Hospital padrino: a collaborative strategy model to tackle maternal mortality: a mixed methods study in a middle-income region

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Summary

Background Reducing maternal mortality ratio (MMR) remains a paramount goal for low- and middle-income countries (LMICs), especially after COVID-19's devastating impact on maternal health indicators. We describe our experience implementing the Hospital Padrino Strategy (HPS), a collaborative model between a high-complexity hospital (Fundación Valle del Lili) and 43 medium- and low-complexity hospitals in one Colombian department (an administrative and territorial division) from 2021 to 2022, to sustain the trend towards reducing MMR. The study aimed to assess the effects of implementing HPS on both hospital performance and maternal health indicators in Valle del Cauca department (VCD).

Methods A mixed-methods study was conducted, comprising two phases. In the first phase, we investigated a cohort of hospitals through prospective follow-up to assess the outcomes of HPS implementation on hospital performance and maternal health indicators in VCD. In the second phase, qualitative data were collected through focus groups with 131 health workers from 33 hospitals to explore the implications of the HPS implementation on healthcare personnel. All data were obtained from records within the HPS implementation and from the Health Secretary of VCD.

Findings Evidence shows that in the context of HPS, 51 workshops involved 980 healthcare workers, covering the entire territory. Substantial improvements were observed in hospital conditions and healthcare personnel's technical competencies when providing obstetric care. Seven hundred eighty-five pregnant women with obstetric or perinatal emergencies received care through telehealth systems, with a progressive increase in technology adoption. Nine percent required Intensive Care Unit (ICU) admission, and none died. The MMR decreased from 78.8 in 2021 to 12.0 cases per 100,000 live births by 2022. Improvements in indicators and conducted training sessions instilled confidence and empowerment among the healthcare teams in the sponsored hospitals, as evidenced in focus groups derived from a sample of 131 healthcare workers from 33 hospitals.

Interpretation Implementing the Hospital Padrino Strategy led to a significant MMR reduction, and consolidated a model of social healthcare innovation replicable in LMICs.

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Research in context

Evidence before this study

The Hospital Padrino Strategy is supported by the concept of the Network for Improving Quality of Care for Maternal, Newborn and Child Health (Quality of Care Network) of the World Health Organization and the evidence of effective programs to reduce the maternal mortality ratio (MMR). Scientific recommendations were reviewed for implementing intervention packages in managing obstetric emergencies, educational models supported by simulation for multidisciplinary teams, strengthening of non-technical skills of hospitals, and adopting telehealth technologies. A PubMed search covered articles published between January 1, 2000 and June 1, 2023, without language restrictions, using the search terms 'care network' OR 'simulation-based education' OR 'non-technical skills' OR 'telehealth' OR 'maternal mortality' OR "Bundles" AND obstetric emergencies". We evaluated the titles of the initial 1000 articles and examined the abstracts when available, examining the full article when the abstract suggested possible relevance. In addition, we included reports from United Nations agencies. Successful interventions highlight universal access to quality prenatal and postnatal care, technological advances in obstetric care, and improvements in sexual and reproductive health education. Strengthening health systems, creating care networks, and training health workers to provide quality obstetric care also contribute to positive trends.

Added value of this study

Creating collaborative models between high-complexity and medium-to low-complexity hospitals, coupled with telehealth technologies, enables significant improvements in hospital conditions and the skills of healthcare personnel, thereby, positively impacting maternal health.

Implications of all the available evidence

This research provides a practical solution for low- and middle-income countries (LMICs) and underscores the potential of social innovation in addressing maternal health challenges.

Introduction

Reducing the maternal mortality ratio (MMR) is a global health priority aligned with the Sustainable Development Goals (SDGs) that reflect a country's development level.[1] Despite efforts, achieving these goals has been challenging, particularly due to the impact of COVID-19 pandemic on low- and middle-income countries (LMICs).[2,3] In 2020, the global MMR was 223 maternal deaths per 100,000 live births (LB), nearly 800 maternal deaths daily.[4] In LMICs scenarios, 50 women experience Maternal Near Miss (MNM) for each maternal death, and 8% of hospital deliveries face complications.[1]

Colombia's MMR mirrors this global trend. In 2021, the National Institute of Health (NIH) reported 661 maternal deaths, 485 of which were early maternal deaths. This represents an increase of 24.1% compared to 2020, with an MMR of 78 deaths per 100,000 LB, reaching levels last seen 12 years ago.[5] The Valle del Cauca department (VCD) established in the "*Plan de Desarrollo Departamental Valle Invencible*" 2020–2023 (Invincible Valle Departmental Development Plan) to maintain the MMR below 25 per 100,000 LB. However, the MMR in 2021 remained above the national average at 78.6 deaths per 100,000 LB. The causes of death were COVID-19 infection, hypertensive disorders, postpartum hemorrhage (PPH), and maternal sepsis. Critical determinants that contributed to this issue were limited access to prenatal care and follow-up, the challenge of timely detection and treatment of preventable diseases as well as promptly prevention of fatal outcomes, access barriers in low and medium-complexity hospitals, and health workers' challenges in providing adequate obstetric care.[6,7]

Fundación Valle del Lili (FVL), a non-profit university hospital and referral center, has the most extensive obstetric critical unit in southwest Colombia.[8] To halt the rise in MMR in the VCD, the FVL, in alliance with the Health Secretary of VCD and Propacifico (a non-governmental organization), created an intervention model called Hospital Padrino Strategy (HPS) in June 2021. This strategy is a model of social innovation in health that focuses on vulnerable populations. It aims to contribute to health equity, promote knowledge, ensure timely access to quality health services, and strengthen facilities to reduce preventable maternal deaths. The primary goal of HPS was to enhance obstetric care and the management of obstetric emergencies, thereby maintaining the trend of reducing maternal mortality.[9,10]

We describe our experience in implementing the HPS as an emergent response to the increasing MMR in VCD, Colombia. This was achieved through a collaborative work model involving FVL, serving as the high-complexity hospital, sponsoring 43 medium- and low-complexity hospitals within the VCD health network

from 2021 to 2022. The objective of this study is to assess the outcomes of implementing the HPS on hospital performance and maternal health indicators in the VCD.

Methods

Design and context

We conducted a mixed-methods study consisting of two phases. In the first phase, we investigated a cohort of hospitals through a follow-up to assess the outcomes of the HPS implementation on hospital performance and maternal health indicators in VCD. In this first phase, we considered information obtained from the two primary stages of the HPS: educational modules to strengthen teams in the management of obstetric emergencies, and the subsequent implementation of telemedicine strategies to guide management in the sponsored hospitals. Over the course of a year, these modules were implemented, assessing safety conditions for obstetric emergency care and establishing a secure care network.

In the second phase, data from focus groups were collected to explore the implications of the HPS implementation on healthcare personnel. All data were obtained from records within the HPS implementation. Information on the indicators was sourced from the Health Secretary of VCD, and these data are freely available upon request. The Ethics Committee of Fundación Valle del Lili reviewed and approved the study protocol (CRI/CE No. 181; Act No. 09-2022). Informed consent was not required as the data were retrospectively obtained from the HPS registry.

Valle del Cauca is located in southwestern Colombia, comprising 42 municipalities divided into four subregions: North, Central, South, and Pacific.[11] By 2018, the population was approximately 4,475,886 inhabitants, of which 52.5% were women. Each municipality houses at least one public hospital authorized to provide obstetric care, they can work together in a network to solve emerging problems. The difficulties are greater in the north of the department, where a person needs to travel approximately 200 km to access to these hospitals. In July 2021, due to the report of 39 maternal deaths, the HPS was implemented around these obstetric care facilities. A key feature, or 'differential factor' of this initiative, was the sponsorship of the hospitals by strategic nodes, which refers to central and strategic locations. These nodes served as convergence points for healthcare personnel from nearby regions, facilitating the implementation of intervention activities. This approach recognized the network operation of the territory. The Valle del Cauca department has two special districts: Cali and Buenaventura. Each of the districts has a care model and independent health secretary. The 40 additional territories are centralized in the Health Secretary of the VCD. The 43 medium- and low-complexity hospitals sponsored by the HPS are located in these 40 territories. The districts of Cali and Buenaventura were excluded from this project. FVL is situated in the city of Cali, which serves as the capital of the VCD.

Overview of the HPS

HPS is a collaborative hospital partnership model where a public or private hospital of high complexity and quality (Hospital Padrino) supports and guides providers of less complex hospitals (Sponsored Hospital) to improve the quality, timeliness, and resolution of patient care, under the coordination of the government. HPS has two components: an educational model and a telehealth system. Using life-saving educational strategies, we seek to strengthen the knowledge and skills of the health workers of the Sponsored Hospitals, through theoretical and practical workshops that emphasize the development of soft skills for teamwork and humanization.

Furthermore, the strategy strengthens telehealth services across the region, directly improving patient care conditions through telemedicine system from the HPS. This allows pregnant women at sponsored hospitals to access specialized medical care and receive faster diagnosis and treatment. The strategy was supported by the network of care proposal, where an interconnected care network manages an administrative and clinical model that prioritizes patient-centered care.[12]

The HPS was discussed with the department's health secretary, defining the one-year coverage and expansion process. The hospitals with the greatest need for improvement were jointly selected, considering each hospital's morbidity and maternal mortality indicators, the human development index of each territory, the proportion of the migrant population served, and the coverage of the rural and minority populations. Before implementation, we standardized management protocols, medical guides, checklists, and educational modules using obstetric emergency management bundles previously tested in FVL.[13–18] Additionally, workshops focused on strengthening concepts of communication, teamwork, and safety culture were carried out.[19,20]

First, the HPS team together with the medical staff of the sponsored hospitals, evaluated and diagnosed the installed capacity, safety of emergency obstetric care, and adoption of telemedicine services. This led to defining which conditions should be strengthened as a priority for the success of the project. Afterward, on-site simulation training workshops were conducted at the participating institutions. These workshops, lasting from 6 to 12 h each, were mandatory for all healthcare personnel responsible for pregnant women's care, including nursing assistants, registered nurses, general practitioners, and gynecologists. Special emphasis was

placed on training the nursing assistants, as this group has the lowest staff turnover.[21] The educational model was directed by obstetrician-gynecologists with subspecialties in critical medicine from the FVL. Modules encouraged prompt identification of obstetric emergencies using the Modified Early Obstetric Warning System (MEOWS), management of the safe delivery of care, postpartum hemorrhage, hypertensive disorders of pregnancy, maternal sepsis, and contraception after obstetric events.[22,23] Knowledge assessments were conducted before and after the training modules. Each hospital received four workshops and six follow-up visits during the intervention. Trainers also organized group-specific teleconferences every three months to address implementation issues, compliance, or challenges.

Once education was completed, remote monitoring began with health communication technologies (tele-expertise and telecare) using licensed communication platforms. FVL developed the platform "Liliconnect" for tele-expertise, allowing a legal exchange of information and recording the clinical history of each patient for both institutions. The teleassistance system was formalized by WhatsApp chats for each institution. HPS assembled a support team of qualified specialists and a telehealth service available 24/7, facilitating communication among professionals across the 43 hospitals. Health workers at sponsored hospitals received guidance during critical moments and continued support until patients were transferred to a high-complexity facility. The transfer of patients was conducted according to their clinical situation (urgency or emergencies), the insurer's networks, and the government. This model had been previously tested to a lesser extent by FVL.[9,10] The details of the HPS are presented in the Supplementary material.[24]

Population

The inclusion criteria were pregnant women with MNM cases, obstetric emergencies, or high-risk pregnancies of the 43 hospitals included in the HPS. Table 1 clarifies the hospital's care level in VCD. MNM were defined according to the Colombian Ministry of Health.[25] The patient's records of tele-expertise were collected prospectively in the Liliconnect platform database, and a dashboard was created to record information of patients who were commented on the telemedicine chats. After the initial evaluation, pregnant women could receive care in their primary care center or be referred to a more complex level, depending on the severity, distance, and availability of care in the department or the city of Cali. Parallel to this study, HPS was implemented in Cali in 16 obstetric care facilities capable of receiving pregnant women in critical conditions referred from the 43 sponsored hospitals. Only extremely critical patients were referred in all cases to FVL. All the patients were followed up until they were definitively attended and were also followed-up for seven days.

Variables

The variables were categorized into four groups:

1. Educational Model in Sponsored Hospitals: This category covers variables such as the total number of individuals trained, their occupations, the establishment of baseline conditions, ongoing follow-up on hospital obstetric care conditions, and documented pre and post-test results from training sessions.
2. Telehealth Model: This section provides detailed information on pregnant or postpartum women using telehealth services. Variables include age, residence, pregnancy risk classification, previous pregnancies, gestational age at care, consultation reason, and the need for referral to a higher complexity hospital. The adoption indicator for the telehealth system was also considered.
3. Official VCD Maternal and Perinatal Health Indicators: This category systematically analyzes VCD indicators for maternal and perinatal health, encompassing total maternal deaths for 2021 and 2022, early and late maternal deaths, preventable deaths, Maternal Near Miss (MNM) cases in 2021 and 2022, and perinatal and early neonatal mortality rates.
4. Qualitative Evaluation: This section delves into qualitative insights from the study, exploring the intervention's impact on healthcare practices, patient experiences, and overall program effectiveness."

The telehealth model collected sociodemographic and clinical characteristics of the pregnant women consulted, and maternal and perinatal outcomes. Medical records from high-complexity hospitals other than FVL were not reviewed. The variables were defined as follows:

- Postpartum Hemorrhage (PPH): A cumulative blood loss greater than or equal to 500 mL during vaginal delivery or 1000 mL in cesarean section, or blood loss accompanied by signs or symptoms of hemodynamic instability.[26]
- Eclampsia: New onset of seizures or coma in pregnant women with preeclampsia.[27]
- Hypertensive crisis: Persistent (lasting 15 min or more), acute-onset, severe hypertension, defined as systolic blood pressure > 160 mmHg or diastolic blood pressure > 110 mmHg in the context of preeclampsia or eclampsia.[27]
- Sepsis: A life-threatening condition defined as organ dysfunction resulting from an infection during pregnancy, delivery, puerperium, or after an abortion.[28]
- Modified Early Obstetric Warning System composed of physiological parameters with a predetermined

Attention node	Lead city and training location	Municipality	Hospital name	Hospital level of care*
North	Cartago	Cartago	Hospital San Juan De Dios	3
			I.P.S Del Municipio De Cartago E.S.E	1
		Alcalá	E.S.E Hospital San Vicente De Paul	1
		Ulloa	Hospital Local Pedro Saenz Diaz	1
		Obando	E.S.E Hospital Local De Obando	1
	Ansermanuevo	Ansermanuevo	Hospital Santa Ana De Los Caballeros E.S.E	1
		El águila	Hospital San Rafael E.S.E	1
		Argelia	Hospital Pio Xii E.S.E	1
		El Cairo	E.S.E Hospital Santa Catalina	1
	La Unión	La Unión	Hospital Gonzalo Contreras E.S.E	1
		Toro	Hospital Sagrada Familia E.S.E	1
		Versalles	E.S.E Hospital San Nicolas	1
	Zarzal	Zarzal	Hospital Departamental San Rafael De Zarzal E.S.E.	2
		La Victoria	E.S.E Hospital Nuestra Señora De Los Santos	1
Center Tuluá	Roldanillo	Roldanillo	Hospital Departamental San Antonio De Roldanillo E.S.E	2
		Bolívar	Hospital Santa Ana E.S.E	1
		El Dovio	Hospital Santa Lucia E.S.E	1
		Trujillo	E.S.E Hospital Santa Cruz	1
	Sevilla	Sevilla	E.S.E Hospital Departamental Centenario De Sevilla	2
		Caicedonia	E.S.E Hospital Santander	1

(Table 1 continues on next page)

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	Andalucia	Andalucía	Hospital San Vicente Ferrer E.S.E	1
		Bugalagrande	Hospital San Bernabe E.S.E	1
	Tuluá	Tuluá	Hospital Departamental Tomas Uribe Uribe De Tulua	2
		Tuluá	Hospital Ruben Cruz Velez	1
		San Pedro	E.S.E Hospital Local Ulpiano Tascon Quintero	1
		Riofrío	Hospital Kennedy E.S.E	1
Center Buga	Buga	Buga	Fundación Hospital San Jose De Buga	2
		Buga	E.S.E. Hospital Divino Niño	1
		Guacarí	Hospital San Roque	1
		Ginebra	Hospital Del Rosario	1
		Yotoco	E.S.E Hospital Local Yotoco	1
		Darién	Hospital San Jorge	1
		Restrepo	Hospital San Jose	1
South east	Palmira	Palmira	E.S.E. Hospital Raul Orejuela Bueno	2
		El Cerrito	E.S.E Hospital San Rafael	1
	Candelaria	Candelaria	E.S.E - Hospital Local	1
		Florida	E.S.E Hospital Benjamin Barney Gasca	1
		Pradera	E.S.E Hospital San Roque	1
South west	Dagua	Dagua	Hospital Local Jose Rufino Vivas E.S.E	1
	Jamundí	Jamundí	E.S.E Hospital Piloto Jamundi	1
	Yumbo	Yumbo	Hospital La Buena Esperanza E.S.E	1
		La cumbre	Hospital Santa Margarita E.S.E	1
		Vijes	Hospital Francineth Sanchez Hurtado	1

E.S.E: Empresa Social del Estado (State Social Entreprise), I.P.S: Institución Prestadora de Servicios (Service Providing Institution).

Table 1: **Distribution and levels of hospital care by HPS nodes.**

threshold that determines evaluation, treatment, or intervention.[17]

The definitions of maternal and perinatal health indicators were established by the Colombian Ministry of Health and adapted from the World Health Organization (WHO).[29] Maternal lethality rate was defined as the number of early Maternal Mortality (MM) per 100 cases of MNM.

Statistical analysis

Descriptive data were presented using absolute frequencies and percentages for qualitative variables, while quantitative variables were summarized with medians and interquartile ranges (IQR). To explore the difference between the medians of the scores measuring the adherence of participating health centers in the management of gynecological pathologies before and after the intervention of the HPS, as well as the score before and after training in the participants in each workshop, we conducted a paired median test, specifically the Wilcoxon signed-rank test with continuity correction. This approach was chosen as it involves the same population evaluated before and after the program intervention and before and after the training conducted. A significance level of $p < 0.05$ was considered.

Maternal-fetal outcome indicators were based on Colombian surveillance protocols for maternal mortality, extreme maternal mortality, late neonatal mortality, and perinatal mortality. We considered the years 2020, 2021, and 2022 to assess changes in maternal and perinatal health indicators. The statistical analysis was performed using the R statistical software version 4.2.1 (R Foundation for Statistical Computing) through RStudio 2022.12.0. The package used to create the figures and graphs was ggplot2.

Qualitative evaluation

The qualitative evaluation was conducted by an external entity, the Yunus Center of the ICESI University. This qualitative research involved ten focus groups designed as participatory discussion sessions, which included medical and healthcare personnel from 33 hospitals. The workshops were designed having as a conceptual basis three so-called social innovation methodologies, namely: participatory action research (which always tries to improve the conditions of those communities that are the object of research), Appreciative Inquiry (which looks at an organizational situation or community from its strengths and not from its limitations or shortcomings) and the approach of the Theory of the U (which allows a deep process of reflection and introspection to recognize when a project or an initiative is susceptible to being improved and re-empowered).[30] Each focus group session lasted 3 h and encompassed the following four key moments:

1. Initial reflection on the situation and routines before and after HPS implementation.
2. Compilation of sources of evidence and case studies on the impact of the HPS.
3. Discuss the aspects of improving the HPS.
4. They imagined the deployment and future shape of the HPS.

The interviewees' quotes were translated from Spanish to English language.

Role of the funding source

This project was financially supported in collaboration with Fundación Valle del Lili and the Health Secretary of Valle del Cauca. In addition, this project was funded in part through a general research grant from Tecnoquimicas S.A. Exclusively, the research team at Fundación Valle del Lili was responsible for the study design, data collection, data analysis, interpretation, and report writing.

Results

Indicators of educational model in sponsored hospitals

Between 2021 and 2022, 51 HPS workshops were held with 980 participants, including gynecologists, general practitioners, nurses, and nursing assistants (Table 2). These workshops covered 100% (43/43) of the sponsored hospitals. To establish the safety baseline for obstetric care, checklists of hospital conditions were employed with each hospital team. In the initial evaluation of the safety conditions of obstetric care reported, a median score of 15% was reported. In the first follow-up measurement, an improvement of 64% was evidenced (Table 3). Pre and post-tests were conducted to evaluate the educational modules. Changes in test results were also statistically significant (Fig. 1).

Telehealth model indicators

Telehealth systems provided care for 782 pregnant women facing obstetric or perinatal emergencies, with a gradual rise in technology adoption (Fig. 2). The patients had a median age of 24 years (IQR 20–29), 40% (313/782) resided in rural areas, 42% (328/782) were identified as high-risk pregnancy, 66% (516/782) had had at least a previous pregnancy, and 86% (673/782) were in the second or third trimester of pregnancy. The main reasons for seeking teleassistance were hypertensive

Name of the educational module	Year	Workshops number
Obstetric emergencies	2021	17
Safe delivery care and maternal sepsis	2022	17
Sexual and reproductive health	2022	17

Table 2: **Education workshops in Valle del Cauca, years 2021–2022.**

	Measurement prior to the intervention Hospital Padrino n = 43 Median (Q1-Q3)[a]	Measurement after the intervention Hospital Padrino n = 43 Median (Q1-Q3)[a]	p value[b]
Score in measuring adherence to Postpartum	15.0 (10.0, 30.0)	79.0 (71.0, 79.0)	<0.0001
Score in measuring adherence to hypertensive crisis and eclampsia bundle	5.0 (1.0, 5.0)	83.0 (74.5, 83.0)	<0.0001

[a]Interquartile range. [b]Wilcoxon signed rank test with continuity correction.

Table 3: **Comparison between the scores of obstetric emergencies bundles with Hospital Padrino intervention.**

disorders of pregnancy (21%, 164/782), very high-risk perinatal conditions (23%, 180/782), and PPH (7%, 55/782). Of the patients, 64% (500/782) were stabilized at their hospitals of origin, and among those referred, 36% (282/782) were treated in the FVL, and 9% (70/782) required ICU admission, none died. By the end of the first year, the rate of telehealth care per 1 million inhabitants by municipality in VCD was 102.7, and the proportion of municipalities with telehealth adoption was 73% (29/40).

Official VCD maternal and perinatal health indicators

The HPS began in July 2021. In that year, 41 cases of maternal deaths in VCD were reported (24 early maternal deaths), with an MMR for VCD of 78.8 cases per 100,000 LB. Two patients died after initiating the strategy, and one of those was deemed non-preventable. In 2022, two early maternal deaths classified as non-preventable, three cases of late maternal mortality, and three coincidental cases were reported, representing a MMR of 12.0 cases per 100,000 LB. A significant decrease in MMR is evident compared to the average over the preceding two years, remaining within the national goal during the last year (Fig. 3). The official report of the National Institute of Health of Colombia in 2022 showed a significant decrease in the reduction of MMR in the intervention territory.[6] The MMR was evaluated globally in the Valle del Cauca department and for each of the hospitals and their territories of inference, historically, to establish a tendency. No comparisons were made with other regions or hospitals with the same characteristics.

MNM presented a progressive increase in cases reported with an MNM rate of 54 per 1000 LB in 2022 (Fig. 4). As a complementary indicator, we used the maternal case fatality rate, which reported a value of 1.5 for 2022, placing it within the yellow threshold of the Colombian surveillance system. The above demonstrates a significant improvement with the implementation of HPS, as there are fewer maternal deaths among patients with near-miss maternal cases in 2022 compared to previous years, remaining within an acceptable range for the national target (Fig. 5). The late perinatal and neonatal mortality rate was around 13 per 1000 LB (Fig. 6); when adjusted for NMM cases, the late perinatal and neonatal mortality rate remained in the red threshold, exceeding 5.1%, beyond the country's goal according to the guidelines of the National Institute of Health of Colombia (Fig. 7).

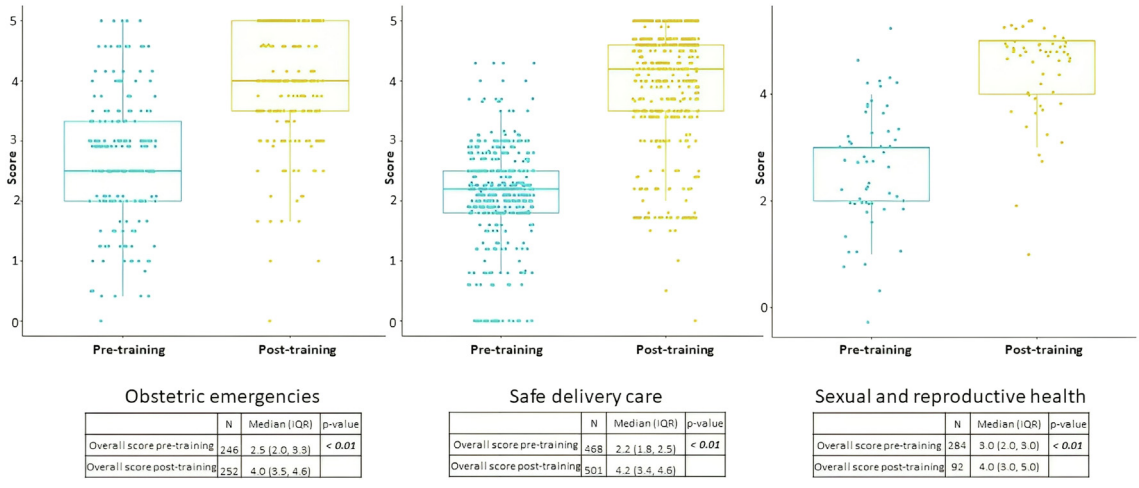

Fig. 1: Distribution of the pre-test and post-test of the workshops on obstetric emergencies, safe delivery care and sexual and reproductive health, from 2021 to 2022. Wilcoxon signed rank test with continuity correction.

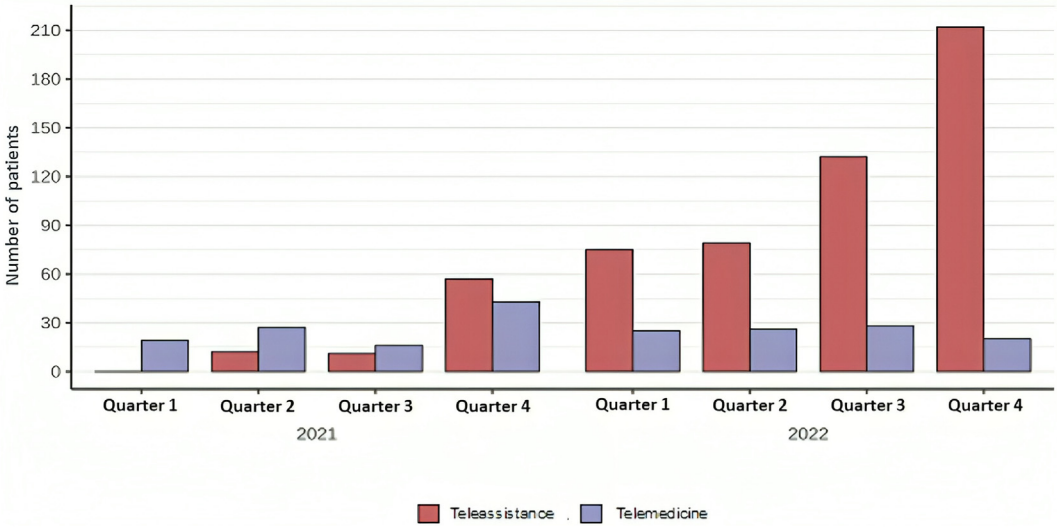

Fig. 2: Behavior of the telehealth services of the Hospital Padrino strategy (N = 782). Y-axis: absolute number of patients in the telehealth service in the Hospital Padrino strategy. X-axis: quarter for the years 2021 and 2022.

Results of the qualitative evaluation

Ten focus groups were conducted with 131 healthcare professionals from 33 hospitals during the qualitative evaluation. Focus group participants included physicians (n = 39), nursing assistants (n = 56), and registered nurses, and within the administrative sector (n = 2), female representation was 80%. All the facilities confirmed that the quality of care and emergency management had improved due to the clarity and insights provided. The training had an immediate and sustained effect over time, improving professional performance and humanizing the teams. These

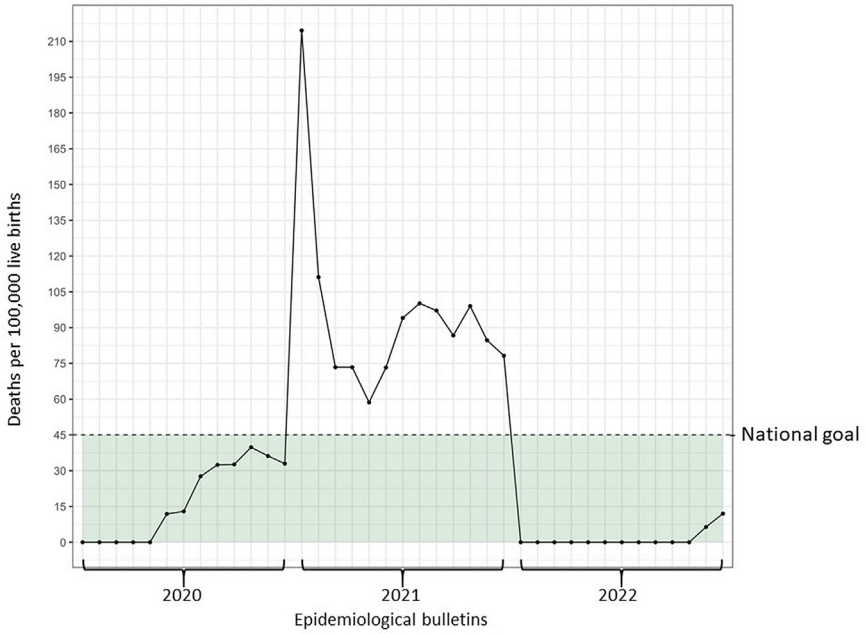

Fig. 3: Behavior of the maternal mortality ratio—2020 to 2022, Valle del Cauca, Colombia. Y-axis: deaths per 100,000 live births, the risk of dying from pregnancy, childbirth, and postpartum-related issues. X-axis: epidemiological bulletins numbers 6, 8, 12, 16, 20, 25, 28, 32, 36, 40, 44, 48, 53, for the years 2020, 2021, and 2022. National goal: Reduce the maternal mortality ratio to 45 per 100,000 live births.

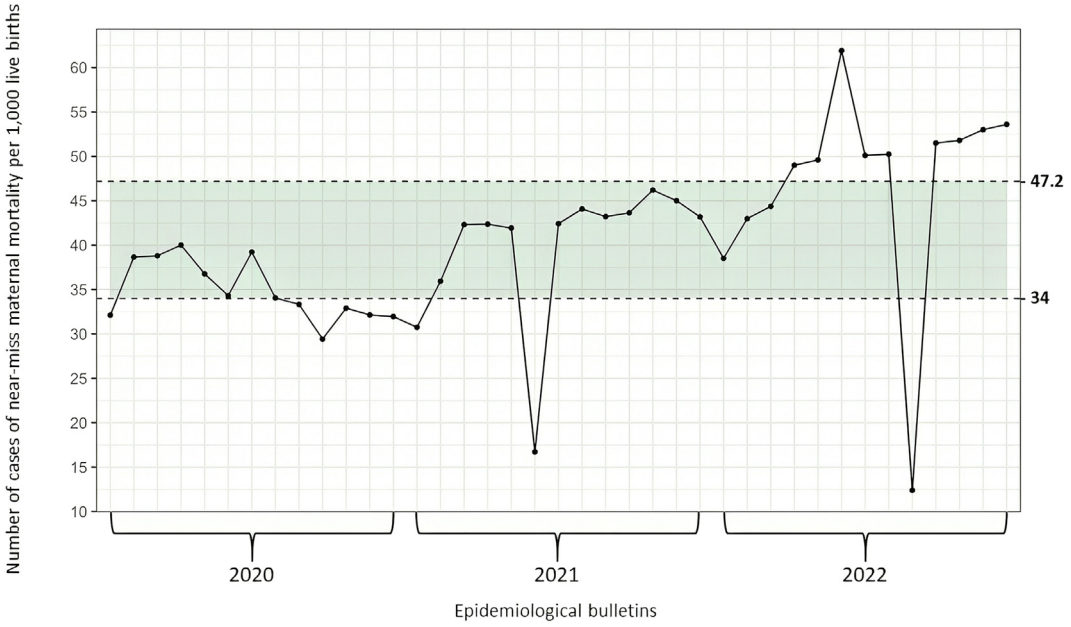

Fig. 4: Behavior of the near-miss maternal mortality ratio—2020 to 2022, Valle del Cauca, Colombia. Y-axis: number of cases of Near-miss Maternal Mortality per 1000 live births. X-axis: epidemiological bulletins numbers 6, 8, 12, 16, 20, 25, 28, 32, 36, 40, 44, 48, 53, for the years 2020, 2021, and 2022. The shaded green area, according to the national government, presents the safety zone, where no significant cases of false reports or lack of reports are expected.

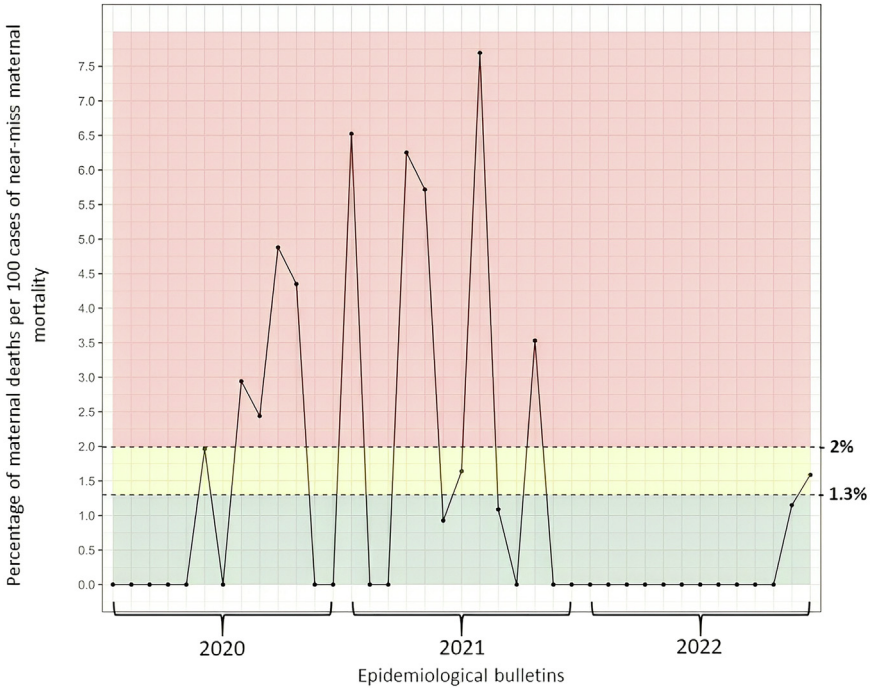

Fig. 5: Behavior of the maternal case fatality rate—2020 to 2022, Valle del Cauca, Colombia. Y-axis: percentage of maternal deaths per 100 cases of near-miss maternal mortality. X-axis: epidemiological bulletins numbers 6, 8, 12, 16, 20, 25, 28, 32, 36, 40, 44, 48, 53, for the years 2020, 2021, and 2022. The shaded areas represent the thresholds established for the country, where green refers to the desired national goal, red indicates the zone to avoid, and yellow represents the transitional zone.

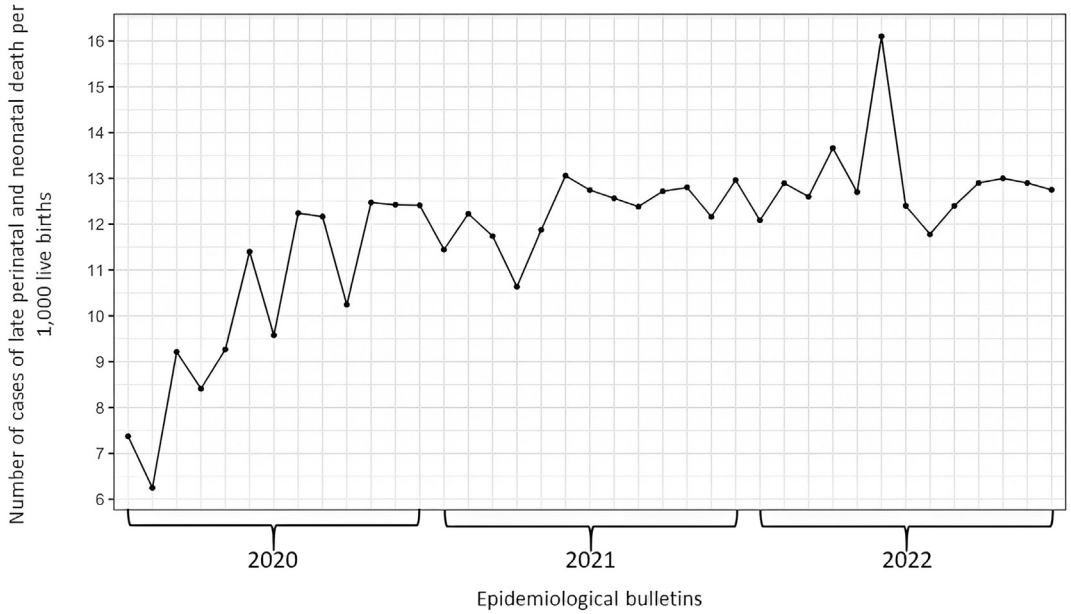

Fig. 6: Behavior of perinatal and late neonatal death rate—2020 to 2022, Valle del Cauca, Colombia. Y-axis: level of perinatal and early neonatal mortality in the studied territory. X-axis: epidemiological bulletins numbers 6, 8, 12, 16, 20, 25, 28, 32, 36, 40, 44, 48, 53, for the years 2020, 2021, and 2022.

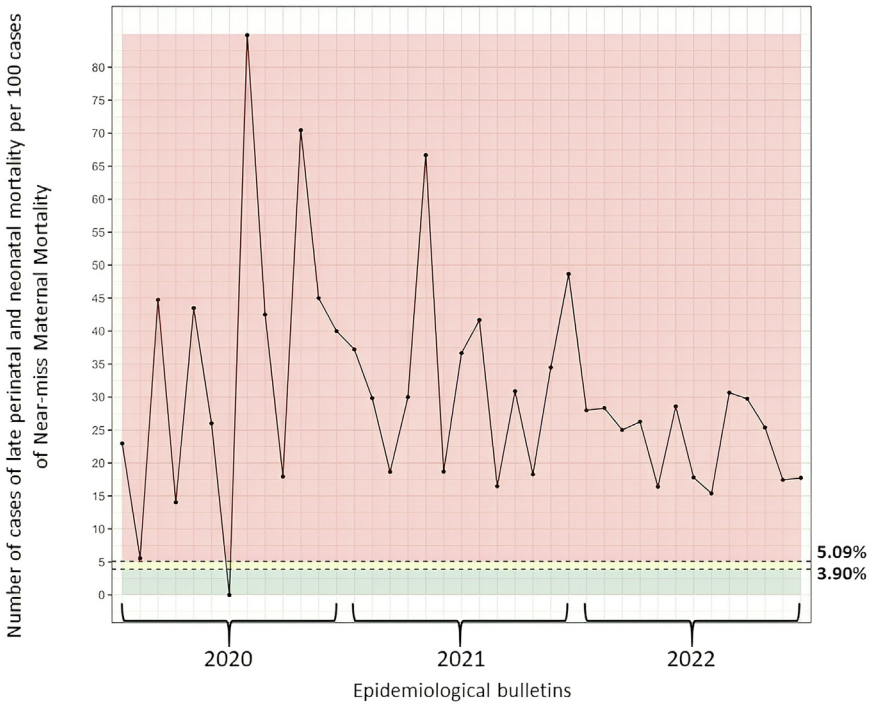

Fig. 7: Behavior of late perinatal and neonatal mortality rate adjusted for cases of near-miss maternal mortality—2020 to 2022, Valle del Cauca, Colombia. Y-axis: number of cases of late perinatal and neonatal mortality per 100 cases of Near-miss Maternal Mortality. X-axis: epidemiological bulletins number 6, 8, 12, 16, 20, 25, 28, 32, 36, 40, 44, 48, 53, for the years 2020, 2021, and 2022. The shaded areas represent the established thresholds for the country, where green indicates the desired national goal, red is the zone to avoid, and yellow is the transition zone.

noticeable improvements in the strategy empowered and fostered higher levels of trust and security in healthcare workers. Telehealth strategies allowed direct access to specialized professionals that were previously difficult to reach. The MMR reduction was the best evidence of the impact of HPS on the teams. Participating institutions proudly counted the months without devastating maternal mortality events. Some institutions reported infrastructure and medical supply enhancements, all influenced by the HPS. Developing and strengthening communication channels between institutions led to reduced administrative barriers. More fluid communication, coupled with staff empowerment and trust, reduced referrals and hospital stays.

The attached quotes are from the interviewees, providing information on the benefits gained from the Hospital Padrino strategy in each of the mentioned competencies.

Quality of care and emergency management:

- "I felt that with the knowledge I acquired, I improved my quality of obstetric emergency care."
- "When an emergency arises, I can address it more assertively."
- "The quality of our care is reflected in our patients, even if they don't express it."

Professional performance and humanization of the teams:

- "Previously, I didn't consider the idea of family/father witnessing the birth; now, with education, I could enhance that aspect."
- "I understand the importance of humanizing childbirth and its impact on the family's health and maternal–fetal well-being."
- "The patient's calmness and confidence in the process transmit to the team."

Levels of trust and security of healthcare workers:

- "Having relevant and updated knowledge gives me a better sense of empowerment. I am more confident in what I know and can achieve."
- "Now I have more confidence and clinical management judgment."
- "My team and I perform much better with increased confidence."

Access to specialized professionals:

- "Thanks to the strategy and the integration of telemedicine, we have greater access to specialties that we didn't have contact with before."
- With access to specialties, I feel more comfortable and with a better clinical focus."
- "Many patients benefit from specialties through the strategy, thus improving their quality of life."

Report of infrastructure and medical supplies enhancements:

- "Thanks to the influence of the Padrino Hospital strategy, we have more supplies and improvements in our rooms and machines, allowing us to enhance our care."
- "With the influence of Padrino Hospital, I can address more pathologies due to improvements in supplies and infrastructure."
- "I could establish better medical management with more supplies and medications."

Development and strengthening of communication channels:

- "My role and that of my colleagues are much clearer, with a more suitable and organized protocol follow-up."
- "With the development of protocols, team communication has improved."
- "We are more efficient with more established communication channels and roles."

Fluid communication:

- "My communication is more assertive and clearer."
- "Communication has become better and simpler, leading to more successful outcomes."
- "My orders are clearer."

Staff empowerment:

- "I noticed better results that allowed me to perform with more empowerment and confidence."
- "I can act more securely and effectively or suggest a course of action."
- "Now I feel more confident and with better judgment."

Discussion

Implementing the Hospital Padrino strategy in 43 hospitals across VCD, Colombia, resulted in a significant reduction in MM and consolidated a model of social innovation in healthcare that can be replicated in LMICs. The MMR was evaluated globally in the VCD and for each of the hospitals and their territories of inference, historically, to establish assistance. No comparisons were made with other regions or hospitals with the same characteristics. The reason why the rate of perinatal and late neonatal death increased in the study period is unclear and was not the subject of research explicitly targeting the indicator. By increasing the rigor of epidemiological surveillance by the control entities

that participated in our study, the reporting of maternal and perinatal morbidity-mortality records increased.

After the devastating effects of the COVID-19 pandemic on maternal health indicators in Latin America, it becomes necessary to accelerate efforts to achieve the SDGs. The Strategies to End Preventable Maternal Mortality (EPMM) of WHO established that each region,[29] in the case of Colombia, needs tools to determine priorities based on the epidemiology of MM adapted to the context. HPS aligns with these principles by being a collaborative public-private alliance, addressing the department's health secretary's and sponsored hospitals' needs. The governance exercised by the departmental health secretariat played a crucial role in securing hospital participation and ensuring coverage across the entire territory.

HPS focused on creating an interconnected network of hospitals coordinated from a lead hospital with shared standards of care. Evidence demonstrates that poor quality and fragmentation of obstetric care service delivery directly affect MM.[12] Pregnant women may require care at multiple points of contact, and continuous, good-quality medical support requires systematic coordination between service delivery sites, including the community level. This coordination implies understanding the hospitals' conditions, the healthcare systems' social context and formalizing existing relationships between hospitals with fewer resources and referral hospitals.[31] For managing obstetric emergencies and referral as the final point of care, it is essential to strengthen all possible delivery places in each area of influence. The strategy focused on improving the teams' technical skills through in-person training at selected hospitals, based on an exhaustive review of available medical guidelines adapted to the local context, that led to the develop of a workshop to optimize care and generate motivation.[32–34] Changes in the evaluations of technical competencies reflect the effort invested in creating an effective educational model.

Training with practice drills for all teams, supportive supervision, and subsequent corrective measures were definitive in the gradual empowerment of the HPS. Evidence also shows that when evidence-based care is not practiced, outcomes are inadequate. Most maternal and perinatal services are provided in primary and secondary-level healthcare facilities, where health personnel often require additional training. Functional models of continuing medical education for complete services (doctors, nurses, nursing assistants, midwives, and traditional doctors) have proven effective in maintaining skills and ensuring the delivery of quality care.[12,35,36] Additionally, a more pertinent, timely, and in better condition referral was reissued for the patients discussed through the strategy. In addition, the clinical results of emergency patients treated in sponsored hospitals and those referred in critical conditions were evaluated by a strategy committee to define adherence to the taught protocols, showing that compliance progressively improved.

To organize networks and centralize high complexity care, it was imperative to enhance hospital conditions, resulting in improved hospitals safety conditions at the end of the project. Care networks depend on the availability and management of essential supplies, medications, diagnostics, equipment and consumables, and adequate infrastructure.[37] The procurement of new equipment or supplies for hospitals was provided by the Secretary of Health and the HPS, according to the needs reported by each hospital. This aspect was crucial, as reducing shortages in hospitals bolstered the teams' confidence and the utilization of their services, which probably contributed to the reduction in external obstetric referrals.

Implementing telehealth modalities and the gradual adherence to new technologies by hospital teams was definitive in improving outcomes for pregnant women. Telehealth is a broad term that encompasses a wide range of healthcare services, education, and information delivered remotely using telecommunication technologies. It includes clinical and non-clinical services like health education, remote monitoring of vital signs, and administrative meetings conducted through video conferencing. Telemedicine is a subset of telehealth that refers explicitly to using telecommunication technologies to provide clinical healthcare services remotely. It involves the diagnosis and treatment of patients by healthcare professionals using technology.[38]

Prior to the introduction of HPS, telehealth models were practically nonexistent in the VCD. Using early warning systems to define the complexity of cases commented by telehealth, improved the processes, standards, and times of emergency referrals, and increased the number of telehealth events as has been described in the evidence.[39,40] The project's biggest challenge was coordinating a referral system that would connect all points of contact, guaranteeing the origin and destination of the patient. This coordination improved significantly from the third quarter of the first year. Once this cooperation and shared responsibility among the health workers of the Hospital Padrino and the sponsored hospitals were achieved, it was considered a successful integration of services.[41]

The qualitative research revealed that HPS represents a regional and organizational exemplar of social innovation in healthcare. Social innovations strive to achieve three objectives: generating social value, fostering skill development (especially the skills of local communities), and the generation of higher and shared levels of well-being.[42] Throughout this research, we evidenced that HPS has met these objectives. The model had an enormous impact on the humanization of the teams, evidenced by the reduction of complaints about poor care that were officially made to the Health

Secretary of Valle del Cauca. For the first time, hospitals fully implemented the humanized delivery strategy they had not previously had, and external analysis in focus groups evidenced the perceived change. Moreover, it demonstrates the potential for expansion and replication in other regions of the country and around the world. This is contingent upon the presence of both the desire and resources (not solely financial) from a leading organization to oversee the process, taking on the role of a Hospital Padrino, as well as an engaged government and dedicated sponsored hospitals. The increased confidence and awareness of the teams in the model allows for even better data presentation, tracking, and monitoring, as evident in the more significant number of reported MNM cases.

The financing of HPS is possible thanks to the contribution of a public-private alliance made for the execution of this project. The Health Secretary of Valle del Cauca contributes from the Collective Interventions Plan, which is a benefits plan composed of health promotion and risk management interventions, which are framed in the strategies defined in the Territorial Health Plan and seek to positively impact the social determinants of health and achieve the results described in the department's Primary Health Care strategy. The FVL contributes from the Social Responsibility Unit and the Global Health Equity Unit, which manages resources with private companies and international cooperation agencies. Consolidating these models and new sustainable finance alternatives are definitive challenges for the strategy. Although it is necessary to improve in-person and virtual educational model incorporating technological advancements such as artificial intelligence for decision-making within healthcare teams at sponsored hospitals and developing sustainability models, HPS opens opportunities for social innovation approaches in healthcare to reduce maternal mortality. Efforts to mitigate health inequities in LMICs directly impact the maternal and perinatal health indicators pursued in the SDGs.

Conclusions

The significant reduction in maternal mortality and lethality rates became achievable through the training provided by the Padrino Hospital strategy, both through telemedicine and in-person training, and the collaborative efforts of teams that previously lacked communication, standardized care practices, and a highly trained workforce. Mapping service delivery sites, regionalizing them, and then intentionally organizing them through public-private partnerships made it possible to achieve the general objective and specific expectations for each network node.

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All authors discussed the results, contributed and approved the final version of the manuscript.

Data sharing statement

The data that support the findings of this study are available from the corresponding author (MFE) upon reasonable request.

Declaration of interests

The authors have no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.lana.2024.100705.

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