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The history of infant nutrition

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Abstract

Objective: To retrace the history of infant nutrition with the objective of better understanding breastfeeding.

Sources of data: Bibliographic searches were run on MEDLINE, LILACS, SciELO, and the Internet. Encyclopedias, scientific textbooks and books for the general public, in addition to literature, art and history, were also used. Texts on child care from several different periods were consulted, in addition to the history of medicine and recent scientific articles on infant nutrition.

Summary of the findings: During the preindustrial period, customs varied little and the likelihood of survival was linked to breastfeeding or its substitution by a wetnurse's milk. Where this was not possible, infants were given animal milk, pre-chewed foods or paps that were poor in nutrients and contaminated, which caused high mortality rates. There was nothing that could successfully substitute breastfeeding and the survival of the species was dependent on breastfeeding. Once the industrial revolution had started, women who had been accustomed to breastfeeding went to work in factories, stimulating the search for alternative infant nutrition. Consumption of animal milk and formulae (diluted, flour-based, powdered milk) and premature introduction of complementary foods compromised children's health. The feminist movement and the contraceptive pill caused a fall in birth rates. Manufacturers in search of profits developed modified formulae and invested in advertising. Society reacted with breastfeeding support movements.

Conclusions: Nowadays, the advantages of breastmilk are recognized and exclusive breastfeeding is recommended up to 6 months, to be supplemented with other foods from this age on and continued until at least 2 years of age. Infant nutrition, whether natural or artificial, has always been determined and conditioned by the social value attributed to breastfeeding.

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Introduction

As mammals, human beings have always depended on breastmilk for survival. However, throughout history breastfeeding has been molded by cultural values, many of which are today considered to be harmful to the practice and, consequently, to children's health. An understanding of how and why societies gave support to certain beliefs and customs which were, in many cases, recommended by physicians, can be useful to the health professionals of today who work to promote breastfeeding.

The objective of this article is to retrace, in a succinct manner, the advances and retreats in the process of feeding infants during their first years of life that have meant that a practice as natural as breastfeeding nowadays needs to be encouraged in a variety of ways and protected by law.

Synthesis

If one were to be asked what food is usually given to infants who are not breastfed, the immediate reply would be non-human milk. However, if we roll back the clock to prehistoric times we will soon see that this has not always been the correct answer. There was a time when humans hunted and gathered the food they needed to survive.[1,2] Thus, if a mother could not breastfeed, then her child was

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condemned to death unless another woman took her place. At that time it is probable that breastfeeding continued until the child was able to find its own food. Even during the Neolithic period, when humans began to find practical solutions to everyday problems, planting and harvesting and raising livestock, it still took a long time before animals were milked.[1-3] As domestic herds formed, many children survived as a result of being fed on animal milk, given in vessels or directly from the udder.[3-5]

The story of Moses, as told in the Old Testament (Exodus 1:15 to 2:10), describes the way that Hebrews and Egyptians sought wetnurses to guarantee the survival of children separated from their mothers.[6] Another Biblical reference gives an idea of how long children were breastfed. In 1000 BC Samuel was taken to live with Eli when he was 3 years old, after he had been weaned (I Samuel 1:22-24).[6] Teachings in the Talmud that date from 200 BC encouraged mothers to breastfeed for 2 years and emphasized that the procedure was important "to preserve life."[4]

Despite cultural differences, the people of Mesopotamia, Egypt and Hebron cared for their children in a similar way, which remained constant for millennia.[2,4] They considered children to be divine gifts. After the Egyptians were dominated by the Romans, the Greco-Roman culture dominated and children lost their value in that culture too. Families would make contracts with wetnurses who would take children to their own homes and only return them years later. This custom spread throughout the Greek colonies and the Roman Empire and was introduced into Europe in that period. Descriptions indicate that some babies were given milk and eggs before being weaned from the breast; fruit and vegetables were only introduced after weaning.[4] When a wetnurse was not available, children were suckled directly from animals' udders or given milk using vessels.[7]

The western world's childcare customs have their roots in Greco-Roman and Arab medical knowledge.

Hippocrates indicated that solid foods should be introduced as soon as children cut their first teeth.[8] Aristotle discusses milk (both human and animal) and its qualities in *Historia animalium* stating that "milk is composed of whey and curds," "milk that is rich in curds is more nutritious," but "the healthiest milk for children is that with the lowest quantity of curds."[9] He advised mothers not to breastfeed a previous child when pregnant, "because the colostrum produced before the seventh month is inappropriate, becoming appropriate only after the child is born." He was against giving children wine, which was a common habit at the time, because it "encourages the appearance of convulsions, and red is worse than white, particularly if undiluted."[10] Little more is known about other foods given to non-breastfed children during this period. However, Fildes comments that they probably survived on milk with honey, milk with cereals, pre-chewed food or by suckling from animals.[4]

The first Roman texts to discuss childcare were written by Soranus and Galen, who were Greek physicians practicing in Rome during the start of the Christian era.[11] Table 1 summarizes the main points of their dietary guidance for infants.[2,4]

Although these were the recommendations, vessels found in children's tombs suggest that the poorer classes were often weaned during the neonatal period.[4]

During the same period, philosophers and moralists argued against the use of wetnurses. Pliny, Plutarch and Tacitus understood that, in addition to milk being the best food for infants, the act of breastfeeding helps to strengthen emotional bonds "avoiding future problems."[2] Mothers should only be relieved of this duty if they were ill or wished to become pregnant.[4] According to Badinter,[12] Plutarch started the first moral movement in favor of breastfeeding.

Physicians were less demanding than moralists when it came to breastfeeding. However, since they believed that

Table 1 - Soranus' and Galen's dietary prescriptions for infants

Prescription	Soranus (circa 70-130 AD)	Galen (circa 130-200 AD)
First food	Honey + cow's milk	Honey
Start of breastfeeding	Wetnurse on 2nd day, mother on 20th day	
Breastfeeder (mother or wetnurse)	Mother, wetnurse (only if necessary)	Mother
Technique	Don't give colostrum	
Quantity	Frequently	
Introduction of foods	After 40th day; preferably after 6 months	After first tooth
Complementary foods	Cereal, bread + milk or wine, porridge, eggs; not pre-chewed	Bread, vegetables, meat, milk
Wine	Diluted	Contraindicated
Weaning	18-24 months, gradual	3 years

by suckling the child would absorb characteristics from the nursing female, they recommended that when choosing wetnurses both their qualities as a milk provider and as a woman should be taken into account, including age, health, height, temperament and morals.[2,4]

The knowledge of ancient Greece arrived in the Arab world in the ninth century BC. The most important authors of Islamic medical texts were not, in truth, Arabs, but Persians. Notable among them was Avicenna, author of the *Canon of Medicine*.[2,4,11,13]

Avicenna believed that the state of health and the characteristics of the nursing mother influenced the health of the baby. If she were to become ill, she should be substituted by another woman. If the milk was thick or unpleasant smelling the recommendation was that it should be expressed, exposed to fresh air and then given to the child in "vessels or horns with artificial teats."[4,13] Avicenna recommended that children be breastfed for as long as possible, because "it is the most appropriate food for growth and development."[13] Avicenna's conduct is summarized in Table 2.

In that era a good meal comprised meat, grain, sweets and wine. Other foods were considered medications or preservatives. Fresh fruit was only good for those carrying out hard work, and vegetables were considered to have an effect on febrile diseases.[13] Diets were very poor and did not provide sufficient nutrients, not for children weaned after 2 or 3 years and even less so for those weaned early.

The medical texts of the Middle Ages reflect the thinking of Soranus and Galen and also that of Avicenna, since the Canon of Medicine was translated into Latin and was used in European Universities until the seventeenth century AD.[11,13] Works of art, stories, poems, letters, records found in orphanages and other documents that have survived also provide information about the diet and childcare received by children during the period.

During the Renaissance (thirteenth to seventeenth centuries), the ideal of humanism and the invention of the printing press stimulated the publication of books. Among the medical texts of the time were four treatises on Pediatrics, known as the *Paediatric Incunabula*.[2,14] The authors of these books follow the recommendations of Avicenna; they recommended breastfeeding (mother or wetnurse), but the colostrum was not valued. The advance was that books began to appear written in languages other than Latin, increasing access to information. The first drawings of infants being fed with vessels similar to babies' bottles appeared in *Versehung von Lieb* (1429).[4,15]

The Renaissance and the Reformation were responsible for changes in customs.[11] Handbooks for midwives appeared. Discussion about breastfeeding continued, but the scarcity of data on alternative feeding should not be interpreted as meaning the practice was rarely employed.[4]

Concepts about infant nutrition began to change after publication of *The Accomplisht Midwife* (1668).[2] In this work, Mauriceau led the way with new ideas about caring for newborn infants based on empiricism, which began to influence thinking, and the theories of Avicenna, Soranus and Galen, which until then had dominated the medical recommendations, were sidelined.[4,11] The principal change was in relation to nutrition for infants whose mothers did not have milk to feed them. Paps and other substitutes began to be more accepted than using wetnurses. The interest in the infant had given way to the mother-child pair and, later, the focus moved to the wellbeing of the mother.

The value accorded to colostrum began to change after publication of *Essay Upon Nursing and the Management of Children* by Cadogan in 1748.[2,4] Initially, the colostrum was credited with having cleansing properties that helped to eliminate meconium, but soon its influence on prevention of certain diseases, both of the mother (milk fever) and of the infant (gastrointestinal infections).[4] Cadogan also believed in the importance of the "emotional bond" that

Table 2 - Avicenna's dietary prescriptions for infants

Prescription	Avicenna (980-1036 AD)
First food	Honey
Start of breastfeeding	Day 1, wetnurse
Breastfeeder (mother or wetnurse)	Mother
Technique	Don't give colostrum
Quantity	2-3 times a day
Introduction of foods	When child starts to request it
Complementary foods	First pre-chewed bread; then bread + wine, honey or milk
Wine	Diluted
Weaning	2 years

is established "when a mother breastfeeds her child from its first hours of life." He condemned the habit of giving newborn infants butter with sugar or paps while breastmilk has not yet become "mature milk."[2] He also advised against wetnurses and introducing complementary feeding before 6 months. He believed that boiling animal milk altered its properties, making it bad for the health.[4] As a result, he recommended that when it was used in paps it should be added after the other ingredients had been cooked.

Data indicate that between 1675 and 1750 there was a gradual fall in infant mortality in England. According to Hollingsworth[16] apud Fides,[4] this reduction was due to changing habits with relation to giving infants colostrum.

In 1749, a demographic study showed that infant mortality had decreased in Sweden during the eighteenth century. This advance was attributed to the work of physicians and midwives to convince mothers to breastfeed.[15] If, at the start of the century, half of all children died during their first year of life, 40 years later this rate had been halved.

Infant feeding habits truly changed when it was observed that children in Foundling Hospitals (1741) who were fed with animal milk (goats and mules) or who were given substitute foods were less likely to survive than children breastfed by their mothers.[4] This relationship was confirmed after "infirmaries" were set up (1747), in which mothers spent the first few days after delivery breastfeeding their children from their first hours of life onwards.[2]

During the sixteenth and seventeenth centuries, it was more common for Protestant mothers to breastfeed than for Catholic mothers. However, between the end of the seventeenth century and the start of the eighteenth, the number of women hiring wetnurses began to increase once more.[15] The practice became so common that agencies appeared that recruited wetnurses and conducted negotiations between the two parties. Mothers who did not wish to breastfeed would explain their decision as being due to adverse effects on their health and appearance, difficulties due to flat or inverted nipples (caused by the tight clothing they wore) and their husbands' attitudes to the idea that breastfeeding women could not have sex,[12,15] because the Catholic church prohibited carnal relations during lactation.[4,12]

During this period, mothers who did not breastfeed started to prefer paps and bread sops rather than wetnurses. The first references to this type of diet are from before the fifteenth century. Recipes consisted of a liquid ingredient (milk, beer, wine, vegetable or meat stock, water), a cereal (rice, wheat or corn flour, bread) and additives (sugar, honey, herbs or spices, eggs, meat).[2,4]

Up to the sixteenth century, the nutritional value of these paps was reasonable, with only vitamin C deficiency obvious, resulting from inadequate intake of fruit and vegetables.[4] From the seventeenth century on, their nutritional content worsened with a significant impact on child health, since animal milk and meat stocks were gradually substituted by water. Other ingredients, such as eggs, egg yolks, butter and fats, important sources of vitamins A and D, proteins, calcium and iron, also ceased to be included in recipes.[4] Children began to suffer from rickets, kidney stones and scurvy. Contamination of utensils and food, often prepared in advance and reheated countless times, also increased the incidence of tuberculosis, brucellosis and gastrointestinal infections.[4,17]

Data show that medical recommendations are not always followed. At the start of the eighteenth century, families persisted in many practices that were condemned by physicians.[4] The habit of offering pre-chewed food has existed for centuries, indeed, both Soranus and Galen mentioned it.[2,4,11] Possibly because it was a common custom, people did not believe it could damage the health.

The introduction of complementary foods, which happened between 7 and 9 months in the sixteenth century, moved forward to the second or fourth month during the next two centuries. Little is known about the frequency and quantities offered, but it is notable that, as the wellbeing of mothers began to be prioritized (Cadogan), on-demand breastfeeding was substituted by four to six feeds per day, probably making it necessary to introduce other foods.[15,18] Only at the end of the eighteenth century did the first texts appear commenting on the excessive quantity of food given to children and recommending breastfeeding with no fixed times.[4]

The Industrial Revolution began in England in the eighteenth century and influenced thousand-year-old practices of infant feeding as poor rural women, who had breastfed their own children and those of more privileged classes, moved to the cities.[17] In an age when no method had yet been discovered to preserve milk, other foods were introduced ever earlier and more often. Mortality rates increased and the State, interested in manual labor and troops, invested in the search for solutions to reduce the high infant mortality rates. These changes began in the eighteenth century and bore fruit in the next century (Table 3).[17] Urbanization changed the way that families lived; they began to depend on monetary power, since in cities they could not plant or raise livestock for subsistence. Living conditions were poor, with people living in slums where they were crowded together in small quarters with little hygiene. Exploitation of labor through low wages obliged women to go to work. Children left at home or in institutions needed to be fed somehow. There were no more wetnurses, or money to pay them with. Ignorance of techniques for preserving milk, whether during transportation from rural areas to the cities or during storage at home, further compromised infants' nutrition.

At the end of the nineteenth century, authors were already pointing out the high malnutrition and mortality

rates related to the reduction in the number of children being breastfed and the increase in the use of animal milk. Jelliffe & Jelliffe[17] mention that "in 1863, 60% of breastfed children in Manchester were well-nourished at 9 months compared with just 10% of those given milk in a bottle." According to Radbill,[19] feeding with paps or non-human milk caused 100% of mortality during the first week of life. Survival increased when alternative foods were introduced after the first month, but, even so, mortality was greater than 50%.[20]

The stimulus to seek alternatives came when women realized that, even being paid lower wages than men, they could earn more money working in factories than as wetnurses.[20]

The argument in favor of animal milk was reinforced after 1838 when Simon discovered that cow's milk contains more protein and less carbohydrate than human milk.[18,20] As time passed it was realized that CM was indigestible because it formed more curds than breastmilk.[21] Physicians began to blame deaths on "intoxication" by milk protein

Table 3 - Significant events in the history of infant nutrition since the Industrial Revolution

Date	Event
1838	Simon: "CM contains more protein than BM."
1856	Gail Borden: condensed milk.
1867	Leibig: First commercial formula (wheat flour + malt + potassium bicarbonate); powder to be added to diluted milk.
1872	Warning: condensed milk (high energy and low fat content).
1874	First complete artificial formula (powdered milk + wheat flour + malt + sugar); powdered milk to be mixed with water. Too expensive for the majority.
1880	Chlorinated water.
1883	Myenberg: evaporated milk. Advantage: no sugar, more fat, sterile, more digestible.
1885	Meigs (United States) and Biedert (Germany) revealed the exact composition of BM.
1890	Pasteurization of milk. Many people were opposed.
1895	Rotch: "mathematical formulae" based on proportions for preparing milk at home. Impractical for the majority, so formulae were made up and sold in bottles (ready-to-use milk). Electricity made it possible to use refrigeration to conserve milk. Advertising of formulae + pasteurization + refrigeration; reduced breastfeeding and increased intake of CM and formulae. The first milks produced to imitate the composition of BM.
1912	Funk: linked beriberi, scurvy, pellagra and rickets to vitamin deficiencies. Energy requirements recommendation.
1920	Recommendation: supplement feeding with juice and cod liver oil. Tendency to move to solids earlier.
1929	Soy formula for children allergic to CM. (Isolated protein formula was only produced in 1960.)
1940	Evaporated or pasteurized milk fortified with vitamin D; children were given juice to guarantee a source of vitamin C
	After the Second World War: advertising and increased birth rate bring profits.
1960	Feminism + contraceptive pill reduce birth rate. Industry expands to the Third World. Baby foods containing monosodium glutamate, sugar and starch to improve texture and appearance. Constant changes to formulae (lactic acid, lactose, fat, minerals, vitamins) to meet needs of infants.
1962	Formula ingredients regulated.
1970	Breastfeeding support movement formed. CM introduced ever later. Recognition of allergy, diarrhea and iron deficiency anemia. Formula with Fe or CM with fortified cereal for non-breastfed children.
1990	Innocenti Declaration, Baby Friendly Hospital Initiative, Ten Steps for Successful Breastfeeding, regulation of advertising of teats, bottles and formulae.
1993	WHO: the difference in growth of breastfed children.
1997-2003	WHO Multicenter Growth Reference Study. New Growth Charts WHO-2006. Growth charts for the twenty-first century.
Twenty-first century	Recommendation: EBM up to 6 months, then BM + complementary foods at least until 2 years.

BM = breastmilk; CM = cow's milk ; EBM = exclusive breastmilk; WHO = World Health Organization.

or on excessive electrolytes.[20] This knowledge led them to prescribe diluting milk before giving it to infants. Mortality rates dropped, but it was soon found that children were not thriving.[18] Physicians then began to recommend, on an empirical basis, adding sugar and cream to the diluted milk.[20] The discovery that this procedure led to children surviving and developing well was a watershed in the argument in favor of cow's milk, which began to dominate from the end of the nineteenth century.[18]

Between 1850 and 1910, scientific advances in the field of bacteriology led to improvements in health and nutrition.[17] The process of pasteurization, suggested by Appert in 1795, was confirmed by Pasteur's discovery (1864) that keeping wine at high temperatures eliminated the bacteria that turned it to vinegar.[5,21] The process was only employed to stop milk from going sour after 1890.[2] Many physicians, however, were opposed to the method because they believed it reduced the nutritional value of the milk, which was indeed confirmed later when it was found that pasteurized milk was low in vitamins C and D. Pasteurization only became routine practice in the United States after 1915.[21]

Another alternative emerged in 1856 when Gail Borden discovered a method for making condensed milk.[18,20,21] The milk was heated to high temperatures (removing half of the water content) and large quantities of sugar were added. The resulting milk was sterile and could be stored because its hyperosmolarity prevented bacterial growth. It was initially used to feed soldiers in the American Civil War (1861-1865) and was only later indicated as a food for children.[21] Many physicians were opposed to the practice because of the high energy density and because they observed that infants were not thriving because of the low fat content of the milk.[18]

The first commercial infant formula was developed by Leibig (1867).[5,20-22] It rapidly became popular in Europe. Leibig did not dare to challenge the prevailing idea that breastmilk was the "best food for infants," but claimed he had managed to produce a combination of ingredients that resulted in a "flour," which, when added to milk, resulted in a food "identical" to breastmilk. The formula contained wheat flour, malt and potassium bicarbonate and was to be mixed with preheated milk.[5,21] Countless imitations soon followed[23,24] and some physicians began to recommend that using formula was a better choice than a wetnurse.[25]

A few years later (1874) saw the first "complete artificial formula for feeding infants," since it no longer needed to be mixed with milk because it contained powdered milk, wheat flour, malt and sugar.[21] Advertising claimed this was the "best food for children," because cow's milk can cause gastrointestinal diseases in the heat and all that was necessary to prepare the new formula was to "just mix the powder with water."[25] Although they were available on both the United States market and in Europe, the price of these formulae made them inaccessible to the majority of the population.[21]

Water began to be chlorinated in the first world in around 1880, producing favorable conditions for the preparation of powdered milk.[24] However, the process was slow to reach other countries, so that preparing milk from powder continued to pose a risk to child health because the powder was mixed with contaminated water.

As the nutritional requirements of children were discovered, pediatrics became established as a specialty. Pediatricians were made responsible for preparing milk (in laboratories), which was supplied in "ready-to-use" bottles,[17] and for providing guidance on how to prepare "homemade formulae."[21] These formulae were based on percentage proportions, to reduce the quantity of casein in the milk, using the method developed by Biedert and perfected by Rotch.[2,5] The objective of the method was to approximate the composition of cow's milk as close as possible to that of human milk (dilution, adding sugar or honey and cream)[21] in terms of protein, sugar and fat content, but ended up reduced to a mathematical exercise that was impractical for the majority of people.[2,5,17] This prescription predominated from 1890 to 1915 because many believed that flour-based formulae were nutritionally inadequate for children's needs.[21]

In 1883, Myenberg discovered a method for producing evaporated milk.[18,20] This product did not contain sugar in excess nor did it lack fat, like condensed milk.[18,20] The manufacturing process consists of evaporating 60% of the water content from milk and then heating it to 200 °C in sealed cans.[20,21] The procedure changes the properties of the milk, making it more digestible because it reduces curd formation and also offering the advantage of sterilizing it.[21]

Another important discovery was made simultaneously in the United States and in Germany, when Meigs and Biedert revealed the exact composition of breastmilk (1885), confirming the low percentage of protein (1.1 g/100 mL; 40% casein and 60% whey protein), when compared with cow's milk (3.5 g/100 mL; 82% casein and 18% whey protein).[5,17,18]

In parallel with these developments in the food industry, glass feeding bottles and rubber teats were patented (1845).[18,21] These innovations helped to encourage the use of breastmilk substitutes. Until then, substitutes had been fed to children in horns, pewter or porcelain vessels or spoons.[4] Aiming to reach mothers and the medical profession, manufacturers began to promote evaporated milk.[18]

With the discovery of electricity and the advent of refrigeration and because of frustration with the complexity of the formulae written by Rotch, physicians started to prefer evaporated milk or commercial formulae (powdered or "ready-to-drink" liquids). Countless patents were registered

from 1898 onwards.[21,23,24] These factors, associated with promotional campaigns, contributed to the decline of breastfeeding.[2,18] Between 1912 and 1919, a study indicated that just 13% of 1-year-old infants living in urban centers in the United States were fed breastmilk exclusively, while 45% were given breastmilk and formula.[26] Another study compared data from 1911 and 1967 and found that, if at the start of the century 58% of 1-year-old infants in the United States were breastfed, 50 years later only 25% were on exclusive breastfeeding when discharged from maternity.[17]

At that time the dilution method (homemade formulae) was the most popular in Europe and in the United States.[24] Whereas the Germans used boiled milk, in the United Sates milk was used *in natura* because of the observation that certain diseases, such as scurvy, predominantly affected children fed on sterilized, pasteurized or condensed milk.[24] In 1912, Funk suggested that beriberi, scurvy, pellagra and rickets were caused by a lack of vitamins in the diet. This discovery led to the recommendation that diets be supplemented with fruit juice and cod liver oil.[24] From then on, boiled milk was no longer a threat to health, and the use of diluted formulae became popular.

Continuing to search for a good substitute for breastmilk, the industry began to invest in producing modified milks (industrial formulae) in order to "humanize them," i.e., to approximate their composition to the characteristics of breastmilk.[21,24] Emphasis was put on the proportions of protein, fat and carbohydrates and not on the energy provided. With recognition of calorie requirements came the recommendation of a daily intake of 100 kcal/kg during the first months of life.[24] Even so, between 1925 and 1930 modified milks still varied considerably in terms of energy density.

In 1909, Ruhräh produced the first formula made from Soy, but it only became commercially available (United States) after 1929, when Hill proposed it as an alternative option for children who are allergic to cow's milk.[2,24,27] Many parents complained about the color of this milk and said that it made their children's feces foul smelling and stained their clothes, causing more frequent rashes. These effects were due to the large quantity of fiber contained in soy milk.[24] In the 1950s it began to be noticed that children fed on soy formulae had vitamin deficiencies.[24,28] Formulae were not fortified, however, because scientists believed that vitamins could trigger or exacerbate allergy. Only in the mid-1960s did formulae appear made from isolated soy protein-based formulae, which were similar in color to milk-based formulae and nearly odorless, leading to increased toleration.[28]

Since Leibig developed the first flour-based formula, cereals had always been added to milk with the objective of reducing curd formation and improving digestibility. When evaporated milk was invented, with reduced curd formation because of the production process, it was no longer necessary to add cereals.[24]

As mothers breastfed less, solids were introduced ever earlier. If the 1911 edition of Diseases of Infancy and Childhood (Holt) recommended that vegetables should be introduced after 3 years, the 1929 edition indicated doing so at 9 months.[2] Other studies also demonstrated this tendency. In 1920, strained vegetables were introduced at the end of the first year, root vegetables at 18 months and other foods only after 2 years.[29] In the 1950s, fruit and vegetables were prescribed from 4 months onwards and, by the next decade, 83% of 1 month old children seen in the District of Columbia were already eating some form of semi-liquid or solid food.[30] In research conducted in Los Angeles in 1976, Hollen observed that one third of physicians indicated introducing solids within 6 weeks and almost two thirds before 3 months.[31] At the same time, animal milk was being introduced earlier and earlier and the prevalence of breastfeeding reduced even further between 1930 and 1970.[17,24] Very often, commercial formulae were used for a few months only, because of their high cost when compared with cow's milk.[24]

In the 1940s, homemade formulae in the United States were made by mixing evaporated milk or pasteurized cow's milk with water and corn syrup or sucrose. Rickets and scurvy were no longer feared because all processed milk was fortified with vitamin D and children were given juice to guarantee a source of vitamin C. Physicians believed that using formula was just as safe and satisfactory as breastfeeding.[24]

Since the start of the century laboratories invested in developing modified milks. There were so many options on the market that even physicians found it difficult to choose the most appropriate formula for a given child. In search of increased profits, which had been hurt by falling birth rates are caused by the Second World War, manufacturers began "perverse" promotion of breastmilk substitutes.[18] After the war, sales increased in response to the advertising campaigns and because of the baby boom. The formulae that predominated between 1950 and 1960 were similar to evaporated milk, but with added vitamins, or were low in protein and had vegetable oil and vitamins and minerals added.

In the 1960s birth rates began to fall again as a result of the contraceptive pill and the feminist movement. Breasts, which hitherto had had functional connotations, gained esthetic and sexual roles.[17] Feeding bottles were adopted as a symbol of women's liberation. The food industry diversified its products even further, increased advertising and expanded into the Third World.[18] The compositions of formulae were changed (lactic acid, lactose, fat, minerals, vitamins) to adapt them to new knowledge about nutrition and to gain sales by offering advantages over other similar products or by reducing cost.[17,28,32] The

term "humanized milk" gave way to "adapted milk."[17] All of these changes contributed to the fall in breastfeeding rates, the predominance of artificial feeding and the early introduction of supplementary foods.

Until then, infant formulae available commercially were in powder form and based on whole cow's milk. After 1951, concentrated liquid formulae began to appear in the United States and Canada. They dominated the market until the mid-1960s when ready-to-feed formulae were launched that no longer needed added water and had a casein/whey protein ratio similar to human milk.[28,33] The market for these products was restricted to North America, since, with few exceptions, they were not made available in other countries.

Infant formulae have constantly changed since the mid-20th-century in attempts to meet as closely as possible the needs of infants.[34] Technological advances made it possible to produce products that helped to reduce malnutrition, compensate for digestive and absorptive deficiencies and deal with allergy problems and gastroesophageal reflux.

Breastmilk is the best possible food for an infant, but faced with a situation in which breastfeeding is not possible (work, retrovirus infection, innate errors of metabolism, weight deficit) a formula should be chosen that is adequate for the age group, since formulae change depending on requirements. These formulae are more expensive than unmodified cows milk, whether powdered or liquid, and are very often inaccessible to low-income families.[34] Notwithstanding, it is known that unmodified cows milk is unsuitable for infants less than 1 year old because of the high concentration of protein, the incorrect casein to whey protein ratio, and high levels of sodium, chloride, potassium and phosphorus, insufficient carbohydrate, low quantities of essential fatty acids (linoleic and linolenic), of vitamins (C, D and E) and of iron, zinc, copper and selenium.[34,35] These differences from the ideal composition compromise digestion and absorption, lead to inadequate weight gain, overload the kidneys, contribute to obesity, predispose to diarrhea and dental caries and do not meet requirements for essential fatty acids, vitamins or trace elements. In addition to these risks, premature exposure to cow's milk can lead to hypersensitivity to milk protein, predisposing to allergy, infection and anemia, because of intestinal micro-hemorrhages.

At the same time as infant formulae diversified, the industry evolved in terms of both sweet and savory baby foods. Countless options appeared. In the 1960s, many substances such as monosodium glutamate, sugar and starch began to be added to paps with the intention of improving their appearance, density and texture, adjusting them to the adult palate.[28] Over time, this practice was regulated and the quantities of salt and sugar added to manufactured baby foods was reduced.

The world breastfeeding support movement began in the 1970s, but it is difficult to identify the causes that triggered the change in prevailing mentality.[24] The reasons appear to be rooted in society, which accused the industry of interfering in breastfeeding using aggressive advertising campaigns.[36]

Powdered formulae currently dominate the market for breastmilk substitutes practically all over the world. They consolidated public preferences as they became more and more soluble.[24,28]

As breastfeeding returns to popularity, a tendency is observed to introduce cow's milk ever later, since after weaning mothers are choosing powdered formulae.[24] In addition to the practicality, the choice is also probably partly the result of studies that have linked cow's milk to anemia. However, the use of fortified formulae had a modest effect on the prevalence of iron deficiency anemia when it was restricted to the first few months.[37] As a result of this observation it was recommended that fortified formulae were used at least until the end of the first year of life, or where this is not possible, that fortified cereals be added to cow's milk.[28,38,39]

In 1979, Fomon et al.[38] suggested that premature introduction of supplementary foods before 4 months contributed to forming unhealthy habits, with increased incidence of overweight and obesity. These authors considered that this was probably because at this age children are not yet able to refuse food when satisfied by closing their mouths and turning their faces away.

The return to popularity of breastfeeding also influenced the time when complementary foods were introduced, delaying it.[28] If in 1976, 60% of children in the United States were already eating solid foods at 1 month, by the start of the 1990s this rate was below 10%.[24] Unfortunately, the same was not true of juices, since sales increased from 9.7% in 1971 to 16.7% in 1984,[40] which was unjustifiable, since both breastmilk and formulate contained vitamin C.

The prevalence of breastfeeding reached its low point in 1972 when data show that just 22% of newborn infants in the United States were breastfed when discharged from hospital.[41] This rate they inclined, reaching 34% in 1975 and 59.7% in 1984.[42] Among the factors responsible for this increase are the Natural Childbirth Movement (1960), which questioned the medical model of delivery, claiming that it negatively impacted on the mother-child bond and on breastfeeding, and the Baby Friendly Hospital Initiative, launched by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), to promote, protect and support breastfeeding (Innocenti Declaration) through the Ten Steps to Successful Breastfeeding (1990).[40]

In this context, these entities took action to prohibit advertising of baby milk, bottles, teats and pacifiers (1980-90). Under pressure, the industry adopted the following slogan in advertising "breastmilk is the best food for infants,"

emphasizing that its products should only be used when breastfeeding was not possible.[18,28]

In 1993, the WHO observed that healthy breastfed children had a different pattern of growth from that illustrated by the National Center for Health Statistics growth charts (NCHS, 1977). This demonstrated the need to construct growth curves for breastfed children and use them as the target growth profile. Therefore, between 1997 and 2003, data were collected from children of six different ethnic groups to construct international reference curves. The study that led to the New Growth Charts (WHO, 2006) showed that, in contrast with what had been claimed, children from different ethnic groups had similar growth if given satisfactory conditions.[43]

Studies undertaken during the last 25 years have further highlighted the importance of breastfeeding, the role of vitamins and mineral salts in nutrition and the importance of the energy density of foods.[44-46] Advances in the fields of nutrology, immunology and psychology have helped to consolidate the position of breastfeeding.[43]

In common with the WHO,[46,47] the Pan American Health Organization (PAHO)[47] and the Brazilian Society of Pediatrics (Sociedade Brasileira de Pediatria, SBP)[35] currently recommend feeding infants only on breastmilk until 6 months, with no water or teas, and recommend introducing complementary foods (cereals, root vegetables, pulses, meat, greens, vegetables and fruit) from 6 months onwards (3 times a day for breastfed children and 5 times a day children who have already been weaned).[35,47,48] Consistency should be thickened gradually, sugar avoided and salt used sparingly. Home cooked food should be preferred to manufactured foods, which vary little and contain additives, preservatives and antimicrobials that are prejudicial to the health. It is recommended that coffee, soft drinks, tinned food, fried food and delicacies be avoided, that children's tolerance be respected and that children be encouraged to drink liquids from cups or months once supplementary foods have been introduced. These foods, known as transitional foods (which are prepared especially for children) should be of a pasty consistency until children can manage food in pieces. The recommendation is that by the end of the first year the infant should be eating the same food as the rest of the family. The phase of introducing supplementary foods is a potential risk period because of the possibility of contamination. Breastfeeding should be encouraged at least until 2 years of age.

Science advances rapidly and health professionals must keep themselves constantly up-to-date. Although the prevalence of breastfeeding is improving in Brazil, it is still well below the ideal[48] and health professionals must work in conjunction with the state to improve these figures, not merely by advising mothers to breastfeed but by seeking to provide them with the conditions in which they can do so, for example in the current fight to increase maternity leave from 4 to 6 months.

Conclusions

Infant nutrition, whether natural or artificial, has always been determined and conditioned by the social value attributed to breastfeeding. Over time, women breastfed less and less, particularly after the industrial revolution. Initial discoveries resulted in high infant mortality rates, which were not in the interests of the State. Necessity stimulated the search for alternatives which furthered the decline of breastfeeding and led to a peak in artificial feeding. Current knowledge about the benefits of breastfeeding have led to laws being passed regulating breastmilk substitute advertising and guaranteeing the right to maternity leave, with the objective of increasing breastfeeding prevalence rates and ensuring that children have the best possible growth and development.

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