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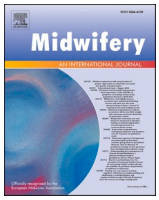

Research Article

Midwife-attended planned home births versus planned hospital births in Spain: Maternal and neonatal outcomes

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ABSTRACT

Background: The debate on the safety and outcomes of home versus hospital births highlights the need for evidence-based evaluations of these birthing settings, particularly in Catalonia where both options are available.
Aim: To compare sociodemographic characteristics and maternal and neonatal outcomes between low-risk women opting for home versus hospital births in Catalonia, Spain.
Methods: This observational cross-sectional study analysed 3,463 low-risk births between 2016 and 2018, including 2,713 hospital and 750 home births. Researchers collected sociodemographic data, birthing processes, and outcomes, using statistical analysis to explore differences between the settings.
Findings: Notable differences emerged: Women choosing home births typically had higher education levels and were predominantly Spanish. They were 3.43 times more likely to have a spontaneous birth and significantly less likely to undergo instrumental births than those in hospitals. Home births were associated with higher utilization of non-pharmacological analgesia and a more pronounced tendency to iniciate breastfeeding within the first hour post birth and stronger inclination towards breastfeeding. Hospital births, conversely, showed higher use of the lithotomy position and epidural analgesia. There were no significant differences in neonatal outcomes between the two groups.
Conclusions and implication for practice: Home births managed by midwives offered better obstetric and neonatal outcomes for low-risk women than hospital births. These results suggest home birth as a safe, viable option that promotes natural birthing processes and reduces medical interventions. The study supports the integration of midwife-led home birth into public health policies, affirming its benefits for maternal and neonatal health.

Introduction

Problem or issue
In Spain, planned home births function independently of the healthcare system, led primarily by midwives, lacking studies comparing outcomes based on birth locations.

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What is Already Known
For women with normal to low-moderate risk pregnancies, planned home births with trained midwives in an integrated healthcare system reduce childbirth interventions (forceps, episiotomies, cesarean sections) without increasing maternal or neonatal morbidity.

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What this Paper Adds

Our study enhances our understanding of planned home births assisted by midwives in our specific context. It provides insights into obstetric outcomes for home and hospital births, examining care models, user profiles, and maternal/neonatal outcomes. This research offers a comprehensive understanding, aiding better-informed decision-making for those considering such births.

Despite efforts to implement a physiological, holistic, salutogenic approach (Downe et al., 2020; Ferguson and Davis, 2019), pregnancy and childbirth are still mainly considered from a biomedical perspective (Biescas et al., 2017; Healy et al., 2017; Prosser et al., 2018). This biomedical view of birth, more focused on risks and professionals than on women's and babies' needs, has led to excessive interventionism in hospital low-risk births that has not only failed to improve health but also had a negative physical and psychoemotional impact on the mother–child dyad (Miller et al., 2016; Rydahl et al., 2021). Thus, to improve the birthing experience and perinatal outcomes, the focus must shift to the women and their needs, desires and expectations (Downe et al., 2018).

In the context of low-risk pregnancies, the safety and effectiveness of planned home births under midwifery care within an integrated health system have gained significant attention (Hutton et al., 2019; Olsen and Clausen, 2023). Several studies have highlighted that, in low-risk women, planned home births result in lower rates of instrumental births and caesarean sections (Brocklehurst et al., 2011; Kooy et al., 2017), higher breastfeeding rates (Quigley et al., 2016) and heightened maternal satisfaction with the birthing experience when compared to hospital births (Alcaraz-Vidal et al., 2023; Fleming et al., 2016; Handelzalts et al., 2016; Jouhki et al., 2017), all while maintaining similar perinatal outcomes (Hutton et al., 2019; Scarf et al., 2018).

In Spain, the majority of healthy women give birth at conventional obstetric units assisted by midwives, but most of these units are led by obstetricians and do not offer a continuity of care model led by midwives. Currently, Spain's public health system is far from effectively implementing midwife-led and midwife-provided care across primary care and hospitals, hindering care continuity (Martin Arribas et al., 2020).

Midwifery models of continuity of care in Spain, is only provided by home-birth midwives outside the public health system (Alcaraz-Vidal et al., 2021; Ortega Barreda et al., 2017) and in the midwifery-led birth unit of some public hospitals (Alcaraz-Vidal et al., 2024; Palau-Costafreda et al., 2023).

Home births in Spain, constituting a mere 0.32 % of births (Galková et al., 2022; National Statistics Institute (INE), 2018), involve private practitioners, with no official coordination with the public health system. Nevertheless, women who opt for birth at home with an independent midwife or team of midwives also usually use public health services for complementary tests (ultrasound, laboratory tests and cultures) (Alcaraz-Vidal et al., 2021; Ortega Barreda et al., 2017).

Insights into the variables affecting the planning and outcomes of home births remain limited. Among 3011 home births attended by professionals from 2016 to 2018, 37.6 % occurred in the region of Catalonia (National Statistics Institute (INE), 2018). Catalan Association of Homebirth Midwives (CAHBM) data from 949 planned home births revealed trends and outcomes.

To our knowledge, no published studies have compared the care that women receive in home versus hospital births in Spain. The current research compares the care received by women with low obstetric risk with the assistence of the registered midwives in public hospitals versus the care received by women with low obstetric risk in planned home births attended throughout pregnancy by midwives employing a case-load model.

We aimed to compare the sociodemographic characteristics and maternal and neonatal outcomes in low-risk women who planned to give birth at home versus those who planned to give birth in hospitals led by a midwife at the onset of labour and analyse the variables that act as predictors of birth planning at home or in the hospital.

Participants

This study included only women aged 18 to 40 years with low-risk pregnancies, with a single foetus in the cephalic position, and spontaneous onset of labour between week 37+0 and week 42+0, who had not undergone caesarean section or had complications in prior pregnancies. Fig. 1 is a flowchart of the study. We analysed data from 2713 planned hospital births and from 750 planned home births.

Ethics

The Parc de Salut Mar de Barcelona's clinical research ethics committee approved the study (2018/8120/l). All CAHBM midwives received oral and written information detailing the study. All pregnant women provided informed written consent for their data to be registered in the CAHBM database and used in observational studies. The CAHBM approved the use of these data for this study, and this approval was recorded in the minutes of the assembly held on December 15, 2017.

Methods

This observational cross-sectional study compared data from women who planned to give birth at home versus those who planned to give birth in the hospital attended by midwives.

Variables

To ensure that the data from the two databases were comparable, we examined and classified the definitions of the variables included (Table 1).

The main outcomes were classified as: maternal factors related to the birthing process, maternal morbidity and neonatal outcomes. The factors related to the birthing process were: type of birth (spontaneous/instrumental/caesarean), movement and walking during labour (yes/no), posture adopted during the expulsive stage (lithotomy/other), use of epidural analgesia, (yes/no), use of non-pharmacological analgesia (yes/no), desire to breastfeed (yes/no), the presence of an accompanying person during the entire birth process (yes/no) and intrapartum transfer of care (yes/no).

The maternal outcomes were: severe perineal lesion (yes/no), episiotomy (yes/no) and admission to the intensive care unit [ICU] (yes/no); and the neonatal outcomes were: weight at birth categorized as $<$2500 g, 2502–4000 g and $>$4000 g, Apgar score categorized as 5′ $\langle$7 and 5′ $\rangle$ 7 and admission to the neonatal ICU (NICU) (yes/no).

The maternal and neonatal outcomes of women who planned home birth and were transfered to te hospital were attributed to the home birth group.

Sociodemographic variables were used to adjust the results, as they are known to be potential confounders between place of birth and maternal and neonatal outcomes. The sociodemographic variables were: maternal age categorised as $<$ 24 year, 25–29 year, 30–34 year, 35–39 year and $<$39 year, education categorised as primary, secundary, higher and unknown, nationality (born in Spain/not born in Spain), parity categorized as nulliparus or multiparous and gestational age categorized as 37 – 40 weeks and $>$ 40 weeks.

Data collection

Hospital data were taken from the Midconbirth study (Escuriet et al., 2017) and corresponded to births in 2016 and 2017 in 29 public hospitals in Catalonia. Obstetric unit sizes with differing degrees of midwifery autonomy, intrapartum interventions and birth outcomes were included in this study.

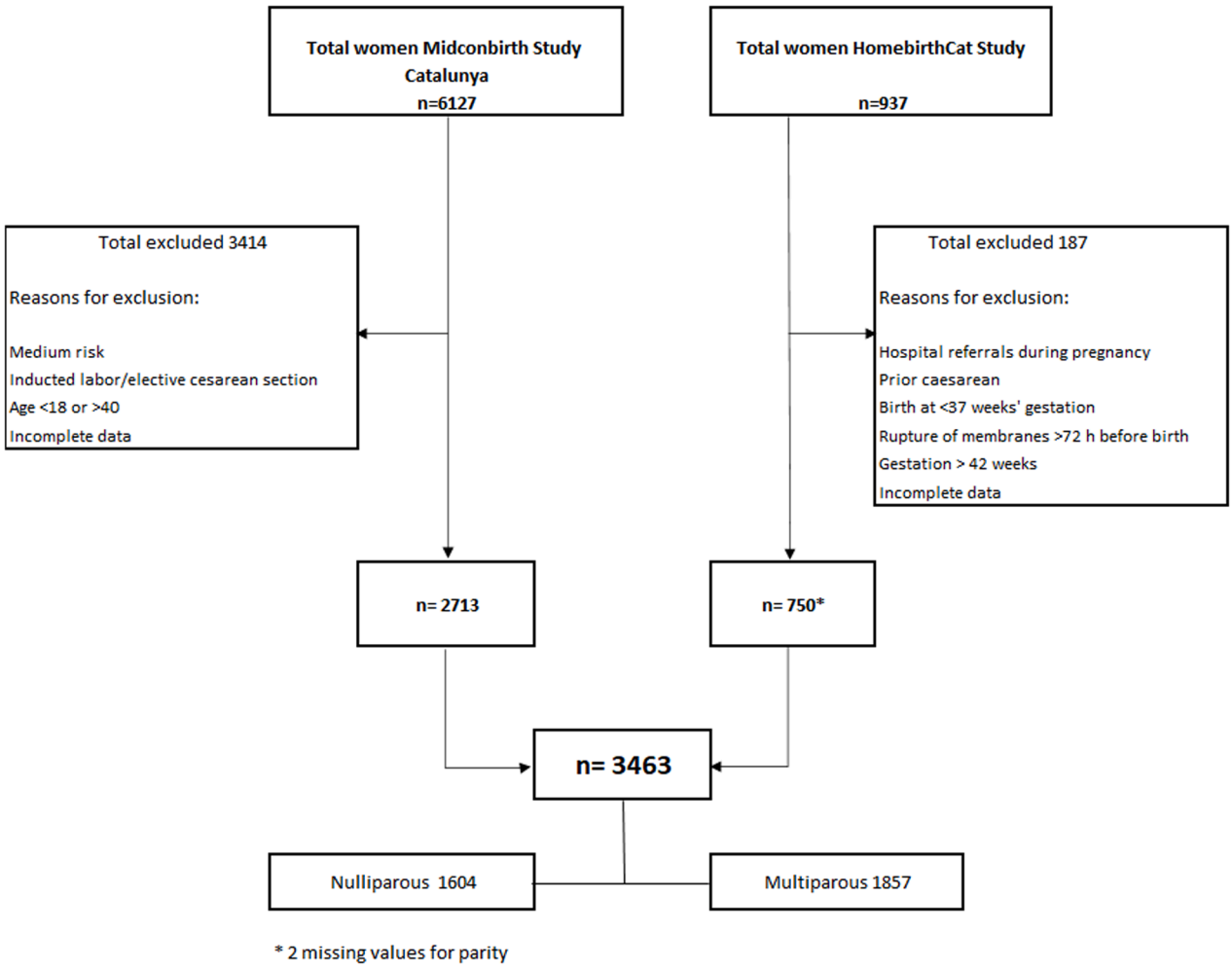

Fig. 1. Flowchart showing inclusion of women from the Midconbirth Study and HomebirthCat Study.

Data about home births were taken from the HomebirthCat study database (Alcaraz-Vidal et al., 2021) and corresponded to births in 2016, 2017 and 2018.

Data quality control

These analyses form part of a broader study registered at Clinical Trials (code: ISRCTN94453122), and this paper follows the STROBE guidelines for reporting observational studies and the recommendations of the ResQu Index (Vedam et al., 2017) for research about the place where women give birth.

Statistical analysis

In the methods section of our study, we conducted a comprehensive analysis of all variables. Sociodemographic variables, and clinical variables related to the birthing process, as well as maternal and neonatal outcomes were examined using descriptive statistics. Categorical variables, including nominal such as nationality, partograph, movement or desire to breastfeed, as well as ordinal variables like education levels, type of birth or Apgar scores, were presented as counts and percentages to depict their distribution within the sample.

To explore associations between categorical variables for maternal and birthing process factors, we assessed the proportions within each group (home vs. hospital birth) and used contingency tables to identify associations between categorical variables. The chi-square test was used for larger sample sizes, while Fisher's exact test was employed for smaller samples or instances where expected frequencies were low. Cramer's V was used to measure the strength of these associations (≤ 0.2 weak association, 0.2–0.6 moderate association, >0.6 strong association). The precision of the analysis was evaluated by calculating confidence intervals for the Odds Ratio (OR) of the association measures.

Furthermore, we developed a multivariate model to integrate factors that demonstrated clinically significance or a moderate-to-high strength of association with the differences between home and hospital births. This model included a simple logistic regression for each outcome variable and a multivariable logistic regression adjusting that adjusted for the included variables along with sociodemographic confounding factors. Incidences and odds ratios, along with their 95 % confidence intervals (CI), were computed and presented for all maternal and neonatal outcomes. Variables with a value of 0 within any group were excluded from the multivariate model. To enhance clarity and understanding, odds ratios less than 1 were expressed inversely during interpretation.

All statistical analysis were performed using IBM SPSS Statistics version 22.0. Two-tailed tests with a significance level set at 5 % (α=0.05) were employed. This rigorous approach ensured transparency in the analysis of the data, facilitating a robust comparison of outcomes between home and hospital birth settings. These statistical analyses contributed to the scientific understanding of the topic.

Table 1
Definitions.

Sociodemographic factors	
Age at childbirth	0–24 years; 25–29 years; 30–34 years; 35–39 years; >39 years
Education	Primary school; secondary school; higher education; unknown
Nationality	Spanish (Born in Spain); Not Spanish (not born in Spain)
Parity	Nulliparous: no previous births Multiparous: ≥1 birth after 22 weeks' gestation, regardless of the neonatal outcome
Gestational age at the start of labour	37–40 weeks; > 40 weeks
Presence of companion throughout the process	At least 1 person of the woman's choice has accompanied her through most of the process without unjustified restrictions
Factors related to the birthing process	
Type of birth	Spontaneous birth: instrumental, caesarean
Transfer of care	The professional who starts the care process for the birth transfers responsibility for care to another professional regardless of the reason. A transfer is considered to have taken place even if the referring professional continues to collaborate o give support in the care of the patient. In planned home births, a transfer occurs when the patient is taken to the hospital.
Movement during labour	The woman is free to move and ambulate throughout most of her labour. This variable also applies after locoregional analgesia when motor capacity for ambulation is preserved.
Position adopted during the second stage of labour	Lithotomy vs. any other position adopted during the second stage of labour
Epidural analgesia	Use of epidural analgesia at any time
Non-pharmacological analgesia	The use of any nonpharmacological method to relieve or manage pain (e.g., water, massage, movement, self-hypnosis, etc.) at any time during the process. This variable also includes homeopathy products.
Breastfeeding. Initiation	Early initiation of breastfeeding is promoted or facilitated through early contact and support for the mother. A first feeding must be observed during the immediate postpartum period (≤2 h after birth).
Breastfeeding. Mother's desire	The mother has expressed the desire to breastfeed in any way at any time.
Maternal morbidity variables	
Severe perineal lesion	**Third-degree tears** (subtypes a, b, and c, depending on the degree of involvement of the external and internal anal sphincters) and **fourth-degree tears** (perineal lesions affecting both sphincters and the anal mucosa) (National Institute for Health and Care Excellence. 2014)
Episiotomy	
Admission to an intensive care unit	Admission during or in the 7 days following birth.
Neonatal morbidity variables	
Low birthweight	Weight < 2500 g within the first 24 h of life
High birthweight	Weight > 4000 g within the first 24 h of life
Apgar score 5 min after birth < 7	
Admission to a neonatal intensive care unit	Admission within 24 h after birth

Results

Socio-demographic characteristics of the study participants

Fig. 1 is a flow diagram showing how the sample of 3463 low-risk women included in the study was derived from the total population of 6127 planned hospital births and 937 planned home births.

In Table 2, the sociodemographic characteristics of the participants are presented based on their planned place of birth, either hospital or home. In the hospital-planned births, the most frequent age group was 25–29 years, whereas women aged 30–39 years were the most frequent group planning home birth. The women opting for home birth had higher education (27.6% vs 72.9 %, $Z = 22.7$, $p < 0.01$) and were predominantly Spanish, whereas those opting for hospital birth were more commonly of nationalities other than Spanish (56.8% vs 81.2 %, $Z = 12.2$, <0.01). Just over half of the women were multiparous in both hospital and home births. Women who had a hospital birth mostly completed gestation before 40 weeks, whereas those who opted for home birth were more likely to exceed 40 weeks of gestation at the time of birth (13.2% vs 54.1 %, $Z = 23.9$, $p < 0.01$).

Comparison between obstetric and perinatal variables of home birth and hospital birth

Table 3 presents the associations between variables related to birthing process and the chosen place of birth.

The main findings of the study on the birthing process revealed significant differences between planned hospital births and planned home births (Table 3). Most of both planned hospital births (83 %) and planned home births (92.7 %) were spontaneous, with a statistically significant association ($\chi2 = 43.23$, $p < 0.001$), indicating a higher likelihood of spontaneous birth for planned home births (OR = 0.39, 95 % CI = 0.29–0.52). Planned hospital births had a higher proportion of instrumental births (12.8 %) compared to planned home births (3.3 %), with a statistically significant association ($\chi2 = 55.10$, $p < 0.001$) and a higher likelihood of instrumental birth for planned hospital births (OR = 4.27, 95 % CI = 2.82–6.46). However, there was no significant association between the planned place of birth and the occurrence of caesarean births ($\chi2 = 0.04$, $p = 0.918$).

A significant association was found between the planned place of birth and the position during labor ($\chi2 = 644.42$, $p < 0.001$). Planned hospital births had a higher proportion of lithotomy positions (62.2 %) compared to planned home births (6.7 %), with an OR of 22.84 (95 % CI = 16.65–31.33) for lithotomy position in planned hospital births. Planned hospital births had a higher rate of epidural analgesia (80.3 %) compared to planned home births (9.4 %), with a highly significant association ($\chi2 = 1249.74$, $p < 0.001$) and an OR of 39.01 (95 % CI = 29.81–51.04). Conversely, the use of non-pharmacological analgesia was statistically higher in planned home births (95.8 %) compared to planned hospital births (5.1 %), with a significant association ($\chi2 = 2652.51$, $p < 0.001$) and an OR of 0.002 (95 % CI = 0.002–0.003) for non-pharmacological analgesia in planned home births.

Planned homebirths had a higher rate of women who were accompanied (100 %) compared to planned hospital births (96.2 %) with significant association ($\chi2 = 29.64$, $p < 0.001$).

Planned hospital births had a higher rate of transfer of care from the planned place of birth (30.7 %) compared to planned home births (14.4 %), with a significant association ($\chi2 = 79.23$, $p < 0.001$) and an OR of 2.64 (95 % CI = 2.12–3.29) for planned hospital births.

Table 4 presents the results of potential predictive factors for maternal and neonatal outcomes based on the planned place of birth.

Regarding maternal outcomes, there was a higher incidence of episiotomy in planned hospital births (31 %) compared to planned home births (2.1 %), showing a strong association ($\chi2 = 245.09$, Cramer $V = 0.274$). The odds ratio (OR) for episiotomy in planned home births was 0.05 (95 % CI = 0.03–0.08), and the difference was statistically significant ($p < 0.001$). However, there were no significant associations with the incidence of perineal tear or maternal ICU admission based on the planned place of birth.

In terms of neonatal outcomes, the distribution of birthweights varied slightly between the two groups. There were no significant differences in the rates of low birthweight (< 2500 g) between planned hospital births (0.9 %) and planned home births (0.5 %). For birthweights between 2501 g and 4000 g, there was a slightly higher proportion in planned hospital births (94 %) compared to planned home births (91.1 %), with a marginal association ($\chi2 = 8.58$, Cramer $V = 0.05$). The OR for this category was 1.55 (95 % CI = 1.15–2.08),

Table 2
Descriptive statistics and bivariate analysis of potential sociodemographic confounding factors and planned place of birth.

	Total (n = 3463)	Planned hospital births n = 2713	Planned home births n = 750	Pearson χ^2	Cramer V	OR (95 % CI)[d]	p-value
Age at childbirth[a]							
0–24 years	444 (12.8 %)	436 (16.1 %)	8 (1.1 %)	337.11	0.312	—	< 0.001
25–29 years	809 (23.4 %)	703 (25.9 %)	106 (14.2 %)				
30–34 years	1238 (35.8 %)	958 (35.3 %)	280 (37.4 %)				
35–39 years	860 (24.8 %)	580 (21.4 %)	280 (37.4 %)				
>39 years	111 (3.2 %)	36 (1.3 %)	75 (10 %)				
Education							
Primary	664 (19.2 %)	636 (23.4 %)	28 (3.7 %)	577.03	0.408	—	< 0.001
Secondary	1076 (31.1 %)	901 (33.2 %)	175 (23.3 %)				
Higher	1297 (37.5 %)	750 (27.6 %)	547 (72.9 %)				
Unknown	426 (12.3 %)	426 (15.7 %)	0 (0 %)				
Nationality							
Not Spanish	1312 (37.9 %)	1171 (43.2 %)	141(18.8 %)	148.20	0.207	0.31 (0.25 - 0.37)	< 0.001
Spanish	2151 (62.1 %)	1542 (56.8 %)	609 (81.2 %)				
Parity[b]							
Nulliparous	1604 (46.3 %)	1277 (47.1 %)	327(43.6 %)	2.65	0.028	0.87 (0.74 - 1.03)	0.103
Multiparous	1857 (53.6 %)	1436 (52.9 %)	421 (56.1 %)				
Gestational age at the start of labour[c]							
37–40 weeks	2700 (78 %)	2356 (86.8 %)	344 (45.9 %)	572.36	0.407	0.13 (0.11 – 0,15)	< 0.001
> 40 weeks	762 (22 %)	357 (13.2 %)	405(54.1 %)				

[a] 1 missing in HomeBirthCat.
[b] 2 missing in HomeBirthCat.
[c] 1 missing in HomebirthCat.
[d] OR = Odds Ratio, CI = Confidence interval. OR is not calculated in variables with empty boxes or with very few cases.

Table 3
Descriptive statistical and Bivariate analysis of potential predictive birthing process factors to the planned place of birth.

	Total (n = 3463)	Planned hospital births n = 2713	Planned home births n = 750	Pearson χ^2	Cramer V	OR (95 % IC)[d]	p-value
Type of birth							
Spontaneous	2947 (85,1 %)	2252 (83 %)	695 (92,7 %)	43.23	0.112	2.59 (1.93 – 3.47)	< 0.001
Instrumental	373 (10,8 %)	348 (12,8 %)	25 (3,3 %)	55.10	0.126	0.23 (0.16 – 0.36)	< 0.001
Caesarean	143 (4,1 %)	113 (4,2 %)	30 (4 %)	0.04	0.003	1.04 (0.69 – 1.57)	0.918
Movement/ambulation							
NO	701 (20.2 %)	701 (25.8 %)	0 (0 %)	242.97	0.265	—	< 0.001
YES	2762 (79.8 %)	2012 (74.2 %)	750 (100 %)				
Position during the second stage of labour[a]							
Lithotomy	1660 (51 %)	1616 (62.2 %)	44 (6.7 %)	644.42	0.445	0.04 (0.03– 0.06)	< 0.001
Other	1596 (49 %)	984 (37.8 %)	612 (93.3 %)				
Epidural analgesia[b]							
NO	1177 (34.4 %)	535 (19.7 %)	642 (90.6 %)	1249.74	0.604	0.03 (0.02 – 0.03)	<0.001
YES	2245 (65.6 %)	2178 (80.3 %)	67 (9.4 %)				
Non-pharmacological analgesia							
NO	2638 (76.4 %)	2600 (95.8 %)	38 (5.1 %)	2652.51	0.876	425.1 (291.6 – 619.6)	< 0.001
YES	815 (23.6 %)	113 (4.2 %)	702 (94.9 %)				
Desire to breastfeed[c]							
NO	187 (5.4 %)	182 (6.7 %)	5 (0.7 %)	41.69	0.110	10.65 (4.36 – 26)	<0.001
YES	3269 (94.6 %)	2529 (93.3 %)	740 (99.3 %)				
Accompanied							
NO	104 (3 %)	104 (3.8 %)	0 (0 %)	29.64	0.093	—	< 0.001
YES	3359 (97 %)	2609 (96.2 %)	750 (100 %)				
Transfer of care							
NO	2521 (72.8 %)	1879 (69.3 %)	642 (85.6 %)	79.23	0.151	0.38 (0.30 – 0.47)	<0.001
YES	942 (27.2 %)	834 (30.7 %)	108 (14.4 %)				

[a] 93 missing in planned home births.
[b] 41 missing in planned home births.
[c] 5 missing in planned home births.
[d] OR=Odds Ratio, CI= Confidence interval. OR is not calculated in variables with empty boxes or with very few cases. Calculated OR of home birth to hospital birth.

indicating a slightly higher likelihood of this birthweight range in planned hospital births. Conversely, birthweights above 4000 g were more prevalent in planned home births (8.4 %) compared to planned hospital births (5.2 %). The association was marginally significant ($\chi2$ = 11.18, Cramer V = 0.057), and the OR was 0.59 (95 % CI = 0.44–0.81), suggesting a decreased likelihood of higher birthweights in planned hospital births. Most neonates had Apgar scores at 5 min of 7 or higher, with no substantial differences observed between the groups.

Regarding neonatal ICU admission, there was a slightly higher proportion in planned hospital births (2.8 %) compared to planned home births (1.1 %), with a marginally significant association ($\chi2$ = 7.27, Cramer V = 0.046). The OR for neonatal ICU admission in planned hospital births was 2.64 (95 % CI = 1.27–5.50), indicating a higher likelihood of ICU admission in this group.

Finally, early initiation of breastfeeding differed slightly between the two groups, with a higher percentage of mothers initiating breastfeeding early in planned home births (91.7 %) compared to planned hospital births (89 %). The association was significant ($\chi2$ = 4.38, Cramer V =

Table 4
Descriptive statistical and Bivariate analysis of potential predictive maternal and neonatal outcomes to the planned place of birth.

	Total ($n = 3463$)	Planned hospital births $n = 2713$	Planned home births $n = 750$	Pearson χ^2	Cramer V	OR (95 % IC)[c]	p-value
Maternal outcomes							
High-grade perineal tear[a,b]							
YES	50 (1.5 %)	45 (1.7 %)	5 (0.7 %)	3.391	0.032	0.43 (0.17 – 1.09)	0.066
NO	3217 (98.5 %)	2555 (98.3 %)	662 (99.3 %)				
Episiotomy[a,b]							
YES	841 (25.2 %)	827 (31 %)	14 (2.1 %)	245.09	0.274	0.05 (0.03 – 0.08)	<0.001
NO	2426 (74.3 %)	1773 (66.2 %)	653 (97.9 %)				
ICU admission							
YES	8 (0.2 %)	7 (0.3 %)	1 (0.1 %)	0.396	0.011	1.94 (0.24 – 17.77)	0.529
NO	3455 (99.8 %)	2706 (99.7 %)	749 (99.9 %)				
Neonatal outcomes							
Birthweight							
< 2500 g	28 (0.8 %)	24 (0.9 %)	4 (0.5 %)	0.90	0.016	1.67 (0.58 – 4.81)	0.489
2501–4000 g	3231 (93.3 %)	2549 (94 %)	682 (91.1 %)	8.58	0.05	0.65 (0.48 – 0.87)	0.004
> 4000 g	203 (5.9 %)	140 (5.2 %)	63 (8.4 %)	11.18	0.057	1.69 (1.24 – 2.30)	0.001
Apgar							
Apgar 5' < 7	29 (0.8 %)	21 (0.8 %)	8 (1.1 %)	0.606	0.013	1.38 (0.61 – 3.13)	0.495
Apgar 5' ≥ 7	3434 (99.2 %)	2692 (99.2 %)	742 (98.9 %)				
ICU admission							
YES	84 (2.4 %)	76 (2.8 %)	8 (1.1 %)	7.27	0.046	0.38 (0.18 – 0.79)	0.009
NO	3370 (97.6 %)	2637 (97.2 %)	733 (98.9 %)				
Early initiation of breastfeeding							
YES	3058 (89.6 %)	2415 (89 %)	643 (91.7 %)	4.38	0.036	1.37 (1.02 – 1.84)	0.037
NO	356 (10.4 %)	298 (11 %)	58 (8.3 %)				

[a] % calculated by subtracting the number of women who gave birth by caesarean section.
[b] 53 missing values in planned homebirth.
[c] OR=Odds Ratio, CI= Confidence interval. OR is not calculated in variables with empty boxes or with very few cases. Calculated OR of home birth to hospital birth.

0.036), and the OR was 1.37 (95 % CI = 1.02–1.84), indicating a slightly higher likelihood of early breastfeeding initiation in planned home births.

Table 5 presents the adjusted Multiple logistic regression model of birthing process and maternal or neonatal outcomes with place of birthing as the outcome variable and the explanatory variables: maternal age, education, nationality, and gestational age

Women who planned a home birth were 3.43 times more likely to experience a spontaneous birth compared to those who planned a hospital birth ($p < 0.001$) and had a significantly reduced likelihood of having an instrumental birth compared to those who planned a hospital birth (adjusted OR 0.19; $p < 0.01$). Additionally, planning a home birth was significantly associated with the use of non-pharmacological analgesia (adjusted OR 496.38; $p < 0.01$) and positively associated with the desire to breastfeed (adjusted OR 10.01; $p < 0.01$) compared to hospital birth. However, hospital birth was associated with a higher likelihood of the lithotomy position during the third stage of labour (adjusted OR 20; $p < 0.01$) and a greater use of epidural analgesia (adjusted OR 50; $p < 0.01$).

Finally, women who planned a home birth had a lower risk of transfer of care during labour compared to those who planned a hospital birth (adjusted OR 0.29; $p < 0.001$). Regarding maternal and neonatal outcomes, no significant association was found between the place of birth and severe perineal tear or birth weight. On the other hand, women who planned a hospital birth had a significantly increased likelihood of receiving an episiotomy compared to those who planned a home birth (adjusted OR 25; $p < 0.01$).

Table 6 shows the incidence of maternal and neonatal adverse outcomes and the predictive model by planned place of birth and parity.

In the group of nulliparous women who planned a home birth, there was an incidence of 7.6 % of instrumental births, significantly lower compared to the group of nulliparous women who planned a hospital birth (23.1 %), indicating a lower risk of instrumental birth in the home birth group (adjusted OR 0.156; $p < 0.001$). However, nulliparous women who planned a hospital birth had a 45.7 % incidence of transfer of care, significantly higher compared to the group of nulliparous women who planned a home birth (29.7 %), indicating a higher risk of transfer of care in the hospital birth group (adjusted OR 2; $p < 0.001$). No significant differences were found in the incidence of caesarean births, maternal ICU admission, or neonatal outcomes between nulliparous women who planned a home birth and those who planned a hospital birth.

In the group of multiparous women who planned a hospital birth, there was a higher risk of neonatal ICU admission (incidence 2% vs 0.5 %; adjusted OR 4.17; $p = 0.049$) and a higher risk of transfer of care (incidence 17.4% vs 2.6 %; adjusted OR 7.7; $p < 0.01$) compared to the group of multiparous women who planned a home birth. However, multiparous women who planned a hospital birth had an 11.2 % incidence of transfers of care, significantly higher compared to the group of multiparous women who planned a home birth (6.5 %), indicating a higher risk of transfer of care in the hospital birth group (adjusted OR 1.79; $p = 0.002$). No significant differences were found in the incidence of spontaneous births, caesarean sections, maternal ICU admission, birth weight <2500 g, or Apgar score <7 between multiparous women who planned a home birth and those who planned a hospital birth.

Discussion

The study found significant differences in the characteristics of the women who planned to give birth at home and those who planned to give birth in the hospital. Those who planned to give birth at home were older, more likely to have been born in Spain and had a higher level of education. These results align with those reported in studies in other countries (Cheyney et al., 2014; de Jonge et al., 2013; Goyal et al., 2020; Zielinski et al., 2015).

The gestational age at birth differed between planned home births and planned hospital births. This finding is striking given that the mean gestational age at the beginning of labour is 40 weeks + 5 days in nulliparous women and 40 weeks + 3 days in multiparous women (Jukic et al., 2013; Smith, 2001) and 5 % to 10 % of gestations last more than 42 weeks (Zeitlin et al., 2007). The data collected in the current study do not allow us to explain the difference in gestational age between planned home births and planned hospital births. Similar studies have also found that women who planned to give birth at home were more likely to give

Table 5
Adjusted Multiple logistic regression model of birthing process and maternal or neonatal outcomes with place of birthing as the outcome variable and the explanatory variables: maternal age, education, nationality, and gestational age.

	Adjusted ORa (95 % IC)	P-value
Birthing process		
Spontaneous birth		
Planned home birth	3.43 (2.41 – 4.87)	<0.001
Planned hospital birth	1	
Instrumental birth		
Planned home birth	0.19 (0.12 – 0.31)	<0.001
Planned hospital birth	1	
Lithotomy position during second stage of labour		
Planned home birth	0.05 (0.04 – 0.07)	<0.001
Planned hospital birth	1	
Nonpharmacological analgesia		
Planned home birth	496.38 (304.77 – 808.46)	< 0.001
Planned hospital birth	1	
Epidural analgesia*#		
Planned home birth[a]	0.02 (0.02 – 0.03)	< 0.001
Planned hospital birth	1	
Desire to breastfeed		
Planned home birth	10.01 (3.93 – 25.50)	<0.001
Planned hospital birth	1	
Transferred		
Planned home birth	0.29 (0.22 – 0.37)	<0.001
Planned hospital birth	1	
Maternal and neonatal outcomes		
High-grade perineal tear	0.44 (0.15 – 1.30)	0.134
Planned home birth	1	
Planned hospital birth		
Episiotomy		
Planned home birth	0.04 (0.02 – 0.07)	<0.001
Planned hospital birth	1	
Birthweight 2501–4000 g		
Planned home birth	0.85 (0.58 – 1.25)	0,408
Planned hospital birth	1	
Birthweight > 4000 g		
Planned home birth	1.14 (0.76 – 1.71)	0.522
Planned hospital birth	1	
ICU admission (baby)[1]		
Planned home birth	0.36 (0.16 – 0.80)	0.013
Planned hospital birth	1	
Early initiation of breastfeeding		
Planned home birth	0.75 (0.53 – 1.08)	0.119
Planned hospital birth	1	

Multilevel analysis of birthing process and maternal or neonatal outcomes. Adjusted for maternal age, education, nationality, and gestational age.
[a] ORa = Adjusted Odds Ratio, CI = Confidence interval.

birth between 41 and 41+6 weeks, although the differences between planned home births and planned hospital births in those studies did not reach statistical significance (Bolten et al., 2016; De Jonge et al., 2017; Kooy et al., 2017). The greater proportion of babies weighing >4000 gs in planned home births could be due to the greater gestational age at the time of birth, as noted by Terán et al. regarding births in Spain (Terán et al., 2017) and Ramos et al. regarding births in Catalonia (Ramos et al., 2009).

Women who opted for a home birth experienced a higher rate of spontaneous births and a lower rate of instrumental births. This suggests that the home environment encourages a more natural and less interventionist birthing process, lending support to the notion that it may facilitate conditions conducive to the natural progression of labour. Similar findings have been reported by other researchers (Homer et al., 2019; Kooy et al., 2017; Reitsma et al., 2020).

An unexpected finding was the low rate of caesarean sections in both groups (4.0 %), far below the overall proportion (17.7 %) documented in Catalonia in 2018 (Agència de Qualitat i Avaluació Sanitàries de Catalunya, 2019) and even farther below the percentage of caesarean sections in Catalonia between 2013 and 2017 reported by Carrillo-Aguirre et al.(Carrillo-Aguirre et al., 2020): 22.61 % for Robson groups 1 and 2 and 9.45 % for Robson groups 3 and 4. This finding corroborates those of other studies showing that midwife-led care models are associated with lower rates of caesarean sections without increases in neonatal morbidity (Chapman et al., 2019; Hanahoe, 2020; King, 2020; Martin Arribas et al., 2020).

Three findings from this study characterise the approach to childbirth in the hospitals that participated: the high rate of epidural analgesia, the low rate of ambulation during labour and the high prevalence of the lithotomy position in childbirth. These results are interrelated and reflect a cascade of interventions in the biomedical model of care during childbirth. We cannot know whether the women who planned to give birth in the hospital were urged to ambulate and change positions before they were administered epidural analgesia or whether they were encouraged to move after administration. However, reviews by Lawrence et al. (2013) and Halliday et al. (2022) found that changes in position and ambulation reduce the need for epidural analgesia and that less ambulation during labour is associated with a higher frequency of epidural analgesia (Halliday et al., 2022; Lawrence et al., 2013). Furthermore, epidural analgesia is coupled with continuous monitoring of the foetus, further limiting mobility and thus forming part of the cascade of interventions (World Health Organization, 2018). The results of the current study corroborate the findings for hospital births reported in a similar context by Garcia-Lausin et al., where a high proportion of women received epidural analgesia and a high proportion of those undergoing vaginal birth without instrumentation gave birth in the lithotomy position (Garcia-Lausin et al., 2019).

Another important finding in our study is that non-pharmacological analgesia (measures such as position changes, massage, local heat or warm water immersion) was significantly more common in planned home births than in planned hospital births. Buerengen et al. (2022) found that the one-to-one model of care inherent in home births was associated with a lower probability of receiving epidural analgesia and a higher probability of receiving massage during childbirth(Buerengen et al., 2022). Another possible explanation for the difference we found between the two groups is the high proportion of women with low-risk pregnancies who receive epidural analgesia in hospital births in Catalonia (Garcia-Lausin et al., 2019).

These findings raise the question of why most Spanish hospitals have not fully implemented non-pharmacological analgesia when these measures have proven effective and are recommended by both national (Ministry of Health and Social Policy and Equality., 2012) and international guidelines (National Institute for Health and Care Excellence (NICE), 2023; World Health Organisation, 2018). Hospitals in Spain may not be consistently following the recommended protocols as they persist in prioritising epidural analgesia as the primary method for pain management during childbirth. Although approximately 38.8 % of public hospitals in Spain have protocols that incorporate non-pharmacological measures, such as warm water immersion, local heat, lumbosacral massage and hypnobirthing, the absence of a standardised public registry poses a challenge in gauging the widespread implementation of these approaches.

Despite evidence that accompaniment during childbirth by a person of the mother's choice improves maternal and neonatal outcomes (Bohren et al., 2017), and the recommendations of the World Health Organization(World Health Organisation, 2018), the National Institute for Health and Clinical Excellence(National Institute for Health and Care Excellence (NICE), 2023) and the Catalan Department of Health(Health Department, 2018), 3.8 % of the women who planned to give birth in the hospital were unable to have the accompaniment that they desired. Exploring the reasons for this is outside the scope of this study, but it would be interesting to use qualitative research techniques to examine why this situation occurs in some delivery rooms.

During childbirth, regardless of where it is planned to take place, all women should be accompanied by a person of their choice and attended by a midwife with the support of a transdisciplinary team to ensure proper care for the mother and child if problems develop (World Health

Table 6
Incidence of morbidities/adverse events and the predictive model depending on the planned place of birth and parity.

	Nulliparous (n = 1604)						Parous (n = 1857)					
	No of events/ births	Incidence (%)	Pearson χ^2	Cramer V	OR (95% CI)[a]	p-value	No of events/ births	Incidence (%)	Pearson χ^2	Cramer V	OR (95% CI)[a]	p-value
Birthing process												
Instrumental birth												
Planned home birth	25/327	7.6	38.94	0.156	0.28 (0.18 - 0.42)	<0.001	0/421	0	16	0.093		0.997
Planned hospital birth	295/1277	23.1			1		53/1436	3.7				
Caesarean birth												
Planned home birth	27/327	8.3	0.09	0.008	1.07 (0.69 - 1.67)	0.762	3/421	0.7	0.25	0.012	0.73 (0.21 - 2.55)	0.621
Planned hospital birth	99/1277	7.8			1		14/1436	1			1	
Transferred												
Planned home birth	97/327	29.7	27.51	0.131	0.50 (0.39 - 0.65)	<0.001	11/421	2.6	59.01	0.178	0.13 (0.07 - 0.24)	<0.001
Planned hospital birth	584/1277	45.7			1		250/1436	17.4			1	
Maternal outcomes												
ICU admission												
Planned home birth	1/327	0,3	1.08	0.026	3.91 (0,24 - 62.74)	0.355	0/421	0	1.77	0.031		0.999
Planned hospital birth	1 /1277	0,1			1		6/1436	0,4				
Neonatal outcomes												
Birthweight <2500 g												
Planned home birth	3/327	0,9	0.16	0.010	0.78 (0,22 - 2.71)	0.694	1/421	0,2	0.921	0.022	0.38 (0.05–2.99)	0.356
Planned hospital birth	15/1277	1,2			1		9/1436	0,6			1	
Birthweight > 4000 g												
Planned home birth	16/327	4,9	1.17	0.027	1.38 (0.77 - 2.47)	0.282	47/421	11,2	9.90	0.073	1.79 (1.24–2.60)	0.002
Planned hospital birth[a]	46/1277	3,6			1		94/1436	6,5			1	
Apgar 5′ <7												
Planned home birth	7/327	2,1	2.20	0.037	0,51 (0,20–1,27)	0.146	1/421	0,2	0.47	0.016	2.06 (0.25–16.77)	0.500
Planned hospital birth	14/1277	1,1			1		7/1436	0,5			1	
ICU admission (baby)												
Planned home birth	6/326	1,8	2.75	0.041	0,49 (0,21–1,16)	0.104	2/421	0,5	4.59	0.05	0.24 (0.06 - 0.99)	0.049
Planned hospital birth	47/1277	3,7			1		29/1436	2			1	

[a] OR=Odds Ratio, CI= Confidence interval. OR is not calculated in variables with empty boxes or with very few cases. Calculated OR of home birth to hospital birth.

Organisation, 2018). Women need to be accompanied and listened to during birth; they need individual care from attentive, competent professionals who devote adequate time and appropriate means. Midwives are the optimal professionals to provide this care with minimal disruptions in one-to-one care (de Jonge et al., 2021; M. Healy et al., 2020; Sosa et al., 2018). Care centred on women's needs during pregnancy, birth and the postpartum period, led by and delivered by midwives, helps to reduce instrumental births and the need for epidural analgesia, without increasing adverse outcomes for the mother or baby (Sandall et al., 2016). This model of care also contributes to better maternal experiences, especially when it is provided by a familiar midwife or group of midwives (Alcaraz-Vidal et al., 2023; Sandall et al., 2016; World Health Organisation, 2018). Perriman et al. (2018) concluded that the bond of trust between women and midwives within the midwifery continuity of care model is forged through the personalised delivery of care and empowerment of women(Perriman et al., 2018).

The reduced frequency of episiotomies in planned home births aligns with findings from studies conducted by Brocklehurst et al. (2011) and Homer et al. (2019), as well as a systematic review by Reytsma et al. (2020). These sources collectively indicate a lower likelihood of episiotomy in planned home births compared to planned hospital births.

In our study, the percentage of women who planned to give birth in the hospital who received episiotomies (22.9 %) was similar to that reported by Escuriet et al. (Escuriet et al., 2015), confirming the

tendency toward fewer episiotomies in Catalonia noted by these authors. In our study, most episiotomies in spontaneous birth were done in women who planned to give birth in the hospital (22.9% vs 0.6 %). This shows that the practice of episiotomy is entrenched in Spain, despite efforts to reduce it. Between 2010 and 2018, the percentage of episiotomies in births in Spain decreased by 14.62 percentage points (from 42.14 % to 27.52 %) (Ministerio de Sanidad de España, 2021), but it remains above the 10 % recommended by the World Health Organization (World Health Organisation, 2018).

The newborns from the home birth group had fewer admissions to the NICU. This is consistent with outcomes reported by Scarf et al. (Scarf et al., 2018), Homer et al. (Homer et al., 2019) and de Jonge et al. (de Jonge et al., 2013). This result may be related to various factors such as a less stressful environment for the woman and the continuity of care model by midwives, which fosters self-confidence and greater control over the process and avoids unnecessary interventions. Although more than 90 % of the women in the two groups expressed the desire to breastfeed their babies, breastfeeding was more common in planned home births. One likely explanation is that women who opt to give birth at home tend to have more information about the physiological process in which natural breastfeeding is integrated, and this information directly relates to the continuity of care in midwife-led models based on knowledge of and respect for physiology. This finding is in line with those reported by Quigley et al. (Quigley et al., 2016) and Hutton et al. (Hutton et al., 2016), who also found that newborns born at home were more likely to breastfeed.

The rate of transfers of care was twice as high in planned hospital births than in planned home births. Blix et al.'s (2014) systematic review of the rates of transfer of care to hospital in planned home births found that the incidence of transfers of care ranged from 9.9 % to 31.9 %(Blix et al., 2014). Bauer (2020) noted that the lack of a universal definition of the concept of transfer of care and procedural differences in how transfers of care are carried out have a major influence on the wide variability in the reported incidence of transfers of care in countries where home childbirth is integrated into the public health system (9.4 % in Sweden, 12.41 % in Denmark, 12.5 % in Germany, 21.0 % in the United Kingdom and 24.8 % in Iceland for all women; 49.3 % in nulliparous women and 12.1 % in multiparous women in the Netherlands)(Bauer, 2020). Examining the transfer of care of low-risk women from midwives to obstetricians during labour in hospitals in Spain and Ireland, Martin-Arribas et al. (2020) identified an incidence ranging from 29.4 % to 47.1 % (Martín-Arribas et al., 2020). This aligns with our study, which reported a rate of 30 %.

Nulliparous women in both groups were more likely to be transferred than multiparous women. The finding was to be expected because it was also reported in other studies (Bolten et al., 2016; Brocklehurst et al., 2011; Geerts et al., 2014; Martín-Arribas et al., 2020; Seijmonsbergen-Schermers et al., 2020).

Notably, the proportions of transfers of care of nulliparous and parous women who planned hospital births were higher than in planned home births. These results corroborate those of Martín-Arribas(Martín-Arribas et al., 2020), who found a higher proportion of transfers of care in women who received epidural analgesia and pharmacological stimulation. These interventions are rooted in the biomedical model of care during childbirth that predominates in hospitals in Spain, and they are associated with worse perinatal outcomes.

The disparity in the rates of transfer of care to obstetrician-led care in our study might be due to various factors. Although the international guidelines recommend that the duration of labour should be considered individually (World Health Organisation, 2018), the times allotted for dilation and birth in hospitals continue to be governed by strict protocols. By contrast, home birth midwives consider other parameters of normalcy, systematically recording the duration of the different phases of childbirth but not considering the durations in conjunction with other factors when making clinical decisions (Alcaraz-Vidal et al., 2023; Alcaraz-Vidal et al., 2021). Another important aspect that might explain the difference in transfers of care is the improved obstetric outcomes, particularly the use of non-pharmacological analgesic methods such as warm water immersion. Lukasse et al. (2014) found that the use of warm water in planned home births was associated with a decrease in the likelihood of being transfer of carered to the hospital (Lukasse et al., 2014).

Nulliparous women who were transferred from the planned home-birth group had fewer instrumental deliveries than those who planned their birth in a hospital. This finding aligns with the systematic reviews by Reitsma et al. (2020) and Scarf et al. (Scarf et al., 2019) However, it cannot be explained by the women's risk factors, as all participants met the same inclusion criteria, nor by sociodemographic differences. It is likely attributable to the higher percentage of transfers of care among nulliparous women who planned hospital births, coupled with a more medicalised approach to labour management, as suggested by Jardine et al. (Jardine et al., 2020)

Strengths and limitations

This study possesses both limitations and strengths. Among its strengths, we recognise its contribution of results from a comprehensive sample on home birth in Catalonia compared to hospital birth.

The sample is representative of both women who planned a home birth and those who planned a hospital birth. Regarding planned home births, the number included represents nearly one-third of all home births attended in Spain during the study years. Additionally, despite planned home births being a private service in Spain, the analysed births were attended by midwives who adhere to a unified set of guidelines and are committed to recording the data of all births they attend in the same database. This approach helps to avoid potential data omission bias and variability in care. For planned hospital births, the sample comes from hospitals with different levels of complexity in Catalonia

Rigorous control for confounding factors is another strength, enhancing the accuracy of the results in reflecting the genuine effects of the birthing environment on outcomes. The meticulous adjustment for potential confounders lends credibility to the findings, suggesting that the observed differences in maternal and neonatal outcomes can be attributed to the birth setting rather than other variables.

Concerning limitations, this was a cross-sectional study so it does not allow for the establishment of causal relationships. Additionally, the circumstances surrounding the choice of place to give birth introduce a selection bias in the characteristics of the women who plan to give birth at home. Care during planned home births in Spain is a private service; women attended in the public system are not offered a choice about where they want to give birth, and the default location is the hospital.

On the other hand, the reasons for transfers of care and the degree of emergency in transfers of care within hospitals in the Midconbirth sample were not recorded, so we cannot compare them with the reasons for transfer of care to the hospital in planned home births (prolonged labour, mother's wishes or suspected foetal distress) (Alcaraz-Vidal et al., 2021).

An important informational bias exists due to the lack of traceability of the data for the women who were transferred to the hospital during planned home births. These data were completed with the women's recollection; therefore, a recall bias is acknowledged.

As noted in other studies (Downe et al., 2018; Hildingsson et al., 2020; Sandall et al., 2016; Seijmonsbergen-Schermers et al., 2020), we cannot rule out the possibility that some of our results could be affected by the presence or absence of the continuity of care through the involvement of the same midwife or team of midwives.

It's worth noting that, despite the sample being representative, the low incidence of some maternal outcomes (ICU admission, high-grade tearing) and neonatal outcomes (NICU admission) results in a moderate effect size. Long-term follow-up would be necessary to better assess the association of these variables with the planned place of birth.

Finally, we did not include information about foetal or neonatal

mortality for planned hospital births, which is one of the most commonly used indicators to evaluate safety regarding the place of childbirth. Nevertheless, we were able to evaluate neonatal safety based on other neonatal variables.

Conclusion

The sociodemographic characteristics of pregnant women who planned home births differed from those who planned hospital births in terms of maternal age, education level, nationality, and gestational age. Women in the planned home birth group experienced more spontaneous births and fewer obstetric interventions, such as instrumental birth, episiotomy, and epidural analgesia, as well as fewer baby ICU admissions. Most women who planned hospital births gave birth in the lithotomy position, did not mobilise, and did not use non-pharmacological pain relief measures.

The transfer of care rate was higher in the planned hospital birth group, particularly among nulliparous women. Nulliparous women who were transferred during a planned hospital birth underwent more instrumental births than those transferred from a planned home birth. No significant differences were found in the incidence of caesarean birth, maternal or neonatal ICU admission, and Apgar scores below 7 at 5 min between nulliparous women who planned a home birth and those who planned a hospital birth

Implications for practice

Changes to the model of care in birthing require women to have safe options for giving birth. Establishing public birthing centres and including home birthing among the services offered within public health systems are among the demands of women that should be validated by public health managers and health care professionals. Implementing midwifery-led care would ensure the continuity of care throughout pregnancy, birth and the postpartum period, regardless of where a woman chooses to give birth.

Home birth for low-risk women emerges as a safe option that can be recommended, offering improved obstetric and perinatal outcomes compared to the hospital setting. This model of birth emphasises the significance of a comfortable, low-intervention environment, aligning with natural childbirth practices and potentially enhancing maternal and newborn well-being. The safety and benefits noted are predicated on skilled care and risk assessment, underscoring the importance of supportive health systems that cater to informed maternal choices.

Public health administrators should consider these evidence-based models that have been endorsed by different international organisations and yielded good results in other countries where they have been implemented. The positive impact that these models could have on maternal and neonatal health, as well as on the health system itself, should also be considered since they decrease the proportion of medicalisation of birth, instrumental births and episiotomies, all of which increase the risk of short- and long-term complications after birth and lead to increased healthcare costs.

Author agreement

The article is the authors original work, the article has not received prior publication and is not under consideration for publication elsewhere that all authors have seen and approved the manuscript being submitted the authors abide by the copyright terms and conditions of Elsevier

Ethical statement

The Parc de Salut Mar de Barcelona's clinical research ethics committee approved the study (2018/8120/l).

Authors' contribution statement

All authors have agreed on the final version and meet at least one of the following criteria recommended by the ICMJE:

(a) substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data.

(b) drafting the article or revising it critically for important intellectual content.

CRediT authorship contribution statement

Lucia ALCARAZ-VIDAL: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Ramon ESCURIET:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Roser PALAU-COSTAFREDA:** Writing – review & editing, Writing – original draft, Investigation, Data curation. **Fatima LEON-LARIOS:** Writing – review & editing, Writing – original draft, Supervision, Software, Investigation, Formal analysis. **Gemma ROBLEDA:** Writing – review & editing, Writing – original draft, Investigation, Formal analysis, Data curation.

Declaration of competing interest

The authors have declared no conflict of interest.

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Data availability statement

The data supporting this study's findings are available from the corresponding author upon reasonable request.

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Supplementary materials

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