

QUALITY IMPROVEMENT ARTICLE

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Hospital Padrino Strategy associated with reductions in perinatal mortality in Colombia's Pacific region: addressing public health challenges

María Fernanda Escobar^{1,2,3✉}, Martha Lucia Jaramillo Salazar⁴, Betsy Marilis Mancera Martínez⁴, Adriana Ballesteros Castro⁴, Ivonne Aldana Vallejo⁴, Jaime Orrego Gaviria⁴, Nancy Liliana Llanos Durán⁴, Iván Enrique Padilla Mejía⁴, Ana María Gómez Vásquez⁴, Carmen Lorena Villota Gonzalez⁴, Aida Masson⁴, Sandra Lorena Moreno Arias⁴, Virginia Vargas Rey⁴, Victoria Eugenia Gutiérrez Echeverri⁴, Claudia Lorena Guerrero Moreno⁴, María Cristina Lesmes⁵, Andrea Melissa Porras⁵, Melissa Perafan⁶, María Isabel Irurita⁷, Johan Sebastián Loaiza⁸, Daniel Echeverri⁸, Juan Sebastián Galindo-Sánchez^{3,9}, Yhan Carlos Cárdenas⁹, Hernán Gómez-Moreno⁹, Alejandra Guevara⁹, Sergio Iván Prada⁹ and Victoria Soto¹⁰

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BACKGROUND: The reduction of the perinatal and late neonatal mortality ratio (PNR) is a universal indicator of development. We describe the implementation of the Hospital Padrino Strategy (HPS), a collaborative model between a high-complexity hospital and 55 medium- and low-complexity hospitals from 2023 to 2025. The strategy included strengthening human health talent, utilizing Bubble continuous positive airway pressure (bCPAP), and implementing telehealth systems between hospitals.

METHODS: A mixed-methods study was conducted in two phases across hospitals participating in HPS. Phase 1 involved the prospective evaluation of hospital performance and clinical indicators for perinatal and neonatal care over two years. Phase 2 collected qualitative data from healthcare personnel through focus groups to assess perceptions, barriers, and changes in professional practice.

RESULTS: From January 2023 to June 2025, 60 workshops on neonatal care were held involving 1334 healthcare workers. Improvements were observed in hospital conditions and healthcare personnel's technical competencies. Seventy-nine neonates with emergencies received care through telehealth systems. During the implementation period, the PNR decreased from 13.37 to 6.91 per 1000 live births. Qualitative findings for 119 participants demonstrated strengthened professional commitment and collaborative culture.

CONCLUSION: The HPS was associated with improvements in neonatal care conditions and reduced PNR in participating territories.

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IMPACT:

- The Hospital Padrino Strategy (HPS) was associated to reduce the Perinatal and Late Neonatal Mortality Ratio (PNR) from 13.37 to 6.91 per 1000 live births across 55 hospitals in Colombia's Pacific region (2023–2025).
- This study demonstrates the effectiveness of combining capacity-building, bubble CPAP implementation, and telehealth networks to improve neonatal care in low-resource hospital networks.
- Findings provide qualitative evidence of strengthened professional commitment and collaborative culture, highlighting human-resource engagement as a key driver for neonatal survival.
- This network-based strategy offers a model for Low- and Middle-Income Countries (LMICs), supporting global initiatives to reduce preventable neonatal deaths and improve health equity.

INTRODUCTION

By 2030, Sustainable Development Goal 3 on Health and Well-being aims to end preventable deaths of newborns and children under 5 years of age, ensuring that all countries seek to reduce

neonatal mortality to at most 12 per 1000 live births and under-5 mortality to at most 25 per 1000 live births.¹ However, 4.8 million children die annually, 2.3 million in the neonatal period, and more than a third of neonatal deaths occur on the day of birth.² In Latin

¹Unidad de Equidad Global en Salud, Fundación Valle del Lili, Cali, Colombia. ²Departamento de Ginecología y Obstetricia, Fundación Valle del Lili, Cali, Colombia. ³Facultad de Ciencias de la Salud, Universidad Icesi, Cali, Colombia. ⁴Unidad de Cuidado Intensivo Neonatal, Fundación Valle del Lili, Cali, Colombia. ⁵Secretaría de Salud del Valle del Cauca, Cali, Colombia. ⁶Secretaría de Salud del Cauca, Popayán, Colombia. ⁷Centro Yunus, Universidad Icesi, Cali, Colombia. ⁸Fundación para el Desarrollo Integral del Pacífico - Propacífico, Cali, Colombia. ⁹Centro de Investigaciones Clínicas, Fundación Valle del Lili, Cali, Colombia. ¹⁰Centro de Estudios en Protección Social y Economía de la Salud - Proesa, Cali, Colombia. ✉email: maria.escobar.vi@fvl.org.co

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America, neonatal mortality represents the largest contribution to overall childhood mortality. In Colombia, a similar pattern is observed. According to data from the National Institute of Health (NIH), the perinatal and late neonatal mortality ratio (PNR) in 2021 was 14.9. In the Colombian Pacific region in 2021, perinatal and neonatal health indicators lagged the national average, and departments such as Valle del Cauca (VC) and Cauca had PNRs of 12.2 and 16.6, respectively.³

High-impact labor and delivery interventions focused on the 24 h around the time of birth have the most significant potential to reduce PNR. However, access to a limited number of qualified health workers in strategies such as neonatal resuscitation, geographic inaccessibility, and lack of services with safe and quality conditions, and availability of supplies such as Bubble continuous positive airway pressure (bCPAP), contribute to limitations in adequate coverage for neonatal care and therefore, in the real possibility of reducing avoidable PNR.^{4,5} Added to this are the strengthening of infrastructure, referral and counter-referral systems, and the elimination of financial barriers, which would improve the quality of care in highly vulnerable settings 6.

Fundación Valle del Lili (FVL) is a non-profit university hospital and referral center with one of the largest neonatal units in southwest Colombia. To impact public health indicators in the Pacific region, FVL designed the Hospital Padrino strategy (HPS) that, in alliance with local governments, established a model of social innovation in health that focuses on vulnerable populations, with impactful results for the reduction of the maternal mortality ratio.⁶ Due to the behavior of the perinatal and neonatal mortality rate outside global standards and in agreement with the health secretaries of the departments of VC and Cauca, a project was generated with the primary goal of enhancing neonatal care, thereby maintaining the trend of reducing neonatal mortality.

We describe our experience in implementing the HPS and its impact on perinatal and neonatal care indicators. It was achieved through a collaborative work model involving FVL, which served as the high-complexity hospital and sponsored 55 medium- and low-complexity hospitals within the VC and Cauca departments' health network from 2023 to 2025.

MATERIALS AND METHODS

Design and context

We conducted a quasi-experimental, observational cohort study with a pre-post design and no control group, using a mixed-methods approach. The study was implemented in two phases in 42 municipalities of the VC department and 13 municipalities of the Cauca department (located in the north of the territory). 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 neonatal health indicators. HPS was implemented as an integrated bundle of interrelated interventions. This bundle included: (1) a structured, cyclical educational model for hospital teams; (2) the provision of essential neonatal technology, including training in the use of the Vayu® bCPAP device; and (3) the implementation of a telehealth model to support real-time clinical decision-making and case management in sponsored hospitals. We considered information obtained from the education model for hospital teams, including the provision and training of the Vayu® bCPAP device, and implementation of the telehealth model strategies to guide management in the sponsored hospitals. The educational model aimed to strengthen teams in neonatal care and resuscitation and was organized into four cycles from January 2023 to July 2025. Over the course of a year and a half, these modules were implemented, assessing safety conditions and establishing a safe care neonatal 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, and information on the indicators was sourced from the Health Secretaries. This study did not involve any intervention or intentional modification of the participants' biological, physiological, psychological, or social variables; therefore, informed consent was unnecessary. The Ethics Committee of

Fundación Valle del Lili reviewed and approved the study protocol on April 26, 2022, under approval number No. 181-2022.

The departments of VC and Cauca belong to the Colombian Pacific region, which lags in Colombia's development index and neonatal care indicators.⁷ VC comprises 42 municipalities divided into four subregions: North, Central, South, and Pacific, with a population of approximately 4,638,029 inhabitants.⁸ Each municipality houses at least one public hospital of low or medium complexity authorized to provide primary obstetric and neonatal care; they can work together in a network to solve emerging problems. The public care network has only one neonatal intensive care unit (NICU) and two intermediate neonatal intensive care units. If a neonate requires a higher level of complexity for care, the patient must be referred to the department's capital, Santiago de Cali, where the FVL is located. Cali is a health district independent from the VC Health Secretariat, and it is not included in the presentation of the results of this project.

The department of Cauca has 1,243,503 people distributed in 42 municipalities. According to the National Administrative Department of Statistics, the indicator of Unsatisfied Basic Needs—UBN—used to measure poverty in Colombia, has been reported at 46.6% for this territory,⁹ and most of these municipalities are characterized by a very high armed conflict intensity index.¹⁰ The hospitals are grouped into State Social Enterprises (ESE), which are public institutions responsible for providing health services directly. Seven ESEs with 13 hospitals in the north of the department were included in this study. Notably, only one hospital is of medium complexity, and none has a neonatal NICU. All newborns who require more complex care will necessarily be referred to the cities of Santiago de Cali or Popayan (capitals of both departments).

Overview of the HPS

HPS is a collaborative hospital partnership model where a high-complexity, high-quality public or private hospital (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 the telemedicine system from the HPS. 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.¹¹

Given the positive results in reducing maternal mortality achieved with the implementation of the HPS in the VC,⁶ it was decided, in agreement with the health secretaries of both departments, to expand the strategy's scope to the neonatal population. Fifty-five hospitals in the region that serve the most vulnerable, migrant, rural, and minority populations were selected.

The educational model focused on the proper management of neonatal care at the low and medium complexity levels in areas with limited supply or access to neonatology. Before implementing the strategy, a process of standardization and preparation of the educational component was carried out by FVL neonatologists, which was fundamental to the project's success. It included the development of educational materials, protocols, checklists, videos, and procedure documentation templates. Training workshops were designed with a theoretical component, complemented by an on-site simulation session at the participating institutions. A schedule was developed for the delivery of the workshops; however, sessions that could not be conducted due to logistical constraints were rescheduled to ensure completion of the planned training activities across all participating hospitals. The projects began on January 23, 2023, and were divided into four cycles, each lasting 12 h:

- The first cycle focused on Essential newborn care, the Golden Minute strategy, and neonatal resuscitation.^{4,12,13}
- The second module included neonatal stabilization, transport from a lower to a higher complexity, and donation and training in the use of the bCPAP device.¹⁴
- A third cycle where greater emphasis was placed on neonatal resuscitation and transportation, as well as on the use of the device.
- The fourth cycle included neonatal resuscitation, neonatal stabilization and transport, and training in the use of bCPAP.

Additionally, workshops focused on strengthening communication, teamwork, and safety culture concepts.¹⁵ The workshops were carried out periodically, covering all registered hospitals.

The assessment of the installed capacity of the sponsored hospitals for neonatal care was conducted using a self-assessment model at the beginning of the project, with the medical and management staff of each center. Priority needs resulting from the assessment were addressed directly by the management of each hospital or by the regional health department. Afterward, on-site simulation training workshops were conducted at the participating institutions. These workshops were mandatory for all healthcare personnel responsible for neonatal care, including nursing assistants, registered nurses, general practitioners, and pediatricians. Only one hospital had neonatologists who also participated in the educational model. Knowledge assessments were conducted before and after the training modules. Each hospital received at least four workshops. And one follow-up visits during the intervention.

Upon completion of the training, a telehealth communication system integrating tele-assistance and digital interconsultation modalities was implemented to address all neonatal cases requiring assistance. The telehealth model included licensed communication platforms developed by FVL, "Liliconnect," which were used to conduct digital consultations on all reported cases. A tele-assistance model was also implemented. The system was formalized through WhatsApp chats for each institution, which served as an easily accessible strategy for team communication and notification of emerging events. HPS convened a support team of qualified specialists and a 24/7 telehealth service, facilitating communication among professionals at the 55 hospitals. Healthcare personnel at the sponsored hospitals received guidance until patients were transferred to a high-complexity center. Patients were assigned based on their clinical situation (urgent or emergency), insurance network, and government guidelines.^{16,17}

Population

The inclusion criteria were neonates who required assistance for some pathology, condition, or emergency during birth, the perinatal period (up to 7 days of life), or in the first 30 days of life. Table 1 clarifies the hospital's care level in VC and Cauca. The patients' records of tele-expertise were collected prospectively in the Liliconnect platform database, and a dashboard was created to record information on patients who commented on the telemedicine chats. Extremely critical patients were referred in all cases to FVL. All the patients were followed up until they were definitively attended and followed up for 7 days.

Variables

The variables were categorized into five groups:

1. Educational Model in Sponsored Hospitals: This category covers variables such as the number of individuals trained, their occupations, the establishment of baseline conditions, ongoing follow-up on hospital neonatal care conditions, and documented pre- and post-test results from training sessions. The FVL neonatology group developed an instrument (Supplementary Table S1) to assess neonatal care conditions, including the availability of supplies, medications, protocols, and safety standards.
2. Telehealth Model: This section provides detailed information on neonatal patients using telehealth services. The adoption indicator for the telehealth system was also considered. The telehealth model collected sociodemographic and clinical characteristics of the neonatal patients consulted and their outcomes. Medical records from high-complexity hospitals other than FVL were not reviewed.
3. Official VC and Cauca Neonatal and Perinatal Health Indicators: This category systematically analyzes VC and Cauca indicators for neonatal and perinatal health, for 2021 and 2025. This information was obtained directly from the departmental health secretariats.
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 variables were defined as follows:

- Perinatal mortality: Death occurs between 22 completed weeks (154 days) of gestation or with a fetal weight of 500 g or more, and seven days after birth.¹⁸

- Neonatal death: Death occurring between birth and the first 28 full days of life. This is further divided into:
 - Early neonatal deaths: occurring during the first 7 days of life (0–6 days).
 - Late neonatal deaths: occurring after 7 days until day 28 of life (7–28 days).^{18,19}
- Severe Neonatal Morbidity: health complications in a newborn, defined as a composite of severe adverse outcomes like severe infection, neurological issues, serious respiratory problems, or major birth defects.²⁰
- Neonatal respiratory distress syndrome (RDS): respiratory distress in a newborn, presenting within hours after birth, most often immediately after delivery.²¹
- Neonatal sepsis defines the systemic condition that arises from bacterial, viral, or fungal origin, associated with hemodynamic changes and clinical findings, and causing severe morbidity and mortality.²²
- Birth asphyxia (BA): assumed to be related to intrapartum hypoxia-ischemia. In the LMIC setting, it is usually defined as a failure to initiate or sustain spontaneous breathing at birth.²³

The definitions of neonatal and perinatal health indicators were established by the Colombian Ministry of Health and adapted from the World Health Organization (WHO).¹⁸

Data analysis

Descriptive data were presented as absolute frequencies and percentages for qualitative variables, while quantitative variables were summarized using medians and interquartile ranges (IQR). To explore differences in adherence scores to neonatal intervention packages during the three years of implementation in the Hospital Pádrino sites, a global Friedman test was used. For the workshop participants' scores before and after training, a paired median test (Wilcoxon signed-rank test with continuity correction) was conducted. This methodology was chosen because the same population was evaluated before and after both the program intervention and the training. A significance level of $p < 0.05$ was considered. Statistical analysis was performed using R software version 4.2.1 (R Foundation for Statistical Computing) via RStudio 2022.12.0. Neonatal outcome indicators were based on Colombian surveillance protocols for late neonatal mortality and perinatal mortality. We considered 2021, 2022, 2023, 2024 and 2025 to assess changes in health indicators.

Qualitative evaluation

The qualitative evaluation was conducted by an independent external entity, the Yunus Center at Universidad Icesi, a research center with expertise in qualitative and participatory research methodologies. The Center was responsible for the design of the qualitative evaluation, facilitation of the focus groups, and analysis of the qualitative data. A purposive sampling strategy was used to recruit healthcare professionals directly involved in the implementation of the Hospital Pádrino Strategy (HPS) across participating hospitals. Participants were invited through an institutional call coordinated with the participating hospitals. Each hospital was encouraged to include representatives from the main professional roles involved in neonatal care, including general physicians, nurses, nursing assistants, and other healthcare personnel, to capture diverse perspectives across professional categories and sites.

Data were collected through focus group discussions using a semi-structured discussion guide, allowing both guided dialog and open exploration of participants' experiences with the strategy. A total of seven focus groups involving 119 participants were conducted: three virtually in 2024 and four in person in 2025. Data collection continued until thematic saturation was reached, defined as the point at which no substantially new themes emerged from the discussions.

Focus group sessions were structured around four phases of reflection and evaluation of the intervention:

- Initial reflection on the situation and clinical routines before and after the implementation of the HPS.
- Identification of sources of evidence and case examples illustrating the impact of the HPS.

Table 1. Distribution and levels of hospital care by HPS nodes in Valle del Cauca.

Department	Attention node	Municipality	Hospital name	No	Hospital level of care
Valle del Cauca	North	Cartago	Hospital San Juan de Dios	1	2
		Alcalá	Empresa Social Del Estado Hospital San Vicente De Paul	2	1
		Ulloa	Hospital Local Pedro Saenz Diaz	3	1
		Obando	Empresa Social Del Estado Hospital Local De Obando	4	1
		Ansermanuevo	Hospital Santa Ana De Los Caballeros - Ese Empresa Social Del Estado	5	1
		El águila	Hospital San Rafael Empresa Social Del Estado	6	1
		Argelia	Hospital Pio XII Empresa Social Del Estado	7	1
		El Cairo	Empresa Social Del Estado Hospital Santa Catalina	8	1
		La Unión	Hospital Gonzalo Contreras Empresa Social Del Estado	9	1
		Toro	Hospital Sagrada Familia Empresa Social Del Estado	10	1
		Versalles	Empresa Social Del Estado Hospital San Nicolás	11	1
		Zarzal	Hospital Departamental San Rafael De Zarzal Empresa Social Del Estado	12	2
		La Victoria	Empresa Social Del Estado Hospital Nuestra Señora De Los Santos	13	1
	Center Tuluá	Roldanillo	Hospital Departamental San Antonio De Roldanillo Empresa Social Del Estado	14	2
		Bolívar	Hospital Santa Ana Empresa Social Del Estado	15	1
		El Dovio	Hospital Santa Lucia Empresa Social Del Estado De El Dovio Valle	16	1
		Trujillo	Empresa Social Del Estado Hospital Santa Cruz	17	1
		Sevilla	Empresa Social Del Estado Hospital Departamental Centenario De Sevilla	18	2
		Caicedonia	Empresa Social Del Estado Hospital Santander	19	1
		Andalucía	Hospital San Vicente Ferrer Empresa Social Del Estado	20	1
		Bugalagrande	Hospital San Bernabe Empresa Social Del Estado	21	1
		Tuluá	Hospital Departamental Tomas Uribe Uribe De Tuluá	22	2
			Hospital Ruben Cruz Velez	23	1
		San Pedro	Empresa Social Del Estado Hospital Local Ulpiano Tascon Quintero	24	1
		Riofrío	Hospital Kennedy Empresa Social Del Estado	25	1
	Center Buga	Buga	Fundacion Hospital San Jose De Buga	25	2
			Empresa Social Del Estado Hospital Divino Niño	27	1
		Guacarí	Hospital San Roque	28	1
		Ginebra	Hospital Del Rosario	29	1
		Yotoco	Empresa Social Del Estado Hospital Local Yotoco	30	1
		Darién	Hospital San Jorge	31	1
		Restrepo	Hospital San Jose	32	1
	South east	Palmira	Empresa Social Del Estado Hospital Raul Orejuela Bueno	33	2
		El Cerrito	Empresa Social Del Estado Hospital San Rafael	34	1
		Candelaria	Empresa Social Del Estado Hospital Local	35	1
		Florida	Empresa Social Del Estado Hospital Benjamin Barney Gasca	36	1

Table 1. continued

Department	Attention node	Municipality	Hospital name	No	Hospital level of care
	South west	Pradera	Empresa Social Del Estado Hospital San Roque	37	1
		Dagua	Hospital Local Jose Rufino Vivas Ese	38	1
		Jamundi	Empresa Social Del Estado Hospital Piloto Jamundi	39	1
		Yumbo	Hospital La Buena Esperanza Empresa Social Del Estado	40	1
		La cumbre	Hospital Santa Margarita Empresa Social Del Estado	41	1
		Vijes	Hospital Francineth Sanchez Hurtado	42	1
Cauca	ESE Nivel II Santander	Santander de Quilichao	Hospital Francisco de Paula Santander Empresa Social Del Estado	43	2
	ESE norte I	Buenos Aires	Hospital de Buenos Aires	44	1
		Suarez	Hospital de Suarez	45	1
		Miranda	Hospital de Miranda	46	1
	ESE norte II	Corinto	Hospital de Corinto	47	1
		Guachené	Hospital de Guachené	48	1
		Caloto	Hospital de Caloto	49	1
		Puerto Tejada	Hospital de Puerto Tejada	50	1
	ESE norte III	Padilla	Hospital de Padilla	52	1
		Toribio	Hospital de Toribio	53	1
	Cxayuce Jxut ESE	Caldono	Hospital de Caldono	54	1
	ESE Centro I	Silvia	Hospital de Silvia	55	1

- Discussion of aspects of the strategy requiring improvement.
- Exploration of future development and potential expansion of the HPS model.

All sessions were documented, and qualitative data were organized using the Easy REDCap platform to facilitate systematic data management.

Qualitative data were analyzed using thematic content analysis. Coding and interpretation of the qualitative material were conducted by a qualitative research expert from the Yunus Center, who systematically reviewed the transcripts and identified emerging themes through an iterative process of thematic development and interpretation. Due to the structure of the external evaluation process, dual coding was not performed. The results of the qualitative analysis were not returned to participants for member checking, as the evaluation was conducted as part of an external program assessment rather than a participatory qualitative research process. Finally, qualitative and quantitative findings were integrated using a mixed-methods triangulation approach, in which qualitative insights were used to contextualize and interpret the quantitative results of the intervention.

RESULTS

Indicators of the educational model in sponsored hospitals

Between January 2023 and June 2025, 60 HPS workshops were held with 1334 participants, including pediatricians, general practitioners, nurses, and nursing assistants (Table 2). These workshops covered 100% (55/55) of the sponsored hospitals.

To establish the baseline safety and quality for neonatal care, the FVL neonatal team developed an assessment instrument to be used with each hospital. In the initial assessment (2023) of neonatal care safety conditions, a median score of 62% was reported in the first follow-up measurement conducted in November 2024, an improvement to 71% was observed. By the end of the project in June 2025, this value had increased significantly to 80% (Table 3). During the study period, all bCPAP device dotations were completed in the sponsored hospitals by March 4, 2024 along with the corresponding educational model

for its use. From 2023 to 2025, 198 newborns were assisted by a CPAP, and 27 were exclusive bCPAP users.

Pre- and post-tests were conducted to evaluate the educational modules. Changes in test scores were also statistically significant (Fig. 1 and Supplementary Table S2).

Telehealth model indicators

Telehealth systems provided care to 79 newborns in neonatal emergency conditions. The average gestational age at birth was 38 weeks (Min: 23.4, Max: 41.0), and most cases were managed on the first day of life. The main reasons for requesting telecare were respiratory distress syndrome (22%), neonatal sepsis (14%), and perinatal asphyxia and neonatal jaundice (7.8% for each entity). Of the patients treated via telemedicine, 44% were stabilized in their hospitals of origin, and among those referred after clinical stabilization was achieved, 28% were treated at the FVL. All patients who required exclusive use of bCPAP were assisted by telemedicine.

Official perinatal and neonatal health indicators

During the implementation period of the Hospital Padrino initiative in both departments, a total of 911 neonatal deaths occurred within the first 30 days of life, out of 76,870 live births. To assess the performance of public neonatal health indicators, perinatal and late neonatal mortality rates (PNR) were analyzed in the intervention territories from 2021 to 2025, with the intervention period beginning in 2023 (Fig. 2, Fig. 3, and Supplementary table S3).

In Colombia, the Neonatal Resuscitation Program (NRP) reporting has been prioritized since the 2014 National Policy on Sexuality, Sexual Rights, and Reproductive Rights. The Ten-Year Public Health Plan (PDPH) 2022–2031 maintains the challenge of reducing the perinatal death rate to 13.5 per 1000 live births (LB) and the neonatal death rate to 6 per 1000 births in the territories by 2031.²⁴ In 2023, the NHI constructed the thresholds to guide public health surveillance actions, based on the goals established in the PDPH. The security zone includes NRPs less than 13.5 cases

Table 2. Education workshops in Valle del Cauca and Cauca, years 2023–2025.

No.	Dates	Total training sessions	Total Participants
Cycle 1	23/01/2023–04/09/2023	21	469
Cycle 2	27/11/2023–04/03/2024	10	282
Cycle 3	11/03/2024–24/01/2025	22	472
Cycle 4	31/03/2025–17/07/2025	7	111
Total (all cycles):		60	1334

Table 3. Comparison between the scores of neonatal care with Hospital Padrino intervention.

Year Hospitals	2023 N = 55	2024 N = 55	2025 N = 55	Global test (Friedman) p- value
Scores	61.2 (56.4, 70.9) ^a	71.1 (62.6, 81.2) ^a	80.4 (72.7, 88.4) ^a	$p < 0.001$

Post hoc analysis. Paired comparisons were performed using the Wilcoxon test with Bonferroni correction.

Comparison Bonferroni-adjusted p -value 2023 vs. 2024 0.0000 2023 vs. 2025 0.0000 2024 vs. 2025 0.0006.

^aMedian (Q1, Q3).

per 1000 LB (green) and the risk zone with NRPs greater than 13.6 cases per 1000 LB births (red). The study results showed an association between the implementation of the intervention and a reduction in late perinatal and neonatal mortality rates compared with previous years, meeting national targets and remaining well below national averages.

Results of the qualitative evaluation

Seven focus groups were conducted, three virtually in 2024 (36 participants in total) and four in person in March 2025, for a total of 119 participants, representing most of the hospitals involved in the intervention. Of the 119 participants by professional category, 35 (29.9%) were registered nurses, 35 (29.9%) were general physicians, 1 (0.9%) was a specialist physician, none were residents, and 46 (39.3%) reported other roles.

The complex working conditions in many hospitals' rural areas make it virtually impossible to update knowledge or provide ongoing training for healthcare personnel, who lack the financial resources to professionalize and stay at the forefront of technological innovations for their clinical practice. In this context, healthcare professionals described the HPS as a unique training opportunity that brings education directly to their institutions, eliminating the need to travel outside their territories. The program also contributed to institutional strengthening by promoting standardized clinical protocols, introducing practical tools such as checklists, and reinforcing best practices for patient monitoring and clinical follow-up during training activities. Additionally, communication barriers between doctors, nurses, and assistants within the same institution have begun to be overcome through more direct conversations, more open and equal dialog, as a result of the trust that training fosters. "Doctors no longer have the same attitude," commented on one participant.

These staff also recognize that, following the implementation of HPS for neonatal care, there has been a decrease in newborn deaths in the intervention areas, permanent contact with more complex specialists through telemedicine, and improved care conditions. Staff participating in the focus groups commented, "We didn't have the supplies before, but now we do." HPS has become a channel for attracting more resources to healthcare institutions, including physical, technological, medical, and organizational resources. All these interventions generate higher

levels of trust and confidence in clinical practice among health workers in low-complexity facilities, in the presence of emergencies or complex cases that require specific levels of specialization. Focus group participants believe that the reduction in the number of referrals is aligned with these new levels of safety. Team members expressed phrases such as, "Where there was once doubt or fear, now there is confidence," and "The walk of death is over," which, for them, represent a safe and timely transfer.

Participants from different territories report that administrative and communication barriers between institutions have been minimized due to improved communication and access to information, which improves the patient experience and reduces stress for both patients and the healthcare staff who care for them. This project allowed them to reduce the number of complaints received and the levels of dissatisfaction among those served and their families: "We went from having complaints and claims to not having a single one," commented on one nurse.

Human healthcare talent was identified as a critical factor for the sustainability of the intervention. Participants emphasized the importance of continuous training, strong managerial support to facilitate staff participation, and the need to expand educational activities to a larger number of healthcare workers in each hospital. They also expressed concern about high staff turnover, which can undermine the continuity of training efforts as recently trained personnel leave the institution. They believe this situation, typical of the Colombian healthcare system, could be mitigated through a regular, hybrid training system, with more accurate monitoring of actual coverage in healthcare institutions. They believe that all hospitals should be approached (not just in nodes) as an ethnographic exercise and a deep understanding of a foreign reality. Seeing firsthand the limiting and compromising realities that characterize these remote locations would be a source of new ideas and new components.

Finally, they believe that each hospital should be constantly retrained on the benefits of using telemedicine, creating clear rules and commitments when agreeing to participate in one of these chats, where the discussion focuses on ways to save lives. All institutions reiterated the need to improve internet access and quality in their territories.

DISCUSSION

Teams

The implementation of the Hospital Padrino strategy for neonatal care, with its educational and telehealth components, combined with the provision of bCPAP devices, in 55 hospitals in two territories in the Colombian Pacific was associated with a reduction in perinatal and late neonatal mortality and improved the quality and safety of care in the institutions involved in this project. These results confirm the consolidation of the HPS as a scalable and sustainable model of social innovation in health (Box 1).

Conceptual summary of system-level interventions.

- Health workforce strengthening: Cyclical, simulation-based training in essential newborn care, neonatal resuscitation, stabilization, and transport.

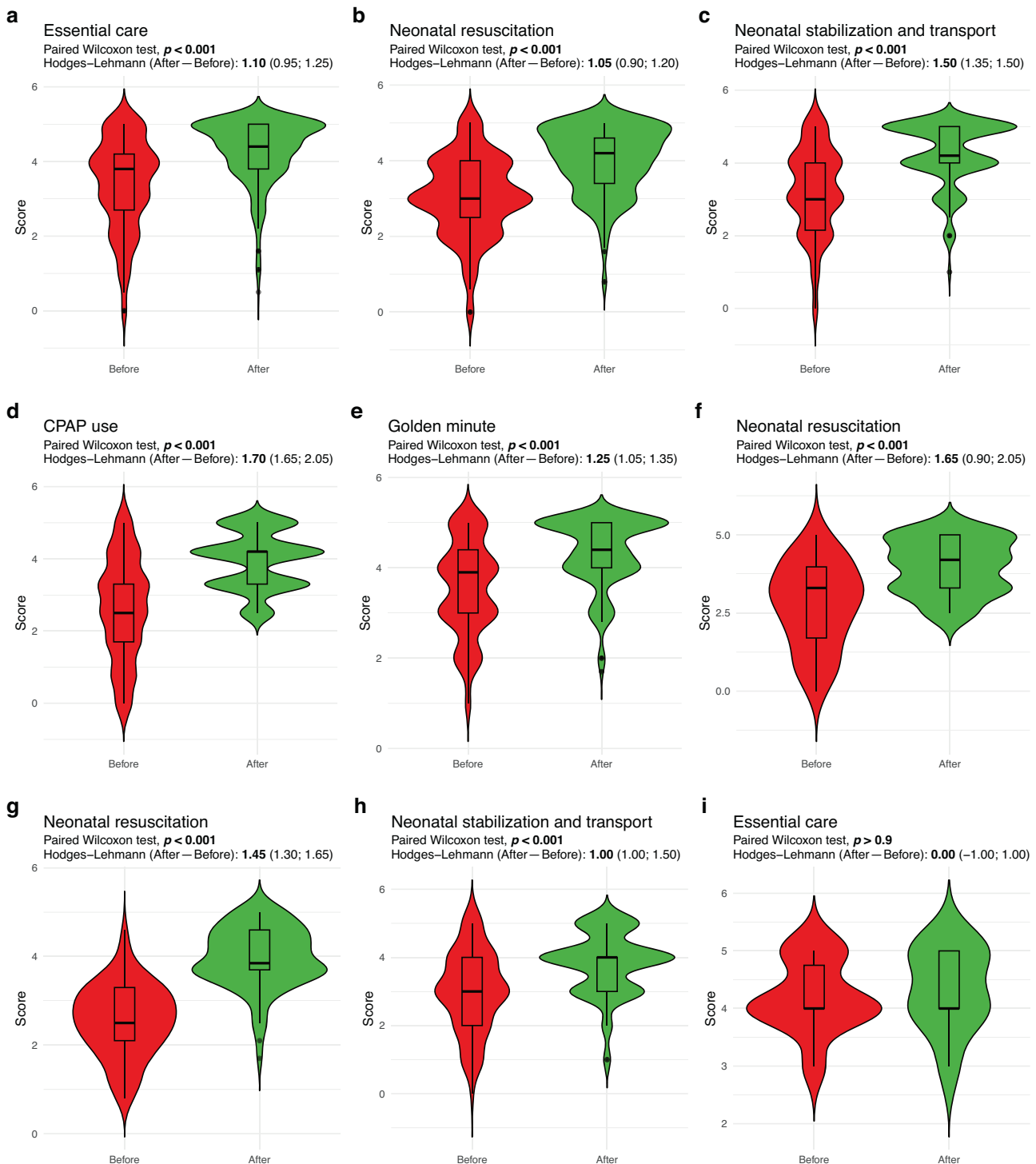


Fig. 1 Distribution of the pre-test and post-test of the workshops on neonatal care, from 2023 to 2025. Violin plots comparing before and after training scores for: (a) Essential care, (b) Neonatal resuscitation, (c) Neonatal stabilization and transport, (d) CPAP use, (e) Golden minute, (f) Neonatal resuscitation, (g) Neonatal resuscitation, (h) Neonatal stabilization and transport, and (i) Essential care. Wilcoxon signed rank test with continuity correction. Y-axis: Total evaluation score (minimum 0.0 to maximum 5.0). X-axis: Timing of the evaluation relative to the training (before and after).

- Telehealth-enabled specialist support: Continuous remote assistance to support clinical decision-making and referral in low- and medium-complexity hospitals.
- Essential neonatal technologies: Implementation of low-cost, context-appropriate technologies (e.g., bCPAP) supported by standardized protocols and training.
- Strengthened referral networks: Clear referral criteria, communication pathways, and coordination across levels of care.
- Contextualization: These interventions should be adapted to local health system capacity, workforce availability, infrastructure, geography, and governance.

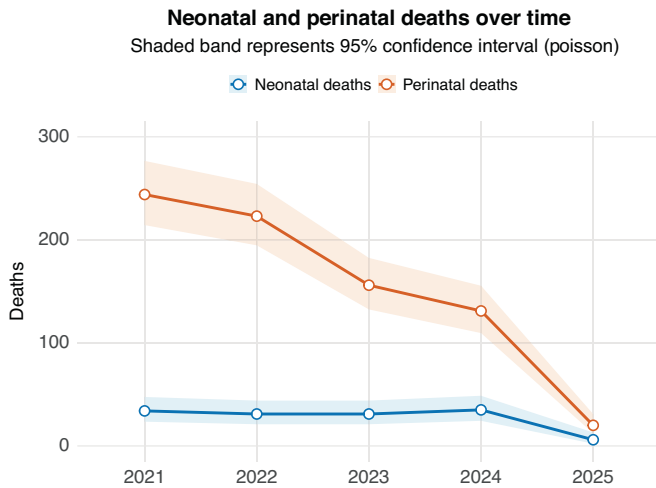


Fig. 2 Neonatal and perinatal mortality cases from 2021 to 2025 in Valle del Cauca and northern Cauca. Y-axis: absolute frequency of perinatal and neonatal death cases. X-axis: year. The years 2021, 2022, 2023, and 2024 are presented with complete data. For the year 2025, data are reported from January 1st to June 30th.

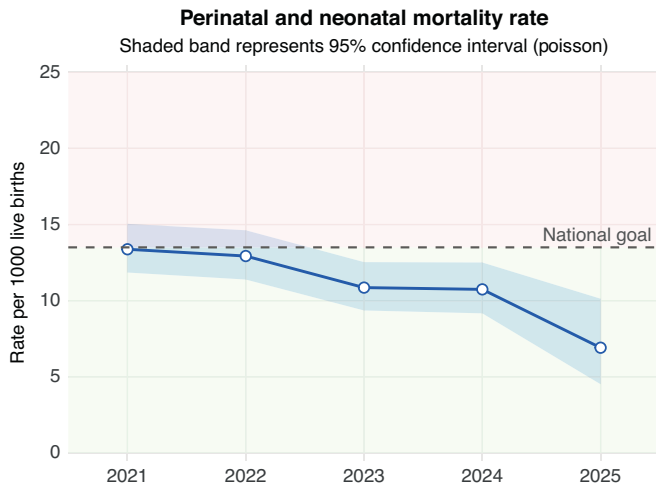


Fig. 3 Perinatal and neonatal mortality rate from 2021 to 2025 in Valle del Cauca and northern Cauca. Y-axis: perinatal and neonatal deaths per 100,000 live births. X-axis: year. National target: Reduce the Perinatal and Neonatal Mortality Rate to 13.5 per 100,000 live births. The years 2021, 2022, 2023, and 2024 are presented with complete data. For the year 2025, data are reported from January 1st to June 30th.

The first 28 days of life, the neonatal period, are the most vulnerable time for a child's survival. Despite efforts to reduce mortality in early infancy, interventions that improve survival in the critical 48-hour window of labor and delivery and the first 28 days have been less widely implemented.²⁵ As a result, mortality during the neonatal period is declining more slowly than during other periods of infancy. Reducing PNR, therefore, requires an organizational approach²⁶ to provide essential (or emergency) early neonatal care (EONC) involving trained personnel in delivery care and neonatal resuscitation, within an enabling environment with infrastructure, essential medications, and an effective referral system.²⁷ Under these premises, HPS implemented a model that brings together evidence-based recommendations, coupled with efforts to implement low-cost technology (telemedicine and bCPAP) in the challenging environment of an LMIC such as Colombia. These findings provide implementation insights that

may inform similar neonatal care strengthening initiatives in other LMIC settings and health system context like ours, particularly those seeking to improve institutional capacity and adopt evidence-based practices in perinatal and neonatal care.

The World Health Organization (WHO) defines the quality of care for women and newborns as the extent to which health care services improve desired health outcomes.²⁸ In LMICs, access to a scarce number of skilled health workers and their unequal distribution contribute to limitations in neonatal care, especially for patients with special needs or in critical condition.²⁹ On average, 59% of low-risk births occur in hospitals with fewer than 1000 births per year, where these neonatal emergency events may occur.³⁰ Therefore, educational efforts should be undertaken in all institutions providing neonatal care services, regardless of the level or volume of care. In remote or rural areas of Colombia, low-complexity hospitals are often the only local care option. Evidence has shown that improving neonatal care and resuscitation skills can reduce NRP in LMICs^{12,31} through programs such as the WHO Essential Newborn Care (ENC), the American Academy of Pediatrics Neonatal Resuscitation Program (NRP), and the Helping Babies Breathe (HBB) program.^{32,33} Two meta-analyses in low-resource settings have shown that basic neonatal resuscitation (BRN) reduces birth-related deaths, and that basic neonatal resuscitation (NBR) training reduces stillbirths, 7-day mortality, and perinatal mortality.^{33,34} The proper implementation of an effective educational model requires identifying the specific needs of the territory, using simulation-based medical education, developing a post-training skills practice plan to maintain knowledge, and collaborating with local governments for program sustainability.^{35–37} All these considerations were evaluated for the organization of HP's educational model, which migrates to the region and strengthens the competitiveness of its human talent. The neonatology team designed a program in cycles that included the stabilization and transport of babies and, on an ongoing basis for two and a half years, supported health workers from the sponsored hospitals. This model was effective in improving the technical and non-technical skills of the medical teams. Once these results are achieved, the primary challenge is to maintain the quality standard through collaborative and inter-agency work for the sustainability of the model and a governance system that prioritizes education as a pillar of development.

The use of noninvasive ventilatory support and continuous positive airway pressure is considered the respiratory support treatment of choice for newborns with respiratory distress syndrome (RDS), as recommended by the WHO. The use of CPAP (continuous positive airway pressure) has been shown to improve oxygenation and ventilation of newborns, reduce the use of mechanical ventilation and reintubation events, and decrease morbidity and mortality. Based on evidence, it is included among the priority medical devices for neonatal health. The results of a systematic review of the evidence on 38 interventions to improve neonatal health, evaluated in 49 studies among 46,993 participants in 21 LMICs, identified bCPAP as the most cost-effective, easy-to-use, and safe device in settings with trained personnel but limited resources.³⁸ The incorporation of this input into HPS was crucial in achieving the results, and although the input itself does not make a difference, incorporating it into the model was identified as strategic by all stakeholders participating in the focus groups. In LMICs, novel inputs require a complex adoption system, a high investment in face-to-face education, and strict monitoring due to high staff turnover. In our project, once the use and impact of bCPAP were understood, its use gradually increased, generating confidence in the teams.³⁸

NICU availability in LMICs is below the actual needs of newborns. In the Colombian Pacific region, the deficit can exceed 100 beds, and the costs of these needs are impossible to cover by the underfunded health systems of LMICs.³⁹ In the neonatal area, the lack of NICUs can be addressed by implementing

regionalization policies that emphasize tailoring patient care to the hospital's capacities, thereby impacting neonatal morbidity, mortality, and associated costs.⁴⁰ In the reality of LMICs, there are barriers to regionalization due to the complex coordination and consensus among providers, payers, hospitals, and patients inherent to their operation, and the emotional and financial burden of transferring pregnant women and their babies. Solutions to these barriers include standardizing the use of criteria to determine the need for transfer and safe transfer policies.⁴⁰ After two years of HPS implementation, these criteria were consolidated among the 55 hospitals, enabling the organization of a network capable of supporting less complex hospitals, increasing their response capacity, and allowing the safer and more effective transfer of newborns when necessary.

The use of telemedicine to access better-qualified personnel from rural and low-complexity hospitals and increase cooperation between different levels of care complements and strengthens regionalization models and has successfully impacted mortality in some populations. Telemedicine can provide safe, real-time (synchronous) medical care, reducing costs and barriers such as transportation and travel expenses for pregnant women. However, the science of telemedicine implementation requires adaptation to the context, with data specific to each territory.⁴⁰ Before this study, the use of telemedicine between health institutions had only been employed in the HP project to reduce maternal mortality. Given the positive experience, the same interconnection model was used.^{6,16} This technology for treating newborns in emergencies met with greater resistance from medical groups, who were accustomed to unsafe referrals. The adoption of this clinical service required multiple interventions by the leaders of the sponsored hospitals and ongoing monitoring and follow-up by the health secretariats.

Limitations

This study has limitations inherent to its quasi-experimental pre-post design without a control group. Observed reductions in perinatal and late neonatal mortality should therefore be interpreted as associations. In addition, the Hospital Padrino Strategy was implemented as a bundled intervention integrating education, telehealth, and bCPAP provision, preventing assessment of the independent effect of each component. Neonatal and perinatal mortality indicators were derived from routine, aggregated surveillance data, which may be affected by underreporting, variability in data quality across municipalities, and potential ecological bias when inferring hospital-level impact. Patient-level outcome data were limited to cases managed within the HPS and telehealth records, and outcomes from referral hospitals other than Fundación Valle del Lili were not available. The qualitative data were analyzed by a single qualitative research expert using thematic content analysis, and dual coding was not performed. In addition, findings were not returned to participants for member checking, as the evaluation was conducted as part of an external program assessment. These factors may influence the credibility of the qualitative findings. Finally, high staff turnover and the focus on two departments of the Colombian Pacific region may limit implementation to other settings.

CONCLUSION

Neonatal care to reduce associated mortality must be safe, effective, timely, efficient, equitable, and people-centered. The implementation of the HPS for neonatal care, adapted to the needs of the Colombian Pacific, combining high-quality education strategies, low-cost supplies, the incorporation of a telemedicine model, and the creation of a unified hospital care network, enabled a sustained reduction in PNR. Social innovation models in health, incorporating cost-effective, evidence-based clinical strategies like HPS, can provide a solution to the challenging problem

faced by LMICs, which hinders their ability to meet international standards of quality care for sick newborns. Our results encourage more LMICs to explore the great potential to improve institutional performance by increasing resources and implementing evidence-based practices in perinatal and neonatal care.

DATA AVAILABILITY

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

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AUTHOR CONTRIBUTIONS

Conceptualization: María Fernanda Escobar. roboData Curation: Hernán Gómez-Moreno, Alejandra Guevara, Juan Sebastián Galindo-Sánchez, Andrea Melissa Porras, Melissa Perafan, Yhan Carlos Cárdenas. Methodology: María Fernanda Escobar, Juan Sebastián Galindo-Sánchez, Sergio Iván Prada. mInvestigation: María Fernanda Escobar, Martha Lucia Jaramillo, Betsy Marilis Mancera Martínez, Adriana Ballesteros Castro, Ivonne Aldana Vallejo, Jaime Orrego Gaviria, Nancy Liliana Llanos Durán, Iván Enrique Padilla Mejía, Ana María Gómez Vásquez, Carmen Lorena Villota Gonzalez, Aida Masson, Sandra Lorena Moreno Arias, Virginia Vargas Rey, Victoria Eugenia Gutiérrez Echeverri, Claudia Lorena Guerrero Moreno. Supervision: María Fernanda Escobar, Sergio Ivan Prada. Project administration: María Fernanda Escobar, María

Cristina Lesmes, Andrea Melissa Porras, María Isabel Irurita, Johan Sebastián Loaiza, Daniel Echeverri, Victoria Soto. Formal analysis: María Fernanda Escobar, Juan Sebastián Galindo-Sánchez, Yhan Carlos Cárdenas. Writing - Original draft: María Fernanda Escobar. Review and editing: María Fernanda Escobar, Juan Sebastián Galindo-Sánchez, Yhan Carlos Cárdenas. All authors discussed the results, contributed and approved the final version of the manuscript.

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COMPETING INTERESTS

The authors declare no competing interests.

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Correspondence and requests for materials should be addressed to María Fernanda Escobar.

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