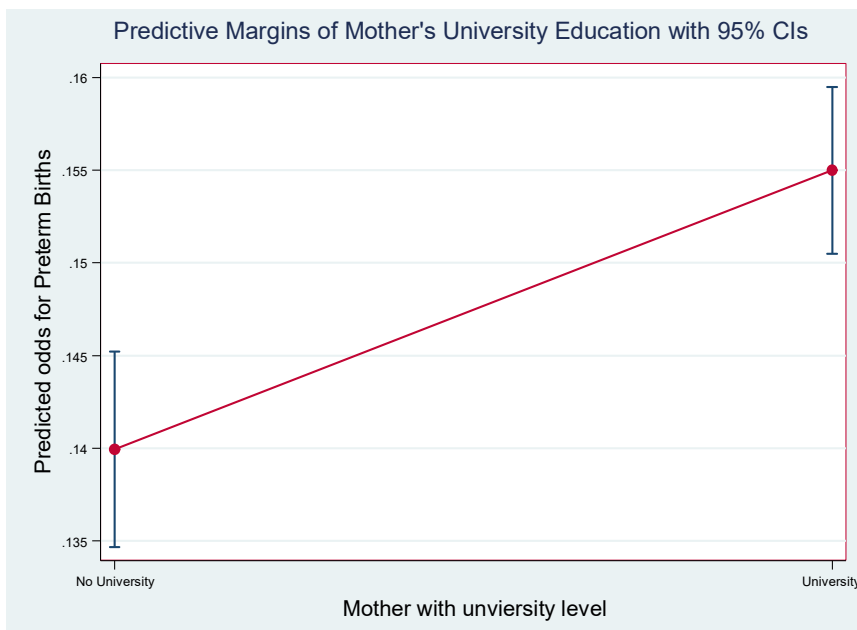
Figure 1
Predicted preterm births by regional violence, when estimating the moderation effect of education: Colombia, 2002



Source: own elaboration based on the coefficients of Model 2 in Table 2

Results from Model 1, Table 2, Figure 2, highlights the educational paradox of mother's education level and PTB. Mothers who were capable to achieved university education were 12.8% more prone to PTB than those with no university education. Figure 2 illustrates the educational paradox in terms of PTB.

Figure 2
Predicted preterm birth odds by mothers' education level and territories with different levels of violence: Colombia, 2002



Source: own elaboration based on the coefficients of Model 1 in Table 2

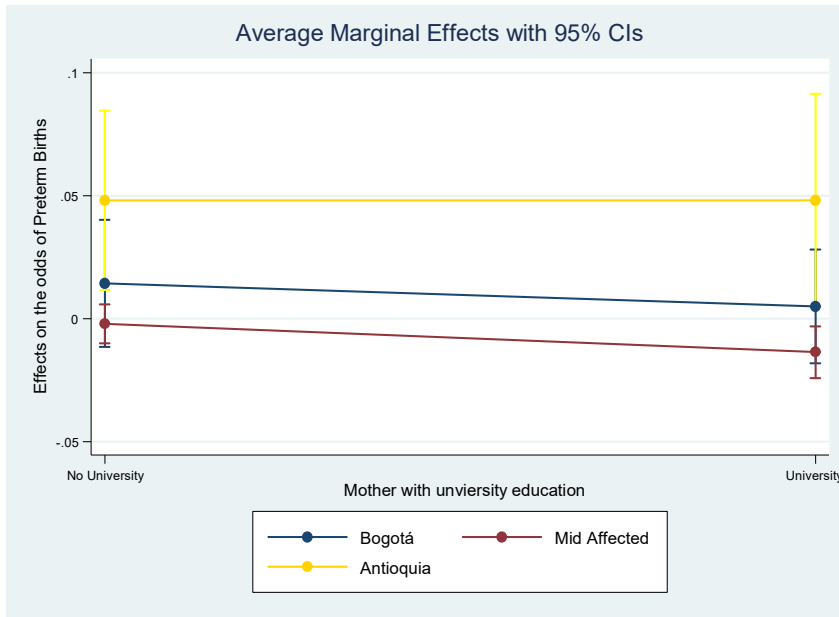
Women's educational puzzle. Preterm births increase in mothers with university education due to the significant mismatch between the region's socioeconomic and demographic reality and women

expectations. This is worse in highly privatized higher education systems such as the Colombian. However, mothers who have reached university education were more capable of facing adversity, thus shielding the dyad, overall, when they were living in Bogotá and mid affected regions by the armed conflict.

As we observe from Figure 3, Model 2 results (second column in Table 2) the Mid affected regions such as Risaralda, Nariño, Huila, Cesar or Quindío, shows the highest and significant marginal effects of mothers with university level on reducing the odds of PTB. Those regions less affected by violence but hardly affected by poverty, unemployment and indigence were healthier in terms of PTB. This happened when we compute the interaction effect of mother's education level and regional violence.

Antioquia and Bogotá were the most affected regions by the armed conflict national scenario. Antioquia in terms of direct violence and Bogotá in terms of its consequences such as forced displacement, urban crime and indigence. The greater variability in these region-cities makes more heterogeneous population groups, especially in the metropolitan and urban centers hosting displaced individuals, along with greater availability of specialized healthcare, thus attracting populations with varying degrees of exposure to violence.

Figure 3
Predicted preterm birth odds by mothers' education level and territories with different levels of violence: Colombia, 2002



Source: own elaboration based on the coefficients of Model 1 in Table 2

All the clustered regions performed better than Antioquia in Model 1, even the poorest regions such as Huila, Boyacá, Chocó and Magdalena. According to the results of Model 2, Table 2, Figure 2, if we consider the interaction effect between mothers with university education and regional violence, we can say that the trends of the marginal effects on the probability of PTB are clearly different in the three clusters. In Bogotá and the moderately affected regions there is a clear downward trend, whereas in Antioquia it is clear that the level of affection is the same regardless of the mother's university education. All women were equally affected by the high levels of violence resulting from the armed conflict. Also,

regional factors such as unemployment are clearly macrosystemic stressors for pregnant women with university education who lived in the other regions.

When considering the standard deviation clustering by the Area of Housing (where mothers were living), we acknowledge the great participation of urban families in the sample. Mostly, mothers who are living in rural and rural dispersed areas have lower levels of education and are less capable to access and complete university level due to regional gaps in terms of education and financial opportunities.

Resilience of mothers with university level. Mothers with a university education exhibit remarkable resilience, demonstrating a capacity to confront adversity and mitigate the detrimental impact of violence on their infants. Pregnant women with a university-level education residing in less affected regions such as Bogotá, or Mid affected regions such as Huila, or Nariño show a heightened ability to confront and diminish the harmful effects of violence on their infants compared to those in Antioquia, the most affected region.

The interaction, moderation, or shielding effect observed in mothers with higher education levels in mismatched environments appears to alleviate the impact of regional violence. In Bogotá, this interaction effect significantly altered the effect on preterm birth (PTB) odds (OR: 0.93 p value = 0.00). Only mothers who had completed any university semester or obtained a university degree

were more likely to reduce the odds of experiencing PTB. For mothers in Bogotá, the odds decreased by 7%. In mid-affected regions, the interaction effect was even more pronounced (OR: 0.92 p value = 0.00), resulting in a 8% reduction. In the case of Antioquia the interaction effect shows the lowest correlation coefficient (OR: 0.96 p value = 0.004) indicating that mothers with a university education were better equipped to moderate the impact of violence, albeit insufficiently in this highly affected region.

The opportunity to access university education, even if not attaining a bachelor's degree, appears to have a positive correlation with the number of attended antenatal medical controls. These health findings significantly decrease the odds of preterm birth (PTB) by approximately 20% across both models. For insurance regimes, the odds of giving birth after 37 weeks or more increase for mothers in the subsidized and beneficiary healthcare regimes compared to the contributor regime, whereas mothers in the Other healthcare regimes exhibit an increase in the odds of PTB of 10%. The odds for those in the "Particular" regime increase without statistical significance. These results apply consistently across both models.

In terms of marital status and family structure, being born to a married or cohabiting mother reduces the odds of preterm birth (PTB) by around 6% in both models. Paradoxically, widows, separated, or divorced mothers also exhibit 9% lower odds of PTB with a p value of 0.149, not significant. Considering mother's age, giving birth between 20 and 29 years old reduces the odds of PTB

by around 13%, while giving birth between 30 and 39 years old reduces it by 1%, and giving birth between 40 and 54 increases it by around 30%. Results for the number of siblings alive reduces the odds in around 7%, while having one or more deceased siblings increases the odds by around 10%. Regarding gender, girls show around 6% lower odds of PTB compared to boys.

3.8 Discussion

Previous research on PTB assessment in Colombia has shown a significant and positive association between maternal education level and the likelihood of PTB in 2010 (Ramos Jaraba et al., 2020). Our findings are consistent with this research and add to the evidence on the impact of regional violence on newborn health. However, we have gone further in exploring this paradoxical relationship by considering the moderation/shielding effect of maternal education level in reducing the innocuous effect of violence on a newborn's PTB. We present evidence for the case of Bogotá, a historical refugee city (13,109 families arrived in 2002) with low level of violence, high unemployment (18.2%) and moderate poverty (26.5%), where mothers with a university education were more prone to PTB, but also more able to reduce the harmful effects of violence on their babies. The same holds true for regions with moderate poverty.

Firstly, the urban areas became refuge territories affected by high rates of unemployment poverty and indigence. Hence, distress within urban perimeters frequently affected pregnant women's

psychology and behavior. For instance, cities such as Bogotá, Cali, and Barranquilla were refugee cities for running families. This internal migration phenomena increased the levels of social vulnerability whereas safeguarding from violence. Likewise, according to Bronfenbrenner (1979) these "ecological transitions" forced by violence or high unemployment rates is likely to change mothers in their role and setting, moreover during pregnancy. War leads to maternal and familial stress resulting in misleading and toxic or inconvenient familial behavior (Calam, 2017), even more so when low educational levels are a factor. Calam (2017) shows how a higher level of intra-familial violence in Afghanistan predicted poorer childhood outputs. Also, evidence of this effect is shown for the Colombian case (Ramos Jaraba et al., 2020). We might argue that results suggest that in fragile and violent regional contexts such as Antioquia in terms of armed conflict and economic crises, make families are prone to experience fear and stress which will be transfer to the dyad.

In addition, Bronfenbrenner's concept of 'ecological transitions' explains how the experience of a new level of responsibility that comes with pregnancy, while trying to maintain or find a new job related to their studies that may not be paid, is likely to cause women to increase their stress levels and overproduce cortisol (Waldfoegel et al., 2010; Van den Bergh et al., 2017; Urizar et al., 2019). This could explain the positive increase in the odds ratio when mothers were able to complete their studies in insecure contexts in terms of job opportunities/continuity and peace.

Due to economic crises combined to the peak of violence experienced in 2002 (Poverty Mission, 2012; NCHM, 2013) there was a miss match between the labour market supply, their professional skills and the expected jobs. Thus, they were likely to be experiencing frustration for not achieving their professional goals and accomplish family expectations. In addition, the traditional vehicle to fiancé higher education studies in Colombia is that women and men must pursue loans and get in debt to have access to higher education studies (University Level). This debt, in most cases, must be repaid once you finish your career and luckily find a job. This combine with the fact that in 2002 had ones of the higher figures of unemployment it is likely to increase the stress levels of those pregnant women who were professional but had no job after or during their pregnancy. Still, either way, they had to pay their study loan. In contrast, women who have been living with no education aspirations were finding jobs in the same sector they have been working on with the tranquility of not being in debt or not having to pay any students loans. Not expiriencing “ecological transitions” (Bonfenbrenner, 1979).

For almost 40 years, the private sector have been cooperating with state and now represents 50% of the total graduation rate, as well as in the growing matricula rate, around 100% in the last 20 years. We explain that financial burden is heavier in woman who are obliged to pay for their higher education studies, sometimes even without finishing and without a job. In Colombian higher education system

makes relevant to consider this contextual pressure even though we could not really measure it at any level. The evolution of financial terms for higher education loans provided by the national authority, ICETEX, as depicted in ICETEX's terms for 2002 were less favorable for those students who had finished their career before 2002, particularly given the prevailing macroeconomic conditions and the backdrop of armed conflict. Consequently, in 2003, adjustments were made to alleviate the financial burden on undergraduate candidates. Subsequent revisions have followed, albeit without explicit reference to the circumstances of pregnant women. It is apparent from the table that in 2002, indebted students experienced more pronounced financial strain compared to those who did not pursue university education. Furthermore, considering that private universities in Colombia graduate half of the university-educated population, of whom many rely on ICETEX student loans to afford higher education at market rates, this issue assumes prominence. ICETEX remains the sole public national entity empowered by the legal framework (Law 132 of 1992) to administer higher education financing and university studies. Although we lack statistical data to establish a direct link between student loans and the likelihood of preterm births (PTB), potential hidden stressors for pregnant women with bachelor's degrees include mounting student debt, academic obligations, professional duties, and expectations.

On the other hand is widely recognized that the implications of being pregnant involve responsible care habits that may be of

secondary importance for pregnant women attempting to avoid violence and adversity while simultaneously experiencing stress due to income, job or health deprivation, due also to their ethnic precedence (Gonzalez, 2002). Therefore, those pregnant women with no university education will be always at the category of more vulnerable population.

These considerations help us to better understand the paradoxical relationship between antenatal university education and the likelihood of preterm birth in war contexts, such as Colombia in 2002. We agree with Jaraba (2020), who finds that the likelihood of a PTB increases when mothers have a university education, as well with other scholars (Márquez-Beltrán et al., 2013; Ramos Jaraba et al., 2020). Nevertheless, when estimating the interaction effect of maternal education level and regional violence, we found a lower effect of violence when mothers had a bachelor's degree and lived in low and medium affected regions. In Bogotá and in moderately affected regions such as Huila, Nariño, Cesar, Córdoba and Risaralda, mothers with a university degree were more likely to reduce the negative effect of regional violence. Despite of that, the convergence of regional violence and social inequality may contribute to feelings of insecurity and economic instability. Moreover when the level of violence is high such as Antioquia.

CHAPTER 4

**Being born alive during a peak of violence. A
multilevel approach.**

4.1 Abstract

Background: For the most violent year in the last 4 decades of the Colombian Armed Conflict, 2002, we merged regional data from the National Centre of Historic Memory (NCHM) detailing the number of victims with the National Health Statistics Survey (NHSS) which includes number of births, stillbirths and early losses.

Aim: With a final sample of 676,498 women/newborn infants, and 11,675 stillbirths (SB) miscarriages (MC) and early losses (before 1 year old), we explored the effect of regional violence on the well-being of newborns, and tested the protection effect of women university education from a multilevel perspective.

Methods: We use a multilevel regression model to test the relationship between regional violence and live birth.

Findings: There is a significant correlation between regional violence and the predicted mean of experiencing stillbirths, miscarriages (SB–MC, merging the two acronyms) or early losses. This means that women living in less violent regions were more prone to giving birth to a live baby and protect the dyad during the first year of live. We show the positive effect of university education on the predicted mean of a live birth and on avoiding a violent or inexplicable loss.

Discussion: When computing the cross-level effect, mothers with university education were not significantly more or less capable of dealing with adversity and stress during the pregnancy period. These results highlight the effect of regional violence in diminishing the shielding effect of maternal university education.

Keywords: Stillbirth, Miscarriage, Regional Violence, Maternal University Education

4.2 Introduction

According to (Valente, 2015) the literature, an integral perspective of newborn well-being within war and armed conflict contexts must put emphasis on analyzing stillbirths (SB), miscarriages (MC) and early losses (Valente, 2015). It is recommended by (Valente, 2015) to include pregnancies that had these outcomes in order to clearly observe the effect of violence on early well-being. On this basis, in 2002, the most violent year in the last six decades of the Colombian Armed Conflict (CAC), 14,350 women experienced a miscarriage (MC), stillbirth (SB) or early losses. Of all national losses, Antioquia accounted for 27.84%, while representing 13.34% of all births in 2002. Tolima accounted for 10.03% and 3.44% respectively. Both regions have a historical presence of paramilitary groups. Additionally, Huila represented 8.71% of all losses and 3.09% of national births. Huila was the poorest region in 2002, with a poverty rate of 64.12% (Poverty Mission, 2012). These three regions had the highest rates of stillbirths, miscarriages, and early losses. Furthermore, from the national perspective, Antioquia (13.32%), Tolima (17.65%), and Caldas (13.84% - located between Antioquia and Tolima) represented the highest rates of violent or inexplicable losses, according to the 2002 NHSS.

The scientific community has recognized that an armed conflict context is a threatening and turbulent environment for healthy pregnancies, early childhood wellbeing, and people's life courses in

general (Castro Torres & Urdinola, 2019; Duque, 2017; Hong et al., 2021; Lee, 2014; Mendoza Tascón et al., 2016; Ramos Jaraba et al., 2020). We build upon this sociological premise by examining the case of the turbulent environment reigning in Colombia in 2002. This year, compared to 2001, when 31,921 people were victims of CAC violence, 4,983 more people were victims of one of the eleven categories of violence, such as acts of war, assassinations, attacks against the population, terrorist attacks, damage to public property, enforced disappearances, mass killings, anti-personnel mines, recruitment of children, abductions and sexual violence (NHCM, databases from 2001 to 2002). In addition, at the national level, extreme poverty affected 11% of people, poverty 39% and unemployment 15.4% (Poverty Mission, 2012). Hence, our starting point is the fact that families and pregnant women were highly exposed to different levels of violence. The multilevel combination of war and socioeconomic vulnerability likely led to different but even higher levels of stress manifested in stillbirths, miscarriages (SB-MC) and early losses. Despite the low intensity and reach of the CAC, we show that the regional impact of violence on newborn well-being, in terms of the odds of experiencing a stillbirth, a miscarriage, or a violent or unexplained loss, was affected by the 2002 peak in violence and its combination with the economic downturn.

Because of the potential existence of unobserved factors at the regional level and for women, such as the quality of health system services or household living conditions, and because of the structure

of the Vital Survey, we approach the problem from a multilevel and fixed effects model to calculate these deviations at the regional level. We compute the regression coefficients for a live birth or for having experienced a violent or inexplicable death. Both models estimate the cross-level interaction and the *modifier effect* between regional violence and a mother's university education. In this way, we defined two levels (Regional – Individual). We control for other maternal demographic features such as age, area of residence, socioeconomic stratification, and marital status. We focus on maternal university education as the best mechanism to protect newborn's well-being, and analyse the interaction effect with regions. This research makes a significant contribution to the existing literature, as it complements the evidence collected by other researchers in Colombia (Márquez-Beltrán et al., 2013; Ramos Jaraba et al., 2020) on maternal university education and neonatal outcomes.

4.3 Theoretical framework

4.3.1 Stillbirths, miscarriages and early loses

According to the World Health Organization, it is estimated that every year, 2.6 million stillbirths occur. A stillbirth is understood as the death of an unborn baby after 28 weeks of gestation, before birth or during it (Allanson et al., 2016). A miscarriage is understood as when this happens before 28 weeks of gestation. Approximately 40% of all stillbirths occur during the birth process (Allanson et al., 2016; WHO, 2023.), and between 10% and 15 % of miscarriages are experienced by women who knew they were

pregnant (Purdie, 2019). The causes explored by medical and health research concern complications in labor, post term pregnancy, maternal infections such as malaria, syphilis and HIV, and maternal conditions, especially hypertension, diabetes, and fetal restriction. Likewise, global research has found that for low and middle income countries, the causes for 43.7% of stillbirths were unexplained, 18.7% were due to an unspecified condition, 13.7% due to a placental condition, 11% due to a specific fetal/pregnancy pathology, 9.1% due to a antepartum hemorrhages, and 3.8% to other known causes (Reinebrant et al., 2018). Most of the cases of stillbirths (98%) occur in low-income and middle-income countries (Almasi-Hashiani et al., 2017). The consequences go beyond the newborn well-being, and imply psychological consequences for women, especially women in vulnerable conditions in terms of exposure to stress (Allanson et al., 2016).

Recently, a ten-country case study presented insights concerning women's and children's healthcare services in armed conflict contexts such as Afghanistan, Colombia, Democratic Republic of the Congo, Mali, Nigeria, Pakistan, Somalia, South Sudan, Syria, and Yemen (Singh et al., 2021). They found that despite the variations in policies and local conflict dynamics, in all the contexts, the healthcare measures present included the following: antenatal care, basic emergency obstetric and newborn care, comprehensive obstetric and newborn care, immunization, infant and young child feeding and nutrition, treatment of common childhood illness, and screening (Singh et al., 2021). The study presented evidence to

recognize that armed conflict contexts are a complex scenario in terms of variables linked to data concerning women's and children's health, and other contextual and demographics considerations. Nevertheless, the same study make it clear that one common issue in terms of health policy was that in the ten countries, the women's and children's healthcare services lack tools specifically designed to help women and children, or interventions to address stillbirths and they are often included in general reproductive, newborn, and adolescent healthcare services (Singh et al., 2021).

4.3.2 Maternal university education, the shield effect

Beyond the medical and health causes of well-being or distress during the in-utero, antenatal, and pregnancy period, there are other demographic factors that are likely to impact women's pregnancies that drive the newborn well-being. Empirical research conducted in Iran presented evidence about the probabilities of stillbirths when considering parental demographic features such as education or age (Almasi-Hashiani et al., 2017). There was a significant increase in the odds for stillbirths for mothers between 15 and 25 years of age, and for those with lower economic status (Almasi-Hashiani et al., 2017). Complementary research conducted in Canada has shown evidence of the protective effect of maternal education to avoid stillbirths (Luo, Wilkins, & Kramer, 2006). Along the same lines, other research in Australia has shown the high distribution of stillbirths among mothers with lower levels of education and those with public healthcare regime / insurance (Rodriguez, 2022; Squibb,

2020; Hug L. et al., 2021). For instance, the literature suggests that socioeconomic inequality in terms of access to higher levels of education and healthcare services are likely to diminish in-utero well-being. Complementary to this, there is scientific evidence that leverages the direct and significant correlation between university education and antenatal tests and pregnancy monitoring. This finding, among the widely acknowledged of socioeconomic benefits for having university education, make it plausible that levels of knowledge about pregnancy and birth might be correlated to the mother's higher educational profile or higher educational levels, thus leading to those with a university education taking more care of their health during their pregnancies. Nevertheless, it is also recognized that war, armed conflict and high levels of social inequality open up a completely different scenario in terms of obtaining a university education.

On the other hand, scholars have noticed the negative and significant correlation between vectors of violence and a mother's university education. In the CAC, the more violent the region or municipality, the fewer the mothers with a higher education (Duque, 2017; Mera, 2021). Even though there are health and demographic studies available on newborn health, specifically for Colombia, it has been impossible to find any relevant quantitative evidence when considering the number of SB-MC and maternal demographic features such as maternal university studies. This, according to literature is a critical point if we really aim to assess the impact of

violence on newborn well-being in such turbulent, violent and unequal contexts as Colombia in 2002.

4.3.3 A turbulent environment

Defining the Colombian context as a fragile one leverages the coexistence of violence and social inequality (Echandía Castilla, 2006). Along these lines, scholars suggest that because of the CAC, access to basic healthcare and university education remains worsen in some regions and overall in rural areas (Pacheco, 2020). More importantly, respect for the rights of children and the development of their capabilities decreases in these more fragile contexts (José Hernando & Liliana, 2011). Families and entire municipalities have been the target of violence all through history (Arias Nieto et al., 2009). For instance, in some regions the positive correlation between fertility and armed conflict evinces sexual harassment as a practice of terror within war. Hence, the terrible consequences for women and newborn infants (Castro Torres & Urdinola, 2019). Deprivation can start in the mother's womb for the children of women living in the most affected regions, as a result of potential rapes and violence (Castro Torres & Urdinola, 2019). Other evidence strongly suggests that during pregnancies, families and mothers living in municipalities and towns exposed for prolonged periods to violent dynamics and social inequality are transferring traumas and deprivation to their children, causing neurological and developmental delays (Duque, 2019). Specifically, in turbulent environments, families might be buffering the violence that is

everywhere by increasing physical aggression to their children (Ramos Jaraba et al., 2020).

In addition, in 2002 the country was suffering one of the worse economic crises of the last three decades, with high levels of unemployment, poverty, extreme poverty and internal displacement. Regions such as the capital, Bogota, had an unemployment rate of 18.2%, a poverty rate of 26.5%, and an extreme poverty rate of 5.92%, and 13,109 families relocated there (Poverty Mission, 2012; Great Household Survey, 2010; Victims Unit, 2018). Other regions were in an even worse situation, including Choco, Norte de Santander, Cauca, Caqueta, Bolivar, Nariño, Cundinamarca, Cesar, Huila, Sucre, Magdalena, La Guajira, Boyacá, Quindio and Cordoba. All these had poverty rates of over 40% and extreme poverty rates of over 10%.

Nevertheless, according to the literature, this transmission of inequality through the mechanisms of antenatal stress could be prevented, or at least tackled, if families and pregnant women could be taught how to manage stressful situations and have access to antenatal medical care. As shown by some scholars (Urizar et al., 2019), prenatal cognitive-behavioral stress management (CBSM) interventions are likely to improve stress outcomes among low-income pregnant women and perhaps infant health outcomes in the short and long term.

4.4 Hypotheses

The data has a multilevel structure with pregnant women/newborn infants nested in 33 regions including Bogota. Level 1 is the mother/newborn dyad. Level 2 represent the regional level, with 33 regions including Bogota which had the most representative sample with 16.30 % of the total; this is followed by Antioquia with 13.68 % of the total. The other regions did not reach 6% within the sample.

At the individual level we propose the following hypothesis:

(University Education Shield) Having a university education becomes a driver of well-being during pregnancy in terms of increasing the odds of giving birth to an alive son/daughter, and potentially avoiding a violent or inexplicable early loss. However, regardless of university education, regional violence modifies its shielding effect and impacts all mothers equally, except those with unknown educational levels, those more vulnerable.

At te regional level we propose the following hypothesis:

(Armed conflict). Regional violence significantly decreases the odds of giving birth to an alive son/daughter. Likewise, among those mothers who lost their sons/daughters, regional violence increases the marginal effects on the log of odds of SB-MC and early losses occurring due to violent or inexplicable events.

4.5 Data

As previously mentioned, the paper uses secondary data sources from the National Health Statistics Surveys (NHSS) of 2002, which is a cross-sectional survey that has been conducted annually since 1998 for the National Statistics Department of Colombia (DANE). It has been used extensively to examine the characteristics of key events regarding newborn infants' health. The NHSS has one database for newborn infants (700,455 but after running the model the sample was reduced to 676,498) and another for the SB-MC (14,350 but after running the model the sample was reduced to 11,675). Thirty-three regions are surveyed, including Bogota. The merged data contains 711,675 observations regarding pregnant women/newborns. The survey aims to collect information concerning certain events which occur in the event of giving birth to a baby. The data collection is based on formats that have been designed according to international standards and country characteristics. The process involves sub-national entities and sub-national healthcare dependencies. Once the "vital statistics register" for each newborn has been generated within each region, the information is collected by the DANE. As per international standards, the survey is randomized and passes through a rigorous statistical quality control. Even though there are more recent NHSS, 2002 was selected to take into account considerations regarding violence and high levels of poverty and unemployment that year. This makes up the specific scenario for our study.

Merged data in terms of CAC and regional violence allows the computation of the human victims' index, based on the databases from the NCHM's violent acts databases. These databases are made up of eleven violent acts, which are organized by region and by year. Those previously mentioned. Thus, the estimation of the regional violence level.

Table 1 below displays the descriptive statistics for the proportion distributions and variables included in the regression models, sourced from the Fetal and Alive databases of the NHSS.

Table 1
Alive and neonatal losses in 2002: Descriptive Statistics (n= 713,894, 33 regions)

Demographic features	Alive	Stillbirths and miscarriages (SB - MC) %	Violent or inexplicable loss %, from SB - MC
Marital Status			
No couple	97.21	2.79	8.14
Couple	98.34	1.66	5.85
Healthcare regime			
Contributor	98.23	1.77	4.03
Subsidiary	97.94	2.06	5.63
Beneficiary	97.67	2.33	12.96
Particular	98.64	1.36	8.94
Other	96.01	3.99	3.29
Mother's education level			
No University	98.30	1.70	4.54
University	98.70	1.30	3.61
No mention	91.70	8.43	18.53
Urban location of residence			
Rural and rural dispersed	97.62	2.38	4
Urban settlements	98.15	1.85	8.28
Mother's age			
10 - 19	98.28	1.72	6.29

20 - 29	98.35	1.65	7.54
30 - 39	97.82	2.18	6.40
40 - 54	95.43	4.57	6.03

Source: Own elaboration on Fetal and Alive surveys from 2002 National Health Statistics Survey

As shown in Table 1, from the total of the 33 regions, 713,894 women could have had a baby in 2002. However, 699,544 gave birth to a live baby and 14,350 did not. In addition, of the women who lost their babies, 1,062 (7.40%) were the result of a violent or unexplained event. The mean age of the mothers was 25.19 years. The distribution of marital status showed that 2.79% of pregnant women with no couple experienced a stillbirth or miscarriage, whereas only 1.66% of pregnant women with a couple experienced the same event. In terms of socioeconomic status, mothers without a job belonging to the subsidiary, the beneficiary and other healthcare regime present the higher percentages in experience a SB-MC. Likewise, in terms of violent or unexplained loss, highlighting the beneficiary healthcare regime (12.96%). In terms of having a university education, only 1.30% of those women who had a university education experienced a SB-MC, while those without a university or who did not mention their level of education represent almost the 10%. In addition, 18.53% of those who did not state their level of education experienced a violent or unexplained loss. Looking at the figures for women's age, the older women represent the higher figures, the women above 40 years of age represent the 4.57% of the SB - MC. Nevertheless, in terms of violent and unexplained losses, women between 20 and 29 years of age represent the 7.54%. For urban and rural locations, the 2.38% of women living in rural and rural dispersed areas experienced a SB-

MC, while only the 1.85% was for the urban areas. The opposite was true for having experienced a violent or unexplained loss.

4.6 Methods

To estimate the regional level of violence, we built a human victim index, which is the result of computing the number of victims by region and by category of violence within the National Centre for Historic Memory (NCHM) databases. We divide the number of human victims by each region's population, to be able to compute the rate of violence by region by assessing the number of victims. The eleven documented categories of violence include actions of war, kidnappings, mines, selective murders, mass murders, damage to public goods, population attacks, death of civilians by armed actions, sexual harassment, forced disappearances, children in war and terrorist attacks. It is essential to mention that all actions have equal weighting in the computation of the indicator. We embed this regional index of violence in the NHSS of unborn babies SB-MC and early losses, as well as in the NHSS of newborn infants, separately.

Our response variable Y will be a binary indicator that takes the values 0 and 1. The “logit” model is a model for the log-odds of the probability that $Y = 1$. The output is differentially defined for the two pairs of models due to the use of two different databases used to examine the manner of SB_MC and early loss. First model: 711,675 live births, unborn babies, or early losses (0 = Live birth; 1 = SB-MC and early loss). Second model: 14,350 SB-MC or early

losses, (0 = normal or identified cause of SB-MC or early loss, 1 = violent or unexplained cause of SB-MC or early loss). The explanatory variables used by our research are levels of regional violence and the mothers' university education level, and their cross-level regression coefficient. We include an educational category for mothers who did not disclose their educational level in the survey. The reason for this was to have a reference line compared to those for whom we were sure did or did not have university education. Even though we could not know their educational level, we do acknowledge the fact that in this violent context, the information collected reflects unobservable individual and administrative factors and reasons, which in this case are clearly affected by regional violence in different ways. Hence, having a different category in which we do not know a respondent's education level allows us to observe reasons other than education level. Mainly, within the NHSS for unborn babies, 20% of the women did not disclose their education levels in the survey. This must be explored in further research, delving into the reasons why there are a great number of mothers who did not disclose their educational levels.

All the multilevel models respond to the nested structure of the surveys where the dyad (pregnant woman/unborn baby or early loss) is nested in regions. We defined a two-level model: regions (33), and mothers/newborns (714,805). However, due to missing values the first part of the models used only 11,675 observations. For the

second part, we merged the two databases and used the 678,498 observations available.

$$\begin{aligned}
 & \text{Log Odd Prob } (Y_{ij}) = 1 \\
 & = \beta_0 + \beta_1(RV_j) + \beta_2(MHE_{ij}) + \beta_3(RV_j \times MHE_{ij}) + \beta_4(Age_{ij}) \\
 &) + \beta_5(\text{healthcare regime insurance}_{ij}) + \beta_6(\text{Marital Status}_{ij}) + u_j
 \end{aligned}$$

The equation above uses a cross-level interaction. In this general multilevel logistic model, Y is the one of the newborn well-being outputs, i is the newborn/pregnant women living in region j . The first component of the model, β_0 , is the intercept. β_1 is the regression coefficient for the regional violence indicator; β_2 is the regression coefficient for mothers with university education; β_3 is the regression coefficient for the interaction between regional violence and mothers having a university education; β_4 is the mother's age (on average 19, 29, 39 and 54 years old); β_5 is for her healthcare regime / insurance (based on Law 100 of 1993, five inferred categories of income and health care access); β_6 for her marital status (having a partner/husband or not). Finally, u_j is the random effect at the region level with normal distribution, zero mean and variance to be estimated. We conduct four multilevel models: two for the merged surveys to compute the effect on a live birth or otherwise, and two for the unborn baby survey. The only difference between them is the output.

We now present the results of the four multilevel models conducted. It should be pointed out that our results considered the marginal

effect on the log of odds as constant, while the predicted probabilities are not constant. Thus, we choose a baseline for each variable as a reference point. The baseline then is defined as the values of the covariates of one category with respect to the value. All the models were defined as two-level models with regions and the mother/newborn dyads. Model (1a) merges both databases without the cross-level interaction effect and computes the odds of a live birth. Model (1b) uses the same databases while considering the cross-level interaction effect on the odds of a live birth or experiencing a SB-MC or early loss. Going further, Model (2a) only considers the unborn baby or early losses databases with no cross-level interaction between regional violence and mothers with university education. Model (2b) consider same unborn baby or early losses databases with the cross-level interaction effect.

4.7 Results

Table 2 presents the regression coefficient and the standard error for the main two models (1a and 1b). For a deeper exploration we included a secondary pair of models (2a and 2b). All the range of variables were included in the four multilevel logistic regression models.

One first relevant result concern the differential effect of regional violence on newborn well-being when considering the standard error across the 33 regions including Bogota. In Model 1a we observe that the level of regional violence significantly increases the negative effect on newborn well-being, defined as a live birth (-

0.942), and (-0.946) in model (1b). Hence, proving the first part of our second hypothesis regarding the diminishing effect of regional violence on the odds being born alive.

Considering the mother's university education, the log of odds for model (1a) was (1.306), and for model (1b) was (1.439), using a mother with no university education as a baseline. Mothers who did not disclose their education level showed a regression coefficient of (-0.228) for model (1a) and (-0.329) for model (1b). This suggests that a university education significantly increases the log of odds of a respondent's pregnancy resulting in a live birth. Hence, proving the first part of our first hypothesis regarding the advantage and shielding effect of maternal university education for newborns well-being.

In model (2a and 2b) of Table 2, we notice that regional violence level significantly increases the negative effect on newborn well-being, defined as being more prone to suffer a violent or inexplicable death. The regression coefficient for regional violence is (-1.099) for model (2a) and (-1.074) for model (2b). Hence, regional violence increases the odds of experiencing a SB–MC. Its regression coefficient reduces in model (2b), when the cross-level interaction effect is computed.

Table 2
Multilevel logistic regression coefficient estimates and standard errors on newborn well-being

	Log odds for a live birth n = 676,498		Log odds for experiencing a violent or inexplicable SB-MC n = 11,675	
	1a	1b	2a	2b
Regional Violence	- 0.9428 *** (0.0015)	- 0.9466*** (0.0016)	1.099 ** (0.0336)	1.074** (0.0338)
Education (no University)	baseline	baseline	baseline	baseline
University Education	1.3061 *** (0.061)	1.4399*** (0.0975)	- 0.555 ** (0.247)	-0.3190* (0.1812)
Unknown	-0.2281*** (0.007)	- 0.3297 *** (0.0187)	5.372*** (0.095)	2.043** (0.543)
Married or Having a Partner	1.7697*** (0.022)	1.772*** (0.0391)	-0.884 (0.0834)	-0.862 (0.0817)
Average Age in Years	- 0.9706*** (0.0011)	- 0.970*** (0.0011)	-0.992 (0.005)	-0.992 (0.005)
Urban Housing	1.1915*** (0.0265)	1.195*** (0.0267)	1.509*** (0.173)	1.511*** (0.1744)
healthcare regime and formal Job Status				
Contributor - earning at least 1 MLWS	base line	base line	base line	base line
Subsidized - no income or under 1 MLWS	- 0.957 (0.0242)	- 0.956* (0.242)	1.444* ** (0.188)	1.418 ** (0.1842)
Beneficiaries - by couple or parent	- 0.8894*** (0.0229)	- 0.888*** (0.0229)	4.976*** (0.631)	4.896*** (0.6621)
Private - high income	1.696*** (0.078)	1.689*** (0.078)	2.044 ** (0.483)	2.026 ** (0.480)
Particular – paying for healthcare services	- 0.460*** (0.0223)	- 0.459*** (0.0223)	-0.7173 (0.2082)	- 0.709 (0.205)
CROSS-LEVEL INTERACTION: Regional Violence and Education				
University	0	- 0.9873* (0.0064)	0	1.051 (0.447)
Unknown	0	- 0.9631*** (0.0044)	0	1.081*** (0.0214)

Level 2 - Variance	1.675 (0.605)	1.70 (0.614)	2.652 (0.898)	2.705 (0.921)
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*Own elaboration, based on the National Health Statistics Survey of 2002, Poverty Mission 2012, and National Centre of Historic Memory databases

*Coefficients Standard errors in parentheses - Significance,

*** p<0.01, ** p<0.05, * p<0.1

General Model *Prob > chi2 = 0.0000

R2 = 0.545

*Marginal effects on the log of odds are constant, while the predicted probabilities are not. Thus, we choose a baseline for each variable, computed as a value that is covariate to the output.

*Note: control variables are Gender, healthcare regime, Marital Status, Medical tests attended, labor Typology, Number of living children and number of deceased children. Also, regional macro socioeconomic indicators: poverty, unemployment, and displacement.

*The reduction in the value of n does not represent a geographical bias, but rather to the exclusion of cases due to missing information regarding other independent variables. This exclusion is done to ensure the integrity and reliability of the model results. It's important to note that the lack of information on certain variables can distort the model results, as it affects the model's ability to adequately capture and explain variability in the data. Therefore, excluding cases with missing data is a standard procedure in statistical analysis to ensure the validity of the results.

When considering the cross-level interaction (since the mother's university education is a level 1 variable while regional violence is a level 2 variable) we interpreted the results as the effect of the level 1 explanatory variable (the mother's university education) on the response variable Y, which is a binary indicator that takes the values of 0 or 1. 1 is a live birth. Thus, the effect of a mother's university education is modified by the level 2 explanatory variable (regional violence). This is statistically known as the *effect modifier* (Pekka et al., 2004). In this case, regional violence modifies the effect of a mother having a university education on the log of odds of experiencing a stillbirth, miscarriage (SB-MC) or early loss. For all four models, the regression coefficient indicates that having a university education reduces the risk of losing the baby moreover from a violent or unexplained event. However, the cross-level interaction implies the opposite, thus diminishing/ modifying the protective/shielding effect of a university education.

Likewise, the effect was modified when the cross-level interaction in models 1b and 2b was computed. We noticed that when computing the cross-level interaction, the effect on newborn well-being of their mother having a university education depends on regional violence (i.e., the effect is not always the same, but changes according to the degree of regional violence). In addition, where violence is high, the odds of being able to complete university studies before giving birth are less compared to regions that are less affected by violence such as Bogota, Amazonas or the San Andres Islands.

As mentioned in the Methods section, we included an educational category for mothers who did not disclose their educational level. The results leverage the vulnerability of this group of women with unknown educational level. Across the two models, the cross-level interaction shows the same modification effect as mothers with university education, but greater in magnitude. A mother's university education is modified by regional violence. In model 1b, the effect of modification for university education shows a regression coefficient of (-0.987 with a p value of 0.052) and in model (2b) of (0.05 with a p value of 0.242) both not significant. For those who did not disclose their education level, the cross-level interaction was significant (-0.963) for model 1b and (1.08) for model 2b but was not significant. Other demographic controls in the results in Table 2 show that single mothers with no university education were more prone to experiencing a SB-MC or early loss than when they had a university education. For instance, in regions

such as Antioquia or Magdalena, no highly educated single mothers between 20 and 29 years of age suffered a stillbirth, miscarriage (SB-MC) or early loss. Counterintuitively, under the same conditions, when computing the total effects on each newborn's well-being, mothers who had university studies and were married or living with a partner were more prone to experiencing SB-MC or early loss compared to mothers who had university studies and were living on their own.

In a similar way, when considering healthcare regime / insurance regime and a approximation of job status, Table 2 shows that mothers who did not have a formal job were less prone to having a live birth from those in the contributor healthcare regime. For instance, mothers in the subsidized regime, considered the poorest, showed a not significant correlation coefficient of (0.957 with a p value of 0.83 and 0.956 with a p value of 0.083, Models 1a and 1b respectively). However, the results suggests that those same mothers who belong to the subsidiary healthcare regime (i.e., whose healthcare regime / insurance is subsidized by the state due to their vulnerable economic status, such as not having a job or earning less than the minimum wage) were more prone to experiencing a violent or inexplicable SB-MC or early loss than those in the contributor healthcare regime, with a coefficient of (1.444 and 1.418, Models 2a and 2b respectively, both with significant p values of 0.000). When mothers belong to a beneficiary healthcare regime (those whose husbands or parents work and thus include her in their healthcare regime / insurance) they were less prone to having a live

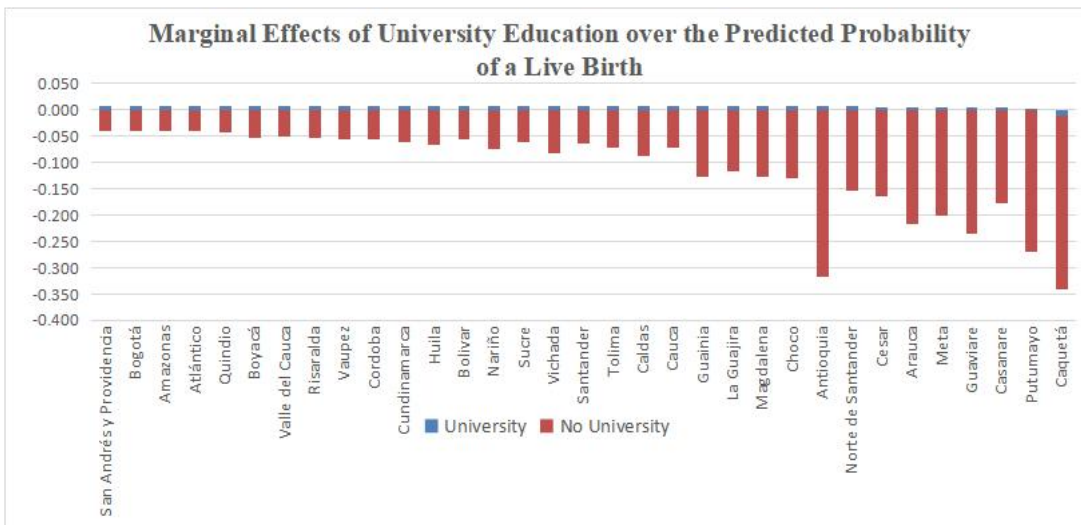
birth whereas more prone to experiencing a violent or inexplicable SB-MC or early loss. The most affected women in terms of not having a live birth, were women in the Particular healthcare regime, those who had to pay for healthcare services or did not belong to any healthcare regime. Those in the “Particular” healthcare regime shows a correlational coefficient of (-0.460 and -0.459, Models 1a and 1b respectively) whereas the most advantaged were those women who had “Private” healthcare regime, those with high income, with a significant correlational coefficient of (1.69 Model 1a, and 1.68 Model 1b).

According to the results, mothers who were married or living with a partner were significantly more prone to having a live birth (models 1a and 1b). However, the results are not significant to avoid a violent or inexplicable SB-MC or early loss. These findings leverage the previously proved idea of couples buffering the turbulent environment within the household, thus affecting the in-utero period of living in terms of having a live birth. This might be link to the uninformed educational level by 20% in the NHSS of unborn babies, SB-MC and early losses.

Figure 1 illustrates the marginal effect of university education over the predicted probability of a live birth by regions. It leverages the distribution of the marginal effect by the mother’s educational level. Both Figure 3 and Figure 4 show the diminishing effect of regional violence on the correlation between university education and newborn wellbeing. Hence, we add more evidence to our first

hypothesis, which states that women who finished their university studies were more likely to have live births, with a coefficient of (1.306) in Model 1a and (1.439) in Model 1b, considering the cross-level interaction in Table 2. For mothers with university education who live in the most violent regions such as Arauca, Meta, Casanare, Caquetá or Putumayo, the marginal effect on the predicted mean sharply decreases. However, mothers with university-level education were more likely to be able to tackle adversity and moderate the harmful effects of violence in regions less violent. Thus, pregnant women with university-level education who live in regions that are less affected by violence, such as Bogota, Huila or Nariño were more likely to tackle and reduce the harmful residual effect of violence over their unborn babies than those living in the most affected regions such as Antioquia, Caquetá, Guaviare, Putumayo or Meta.

Figure 1.

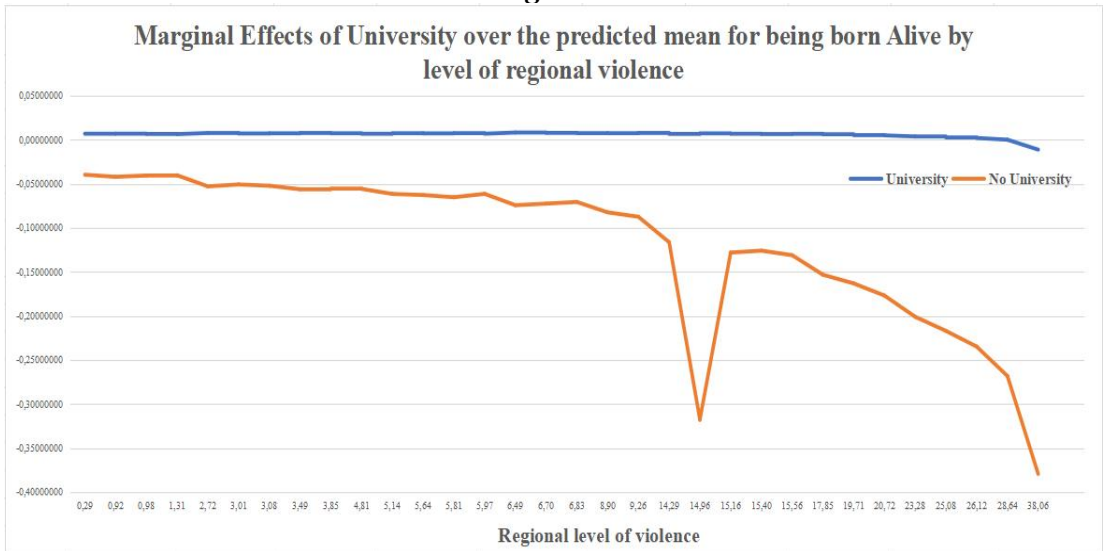


Source: own elaboration, based on the Model 1b results
Marginal effects on the log of odds are constant, while the predicted probabilities are not. Thus, we choose a baseline for each variable, computed as a value that is covariate to the output in Table 2

The evidence suggests that mothers with a university education who live in regions that are less affected by violence were more prone to having a live birth. Likewise, those mothers who were able to finish their university studies were less prone to experiencing a SB-MC or early loss than those who live in the same region and have no university education or who did not disclose their education level. Nevertheless, as illustrated in Figure 2, the *effect modification* of regional violence reduced the shielding effect of university education on the log of odds for newborn well-being. Proving our second part of the first hypothesis. As mentioned above, the regions that were most affected by violence were highly turbulent for women with a university education. Nevertheless, the shielding effect was still able to protect the unborn baby but not significantly differentiated from those without university education.

Figure 2 illustrates the marginal effect of university education on the log of odds of a live birth, considering the level of violence in the region. When computing the cross-level interaction between regional violence and a mother's university studies, we observed a decrease in the log of odds of a live birth occurring (Model 1b). This might be due to the existence of a significant and negative correlation between regional violence and the number of mothers with university studies.

Figure 2



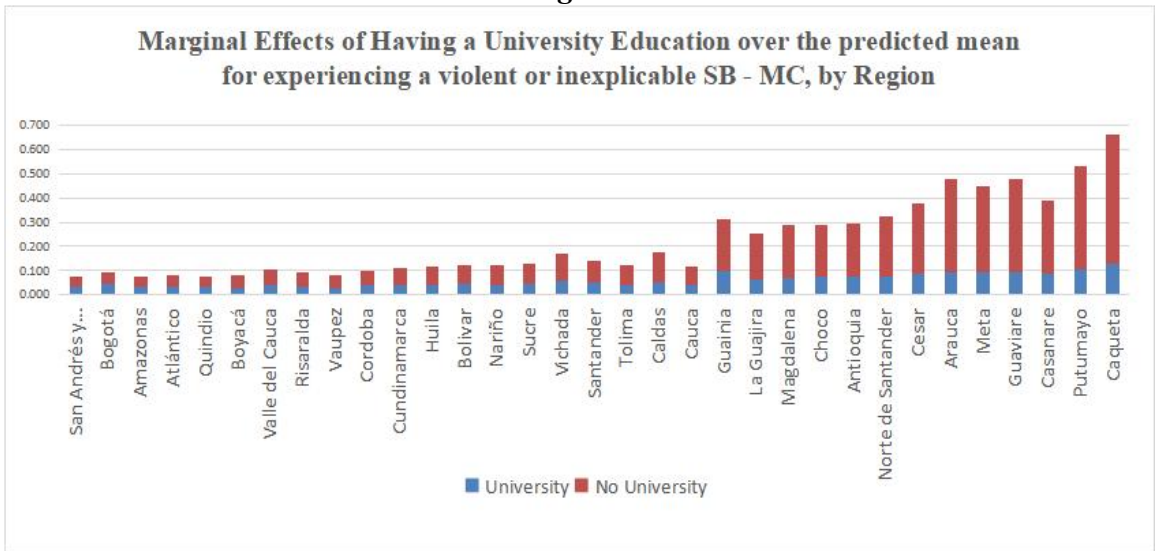
Source: own elaboration based on the Model 1b results in Table 2

Marginal effects on the log of odds are constant, while the predicted probabilities are not. Thus, we choose a baseline for each variable, that is computed as a value that is co variate to the output in Table 2

It may be caused by the lack of state presence and capacity to make those regions safe and invest in the more severely affected regions to improve macroeconomic features such as employment or even access to higher education. Here, the *effect modification* leverages the diminishing trend of university education shielding newborn well-being, which is slightly decreasing due the higher levels of regional violence. Nevertheless, it decreases sharply for mothers with no university education and no shield in that area of well-being; these are women that could not access higher education or were not willing to disclose their educational level. In addition, Figure 2 illustrates that independently of their education level, mothers that live in areas that are most affected by violence from the armed conflict were more prone to experiencing a SB-MC or early loss and less prone to having a live birth.

Delving deeper into the analysis, Figure 3 presents the marginal effect on the predicted mean of experiencing a violent or inexplicable SB-MC or early loss (Model 2a). Figure 3 shows that women with no university education who were living in regions that were most affected by violence such as Meta, Caquetá, Putumayo and Guaviare were more vulnerable in terms of experiencing a violent or inexplicable SB-MC or early loss than those who did have a university education. In this scenario, the shielding effect of a university education is maintained (see model 2a). It is important to note that the results are obtained by keeping all the other model variables values invariable while considering the standard deviations between area of residence.

Figure 3



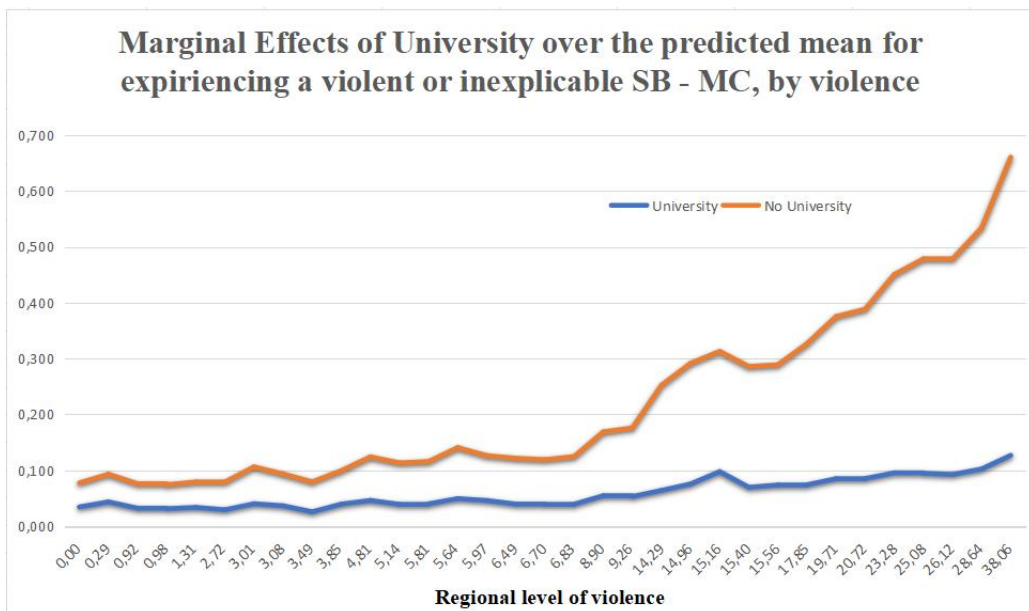
Source: own elaboration based on Model 2a results.

Marginal effects on the log of odds are constant, while the predicted probabilities are not. Thus, we choose a baseline for each variable that is computed as a value that is covariate to the output in Table 2

When considering the cross-level interaction between regional violence and a mother's educational level, mothers with a university

education were not significantly more likely to avoid a violent or inexplicable loss compared to those with no education or those who had not disclosed their education levels. Figure 4 illustrates the correlation between regional violence and the rise of the marginal effects on the log of odds of experiencing a violent or inexplicable SB-MC or early loss. The worst region was Caquetá with a level of violence of 30.61.

Figure 4



Source: own elaboration based on the Model 2b results

Marginal effects on the log of odds are constant, while the predicted probabilities are not. Thus, we choose a baseline for each variable, computed as a value that is covariate to the output in Table 2

The three categories of women with varying education were differently modified by regional violence, suggesting that mothers with university education were also highly impacted by regional violence, reducing their educational advantages. Furthermore, when computing the cross-level interaction coefficient, the *modifier effect*

was high enough to erase the shielding and protection effect of having a university education from those who did not have university education but no from those with unknown education. Hence, we suggest that there are unobserved factors within the category of women that have not disclosed their level of education, mainly in the NHSS for unborn babies, stillbirths, miscarriages and early losses. In addition, when considering the cross-level interaction between regional violence and a mother's university education in Model 2b, mothers who had had the opportunity to finish their university education were less prone to experiencing a violent or inexplicable SB-MC or early loss than those who had not been able to study at university or did not disclose their level of education. However, as presented in model 2b, having a university education was not significantly modified by regional violence.

According to previous results, there is a significant impact on increasing the log of odds of experiencing a stillbirth, miscarriage or early loss when mothers were not able to have a university education, as shown in Figures 1 and 2 and Models (1a) and (1b). However, we found insignificant evidence that suggests that regional violence could affect more those women with university education due to the *modifier effect* of violence. Those mother without university education were also more likely to experience a violent or inexplicable loss when the regional level of violence was high, as seen in Figures 3 and 4 and Models (2a) and (2b). We propose that pregnant women with a university education were at a higher risk of experiencing SB-MC or early loss when residing in

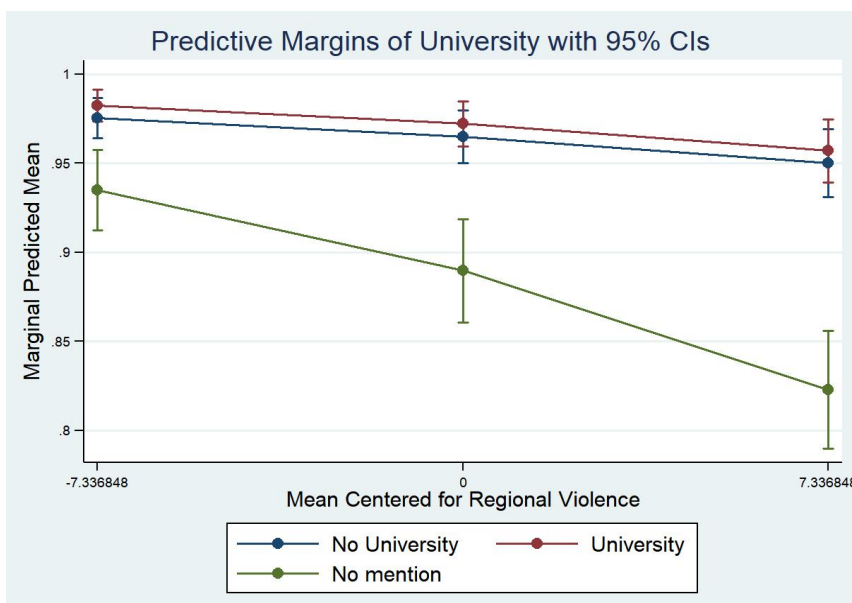
regions most impacted by violence, including Caquetá, Putumayo, Casanare, Guaviare, Meta, Arauca, Cesar, Norte de Santander, Antioquia, Chocó, and Guainía, compared to those with a university education residing in less affected areas. Similarly, they were more likely to report SB-MC in these highly affected regions than women without a university education. However, within less affected regions by violence, such as Bogota or Amazonas mothers with university education were more prone to protect the dyad, thus the newborn well-being. Along the same lines, regional violence had a higher *effect modifier* on women with university education and who has not disclosed their education levels than those without university education. Further research is required.

Testing the Cross-Level Interaction, *Modifier Effect of Violence on Maternal Education*

In this section, we will present the results of the test run for the multilevel model that contains the effect modifier according to the educational level of the mothers. It is important to note that mothers with the educational category "not mentioned" are mothers who did not respond to the educational level question. More details are presented in the Appendix. Taking into account the above, after we test the cross-level interaction and the effect modifier, we will proceed to a descriptive analysis that will provide us with more information to identify the characteristics of these mothers, which, according to the results, suggest that they are the most vulnerable in terms of not giving birth to an alive son/daughter and also of experiencing SB-MC and early losses.

Figure 5 presents the results of the cross-level interaction and *effect modifier* between regional violence and mothers' educational level. For this, we centered the mean of regional violence and subsequently obtained the marginal effects of the moderating effect on the probabilities of being born alive in the multilevel model.

Figure 5.



Source: own elaboration based on Model 1b results.

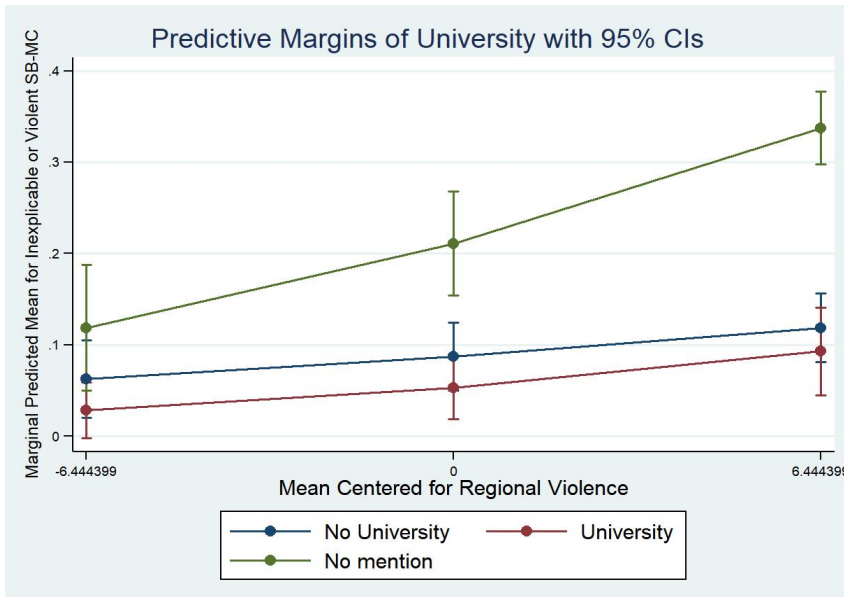
Marginal effects on the log of odds are constant, while the predicted probabilities are not. Thus, we choose a baseline for each variable, computed as a value that is covariate to the output in Table 2

Having the regional violence mean-centered, one standard deviation below, and one standard deviation above the mean, the results show a low level of significance of the cross-level interaction effect modifier. That is, regardless of the mothers' college education, the level of regional violence will always marginally decrease the probability of being born alive. However, in the (Not mentioned)

category, the significance levels of the cross-level interaction effect modifier are significant. That is, those mothers who did not report their educational level were the mothers who were most affected by the level of violence. Despite this finding, we must say that although the shielding effect of university education is affected by the effect modifier of regional violence making it insignificant compared to those mothers with no university education, it is also true that those mothers with a university education continue having marginally more likely to give birth to an alive son/daughter, as shown in Figure 5, the red line, which is above the blue line (no university education) and the green line (Not mentioned).

Similar results were obtained for the marginal effects of the cross-level interaction effect on the predicted mean for experience a violent or inexplicable stillbirth or miscarriage. Figure 6.

Figure 6



Source: own elaboration based on Model 1b results

Marginal effects on the log of odds are constant, while the predicted probabilities are not. Thus, we choose a baseline for each variable, computed as a value that is covariate to the output in Table 2

Fig. 6 shows how regardless of the mother's level of education, regional violence continues to affect children's well-being. That is, regardless of educational level, those mothers who lived in the most violent regions were more likely to suffer an unexplained or violent loss of their child. However, mothers in the "Not mentioned" category were more likely to suffer such violent or unexplained losses (Appendix). Likewise, it is in the most violent regions where such women, as well as women with no university education, are most at risk.

4.8 Discussion

The results suggest that mothers with university education were more likely to have a live birth compared to less educated women. Furthermore, when looking at the cross-level interaction, we found

an effect modifier of regional violence on maternal university education. This effect modifier reduced the shield/protection provided by university education, making it practically insignificant compared to mothers with no university education. However, this effect modifier exploits the advantage of university educated mothers living in less affected regions to give birth to a live baby and also to be better able to avoid a violent or unexplained SB-MC.

Previous findings should be further explored, taking into account possible correlations between maternal demographic characteristics and other contextual variables such as poverty, unemployment and regional health care services performance. Nevertheless, we suggest that the modifier of the regional violence effect increases for university educated mothers due to the significant mismatch between the socioeconomic and demographic reality of the region and women's expectations. This results in a lack of opportunities to face adversity more effectively and to make progress by studying before childbirth and during the first year of a newborn's life. This is likely to be worse in highly privatized higher education systems, such as Colombia's, where student loans were and still are the general condition for access to university education. However, after testing, we find that mothers with a university education were better able to cope with adversity, and thus protect the dyad as a whole, if they lived in regions less affected by armed conflict. They were also more likely to avoid violent or unexplained SB-MC or early loss.

Our findings add more evidence of the effect of regional violence on newborn health, beyond violence at the municipal level (Duque, 2017). We have gone further in exploring this paradoxical relationship by considering the protective/shielding effect of a mother's educational level in terms of reducing the harmful effect of violence on newborn well-being. Furthermore, in testing the *effect modifier* of regional violence over mother's education. Other demographic features should be taken into account in further research, such as ethnic background, medical background, occupation, life stories, household dynamics, family environment, and others which according to the Ecological Theory of Urie Bronfenbrenner (1979) reinforce their roles within the dyad and might be correlated with pregnancy outcomes.² We also add evidence to earlier findings in the Vital Statistics descriptive and empirical research in Colombia (Márquez-Beltrán et al., 2013; Ramos Jaraba et al., 2020). One of these medical and population studies analysed 14,520 women included in the 2010 National Health Statistics Survey and showed a negative and significant association between higher levels of regional violence and neonatal outcomes using bivariate analyses, binomial regression and stratified models by age (Ramos Jaraba et al., 2020). One systematic cause is the negative relationship between healthcare systems and violence in armed conflict, which has been evidenced (Bernal et al., 2024; Squibb, 2020). Regardless of these findings, the present research has obtained significant evidence of the

² Nevertheless, it is relevant to mention the lack of data regarding other developmental dimensions for mothers in our regression models, such as ethnicity or levels of student debt .

shielding effect of a mother's university education for having a live birth and avoiding losing the infant violently or inexplicably when regional violence is low. This is clearly a step forward from earlier paradoxical results obtained by previous researchers in terms of newborn weight and the odds of being preterm.

4.9 Appendix

We now proceed to present some descriptive statistics that allow us to identify the profile of those mothers who chose not to report their educational level or the data were not collected within the NHSS. We present the region where they were living, their health status, their age, their marital status, and their urban or rural location. As Table 3 shows, 4.43% of those women were living in the Urban area whereas the 5.35% were living in the rural and rural dispersed areas. The 3.62% of those women had a couple whereas the 3.11% had no couple and the rest 93% we do not know their marital status. The 8.86% were 29 or less years old whereas the 9.97% were above 29 years old. The 14.6% had no healthcare regime insurance and the had to pay for healthcare services. Finally, the most relevant regions in terms of "Not mentioned" maternal education category were Tolima (14.08%), San Andrés (12.20%), Amazonas (12.08%), La Guajira (11.57%), Guainía (10.36%), Risaralda (8.73%), Putumayo (8.03%), Norte de Santander (7.73%), and Vichada (7.53%). Figures are presented in Table 3.

Table 3. Women with “No informed Education Level”

Demographics maternal features	Not informed Education Level
Urban	4.43%
Rural	5.35%
With a Partner	3.62%
No Partner	3.11%
Ages	
< = 29 year old	8.86%
> = 29 year old	9.97%
No healthcare regime	14.59%
Regions	
La Guajira	11.57%
Tolima	14.08%
San Andrés Islands	12.20%
Amazonas	12.08%
Guinía	10.36%
Norte de Santander	7.73%
Vichada	7.56%
Putumayo	8.03%
Risaralda	8.73%

Source: Own elaboration from NHSS 2002

Table 4 presents the coefficients for an OLS model for women years of education taking as base line not informed. We compute the odds of ratio in a logistic regression model with a numerical dependent variable defining as independent variable the 33 regions previously assessed.

Table 4. (OLS) Regression Model on Years of Education, n = 676,498

Year of Education	Coefficients and SD ()
Age	0.0089*** (0.0005)
Marital_Status	- 0.059*** (0.010)

Urban	1.8021*** (0.010)
Health_Job	
Contributor	0 (base)
Subsidiary	-2.971*** (0.010)
Beneficiary	-2.851*** (0.010)
Particular	-2.638*** (0.015)
Private	-2.057*** (0.028)
Region	
Antioquia	0 (base)
Atlántico	0.814*** (0.020)
Bogotá	0.999*** (0.014)
Bolivar	0.560*** (0.022)
Boyacá	0.424*** (0.0251)
Caldas	-0.164*** (0.028)
Caqueta	-0.443*** (0.044)
Cauca	-0.061*** (0.027)
Cesar	0.201*** (0.027)
Cordoba	0.389*** (0.025)
Cundinamarca	0.481*** (0.020)
Choco	0.431*** (0.051)
Huila	-0.171*** (0.024)
La Guajira	0.476*** (0.036)
Magdalena	(0.397)*** (0.027)
Meta	-0.166*** (0.030)
Nariño	-0.004*** (0.025)
Norte de Santander	-0.295*** (0.025)
Quindio	0.35*** (0.036)
Risaralda	-0.458*** (0.029)
Santander	0.067*** (0.021)
Sucre	0.213*** (0.031)
Tolima	0.186*** (0.023)
Valle del Cauca	0.393*** (0.017)
Arauca	-0.083** (0.048)
Casanare	-0.154*** (0.046)
Putumayo	0.512*** (0.05)
San Andrés y Providencia	1.746*** (0.110)
Amazonas	0.073 (0.096)
Guainia	-1.069*** (0.137)
Guaviare	-0.190*** (0.091)
Vaupéz	-0.555*** (0.149)
Vichada	-0.0334*** (0.123)

Source: Own elaboration based on databases of the NHSS, Fetal and born Alive 2002.

Table 4 presents the findings from the ordinary logistic regression model. The analysis reveals a significant association between

regional violence and the likelihood of women either lacking education or choosing not to disclose their educational attainment. This suggests that higher levels of violence are linked to fewer years of education and reduced willingness to disclose educational status. Specifically, compared to Antioquia, regions heavily impacted by violence, as well as those with high poverty rates or proximity to affected areas such as Caqueta, Guaviare, Putumayo, Meta, Casanare, Norte de Santander, Guainía, Guaviare, Vaupez, Vichada, Huila, Risaralda, Arauca, Nariño, and Cauca, are associated with lower levels of education.

Regarding marital status, women in relationships are more likely to withhold information about their education. Furthermore, urban-dwelling women tend to have higher levels of education, thus a greater likelihood of university education. In terms of healthcare, women with higher education levels are more likely to be employed and enrolled in the contributive healthcare regime, which may lead to underreporting of educational attainment compared to women in subsidiary, beneficiary, or other regimes.

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CHAPTER 5

Stillbirths miscarriages and early loses in armed conflict contexts. The modification effect of violence. The Colombian case. (1998 - 2007)³

5.1 Abstract

Background: Colombia experienced a prolonged armed conflict that affected differently regions and periods. We explored how this regional violence influenced the well-being of newborns, using data from the National Centre of Historic Memory (NCHM) and the NHSS. The NCHM recorded the number of victims, while the NHSS reported data on births, stillbirths, and early losses.

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Mera L. Harold. *Stillbirths, miscarriages and early losses in armed conflict contexts. The modification effect of violence. The Colombian case.* <https://www.sciencedirect.com/science/article/pii/S0277953623005324> . Social Science and Medicine Journal. Oct 2023; Vol 334

Aim: We aimed to assess the impact of regional violence on newborns' well-being and to examine whether mothers' university education mitigated these effects. We focused on comparing two periods: 1998-2002 and 2003-2007, and two group of regions which differed in the intensity and distribution of violence.

Methods: We applied a difference-in-differences approach and logistic regression analysis to estimate the odds of stillbirths and miscarriages in regions exposed to violence during the treated regions. We also estimated the interaction effect between treated groups and mothers' university education.

Findings: We found a significant association between living in the most violent regions and having a higher risk of stillbirths, miscarriages, or early losses (OR: 1.721). Women living in less affected regions had a higher probability of giving birth to live babies and preserving the dyad. However, we observed a negative modifier effect of violence on the likelihood of live births for mothers with university education (OR:1.273).

Discussion: We observed that the effect modification points to a higher impact of stress on mothers with university education in violent regions and periods compared to those without higher education. These findings unveil the concealed impact of regional violence, which diminishes the protective influence of maternal education, regardless of the level attained.

Keywords: Stillbirth, Miscarriage, Regional Violence, Maternal University Education

5.2 Introduction

According to the literature, an integral perspective of newborn well-being within war and armed conflict contexts must put emphasis on analyzing stillbirths (SB), miscarriages (MC) and early losses (Akthar, 2019; Valente, 2015). It is recommended to include pregnancies that had these outcomes in order to clearly observe the effect of violence on early well-being. On this basis, between 1998

and 1997, one of the most violent periods in the last six decades of the Colombian Armed Conflict (CAC), 197,715 women experienced a miscarriage (MC), stillbirth (SB) or early losses. Guainía (10.39%) with a precarious healthcare system, San Andres (14.98%) a pass through narcotraffic routes to Mexico and the North, Antioquia (5.69%) and Tolima (4.87%), both regions historically held by the paramilitary and urban and rural violence, and Huila (4.66%), the poorest region (with a poverty rate of 64.12%) in 2002 and pass through for the guerrillas, were the regions that had the highest rates of SB-MC and early losses. Furthermore, Cordoba (32.87%) highly affected by poverty and forced displacement, Tolima (11.54%) and Caldas (18.52% - located between Antioquia and Tolima) had the highest rates of violent or inexplicable losses, according to the NHSS.

The scientific community has recognized that an armed conflict context is a threatening and turbulent environment for healthy pregnancies, early childhood well-being, and people's life courses in general (Akhtar, 2019; Castro et al., 2019; Duque, 2017; Hong et al., 2021; Jaraba et al., 2020; Lee, 2014; Mendoza et al., 2016). We build upon this sociological premise by examining the case of the turbulent environment reigning in Colombia between 1998 and 2002. During that period, compared to the 121,844 victims between 2003 and 2004, 16,607 more people were victims of one of the eleven (11) categories of violent acts in armed conflict: actions of war, murders, attacks on the population, terrorist attacks, damage to public goods, forced disappearances, mass murders, antipersonnel

mines, recruitment of children, kidnappings and sexual violence. Hence, our starting point is the fact that regions and pregnant women were highly exposed to different levels of violence. The combination of war and social inequality in health care and education likely led to different but even higher levels of stress manifested in stillbirths, miscarriages (SB-MC) and early loses. Despite the lack of data and the low intensity and reach of the CAC, we show that due to the sharp slope of violence experienced between 1998 and 2002 and the combination of available data, the regional impact of violence on the well-being of newborns could be estimated.

We noticed the existence of several unobserved factors at the regional level and across women that should be included in further explorations, including household living conditions, quality of subnational healthcare systems, maternal clinical stories. Therefore, and because of the structure of the Vital Survey, we approach the issue from a difference in difference fixed effects model adjusting for the standard errors of a cluster of 330 regions-year-violence estimators (one for each of the 33 regions and the 10 years). First, we compute the regression coefficients for a SB-MC comparing two group of regions (Most affected and less affected) in two different periods (1998-2002 and 2003-2007); furthermore we use a matching technique to compare two regions, Meta and Tolima (one highly affected and the other one low affected) in the same periods than in the first model. Both models estimate the interaction and the *modification effect* between regional violence and a mother's

university education. We control for other maternal demographic features such as age, area of residence, an approximation of socioeconomic stratification as healthcare regime / insurance, and marital status. We focus on a mother's university education and complement the evidence gathered by other researchers in Colombia (Beltrán et al., 2013; Jaraba et al., 2020) concerning maternal higher education and outputs related to newborn infants.

5.3 Theoretical framework

5.3.1 Stillbirths, miscarriages and early loses

According to the World Health Organization, it is estimated that every year, 2.6 million stillbirths occur. A stillbirth is understood as the death of an unborn baby after 28 weeks of gestation, before birth or during it (Allanson et al., 2016). A miscarriage is understood as when this happens before 28 weeks of gestation. Approximately 40% of all stillbirths occur during the birth process (Allanson et al., 2016; Hug L. et al., 2021), and between 10% and 15 % of miscarriages are experienced by women who knew they were pregnant (Purdie, 2019). The causes explored by medical and health research concern complications in labor, post term pregnancy, maternal infections such as malaria, syphilis and HIV, and maternal conditions, especially hypertension, diabetes, and fetal restriction. Likewise, global research has found that for low and middle income countries, the causes for 43.7% of stillbirths were unexplained, 18.7% were due to an unspecified condition, 13.7% due to a placental condition, 11% due to a specific fetal/pregnancy pathology, 9.1% due to a antepartum hemorrhages, and 3.8% to

other known causes (Reinebrant et al., 2018). Most of the cases of stillbirths (98%) occur in low-income and middle-income countries (Almasi-Hashiani et al., 2017). The consequences go beyond the newborn well-being, and imply psychological consequences for women, especially women in vulnerable conditions in terms of exposure to stress (Allanson et al., 2016).

Recently, a ten-country case study presented insights concerning women's and children's healthcare services in armed conflict contexts such as Afghanistan, Colombia, Democratic Republic of the Congo, Mali, Nigeria, Pakistan, Somalia, South Sudan, Syria, and Yemen (Singh et al., 2021a). They found that despite the variations in policies and local conflict dynamics, in all the contexts, the health care measures present included the following: antenatal care, basic emergency obstetric and newborn care, comprehensive obstetric and newborn care, immunization, infant and young child feeding and nutrition, treatment of common childhood illness, and screening (Singh et al., 2021a). The study presented evidence to recognize that armed conflict contexts are a complex scenario in terms of variables linked to data concerning women's and children's health, and other contextual and demographics considerations. Nevertheless, health science studies make it clear that one common issue in terms of health policy was that in the ten countries, the women's and children's healthcare services lack tools specifically designed to help women and children, or interventions to address stillbirths and they are often included in general

reproductive, newborn, and adolescent healthcare services (Singh et al., 2021a).

5.3.1 Maternal education

Beyond the medical and health causes of well-being distress during the in-utero, antenatal, and pregnancy period, there are other demographic and economic factors that are likely to impact women's pregnancies that drive the newborn well-being (Agustine et al., 2014). Empirical research conducted in Iran presented evidence about the probabilities of stillbirths when considering parental demographic features such as education or age (Almasi-Hashiani et al., 2017). There was a significant increase in the odds for stillbirths for mothers between 15 and 25 years of age, and for those with lower economic status (Almasi-Hashiani et al., 2017). Complementary research conducted in Canada has shown evidence of the protective effect of maternal education to avoid stillbirths (Luo et al., 2006). Along the same lines, other research in Australia has shown the high distribution of stillbirths among mothers with lower levels of education and those with public healthcare regime / insurance (Rodríguez, 2022; Squibb, 2020; Hug L, 2021). For instance, the literature suggests that socioeconomic inequality in terms of access to higher levels of education, income and healthcare services are likely to diminish in-utero well-being (Agustine et al., 2014). Complementary to this, there is scientific evidence that leverages the direct and significant correlation between university education and antenatal tests and pregnancy monitoring. This finding, among the widely acknowledged of socioeconomic benefits

for having university education (Agustine et al., 2014), make it plausible that levels of knowledge about pregnancy and birth might be correlated to the mother's higher educational profile or higher educational levels, thus leading to those with a university education taking more care of their health during their pregnancies. Nevertheless, it is also recognized that war, armed conflict and high levels of social inequality open up a completely different scenario in terms of obtaining a university education (Agustine et al., 2014).

On the other hand, scholars have noticed the negative and significant correlation between vectors of violence and a mother's university education. In the CAC, the more violent the region or municipality, the fewer the mothers with a higher education (Duque, 2017). Even though there are health and demographic studies available on newborn health, specifically for Colombia, it has been impossible to find any relevant quantitative evidence when considering the number of SB - MC and maternal demographic features such as maternal university studies. This, according to literature is a critical point if we really aim to assess the impact of violence on newborn well-being in such turbulent, violent and unequal contexts as Colombia in 2002.

5.3.3 A fragile context for in-utero well-being

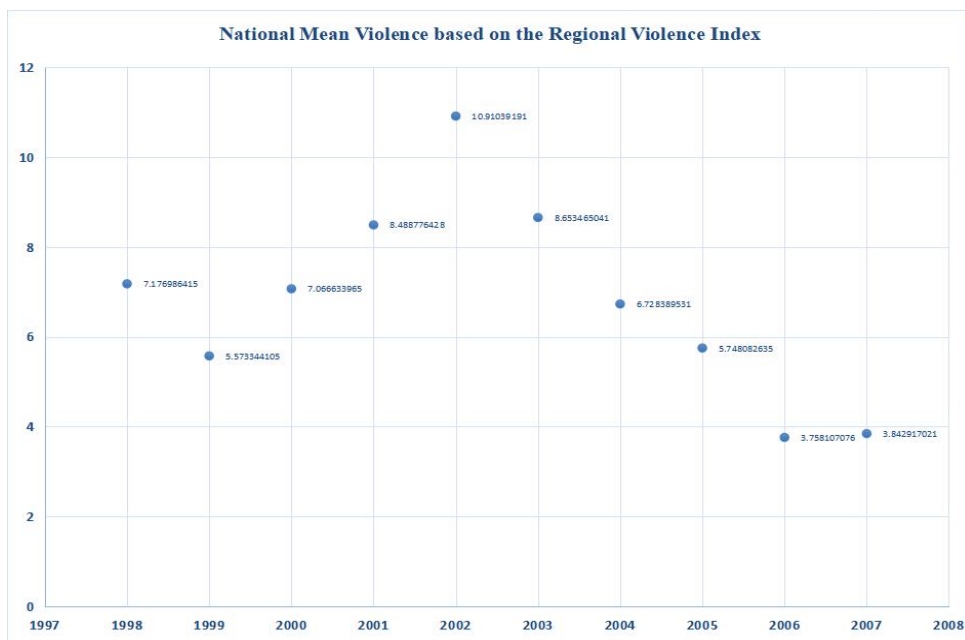
Defining the Colombian context as a fragile one leverages the coexistence of diverse violent dynamics across regions (Echandía, 2006). Along these lines, scholars suggest that because of the CAC, access to basic healthcare and university education remains worsen in some regions and overall in rural areas (Pacheco, 2020). More

importantly, respect for the rights of children and the development of their capabilities decreases in these more fragile contexts (Pómez et al., 2011). Families and entire municipalities have been the target of violence all through history (Arias et al., 2009). For instance, in some regions the positive correlation between fertility and armed conflict evinces sexual harassment as a practice of terror within war. Hence, the terrible consequences for women and newborn infants (Castro et al., 2019). Deprivation can start in the mother's womb for the children of women living in the most affected regions, as a result of potential rapes and violence (Castro et al., 2019). Other evidence strongly suggests that during pregnancies, families and mothers living in municipalities and towns exposed for prolonged periods to violent dynamics and social inequality are transferring traumas and deprivation to their children, causing neurological and developmental delays (Duque, 2017). Specifically, in turbulent environments, families might be buffering the violence that is everywhere by increasing physical aggression to their children (Akhtar, 2019, Ramos Jaraba et al., 2020). Fortunately, according to the literature, this transmission of inequality through the mechanisms of antenatal stress could be prevented, or at least tackled, if families and pregnant women could be taught how to manage stressful situations and have access to antenatal medical care. For instance, by practicing meditation or mindfulness. As shown by some scholars (Urizar et al., 2019), prenatal cognitive-behavioral stress management (CBSM) interventions are likely to improve stress outcomes among low-income pregnant women and perhaps infant health outcomes in the short and long term.

5.3.4 The period of 1998 and 2002

Between 1998 and 2002, the military reform carried out by the Pastrana government, although inconclusive, prevented the FARC from fulfilling their "strategic plan," which would have allowed the guerrilla group to transition to another phase of the war and expand its territorial dominance significantly (Echandía & Cabrera, 2019). Despite the Armed Forces' regaining their combat capabilities lost in the previous four years, the actions of the guerrilla escalated at a higher proportion, resulting in an unfavorable balance of forces in the confrontation for the State (Echandía & Cabrera, 2022). Additionally, it is important to note that paramilitary groups contributed to containing the guerrilla's advancement and, in many regions, pushed them back. Particularly in the northern part of the country, paramilitary organizations occupied territories, assassinated suspected sympathizers and militants of the insurgency, and resorted to terror to intimidate the population (Echandía et al., 2017). The following Figure 1 shows better the high violent activity within this period. As depicted in Figure 1, when instrumenting our regional violence indicator, it becomes evident that there is a clear upward trend in the national mean between 1998 and 2002, followed by a declining trend between 2003 and 2007. This rising trend between 1998 and 2002 coincide with violent acts a dynamics entitled in the FARC's greatest success in executing its "strategic plan", precisely during the peace process with the Pastrana's

Figure 1



Source: Own elaboration from the NCHM data bases

government, with the backing of broad sectors of society who saw negotiation as the only way to contain the guerrilla's advance over national territory (Echandía et al., 2017). In November 1998, Mitú, the capital of Vaupés department, was taken by assault, resulting in the death of 16 members of the security forces and the kidnapping of 61 more. It is noteworthy that while the assault on Mitú represented the most significant achievement for FARC, its subsequent recapture in a joint operation by the Police and the Army marked the beginning of a series of successful operations against the guerrilla, resulting from a military transformation process with the cooperation of the United States (Echandía et al., 2017). The military reform which strengthened the Colombian state institutionally, doctrinally, and technologically to confront irregular groups frustrated FARC's goal of achieving strategic balance and

tactically using the scenario for peace negotiations in the municipalities of San Vicente Caguán (Caquetá) and Uribe, Mesetas, Vista Hermosa, and La Macarena (Meta) (Echandía et al, 2017).

As evidenced by the available data of the NCHM, during the negotiations with the Pastrana government, the FARC escalated their armed actions, mainly in the departments of Arauca, Caquetá, Putumayo, Meta, Cundinamarca, Nariño, Cauca, Valle, Chocó, Magdalena, and the Montes de María region located between the departments of Sucre and Bolívar. In 2002, when the peace process broke down, the FARC reached its peak in terms of violent activities (Echandía et al., 2017). On the other hand, during this period, the ELN conducted the highest number of actions in its history, mainly in the departments of Arauca, Santander, Antioquia, Magdalena, Norte de Santander, and Casanare, seeking to pressure the demilitarization of a zone for peace negotiations with the government (Echandía et al., 2017). Additionally, the Armed Forces engaged in increasingly frequent combat with both the FARC and the ELN. The State's major efforts in the fight against armed groups are evident in the fact that combats surpassed the actions carried out by guerrilla groups in Meta, La Guajira, Guaviare, Quindío, Córdoba, Guainía, and Vaupés, as shown in the attached graph and map. The declaration of the Montes de María region and the Arauca department as priority zones for the "Policy of Defense and Democratic Security" in September 2002 marked a turning point in the dynamics of armed confrontation, ultimately contributing

decisively to creating the necessary conditions for achieving negotiated peace with the FARC (Echandía et al., 2017).

5.4 Hypotheses

(Regional Violence): Exposure to high levels of violence during pregnancy increases the risk of stillbirths and miscarriages. Hence, women who lived in the most affected regions within the most violent period of the Colombian Armed Conflict were more likely to lose their babies.

(The Modifier Effect): University education is a protective factor for newborn well-being during pregnancy, as it increases the odds of having a live birth. However, regional violence reduces this protective effect and affects more severely those mothers with university education or not informed educational level.

5.5 Data

Our data has a multilevel structure, with pregnant women/newborn infants nested in 33 regions, including Bogota, and 10 years. Although the survey has a multilevel structure, our quantitative technique of analysis enables us to estimate the impact of violence while accounting for the standard error between regions and accounting for the weight of regions within the National Health Statistics Surveys. Thus adjusting for standard errors across the 330 regional clusters.

As previously mentioned, the paper uses secondary data sources from the National Health Statistics Survey (NHSS) between 1998 and 2007 , which are a cross-sectional surveys that has been conducted annually since 1998 for the National Statistics Department of Colombia (DANE). The NHSS has been used extensively to examine the characteristics of key events regarding newborn infants' health. The survey aims to collect information concerning certain events which occur in the event of giving birth to a baby. The data collection is based on formats that have been designed according to international standards and country characteristics. The process involves sub-national entities and sub-national healthcare dependencies. Once the “vital statistics register” for each newborn has been generated within each region, the information is collected by the DANE. As per international standards, the survey is randomized and passes through a rigorous statistical quality control. Even though there are more recent NHSS, the period of analysis was selected to take into account considerations regarding violence and high levels and low levels of violence in two different periods. This makes up the specific scenario for our experiment. Thirty-three (33) regions were surveyed in ten (10) years, including Bogota which had the the largest sample, with 16.40% of the total, followed by Antioquia with 13.88%. The other regions had less than 6% of the sample, except for Valle del Cauca (8.56%). The model was enhanced by incorporating a weighting command.

We computed a human victims' index by merging data on Colombian Armed Conflict and regional violence, based on the databases from the National Centre for Historic Memory (NCHM's) that record the human victims of eleven violent acts from 1998 to 2007. These databases are organized by region and by year. This allowed us to estimate the level of regional violence.

5.6 Methods

We applied the methodological approach of (Cozzani et al., 2022), which measured the effect of the Madrid train bombings on pregnancy outcomes using a difference-in-difference technique. We assessed the impact of regional violence on the odds of having a miscarriage or stillbirth, controlling for the interaction between the treatment status and maternal education. We compared the risk of women living in regions with high and low exposure to the violence. We also contrasted Meta and Tolima, two regions with similar characteristics and survey weights but different levels of violence.

For the estimation of the regional level of violence index we divided the number of human victims by each region's population in that specific year. Thus, to be able to compute the rate of violence by region by assessing the number of victims and its weight based on each region population. The eleven documented categories of violence include actions of war, kidnappings, mines, selective murders, mass murders, damage to public goods, population attacks, death of civilians by armed actions, sexual harassment, forced disappearances, children in war and terrorist

attacks. It is essential to mention that all actions have equal weighting in the computation of the indicator. We embed this regional index of violence in the NHSS of unborn babies SB-MC and early losses, as well as in the NHSS of newborn infants.

Our response variable Y will be a binary indicator that takes the values 0 and 1. The “logit” model is a model for the log-odds of the probability that $Y = 1$. Thus, the log-odds to $Y = 1$. We will be then computing the odds for being an unborn baby, or early lost (0 = Live birth; 1 = SB-MC and early loss).. The explanatory variables used by our research are the DID estimator and the mothers’ university education level, and their interaction coefficient. We include an educational category for mothers who did not disclose their educational level in the survey. The reason for this was to have a reference line compared to those for whom we were sure did or did not have university education. Even though we could not know their educational level, we do acknowledge the fact that in this violent context, the information collected reflects unobservable individual and administrative factors and reasons, which in this case are clearly affected by regional violence in different ways. Hence, having a different category in which we do not know a respondent’s education level allows us to observe reasons other than education level. Mainly, within the NHSS for unborn babies, 19,71% of the women did not disclose their education levels in the survey. This must be explored in further research, delving into the reasons why there are a great number of mothers who did not disclose their educational levels.

To examine the impact of regional and temporal violence, we employ a Difference-in-Differences (DID) estimator. For our comprehensive analysis, we focus on newborns born between 1998 and 2007 in the 32 regions. We categorize them into four groups. The first two groups are based on treatment periods: i) Newborns and losses during the most violent period between 1998 and 2002, and ii) Newborns and losses after the most violent period, from 2003 to 2007. The second set of groups focuses on treated regions: i) Regions heavily affected by violence, as indicated by the regional violence index (Antioquia, Guaviare, Norte de Santander, Choco, Putumayo, Meta, Caquetá, Casanare, Arauca, Cesar, La Guajira, Magdalena, and Vaupez), and ii) Less affected regions excluding Bogota (Amazonas, Atlantico, Bolivar, Boyaca, Caldas, Cauca, Cordoba, Cundinamarca, Guainia, Huila, Nariño, Quindio, Risaralda, Santander, Sucre, Tolima, Valle del Cauca, San Andres). In a separate model, we narrow our focus to Meta and Tolima regions and employ the same methodology.

The estimation of DID parameters is conducted using logistic probability models with fixed effects for regions and years. Specifically, we employ a logistic difference-in-differences (DID) model to assess the causal impact of the treatment on the log odds for a SB-MC. In this model, the treatment variable, denoted as `Treated_R`, indicates whether the mother belongs to the treatment group or not. The time variable, `Time`, distinguishes observations within the violent period from those outside it. The DID variable

captures the average treatment effect on the treatment group in the violent period. To account for potential confounding factors, we include additional covariants that may influence the outcome, such as University, Health, Age, Couple, and Urban. Moreover, we introduce an interaction term between DID and University to examine whether the treatment effect varies based on the mother's educational level.

$$\begin{aligned}
 \text{Log Odd Prob } (Y_{ij}) &= 1 \\
 &= \beta_0 + \beta_1(\text{Treated}_j) + \beta_2(\text{Time}) + \beta_3(\text{DID}_j) + \beta_4(\text{University}) \\
 &\quad + \beta_5(\text{DID}_j \times \text{University}) + \beta_6(\text{Health}) + \beta_7(\text{Age}) + \\
 &\quad \beta_8(\text{Couple}) + \beta_9(\text{Urban}) + u
 \end{aligned}$$

In this general logistic model, Y is the log odds of the baby being born alive or not, i is the newborn/pregnant women living in region j . The first component of the model, β_0 , is the intercept or the mean value of the log odds when all explanatory variables are zero. β_1 is the average effect of the violence on the treatment group before the intervention.; β_2 is the effect of violent period on the log odds.; β_3 is the average effect of regional violence on the most affected regions during the most violent period. This is the parameter of interest that measures the causal impact of the treatment. β_4 is the effect of the mother's educational level on the log odds; β_5 is the interactive effect between treatment and mother's educational level on the log odds; β_6 is for her healthcare regime / insurance regime (based on Law 100 of 1993, five inferred categories of income and health access); β_7 is the mother's age (on average 12, 17, 22, 32, 37, 42, 47

or 52 years old); β_8 for her marital status (having a partner/husband or not); β_9 is the effect of urban or rural municipal location on the log odds. Finally, u is the error term that captures variations not explained by the model. We are weighting observations by Region, and clustering standard errors by 330 measures of violence, one for region in each year, which represents region-year pairs. This implies that we are assuming that there is heterogeneity in treatment effects across regions and correlation in errors within each region-year. We conduct two models: i) comparing two group of regions, most affected (above the regional mean violence) and less affected (under the mean); and ii) comparing Meta and Tolima. This is due to the similarity and weight of those regions within the surveys and their opposite level of violence.

5.7 Results

Table 1 presents the coefficient and the standard errors for the two pair of models. All the range of variables were included in the four logistic regression models. However, only models 1b and 2b included the estimation of the interaction effect between the DID coefficient and the mother's university education level.

In four models, we observe that the (DID) estimator significantly amplifies the negative impact on newborn well-being, as indicated by an increased log odds of not being born alive (OR: 1.6889 in 1a and OR: 4.00 in 2a), and (OR: 1.7219 in 1b and OR: 3.678 in 2b). These findings provide support for our initial hypothesis regarding the detrimental effect of high levels of violence during pregnancy

on fetal outcomes. Even the coefficients for the interaction term were indicating the worsen conditions within those contexts (Models 1b and 2b). Hence, women residing in regions heavily affected by the CAC were at a heightened risk of experiencing stillbirths and miscarriages ,as our first hypothesis of regional violence state.

Concerning mother's university education, the log of odds for SB_MC in four models was indicating always significantly improving the newborns well-being (OR: -0.7023; OR: -0.6902; OR: -0.649; OR: -0.632). Mothers who did not disclose their education level showed a disadvantage in four models (OR: 3.50; OR: 3.58; OR: 2.04; OR: 1.99). This suggests that a university education significantly increases the log of odds of a respondent's pregnancy resulting in a live birth, when the interaction effect is zero (0). Hence, proving the previous findings regarding the advantage of maternal university education for newborns well-being, without considering the impact of violence.

Table 1.
Difference in Difference logistic regression coefficient estimates and standard errors on the log of odds of stillbirth or miscarriage

	Log odds for a SB-MC Regions most Affected n = 5,778,397		Log odds for a SB-MC Meta and Tolima n = 381,823	
	1a	1b	2a	2b
Violent Period (1998 - 2002)	- 0.5308 *** (0.0728)	- 0.5299*** (0.07283)	-0.3645*** (0.1044)	-0.3651*** (0.1048)
Treated Regions	-0.4653*** (0.0849)	-0.4650*** (0.0848)	-0.760*** (0.0066)	-0.076*** (0.0065)
University Education	-0.7023 *** (0.0216)	-0.6902*** (0.0230)	- 0.6491 (0.0454)	-0.6326 (0.0461)
Not informed	3.5012*** (0.4462)	3.5862 *** (0.5081)	2.046*** (0.45)	1.992*** (0.456)
Married or Having a Partner	-0.5485*** (0.0182)	-0.5485*** (0.0182)	-0.5148*** (0.0242)	-0.5147*** (0.02427)
Average Age in Years	1.0362*** (0.0011)	- 1.036*** (0.0011)	-1.039*** (0.0014)	1.039*** (0.0014)
Urban Housing	1.2375*** (0.0496)	1.2376*** (0.0496)	1.7517*** (0.095)	1.7516*** (0.095)
healthcare regime and formal Job Status				
Contributor - earning at least 1 MLWS	base line	base line	base line	base line
Subsidized - no income or under 1 MLWS	1.5941*** (0.0948)	1.5932*** (0.0946)	2.727*** (0.287)	2.723*** (0.286)
Beneficiaries - by couple or parent	2.1027*** (0.1656)	2.1013*** (0.1653)	3.246*** (0.4198)	3.242*** (0.4193)
Particular or no job - paying	-0.7347 (0.1423)	-0.7370 (0.1427)	2.063 (0.9358)	2.053 (0.9327)
None	6.170*** (0.7652)	6.1684*** (0.0.7646)	4.9647*** (1.809)	4.9563*** (1.805)
DID - Difference in Difference Estimator	1.6899*** (0.3787)	1.721961*** (0.3824)	4.000*** (1.093)	3.7689*** (1.068)
Interaction Effect (DID - UNIVERSITY)				
University		1.273** (0.115)		1.8621*** (0.2356)
Not informed		-8097 (0.1333)		1.680*** (0.4360)
Intercept / Constant	0.00932*** (0.0009)	0.00932*** (0.0.0009)	0.0123*** (0.0011)	0.0123*** (0.0011)

***Own elaboration, based on the National Health Statistics Survey of 1998 - 2007, and National Centre of Historic Memory databases**

***Coefficients Standard errors in parentheses - Significance,
*** p<0.01, ** p<0.05, * p<0.1**

***General Model Prob > chi2 = 0.0000
R2 = 0.545**

***Marginal effects on the log of odds are constant, while the predicted probabilities are not. Thus, we choose a baseline for each variable, computed as a value that is covariant to the output.**

***Note: control variables are healthcare regime, Marital Status, Age and Urban location.**

***The reduction in the value of n does not represent a geographical bias, but rather to the exclusion of cases due to missing information regarding other independent variables. This exclusion is done to ensure the integrity and reliability of the model results. It's important to note that the lack of information on certain variables can distort the model results, as it affects the model's ability to adequately capture and explain variability in the data. Therefore, excluding cases with missing data is a standard procedure in statistical analysis to ensure the validity of the results.**

In models (2a and 2b), we conduct a comparative analysis between Meta (highly affected) and Tolima (low affected) using a matching strategy that took into account survey weights and socioeconomic conditions and development features between the two regions. The aim was to assess more clearly the impact of violence and the influence of maternal university education in two similar regions with opposite levels of violence, Tolima (5.4) and Meta (14.7). Our findings reveal that the (DID) estimator significantly amplifies the negative impact on newborn well-being, with mothers in Meta, being more susceptible to experiencing stillbirths or miscarriages (Or: 3.7 in model 2b).

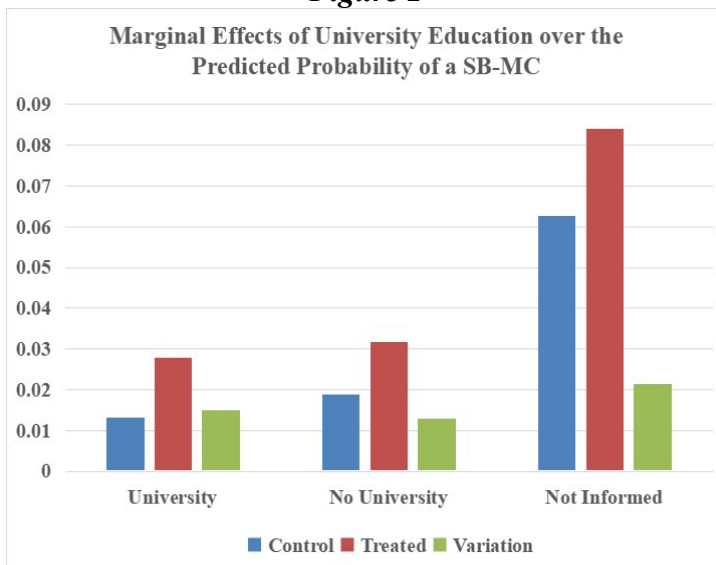
In both models (1b and 2b), when considering the interaction effect, the effect of a mother's university education is modified by the DID estimator variable (regional-period of violence) and strongly in the matching model for case of Meta. This is statistically known as the

effect modification (Pekka et al., 2004). In this case, regional violence modifies the effect of a mother having a university education on the log of odds of experiencing a stillbirth, miscarriage (SB-MC) or early loss. As mentioned before, for all four models, the regression coefficient indicates that having a university education reduces the risk of losing the baby while not considering the *effect modification*. However, the interaction implies the opposite, thus diminishing/ modifying the protective/shielding effect of a university education (OR: 1.27 in 1b and OR: 1.86). For women who did not informed their education level (OR: 0.80 not significant in 1b and OR: 1.68 significant in 2b). We noticed that when computing the interaction, the effect on newborn well-being of their mother having a university education depends on violence (i.e., the effect is not always the same, but changes according to the degree of regional violence and period of exposure). Across the two models (1b and 2b), the interaction shows the effect modification as mothers with university education, but greater in magnitude in 2b. A mother's university education is modified by DID, regional-period violence.

When considering the control variables, the healthcare regime / insurance regime as an approximation of socioeconomic status and inequality (i.e., whose healthcare regime / insurance is subsidized by the state due to their vulnerable economic status, such as not having a job or earning less than the minimum wage), shows that was always better to have a job thus belonging to the Contributive regime (the base line category), The most affected women were

those women who did not belong to a healthcare regime or had any healthcare regime / insurance (OR: 6.1 for model 1b and OR: 4.47 for model 2b). According to the results, mothers who were married or living with a partner were significantly more prone to having a live birth and avoid a SB-MC (OR: 0.548 in 1b and OR: 0.51 in 2b). For those women living in and urban settlement, the odds of SB-MC were always and significantly higher compared to those living in rural areas (OR: 1.23 in 1b and OR: 1.75 in 2b).

Figure 2



Source: own elaboration, based on the coefficients of Model 6 in Table 1

Marginal effects on the log of odds are constant, while the predicted probabilities are not. Thus, we choose a baseline for each variable, computed as a value that is covariant to the output in Table 1 (Model 1b)

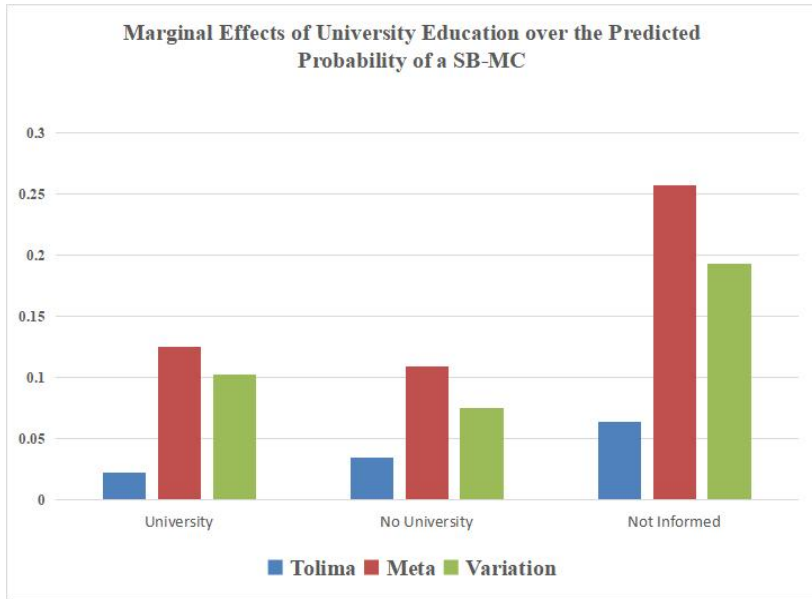
Likewise mother`s age, an increment in the log of odds of experience a SB-MC (OR: 0.36 in 1b and OR: 0.39 in 2b). Figure 1 illustrates the marginal effect of maternal education over the predicted probability of SB-MC by regions and university education

levels. It also shows the variation by the categories of the DID estimator.

Figure 2 highlights the stronger effect modification of the DID estimator on the correlation between mother's education and newborns' well-being. This effect is particularly pronounced for mothers with university education residing in the most affected regions between 1998 and 2002, including Antioquia, Guaviare, Arauca, Norte de Santander, Cesar, Meta, Casanare, Caquetá, Magdalena, La Guajira, Vaupéz, and Putumayo. In these regions, the marginal effect on the predicted mean of mother's university education substantially decreases due to the heightened levels of violence.

Consistent with our second hypothesis, we observe that pregnant women with university education who lived in regions that were less affected by violence and between 2003 and 2007, such as Tolima, Huila, Nariño, Cundinamarca, Boyacá, or Atlántico, were more likely to effectively cope with and reduce the harmful residual effects of violence on their stress levels compared to those residing in the most affected regions during the earlier period of 1998 and 2002. These findings provide valuable insights into the differential impact of violence on pregnancy well-being and suggest the significance of region-specific interventions in promoting better health outcomes during pregnancy.

Figure 3



Source: own elaboration, based on the coefficients of Model 6 in Table 1

Marginal effects on the log of odds are constant, while the predicted probabilities are not. Thus, we choose a baseline for each variable, computed as a value that is covariant to the output in Table 1 (Model 2b)

In Figure 3, we apply a similar approach as in the previous analysis but now with the matching strategy for models 2a and 2b, which involves comparing the regions of Meta and Tolima. Notably, the DID estimator correlation coefficients exhibit a stronger effect modification on university education for women residing in Meta, as opposed to those living in Tolima, during the treated period of 1998 and 2002. This finding sheds light on the differential impact of the conflict on maternal well-being and educational attainment in these two regions.

The three categories of women with varying education were differently modified by regional violence, suggesting that mothers with university education were also highly impacted by regional violence, reducing their educational advantages. Furthermore, when

computing the interaction coefficient for Meta and Tolima, the effect modification was high enough to erase the shielding and protection effect of having a university education from those who did not have university education but not from those with unknown education. Hence, we suggest that there are unobserved factors within the category of women that have not disclosed their level of education, mainly in the NHSS for unborn babies, stillbirths, miscarriages and early losses.

The cause of this effect modification may be caused by the lack of state presence and capacity to make those regions safe and invest in the more severely affected regions to improve macroeconomic features such as employment or even access to higher education. Here, the effect modification leverages the diminishing trend of university education shielding newborn well-being, which is slightly decreasing due the higher levels of regional violence during that period (1998-2002). the effect modification of regional-period violence reduced the shielding/protective effect of university education on the log of odds for newborn well-being. Proving our second part of the first hypothesis. As mentioned above, between 1998 and 2002 those regions that were most affected by violence were highly turbulent for pregnant women with a university education. In contrast, within regions less affected by violence between 2003 and 2007, such as Tolima, Atlántico, Cundinamarca, Nariño, and Huila, we observe that mothers with university education were more successful in protecting the dyad and ensuring newborn well-being. Furthermore, our analysis indicates that

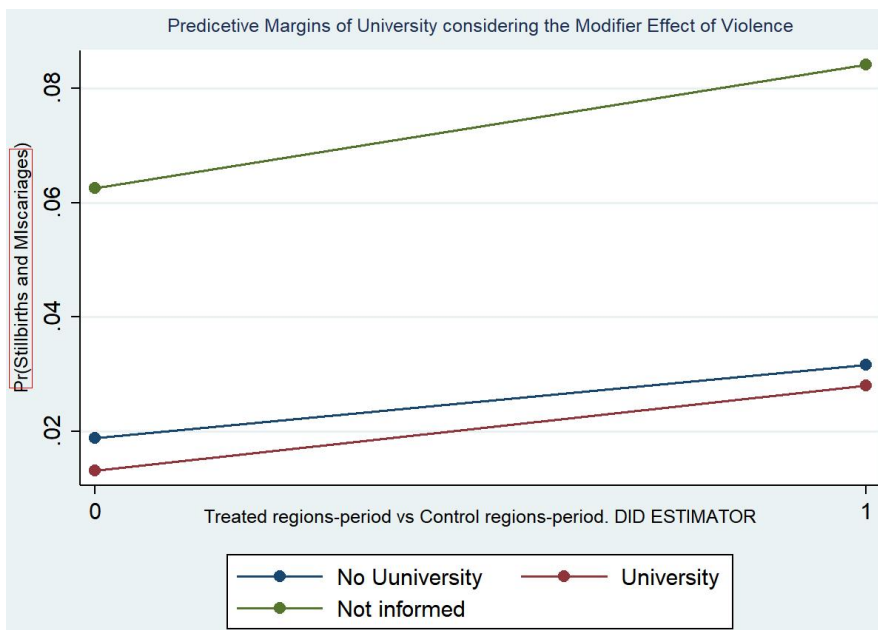
regional violence had a more pronounced effect on women with university education compared to those who did not disclose their education levels or had no university education.

Given these significant findings, further research is needed to comprehensively understand the complex interplay between regional violence, maternal educational levels, and its impact on maternal and newborn health outcomes. These insights can pave the way for targeted interventions and policies to safeguard the well-being of pregnant women and newborns in regions affected by violence.

Testing the Cross-Level Interaction, *Modifier Effect of Violence on Maternal Education*

Figure 4 presents the results of the interaction and effect modification between treated regions-periods (DID estimator) and mothers' educational level. For this, we obtained the marginal effects of the interaction effect on the probabilities of experience a stillbirth or miscarriage in the DID logistic model.

Figure 4.

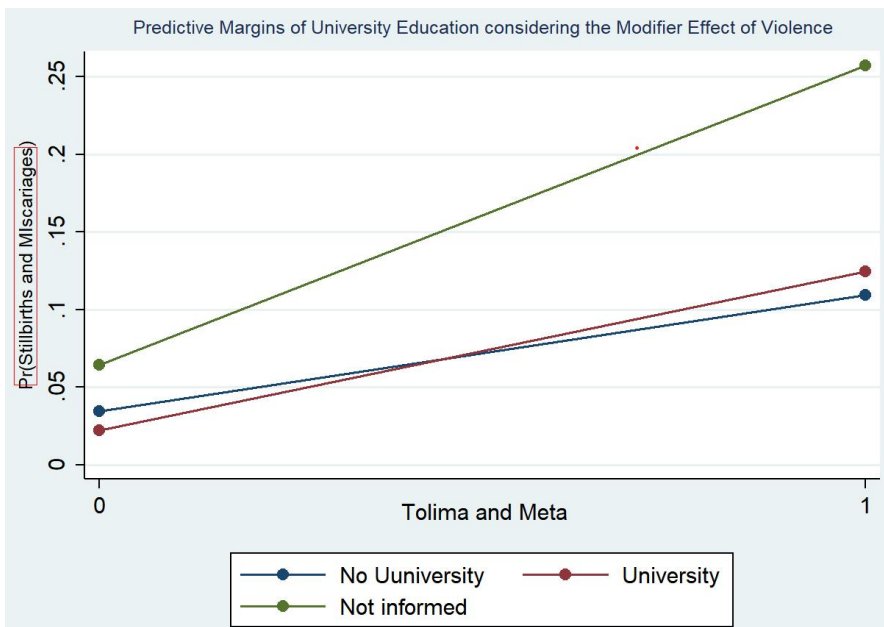


Source: own elaboration, based on the coefficients of Model 6 in Table 1
Marginal effects on the log of odds are constant, while the predicted probabilities are not. Thus, we choose a baseline for each variable, computed as a value that is covariant to the output in Table 1 (Model 1b)

Regardless of the mothers' university education, the level of regional violence will always marginally decrease the probability of being born alive. However, in the (Not mentioned) category, the significance levels of the cross-level interaction effect modifier are way higher. That is, those mothers who did not report their educational level were the mothers who were most affected by the level of violence. Despite this finding, we must say that although the shielding effect of university education was affected by the effect modification of violence shows a a steeper slope than those mothers with no university education, it is also true that those mothers with a university education continue having marginally more likely to give birth to an alive son/daughter, as shown in, the

red line, which is under the blue line (no university education) and the green line (Not mentioned). However, in the matching models of Meta and Tolima this is not the case. Figure 5 illustrates the detrimental trend due to the modification effect of violence over mother’s university education.

Figure 5



Source: own elaboration, based on the coefficients of Model 6 in Table 1
Marginal effects on the log of odds are constant, while the predicted probabilities are not. Thus, we choose a baseline for each variable, computed as a value that is covariant to the output in Table 1 (Model 2b)

Here in Figure 5, the interaction between the DID estimator and university education for pregnant women residing in the Meta region compared to those living in Tolima evidence the higher impact of the modification effect of violence over mother’s university education thus on newborns well-being. This matching

technique allows us to clearer observe the impact of violence on newborns' well-being by diminishing the protective effect of university education during pregnancy in preventing stillbirths and miscarriages. Our findings suggest that the effect modification has a more significant impact on women with university education, evidenced in the steeper slope and increased marginal effects of experiencing a stillbirth or miscarriage compared to women without university education living in the same region, specifically in the case of Meta.

5.8 Discussion

The findings suggest that initially, mothers with university education were more likely to have live births compared to those without university education or with unknown education levels, without considering the impact of violence. However, upon examining the interaction between the DID estimator and maternal education level, we found that violence altered the correlation between maternal university education and newborn well-being. Significantly, we observed a decrease in the protective effect of university education, making it practically insignificant when compared to mothers without university education. This trend persisted throughout the analysis period, despite a rise in the percentage of women with university education giving birth in Meta, from 6.72% to 12.94%, an increase of 6.22%, and in Tolima, from 8.41% to 12.09%, an increase of 3.68%. Further investigation is needed to explore potential correlations between maternal demographic characteristics and contextual factors like poverty,

unemployment, and healthcare service quality. Nevertheless, these findings align with prior research on the impact of violence on newborn outcomes, highlighting the significant stress caused by violence. However, there are variations in the spread of socioeconomic stratification's marginal effects, as observed in previous studies (Cozzani et al., 2022; Duque, 2017; Ramos Jaraba et al., 2020; Lee, 2014; Valente, 2015)..

However, we suggests that the effect modification of violence increases for mothers with university education, primarily due to significant mismatches between the region's socioeconomic and demographic reality and women's expectations. Additionally, in most affected regions there are potential obstacles to employability and investment in highly skilled work due to the lack of security and state presence in those regions affected by violence. The prevalence of high levels of violence makes it more challenging for highly educated women to find suitable employment during periods of armed conflict. Moreover, regions with less violence tend to experience less migration of investments due to safer conditions for businesses, leading to a higher likelihood of finding employment for individuals with sophisticated knowledge. Furthermore, in regions and periods of high violence, the odds of completing university studies before giving birth might be significantly lower compared to regions that are less affected by violence, such as Tolima. And more important is the detrimental effect of violence in antenatal health care (Rodríguez, 2022; Bernal et al., 2024). After the test of the interaction effect, we state that mothers who have university

education were more able to tackle adversity in the group of regions treated, thus shielding the dyad, overall, when they were living in regions that were less affected by the armed conflict. This was not the case for the matching model between Meta and Tolima, where women with university education passed to be more affected by the effect modification of violence.

Our findings add more evidence of the effect of regional violence on newborn health, beyond violence at the municipal level in Colombia (Rodríguez, 2022; Ramos Jaraba et al., 2020; Duque, 2017;). We have gone further in exploring this paradoxical relationship by considering the protective/shielding effect of a mother's educational level in terms of reducing the harmful effect of violence on newborn well-being. Furthermore, in testing the impact of violence over mother's education and newborns' well-being. Other demographic features should be taken into account in further research, such as ethnic background, medical background, occupation, life stories, household dynamics, family environment, and others which according to the Ecological Theory of Urie Bronfenbrenner (1979) reinforce their roles within the dyad and might be correlated with pregnancy outcomes. We also add evidence to earlier findings in the NHSS research in Colombia (Rodríguez, 2022; Beltrán et al., 2013; Ramos Jaraba et al., 2020). One of these pieces of medical and population research analyzed 14,520 women included in the 2010 Demographic Health Survey and, through bivariate analyses, binomial regression and stratified models by age showed a negative and significant correlation

between higher levels of regional violence and newborn outcomes (Ramos Jaraba et al., 2020). Regardless of these findings, the present research has obtained significant evidence of the shielding effect of a mother's university education for having a live birth when regional violence is low. This is clearly a step forward from earlier paradoxical results obtained by previous researchers in terms of newborn weight and the odds of being preterm.

CHAPTER 6

GENERAL CONCLUSION

6.1 The Armed Conflict Dynamics

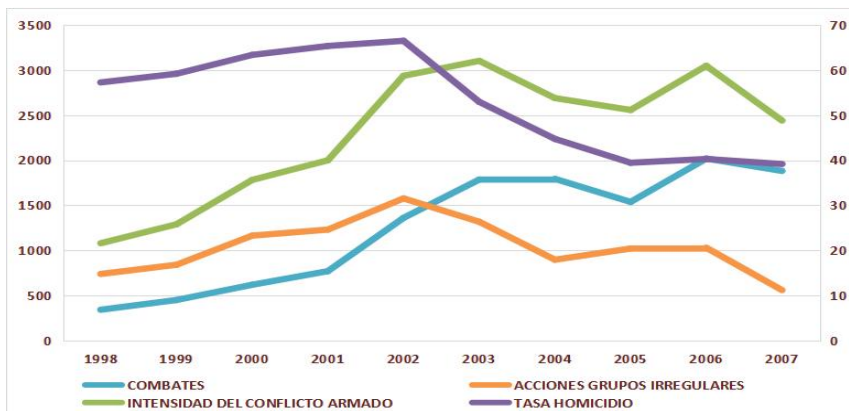
6.1.1 The escalation of violence

It is important to note that certain episodes of violence have left a violent legacy within the regions. In November 1998, Mitú, the capital of the Vaupés region, was attacked in an operation that left 16 members of the security forces dead and 61 others kidnapped (Echandía, 2006). It is no coincidence that Vaupés was the second most affected region in terms of newborn well-being during this period.

While the attack on Mitú was the FARC's most significant achievement, its subsequent swift recapture by a joint police-army operation marked the beginning of a series of successful operations against the FARC (Echandía, 2006). This was the result of the transformation of the state's military capabilities with the help of the United States (Echandía, 2019). In fact, as shown in Figure 1, since 1999 there has been a sustained increase in fighting initiated by state forces (Echandía & Cabrera, 2017). On the other hand, the FARC, in order to compensate for its inferiority, also increased its activities, which peaked in 2002 (Echandía, 2006). In particular, through systematic attacks on communities, the FARC sought, among other things, to compensate for the loss of access to the sea via the Gulf of Urabá, a position over which paramilitary groups had gained control since the second half of the 1990s (Echandía, 2006; Echandía & Cabrera, 2017). The location of these attacks revealed an intention to create a corridor to the sea between the

southeastern departments and the Pacific coast, passing through municipalities in the departments of Huila, Tolima, Valle, Cauca and Nariño (Echandía & Cabrera, 2017).

Figure 1
Evolution of CAC intensity and homicide rates between 1998 and 2007



Source: Worked by Echandía, 2023 using Multitemporal Data Platform of the Project for Monitoring the Armed Conflict in Colombia, Center for Research and Special Projects (CIPE), Externado University of Colombia.

At the same time, as the armed conflict escalated and the neonatal health dimension diminished, paramilitary groups gained significant prominence and influence in the dynamics of violence (Echandía & Cabrera, 2017). The increasing number of murders and massacres, as shown in Figure 1, and the upward trend in the homicide rate between 1998 and 2002 can be explained by the logic of paramilitary expansion (Echandía, 2006). This expansion was driven by the objective of creating a corridor that would separate the north from the centre of the country, while allowing control over the coca production centres of Urabá and Bajo Cauca (Antioquia), the southern parts of the departments of Bolívar and Cesar, and

Catatumbo (Norte de Santander) (Echandía & Cabrera, 2017). In addition, paramilitary groups penetrated the rear areas of the FARC in the south and east of the country (Echandía, 2006). They established de facto hegemony in many areas, often with the support of entrepreneurs, traders and representatives of the state (Escobedo, 2011).

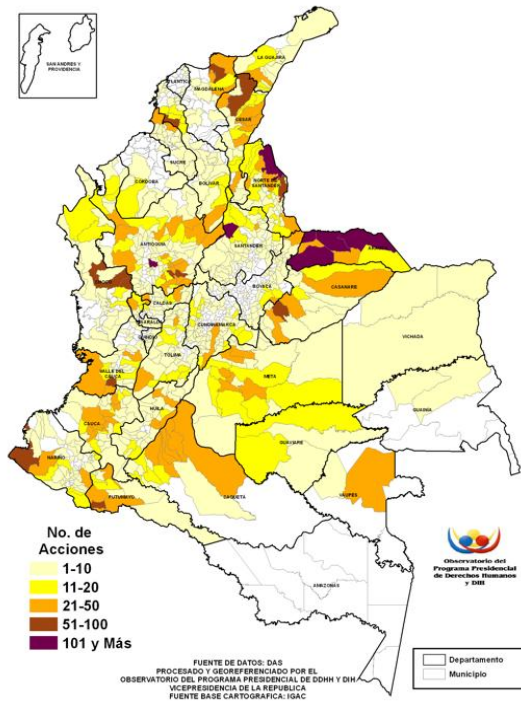
In the struggle for control of strategic positions, the guerrilla groups ended up imitating the paramilitaries' methods of terror, including assassinations and massacres, with corresponding effects on the fear and stress levels of pregnant women throughout the country (Echandía, 2006).

In the department of Chocó, the majority of towns and small urban centres located along the Atrato, Baudó and San Juan rivers were subject to encirclement by paramilitary groups (Echandía & Cabrera, 2017). Similarly, towns located in higher areas faced a similar situation at the hands of the FARC. Both groups set up checkpoints along rivers and roads to prevent the movement of people and goods (Echandía & Cabrera, 2017; Echandía & Cabrera, 2022). Meanwhile, in the department of Antioquia, clashes between guerrillas and paramilitaries also affected other scenarios, particularly in areas strategically linked to the drug trade, such as cultivation, processing centres, corridors and transit zones (Echandía & Cabrera, 2017). In the case of Medellín and the Aburrá Valley, while paramilitary groups acted to limit the guerrillas' capacity, the so-called Cacique Nutibara and Bloque Metro blocs

ended up in conflict over control of different sectors of the capital of Antioquia and its surroundings (Echandía, 2019). Paramilitary groups also ventured into plains or regions with dynamic economies besieged by guerrillas, such as the Magdalena Medio and eastern Antioquia (Echandía, 2019). They also exerted influence in mountainous areas and in the western part of the department.

As Figure 2 shows, during the negotiations with the Pastrana government, the FARC concentrated its armed actions mainly in the departments of Arauca, Caquetá, Putumayo, Meta, Cundinamarca, Nariño, Cauca, Valle, Chocó, Magdalena and the Montes de María region between the departments of Sucre and Bolívar (Echandía & Cabrera, 2017). Between 1998 and 2002, the increase in violence was strategically located in areas where corridors were critical for drug trafficking, as shown in Figure 2 (Echandía & Cabrera, 2017). These areas proved to be highly affected in terms of neonatal health dimensions such as birth weight, gestational age and being born alive without health disadvantages, especially in 2002.

Figure 2
Municipalities with armed conflict presence 1998 - 2002



Source: Worked by Echandía, 2003, Multitemporal Data Platform of the Armed Conflict Monitoring Project in Colombia, Center for Research and Special Projects (CIPE), Externado University of Colombia.

6.1.2 The peak of violence

Their activities peaked in 2002, when the peace process collapsed. Meanwhile, the guerrilla group Ejército de Liberación Nacional (ELN) intensified its armed actions in the departments of Arauca, Santander, Antioquia, Magdalena, Norte de Santander and Casanare, with the aim of forcing the demilitarisation of an area in order to enter into peace negotiations with the government (Echandía, 2006). On the other hand, the military's combat operations, which were

primarily directed against the FARC, also escalated against the ELN (Echandía & Cabrera, 2017). The state's greatest efforts in the fight against armed groups are manifested in the fact that combat operations exceeded those carried out by guerrilla groups in Meta, La Guajira, Guaviare, Quindío, Córdoba and Guainía (Echandía, 2019). Although the combat capacity of the armed forces resumed its upward trend, guerrilla actions escalated to a greater extent, resulting in an unfavourable balance of power in the confrontation for the state (Echandía & Cabrera, 2017).

In addition, the breakdown of the peace process between the Pastrana government and the FARC in February 2002 led to an escalation of the armed conflict, characterised by increased combat operations by the armed forces and guerrilla activities aimed at undermining the government (Echandía, 2006). This included threats against local authorities, who were forced to resign (Echandía, 2006). By 2002, 158 of the country's 1,098 municipalities had no police presence due to repeated attacks on the population, while 131 mayors under threat were forced to leave their municipalities (Echandía, 2019).

With the arrival of Álvaro Uribe Vélez in the Colombian presidency in 2002, the balance of power with irregular groups shifted in favour of the state (Echandía, 2019). The government sought to restore public order as a prerequisite for effective territorial control. To achieve this goal, the Policy of Democratic Defence and Security (PDSD) was designed and implemented (Echandía, 2019).

This policy prioritised, on the one hand, the dismantling of irregular groups by increasing the military presence and carrying out large-scale offensive operations (Echandía, 2019). On the other hand, it emphasised the assertion of territorial control through the restoration of the presence of the National Police, the creation of a network of cooperation with the armed forces, and the protection of the country's roads and economic infrastructure (Duncan, 2021).

6.1.3 Violence against violence

The intensification of armed confrontations between 2003 and 2007 was mainly due to fighting carried out by state forces, rather than the actions of irregular groups, which showed a decreasing trend, as shown in Figure 1 (Echandía & Cabrera, 2017). The decline in armed guerrilla activity was influenced by the decisiveness of military operations (Echandía, 2006). In addition, the increase in the demobilisation of members of these groups had an impact, involving not only low-ranking guerrillas but also mid-level commanders, who were crucial for the maintenance of armed structures (Echandía & Cabrera, 2017). Despite the fact that the FARC was the guerrilla group most targeted and suffered the highest number of casualties and captures, its activity remained relatively high until 2006 (Echandía, 2019)

Between 2004 and 2006, the Patriotic Plan was implemented, the main objective of which was to regain control of a large area in the south and east of the country, considered to be the FARC's strategic rear (Echandía, 2019). It was from this region that the guerrilla

organisation derived a significant part of its funding and coordinated its actions (Echandía, 2019). Among the results achieved were the destruction of camps and the discovery of different types of ammunition, explosives and weapons (Echandía, 2006). Undoubtedly, the area of operation of the Patriotic Plan coincided with the scenario in which most of the guerrillas were killed in combat, significantly weakening the FARC (Echandía, 2006).

In addition, the homicide rate has been falling since 2003, with 2007 being the year with the lowest index in the last two decades. With the demobilization of the United Self-Defence Forces of Colombia (AUC) during this period, the drug trade entered its most fragmented phase, resulting in a decrease in violence in Colombia since 2003 (Echandía, 2019). However, criminal groups seized the opportunity to control the areas where demobilization affected the unity of the drug trade. Violence persisted, albeit on a smaller scale, in areas strategic for drug trafficking and illicit income generation, due to disputes between gangs under the control of relatives or second-tier leaders of former paramilitary groups (Echandía, 2019). The decrease in homicides is also linked to the increased operational capacity of state forces, which forced irregular groups to withdraw and reduce their activities (Escobedo, 2011).

As the implementation of the PDSO progressed, the tactics of the guerrilla groups were modified in response to the changing dynamics of the conflict (Echandía & Cabrera, 2017). In particular,

the FARC used their experience to adopt behaviours typical of guerrilla warfare, primarily aimed at avoiding decisive blows by retreating to sanctuaries and carrying out sporadic actions by small groups. This led to a significant reduction in the number and intensity of their actions (Echandía & Cabrera, 2017).

As a result, guerrilla organisations have had to limit their objectives to the occupation of some strategic positions, relying mainly on the planting of anti-personnel mines, a behaviour that has proved particularly costly for the state's armed forces, which have suffered more casualties from mines than in direct confrontations with the enemy (Echandía, 2019). It is important to note that whereas in the past the objective of gaining territorial control was to maintain dominance over an area and its population by force and/or indirect means, today, with the objective of strategic control, it is not primarily the influence over the population that is important, but the advantages associated with the logic of warfare (Pécaut, 2002). The guerrilla *modus operandi* at this time is characterized by intermittent actions carried out by small groups using hit-and-run tactics to minimise casualties and operational costs. Above all, guerrilla structures sought to avoid direct clashes with state forces, opting instead to sabotage economic infrastructure and intensify acts of terrorism in urban areas (Echandía, 2019). Nevertheless, the urbanisation of the guerrillas' armed actions, which included not only acts of terrorism but also urban warfare, risked making them even more vulnerable, as they needed the means to control the main cities and withstand a strong counterattack that could jeopardize

their influence in rural areas (Echandía, 2019). It should also be highlighted that the fight against the guerrillas was successful in areas close to the cities, such as Bogotá and Medellín, where armed structures in urban and rural areas were hit hard (Echandía & Cabrera, 2017).

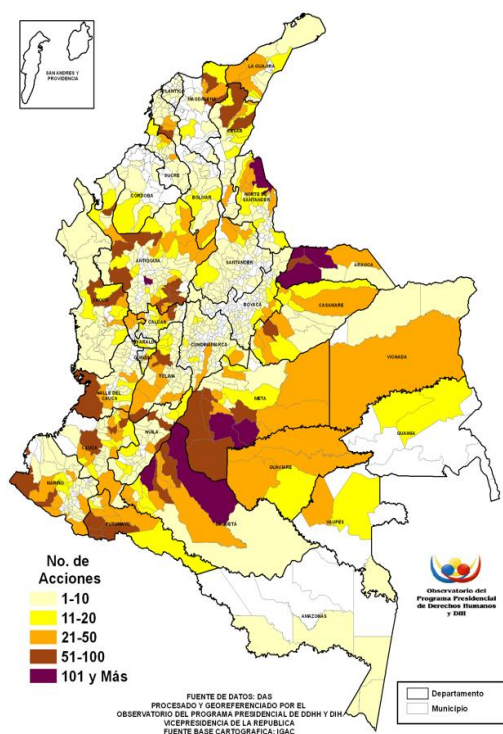
In Cundinamarca, the rear of the FARC was heavily attacked by the army in 2003 during the Libertad I and II operations. Fronts 42, 22, 53, 54 and the Reinaldo Cuellar Column suspended their activities in the department due to the military offensive, which resulted in a high number of battles with significant casualties and captures, forcing these structures to retreat (Echandía, 2019). Consequently, with the disappearance of the encirclement that the FARC had established around Bogotá since the 1990s, the possibility of carrying out armed confrontations and kidnappings in the city was significantly reduced (Echandía, 2019). In addition, operations Mariscal, Meteoro and Orión were carried out in 2002 and 2003 to dismantle urban militias and guerrilla fronts in the municipalities of Medellín (Echandía, 2019; Echandía & Cabrera, 2017). On the other hand, Operation Marcial, with significant results in the eastern part of Antioquia and on the road between Medellín and Bogotá, allowed the army to regain the initiative in the fight against the guerrillas, resulting in a high number of engagements against FARC fronts 9 and 47, as well as Carlos Alirio Buitrago and Bernardo López Arroyabe of the ELN (Ejército de Liberación Nacional) (Echandía, 2019). Faced with strong military pressure, a high number of casualties and prisoners, and an increase in voluntary

surrenders, irregular armed groups were forced to retreat to western Antioquia, eastern Caldas and northern Tolima (Echandía, 2019).

As shown in Figures 4 and 5, the geography of the armed confrontation changed significantly between 2003 and 2007 compared to the previous period. Indeed, the offensive of the state forces led to a significant withdrawal of the guerrillas from the positions they had gained after two decades of territorial expansion. The areas most affected by the armed confrontation returned mainly to rural areas, far from the administrative centres and the main development centres of the country (Echandía, 2019). Nevertheless, as we will analyse below, the urbanisation of the armed conflict between 2003 and 2007 was one of the dynamics that clearly affected the well-being of newborns and increased the modifying effect of violence on maternal educational shielding.

As Figure 3 shows, between 2002 and 2007 state forces engaged guerrillas in a variety of scenarios, including in areas where these groups concentrated their military and economic power, as well as in central areas of political and economic importance (Echandía & Cabrera, 2017). The superiority of engagement over guerrilla action was recorded in just over two-thirds of the country's departments, with notable cases in Antioquia, Meta, Caquetá, Tolima, Arauca and Norte de Santander (Echandía, 2019). On the other hand, in Cauca, Nariño, Valle and Vaupés, the armed actions of the guerrillas exceed the engagements initiated by the armed forces (Echandía, 2019).

Figure 3
Municipalities with armed conflict presence 2003 - 2007



Source: Worked by Echandía, 2023, Multitemporal Data Platform of the Armed Conflict Monitoring Project in Colombia, Center for Research and Special Projects (CIPE), Externado University of Colombia.

In summary, the use of guerrilla warfare methods was aimed at ensuring survival in an exceptionally difficult environment due to the military superiority achieved by the state (Echandía, 2019). Hence the clear priority given by the guerrillas to corridors, areas with economic resources and retreat zones. Nevertheless, the state's military superiority in the confrontation was an insurmountable obstacle for these groups to achieve their territorial objectives,

which had been set since the 1980s (Echandía, 2019). The inability to establish a presence in areas with high strategic potential and to carry out their activities in urban areas would later play a decisive role in the maturation of the conditions for achieving a negotiated peace with the FARC (Echandía, 2019; Echandía & Cabrera, 2017).

As lecturers, reviewers and interested readers may already recognise, the whole thesis revolves around a critical issue in human development - the impact of CAC-related violence on the health and well-being of newborns. It also examines the protective effect of maternal education on the dyad in the context of war and systematic violence.

Beyond the empirical findings presented in the quantitative regression models used in each of the four papers, it is crucial to acknowledge the underpinning sociological and health theories. The family stress model, ecological human development theory and demographic evidence highlight the negative impact of violence and armed conflict contexts on children's early development. These environmental conditions are significantly correlated with major deprivations during pregnancy, including increased odds of stillbirth, miscarriage, violent or unexplained loss, preterm birth (less than 37 weeks gestation) and low birth weight (less than 2500 grams), or a combination of these conditions.

The study of the impact of the Colombian Armed Conflict (CAC) on newborn well-being has therefore provided valuable insights into

the complex dynamics influencing health outcomes in violence-affected regions between 1998 and 2007, particularly during the peak of violence in 2002. This comprehensive analysis of four papers aims to distil overarching conclusions and implications for policy formulation and intervention strategies.

First and foremost, this thesis suggests that the evolving dynamics within the security policy of the Colombian Armed Conflict (CAC), implemented between 1998 and 2007, led to a pronounced downward trend in newborn well-being. This trend intensified after 2002, when the government of Álvaro Uribe strengthened the military strategy to counter the expansion of the FARC through the 'Policy of Democratic Security'. We also note that the high level of violence in the Antioquia region, coupled with the influence of paramilitary groups on organised crime throughout the country, has led to a proliferation of violent phenomena emanating from the highly affected Antioquia region. As a result, during the period under study, it was consistently more advantageous to be born in a region other than Antioquia than in any other region, even when controlling for higher levels of health and development.

6.2 The unhealthy context for newborns well-being and the internal migration

From 1998 to 2007, a period characterized by one of the highest levels of violence in the last six decades of the Colombian Armed Conflict (CAC), the following health outcomes were observed

197,715 women experienced miscarriages (MC), stillbirths (SB) or premature losses; 347,224 newborns were born prematurely and with low birth weight (LBW); 196,306 newborns were born with low birth weight (LBW); 637,625 newborns were born prematurely (PTB); a total of 5,611,135 newborns were born healthy, with no problems related to the above health dimensions. Regionally, Guainía (10.39%) had the SB-MC with a precarious healthcare system; San Andres (14.98%), a transit point for drug trafficking routes to Mexico and the north; Antioquia (5.69%) and Tolima (4.87%), both regions historically affected by paramilitary and rural-urban violence; and Huila (4.66%), the poorest region (with a poverty rate of 64.12% in 2002) and a guerrilla transit route with high levels of kidnapping and extortion. In addition, Cordoba (32.87%), which is highly affected by poverty and displacement, Tolima (11.54%) and Caldas (18.52%) - located between Antioquia and Tolima - had the highest rates of violent or unexplained deaths, according to the NHSS. The statistics used, such as the NHSS, probably include a large number of missing cases due to economic and social instability: in regions such as Chocó (11.82%), Huila (11.17%), La Guajira (9.91%), Meta (11.67%), Nariño (10.77%), Arauca (23.3%), Putumayo (14.71%), Amazonas (20.14%), Guainía (14.29%), Vaúpez (31.12%), Vichada (13.51%).

Furthermore, it's noteworthy that between 1998 and 2007, out of 7,222,258 live births recorded (NHSS, 1998 - 2007), 190,836 births occurred in regions other than the mother's place of residence, excluding those living in foreign countries or without information.

We observed that out of the total births occurring outside the mother's residency region, 87,067 births took place in Bogotá and 17,630 in Valle del Cauca. In Antioquia, which experienced the highest average of violent acts, 7,043 babies were born to immigrant women giving birth in Antioquia, while 6,450 were born from mothers who migrated to another region but were living in Antioquia. It's noteworthy that Bogotá, Valle del Cauca, and Antioquia boast robust healthcare services, particularly in their metropolitan areas. In Caquetá, the most affected region in terms of victim rates, there was a total difference of 186 newborns being born outside Caquetá due to their mothers' relocation. Table 1 presents percentages of regional births by year considering the number of births between 1998 and 2007, declared or registered in regions other than the mother's region of residence.

We have indeed identified a discernible pattern in the variance of internal migration volumes across regions, corresponding to their levels of violence. However, there are instances where this pattern doesn't hold. Take, for example, highly affected regions like Antioquia, which exhibited a positive difference of 593 between mothers immigrating and those migrating out. Similar anomalies are observed in Cesar (950), Arauca (163), Norte de Santander (426), Magdalena (1,821), and Meta (1,963), where there's a notable upward trajectory in the percentage of births from immigrant mothers. Conversely, there are other highly affected regions displaying a negative difference in internal migration, indicating that more women are leaving the region to give birth elsewhere.

This is evident in cases like Caquetá (-187), Putumayo (-1,505), Casanare (-1,193), Chocó (-2,587), Guaviare (-284), Guainía (-35), and La Guajira (-472).

On the contrary, regions unaffected like Amazonas exhibit a positive difference of (296), whereas San Andrés demonstrates a negative difference of (-297).

Table 1. Total Regional Births and percentages by Year. Internal migration of pregnant women.

REGIONS	1998 %	1999 %	2000 %	2001 %	2002 %	2003 %	2004 %	2005 %	2006 %	2007 %	TOTAL BIRTHS
Antioquia (inmigrants)	9,68	9,44	8,33	8,22	9,65	9,63	9,9	10,58	11,83	12,74	7.043
(migrants)	7,77	8,34	9,97	8,73	8,45	8,71	11,8	11,8	12,05	12,39	6.450
dif	1,91	1,1	-1,64	-0,51	1,2	0,92	-1,9	-1,22	-0,22	0,35	593
Atlántico (inmigrants)	10,25	10,5	10,69	9,01	9,68	9,43	8,06	8,57	12,48	11,27	6.467
(migrants)	14,06	14,99	10,44	8,57	9,24	8,7	8,3	10,84	6,83	8,03	747
dif	-3,81	-4,49	0,25	0,44	0,44	0,73	-0,24	-2,27	5,65	3,24	5720
Bogotá D.C (inmigrants)	3,78	8,33	9,98	10,1	10,8	10,84	10,98	10,79	11,69	12,71	87.067
(migrants)	11,7	10	9,39	8,72	7,76	7,39	8,6	9,98	11,14	14,33	4.048
dif	-7,92	-1,67	0,59	1,38	3,04	3,45	2,38	0,81	0,55	-1,62	83019
Bolívar (inmigrants)	24,27	13,2	10,02	8,37	7,74	9,99	6,12	7,57	7,12	5,6	2.893
(migrants)	8,34	8,92	7,78	7,12	8,17	8,77	10,66	11,7	13,32	15,22	8.228
dif	-15,93	-4,28	-2,24	-1,25	0,43	-1,22	4,54	4,13	6,2	9,62	-5335
Boyacá (inmigrants)	12,77	12,6	10,67	10,53	9,2	7,84	7,89	9,46	9,31	9,73	3.382
(migrants)	5,96	7,15	7,63	9,53	12,09	13,49	14,91	9,87	10,45	8,92	3.789
dif	6,81	5,45	3,04	1	-2,89	-5,65	-7,02	-0,41	-1,14	0,81	-407
Caldas (inmigrants)	15,71	13,48	14,78	6,82	7,08	7,03	7,47	8,46	10,28	8,87	4.620
(migrants)	12,59	12,4	11,21	7,93	8,79	8,46	6,94	12,92	9,22	9,55	2.105
dif	-3,12	-1,08	-3,57	1,11	1,71	1,43	-0,53	4,46	-1,06	0,68	2515
Caquetá (inmigrants)	7,76	7,65	7,45	8,27	9,29	9,8	10,31	10,41	15,41	13,67	794
(migrants)	9,07	12,47	10,45	7,56	8,19	8,06	10,96	10,08	10,45	12,72	980
dif	-1,31	-4,82	-3	0,71	1,1	1,74	-0,65	0,33	4,96	0,95	-186
Cauca (inmigrants)	39,07	12,2	8,13	7,04	6,39	7,41	6,1	5,66	4,72	3,27	1.377
(migrants)	7,63	7,33	9,14	9,24	10,59	10,26	10,2	10,81	12,54	12,25	13.719
dif	-31,44	-4,87	1,01	2,2	4,2	2,85	4,1	5,15	7,82	8,98	-12342
Cesar (inmigrants)	7,95	7,66	9,65	9,15	10,76	9,56	9,24	10,37	10,92	14,75	4.415
(migrants)	6,49	7,99	9,15	7,73	7,71	9,29	11,8	11,05	13,36	15,41	3.465
dif	-1,46	0,33	-0,5	-1,42	-3,05	-0,27	2,56	0,68	2,44	0,66	950
Córdoba (inmigrants)	8,54	8,88	10,8	9,45	8,91	8,7	11,79	11,6	10,26	11,06	5.631
(migrants)	8,83	9,39	8,36	7,8	10,65	10,42	8,36	10,89	13,03	12,28	2.525
dif	0,29	0,51	-2,44	-1,65	1,74	1,72	-3,43	-0,71	2,77	1,22	3106
Cundinamarca (inmigrants)	8,54	8,83	11,7	10,09	9,62	7,56	10,33	10,24	10,46	12,62	10.512
(migrants)	4,01	8,41	9,9	9,97	10,46	10,61	10,88	10,94	11,83	12,99	83.291
dif	-4,53	-0,42	-1,8	-0,12	0,84	3,05	0,55	0,7	1,37	0,37	-72779
Chocó (inmigrants)	6,49	7,57	6,49	7,3	10,27	22,43	15,14	7,03	8,11	9,19	370
(migrants)	5,82	6,29	7,14	7,54	8,45	8,15	9,91	13,46	15,45	17,79	2.957
dif	-0,67	-1,28	0,65	0,24	-1,82	-14,28	-5,23	6,43	7,34	8,6	-2587
Huila (inmigrants)	5,76	7,1	7,53	5,48	5,17	7,02	9,78	12,46	20,62	19,09	2.536
(migrants)	8,53	7,53	13,04	12,88	10,87	7,19	12,54	11,54	6,52	9,36	598
dif	2,77	0,43	5,51	7,4	5,7	0,17	2,76	-0,92	-14,1	-9,73	1932
La Guajira (inmigrants)	43,01	30,38	2,82	4,64	3,23	3,43	4,23	2,49	3,02	2,76	1.488

(migrants)	8,93	10,26	10,05	9,49	9,59	9,44	9,54	9,23	10,97	12,5	1.960
dif	-34,08	-20,12	7,23	4,85	6,36	6,01	5,31	6,74	7,95	9,74	-472
Magdalena (inmigrants)	9,77	11,38	11,87	8,9	9,4	9,6	7,73	9,16	12	10,19	5.731
(migrants)	7,95	11,3	5,93	5,83	6,45	8,8	10,28	13,25	16,14	14,07	3.910
dif	1,82	0,08	5,94	3,07	2,95	0,8	-2,55	-4,09	-4,14	-3,88	1821
Meta (inmigrants)	6,74	9	9,68	7,87	8,36	10,08	10,38	12,32	12,83	12,75	3.710
(migrants)	6,35	10,88	11,22	12,65	12,65	11,91	10,19	8,93	7,38	7,84	1.747
dif	-0,39	1,88	1,54	4,78	4,29	1,83	-0,19	-3,39	-5,45	-4,91	1963
Nariño (inmigrants)	52,64	5,11	6,77	4,54	5,34	5,46	4,57	4,48	4,9	6,18	3.368
(migrants)	7,07	9,03	8,33	7,31	9,98	11,23	11,63	12,1	12,88	10,45	1.273
dif	-45,57	3,92	1,56	2,77	4,64	5,77	7,06	7,62	7,98	4,27	2095
Norte de Santander (inmigrants)	16,21	12,47	9	6,85	7,4	8,9	7,95	8,36	10,96	11,92	2.190
(migrants)	10,6	10,54	11,11	8,9	7,2	8,67	8,22	8,84	10,43	15,48	1764
dif	-5,61	-1,93	2,11	2,05	-0,2	-0,23	0,27	0,48	-0,53	3,56	426
Quindío (inmigrants)	15	9,44	8,53	8,77	7,38	7,24	7,24	13,66	13,9	8,86	2.087
(migrants)	11,07	21,44	8,58	8,16	7,88	10,65	5,12	6,92	7,75	12,45	723
dif	-3,93	12	0,05	-0,61	0,5	3,41	-2,12	-6,74	-6,15	3,59	1364
Risaralda (inmigrants)	18,63	13,5	10,45	9,33	8,66	8,73	8,18	7,58	6,91	8,03	3140
(migrants)	9,51	7,31	8,54	8,27	7,48	7,26	7,83	14,08	19,19	10,52	2.272
dif	-9,12	-6,19	-1,91	-1,06	-1,18	-1,47	-0,35	6,5	12,28	2,49	868
Santander (inmigrants)	11,37	11,49	10,55	7,84	6,84	8,48	10,35	10,02	10,76	12,3	7.267
(migrants)	8,92	10,67	10,4	10,01	9,19	10,4	9,75	8,71	10,06	11,89	2.297
dif	-2,45	-0,82	-0,15	2,17	2,35	1,92	-0,6	-1,31	-0,7	-0,41	4970
Sucre (inmigrants)	7,04	9,7	9,81	6,93	9,92	7,7	8,42	9,92	12,96	17,62	1.805
(migrants)	15,35	15,4	12,57	10,52	9,31	8,68	6,99	6,99	6,62	7,57	1.902
dif	8,31	5,7	2,76	3,59	-0,61	0,98	-1,43	-2,93	-6,34	-10,05	-97
Tolima (inmigrants)	33,27	20,94	17,04	3,87	2,68	3,66	6,12	5,42	2,95	4,04	3.691
(migrants)	8,15	8,65	12,57	10,05	9,64	8	10,17	10,4	11,06	11,31	10.316
dif	-25,12	-12,29	-4,47	6,18	6,96	4,34	4,05	4,98	8,11	7,27	-6625
Valle del Cauca (inmigrants)	14,52	10,44	8,6	8,39	9,65	9,08	8,71	9,54	10,95	10,12	17.630
(migrants)	12,39	10,47	10,69	11,04	8,87	9,65	9,5	8,87	8,84	9,69	3.180
dif	-2,13	0,03	2,09	2,65	-0,78	0,57	0,79	-0,67	-2,11	-0,43	14450
Arauca (inmigrants)	11,91	8,51	14,53	10,08	9,82	7,33	10,73	8,12	8,77	10,21	764
(migrants)	8,32	5,82	8,82	8,32	13,14	13,64	8,82	8,65	11,48	12,98	601
dif	-3,59	-2,69	-5,71	-1,76	3,32	6,31	-1,91	0,53	2,71	2,77	163
Casanare (inmigrants)	7,89	15,48	11,9	12,05	10,27	10,57	6,7	8,18	6,85	10,12	672
(migrants)	6,97	8,58	8,42	8,95	9,6	9,54	11,96	11,15	12,98	11,85	1.865
dif	-0,92	-6,9	-3,48	-3,1	-0,67	-1,03	5,26	2,97	6,13	1,73	-1193
Putumayo (inmigrants)	12,08	19,8	11,58	7,89	5,54	6,54	5,2	8,05	11,24	12,08	596
(migrants)	9,04	9,19	11,23	7,95	9,42	9,66	7,66	9,95	11,09	14,8	2.101
dif	-3,04	-10,61	-0,35	0,06	3,88	3,12	2,46	1,9	-0,15	2,72	-1505
San Andrés (inmigrants)	6,67	36,67	10	0	6,67	20	3,33	6,67	3,33	6,67	30
(migrants)	5,5	6,12	8,56	11,62	6,73	4,89	11,31	14,98	20,8	9,48	327
dif	-1,17	-30,55	-1,44	11,62	0,06	-15,11	7,98	8,31	17,47	2,81	-297
Amazonas (inmigrants)	4,79	4,58	5	14,17	9,58	9,38	11,88	9,38	11,04	20,21	480
(migrants)	13,04	9,24	15,22	4,89	13,04	7,61	7,61	9,24	10,33	9,78	184
dif	8,25	4,66	10,22	-9,28	3,46	-1,77	-4,27	-0,14	-0,71	-10,43	296
Guainía (inmigrants)	11,76	13,24	19,12	8,09	5,88	6,62	4,41	9,56	10,29	11,03	136
(migrants)	9,94	12,28	10,53	8,77	4,09	6,43	15,79	6,43	14,62	11,11	171
dif	-1,82	-0,96	-8,59	0,68	-1,79	-0,19	11,38	-3,13	4,33	0,08	-35
Guaviare (inmigrants)	5,16	12,1	8,53	12,3	11,11	11,51	11,31	10,52	7,74	9,72	504
(migrants)	7,99	11,68	12,69	14,21	8,25	12,06	8,88	9,64	7,74	6,85	788
dif	2,83	-0,42	4,16	1,91	-2,86	0,55	-2,43	-0,88	0	-2,87	-284
Vaupés (inmigrants)	7,69	9,62	19,23	13,46	11,54	7,69	1,92	9,62	9,62	9,62	52
(migrants)	1,44	5,76	9,35	11,51	15,83	8,63	14,39	11,51	5,04	16,55	139
dif	-6,25	-3,86	-9,88	-1,95	4,29	0,94	12,47	1,89	-4,58	6,93	-87
Vichada (inmigrants)	8,61	12,92	11	5,26	8,13	7,18	11	11	5,26	19,62	209
(migrants)	4,89	7,48	7,48	5,17	8,86	13,48	9,97	11,54	14,59	16,53	1.083
dif	-3,72	-5,44	-3,52	-0,09	0,73	6,3	-1,03	0,54	9,33	-3,09	874

Source: Own elaboration from NHSS 1998 - 2007 DANE databases

Conversely, regions with lower and moderately violence rates shows a positive internal migration difference, like Bogotá (83,019), Valle de Cauca (14,450), Quindio (1,364), Atlántico (5,720), Cordoba (3,016), and Risaralda (868), and served as havens amidst other regions with moderate-to-high violence, such as Huila (1,932), Caldas (2,515), Córdoba (3,106), Nariño (2,095), Santander (4,970), and Vichá (874). In contrast, several moderately affected regions experienced a net decrease in internal migration of pregnant women, including Bolívar (-5,335), Boyacá (-407), Cundinamarca (-72,779), Tolima (-6,625), Sucre (-97), and Vaupez (-87).

As depicted in Table 1, there is a notable trend towards moderately affected regions, originating from both highly affected and less affected areas. However, there's also a migration pattern observed where women are leaving moderately affected or less affected regions. It's imperative to conduct further research to delve into the insights uncovered by previous studies and fortify the conclusions regarding this internal migration phenomenon and its potential correlation with newborn well-being and neonatal health.

Determining the extent to which internal migration percentages may elucidate the observed results is paramount. Our analysis indicates that, in most regions, internal movement began stabilizing or increasing only post-2002, although exceptions exist, such as Huila, Caldas, Meta, Sucre, and Guaviare. Moreover, the heightened levels of regional violence associated with the Colombian Armed Conflict between 1998 and 2007 likely prompted internal migration among

women seeking safer environments and better healthcare services. The context of war and the widespread impact of violence across regions, coupled with urbanization trends post-2003, likely contributed to a surge in internal migration among pregnant women, potentially elevating their stress levels and diminishing antenatal health outcomes.

6.3 Highlights

As the intensity of the Colombian Armed Conflict (CAC) escalated between 1998 and 2007, **transmission of adverse health outcomes occurred**. We show that pregnant women living in the most violent regions and in 2002 overall had a high probability of transmitting adverse health outcomes to their offspring. In addition, there is a clear expectation of an increased likelihood of stillbirth or miscarriage between 1998 and 2007.

As a result of the changing dynamics of the Colombian Armed Conflict (CAC) between 1998 and 2007, **there was an urbanisation of the CAC between 2003 and 2007**. We show that pregnant women living in urban areas between 2003 and 2007 were more likely to experience adverse outcomes than their counterparts living in rural areas between 1998-2002 and 2003-2007. However, this could be attributed to the representativeness of the urban population in the NHSS dataset.

The thesis highlights the **protective effect of maternal university education on newborn weight**, especially in the turbulent year of

2002. It also highlights the **protective effect of university education on live births and the prevention of violent or unexplained losses** between 1998 and 2007. However, for preterm births, there is a **modifying effect on the protective effect of maternal university education over the dyad**. These paradoxical results require further investigation.

Building on this, the second paper examines the nuanced role of maternal education in relation to preterm birth, revealing a complex interaction with regional violence. **The modifier effect of violence on the protective effect of maternal university education in relation to preterm birth**. Thus, the modifier effect of violence on the protective effect of maternal university education over the dyad reveals a negative effect of violence for mothers with university education for experiencing a PTB.

Looking at the demographic conditions that are likely to protect newborns, we find that women who have successfully completed university education are not always the best at protecting the dyad. We show how the modifier effect of violence on the protective influence of maternal university education could impact on the odds of PTB. Specifically, we find that **in regions where the conditions of the Colombian Armed Conflict (CAC) were more severe, critical factors for well-being such as employment opportunities, access to health care, and general security tended to be lacking**. In addition, given the highly privatised nature of higher education in Colombia, where approximately 50% of higher education is

provided by private institutions, citizens often incur debt to obtain a bachelor's degree. Therefore, following the ecological transitions outlined by Urie Bronfenbrenner in his ecological theory, if a woman completes her university education but struggles to secure employment, is unemployed or faces challenges in repaying her student loans, she may experience increased levels of stress, especially during pregnancy. This could be one of the possible explanations for the high rates of preterm births among women with university education.

Additionally, we analyze internal migration patterns by considering the number of births occurring in same regions of maternal residence as well as those in regions different from the mother's habitual residence. Approximately 190,000 pregnant women relocated from their usual regions to give birth elsewhere. While the specific migration dynamics remain unclear, it appears that between 1998 and 2002-2003, some highly affected regions did not receive a proportional number of pregnant women compared to other areas. Conversely, moderately and moderately-highly affected regions experienced an increase in the percentage of births from mothers residing outside the region. Likewise, highly affected regions with weak healthcare services such as Putumayo, Guaviare, Chocó, Casanaré, Caquetá, Guainía, as well as other mid affected such as Cundinamarca, Bolívar and Sucre witness a negative internal displacement difference, meaning that more women lived the region compared to those entering. This suggests that the **combined factors of violence and inequality created fragile environments,**

particularly affecting pregnant women with lower levels of education and resulting in unequal outcomes from the earliest stages of life.

In summary, it can be inferred that **pregnant women residing in highly affected regions such as Caquetá, Putumayo, Guaviare or Antioquia are more prone to have lower levels of education, particularly in rural areas.** Furthermore, **those with lower levels of education or who refrain from disclosing their educational status for various reasons are more susceptible to the impacts of violence, potentially affecting the health outcomes of their infants.**

While there is a statistically significant difference in the probabilities of newborns experiencing some health disadvantage at birth due to violent contexts (Rodríguez, 2022; Bernal et al., 2024; Beltrán et al., 2013; Akhtar D. et al., 2019; Cozzani et al., 2022; Valente, 2015; Duque, 2017) (such as preterm birth, low birth weight, preterm and low birth weight, or not being born), apart from other clinically relevant factors from the mother's medical history (Akhtar D. et al., 2019; Rodríguez, 2022; Bernal et al., 2024; Reinebrant, 2018; WHO, 2023), we suggest that the dynamics of the Colombian armed conflict, resulting in a **war context, from FARC's escalation of violence and the subsequent implementation of a more aggressive security policy called the "Democratic Security Policy" during the presidential term of Uribe's government (2002-2006), spread the feeling of fear**

across territories. Hence, led pregnant women to search for safety and better healthcare services, thus landing to urban centers and metropolitan areas, mainly of Bogotá, Antioquía, Valle del Cauca, Meta, and Atlántico to be more likely to protect their babies. Nevertheless, the urbanization of the conflict among with other economic regional factors were likely to challenge their protective intention, even when they were highly educated.

One of the potential mechanisms relies on the **higher levels of stress and the over production of cortisol** (Akhtar D., 2019; Stonkoff et al., 2012). This was likely because the **paramilitarization of regions as Antioquia and the oragnization of crime within cities**, among other internal migration flows. Along these lines, we notice that in the year 2002, there was a negative reduction on newborns compared with all years. Nevertheless, we lack of evidence to argue that is due to the intensification of the Colombian armed conflict and a aggressive response from the State. In summary, while the securitization process of Colombian society brought about greater state presence and reduced influence of the FARC guerrillas, it also had an unprecedented impact on the well-being of newborns.

It is crucial to acknowledge that the databases from the National Centre of Historic Memory (NCHM), which encompass the 11 categories of violent acts associated with the Colombian Armed Conflict (CAC), do not distinctly capture the urbanization trends of

the CAC post the demilitarization of paramilitary groups or the organization of criminal networks within cities. The intricacies of urban violence, a facet we couldn't quantify, are not fully represented in these databases. However, delving into historical research on the prevalence of violent organizations across cities and the escalation of military confrontations, such as in Medellín, provides an explanation for the heightened impact on newborns' well-being in urban settlements after 2002.

In conclusion, four papers paints a comprehensive picture of the complexities surrounding newborn well-being in the context of the war such as the Colombian Armed Conflict. Findings emphasize the need to **consider regional factors** as well as **several neonatal health dimensions** to assess **the role of maternal education**. For **avoiding low birth weight (LBW), stillbirths, miscarriages and violent losses within war contexts**, it was showed the **protective factor of maternal university education**. Nevertheless, **this effect changes depending on the impact of violence in different regions**. Hence, it leverage the need for **tailored interventions in terms of public policy**. **This research contributes to the broader discourse on conflict and health, urging policymakers to adopt targeted approaches for enhancing maternal and neonatal health outcomes in regions affected by armed conflict such as univesalization of higher education as a human right and the introduction of a net of antenatal and early childhood unities inside universities, overall, under armed conflict and war contexts.**

6.4 Current situation

The aftermath of the 2016 Havana Peace Accords has seen a disturbing increase in massacres and targeted assassinations, particularly of social leaders and former members of the FARC (Fuerzas Armadas Revolucionarias de Colombia) over the past two years. These disturbing events have been widely reported in the media. It is disheartening to note that forced displacement continues in urban areas and regions characterized by high levels of inequality, as evidenced by high rates of unemployment and poverty. Of particular concern in our study is the low prevalence of mothers who have completed university education before giving birth in these affected areas.

Further research, including more recent data that could capture the violent activities of organized crime, is therefore essential to underpin the urgent need for a systematic and inter-institutional response, particularly between the higher education, health and early childhood policy sectors. Such an approach would aim to address the challenges posed by the evolving demographic and socio-political landscape and ensure a comprehensive understanding of the complex interplay between migration, violence, post-conflict scenarios and educational attainment in the context of maternal and child well-being.

Conversely, the prevailing dynamics of violence within and between regions and communities and the persistence of aggressive behaviour require concerted efforts to intervene. These factors pose

a significant threat to human development and general well-being. It is unfortunate that individuals are forced to live in toxic environments where violence has permeated societies, undermining the fundamental human rights of populations from the womb. Addressing these critical disruptors requires not only research, but also proactive measures and collaborative initiatives across sectors to create environments conducive to the positive development and well-being of individuals and communities.

6.5 Implications and Recommendations

Taken together, the findings highlight the need for targeted interventions that recognize the complex interactions between regional violence, maternal education and newborn well-being. Interventions should take into account specific contexts, such as urbanisation, varying levels of conflict and regional disparities, in order to effectively address the diverse needs of pregnant women and newborns.

Further on, inter-sectorial-ministerial actions are required to deploy an international/national policy addressing gender issues related to pregnancy and vulnerability in terms of health and higher education. For instance, the universalization of higher education needs to be considered a right rather than a service, especially in fragile contexts such as Colombia, Ukraine, Palestine, Congo, Sudan, and other nations biased by the effects of war and armed conflicts. The UNESCO and WHO could lead these essential need.

6.6 Constrains

This thesis recognizes certain limitations. First, the use of more recent data may be open to criticism. However, it's important to underline the methodological strength that comes from reconstructing a toxic and harmful war and violent environment, especially the one experienced in Colombia between 1998 and 2007, especially within the 2002 violence peak. Likewise, we acknowledge that the interpolation of the methodology applied to the 2002 violence peak may be relevant to capture contextual conditions and assess neonatal well-being and pregnancy vulnerability in other war contexts, such as the recent conflicts in Palestine or Ukraine.

Second, while two papers used multilevel statistical modelling, they all implied a theoretical grounding in Bronfenbrenner's multisystemic framework. In the first paper, for example, a robust descriptive data analysis approach ensured coherence between theory and empirical evidence. This was complemented by a series of Ordinary Least Squares (OLS) models using the Huber-White robust standard errors technique to estimate variances between variables. In multi-level settings, research questions are usually multi-level (e.g. the effect of different regional contextual factors that may influence the socio-economic and psychological situation of the mother and thus the outcomes of the newborn). Nevertheless, further research should consider more complex multilevel models, such as slope models with covariates or Bayesian models. Regardless this issue, the theoretical approach of this scientific

paper stress the coherence between Bronfenbrenner's ecological framework and the complementary medical and sociological evidence presented, the rigorous descriptive data analysis and the estimation of the odds ratio for PTB. For instance, Bronfenbrenner's concept of the mesosystem encompasses the interrelationships between two or more settings, such as, for a pregnant woman, the relationships between home, family, work and social life. It is, in Bronfenbrenner's words, a system of microsystems, and it expands as a person moves into different settings. Our aim was therefore to estimate this wide range of observations by estimating the interaction between the regional level of violence and the mother's level of tertiary education.

Third, with regard to the first three papers, which looked at the peak of violence in 2002, there are concerns about potential biases arising from the lack of a more structural analysis that would allow a better assessment of the impact of violence on newborn well-being and its moderating effect on the shielding effect of maternal tertiary education. Therefore, in the fourth paper we address this issue by using a cross-sectional panel for the 33 regions over a 10-year period.

Fourthly, the inability to identify mothers experiencing domestic violence did not allow us to isolate or identify the extent to which this was due to another typology of violence that may or may not be related to the Colombian armed conflict.

Fifthly, although there was no specific socio-economic information on the family or parents, the category of healthcare regime / insurance allowed us to make an approximation of socio-economic and work status, since Law 100 of 1993 defines access to healthcare regime / insurance according to the work status of the member. For example, women in the subsidiary healthcare regime had no job, worked in the informal sector or earned less than the legal minimum monthly wage.

Finally, while providing valuable insights, limitations include the inability to measure certain aspects of the complexity of violence, such as urban violence linked to organized crime and drug trafficking. Future research could delve deeper into the nuances of conflict dynamics, taking into account additional contextual factors and incorporating a longitudinal perspective, especially after the 2016 Havana Peace Accords.

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