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Preparation and validation of a predictive model of breastfeeding initiation in the first hour of life

Ana Ballesta-Castillejos [a], Julián Rodríguez-Almagro [b,*], Juan Gómez-Salgado [c,d], Juan Miguel Martínez-Galiano [e], Cristina Romero-Blanco [b], Antonio Hernández-Martínez [b]

[a] *Department of Obstetrics & Gynaecology. Alcázar de San Juan, Ciudad Real, Spain*
[b] *Department of Nursing. Ciudad Real School of Nursing. University of Castilla La-Mancha, Ciudad Real, Spain*
[c] *Deparment of Sociology, Social Work and Public Health, Faculty of Labour Sciences, University of Huelva, Huelva 21071, Spain*
[d] *Safety and Health Postgraduate Programme, Universidad Espíritu Santo, Guayaquil, Ecuador*
[e] *Department of Nursing, University of Jaén, Spain. Consortium for Biomedical Research in Epidemiology and Public Health (CIBERESP), Madrid, Spain*

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ABSTRACT

Objective: The objective was to develop and validate a predictive model of initiation of breastfeeding in the first hour after delivery.

Methods: Retrospective cohort study on women who gave birth between 2013 and 2018 in Spain. For data collection, an ad hoc questionnaire was designed to be filled in by the mothers, which was distributed to the different Spanish breastfeeding associations which, in turn, shared it with their associate partners. The development of the predictive model was made on a cohort of 3218 women (2/3) and was validated on a cohort of 1609 women (1/3). Mothers whose children were admitted to hospital at the time of birth were excluded. A multivariate analysis was performed by means of logistic regression, and predictive ability was determined by areas under the ROC curve (AUC).

Results: 81.0 % (2608) women started breastfeeding in the first hour in the derivation cohort, and 80.1 % (1289) in the validation cohort. The predictive factors in the final model were: the highest number of children and skin-to-skin contact at birth as flattering factors, while dystocic delivery reduced the likelihood of the onset of breastfeeding. The predictive ability (ROC AUC) in the derivation cohort was 0.89 (CI 95 %: 0.87–0.90), while in the validation cohort it was 0.89 (CI 95 %: 0.87–0.92).

Conclusions: This three-variable predictive model has excellent predictive ability in both the derivation cohort and the validation cohort. This model can identify women who are at high risk of non-initiating breastfeeding within the first hour after delivery.

Introduction

Child nutrition is an important determinant of future health (Tawfik et al., 2019), and maternal breastfeeding (MB) has become globally recognised as a major public health problem with social and economic implications (Ahmed and Salih, 2019). MB is critical to achieving global goals for nutrition, health, economic growth, and environmental sustainability (World Health Organization U 2018). The World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) recommend to start breastfeeding within the first hour after birth, to continue exclusively for the first 6 months of life, and to later maintain it along with supplementary feeding until age 2 or older (World Health Organization U 2018; Bruno Tongun et al., 2018). However, despite the strong evidence of the nutritional and immune benefits of the early onset of breastfeeding in reducing neonatal mortality and morbidity (Edmond et al., 2016), only 44 % of infants initiate MB within the first hour after birth, and 40 % of all infants under 6 months receive exclusive breastfeeding (World Health Organization U 2018).

The importance of early onset of breastfeeding lies in colostrum (Bruno Tongun et al., 2018), which contains bioactive immune factors that protect the newborn against a wide variety of infectious and allergic diseases (Lau et al., 2018).

During the first hour of life, the newborn (NB) secretes catecholamines (Riviere et al., 2017) and begins to coordinate the autonomic

* Corresponding author at: C/Cuadras nº 8 Bajo; Ciudad Real, Spain.
E-mail address: Julianj.rodriguez@uclm.es (J. Rodríguez-Almagro).

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nervous system, and the sensory, motor, and behavioural systems. At this time, the NB is alert, receptive and active to follow natural instincts and find and adhere itself to the mother's breast. During early nipple stimulation, the rapid release of prolactin and oxytocin helps start milk production (Lau et al., 2018).

The importance of early onset of breastfeeding is globally recognised and reflected in several global guidance and policy initiatives and documents (Arts et al., 2017). These documents state that immediate skin-to-skin contact and support for the onset of breastfeeding is a key part of the Ten Steps to Successful Breastfeeding and a part of the Baby-friendly Hospital Initiative promoted by WHO-UNICEF (Arts et al., 2017; Widström et al., 2019; Brimdyr et al., 2018).

The onset of breastfeeding within the first hour of life is associated with a prolonged duration of breastfeeding (Moore et al., 2012; Murray et al., 2007) and with infant mortality decrease, especially in low-income countries (Boccolini et al., 2013; Esteves et al., 2014). Delaying the onset of breastfeeding between 2 and 23 h after childbirth increases the risk of newborn death in the first 28 days of life by 40 % (Arts et al., 2017); if this delay continues beyond the first 24 h, the risk rises to 80 % (Arts et al., 2017), so the number of lives that could be saved if this measure were to be globally implemented is highly relevant.

The positive effects of breastfeeding in newborn health can be attributed, on the one hand, to the components of breast milk, but also to the direct contact between mother and baby. Colostrum, i.e. milk in its early days, contains an epidermal growth factor that accelerates the development of intestinal mucus, as well as bioactive immune factors that provide immune protection for newborns, preventing intestinal colonisation by pathogenic microorganisms (Esteves et al., 2014; Chirico et al., 2008; Aakko et al., 2017).

Although breastfeeding in the first hour of life is considered an indicator of excellence, the characteristics associated with this practice have been little researched (Bollipo et al., 2018). Recent health system meta-analyses and community-based studies around the world indicate that improving individual orientation, group education, supporting immediate breastfeeding at birth, and training health workers in breastfeeding management increases the likelihood of an early onset of breastfeeding by at least 20 % (Bollipo et al., 2018; Debes et al., 2013; Oosterhoff et al., 2014; Smith et al., 2017).

In this sense, it would be interesting to develop predictive models with the aim of determining the likelihood of initiating breastfeeding in the first hour after delivery. In the event that these models have good predictive ability, they could be useful in identifying mothers with a low likelihood of starting MB so as to offer them more intense support and follow-up. Understanding the factors that influence early onset of breastfeeding is important for designing and providing more effective breastfeeding support strategies (Lau et al., 2018).

Therefore, the objective of this study is to develop and validate a predictive model of the onset of breastfeeding within the first hour after delivery.

Material y methods

Design and participants

An observational, analytical study of retrospective cohorts methodology was used with women who had given birth between 2013 and 2018 in Spain. In order to elaborate the predictive model, a historical cohort consisting of 3218 women was used. For validation purposes, data derived from a historical cohort of 1609 women was gathered.

The study population consisted of women who, before delivery, already intended to breastfeed and whose newborns were not admitted to neonatology units.

In an attempt to estimate the sample size, the maximum modelling principle (Peduzzi et al., 1996) was followed. This requires 10 events (women that were not starting to breastfeed in the first postpartum hour, in this particular case) per each included variable. Taking into account that in Spain there is no data on the prevalence of breastfeeding in the first hour, the option here was to choose a potentially lower prevalence of 14.4 % described in the literature by Montenegro (Arts et al., 2017); an initial model of 20 independent variables would require a minimum of 1389 women and approximately half of them (that is, 694 women) would be needed to satisfy the validation process. However, the decision was to recruit the largest number of women. Women were randomly assigned to the derivation and validation cohorts.

Data collection and data sources

The main tool employed to collect relevant data for this study was an ad hoc questionnaire drafted with adapted language so that all mothers could fill it in by themselves. In case of doubt, they should consult their medical records. In Spain, all patients receive a complete medical record at hospital discharge with all the procedures, diagnosis, and treatments received. From this questionnaire, the following variables were collected:

- Primary outcome variable: onset of breastfeeding within the first postpartum hour.
- The independent variables were:
  - Maternal: maternal age, level of studies, nationality, family income, body mass index (BMI), and number of children.
  - Obstetric: previous caesarean-section, number of births, problems during pregnancy (diabetes, hypertension, hypothyroidism, hyperthyroidism, anaemia, oligoamines, Hydramnios), labour induction, type of delivery, use of regional analgesia, use of nitrous oxide, use of general anaesthesia, use of natural analgesic methods, episiotomy, and type III vaginal tearing.
  - Foetal: prematurity, multiple birth, and neonatal birth weight.
  - Breastfeeding-related: Attendance to breastfeeding education classes, previous breastfeeding, skin-to-skin contact (SSC) after childbirth.

The different categories used for each variable are detailed in Table 1.

Statistical analysis

First of all, a descriptive statistical analysis was performed using absolute and relative frequencies for the qualitative variables, and arithmetic means and standard deviation (SD) for the quantitative ones.

A bivariate analysis of the predictive factors, previously identified in the literature as risk factors of delayed onset of breastfeeding, was carried out by using the Student's *t*-test (neonatal birth weight) and Chi-squared test (rest of variables) to calculate quantitative and qualitative variables, respectively. Of these variables, and following Lemeshow's statistical criteria, associations with p-values of <0.25 were chosen to be included in the multivariate binary logistic regression model (Hosmer et al., 2013; Mickey and Greenland, 1989) (Table 1). This model was constructed by using backward elimination (RV in SPSS).

Likewise, parameters of statistical reliability were presented: $-2LL$; Cox-Snell R2; Nagelkerke R2, for model (Table 2), with the values of sensitivity (Se), specificity (Sp), positive predictive value (PPV), negative predictive value (NPV) and likelihood ratio positive (LR+) for different probabilities of model both in the derivation cohort and the validation cohort (Table 3).

In order to assess the prediction in qualitative terms, the Swets' criteria, whose values range from 0.5 to 0.6 (bad), 0.6–0.7 (poor), 0.7–0.8 (satisfactory), 0.8–0.9 (good), and 0.9–1.0 (excellent), was used (Swets, 1988).

Both the derivation cohort and the validation cohort were compared by using the Chi-squared test and Student's *t*-test to calculate qualitative and quantitative variables respectively (Table 4). Finally, the AUC of

Table 1
Descriptive statistical analysis and Bivariate analysis of potential predictive factors of breastfeeding onset within the first hour.

Predictor	Total	Breastfeeding first hour		P-value
	n (%) *n* = 3218	No	Yes	
Maternal age				0.731
<25 years	69 (2.1)	13 (18.8)	56 (81.2)	
25–30 years	494 (15.4)	104 (21.1)	390 (78.9)	
30–35 years	1432 (44.5)	267 (18.6)	1165 (81.4)	
35–40 years	1033 (32.1)	188 (18.2)	845 (81.8)	
>40 years	190 (5.0)	38 (20.0)	152 (80.0)	
Level of studies				0.452
No studies	5 (0.2)	0 (0.0)	5 (100.0)	
Primary	54(1.7)	10 (18.5)	44 (81.5)	
Secondary	854 (26.5)	174 (20.4)	680 (79.6)	
University	2305 (71.6)	426 (18.5)	1879 (81.5)	
Family income				0.957
< 1000 euros	168 (5.2)	33 (19.6)	135 (80.4)	
1001–2000 euros	1063 (33.0)	208 (19.6)	855 (80.4)	
2001–3000 euros	1099 (34.2)	201 (18.3)	898 (81.7)	
3001–4000 euros	630 (19.6)	120 (19.0)	510 (81.0)	
>4000 euros	258 (8.0)	48 (18.6)	210 (81.4)	
Nationality				0.060
Spanish	3046 (94.7)	568 (18.6)	2478 (81.4)	
Foreign	172 (5.3)	42 (24.4)	130 (75.6)	
Body Mass Index **				**<0.001**
<25 BMI	895 (28.0)	133 (14.9)	762 (85.1)	
25.1–30 BMI	1521 (47.6)	289 (19.0)	1232 (81.0)	
>30 BMI	779 (24.4)	184 (23.6)	595 (76.4)	
Smoking habit				0.542
No habit	2475 (76.9)	459 (18.5)	2016 (81.5)	
1–10 cigarettes	546 (17.0)	112 (20.5)	434 (79.5)	
>10 cigarettes	197 (6.1)	39 (19.8)	158 (80.2)	
Number of children				**<0.001**
One	2034 (63.2)	483 (23.7)	1551 (76.3)	
Two	1043 (32.4)	113 (10.8)	930 (89.2)	
Three or more	141 (4.4)	14 (9.9)	127 (90.1)	
Previous caesarean section				**<0.001**
No	2939 (91.3)	530 (18.0)	2409 (82.0)	
Yes	279 (8.7)	80 (28.7)	199 (71.3)	
Three or more children				0.056
No	1270 (39.5)	220 (17.3)	1050 (82.7)	
Yes	1948 (60.5)	390 (20.0)	1558 (80.0)	
Labour induction				**<0.001**
No	2076 (64.5)	317 (15.3)	1759 (84.7)	
Yes	1142 (35.5)	293 (25.7)	849 (74.3)	
Regional analgesia				**<0.001**
No	968 (30.1)	119 (12.3)	849 (87.7)	
Yes	2250 (69.9)	491 (21.8)	1759 (78.2)	
Nitrous oxide				**<0.001**
No	3114 (96.8)	590 (18.9)	2524 (81.1)	
Yes	104 (3.2)	20 (19.2)	84 (80.8)	
General anaesthesia				**<0.001**
No	3188 (99.1)	589 (18.5)	2599 (81.5)	
Yes	30 (0.9)	21 (70.0)	9 (30.0)	
Natural analgesic methods				**<0.001**
No	2928 (91.0)	581 (19.8)	2347 (80.2)	
Yes	290 (9.0	29 (10.0)	261 (90.0)	
Type of delivery				**<0.001**
Normal birth	2005 (62.3)	133 (6.6)	1872 (93.4)	
Instrumental birth	520 (16.2)	85 (16.3)	435 (83.7)	
Planned caesarean	234 (7.3)	113 (48.3)	121 (51.7)	
Emergency caesarean	459 (14.3)	279 (60.8)	180 (39.2)	
Episiotomy				**< 0.001**
No	2157 (67.0)	475 (22.0)	1682 (78.0)	
Yes	1061 (33.0)	135 (12.7)	926 (87.3)	
Third or fourth degree vaginal tearing				0.798
No	3174 (98.6)	601 (18.9)	2573 (81.1)	
Yes	44 (1.4)	9 (20.5)	35 (79.5)	
Prematurity				0.077
No	3126 (97.1)	586 (18.7)	2540 (81.3)	
Yes	92 (2.9)	24 (26.1)	68 (73.9)	
Multiple birth				0.003
No	3170 (98.5)	593 (18.7)	2577 (81.3)	
Yes	48 (1.5)	17 (35.4)	31 (64.6)	
Neonatal birth weight (g)*	3288.7 ± 706.1	3281.3 ± 540.3	3290.4 ± 739.5	0.774*
Attendance to maternal education				**<0.001**
No	688 (21.4)	92 (13.4)	596 (86.6)	
Yes, but not on breastfeeding	580 (18.0)	131 (22.6)	449 (77.4)	
Yes, with breastfeeding training	1950 (60.6)	387 (19.8)	1563 (80.2)	
Previous breastfeeding				**<0.001**
No	2073 (64.4)	488 (23.5)	1585 (76.5)	
Yes	1145 (35.6)	122 (10.7)	1023 (89.3)	
Skin-to-skin contact				**<0.001**
No	564 (17.5)	402 (71.3)	162 (28.7)	
Yes, but less than an hour	320 (9.9)	81 (25.3)	239 (74.7)	
Yes, and for one hour minimum	2334 (72.5)	127 (5.4)	2207 (94.6)	

* (Mean± SD), Student-Fisher *t*-test.
** BMI means Body Mass Index.

ROC for the validation cohort was calculated for the predictive model created (Table 2).

A tool for automatic calculation of the probability of breastfeeding onset within the first hour after delivery, according to individual characteristics, was designed in the attempt to facilitate its application for clinical purposes (Appendix 1).

SPSS 20.0. (SPSS Inc., Chicago, IL) was used for the statistical analysis.

Ethical and legal considerations

The study was conducted in accordance with the principles of the Declaration of Helsinki and approved by the institutional Review Board of the. XXXXXXXXXX. To ensure all participants comprehended the study's objectives and consented to the handling of their data, they were briefed on the study's purpose, its voluntary nature, and the anonymity of their responses before starting the questionnaire. Women were asked to check a box, thereby confirming their understanding of the provided information and their consent to proceed with completing the

Table 2
Early breastfeeding within the first hour risk predictive model.

Number of events in the Derivation Cohort	2608 (81.0 %)		
Number of events in the Validation Cohort	1289 (80.1 %)		
Risk Factor	**Coeff***	**Odds Ratio (95 % CI)**	**P-value**
Number of children			
One		1 (Ref)	
Two	0.689	1.99 (1.50–2.65)	<0.001
Three or more	0.801	2.23 (1.08–4.61)	0.031
Type of delivery			
Normal delivery		1 (Ref)	
Instrumental delivery	−0.383	0.68 (0.49–0.95)	0.025
Planned caesarean	−1.160	0.31 (0.21–0.46)	<0.001
Emergency caesarean	−1.246	0.29 (0.21–0.43)	<0.001
Skin-to-skin contact			
No		1 (Ref)	
Yes, but less than an hour	1.421	4.14 (2.93–5.85)	<0.001
Yes, and for an hour minimum	2.961	19.31 (14.20–26.26)	<0.001
Constant	−0.112		
ÁUC ROC Derivation Cohort		0.89 (0.87–0.90)	<0.001
	2LL: 1916.16		
	Cox-Snell R^2: 0.309		
	Nagelkerke R^2: 0.497		
ÁUC ROC Validation Cohort		0.89 (0.87–0.92)	<0.001

Table 3
Predictive characteristics of the model for different probabilities.

Probability	Sensitivity	Specificity	VPP	VPN	LR+	LR-
Higher 0.5						
Derivation Cohort	94.3	63.9	91.8	72.4	2.61	0.09
Validation Cohort	97.3	57.8	90.3	84.1	2.31	0.05
Higher 0.6						
Derivation Cohort	93.1	67.5	92.5	69.5	2.86	0.10
Validation Cohort	96.5	61.6	91.0	81.4	2.51	0.06
Higher 0.7						
Derivation Cohort	92.3	70.8	93.1	68.2	3.16	0.11
Validation Cohort	94.0	69.7	92.6	74.3	3.10	0.09
Higher 0.8						
Derivation Cohort	87.1	77.9	94.4	58.5	3.94	0.17
Validation Cohort	93.7	70.0	92.6	73.4	3.12	0.09
Higher 0.9						
Derivation Cohort	80.3	81.6	94.9	49.2	4.36	0.24
Validation Cohort	86.7	80.9	94.8	60.2	4.54	0.16

questionnaire.

Results

When constituting the validation cohort, a total of 3218 women were considered as the study population once the exclusion criteria had been applied to an initial reference population of 1609 women.

The incident rate of early onset of breastfeeding within the first hour after delivery was 81.0 % (2618) for women in the derivation cohort, and 80.1 % (1289) for women in the validation cohort.

The variables that after performing the bivariate analysis with early breastfeeding presented a p-value <0.25 and so were selected to carry out the multivariate analysis were: nationality, BMI, number of children, previous caesarean-section, induced delivery, regional analgesia, use of nitrous oxide, general anaesthesia, use of natural methods, type of delivery, episiotomy, prematurity, multiple birth, attendance to breastfeeding education, lactation in previous children, and SSC. (Table 1).

From these variables, the final model was formed by: number of children, type of birth, and SSC (see Table 2). In this way, having two children (OR: 1.99; CI 95 %: 1.50–2.65), having three children or more (OR 2.23; CI 95 %:1.08–4.61), having SSC within the first hour (OR: 4.14; CI 95 %: 2.93–5.85), and SSC for a minimum of one hour (OR: 19.31; CI 95 %: 14.20–26.26) increase the likelihood of starting

Table 4
Comparison between derivation and validation cohort characteristics.

Characteristics	Derivation Cohort $n = 3218$ (n/%)	Validation Cohort $n = 1609$ (n/%)	P Value *
Maternal age			**0.003**
<25 years	69 (2.1)	32 (2.0)	
25–30 years	494 (15.4)	197 (12.2)	
30–35 years	1432 (44.5)	683 (42.4)	
35–40 years	1033 (32.1)	588 (36.5)	
>40 years	190 (5.0)	109 (6.8)	
Level of studies			0.805
No studies	5 (0.2)	1 (0.1)	
Primary	54(1.7)	27 (1.7)	
Secondary	854 (26.5)	417 (25.9)	
University	2305 (71.6)	1164 (72.3)	
Family income			0.997
< 1000 euros	168 (5.2)	87 (54)	
1001–2000 euros	1063 (33.0)	528 (32.8)	
2001–3000 euros	1099 (34.2)	551 (34.2)	
3001–4000 euros	630 (19.6)	311 (19.3)	
>4000 euros	258 (8.0)	132 (8.2)	
Nationality			0.288
Spanish	3046 (94.7)	1511 (93.9)	
Foreign	172 (5.3)	98 (6.1)	
Body Mass Index			0.165
<25 BMI**	895 (28.0)	451 (28.4)	
25.1–30 BMI**	1521 (47.6)	715 (45.0)	
>30 BMI**	779 (24.4)	422 (26.6)	
Smoking habit			0.568
No habit	2475 (76.9)	1240 (77.1)	
1–10 cigarettes	546 (17.0)	282 (17.5)	
>10 cigarettes	197 (6.1)	87 (5.4)	
Number of children			**<0.001**
One	2034 (63.2)	922 (57.3)	
Two	1043 (32.4)	597 (37.1)	
Three or more	141 (4.4)	90 (5.6)	
Previous caesarean section			0.045
No	2939 (91.3)	1441 (89.6)	
Yes	279 (8.7)	168 (10.4)	
Three or more children			0.155
No	1270 (39.5)	601 (37.4)	
Yes	1948 (60.5)	1008 (62.6)	
Labour induction			0.553
No	2076 (64.5)	1053 (65.4)	
Yes	1142 (35.5)	556 (34.6)	
Regional analgesia			0.929
No	968 (30.1)	486 (30.2)	
Yes	2250 (69.9)	1123 (69.8)	
Nitrous oxide			0.410
No	3114 (96.8)	1564 (97.2)	
Yes	104 (3.2)	45 (2.8)	
General anaesthesia			0.830
No	3188 (99.1)	1595 (99.1)	
Yes	30 (0.9)	14 (0.9)	
Natural methods			0.621
No	2928 (91.0)	1457 (90.6)	
Yes	290 (9.0	152 (9.4)	
Type of delivery			0.619
Normal birth	2005 (62.3)	1011 (62.8)	
Instrumental birth	520 (16.2)	239 (14.9)	
Planned caesarean	234 (7.3)	127 (7.9)	
Emergency caesarean	459 (14.3)	232 (14.4)	
Episiotomy			0.232
No	2157 (67.0)	1106 (78.0)	
Yes	1061 (33.0)	503 (31.3)	
Third or fourth degree vaginal tearing			0.860
No	3174 (98.6)	1588 (98.7)	
Yes	44 (1.4)	21 (1.3)	
Prematurity			0.017
No	3126 (97.1)	1542 (95.8)	
Yes	92 (2.9)	67 (4.2)	
Multiple birth			0.621
No	3170 (98.5)	1582 (98.3)	
Yes	48 (1.5)	27 (1.7)	

(*continued on next page*)

Table 4 (*continued*)

Characteristics	Derivation Cohort n = 3218 (n/%)	Validation Cohort n = 1609 (n/%)	P Value *
Neonatal birth weight (g)*	3288.7 ± 706.1	3281.2 ± 456.6	0.697
Attendance to maternal education			0.687
No	688 (21.4)	361 (22.4)	
Yes, but not on breastfeeding	580 (18.0)	290 (18.0)	
Yes, with breastfeeding training	1950 (60.6)	958 (59.5)	
Previous breastfeeding			**<0.001**
No	2073 (64.4)	937 (58.2)	
Yes	1145 (35.6)	672 (41.8)	
Skin-to-skin contact			0.738
No	564 (17.5)	275 (17.1)	
Yes, but less than an hour	320 (9.9)	151 (9.4)	
Yes, and for an hour minimum	2334 (72.5)	1183 (73.5)	

* (Mean± SD), Student-Fisher *t*-test.
** BMI means Body Mass Index.

breastfeeding within the first hour after delivery. On the other hand, having an instrumental birth (OR: 0.68; CI 95 %:0.49–0.95), having a scheduled caesarean (OR: 0.31; CI 95 %:0.21–0.46), and having an emergency caesarean (OR: 0.29; CI 95 %:0.21–0.43) reduce the likelihood of starting breastfeeding within the first postpartum hour.

The predictive ability of this model for the derivation cohort proved to be good, obtaining 0.89 (95 % CI: 0.87–0.90) in the AUC of ROC (Fig. 1). The validation cohort scored 0.89 (95 % CI: 0.87–0.92) (Fig. 2), which is considered as "Good" by the Swets' criteria (Table 2). Consideration was also studied the predictive characteristics of Model for the derivation and validation cohort for different probabilities (see Table 3).

Finally, comparability issues were examined in both cohorts and statistically significant differences were found in some of the variables: maternal age, number of children, previous caesarean-section, prematurity, and previous breastfeeding (see Table 4).

Discussion

This study has developed a predictive model for early onset of breastfeeding within the first hour after delivery, to be applied on women who have given birth. This model suggests good predictive ability for both the derivation cohort (AUC: 0.89) and the validation cohort (AUC: 0.89). The key factors identified in this model are the number of children, the type of birth, and the onset of SSC.

Only two previous predictive model on breastfeeding have been identified. The first model, unlike the one used in this study, focuses on premature cessation of breastfeeding (Berra et al., 2001). Although one of the models focuses on the onset of breastfeeding and the other on its premature cessation, similarities are found among the items they collect. In the model for premature cessation of MB, the items collected are firstborn child, that the first mother-child contact takes place within the first 90 min after delivery, and that the pregnancy has not been planned. When comparing this with the predictive model assessed in the present study, this one also takes into account the number of children and skin-to-skin contact.

The second model focuses on predicting the likelihood of breastfeeding at the time of hospital discharge (Ballesta-Castillejos et al., 2021). Thirteen predictive factors were identified in this model: maternal age at birth, Body Mass Index (BMI), number of children, previous breastfeeding, birth plan, induced labor, epidural analgesia, type of delivery, prematurity, multiple pregnancy, macrosomia, initiation of breastfeeding within the first hour, and skin-to-skin contact. In this instance, the three factors considered in the model of the current study are also included in the predictive model for breastfeeding at hospital discharge.

One of the factors affecting the early onset of breastfeeding that we find in the present study is the type of delivery, a fact that is consistent with the literature. Mothers who give birth vaginally are more likely to start early breastfeeding, as compared to caesarean deliveries (Yılmaz

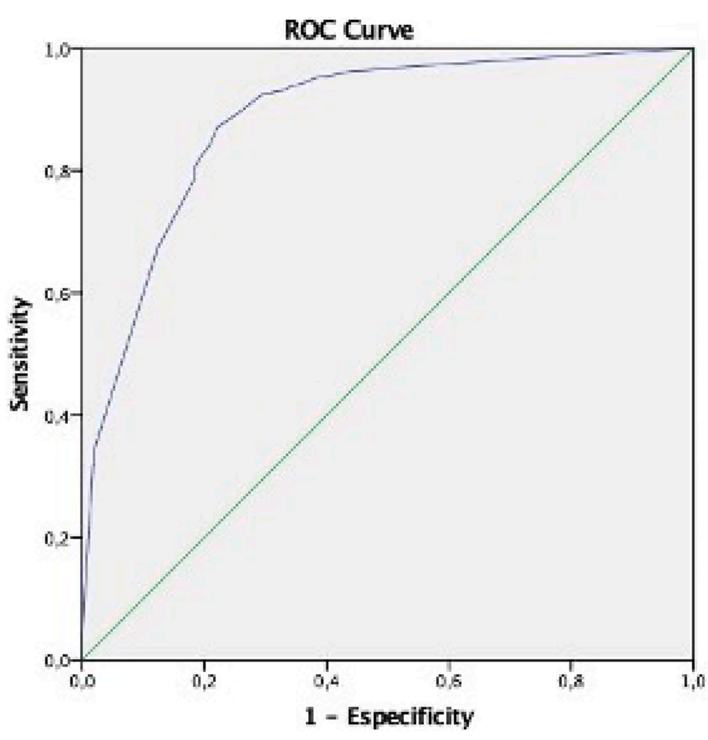

Fig. 1. ROC curve of the predictive model regarding the derivation cohort.
Area under the ROC curve to determine the predictive ability of the model for the derivation cohort, representing the sensitivity in the ordinate axis and specificity in the abscissa.

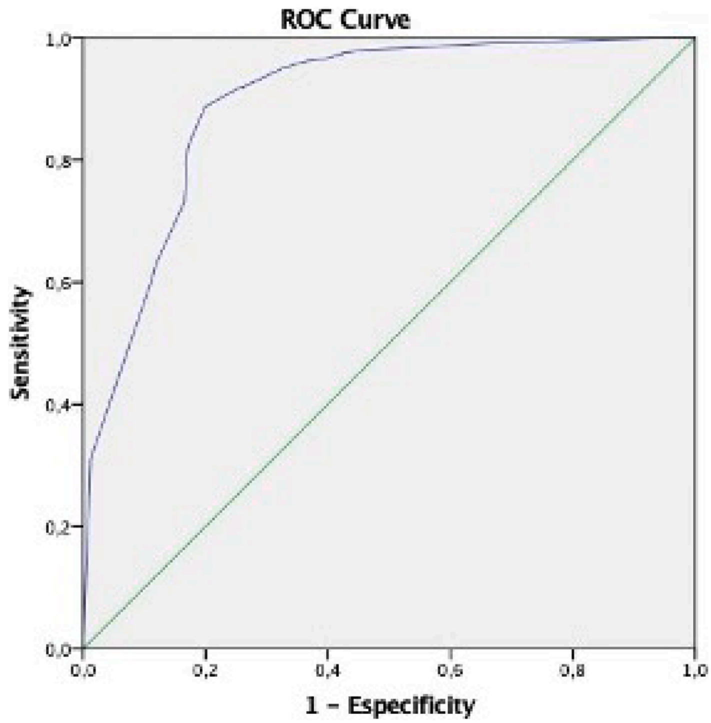

Fig. 2. ROC curve of the predictive model regarding the validation cohort.
Area under the ROC curve to determine the predictive ability of the model for the validation cohort, representing the sensitivity in the ordinate axis and specificity in the abscissa.

et al., 2017). As it is made evident in different studies, caesarean delivery and instrumental delivery are two of the most important obstacles that cause a delay in the onset of breastfeeding (Lau et al., 2018; Radwan, 2013; Theofilogiannakou et al., 2006; Inal et al., 2016; Haghighi and Taheri, 2015; Patel et al., 2015). There are multiple factors that can motivate this delay. Still in many hospitals, mothers are separated from newborns by caesarean section so skin-to-skin contact is delayed; also, the level of pain after a C-section may be higher than in an eutocic delivery (Yılmaz et al., 2017), the delay in breast milk production is not uncommon, and the mobility of these women is limited, which together with the surgery wound can make it difficult to breastfeed in certain positions (Yılmaz et al., 2017; Tully and Ball, 2014). In addition, newborns by caesarean section or instrumental delivery experience more problems taking the breast (Lau et al., 2015), lower suction capacity, and decreased receptivity (Hobbs et al., 2016) which, together, negatively influence taking the breast effectively so as to initiate breastfeeding.

Immediate skin-to-skin contact within 30 min after delivery has been consistently, positively and significantly linked to early onset of breastfeeding in both mothers with vaginal spontaneous delivery and by caesarean section and instrumental delivery (Lau et al., 2018; Patel et al., 2015; Kim, 2017). Skin-to-skin contact between mother and newborn promotes maternal and neonatal well-being (Curationis NB-2014), allows addressing the care demands of babies, which in turn trigger neuropsychobiological pathways that influence, among others, the increase in lactogenesis (Conde-Agudelo and Díaz-Rossello, 2016). Skin to skin contact also facilitates the onset of breastfeeding (Debes et al., 2013) and effective suction (Cantrill et al., 2014).

A possible interpretation of the lack of SSC in caesarean sections and instrumental deliveries may be motivated by staff shortages in the implementation of immediate SSC, due to the woman's possibility to attend to additional breastfeeding lessons and the lack of support to help professionals in the operating room (Lau et al., 2018; Crenshaw et al., 2012). In some centres, routine care practices cause SSC disruption or delay (such as taking vital signs or neonatal physical examination) (Robiquet et al., 2016). Another possibility is that the staff is reluctant to changes and fears that something will go wrong after starting the immediate SSC in the operating room (Hung and Berg, 2011). However, there are multiple studies that highlight the advantages of immediate SSC after a C-section (Stevens et al., 2014). Taking into account the benefits of immediate SSC, health professionals should implement SSC as the first priority in the first 30 min for healthy newborns by C-section or instrumental delivery (Lau et al., 2018). There is a need to provide more trained and motivated staff to implement immediate SCC (Stevens et al., 2014).

Parity has been widely studied as one of the factors influencing breastfeeding (Huang et al., 2019). Some studies show that multiparous women are more likely to initiate breastfeeding (Huang et al., 2019; Kitano et al., 2016; Schafer et al., 2017). However, other studies have not found this effect or have even found a negative effect on the onset and duration of breastfeeding (Ekubay et al., 2018; Villar et al., 2018; Islam et al., 2017). These mixed results led researchers to focus not only on parity but on the experience of prior breastfeeding. Thus, multiparous were found to tend to repeat the duration of their previous lactation, whereas multiparous with no previous experience in breastfeeding or primiparous women are less likely to start breastfeeding (Huang et al., 2019). The reason could be found in the psychological factors that relate to breastfeeding. Different studies show that previous experience in lactation can influence breastfeeding outcomes, as mothers with previous experience show more confidence, self-efficacy, motivation, and willingness to breastfeed (Huang et al., 2019; Moimaz et al., 2017). However, it is also possible that all these positive effects may be diminished by a negative experience with prior breastfeeding (Bartle and Harvey, 2017).

This predictive model is the first to be developed in relation to the onset of breastfeeding within the first hour. The onset of breastfeeding in the first hour of life is associated with greater duration of breastfeeding, so fostering this early onset will help maximise the multiple benefits of this type of feeding. Despite the importance of this fact, it is often difficult to implement new procedures in hospital daily practice due to the high healthcare pressure. In this sense, this predictive model is considered highly favourable, as it only collects three items to be subjected to assessment, so by spending little time, it is possible to identify population at risk and develop specific strategies focused on encouraging the onset of breastfeeding such as close monitoring of intakes, personalised advice for the mother, and close general follow-up. In addition, given the simplicity and facilitating character of the tool, it could be possible to include it in future clinical practice guidelines and hospital protocols.

Among the limitations of the study, it is worth noting that it has been carried out in a Spanish population and it would need validation in other countries and cultural contexts. In terms of strengths, the comparison between the derivation and validation cohorts shows significant differences regarding certain variables. Although both samples show statistically significant differences in some variables, this does not affect the predictive capacity of the model. The existence of these differences is interesting when extrapolating results, so that this validation cohort could almost be considered as an external validation. On the other hand, the fact that this model consists of only three variables allows data to be obtained quickly and accurately and, thus, to objectively assess mothers and detect risk groups.

Conclusion

In summing up, a predictive model has been developed that allows identifying women at risk of not initiating breastfeeding during the first hour of life of the newborn. This may imply a great advantage (may be a step forward) when developing and implementing support strategies for this specific population, and therefore eventually increasing the prevalence of the onset of breastfeeding.

Ethical approval statement

The study was conducted in accordance with the principles of the Declaration of Helsinki and approved by the institutional review Board of the Mancha-Centro District Hospital (C-92).

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CRediT authorship contribution statement

Ana Ballesta-Castillejos: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Julián Rodríguez-Almagro:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Juan Gómez-Salgado:** Writing – review & editing, Writing – original draft, Software, Resources, Data curation. **Juan Miguel Martínez-Galiano:** Writing – original draft, Software, Resources, Methodology, Data curation. **Cristina Romero-Blanco:** Writing – original draft, Software, Resources, Formal analysis, Data curation. **Antonio Hernández-Martínez:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.midw.2024.104019.

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