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Preparation and validation of a predictive model of exclusive breastfeeding at hospital discharge.

--Manuscript Draft--

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Corresponding Author:	Julian Rodriguez-Almagro, PhD University of Castilla-La Mancha: Universidad de Castilla-La Mancha Ciudad Real, SPAIN
First Author:	Ana Ballesta-Castillejos, MsC
Order of Authors:	Ana Ballesta-Castillejos, MsC
	Juan Gómez-Salgado, PhD
	Julian Rodriguez-Almagro, PhD
	Antonio Hernandez-Martinez, PhD
Abstract:	Background: The benefits of breastfeeding for both mother and newborn have been widely demonstrated. However, breastfeeding rates at discharge are lower than recommended, so being able to identify women at risk of not breastfeeding at discharge could allow professionals to prioritise care. Objective: To develop and validate a predictive model of exclusive breastfeeding at hospital discharge. Design: Retrospective cohorts study on women who gave birth between 2014 and 2019 in Spain. Data Sources: The data source was a self-prepared questionnaire distributed through the Spanish breastfeeding associations. The development of the predictive model was made on a cohort of 3387 women and was validated on a cohort of 1694 women. A multivariate analysis was performed by means of logistic regression, and predictive ability was determined by areas under the ROC curve (AUC). Results: 80.2% (2717) women breastfed at discharge in the derivation cohort, and 82.1% (1390) in the validation cohort. The predictive factors in the final model were: maternal age at birth; BMI; number of children; previous breastfeeding; birth plan; induced birth; epidural analgesia; type of birth; prematurity; multiple pregnancy; macrosomia; and skin-to-skin contact. The predictive ability (ROC AUC) in the derivation cohort was 0.76 (CI 95%: 0.74-0.78), while in the validation cohort it was 0.74 (CI 95%: 0.71-0.77). Conclusions: A twelve-variable predictive model has satisfactory predictive ability in both the derivation cohort and the validation cohort. This model can identify women who are at high risk of not breastfeeding at hospital discharge.
Response to Reviewers:	ASSOCIATE EDITOR'S COMMENTS Please amend the title of the paper to make the research design explicit. we suggest: 'Development and validation of a predictive model of exclusive breastfeeding at hospital discharge: retrospective cohort study' Thank you very much for your comment; this has been modified. Page 1, paragraph 1. Well done for undertaking the recommended revisions. Unfortunately there remain some required revisions of the manuscript which I set out below. Please undertake these corrections meticulously (carefully) so that the manuscript reaches a publishable standard. In the Abstract Design: “Retrospective cohorts study on women who gave birth between 2014 and 2019 in Spain”. Please correct cohorts to cohort. Thank you very much for your correction; this has been modified. Page1, paragraph 4, line 1. Page 3, line 33: “Summarising global data on any breastfeeding rates, we find that Canada stands out..”. Please remove “we find that”. Thank you very much for your correction; this has been modified. Page 3, paragraph2,

	line 4. Page 4, line 39: “baby friendly hospital”. Please correct: Baby Friendly ie upper case as it is a recognised assignation. Thank you very much for your suggestion; this has been modified. Page 4, paragraph 5, line 10. Page 5, line 9: “In this sense, the research question is: Could it be possible to predict premature cessation of maternal breastfeeding?”. Please revise this sentence. I suggest the following: The research question is: Is it possible to predict premature cessation of maternal breastfeeding? Thank you very much for your suggestion; this has been modified. Page 5, paragraph 1, line 5. Page 5, line 26: “A retrospective cohorts methodology”. Please correct to: A retrospective cohort method Thank you very much for your correction; this has been modified. Page 1, paragraph 2, line 1. Page 5, line 21: “the online ad-hoc questionnaire”. Please remove “ad hoc”. Thank you very much for your correction; this has been removed. Page 5, paragraph 2, line 3. Page 5, line 40: “In an attempt to estimate the sample size to obtain valid coefficient estimates, the maximum modelling principle (Peduzzi et al., 1996). was followed.” Please revise this sentence. I suggest the following: The maximum modelling principle (Peduzzi et al., 1996) was used to estimate the sample size to obtain valid coefficient estimates. Thank you very much for your suggestion; this has been modified. Page 5, paragraph 3, line 1. Page 6, line 14: A survey methodology was used to collect relevant data for this study. The research team developed the questionnaire taking into account the aspects that other authors had described as related to maternal breastfeeding at hospital discharge. The questions asked in the questionnaire are divided into open questions such as maternal age or number of children, questions about whether the mother is a smoker or has been performed a previous C-section, and multiple answer questions such as the type of delivery. Prior to the mass dissemination of the survey, a pilot study was conducted involving women from two different lactation associations through email. Once checked that the questions were easily understood by the participants and that there were no problems at the technical level when sending the emails, answering them, and receiving the data, the online self-administered questionnaire was sent to the different Spanish breastfeeding associations. In turn, these associations disseminated the questionnaire among their members, who accessed the survey through the link and were able to complete it online. The questionnaire included questions on sociodemographic and clinical aspects of the mother, and also questions on obstetrics, foetal, and breastfeeding topics. Please revise the above text. I suggest the following: The study data was collected using an online questionnaire drawing upon previous research of maternal breastfeeding at hospital discharge. The questionnaire included questions on sociodemographic and clinical aspects of the mother, as well as questions on obstetrics, foetal, and breastfeeding topics. A pilot study was conducted using women from two lactation associations to assess whether the questions were easily understood and that there were no problems at the technical level the online self-administered questionnaire prior to emailing to the different Spanish breastfeeding associations. These associations disseminated the questionnaire among their members for online completion. Thank you very much for your correction; this has been modified. Page 6, paragraph 2. Page 8, line 47: To ensure that participants understood the purpose of the study and accepted the processing of their data, before answering the questions, participants had to receive information on the purpose of the questionnaire and the ethical considerations associated. In order to complete the questionnaire, it was essential that they clicked a box in which they stated that they understood the information and

	agreed to continue with the study. In addition, they were informed that the data collected were completely anonymous, confidential, would not be used for purposes other than those of carrying out this study, and that they were free to (continued on Page 9, line 1) drop form the study at any time. An email address was offered so that participants could contact in case of doubt about the collection or processing of their data or if they wanted to delete their data from our database. The information collected was stored and processed on a computer without internet access so that no one had remote access to the data. Please revise the above text. I suggest the following: Prior to questionnaire completion, all participants gave informed consent by confirming that they understood that their participation was voluntary, and anonymous, and that they could withdraw at any time, that their data would be completely confidential, stored and analysed on a secure computer and would only be used for the study. The participants were given a contact email with the research team for queries and to withdraw their data. Thank you very much for your suggestion; this has been modified. Page 18, paragraph 3, line 3. Page 9, line 38: Please remove 'SPPS' Thank you very much for your correction; this has been modified. Page 9, paragraph 2, line 1. Page 11, line 6: "two studies in the literature that apply the BAS". Please remove "in the literature". Thank you very much for your correction; this has been modified. Page 10, paragraph 3, line 6. Page 11, line 21: "…maternal age. In this sense, some…" Please remove "In this sense". Thank you very much for your suggestion; this has been modified. Page 10, paragraph 4, line 1. Page 11, line 59: (Ahm et al., 2002). "In this sense, blood studies reveal" Please remove "In this sense". Thank you very much for your correction; this has been modified. Page 11, paragraph 2, line 4. Page 12, line 42 : "In this same sense, multiple pregnancies" Please remove "In this same sense". Thank you very much for your suggestion; this has been modified. Page 17, paragraph 2, line 1. Page 13, line 31: "Yet, we must clarify that the most realistic estimates". Please remove "Yet, we must clarify that" Thank you very much for your suggestion; this has been modified. Page 12, paragraph 2, line 2. Page 13, line 36: "In this sense, it would be highly recommended". Please remove "In this sense" and simply state: it is recommended… Thank you very much for your suggestion; this has been modified. Page 12, paragraph 2, line 4. Page 14, line 12: In short, the objective of this paper of developing a predictive model for the breastfeeding at hospital discharge has been accomplish, which may imply an aid for professionals in identifying women with a higher risk of not breastfeeding at hospital discharge in a quick and objective way, so that specific strategies could be implemented to support these women with the ultimate goal of increasing the prevalence of breastfeeding at hospital discharge. Please revise this very long sentence. I suggest the following: A predictive model for breastfeeding at hospital discharge was accomplished. It is hoped that the model will aid professionals in identifying those mothers at higher risk of not breast feeding so that strategies may be implemented to increase the prevalence of breast feeding at hospital discharge. Thank you very much for your suggestion; this has been modified. Page 13, paragraph 2.

Dear Editor:

On behalf of the entire research team, I am pleased to submit the manuscript entitled "Preparation and validation of a predictive model of exclusive breastfeeding at hospital discharge" by Ana Ballesta et al. to be considered for publication in the Journal of Nursing Studies (IJNS) international journal.

This manuscript describes the process of developing and validating a predictive model for breastfeeding at hospital discharge. 3387 women have participated as a derivation cohort, and the model has been validated on a cohort of 1694 women.

This predictive model has shown satisfactory predictive ability in both the validation and derivation cohort, and is made up of twelve variables. There is no predictive model on this topic published in the literature and we believe it could be very useful for professionals who deal with breastfeeding, such as midwives and nurses, by offering counselling and help.

This manuscript is an original research, which has not been submitted and is not being considered for publication by any other journal. The authors state that there is no conflict of interest. All authors have significantly contributed to the scientific content of this research and the final text of the manuscript has been approved by all of them. No funding was needed to conduct this research.

Copyright Questionnaire

The questionnaire used is self-made and does not contain scales or other measuring instruments of third-party authors who have copyright.

We hope you find this manuscript suitable for review and/or publication in the International Journal of Nursing Studies.

Sincerely yours,

Ana Ballesta Castillejos

Preparation and validation of a predictive model of exclusive breastfeeding at hospital discharge.

Author names: Ana Ballesta-Castillejos[1], Juan Gómez-Salgado[2,3], Julián Rodríguez-Almagro[4,*], Antonio Hernández-Martínez [1,3]

Affiliations:

[1] Msc. Department of Obstetrics & Gynaecology. Alcázar de San Juan, Ciudad Real, Spain; ana.ballesta81@gmail.com; inmaores@hotmail.com; antomatron@gmail.com

[2] PhD.Department of Sociology, Social Work and Public Health, University of Huelva, 21071 Huelva, Spain; salgado@uhu.es

[3] Safety and Health Posgrade Program. Universidad Espíritu Santo, Guayaquil 091650, Ecuador.

[4] PhD. Department of Nursing. Ciudad Real School of Nursing. University of Castilla La-Mancha, Ciudad Real, Spain.

Corresponding Author:
Julián Rodríguez Almagro. **Phone:** +34 676683843
Email: julianj.rodriguez@uclm.es
Mailing address: C/Cuadras nº 8 Bajo; Ciudad Real, Spain

Conflicts of Interest
No conflict of interest has been declared by the author(s).

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This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Copyright Questionnaire
The questionnaire used is self-made and does not contain scales or other measuring instruments of third-party authors who have copyright.

Words of Article:

Abstract: 240
Main document (excluding references and tables): 2,704
References: 48

*Author Checklist

IJNS AUTHOR CHECKLIST
You will need to submit a completed version this checklist plus the checklist from the any relevant reporting guideline along with your paper. This checklist addresses a number of important issues. It is intended to help you to make sure your manuscript meets some basic requirements. It should be read in conjunction with the guide for authors, and is not a replacement for it. We have prepared a template that may help you to structure your paper (see guide for authors)

PART 1 Basic requirements - For the items below, please tick or the relevant page number in the right hand column to confirm you have included/addressed the items in your manuscript. For more detail please consult the guide for authors:		Insert a tick or page number(s)
Ethical approval and informed consent	For all research papers *only*, please ensure that your manuscript includes details of the ethical approval granted including the body that granted it and any reference number. If ethical approval was not required, give a clear statement of the basis on which this assessment was made, with reference to the ICMJE requirements. This should include confirmation of informed consent by participants. Place this **at the end of you methods section.**	Page 7
Study registration	Give any study registration number (e.g. ISRCTN) in the **abstract and in the body** of the paper. For clinical trials (as defined by the ICMJE), the abstract should include the registration date and the date of first recruitment. [not applicable to letters / editorials]	-
Funding sources	State sources of funding and the role of funders in the conduct of the research or include a statement 'no external funding' **at the end of the paper**.	Page 12
Conflict of interests	State any actual or potential conflicts of interest in a section **at the end of the paper**. If there are none, include a statement "Conflicts of interest: none". The substance of this declaration should match details provided in file(s) uploaded at submission.	Page 12
Title	The title is in the format 'Topic / question: design/type of paper' [not applicable to letters / editorials]	✓
Abstract	A **structured** abstract of no more than 400 words appropriate to the design of the study (and as directed by relevant reporting guidelines) is included **at the beginning** of your paper. No references are cited in the abstract. [not applicable to letters / editorials]	Page 1
	You may include a final section to their structured abstract with an additional sinal section: "Tweetable abstract" summarising a key message in no more than 140 characters. [not applicable to letters / editorials]	Not included
	No abbreviations (other than SI units) or references are to be used in the title or the abstract of the paper	✓
Key words	Give between four and ten key words, which accurately identify the paper's subject, purpose, method and focus. Use the Medical Subject Headings (MeSH®) thesaurus or Cumulative Index to Nursing and Allied Health (CINAHL) headings where possible (see http://www.nlm.nih.gov/mesh/meshhome.html).	Page 1
Contribution of the Paper statements	**After the abstract** under the headings "What is already known about the topic?" and "What this paper adds" give 2-3 single sentence bullet points (each) summarising key contributions. [not applicable to letters / editorials]	✓ Page 2
Abbreviations	The paper does not contain any abbreviations, acronyms or "initialisms" other than the limited exceptions noted in the guide for authors.	✓
Other Published accounts	Other published and in press accounts of the study from which data in this paper originate are referred to in the paper and the relationship between this and other publications from the same study is made clear in the paper. [not applicable to editorials or letters unless reporting analysis / data]	-

Please provide below full references to ALL other publications from this study and explain the relationship to the current paper. To assist editors upload copies of papers where the abstract / full text is not readily available (including those under review elsewhere, which will be treated in strict confidence).

PART 2 Standards of reporting	The editors require that manuscripts adhere to recognized reporting guidelines relevant to the research design used. Guidelines endorsed by the IJNS are listed below. These and others can be found at http://www.equator-network.org/. As a separate file, we require you to submit a completed **checklist** detailing how and where the matters detailed in the guideline are addressed in your paper. Do NOT submit the guideline itself. Indicate below what guideline you have used. [please note and use the appropriate extensions – eg. CONSORT extension for cluster trials]	**Checklist submitted****
Randomised (and quasi-randomised) controlled trial	CONSORT – Consolidated Standards of Reporting Trials	
Qualitative studies	COREQ: Consolidated criteria for reporting qualitative research	
Systematic Review of Controlled Trials	PRISMA - Preferred Reporting Items for Systematic Reviews and Meta-Analyses	
Study of Diagnostic accuracy / assessment scale	STARD Standards for the Reporting of Diagnostic Accuracy studies	
Observational cohort, case control and cross sectional studies	STROBE **St**rengthening the **R**eporting of **Ob**servational Studies in **E**pidemiology	✓
Quasi experimental / non-randomized evaluations	TREND - Transparent Reporting of Evaluations with Non-randomized Designs	
Other (please name / give source)		
Not applicable (please elaborate)	*If there is no applicable guideline, upload a blank file with the words 'not applicable' when requested at submission.*	

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found **PAGES 1**
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported **PAGE 3,4**
Objectives	3	State specific objectives, including any prespecified hypotheses **PAGE 4**
Methods		
Study design	4	Present key elements of study design early in the paper **PAGE 4**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection **PAGE 5**
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants **PAGE 5**
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable **PAGE 5**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group **PAGE 5**
Bias	9	Describe any efforts to address potential sources of bias **PAGE 6**
Study size	10	Explain how the study size was arrived at **PAGE 6**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why **PAGE 6**
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding **PAGE 6**
		(*b*) Describe any methods used to examine subgroups and interactions **PAGE 6**
		(*c*) Explain how missing data were addressed **PAGE 6**
		(*d*) If applicable, describe analytical methods taking account of sampling strategy **PAGE 6**
		(*e*) Describe any sensitivity analyses **PAGE 6**
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed **PAGE 7,8**
		(b) Give reasons for non-participation at each stage **PAGE 7,8**
		(c) Consider use of a flow diagram **PAGE 7,8**
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders **PAGE 7,8**
		(b) Indicate number of participants with missing data for each variable of interest **PAGE 7,8**
Outcome data	15*	Report numbers of outcome events or summary measures **PAGE 7,8**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included **PAGE 7,8**
		(*b*) Report category boundaries when continuous variables were categorized

		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period **PAGE 7,8**
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses **PAGE 7,8**
Discussion		
Key results	18	Summarise key results with reference to study objectives **PAGE 8,9,10,11,12**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias **PAGE 11,12**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence **PAGE 8,9,10,11,12**
Generalisability	21	Discuss the generalisability (external validity) of the study results **PAGE 12**
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based **NO FUNDING**

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. Information on the STROBE Initiative is available at www.strobe-statement.org.

Development and validation of a predictive model of exclusive breastfeeding at hospital discharge: retrospective cohort study

Abstract

Background: The benefits of breastfeeding for both mother and newborn have been widely demonstrated. However, breastfeeding rates at discharge are lower than recommended, so being able to identify women at risk of not breastfeeding at discharge could allow professionals to prioritise care.

Objective: To develop and validate a predictive model of exclusive breastfeeding at hospital discharge.

Design: Retrospective cohort study on women who gave birth between 2014 and 2019 in Spain.

Data Sources: The data source was a questionnaire distributed through the Spanish breastfeeding associations. The development of the predictive model was made on a cohort of 3387 women and was validated on a cohort of 1694 women. A multivariate analysis was performed by means of logistic regression, and predictive ability was determined by areas under the ROC curve (AUC).

Results: 80.2% (2717) women exclusively breastfed at discharge in the derivation cohort, and 82.1% (1390) in the validation cohort. The predictive factors in the final model were: maternal age at birth; BMI; number of children; previous breastfeeding; birth plan; induced birth; epidural analgesia; type of birth; prematurity; multiple pregnancy; macrosomia; onset of breastfeeding within the first hour; and skin-to-skin contact. The predictive ability (ROC AUC) in the derivation cohort was 0.76 (CI 95%: 0.74-0.78), while in the validation cohort it was 0.74 (CI 95%: 0.71-0.77).

Conclusions: A predictive model of exclusive maternal breastfeeding at hospital discharge has been developed, based on thirteen variables, with satisfactory predictive ability in both the derivation cohort and the validation cohort according to the Swets' criteria. This model can identify women who are at high risk of not breastfeeding at hospital discharge.

Key words: breastfeeding at hospital discharge; predictive model validation.

Contribution of the paper

What is already known about the topic?

- The benefits of breastfeeding for both mother and newborn have been widely demonstrated. Breastfeeding rates at discharge are lower than recommended.
- Identify women at risk of not breastfeeding at discharge could allow professionals (nurses and midwifes) to prioritise care.
- Currently, there is no predictive model developed specifically for exclusive breastfeeding at hospital discharge.

What this paper adds:

- The predictive factors involved in the model were: maternal age at birth; BMI; number of children; previous breastfeeding; birth plan; induced birth; epidural analgesia; type of birth; prematurity; multiple pregnancy; macrosomia; and skin-to-skin contact.
- This predictive model can identify women who are at high risk of not breastfeeding at hospital discharge.

INTRODUCTION

The World Health Organization (WHO), among other institutions, recommends exclusive breastfeeding (EBF) without milk supplements during the first 6 months of life (McDonald et al., 2012; World Health Organization (WHO), 2018). The benefits of exclusively breastfeeding for the long and short term are widely known. A recent meta-analysis has shown that, as soon as they are born, newborns who initiate early breastfeeding have a lower risk of premature death (Smith et al., 2017). In addition, the incidence of certain diseases such as diarrhoea, respiratory infections, otitis, or asthma decreases, and, in the long term, it is also associated with reduced obesity rates, better performance on intelligence tests, and higher wages in adult life (Pattison et al., 2019; Victora et al., 2016). Breastfeeding also offers benefits for the mother; in the short term, decreased postpartum haemorrhage and its associated complications are highlighted, as well as strengthening the mother-child bond (Silva Luz et al., 2018).

United Nations Children's Fund (UNICEF) provides country-disaggregated data on any breastfeeding and breastfeeding in the 1st hour of life, and these rates vary widely between low and middle-income, and high-income countries (UNICEF, 2018a, UNICEF, 2018b). Summarising global data on any breastfeeding rates, Canada stands out with an any breastfeed rate of 89% and USA, with a rate of 74.4%. In Asia, Korea (88%) and Singapore (96%) rates stand out (UNICEF, 2018a). A great variability has been observed between European countries, highlighting the highest rates of Nordic countries such as Sweden (98%) and Norway (95%), which contrast with countries such as France (63%) or Ireland (55%) (UNICEF, 2018a). In contrast, low and middle income countries rates are generally high, highlighting those in Bolivia (98.2%), Niger (98.8%), Madagascar (99%), and Butan (99.3) (UNICEF, 2018a). Focusing now on the data on the onset of breastfeeding in the 1st hour of life, the rates are much less satisfactory according to UNICEF Global Database from 2018 with only two out of five newborns start breastfeeding in the first hour. Highest rates are found in Eastern and Southern Africa (65%), and in Eastern Europe and Central Asia (56%), in contrast with the lowest rates in Middle East and South Africa (35%) and in East Asia and the Pacific (32%) (UNICEF, 2018b). However, the results of this report are incomplete since it does not collect information on North America or Europe (UNICEF, 2018b).

Globally, an estimated 42% of women start breastfeeding in the first hour of life, but this figure rises to 80% of women who start breastfeeding at another moment of the postpartum period (Maimburg, 2017). In this sense, breastfeeding rates in North America are at 76.7% (Herrick et al., 2016), and at European level, between 56% and 97% of newborns receive any type of breastfeeding at birth (Theurich et al., 2019). At national level, Spain does not have a breastfeeding monitoring system, which makes it difficult to collect official data on the breastfeeding situation. However, according to the latest update of the 2018 National Health Report, in 2017, 81.1% of newborns had been fully or partially breastfed in the first 6 weeks of life (Ministerio de Sanidad, 2020).

The factors that affect breastfeeding rates, and therefore are involved in early abandonment of breastfeeding, are varied (Vila-Candel et al., 2019) but can be grouped into: 1) clinical-psychological factors (assisted reproductive treatments, smoking, previous maternal expectations, use of the pacifier during the first month of life, and a feeling of hypogalactia; 2) environmental factors (family/friends/work environment, and health system); and 3) socio-cultural and economic factors (Vila-Candel et al., 2019). It has been proven that there is an association between skin-to-skin rooming and higher rates of onset and duration of breastfeeding (Moore et al., 2016). A delay in the onset of breastfeeding may result in a decrease in the suction capacity of the newborn, thus resulting in reduced or insufficient milk supply (Cohen et al., 2018a). In short, differences in care at the hospital level have an impact on the onset and duration of breastfeeding, hence initiatives such as Baby Friendly hospital have emerged (Gomez-Pomar and Blubaugh, 2018; World Health Organization, 2017) that emphasise health education (Chang et al., 2019), early onset of breastfeeding, not feeding formula milk (O'Connor et al., 2018), or a delay in performing medical examination of the newborn to foster the onset of breastfeeding (Inal et al., 2016), actions that, according to Patterson et al., are considered public health measures (Patterson et al., 2018).

Understanding the factors that influence breastfeeding rates at discharge is important (Lau et al., 2018), but it does not allow us to objectively identify women at higher risk of not breastfeeding. Predictive models are relevant at this point as they are a tool to identify women at risk and thus offer more effective supportive strategies. Predictive models have already been successfully used in other aspects of

obstetrics such as postpartum haemorrhage (Rubio-Álvarez et al., 2018) or premature cessation of lactation (Berra et al., 2001). Recently, a predictive model using a decision tree has been published which deals with cessation of breastfeeding at two months, based on the Chinese version of the Self-efficacy Breastfeeding Scale (Wang et al., 2020), but no predictive models have been designed for breastfeeding to be applied at hospital discharge. In this sense, the research question is: Is it possible to predict premature cessation of maternal breastfeeding? Therefore, the objective of the study has been to develop and validate a predictive model of breastfeeding at hospital discharge.

METHODOLOGY

Design and participants

A retrospective cohort method (Song and Chung, 2010) was used for this study on women who had given birth between 2014 and 2019 in Spain. The study population consisted of women who, before delivery, already intended to breastfeed and who had completed the online questionnaire. A total of 5006 women participated in the study.

Sample selection

The maximum modelling principle (Peduzzi et al., 1996) was used to estimate the sample size to obtain valid coefficient estimates. This requires 10 events (women who didn't breastfeed at discharge, in this particular case) per each included variable. Birth rates in Spain, according to the National Statistical Institute, were 9.17 newborns per thousand inhabitants in 2014, 9.02 in 2015, 8.80 in 2016, 8.41 in 2017, 7.98 in 2018, and 7.62 in 2019 (Instituto Nacional de Estadística). The study by Vila-Candel et al. (Vila-Candel et al., 2019) was taken as reference. It was carried out in Spain in 2019 and showed that no breastfeeding at hospital discharge rates reached 31.8%. A model of 23 independent variables would require a minimum of 723 women, and approximately half of them (that is, 362 women in this case) would be needed to satisfy the validation process. However, the decision was to recruit the largest number of women. In order to elaborate the predictive model, the total sample of women was divided

into two cohorts: a cohort consisting of 3387 women was used (2/3 parts of the study population) for the design of the predictive model and a cohort of 1694 women was (1/3 of the study population) used for validation purposes.

Data collection and data sources

The study data was collected using an online questionnaire drawing upon previous research on maternal breastfeeding at hospital discharge. The questionnaire included questions on sociodemographic and clinical aspects of the mother, as well as questions on obstetrics, foetal, and breastfeeding topics. A pilot study was conducted using women from two lactation associations to assess whether the questions were easily understood and that there were no problems at the technical level regarding the online self-administered questionnaire prior to emailing it to the different Spanish breastfeeding associations. These associations disseminated the questionnaire among their members for online completion. The main outcome variable was: exclusive breastfeeding at hospital discharge (Yes/No). The independent variables were:

- Maternal: maternal age, academic level, nationality, family income, body mass index (BMI), smoking habit, type of conception (procedure through which pregnancy occurred), support from the partner, and number of children.
- Obstetric: previous caesarean-section, birth plan, induced delivery, use of regional analgesia, use of nitrous oxide, use of general anaesthesia, use of non-pharmacologic methods for the management of labour pain, type of birth, episiotomy, and type III-IV vaginal tearing.
- Foetal: prematurity, multiple birth, neonatal birth weight (<2500 gr), macrosomia (>4000gr), and newborn admittance to hospital.

- Breastfeeding-related: Attendance to breastfeeding education classes, previous breastfeeding, skin-to-skin contact after childbirth.

Statistical analysis

A descriptive statistical analysis (Mishra et al., 2019) was performed using absolute and relative frequencies for the qualitative variables, and arithmetic means and standard deviation (SD) for the quantitative ones. Later, 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 Chi-squared test and Student's t-test to calculate qualitative and quantitative 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., 1989) (Table 1). This model was constructed by using backward elimination (RV in SPSS). The automatic selection model was used with PIN values (0.05), POUT values (0.10), LCON (0), and BCON (0.001). PIN specifies the minimum probability that a variable can have to enter the analysis and POUT specifies the maximum probability that a variable can have and not be removed from the model. BCON specifies the change in parameter estimates for terminating iteration and LCON specifies the percentage change in the log-likelihood ratio for terminating iteration.

Together with the automatic selection procedure, the change produced in the regression coefficients was assessed when some variable was excluded from the model, to leave it despite the lack of significance for adjustment reasons.

Likewise, values of sensitivity (Se), specificity (Sp), positive predictive value (PPV), negative predictive value (NPV), and positive likelihood ratio (LR+) were presented for the different probabilities of exclusive breastfeeding at discharge, both in the derivation and the validation cohort (Table 3).

In order to assess the prediction in qualitative terms, the Swets' criteria, whose values range from 0.5-0.6 (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 ROC for the validation cohort was calculated for the predictive model created (Table 2).

A tool for automatic calculation of the probability of breastfeeding at discharge, 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 Mancha-Centro District Hospital (C-92). Prior questionnaire completion, all participants gave informed consent by confirming that they had understood that their participation was voluntary and anonymous and that they could withdraw at any time, that their data would be completely confidential, stored, and analysed on a secure computer and would only be used for the study. The participants were given a contact email address linking to the research team for queries and for their data withdrawal.

RESULTS

A total of 5081 women participated in the study; 3387 women were included in the derivation cohort, and 1694 in the validation cohort. The incidence rate of exclusive breastfeeding at discharge was 80.7% (2717) for women in the derivation cohort, and 82.1% (1390) for women in the validation cohort

The bivariate analysis results are displayed in table 1. The variables associated to breastfeeding at discharge (p-value <0.25) selected to carry out the multivariate analysis were: nationality, BMI, number of children, type of conception, birth plan, support from the partner, previous caesarean-section, pathological pregnancy, induced delivery, regional analgesia, use of nitrous oxide, general anaesthesia, use of non-pharmacologic methods for the management of labour pain, type of delivery, episiotomy, prematurity, multiple birth, attendance to breastfeeding education, newborn admittance, low-weight newborn, macrosomia, breastfeeding in previous children, and skin-to-skin contact.

From these variables, after performing the multivariate analysis with the backward stepwise procedure, the final model was formed by: maternal age at delivery, BMI, number of children, breastfeeding in previous children, onset of breastfeeding within the first hour, birth plan, induced birth, epidural analgesia, type of delivery, prematurity, number of foetus, macrosomia, and skin-to-skin contact (see Table 2).

In this way, having two children (OR: 2.01; CI 95%: 1.26-3.19), breastfeeding previous children (OR: 1.64; CI 95%: 1.03-2.60), starting breastfeeding within the first hour (OR: 2.11; CI 95%: 1.64-2.72), and having mostly followed a birth plan (OR: 1.50 CI 95%: 1.19-1.89) increase the likelihood of exclusive breastfeeding at hospital discharge.

On the other hand, prematurity (OR: 0.43 CI 95%: 0.30-0.62), multiple pregnancy (OR: 0.29 CI 95%: 0.16-0.53), having had induced delivery (OR:0.82; CI 95%: 0.68-0.99), caesarean (OR: 0.75; CI 95%:0.57-0.99), macrosomia (OR: 0.60 CI 95%: 0.39-0.92), higher BMI (OR: 0.98 CI 95%: 0.96-1.00), epidural analgesia (OR: 0.67 CI 95%: 0.53-0.85) and higher maternal age (OR: 0.96 CI 95%: 0.94-0.98) reduce the likelihood of exclusive breastfeeding at hospital discharge. In supplementary Figures 1.A and 2.B, two estimation examples of the likelihood of breastfeeding have been presented for two opposing examples. These estimates have been made using a probability calculator through an Excel sheet that can be found in Appendix 1.

The predictive ability of this model in the derivation cohort proved to be satisfactory, obtaining 0.76 (95% CI: 0.74-0.78) in the AUC of ROC (Figure 1). The AUC of ROC in the validation cohort was 0.74 (95% CI: 0.71-0.77) (Figure 2), which is considered satisfactory according to Swets's criteria (Table 2).

The model's predictive characteristics for the derivation and validation cohort were also studied for the 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

In this study, a predictive model for exclusive breastfeeding at hospital discharge has been developed, with satisfactory predictive ability for both the derivation cohort (AUC: 0.76) and the validation cohort (AUC: 0.74). The predictive factors involved in this model are: number of children, prematurity, multiple pregnancy, induced delivery, type of delivery, previous breastfeeding, onset of breastfeeding within the first hour, skin-to-skin contact, birth plan, macrosomia, BMI, epidural analgesia, and maternal age at delivery.

Only two previous predictive models on breastfeeding have been identified (Berra et al., 2001). The Berra et al. model (Berra et al., 2001) focuses on premature cessation of breastfeeding and collects data on women after the first month and at six months. The second predictive model, carried out by Krombong et al.(Kronborg and Væth, 2019), is designed to be applied in the first few hours after birth and predicts the risk of cessation of breastfeeding before the first 17 postpartum weeks. There are also two studies that apply the BAS (Breastfeeding Assessment Score) scale (Hall et al., 2002) and LATCH assessment system (Tornese et al., 2012) respectively, and which use the scores obtained on these scales as predictors of breastfeeding duration, obtaining good results. Recently, a predictive model using a decision tree has been published which deals with cessation of breastfeeding at two months, based on the Chinese version of the Self-efficacy Breastfeeding Scale (Wang et al., 2020).

One of the factors that affects the type of breastfeeding at discharge is maternal age. Some studies reflect that the older the age of the mother, the greater the likelihood of breastfeeding and of doing so for longer periods of time (Kitano et al., 2016; Scott et al., 2001; Senarath et al., 2010). However, there are also studies that show the opposite trend (Kitano et al., 2016; Whipps, 2017). These disagreements are likely due not only to age, but to a set of factors such as parity or educational level (Whipps, 2017).

The relationship between the number of children and breastfeeding is controversial (Cohen et al., 2018b). While some studies have found no differences between parity and the onset or duration of breastfeeding (Guo et al., 2013; Scott et al., 2001), others reflect that primiparous are more likely to breastfeed but multiparous breastfeed for longer (Scott et al., 2001). Conversely, some studies conclude that being multiparous increases the likelihood of breastfeeding (Amin et al., 2011; Kaneko et al., 2006; Kitano et al., 2016; Wiklund et al., 2009). In the present study, a relationship between the number of children and breastfeeding was identified.

The breastfeeding trend is likely to be related to maternal age, previous breastfeeding experience and parity, but it may also be related to other potentially modifiable factors (Kaneko et al., 2006). In this regard, it is worth noting the role of epidural analgesia since it interferes with the release of endogenous oxytocin (Ahm et al., 2002). Blood studies reveal that oxytocin levels are reduced during childbirth in women with epidural and these reduced levels of oxytocin at childbirth can also play an important role in delaying milk production during the postpartum period (Ahm et al., 2002).

In relation to the type of birth, there are numerous studies that report that women who have a C-section done have lower rates of breastfeeding (Ahmed and Salih, 2019; Azzeh et al., 2018; Cohen et al., 2018b; DiFrisco et al., 2011; McDonald et al., 2012). These differences may be motivated by hospital practices in these interventions, as after a C-section skin-to-skin contact, immediately after birth, is less likely to happen (Ahmed and Salih, 2019; McDonald et al., 2012; Sutherland et al., 2012).

As for maternal BMI, it has been observed that it is closely related to the onset of macrosomia in children (Kominiarek and Peaceman, 2017; Yu et al., 2006) and, in these women, breastfeed has been identified

as less common (Boudet-Berquier et al., 2018) and shorter in duration (Ballesta-Castillejos et al., 2019; Flores et al., 2018).

On the other hand, prematurity and its consequences are serious and extend beyond the prenatal period (Ahmed and Sands Correspondence, 2010). The health benefits these babies obtain from breastfeeding are numerous, but breastfeeding in these cases is a challenge due to their physiological and neuromuscular immaturity (Ahmed and Sands Correspondence, 2010). Delayed lactogenesis and lower milk production at the onset of breastfeeding (Méio et al., 2018) have been observed in women with preterm births, which may increase the use of artificial milk to feed the baby.

Multiple pregnancies are also a major challenge regarding breastfeeding (Whitford et al., 2017). Different studies have shown that mothers with multiple pregnancies are less prone to breastfeeding (Lutsiv et al., 2013), with lower rates of onset of breastfeeding (Yokoyama et al., 2006), and are also likely to offer any type of feeding (Whitford et al., 2017).

Finally, it is worth highlighting the relationship between attendance to maternal education with breastfeeding training and exclusive breastfeeding at discharge. This relationship is in line with the findings made by other authors who have also described that educational interventions improve maternal breastfeeding self-efficacy (Chipojola et al., 2020), and thereby increase breastfeeding rates at hospital discharge (Prasitwattanaseree et al., 2019).

As for the limitations of the study, in the data collection process, an information bias was considered unlikely since the data collected and the way in which the possible answers were presented did not require a high level of education, and the questions were asked in a basic and simple way in order to be easily understood regardless of the level of education. On the other hand, another limitation of the study can be attributed to the system of obtaining data through the different breastfeeding associations, where women are more sensitised to this topic. However, the authors consider that this fact does not affect the results, as it is not a study on determining the prevalence of breastfeeding, but on determining the predictive factors for breastfeeding at discharge. Regarding the predictive model, it must be highlighted

that it has been developed on a population residing in Spain so, to be used in other cultural contexts, it should first be validated.

Regarding the strengths of the study, the validation and derivation cohort show significant differences regarding some variables. However, the predictive model still has good predictability. The most realistic estimates are those resulting from the analysis of the validation cohort, since the results from the derivation cohort suffer from over-optimism. It is highly recommended to validate this model in other totally different populations with social-health resources.

Despite the benefits of breastfeeding for both mother and newborn, breastfeeding rates remain an issue to improve in many countries. Nurses and midwives are the leading professionals in population health education, and breastfeeding provides an unparalleled framework for improving mother and child health both in the long and short term. This predictive model provides a new tool for healthcare professionals to make improvements in their healthcare tasks. Being able to detect women at higher risk of not breastfeeding early allow professionals to develop breastfeeding support strategies adapted to this at-risk population with increased support during hospital admission and greater follow-up by professionals following hospital discharge. For future research, it would also be interesting to adapt this predictive model to other populations so that they may detect women at increased risk of premature cessation of breastfeeding and develop new predictive models that detect the probability of not initiating breastfeeding during pregnancy, so as to implement breastfeeding support measures before delivery.

CONCLUSION

A predictive model for breastfeeding at hospital discharge was accomplished. It is hoped that the model will help professionals to identify those mothers at higher risk of not breastfeeding so that strategies may be implemented to increase the prevalence of breastfeeding at hospital discharge.

Conflicts of Interest

No conflict of interest has been declared by the author(s).

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REFERENCES

Ahm, V.A.N.R., Allgren, A.H., Ögberg, H.H., Urtig, I.H., Dlind, V.O., 2002. Plasma oxytocin levels in women during labor with or without epidural analgesia: A prospective study. Acta Obstet. Gynecol. Scand. 81, 1033–1039. https://doi.org/10.1034/j.1600-0412.2002.811107.x

Ahmed, A.E., Salih, O.A., 2019. Determinants of the early initiation of breastfeeding in the Kingdom of Saudi Arabia. Int. Breastfeed. J. 14, 13. https://doi.org/10.1186/s13006-019-0207-z

Ahmed, A.H., Sands Correspondence, L.P., 2010. Effect of Pre- and Postdischarge Interventions on Breastfeeding Outcomes and Weight Gain Among Premature Infants. JOGNN 39, 53–63. https://doi.org/10.1111/j.1552-6909.2009.01088.x

Amin, T., Hablas, H., Al Qader, A.A., 2011. Determinants of initiation and exclusivity of breastfeeding in al Hassa, Saudi Arabia. Breastfeed. Med. 6, 59–68. https://doi.org/10.1089/bfm.2010.0018

Azzeh, F., Alazzeh, A., Hijazi, H., Wazzan, H., Jawharji, M., Jazar, A., Filimban, A., Alshamrani, A., Labani, M., Hasanain, T., Obeidat, A., 2018. Factors Associated with Not Breastfeeding and Delaying the Early Initiation of Breastfeeding in Mecca Region, Saudi Arabia. Children 5, 8. https://doi.org/10.3390/children5010008

Ballesta-Castillejos, A., Gomez-Salgado, J., Rodriguez-Almagro, J., Ortiz-Esquinas, I., Hernández-Martínez, A., 2019. Obstetric and perinatal complications associated with assisted reproductive treatment in Spain. J. Assist. Reprod. Genet. 36. https://doi.org/10.1007/s10815-019-01631-6

Berra, S., Rajmil, L., Passamonte, R., Fernandez, E., Sabulsky, J., 2001. Premature cessation of breastfeeding in infants: Development and evaluation of a predictive model in two Argentinian cohorts: The CLACYD study*, 1993-1999. Acta Paediatr. Int. J. Paediatr. 90, 544–551. https://doi.org/10.1111/j.1651-2227.2001.tb00796.x

Boudet-Berquier, J., Salanave, B., Desenclos, J.C., Castetbon, K., 2018. Association between maternal prepregnancy obesity and breastfeeding duration: Data from a nationwide prospective birth cohort. Matern. Child Nutr. 14. https://doi.org/10.1111/mcn.12507

Chang, P.C., Li, S.F., Yang, H.Y., Wang, L.C., Weng, C.Y., Chen, K.F., Chen, W., Fan, S.Y., 2019. Factors associated with cessation of exclusive breastfeeding at 1 and 2 months postpartum in Taiwan. Int. Breastfeed. J. 14. https://doi.org/10.1186/s13006-019-0213-1

Chipojola, R., Chiu, H.Y., Huda, M.H., Lin, Y.M., Kuo, S.Y., 2020. Effectiveness of theory-based educational interventions on breastfeeding self-efficacy and exclusive breastfeeding: A systematic review and meta-analysis. Int. J. Nurs. Stud. 109, 103675. https://doi.org/10.1016/j.ijnurstu.2020.103675

Cohen, S.S., Alexander, D.D., Krebs, N.F., Young, B.E., Cabana, M.D., Erdmann, P., Hays, N.P., Bezold, C.P., Levin-Sparenberg, E., Turini, M., Saavedra, J.M., 2018a. Factors Associated with Breastfeeding Initiation and Continuation: A Meta-Analysis. J. Pediatr. 203, 190-196.e21. https://doi.org/10.1016/j.jpeds.2018.08.008

Cohen, S.S., Alexander, D.D., Krebs, N.F., Young, B.E., Cabana, M.D., Erdmann, P., Hays, N.P., Bezold, C.P., Levin-Sparenberg, E., Turini, M., Saavedra, J.M., 2018b. Factors Associated with Breastfeeding Initiation and Continuation: A Meta-Analysis. J. Pediatr. 203, 190-196.e21. https://doi.org/10.1016/j.jpeds.2018.08.008

DiFrisco, E., Goodman, K.E., Budin, W.C., Lilienthal, M.W., Kleinman, A., Holmes, B., 2011. Factors Associated With Exclusive Breastfeeding 2 to 4 Weeks Following Discharge From a Large, Urban, Academic Medical Center Striving for Baby-Friendly Designation. J. Perinat.

Educ. 20, 28–35. https://doi.org/10.1891/1058-1243.20.1.28

Flores, T.R., Mielke, G.I., Wendt, A., Nunes, B.P., Bertoldi, A.D., 2018. Prepregnancy weight excess and cessation of exclusive breastfeeding: A systematic review and meta-analysis. Eur. J. Clin. Nutr. https://doi.org/10.1038/s41430-017-0073-y

Gomez-Pomar, E., Blubaugh, R., 2018. The Baby Friendly Hospital Initiative and the ten steps for successful breastfeeding. a critical review of the literature. J. Perinatol. https://doi.org/10.1038/s41372-018-0068-0

Guo, S., Fu, X., Scherpbier, R.W., Wang, Y., Zhou, H., Wang, X., Hipgrave, D.B., 2013. Taux d'allaitement maternel en Chine centrale et occidentale en 2010: Implications pour la santé de l'enfant et de la population. Bull. World Health Organ. 91, 322–331. https://doi.org/10.2471/BLT.12.111310

Hall, R.T., Mercer, A.M., Teasley, S.L., McPherson, D.M., Simon, S.D., Santos, S.R., Meyers, B.M., Hipsh, N.E., 2002. A breast-feeding assessment score to evaluate the risk for cessation of breast-feeding by 7 to 10 days of age. J. Pediatr. 141, 659–664. https://doi.org/10.1067/mpd.2002.129081

Herrick, K.A., Rossen, L.M., Kit, B.K., Wang, C.Y., Ogden, C.L., 2016. Trends in breastfeeding initiation and duration by birth weight among US children, 1999-2012. JAMA Pediatr. https://doi.org/10.1001/jamapediatrics.2016.0820

Hosmer, D.W., Jr., Lemeshow, S. and Sturdivant, R.X., 2013. Model- Building Strategies and Methods for Logistic Regression. John Wiley & Sons, Ltd, pp. 89–151. https://doi.org/10.1002/9781118548387.ch4

Inal, S., Aydin, Y., Canbulat, N., 2016. Factors associated with breastfeeding initiation time in a baby-friendly hospital in Istanbul. Appl. Nurs. Res. 32, 26–29. https://doi.org/10.1016/j.apnr.2016.03.008

Instuto Nacional de Estadística, n.d. Tasa de Natalidad por comunidad autónoma, según nacionalidad (española/extranjera) de la madre(1433) [WWW Document]. URL https://www.ine.es/jaxiT3/Datos.htm?t=1433#!tabs-tabla (accessed 1.2.21).

Kaneko, A., Kaneita, Y., Yokoyama, E., Miyake, T., Harano, S., Suzuki, K., Ibuka, E., Tsutsui, T., Yamamoto, Y., Ohida, T., 2006. Factors Associated with Exclusive Breast-feeding in Japan: for Activities to Support Child-rearing with Breast-feeding. J. Epidemiol. 16, 57–63. https://doi.org/10.2188/jea.16.57

Kitano, N., Nomura, K., Kido, M., Murakami, K., Ohkubo, T., Ueno, M., Sugimoto, M., 2016. Combined effects of maternal age and parity on successful initiation of exclusive breastfeeding. Prev. Med. Reports 3, 121–126. https://doi.org/10.1016/j.pmedr.2015.12.010

Kominiarek, M.A., Peaceman, A.M., 2017. Gestational weight gain. Am. J. Obstet. Gynecol. https://doi.org/10.1016/j.ajog.2017.05.040

Kronborg, H., Væth, M., 2019. Validation of the breastfeeding score—a simple screening tool to predict breastfeeding duration. Nutrients 11. https://doi.org/10.3390/nu11122852

Lau, Y., Tha, P.H., Ho-Lim, S.S.T., Wong, L.Y., Lim, P.I., Citra Nurfarah, B.Z.M., Shorey, S., 2018. An analysis of the effects of intrapartum factors, neonatal characteristics, and skin-to-skin contact on early breastfeeding initiation. Matern. Child Nutr. 14. https://doi.org/10.1111/mcn.12492

Lutsiv, O., Pullenayegum, E., Foster, G., Vera, C., Giglia, L., Chapman, B., Fusch, C., McDonald, S., 2013. Women's intentions to breastfeed: A population-based cohort study. BJOG 120, 1490–1498. https://doi.org/10.1111/1471-0528.12376

Maimburg, R.D., 2017. Rates of breastfeeding initiation among newborns. Sex. Reprod. Healthc. 12, 1–2. https://doi.org/10.1016/j.srhc.2017.01.001

McDonald, S.D., Pullenayegum, E., Chapman, B., Vera, C., Giglia, L., Fusch, C., Foster, G., 2012.

Prevalence and Predictors of Exclusive Breastfeeding at Hospital Discharge. Obstet. Gynecol. 119, 1171–1179. https://doi.org/10.1097/AOG.0b013e318256194b

Méio, M.D.B.B., Villela, L.D., Gomes Júnior, S.C. dos S., Tovar, C.M., Moreira, M.E.L., 2018. Amamentação em lactentes nascidos pré-termo após alta hospitalar: acompanhamento durante o primeiro ano de vida. Cien. Saude Colet. 23, 2403–2412. https://doi.org/10.1590/1413-81232018237.15742016

Mickey, R.M., Greenland, S., 1989. The impact of confounder selection criteria on effect estimation. Am. J. Epidemiol. 129, 125–137. https://doi.org/10.1093/oxfordjournals.aje.a115101

Ministerio de sanidad, 2020. Situación de Salud Informe Anual del Sistema Nacional de Salud 2018.

Mishra, P., Pandey, C.M., Singh, U., Gupta, A., Sahu, C., Keshri, A., 2019. Descriptive statistics and normality tests for statistical data. Ann. Card. Anaesth. 22, 67–72. https://doi.org/10.4103/aca.ACA_157_18

Moore, E.R., Bergman, N., Anderson, G.C., Medley, N., 2016. Early skin-to-skin contact for mothers and their healthy newborn infants. Cochrane Database Syst. Rev. https://doi.org/10.1002/14651858.CD003519.pub4

O'Connor, M., Allen, J., Kelly, J., Gao, Y., Kildea, S., 2018. Predictors of breastfeeding exclusivity and duration in a hospital without Baby Friendly Hospital Initiative accreditation: A prospective cohort study. Women and Birth 31, 319–324. https://doi.org/10.1016/j.wombi.2017.10.013

Organization, G.W.H., 2017. National Implementation of the Baby-friendly Hospital Initiative, Who.

Patterson, J.A., Keuler, N.S., Olson, B.H., 2018. The effect of Baby-friendly status on exclusive breastfeeding in U.S. hospitals. Matern. Child Nutr. 14. https://doi.org/10.1111/mcn.12589

Pattison, K.L., Kraschnewski, J.L., Lehman, E., Savage, J.S., Downs, D.S., Leonard, K.S., Adams, E.L., Paul, I.M., Kjerulff, K.H., 2019. Breastfeeding initiation and duration and child health

outcomes in the first baby study. Prev. Med. (Baltim). 118, 1–6. https://doi.org/10.1016/j.ypmed.2018.09.020

Peduzzi, P., Concato, J., Kemper, E., Holford, T.R., Feinstem, A.R., 1996. A simulation study of the number of events per variable in logistic regression analysis. J. Clin. Epidemiol. 49, 1373–1379. https://doi.org/10.1016/S0895-4356(96)00236-3

Prasitwattanaseree, P., Prasopkittikun, T., Viwatwongkasem, C., Sinsucksai, N., 2019. Effectiveness of Breastfeeding Skills Training and Support Program among First Time Mothers Effectiveness of Breastfeeding Skills Training and Support Program among First Time Mothers: A Randomized Control Trial, Pacific Rim Int J Nurs Res.

Rubio-Álvarez, A., Molina-Alarcón, M., Arias-Arias, Á., Hernández-Martínez, A., 2018. Development and validation of a predictive model for excessive postpartum blood loss: A retrospective, cohort study. Int. J. Nurs. Stud. 79, 114–121. https://doi.org/10.1016/j.ijnurstu.2017.11.009

Scott, J.A., Landers, M.C.G., Hughes, R.M., Binns, C.W., 2001. Factors associated with breastfeeding at discharge and duration of breastfeeding. J. Paediatr. Child Health 37, 254–261. https://doi.org/10.1046/j.1440-1754.2001.00646.x

Senarath, U., Dibley, M.J., Agho, K.E., 2010. Factors associated with nonexclusive breastfeeding in 5 east and Southeast Asian countries: A multilevel analysis. J. Hum. Lact. 26, 248–257. https://doi.org/10.1177/0890334409357562

Silva Luz, L.I., Minamisava, R.I., Gracinda Silvan Scochi, C.I., Karina Marques Salge, A.I., Medeiros Ribeiro III, L., 2018. Predictive factors of the interruption of exclusive breastfeeding in premature infants: a prospective cohort. Rev Bras Enferm [Internet] 71, 2876–82. https://doi.org/10.1590/0034-7167-2017-0762

Smith, E.R., Hurt, L., Chowdhury, R., Sinha, B., Fawzi, W., Edmond, K.M., 2017. Delayed

breastfeeding initiation and infant survival: A systematic review and meta-analysis. PLoS One 12. https://doi.org/10.1371/journal.pone.0180722

Song, J.W., Chung, K.C., 2010. Observational Studies: Cohort and Case-Control Studies. Plast Reconstr Surg 126, 2234–2242. https://doi.org/10.1097/PRS.0b013e3181f44abc

Sutherland, T., Pierce, C.B., Blomquist, J.L., Handa, V.L., 2012. Breastfeeding practices among first-time mothers and across multiple pregnancies. Matern. Child Health J. 16, 1665–1671. https://doi.org/10.1007/s10995-011-0866-x

Swets, J.A., 1988. Measuring the accuracy of diagnostic systems. Sci. Sci. 240, 1285–1293. https://doi.org/10.1126/science.3287615

Theurich, M.A., Davanzo, R., Busck-Rasmussen, M., Díaz-Gómez, N.M., Brennan, C., Kylberg, E., Bærug, A., McHugh, L., Weikert, C., Abraham, K., Koletzko, B., 2019. Breastfeeding Rates and Programs in Europe. J. Pediatr. Gastroenterol. Nutr. 68, 400–407. https://doi.org/10.1097/MPG.0000000000002234

Tornese, G., Ronfani, L., Pavan, C., Demarini, S., Monasta, L., Davanzo, R., 2012. Does the LATCH score assessed in the first 24 hours after delivery predict non-exclusive breastfeeding at hospital discharge? Breastfeed. Med. 7, 423–430. https://doi.org/10.1089/bfm.2011.0120

UNICEF, 2018a. A Mother's Gift, for Every Child BREASTFEEDING. New York.

UNICEF, 2018b. Capture the moment early initiation of breastfeeding: The best start for every newborn. New York.

Victora, C.G., Bahl, R., Barros, A.J.D., França, G.V.A., Horton, S., Krasevec, J., Murch, S., Sankar, M.J., Walker, N., Rollins, N.C., Allen, K., Dharmage, S., Lodge, C., Peres, K.G., Bhandari, N., Chowdhury, R., Sinha, B., Taneja, S., Giugliani, E., Horta, B., Maia, F., de Mola, C.L., Hajeebhoy, N., Lutter, C., Piwoz, E., Martines, J.C., Richter, L., 2016. Breastfeeding in the 21st century: Epidemiology, mechanisms, and lifelong effect. Lancet. https://doi.org/10.1016/S0140-

6736(15)01024-7

Vila-Candel, R., Soriano-Vidal, F.J., Murillo-Llorente, M., Pérez-Bermejo, M., Castro-Sánchez, E., 2019. Maintenance of exclusive breastfeeding after three months postpartum: An experience in a health department of a Valencian Community. Aten. Primaria 51, 91–98. https://doi.org/10.1016/j.aprim.2017.09.002

Wang, Y., Shan, C., Zhang, Y., Ding, L., Wen, J., Tian, Y., 2020. Early Recognition of the Preference for Exclusive Breastfeeding in Current China: A Prediction Model based on Decision Trees. Sci. Rep. 10, 1–8. https://doi.org/10.1038/s41598-020-63073-w

Whipps, M.D.M., 2017. Education Attainment and Parity Explain the Relationship Between Maternal Age and Breastfeeding Duration in U.S. Mothers. J. Hum. Lact. 33, 220–224. https://doi.org/10.1177/0890334416679385

Whitford, H.M., Wallis, S.K., Dowswell, T., West, H.M., Renfrew, M.J., 2017. Breastfeeding education and support for women with twins or higher order multiples. Cochrane Database Syst. Rev. https://doi.org/10.1002/14651858.CD012003.pub2

Wiklund, I., Norman, M., Uvnäs-Moberg, K., Ransjö-Arvidson, A.B., Andolf, E., 2009. Epidural analgesia: Breast-feeding success and related factors. Midwifery 25. https://doi.org/10.1016/j.midw.2007.07.005

world health organization, (OMS), 2018. WHO | The optimal duration of exclusive breastfeeding: report of the expert consultation. WHO.

Yokoyama, Y., Wada, S., Sugimoto, M., Katayama, M., Saito, M., Sono, J., 2006. Breastfeeding rates among singletons, twins and triplets in Japan: A population-based study. Twin Res. Hum. Genet. 9, 298–302. https://doi.org/10.1375/183242706776382347

Yu, C.K.H., Teoh, T.G., Robinson, S., 2006. Obesity in pregnancy. BJOG An Int. J. Obstet. Gynaecol. https://doi.org/10.1111/j.1471-0528.2006.00991.x

Figure 1. ROC curve of the predictive model for the derivation cohort.

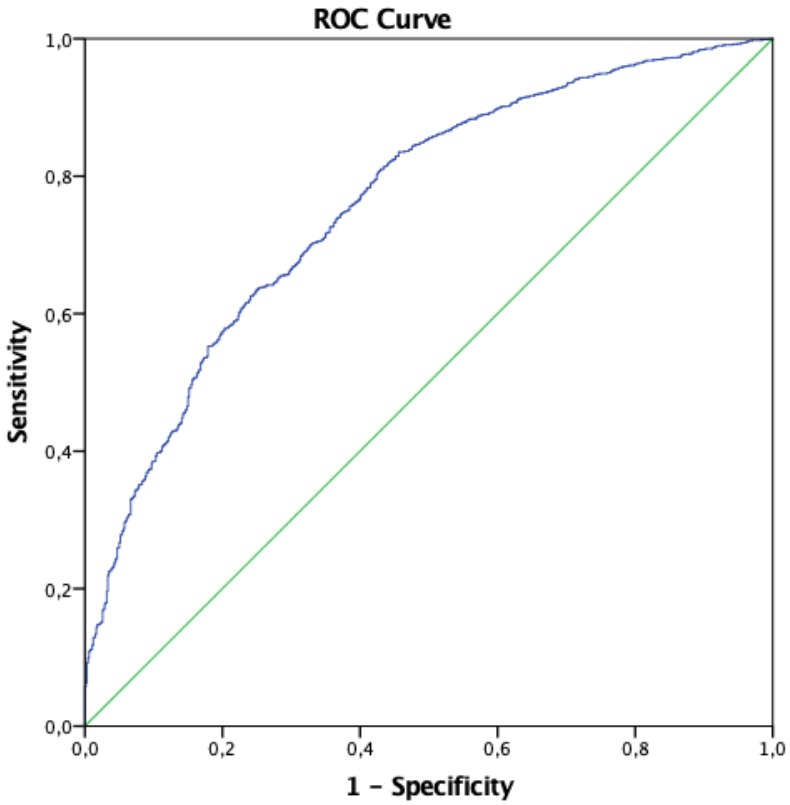

Figure legend. Area under the ROC curve to determine the predictive ability of the model in the derivation cohort, representing the sensitivity on the ordinate axis and specificity in the abscissa.

Figure 2. ROC curve of the predictive model for the validation cohort.

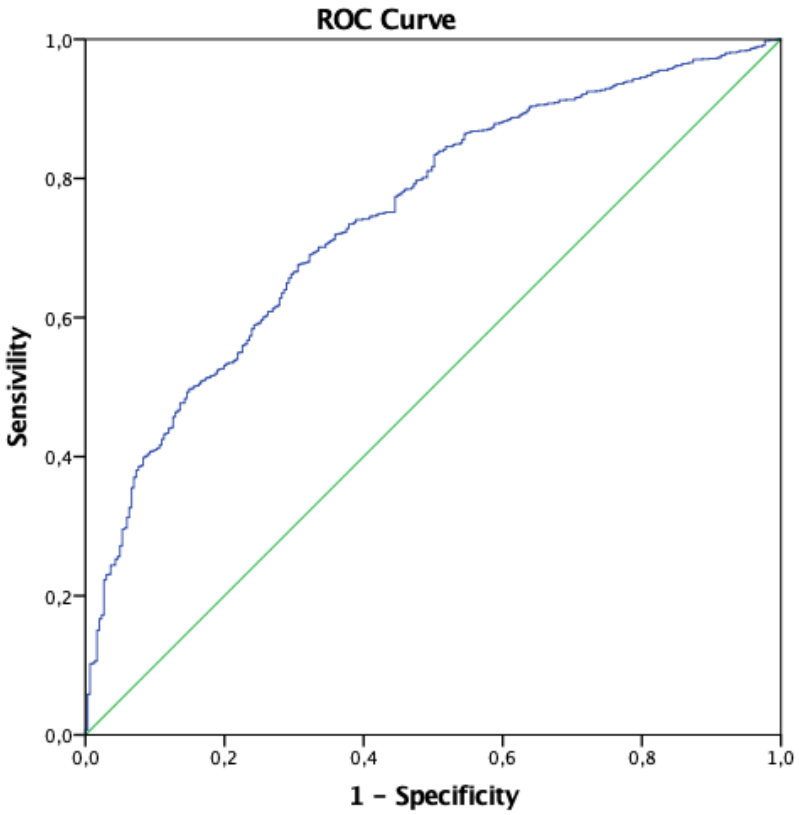

Figure legend. Area under the ROC curve to determine the predictive ability of the model in the validation cohort, representing the sensitivity on the ordinate axis and specificity in the abscissa.

Table 1. Bivariate analysis of potential predictive factors of breastfeeding at discharge.

Predictor	Breastfeeding at discharge		P Value
	No	Yes	
	n (%)	n (%)	
Maternal age Media (SD)	33.9 (4.37)	33.7 (4.25)	0.101
Level of studies			0.518
No studies	0 (0.0)	5 (100.0)	
Primary	15 (25.0)	45 (75.0)	
Secondary	181 (19.7)	736 (80.3)	
University	474 (19.7)	1931 (80.3)	
Nationality			**0.001**
Spanish	609 (19.2)	2561 (80.8)	
Foreign	61 (28.1)	156 (71.9)	
Family income			0.745
≤ 1000 euros	44 (23.2)	146 (76.8)	
1001-2000 euros	218 (19.4)	904 (80.6)	
2001-3000 euros	239 (20.2)	945 (79.8)	
3001-4000 euros	119 (18.9)	509 (81.1)	
>4000 euros	50 (19.0)	213 (81.0)	
Body Mass Index_Mean (SD)	28.4 (4.89)	27.7 (4.27)	**<0.001**
Smoking habit			0.480
No habit	505 (19.3)	2106 (80.7)	
1-10 cigarettes	122 (21.0)	458 (79.0)	
>10 cigarettes	43 (21.9)	153 (78.1)	
Type of conception			**<0.001**
Spontaneous	562 (18.5)	2475 (81.5)	
Artificial Insemination	22 (28.6)	55 (71.4)	
IVF	86 (31.5)	187 (68.5)	

Support from partner			**0.011**
No	151 (23.2)	500 (76.8)	
Yes	489 (18.7)	2120 (81.3)	
Number of children			**<0.001**
One	553 (25.0)	1658 (75.0)	
Two	100 (9.7)	926 (90.3)	
Three or more	16 (11.2)	127 (88.8)	
Previous caesarean section			0.052
No	625 (20.2)	2474 (79.8)	
Yes	44 (15.4)	242 (84.6)	
Birth plan			**<0.001**
No	451 (22.7)	1534 (77.3)	
Yes, but not followed	78 (22.5)	268 (77.5)	
Yes, mostly followed	141 (13.4)	915 (86.6)	
Labour induction			**<0.001**
No	351 (16.5)	1782 (83.5)	
Yes	319 (25.4)	935 (74.6)	
Regional analgesia			**<0.001**
No	127 (12.8)	865 (87.2)	
Yes	543 (22.7)	1852 (77.3)	
Nitrous oxide			0.495
No	649 (19.9)	2617 (80.1)	
Yes	21 (17.4)	100 (82.6)	
General anaesthesia			**0.001**
No	654 (19.5)	2695 (80.5)	
Yes	16 (42.1)	22 (57.9)	

Nonpharmacologic methods to management of labour pain			**0.001**
No	633 (20.5)	2456 (79.5)	
Yes	37 (12.4)	261 (87.6)	
Type of delivery			**<0.001**
Normal birth	275 (13.5)	1766 (86.5)	
Instrumental birth	122 (21.3)	452 (78.7)	
Planned caesarean	80 (33.1)	162 (66.9)	
Emergency caesarean	193 (36.4)	337 (63.6)	
Episiotomy			0.815
No	451 (19.9)	1816 (80.1)	
Yes	219 (19.6)	901 (80.4)	
Third or fourth degree vaginal tearing			0.197
No	665 (19.9)	2680 (80.1)	
Yes	5 (11.9)	37 (88.1)	
Prematurity			**<0.001**
No	584 (18.3)	2609 (81.7)	
Yes	86 (44.3)	108 (55.7)	
Multiple birth			**<0.001**
No	631 (19)	2688 (81.0)	
Yes	39 (57.4)	29 (42.6)	
Low weight			**<0.001**
No	579 (18.2)	2600 (81.8)	
Yes	91 (45.5)	109 (54.5)	
Macrosomia			0.181
No	633 (19.6)	2592 (80.4)	

Yes	37 (24.0)	117 (76.0)	
Newborn admittance			**<0.001**
No	497 (16.7)	2472 (83.3)	
Yes	173 (41.4)	245 (58.6)	
Attendance to maternal education			**<0.001**
No	109 (14.7)	630 (85.3)	
Yes, but not on breastfeeding	144 (23.6)	465 (76.4)	
Yes, with breastfeeding training	417 (20.5)	1622 (79.5)	
Previous breastfeeding			**<0.001**
No	558 (24.7)	1699 (75.3)	
Yes	112 (9.9)	1018 (90.1)	
Skin-to-skin contact			**<0.001**
No (but no mother-child separation)	278 (38.6)	443 (61.4)	
Yes, but less than an hour	94 (26.7)	258 (73.3)	
Yes, and for one hour minimum	298 (12.9)	2016 (87.1)	

Bold: Statistically significant differences

Table 2. Risk predictive model for breastfeeding at discharge

Number of events in Derivation Cohort		3387 (80.2%)	
Number of events in Validation Cohort		1694 (82.1%)	
Predictors	**Beta Coeff.**	**Odds Ratio (95% CI*)**	**P value**
Maternal age at delivery	-0.038	**0.96 (0.94-0.98)**	**0.001**
Number of children			**0.012**
One		1 (Ref)	
Two	0.701	**2.01 (1.26-3.19)**	**0.003**
Three or more	0.631	1.87 (0.92-3.81)	0.080
Prematurity	- 0.830	**0.43 (0.30-0.62)**	**<0.001**
Multiple pregnancy	-1.216	**0.29 (0.16-0.53)**	
Induced delivery	0.095	**0.82 (0.68-0.99)**	**0.046**
Type of delivery			0.109
Normal delivery		1 (Ref)	
Instrumental delivery	-0.026	0.97 (0.75-1.26)	0.845
Caesarean	-0.280	**0.75 (0.57-0.99)**	**0.044**
Previous breastfeeding	0.495	**1.64 (1.03-2.60)**	**0.036**
Onset of breastfeeding within the first hour	0.751	**2.11 1.64-2.72**	**<0.001**
Skin-to-skin contact			**0.001**
No		1 (Ref)	
Yes, but less than an hour	-0.085	0.91 (0.65-1.28)	0.622
Yes, and for an hour minimum	0.416	**1.51 (1.11-2.06)**	**<0.001**
Birth plan			**0.001**
No		1 (Ref)	
Yes, but not followed	0.321	**1.37 (1.02-1.85)**	**0.035**
Yes, and mostly followed	0.409	**1.50 (1.19-1.89)**	**<0.001**
Macrosomia	-0.500	**0.60 (0.39-0.92)**	**0.021**

BMI	-0.019	**0.98 (0.96-1.00)**	**0.077**
Epidural use	-0.391	**0.67 (0.53-0.85)**	**0.001**
Constant	2.593		
AUC ROC Derivation Cohort**		**0.76 (0.74-0.78)**	**<0.001**
AUC ROC Validation Cohort**		**0.74 (0.71-0.77)**	**<0.001**

Beta Coeff.: Beta Coefficient; BMI: Body Mass Index; AUC: Area under the curve.

*CI: Confidence interval

**AUC: Area under the curve

Table 3. **Predictive characteristics of the model for different probabilities.**

Probability	Sensitivity	Specificity	PPV*	NPV**	LR+	LR-
Higher 0.5						
Derivation Cohort	85.4	49.2	87.2	45.3	1.68	0.30
Validation Cohort	84.6	47.5	88.0	40.4	1.61	0.32
Higher 0.6						
Derivation Cohort	74.0	62.7	89.0	37.2	1.99	0.41
Validation Cohort	75.1	56.8	88.0	33.4	1.74	0.44
Higher 0.7						
Derivation Cohort	54.2	82.9	92.8	30.7	3.17	0.55
Validation Cohort	57.9	76.1	91.7	28.4	2.42	0.55
Higher 0.8						
Derivation Cohort	32.0	93.5	95.2	25.3	4.92	0.72
Validation Cohort	39.1	91.7	95.5	24.9	4.17	0.66
Higher 0.9						
Derivation Cohort	10.0	99.4	98.5	21.4	16.7	0.90
Validation Cohort	10.6	98.3	96.7	19.5	6.24	0.91

*PPV: Positive Predictive Value

**NPV: Negative Predictive Value

Table 4. Comparison between derivation and validation cohort characteristics.

Characteristics	Derivation Cohort n=3387 (n/%)	Validation Cohort n=1694 (n/%)	**P Value**
Exclusive breastfeeding			0.117
No	670 (19.8)	304 (17.9)	
Yes	2717 (80.2)	1390 (82.1)	
Maternal age_Mean (SD)	33.7 (4.27)	34.2 (4.22)	**0.001**
Level of studies			0.788
No studies	5 (0.1)	2 (0.1)	
Primary	60 (1.8)	25 (1.5)	
Secondary	917 (27.1)	474 (28.0)	
University	2405 (71.0)	1193 (70.4)	
Nationality			0.966
Spanish	3170 (93.6)	1586 (93.6)	
Foreign	217 (6.4)	108 (6.4)	
Family income			0.740
≤ 1000 euros	190 (5.6)	96 (5.7)	
1001-2000 euros	1122 (33.1)	569 (33.6)	
2001-3000 euros	1184 (35.0)	562 (33.2)	
3001-4000 euros	628 (18.5)	324 (19.1)	
>4000 euros	263 (7.8)	143 (8.4)	
Body Mass Index Media (SD)	27.80 (4.41)	27.96 (4.42)	0.206*
Smoking habit			0.368
No habit	2611 (77.1)	1323 (78.1)	
1-10 cigarettes	580 (17.1)	289 (17.1)	
>10 cigarettes	196 (5.8)	82 (4.8)	
Type of conception			0.513

Spontaneous	3037 (89.7)	1501 (88.6)	
Artificial insemination	77 (2.3)	43 (2.5)	
IVF	273 (8.1)	150 (8.9)	
Support from partner			0.207
No	651 (68.2)	304 (31.8)	
Yes	2609 (66.0)	1344 (34.0)	
Number of children			**<0.001**
One	2211 (65.4)	967 (57.2)	
Two	1026 (30.4)	623 (36.8)	
Three or more	143 (4.2)	102 (6.0)	
Previous caesarean section			**<0.001**
No	3099 (91.6)	1497 (88.4)	
Yes	286 (8.4)	196 (11.6)	
Birth plan			0.445
No	1985 (58.6)	968 (57.1)	
Yes, but not followed	346 (10.2)	168 (9.9)	
Yes, and mostly followed	1056 (31.2)	558 (32.9)	
Labour induction			0.299
No	2133 (63.0)	1092 (64.5)	
Yes	1254 (37.0)	602 (35.5)	
Regional analgesia			0.822
No	992 (29.3)	491 (29.0)	
Yes	2395 (70.7)	1203 (71.0)	
Nitrous oxide			0.247
No	3266 (96.4)	1644 (97.4)	
Yes	121 (3.6)	50 (3.0)	
General anaesthesia			0.467

No	3349 (98.9)	1671 (98.6)	
Yes	38 (1.1)	23 (1.4)	
Natural methods			0.523
No	3089 (91.2)	1554 (91.7)	
Yes	298 (8.8)	140 (8.3)	
Type of delivery			0.611
Normal birth	2041 (60.3)	1025 (60.5)	
Instrumental birth	574 (16.9)	270 (15.9)	
Planned caesarean	772 (22.8)	399 (23.6)	
Episiotomy			0.105
No	2267 (66.9)	1172 (69.2)	
Yes	1120 (33.1)	522 (30.8)	
Third or fourth degree vaginal tearing			0.389
No	3345 (98.8)	1668 (98.5)	
Yes	42 (1.2)	26 (1.5)	
Prematurity			**<0.001**
No	3193 (94.3)	1553 (91.7)	
Yes	194 (5.7)	141 (8.3)	
Multiple birth			0.780
No	3319 (98.0)	1658 (97.9)	
Yes	68 (2.0)	36 (2.1)	
Low weight			0.412
No	3179 (94.1)	1581 (93.5)	
Yes	200 (5.9)	110 (6.5)	
Macrosomia			0.559
No	3225 (95.4)	1620 (95.8)	

Yes	154 (4.6)	71 (4.2)	
Newborn admittance			0.213
No	2969 (87.7)	1464 (86.4)	
Yes	418 (12.3)	230 (13.6)	
Attendance to maternal education			0.273
No	739 (21.8)	402 (23.7)	
Yes, but not on breastfeeding	609 (18.0)	306 (18.1)	
Yes, with breastfeeding training	2039 (60.2)	986 (58.2)	
Previous breastfeeding			**<0.001**
No	2257 (66.6)	985 (58.1)	
Yes	1130 (33.4)	709 (41.9)	
Skin-to-skin contact			0.328
No (but no mother-child separation)	721 (21.3)	339 (20.0)	
Yes, but less than an hour	352 (10.4)	163 (9.6)	
Yes, and for an hour minimum	2314 (68.3)	1192 (70.4)	

***(Mean± SD), Student's t-Fisher test**

SUPPLEMENTARY MATERIAL

Supplementary Figure 1.A: Probability of breastfeeding at discharge. Example 1.

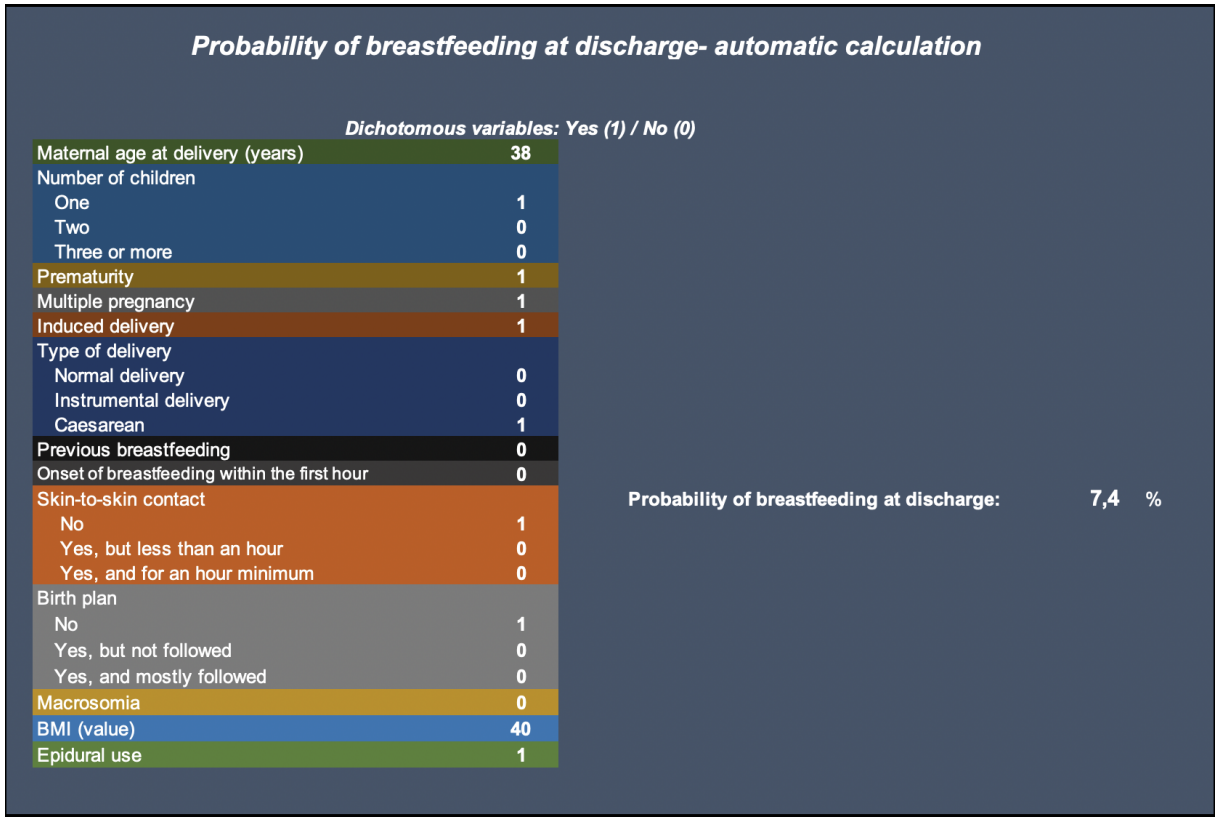

Figure legend. Probability of breastfeeding for a 38-year-old woman, first child, premature, multiple gestation, induced labor, cesarean section, no previous breastfeeding experience, no initiation of breastfeeding in the first hour, no skin-to-skin contact, no birth plan, no macrosomic, with a BMI of 40 and who has used an epidural = 7.4%

Supplementary Figure 1.B: Probability of breastfeeding at discharge. Example 2.

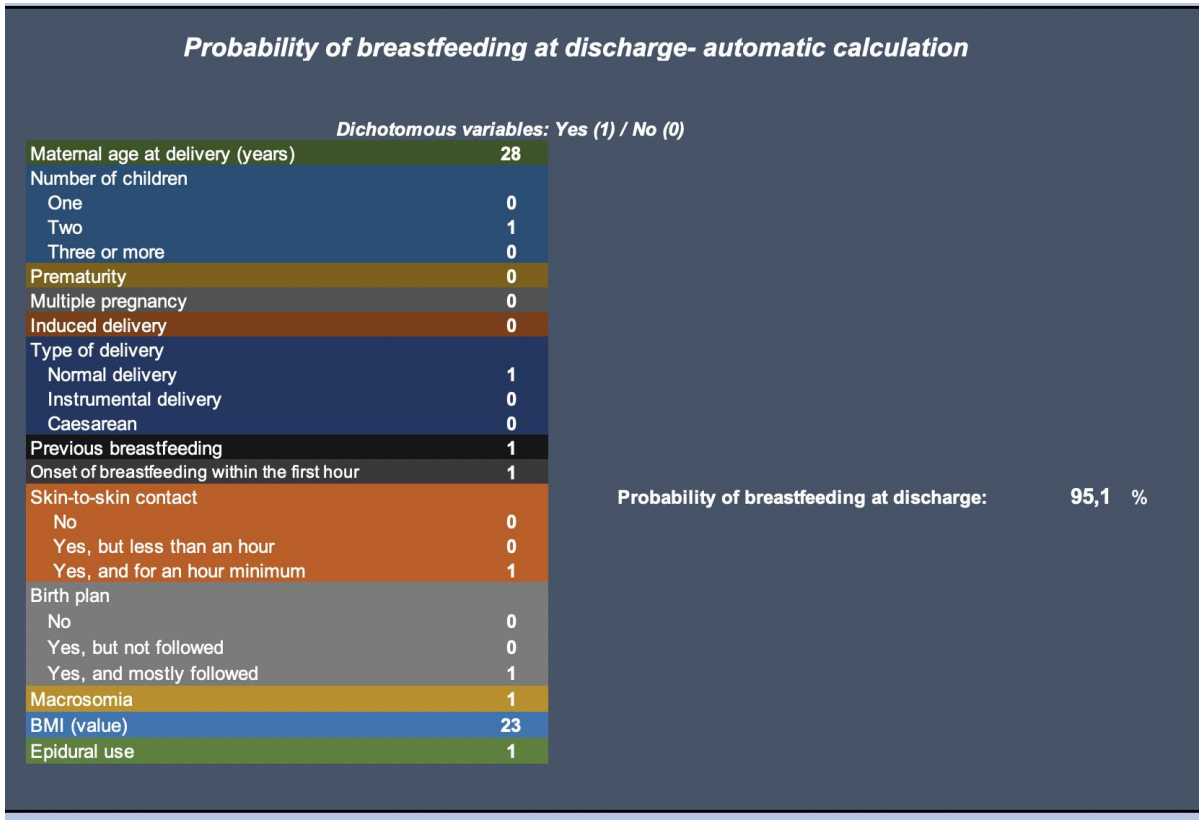

Figure legend. Probability of breastfeeding for a 28-year-old woman, second child, not premature, not multiple gestation, not induced labor, normal labor, with previous breastfeeding experience, with initiation of breastfeeding in the first hour, with skin-to-skin contact, with plan of respected delivery, not macrosomic, with a BMI of 23 and that has used an epidural = 95.1%

Table 1: Published predictive models on maternal breastfeeding.

Year	Author	Population	Objective	Conclusion
2001	Berra, S et al.	700 newborns from two cohorts developed in 1993 and 1995. The study was carried out on 632 newborns.	Develop a model to predict cessation of breastfeeding before 6 months in newborns.	Develop a predictive model that considers 4 factors: previous breastfeeding time period, time breastfeeding, time between delivery and first contact with the child, and whether pregnancy was planned.
2002	Hall, R et al.	1108 mother-infant pairs.	Develop a succinct and comprehensive breast-feeding assessment score (BAS) to accurately identify infants at risk for early cessation of breast-feeding before initial hospital discharge.	The BAS was easily and quickly performed before hospital discharge for near term and term infants, which accurately predicted the risk of breast-feeding cessation within 7 to 10 days of age in the population studied.
2012	Tornese, G et al.	299 mother–infant dyads.	Analyse the relationship between the LATCH score assessed in the first 24 hours after delivery and non-exclusive breastfeeding at discharge.	The LATCH score is a useful tool to identify mother-infant pairs who might benefit from additional skilled support in specific subgroups at risk of non-exclusive breastfeeding at discharge.
2019	Kronborg, H et al.	Derivation cohort collected in 1999, which included 471 Danish-speaking mothers. Validation cohort from 2017 (n = 612).	To validate a revised version of the breastfeeding score using new and expanded data.	The breastfeeding score indicated good ability to discriminate between mothers at risk of early exclusive breastfeeding cessation.
2020	Wang, Y et al.	1,500 mother–infant dyads.	Apply a decision tree (DT) model to predict EBF at two months postpartum.	The DT model showed similar or better performance than the logistic regression model in assessing the risk of early cessation of EBF before two months postpartum. The DT model has potential for application in clinical practice and identifies high-risk subpopulations that need specific prevention.

ASSOCIATE EDITOR'S COMMENTS

Please amend the title of the paper to make the research design explicit. we suggest: 'Development and validation of a predictive model of exclusive breastfeeding at hospital discharge: retrospective cohort study'

Thank you very much for your comment; this has been modified. Page 1, paragraph 1.

Well done for undertaking the recommended revisions.
Unfortunately there remain some required revisions of the manuscript which I set out below. Please undertake these corrections meticulously (carefully) so that the manuscript reaches a publishable standard.

In the Abstract Design: “Retrospective cohorts study on women who gave birth between 2014 and 2019 in Spain”. Please correct cohorts to cohort.

Thank you very much for your correction; this has been modified. Page1, paragraph 4, line 1.

Page 3, line 33: “Summarising global data on any breastfeeding rates, we find that Canada stands out..”. Please remove “we find that”.

Thank you very much for your correction; this has been modified. Page 3, paragraph2, line 4.

Page 4, line 39: “baby friendly hospital”. Please correct: Baby Friendly ie upper case as it is a recognised assignation.

Thank you very much for your suggestion; this has been modified. Page 4, paragraph 5, line 10.

Page 5, line 9: “In this sense, the research question is: Could it be possible to predict premature cessation of maternal breastfeeding?”. Please revise this sentence. I suggest the following: The research question is: Is it possible to predict premature cessation of maternal breastfeeding?

Thank you very much for your suggestion; this has been modified. Page 5, paragraph 1, line 5.

Page 5, line 26: “A retrospective cohorts methodology”. Please correct to: A retrospective cohort method

Thank you very much for your correction; this has been modified. Page 1, paragraph 2, line 1.

Page 5, line 21: “the online ad-hoc questionnaire”. Please remove “ad hoc”.

Thank you very much for your correction; this has been removed. Page 5, paragraph 2, line 3.

Page 5, line 40: “In an attempt to estimate the sample size to obtain valid coefficient estimates, the maximum modelling principle (Peduzzi et al., 1996). was followed.” Please revise this

sentence. I suggest the following: The maximum modelling principle (Peduzzi et al., 1996) was used to estimate the sample size to obtain valid coefficient estimates.

Thank you very much for your suggestion; this has been modified. Page 5, paragraph 3, line 1.

Page 6, line 14: A survey methodology was used to collect relevant data for this study. The research team developed the questionnaire taking into account the aspects that other authors had described as related to maternal breastfeeding at hospital discharge. The questions asked in the questionnaire are divided into open questions such as maternal age or number of children, questions about whether the mother is a smoker or has been performed a previous C-section, and multiple answer questions such as the type of delivery. Prior to the mass dissemination of the survey, a pilot study was conducted involving women from two different lactation associations through email. Once checked that the questions were easily understood by the participants and that there were no problems at the technical level when sending the emails, answering them, and receiving the data, the online self-administered questionnaire was sent to the different Spanish breastfeeding associations. In turn, these associations disseminated the questionnaire among their members, who accessed the survey through the link and were able to complete it online. The questionnaire included questions on sociodemographic and clinical aspects of the mother, and also questions on obstetrics, foetal, and breastfeeding topics.
Please revise the above text. I suggest the following: The study data was collected using an online questionnaire drawing upon previous research of maternal breastfeeding at hospital discharge. The questionnaire included questions on sociodemographic and clinical aspects of the mother, as well as questions on obstetrics, foetal, and breastfeeding topics. A pilot study was conducted using women from two lactation associations to assess whether the questions were easily understood and that there were no problems at the technical level the online self-administered questionnaire prior to emailing to the different Spanish breastfeeding associations. These associations disseminated the questionnaire among their members for online completion.

Thank you very much for your correction; this has been modified. Page 6, paragraph 2.

Page 8, line 47: To ensure that participants understood the purpose of the study and accepted the processing of their data, before answering the questions, participants had to receive information on the purpose of the questionnaire and the ethical considerations associated. In order to complete the questionnaire, it was essential that they clicked a box in which they stated that they understood the information and agreed to continue with the study. In addition, they were informed that the data collected were completely anonymous, confidential, would not be used for purposes other than those of carrying out this study, and that they were free to (continued on Page 9, line 1) drop form the study at any time. An email address was offered so that participants could contact in case of doubt about the collection or processing of their data or if they wanted to delete their data from our database. The information collected was stored and processed on a computer without internet access so that no one had remote access to the data.
Please revise the above text. I suggest the following: Prior to questionnaire completion, all

participants gave informed consent by confirming that they understood that their participation was voluntary, and anonymous, and that they could withdraw at any time, that their data would be completely confidential, stored and analysed on a secure computer and would only be used for the study. The participants were given a contact email with the research team for queries and to withdraw their data.

Thank you very much for your suggestion; this has been modified. Page 18, paragraph 3, line 3.

Page 9, line 38: Please remove 'SPPS'

Thank you very much for your correction; this has been modified. Page 9, paragraph 2, line 1.

Page 11, line 6: "two studies in the literature that apply the BAS". Please remove "in the literature".

Thank you very much for your correction; this has been modified. Page 10, paragraph 3, line 6.

Page 11, line 21: "…maternal age. In this sense, some…" Please remove "In this sense".

Thank you very much for your suggestion; this has been modified. Page 10, paragraph 4, line 1.

Page 11, line 59: (Ahm et al., 2002). "In this sense, blood studies reveal" Please remove "In this sense".

Thank you very much for your correction; this has been modified. Page 11, paragraph 2, line 4.

Page 12, line 42 : "In this same sense, multiple pregnancies" Please remove "In this same sense".

Thank you very much for your suggestion; this has been modified. Page 17, paragraph 2, line 1.

Page 13, line 31: "Yet, we must clarify that the most realistic estimates". Please remove "Yet, we must clarify that"

Thank you very much for your suggestion; this has been modified. Page 12, paragraph 2, line 2.

Page 13, line 36: "In this sense, it would be highly recommended". Please remove "In this sense" and simply state: it is recommended…

Thank you very much for your suggestion; this has been modified. Page 12, paragraph 2, line 4.

Page 14, line 12: In short, the objective of this paper of developing a predictive model for the breastfeeding at hospital discharge has been accomplish, which may imply an aid for professionals in identifying women with a higher risk of not breastfeeding at hospital discharge in a quick and objective way, so that specific strategies could be implemented to support these women with the ultimate goal of increasing the prevalence of breastfeeding at hospital

discharge.

Please revise this very long sentence. I suggest the following: A predictive model for breastfeeding at hospital discharge was accomplished. It is hoped that the model will aid professionals in identifying those mothers at higher risk of not breast feeding so that strategies may be implemented to increase the prevalence of breast feeding at hospital discharge.

Thank you very much for your suggestion; this has been modified. Page 13, paragraph 2.

Questionnaire

*Conflict of Interest form

Declaration of interests

☒ 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.

☒The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

None

CRediT author statement

Ana Ballesta-Castillejos: Visualizaton, Conceptualization, Methodology, Software.
Juan Gómez-Salgado: Investigation, Reviewing.
Julian Rodriguez-Almagro: Data curation, Writing- Original draft preparation, Reviewing and Editing, Supervision .
Antonio Hernández-Martínez: Supervision, Writing- Reviewing and Editing.

DATA AVAILABILITY STATEMENT

Data available on request from the authors:

The data that support the findings of this study are available from the corresponding autor upon reasonable request.