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Prospective primary teachers´ knowledge about breastfeeding as part of scientific literacy

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ABSTRACT
The conceptions that prospective primary teachers (PPTs) have about breastfeeding (BF) were explored as part of their training in school content related to health and the human body. For this, the PPTs answered a questionnaire designed ad hoc, without having received any prior training about the topic. The questionnaire had previously been validated by a panel of experts made up of midwives and researchers in science education. The results show that the PPTs have poorly informed ideas about both the biological processes associated with the genesis of breastmilk and the effects of BF on the mother and infant. Those ideas largely coincide with those of the rest of society (e.g., believing that there are women who produce milk that has insufficient nutritional value for their infants). The results are discussed with the goal of improving PPTs' scientific-didactic training about BF as a topic of scientific, social and environmental importance.

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Introduction

Food practices are often socialised and entrenched as being habits difficult to modify (Rodríguez, 2012; Monterrosa et al., 2019). They are adopted as part of a community's traditions, taboos and beliefs; therefore, they are instituted as something cultural that integrates many misinformed ideas and misbeliefs (Kalnina et al., 2022). And this, without doubt, is an obstacle against changing citizens' eating habits to ones that are healthier (Martínez, 2015; Nsiah-Asamoah et al., 2020; Padró, 2020).

There is scientific consensus about the advisability of starting breastfeeding (BF) infants during their first hour of life (WHO, 2009). Also, exclusive BF of infants is recommended until they are six months old, and then supplementing this with other foods for however long the mother and infant desire (WHO, 2021, 2023). The practice of BF is proven to have protective effects on the health of both mother and child (Van Acker & Bakker, 2012; Zalewski et al., 2017) and thus society. However, as with

other feeding habits, the choice to breastfeed is also influenced by social and cultural factors (Jamie, 2020; Kong & Lee, 2004; Villalobos et al., 2021; Wanjohi et al., 2016) and, in many cases, these are more decisive than scientific factors.

The human species is included within the Class *Mammalia*. Breastfeeding is therefore the natural way to feed human infants (Aguayo-Maldonado et al., 2008; Brines & Billeaud., 2021). But, given that these benefits of breastfeeding, according to science, do not seem to be sufficient or more influential than social or cultural reasons to convince mothers to choose to breastfeed their babies, it is necessary to address this in science education. This should be a subject of study in science education from an early age. Healthy eating is content and/or a basic context for science education. This is stated, for example, in Spain's primary education curriculum (Royal Decree 157/2022), as well as in the international theoretical frameworks for science education TIMSS 2019 (International Study Centre, 2017) and PISA (OECD, 2019). Health is also considered to be a paradigmatic socio-scientific issue in science education (Sibic & Topcu, 2020; Zeyer, 2013). Furthermore, the practice of breastfeeding also contributes to the protection of the environment, avoiding the residues and the carbon footprint produced due to the formula milk consumption, which is why breastfeeding is a central part of the 2030 Agenda for Sustainable Development and is related to many of the Sustainable Development Goals (SDGs) (Katsinde & Srinivas, 2016).

Given that formal education in school may contribute to the scientific and cultural literacy, a promotional approach to breastfeeding at the level of primary education seems adequate in order to promote healthy practices, as BF (Galvão & Silva, 2013).

Based on this and the virtual absence of previous studies on the issue (Palma-Jiménez et al., 2023, 2024), the objective of this research is to explore the prior knowledge of prospective primary teachers (PPTs) about BF, as a first step, to obtain information to guide the future design of proposals for the training of PPTs about this topic. If socio-scientific issues have to be treated as science centres in schools (Yun et al., 2022), teachers have to be formed in their initial training.

Literature Review

Scientific Literacy about Healthy Infant Nutrition

Food literacy is the set of fundamental knowledge, skills and attitudes about food and nutrition. With this set of knowledge individuals can adopt a healthy diet in an autonomous and reflective way, adapted to their capabilities, needs, and resources. It is a subject closely linked to the values and habits rooted in common knowledge (Cullen et al., 2015; España et al., 2014; Nanayakkara et al., 2017). Therefore, food literacy should facilitate the acquisition of skills for the proper use of the information in a critical and responsible manner (Slater et al., 2018) from both a personal and a social perspective. It would thus be possible from the teaching of the sciences to promote and consolidate appropriate and healthy behaviour through the health literacy of teachers (Banet, 2004; Lamanauskas & Augienė, 2019).

From there, the promotion of BF through education, among other areas of action, is one of the four pillars of the prevention of childhood obesity in the Region of Andalusia, southern Spain (Junta de Andalucía, 2021). However, it is also a worldwide concern, especially because obesity is associated with low-level socioeconomic situations and with some minority groups (Lobstein, 2015). That is why it must be a priority of collective responsibility for families, health professionals and teachers.

Specifically, the notion of food literacy is included in international scientific literacy frameworks. For example, the latest PISA theoretical framework for assessing scientific competency (OECD, 2019) establishes the issue of nutrition and healthy eating as a context and content with which to develop that competency. Likewise, in the TIMSS Science Framework (International Study Centre, 2017), within the block of human health, emphasis is placed on describing the daily behaviour that favours good health, including those aspects related to diet. Therefore, it is necessary for teachers to have the appropriate knowledge to teach about this issue (Bahamonde & Pujol, 2005; Coccia et al.,

2020; De Jong et al., 1998; Schibeci & Hickey, 2000). With regard to primary education teachers, in Spain the lack of adequate training about healthy eating has been noted for years. De la Cruz (2021) interviewed six experts in nutrition-medicine, three university teachers and three classroom teachers. Among the findings, an educational reality was expressed by the existence of teachers with a lack of training and limited resources; and aspects linked to the curriculum, management and public policies that limit the scope of Food and Nutrition Education. Rodrigo et al. (2014) studied the knowledge of students (183 potential future primary school teachers and 216 primary care nurses) about food and its dietary functions as a basis for improving their dietary education. The authors found that initially the students revealed conceptual gaps on basic food issues, but didactic actions significantly enhanced their knowledge, so they claim for the introduction of some kind of food literacy in teacher and nurse training curricula. This could result in improvements in their future educational and guidance functions for the population in which they work and even for themselves.

Health education is included in the basic curriculum for primary education in Spain (Royal Decree 157/2022). However, it is not carried out in a consistent and integrated way (González, 2009; Charro-Huerga & Charro, 2017). This situation has for years been denounced in scientific and educational areas. Among other issues, there is the suggestion for children to be educated in the normality of BF (Angell et al., 2011; Singletary et al., 2017; Stuart-Macadam & Dettwyler, 1995). It is noted that there is a need for teachers, with the support of health professionals, to implement educational measures for their pupils to know about BF in the promotion of health. (Galvão & Silva, 2011). Additionally, there is evidence that prior learning experience is useful for children to apply their reasoning skills when responding to socially context-based problems in their biology learning: the students were able to generate justifications towards the issue using rationalistic thought (Subiantoro et al., 2023). Science education is a propitious scenario for this purpose, given its connection with health education (Harrison, 2005). Let us now look at the status of the issue regarding the knowledge of PPTs on infant feeding, specifically BF.

Antecedents in the Diagnosis of Conceptions about Food in Infancy

Mothers' knowledge influences the type of feeding chosen during infancy and how long they will breastfeed (Suárez-Cotelo et al., 2019). Given the social and economic context, women of previous generations perceived their body's ability to breastfeed ambiguously (Pallás-Alonso, 2006) since they did not have adequate family and health support to establish satisfactory BF. Therefore, despite the fact that most mothers have the intention to breastfeed, fewer than half of them manage to keep it up over time (Suárez-Cotelo, 2019; Ministerio de Sanidad, 2018).

There is an ample bibliography about BF. However, there remain the erroneous beliefs that have classically been part of the population's knowledge regarding this topic, and which tend to hinder the practice of BF (Wahren & De Cunto, 2004; Kim et al., 2017; Padró, 2020; Vargas-Zarate et al., 2020). Some of those misconceptions are: the conviction of equivalence between artificial milk and BF (Koura, 2019); restrictions imposed, often without malice, by medical or family advice on the duration of BF (Nsiah-Asamoah et al., 2020); decreased nutritional capacity of breastmilk, depending on the time elapsed or the type of woman (Davanzo, 2018; Koura, 2019; Padró, 2020); association between small size of the breast and low milk production capacity (Koura, 2019); and ignorance of the effects of BF on health (Hamade et al., 2014; Palomino, 2020).

In the few studies carried out with PPTs about this topic, it has been observed that they present difficulties in assigning the function or the type of nutrients that breastmilk contains (Rodrigo & Ejeda, 2009). In addition, PPTs require domain-scientific knowledge to construct and critique arguments about BF (Palma-Jiménez et al., 2023). PPTs also have a lack of knowledge regarding scientific and social aspects of current issues, such as BF (Kokolaki & Stavrou, 2023). For practising biology teachers, a study addressed their biological knowledge and social aspects related to BF (Subiantoro et al., 2021) and concluded that teaching based on socio-scientific issues such as BF improved students' understanding of scientific and social topics.

Furthermore, the PPT's understanding of specific processes related to BF, including the production of breastmilk, is hampered by this lack of understanding of how the human body works as a system. The reason for this is the usual fragmentation when dealing with concepts about the human body in class, where the focus is on the anatomical rather than the functional aspects, as well as the disconnection of this knowledge with everyday life and with health (Charro-Huerga, 2016; Uskola et al., 2022). A lack of knowledge about female anatomy has been detected in secondary students and preservice teachers (Ortuzar-Iragorri et al., 2024; Pozo et al., 2014). It has also been found that primary education teachers tend to be unaware of the effects of BF on the health of the mother and infant (Jiménez, 2016), although they have been found to be willing to incorporate BF into their teaching (Moukarzel et al., 2019; Singletary et al., 2017).

In summary, the reviewed literature shows scarce evidence of BF coverage in initial training of primary teachers. It also indicates the need to educate in competencies using socio-scientific issues. The originality of this work lies in the exploration of the PPT´s initial conceptions about BF. This is the first step to train PPTs in the topic.

Aims of the Research and Research Questions

The aim of this study is to measure what knowledge the PPTs already have about food literacy as the set of fundamental skills, knowledge and attitudes about food and nutrition.

In view of the above, and aware of the need to provide PPTs with basic training about BF, this diagnostic study was carried out, guided by the following research questions:
(RQ1) What is the PPTs knowledge regarding health implications of BF?
(RQ2) What is the PPTs knowledge concerning the human body in relation to BF?

Methods

Research Design

The research consists of an exploratory and descriptive study that aims to survey the knowledge of future teachers about breastfeeding and thus delimit the training needs they present.

For this purpose, health as well as didactic experts were consulted, and a questionnaire was designed and used.

Participants and Context

The sample consisted of 102 PPTs who were studying the subject Didactics of the Experimental Sciences, of a compulsory and annual character, belonging to the 2nd year of the degree of Primary Education (Grado en Educación Primaria) at Seville University (Spain). The sample was chosen for convenience due to the researchers' possibilities of accessing the PPTs during the study. The age range of the participants was between 19 and 28 years (20 years mean), and 80% were women.

The objectives of the subject, Didactics of the Experimental Sciences, was for the PPTs to acquire basic formation about (i) the purposes of science education in primary education, (ii) the value of knowing the pupils' ideas about natural phenomena, (iii) the content of school science for primary education, among which are emphasised those related to food and (iv) the design of didactic proposals to teach science in primary education. The present study was implemented before the PPTs had addressed points (iii) and (iv) in class.

Design and Validation of the Instrument

Delphi technique was used, due to the need to obtain expert opinions and to triangulate the points of view of the different groups (Mengual-Andrés et al., 2016). This structured communication framework allowed the development of the instrument to gather PPT's knowledge.

A questionnaire was designed to obtain ideas from PPTs, which was submitted to the validity and reliability processes prescribed by educational research methodology (Olde Bekkink et al., 2016).

The questionnaire used to diagnose the PPTs' knowledge about BF was drafted in five phases: consulting midwives about the topic; designing preliminary questions from the literature; validation by a panel of experts; pilot test; and preparing the final version.

The bibliographic review to search for antecedents led to the health field. Therefore, help was obtained from experts in infant nutrition from this field, the figure of the midwife and IBCLC (International Board Certified Lactation Consultant). Four midwives were interviewed for 30-40 minutes each in order to know their professional judgment on the minimal knowledge about BF that should be addressed in primary education as part of basic nutrition literacy.

Phase i: Interviews with Midwives

The midwives interviewed agreed on two fundamental aspects. One was to promote pupils being able to observe mothers breastfeeding their infants, which would normalise this circumstance to counteract the effect of messages often transmitted through advertising, toys, television, etc. The other was to mention the function of BF when dealing with topics such as vital functions, healthy eating and the parts of the human body and their functions. The midwives insisted on the importance of making it clear that humans are mammals, with the corresponding anatomical consequences and infant feeding behaviour. They recommended fostering confidence in one's own body and knowing about the protective role of BF compared with other types of nutrition. They also mentioned knowledge about how the human body functions, since this helps to avoid the tendency to feel disgust with certain bodily fluids such as breastmilk. This was also found by Spear (2007) in informal conversations with nursing staff.

Phase ii: Preliminary Design of the Questionnaire

The preparation of the instrument followed a process of bibliographic review interspersed with the instrument's gradual restructuring. Given the exploratory nature of this study and the paucity of literature on the subject, the decision was made to combine open and closed ended questions. Each question was related to the duly substantiated desirable response and to the objective being pursued, regarding to health effects and conditions of BF and physiological and anatomical questions. In repeated revisions by the researchers, the number of questions and their form and content were reviewed. The ultimate objective was to achieve a questionnaire that would gather the necessary information without confusing or exhausting the respondents.

Phase iii: Validation of the Instrument by Experts

After a first complete version of the questionnaire had been prepared, it was submitted to a validation process involving 15 experts. The assessments carried out by experts from different fields were subjected to triangulation. The panel of experts consulted comprised researchers in science teaching (5), experts in language and communication (1), midwife instructors (1), experts in research methods (1), in-service primary education teachers (3), and mothers with experience in breastfeeding (3).

Content and construct validation was carried out regarding relevance (appropriateness of each item regarding the objective of diagnosis), clarity (ease of understanding the item by the

respondents), relevance of the content of the items (incidence on the essential aspects of the topic), and contributions concerning the wording of the items and the structure of the instrument in general. To this end, the panel of experts had a document listing the items whose conformity with the above criteria they had to assess on a scale of 0 to 5. All of their suggestions were studied and incorporated. They were fundamentally of a semantic type, helping to improve the understanding and sense of the items. The results of the experts' assessment did not lead to any of the items initially considered being eliminated since the mean rating was higher than the 3.5 reference value (Abad et al., 2011).

Phase iv: Pilot Testing the Instrument

In addition to the expert assessment, a pilot test was carried out in order to ensure the sufficient reliability of the questionnaire. For this, a purposive sample of students from a previous year was selected (also without previous training), opinions were collected, and the coding for the analysis of the responses was tested. The main changes that this led to were related to the interpretation of the items and the time needed to respond.

Phase v: Obtaining the Final Version of the Instrument

The final instrument was obtained after the different phases of development. Table 1 presents, by way of example, a selection of the phases of the development of an item, after the expert validation, related to the effects of BF on health. The table shows the changes made to avoid conditioning the respondent's answer.

Table 1

Example of reformulation of a health questionnaire item

Initial proposal	Intermediate proposal
Three independent open-response items	One open-response item
What effects does BF have on the infant's health? / What effects does BF have on the infant's immunity? / What effects does BF have on the infant's health in the long term?	What effects does BF have on the overall health of the infant?

The final instrument consisted of three open-response items and six closed-response items with three options (True, False and I don't know), as well as a series of questions for socio-demographic characterisation of the sample (sex and age). The questionnaires were administered during regular class hours, individually in person, using an online form which the participants accessed from their mobile device. Printed paper questionnaires were also provided for those who could not access the electronic questionnaire.

Table 2 relates each item to its specific purpose. The acronyms of the research variables are grouped according to the specific research problem of this study.

Table 2

Items of the questionnaire related to their purpose and the block they belong to

Block	Item	Content for which the intention is to explore PPTs' knowledge or ideas[1]
Identity	Sex	
	Age:	
Previous training: BagBF	Have you received or sought any kind of information about breastfeeding	To check the influence of various sources of information on their knowledge, whether out of interest (informal) or by obligation (formal)
Health:		
Health1	What do you think are the effects of breastfeeding on the mother's health?	Positive or negative effects of BF on the mother's health (physical and affective aspects)
Health2	What do you think are the effects of breastfeeding on the infant's health?	Positive or negative effects of BF on the infant's health (affective aspects / immunity / digestive system / development / long-term effects)
Health3	There are women whose milk has less quality and that is why it is better to supplement this with artificial milk (Yes/No/I don't know)	The alternative conception that the quality of breastmilk varies from mother to mother
Health4	There comes a time, as the months pass by, when breastmilk stops being nutritious (Yes/No/I don't know)	The alternative conception: "breast milk is dilute and not nourishing as the months go by"
Human body:		
HB1	What factors do you think breastmilk production depends on?	Breastmilk production (intervention of anatomical structures, the physiological part, external factors and/or a combination of the above).
HB2	Hypogalactia (low production of milk) is common and can rarely be treated (Yes/No/I don't know)	Belief that many women do not produce enough milk
HB3	A nursing mother's breast always has milk, and the infant only has to suckle for it to come out (Yes/No/I don't know)	Belief that the breast has to refill (and that's why the baby can't breastfeed again soon after doing it)
HB4	Breast size is related to the capacity to produce milk (Yes/No/I don't know)	Belief that women with small breast size cannot produce enough milk / that big breast size produces more milk

Note. 1 In the Health and Human Body blocks, the level of doubt or insecurity is assessed with the response 'I don't know'.

Data Acquisition and Analysis

Once the PPTs had answered the questionnaire, the responses were input into a data file for analysis. Certain precautions were taken in order to minimise sources of error in the production of social data (Fernández, 2003) such as eliminating from the sample individuals who answered fewer than 80% of the questions.

In the closed-ended items, the response categories correspond to the three types of response (True, False and I don't know). However, for open-ended items, a system of initial categories was established based on a literature review and the experts' contributions, and these were revised and adapted as the data analysis process progressed, with even some new categories emerging (Cisterna, 2005). To reduce as much as possible any deviation errors in the interpretation and categorization of the responses and thus ensure reliable interpretation and classification, an intra-rater analysis was carried out. The first author made a first categorisation of the responses and repeated the process a month later. The degree of coincidence between the two categorizations was greater than 90% of the

cases. Then this last categorization was submitted to the assessment of the other researchers in an inter-rater analysis process. The agreement between the researchers was again greater than 90%, as was to be expected given that the category system for classifying the responses had been developed conjointly. The few cases of discrepancies (less than 10% of the total) were discussed by the researchers until reaching majority agreement on the definitive classification. Likewise, in the analysis of the open-response items, low inference descriptors were included (Latorre, 2003) consisting of representative textual extracts of the PPTs' responses, in order to contribute evidence validating the categorisations made, which are shown in the following section.

Findings

Knowledge about Health Related to Breastfeeding

This aspect was investigated through the four items Health1, Health2, Health3 and Health4. The results for item Health1 (effects on the health of the mothers who BF) are given in Table 3. Most of the responses, with 32% of the students stating 'I don't know', were found to represent ignorance. On the other hand, 16% considered that it has positive effects on the mother but could not specify what those were. In addition, although the set of responses referring to positive effects was larger (with more than 33% in total), the 'Physical Negative' category accounted for 26% of the responses.

Table 3

Frequency of responses[1] to item Health1 about the effects of BF on nursing mothers

Categories	Freq. (%)[2]	Low inference descriptors
Positive	15.7 (n=16)	'I think it has many positive effects'; 'I imagine they will not be bad, otherwise mothers would not breastfeed their infants'; 'Good'; 'I imagine that they are positive, since it is generated by the body itself';
Positive Affective	10.8 (n = 11)	'Connects her to her infant'; 'Improves attachment'; 'Better mood because of having such direct contact with her infant'; 'Creates a close bond with her infant'; 'Great self-satisfaction and well-being'
Positive Physical	6.9 (n=7)	'The possibility of suffering from breast cancer is reduced'; 'Her cells regenerate as the body produces milk'; 'The breasts are emptied (retaining milk is bad)'; 'Improves health'; 'Prevents diseases'
Negative	3.9 (n=4)	'Harmful'; 'Negative'; 'In many cases it may be harmful to the mother'
Negative Affective	0 (n=0)	
Negative Physical	25.5 (n=26)	'Weakness'; 'She will feel more tired'; 'Nipple irritation, breast drooping'; 'Somewhat weakened immune system'; 'More swollen breasts and they hurt her'; 'Loss of nutrients, deterioration of the breast, pain'; 'It can cause cracks in her skin'; 'Sensitivity'; 'Lose more energy'; 'Mastitis'
None	9.8 (n=10)	'I think it has no affect'; 'I don't think it has'; 'I think it doesn't have any negative or positive effect'
Don't Know	32.4 (n=33)	'I don't know if it brings any positive aspects or if it can cause any difficulty'; 'I don't know'; 'I don't know them'
No Response	3.9 (n=4)	

Note. [1] Student statements translated from Spanish, [2] Freq. (%): Frequency. The number of responses (n) is greater than the number of participants since the same response might be placed in more than one category.

Table 4 contains the data about the PPTs' knowledge related to the effects of BF on the infant's health (Health2). There is a quite marked tendency to respond that the effects are positive. However, the top ranked category is 'Others' in which are grouped the responses that are not specific or that use indeterminate terms, as can be seen in the examples in the table. It is striking that, despite the fact of

not being mentioned in the question, a good percentage of the responses compare breastmilk with artificial milk, arguing that 'it is more than food', or that 'it is a better food'. Another aspect to consider is that some responses (in the category 'Negative Immunity') link the positive effects to the maternal lifestyle, stating that, if it is inadequate, it is better not to breastfeed. Natural vs artificial arguments were also used, with mentions that artificial milk contains 'chemicals' and thus human milk protects as it does not have them. The second most frequent response referred to the positive effects on infant immunity.

Table 4

Frequency of responses to item Health2 about the effects of BF on infants

Categories	Freq. (%)[1]	Low inference descriptors
Positive Immunity	25.5 (n=26)	'Protects from pathogens'; 'The mother passes her antibodies through her milk'; 'Protects their immunological system'; 'Prevents many diseases'; 'In breastmilk there are some substances that help their system'; 'Improves defences'
Positive Digestive Apparatus	0 (n=0)	
Positive Affective	4.9 (n = 5)	'It brings them closer to their mother'; 'Strengthens the mother-infant bond'; 'Great closeness with the mother'
Positive Others	73.5 (n=75)	'They grow stronger'; 'It will give them more nutrients than if it were artificial milk'; 'It provides the necessary nutrients for their correct development'; 'It is healthier and more natural than artificial milk'; 'It is more nutritious'; 'It gives them more vitamins (compared to artificial milk)'; 'It contains essential substances for the optimum growth of the baby'
Negative Digestive Apparatus	0 (n=0)	
Negative Affective	0 (n=0)	
Negative Immunity	2.0 (n=2)	'It can be a means of transmitting disease'; 'If the breastfeeding mother has some kind of infectious disease, this is not healthy'
Negative Others	1.0 (n=1)	'If the breastfeeding period is prolonged, it can cause problems for the infant'
None	1.0 (n=1)	'I think that breastmilk has no influence on the infant's evolutive development'; 'None'
Don't Know	7.8 (n=8)	'I don't know'
No Response	2.9 (n=3)	

Note. [1] Freq. (%): Frequency. The number of responses (n) is greater than the number of participants since the same response might be placed in more than one category.

Regarding the item Health3 (quality of the breastmilk), the results (Table 5) show that a large proportion of the PPTs (63%) have the inadequate idea that the common need to supplement with artificial milk is because there are women who produce lower quality milk.

Table 5

Frequency of responses to item Health3 (T/F) about the quality of breastmilk and the need to supplement it

Categories	Frequency (%)	Number of responses
Correct	20.6	21
Incorrect	62.7	64
Don't know	16.7	17

When the PPTs are asked whether breastmilk stops being nutritious after a few months (item Health4, Table 6), more doubts arise. About 35% stated that they did not know, and a similar proportion answered correctly marking the statement as false.

Table 6

Frequency of responses to item Health4 (T/F) about changes in the nutritional quality of breastmilk over time

Categories	Frequency (%)	Number of responses
Correct	36.3	37
Incorrect	28.4	29
Don't know	35.3	36

Knowledge about the Human Body in Relation to Breastfeeding

The ideas that the PPTs have about anatomy and physiology are inquired into through the items HB1, HB2, HB3 and HB4. Table 7 lists the results for HB1 (factors involved in the production of breastmilk). Deficiencies were detected in the PPTs' knowledge about human anatomy and physiology in relation to BF. The correct responses, which include anatomical and physiological elements and references to the need for external stimulation, are practically non-existent. The physiological factor was the most mentioned of the three, although only by 23% of the PPTs, with the other two (anatomical and external) only accounting for 8% of the responses each. Furthermore, in the physiological factor there is barely any mention of the hormones involved and no description of the involvement of the pituitary or hypothalamus. In the case of anatomical aspects, references are made to glands or breasts, and alternative conceptions also arise, such as the influence of the woman's complexion.

Grouped into the category 'Others' are the responses that refer to factors that have no influence (e.g., the mother's habits or the type of delivery) or that, if they do, only in extreme cases (such as food). This item reaffirms conceptions already observed in the item Health3 such as that referring to the amount of milk produced.

Table 7

Frequency of responses to item HB1 about the factors involved in the production of breastmilk

Categories	Freq. (%)[1]	Low inference descriptors
Physiological	22.5 (n=23)	'Physiological'; 'The female hormones that develop during pregnancy'; 'Hormonal'; 'Especially the hormone prolactin'
Anatomical	7.8 (n=8)	'Depends on the mammary glands and the organism itself'; 'Depends on the mammary glands and the fat that surrounds them'; 'Depends on whether the mother has some kind of breast related problem'
External	7.8 (n=8)	'Depends on the infant suckling, the milk will continue to be produced until the infant stops suckling'; 'Depends on demand'; 'Effect of practice, it must be provoked for it to come out soon'; 'Stimulation'
Others	43.1 (n=44)	'The person's innate factors, some produce more and others less, but nothing can be done'; 'Psychological'; 'Context in which the infant is born'; 'Depends on the food, rest, whether the mother suffers from health problems, anxiety, etc.'; 'The mother's habits'; 'The mother's age and the environment'; 'Depends on what the mother has eaten'; 'It depends on whether it is a natural birth or a caesarean, if it is a caesarean it takes a bit longer for the milk to come up'; 'I think it is something natural that always happens'
Don't Know	25.5 (n=26)	'I don't know'
No Response	5.9 (n=6)	

Note. [1]Freq. (%): Frequency. The number of responses (n) is greater than the number of participants since the same response might be placed in more than one category.

Table 8 lists the results corresponding to the PPTs' knowledge about item HB2 (frequency or reversibility of hypogalactia, i.e., low production of breastmilk). Slightly fewer than half of the PPTs (45%) did not know whether low milk production is frequent and irreversible, and more than half of those who responded did so affirmatively, thus marking the wrong option.

Table 8

Frequency of responses to item HB2 (T/F) about hypogalactia

Categories	Frequency (%)	Number of responses
Correct	26.5	27
Incorrect	28.4	29
Don't know	45.1	46

The results of item HB3 (presence of milk in the breasts of lactating mothers) are listed in Table 9. More than half (56%) of the PPTs' responses did not coincide with the desirable knowledge which takes into account the continuous presence of milk in the nursing mother's breast. This situation denotes the demand for learning on the part of the PPTs about this aspect of how the human body functions.

Table 9

Frequency of responses to item HB3 (T/F) about the presence of milk in the breast

Categories	Frequency (%)	Number of responses
Correct	27.5	28
Incorrect	55.9	57
Don't know	16.7	17

Table 10 lists the results of item HB4 (relationship of breast size with the capacity to produce milk). The PPTs' ideas about the relationship between breast size and the capacity to produce milk coincide in most cases (67%) with the desirable knowledge, although 6% of the PPTs had alternative ideas and 28% did not know.

Table 10

Frequency of responses to item HB4 (T/F) about the relationship between breast size and the capacity to produce milk

Categories	Frequency (%)	Number of responses
Correct	66.7	68
Incorrect	5.9	6
Don't know	27.5	28

Discussion and Conclusions

The results of the exploration of the PPTs' prior ideas about BF allow one to affirm that their knowledge, unfortunately, is not very different from that of the general population. They reflect the erroneous beliefs about BF that are common among the general population (Breastfeeding Committee of the Spanish Association of Paediatrics, 2004; Martínez, 2015; Padró, 2020; Paricio, 2020, Wanjohi et al., 2016).

The PPTs know that BF is good, agreeing with Palma-Jiménez et al. (2024), but they associate it with inconveniences for the mothers who breastfeed, as shown in studies reporting university students' lack of knowledge of many of the maternal health benefits of BF and the idea that BF is less practical for working mothers (Hamade et al., 2014; Hernández-Pérez, et al., 2021). In terms of the positive effects for the infants, the PPTs tend to attribute general, albeit vaguely defined, benefits (in this research, classified in the category 'Others'). The PPTs accept that breastmilk is good for the body's defences. This fact may be related to the measures taken by governments and institutions to apply the International Code of Marketing of Breastmilk Substitutes. One of the rules of this Code is to warn the public, when an artificial milk product is advertised, of the nutritional superiority of BF in comparison. That warning, however, should be more explicit in pointing out that the benefits for the baby's health go beyond generating antibodies (Wahren & De Cunto, 2004).

Naive ideas that had been quite popular in the literature on Health Education were also detected, for example, that milk favours the infant's growth more than other food. The homogeneity of the belief 'if you drink milk, you grow' was already detected by Banet and Núñez (1991) regarding the milk consumed by school-age children. Núñez and Banet (1997) attribute this and other ideas about human nutrition to the effects of advertising, since nutrients from other foods also promote growth. Despite recent misgivings about milk consumption, due to some misunderstandings about milk allergy and intolerance (Di Constanzo et al. 2021), the PPTs mention the presence of vitamins and other components of milk as being beneficial nutrients, thus coinciding with the results obtained by Membiela and Cid (1998) and Singletary et al. (2017) with pre-university students. What characterises these responses is that they allude to stereotypes of milk as food which do not show knowledge of the complexity of breastmilk's composition. Among other aspects, this would mean knowing its protective effects against many diseases (infectious, cardiovascular, obesity, diabetes, and of the digestive system), as well as contemplating the positive impact on neuronal and affective development (Victora et al., 2016). However, the unique knowledge about benefits of BF do not guarantee a successful BF in young mothers who lack information about breastmilk composition or breast function (Jamie, 2020).

With regard to the dependence on the mother of the nutritional capacity of human milk, the results confirm the observations that have been made about the historical evolution of attitudes related to BF in relation to advertising (González, 2016; Martínez et al., 2008; Vallone, 2009). Although proposals are being made from the health sector to improve the situation (Katsinde & Srinivas, 2016; Pérez-Escamilla, 2020: WHO, 2023). Is still perceived the low self-efficacy on breastfeeding reported by Pallás-Alonso (2006), to which should be added the low perception of general efficacy –no longer only characteristic of the mothers– of the female ability to breastfeed, because some students consider that there are women whose milk is weak (Bottaro & Giugliani, 2008; Davanzo, 2018; Koura, 2019;). It is also related to the influence of the mother's diet and habits, as well as genetic causes in the production of milk which, according to the PPTs, would inevitably lead to using artificial milk supplements (Nsiah-Asamoah et al., 2020; Koura, 2019). With respect to the myth of the decrease in the quality of the produced breastmilk over time (Padró, 2020), the results do not allow it to be determined whether this is established in this study's sample of participating PPTs.

Regarding knowledge about the female human body and BF, there were few allusions found to anatomical factors, thus coinciding with what had been noted by Bottaro and Giugliani (2008) in whose study the school pupils did not associate BF as the primary function of the female breast. This lack of knowledge of the female anatomy was also detected recently by Ortuzar-Iragorri et al. (2024) and earlier by Pozo et al. (2014). However, unlike the results of those works, the PPTs did not seem to associate breast size with milk production (Edgar & Sebring, 2005). Nonetheless, their knowledge about the physiology of BF is quite superficial. The level of perception that the PPTs have of the high likelihood of failure in the mechanisms of milk production is curious, being in contrast with confidence in the normal functioning of the rest of the body's organs (González, 2016). One perceives the disconnection noted by Uskola et al. (2022) between the anatomical and the physiological fields. A systemic vision would improve the understanding of the processes involved in BF.

There are two practical implications of this research for teacher training programmes and curriculum development. The first one is the need to design proposals for the training of PPTs about BF, since, as it has been described, prior knowledge of PPTs about BF is unsatisfactory. The second relates to the need to address socio-scientific issues in science classes. Other studies, although not directly investigating PPTs' knowledge of BF (Palma-Jiménez et al., 2023, 2024), state that PPTs require domain-scientific knowledge to construct and critique arguments about BF. In fact, teaching based on socio-scientific issues like BF improves students' understanding of scientific and social aspects of current topics (Kokolaki & Stavrou, 2023; Subiantoro et al., 2021).

In short, regarding the first research question (RQ1: What is the PPTs knowledge regarding health implications of BF?), the results indicate the superficiality of the knowledge that the PPTs in general have about the topic, as it has been reported in other studies (Kokolaki & Stavrou, 2023). They know that breastmilk is good for the infant, although they are not very sure why. PPTs also consider that BF usually involves exhaustion and physical problems for the mother.

In relation to the second research question (RQ2: What is the PPTs knowledge concerning the human body in relation to BF?), the results are discouraging, although expected, because they are related to what had been detected in the analysis of textbooks about the subject (Illescas-Navarro et al., 2020). Knowledge about the body's structures and functioning in relation to BF is sparse, as only anatomical and external aspects are considered. The PPTs are not found to have the systemic vision necessary to understand the process. In addition, there prevail responses referring the capacity of milk production is conditioned by innate causes in the mother's body.

Limitations and Future Proposals

As this was a convenience sample, bias is assumed to exist, with there being no margin to reduce the limitation in the generalisation and the possible inferences that may arise in an entire population, in this case, of PPTs. Nevertheless, the rigorous validation and reliability processes followed in the study provide it with sufficient robustness for it to be an important referent for other studies with similar characteristics and contexts. Likewise, it has to be said that samples of this type are frequent in education research due to the researchers' possibilities of accessing the prospective teacher. Even so, the sample of this study was close to a hundred participants. Also, this is the usual type of sample in studies oriented to designing specific teacher training plans based on prior knowledge of the training needs of the target group, in this case, the PPTs taught by the study's researchers.

After this exploratory study, the next step would be to check whether the knowledge detected in the PPTs is modified after an educational intervention on the subject of BF. In addition, it would be interesting to study the possible correlation of the PPTs' knowledge related to BF with their educational background, both formal and informal. Other educational actions may consist of integrating detailed modules on BF into the curriculum for PPTs, in health education topics, incorporating media literacy to help PPTs critically assess information from advertisements and societal myths. As well as offering practical exposure through interactions -conducting regular workshops and seminars- with lactation consultants, BF support groups and healthcare professionals to provide updated, accurate information to PPTs.

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Disclosure Statement

No potential conflict of interest was reported by the authors.

Ethical Statement

This study met the ethics requirements for research that involves human subjects at the time the data was collected. Researchers informed all participants why the research was being conducted, the anonymity was assured and how the collected data was being stored.

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