

A generally neglected threat in infant nutrition: incorrect preparation of infant formulae

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Breast milk is the most appropriate food for infants. At least 4-6 months of breast feeding is sufficient for all babies if appropriate growth is monitored monthly. However, for those infants unable to breast-feed sufficiently or at all, formula can be given as an alternative. However, serious health problems such as hypernatremic dehydration, malnutrition, and obesity may develop if powdered formula is not appropriately prepared. In the present study, our aim was to investigate whether or not mothers of formula-fed babies in Özkanlar (İzmir, Turkey) district prepared powdered infant formula appropriately. For this purpose, we visited all (328) families with infants younger than 12 months of age. Forty-two (13%) of these 328 infants were still fed formula. The mothers of the infants were asked to prepare formula for two different meals, and duplicate samples from each prepared formula were taken for the measurement of dry matter. Fifty percent of the mothers diluted formula with 10% more or 10% less water for the second meal as compared with the first meal. Four (10%) mothers diluted formula with 10% or less of the required water, while 27 (64%) prepared formula with 10% or more of the required water. It is concluded that mothers must be informed about the preparation of formula when formula is prescribed for their babies.

Key words: formula, infant nutrition, preparation.

Breast milk is the most ideal food and can solely supply all the biological and physiological requirements of babies during the first four to six months. Although the composition of infant formula is similar to breast milk, it is not a perfect match, because the exact chemical content of breast milk is still unknown and contains unique structures and compounds like living cells, hormones, active enzymes, and immunoglobulins, which cannot be replicated in infant formula. However, developments in technology, industrialization and rapid urbanization have changed the role of women in society, requiring them to be more active in the working environment. As a result, mothers and babies are sometimes forced to stay apart for a major part of the day and thus breast milk is not given to the baby in the required amounts or at optimal frequency to compensate in such situations and in those cases when mothers cannot breastfeed due to severe health problems, infant formulae can be used as the best alternative to breast milk¹⁻⁹.

Correct use of formula is as important as the correct choice of formula. It is extremely important to prepare formula according to instructions. For instance, if formula is not prepared in hygienic conditions, diarrhea may develop; if the quality of the water used for the dilution of formula is not good (i.e. if water contains toxic substances or inappropriate mineral concentrations), it may cause serious detrimental effects on the rapidly growing infant¹⁰⁻¹⁴.

One of the most critical aspects of formula preparation is to dilute powdered formula according to instructions on the label of the package. It is especially important not to add more or less water than recommended. Families who are short of money may be tempted to add extra water to make the formula last longer. Formulae are designed to provide energy (about 20 calories per ounce) and nutrients that a baby needs for proper growth. If the formula is too weak, the infant will be underfed and may have

protein energy malnutrition. On the other hand, not adding enough water to formula can result in hypernatremic dehydration, obesity and other potentially serious disorders¹⁵. The aim of the present study, therefore, was to determine whether or not mothers of formula-fed infants in Özkanlar (İzmir, Turkey) district prepare infant formulae correctly.

Material and Methods

In the Özkanlar district, all families (328) with children aged 0 to 12 months were visited. Among these families, all the formula-fed infants were identified. During a face-to-face interview, demographic characteristics of the families were obtained through a questionnaire, including a detailed enquiry regarding nutrition status of the infants. The mothers of the formula-fed infants were also asked to prepare formula for their babies for two different meals, and samples of the prepared formula were obtained. Duplicated samples were collected from each meal, resulting in a total of four samples per baby. These samples were contained in clean and dry glass bottles, with lids closed, and they were refrigerated until measurement.

In order to measure the amount of dry matter, 5 ml of diluted formula sample was taken into a petri dish that was dried and tared previously. The sample was then cooked in an oven at 100 °C until completely dry and at constant weight. The mass of dry matter in the samples was found by subtracting the weight of the petri dish from the final measurement. This number was then multiplied by 20 in order to find the total dry matter in the 100 ml diluted formula. The dilution difference (technical error) in the duplicate samples taken from the same meal was expressed as percent and was calculated as follows:

$$\frac{A - B}{A} \times 100 \text{ where}$$

A=weight of dry matter in the first sample
 B=weight of dry matter in the second sample

The mean (±SD) difference in the dry matter content between the two samples collected at the same meal was calculated as 3.9±3.1 % (using absolute values). As this number was an acceptable value, it was considered that the technique used to measure dry matter content of formula was appropriate and further analyses were carried out.

The average of duplicated dry matter measurements for each of two different meals was then calculated, and the dilution difference between the averages of dry weight measurements of two different meals were determined as follows:

$$\frac{C - D}{C} \times 100 \text{ where}$$

C= average of the amount of dry matter in the duplicate samples (100 ml) for the first meal

D= average of the amount of dry matter in the duplicate samples (100 ml) for the second meal

In order to determine whether or not mothers diluted the formula according to the instructions, the following equation was used.

$$\frac{E - C}{E} \times 100 \text{ where}$$

E=original dry matter content in 100 ml diluted formula written on the label of the package

Results

In the Özkanlar district, of a total of 328 families, 42 babies (13%) were still formula-fed (Table I). Of these infants, 16 were boys (38%) and 26 were girls (62%). The mean age of this group was 5.6±3.3 months (median, 4.0 months).

Table I. Demographic Characteristics of the Study Subjects

Characteristics	Value*
Characteristics of the mothers	n=42
• Age (year)	
Mean±SD	26.0±3.8
Min-max	19-36
• Education	
Primary school or less	10 (23.8)
Junior high school	3 (7.1)
High school	14 (33.3)
University	15 (35.7)
• Working/not working	16 (39)/26 (61)
• Economic status of the family	
Low	6 (14.4)
Middle	14 (33.4)
High	22 (52.2)
Characteristics of the infants	
• Age (months)	
Mean±SD	5.6±3.3
Min-max	4.0
• Sex	
Male	16 (38)
Female	26 (62)

* The numbers in parentheses are percent values.

The age of the mothers ranged between 19 to 36 years (mean, 26.0 ± 3.8 years). Mothers were mostly housewives (61%); 33% were high school graduates and 35% university graduates.

While only two (4.8%) babies were solely formula-fed, the others were either fed supplementary foods (35%), supplementary foods and breast milk (40.5%), or breast milk (19%), in addition to formula. Twelve babies (29%) were fed less than 30 ml of formula per kilogram body weight, whereas 10 (23%) were fed more than 90 ml of formula (Table II).

Nineteen babies (45.3%) started to take formula within the first month after birth and nine of them (21.4%) took their first formula on their first day. Thirty-four mothers (81%) indicated that they started formula as a result of doctor's recommendation, whereas six of them (14.3%) started on their own, without seeking outside advice.

In this study, all mothers were questioned regarding where they learned to prepare the formula and it was learned that doctors and midwives provided such information. Twelve (28.6%) mothers used this information, 25 (59.9%) reported that they benefited from instruction on formula packages, 1 (2.4%) learned from books and television and 2 (4.8%) from their own experiences. All mothers prepared the formulae with boiled and then cooled tap water for every meal.

Fourteen mothers (33.3%) indicated that they kept formula in the fridge once the package was opened, while 28 (66.7%) kept the package at room temperature.

When they were asked how to prepare formulae, 39 (92.9%) indicated that they added the powder formula with a special measurement instrument and 3 (7.1%) said prepared based on visual estimates (Table III).

Table II. Nutritional Pattern of the Infants

Characteristics	n	%
Current nutrition		
• Exclusively formula	2	4.8
• Breast milk+formula	8	19.0
• Formula+supplementary foods	14	35.7
• Breast milk+formula+supplementary foods	17	40.5
Daily formula intake of the infants per kg body weight		
• <30 ml	12	29
• 30-59 ml	11	27
• 60-89 ml	9	21
• ≥ 90 ml	10	23

Table III. Mothers' Knowledge About Preparation and Preservation of Infant Formulae

	n	%
Knowledge from		
• Instructions on the formulae packages	25	59.5
• Doctor	12	28.6
• Doctor+Instructions on the formulae packages	2	4.8
• Own experiences	2	4.8
• Books and television	1	2.4
How to prepare		
• By measuring	39	92.9
• Visual estimate	3	7.1
Evaluation of mothers' explanation		
• Correct preparation	26	61.9
• Incorrect preparation	16	38.1
Preservation of opened packages		
• Refrigerator	14	33.3
• At room temperature	28	66.7

The mean dilution difference between the duplicate samples of the same meal was found as 3.9 ± 3.1 . When mean difference \pm two standard deviations (10%) was accepted as the limit value, 27 (64.2%) mothers diluted formula more than recommended in the instructions and 4 (9.5%) mothers used less water than required (Fig. 1). Those who diluted formula more than required used an average of $22.2 \pm 14.5\%$ more water, while those who diluted less than required used $12.4 \pm 13.0\%$ less water. Among those who diluted formula excessively, one mother used 60% more water than required. In contrast, one mother used 43% less water than recommended for the preparation of formula. When all the cases were considered, mothers used inappropriate amounts of water by $20.3 \pm 15.1\%$ during the first meal and by $18.9 \pm 14.3\%$ during the second meal (mean \pm SD).

In order to determine whether or not mothers always diluted formula in a similar manner, the dilution of the formula prepared for two different meals was compared (Fig. 2). The formula prepared for the second meal was more or less diluted than the first meal by $16.2 \pm 20.7\%$ (mean \pm SD). For one of the mothers, the dilution difference between the first and second meals was 100%.

Discussion

In this study, it was found that 74% of mothers diluted formula incorrectly due to a lack of education regarding infant formula preparation. During a previous research¹⁵, one group of babies had been fed with ready-to-use liquid formula since birth, while another group was fed with powdered formula requiring dilution at every meal. At the end of the sixth month while only 5% of those babies fed with ready-to-use formula weighed more than normal, the weight of 30% of the babies in the other group was higher than normal. The reason for this difference was believed to be the incorrect dilution of formula.

Another interesting result determined in this study was the inconsistent practices of the mothers for the dilution of formula. In other words, one meal might be overdiluted, whereas the next one might be underdiluted, resulting in significant differences, as high as 100% between two different meals.

If an exclusively formula-fed baby is given overdiluted formula, protein energy malnutrition may develop. On the other hand, and particularly if a baby is fed with concentrated formula for an extended time, if extra water is not given to the baby, especially during the hot summer days,

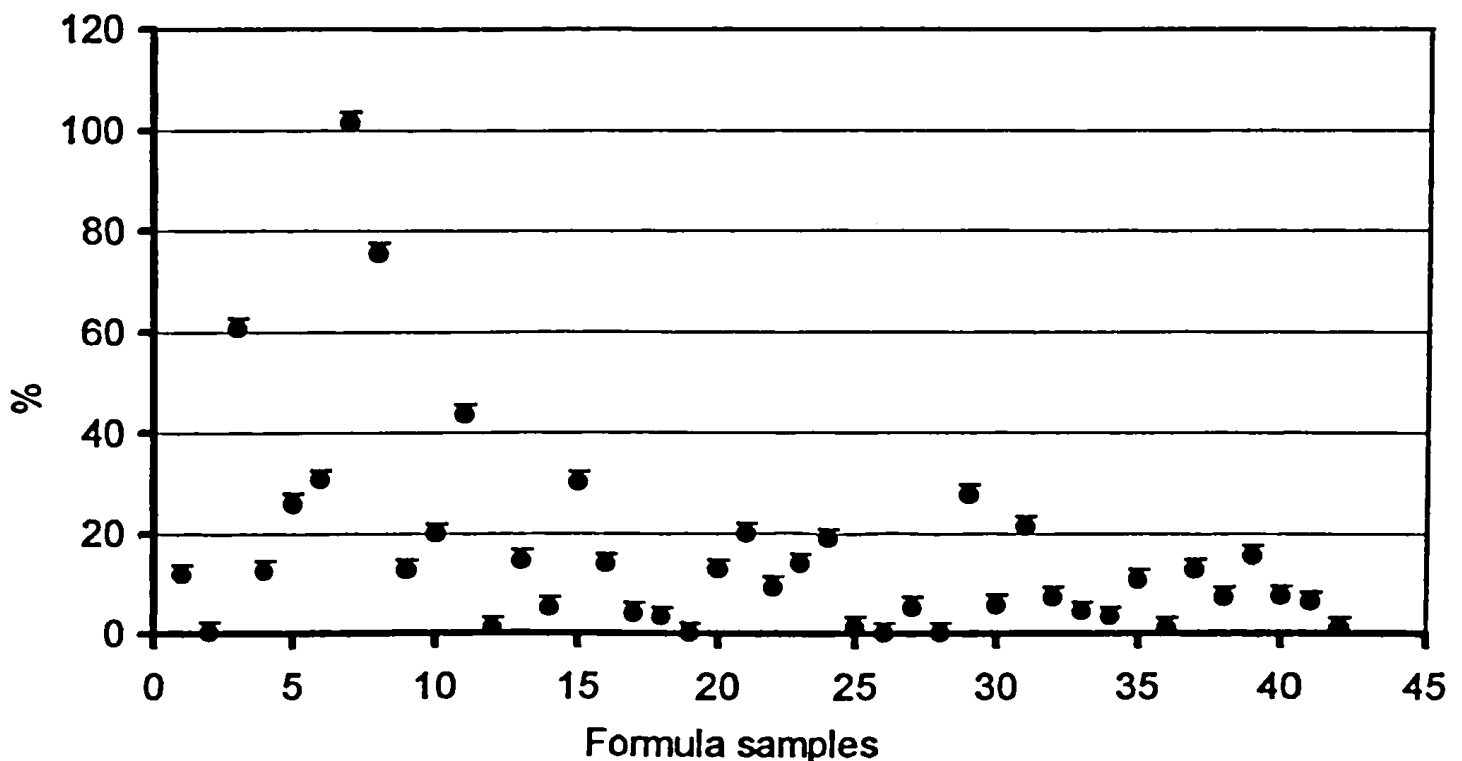


Fig. 1. Difference in the amount of water used for preparation of formula compared with recommended amount of water written on the label of formula package.

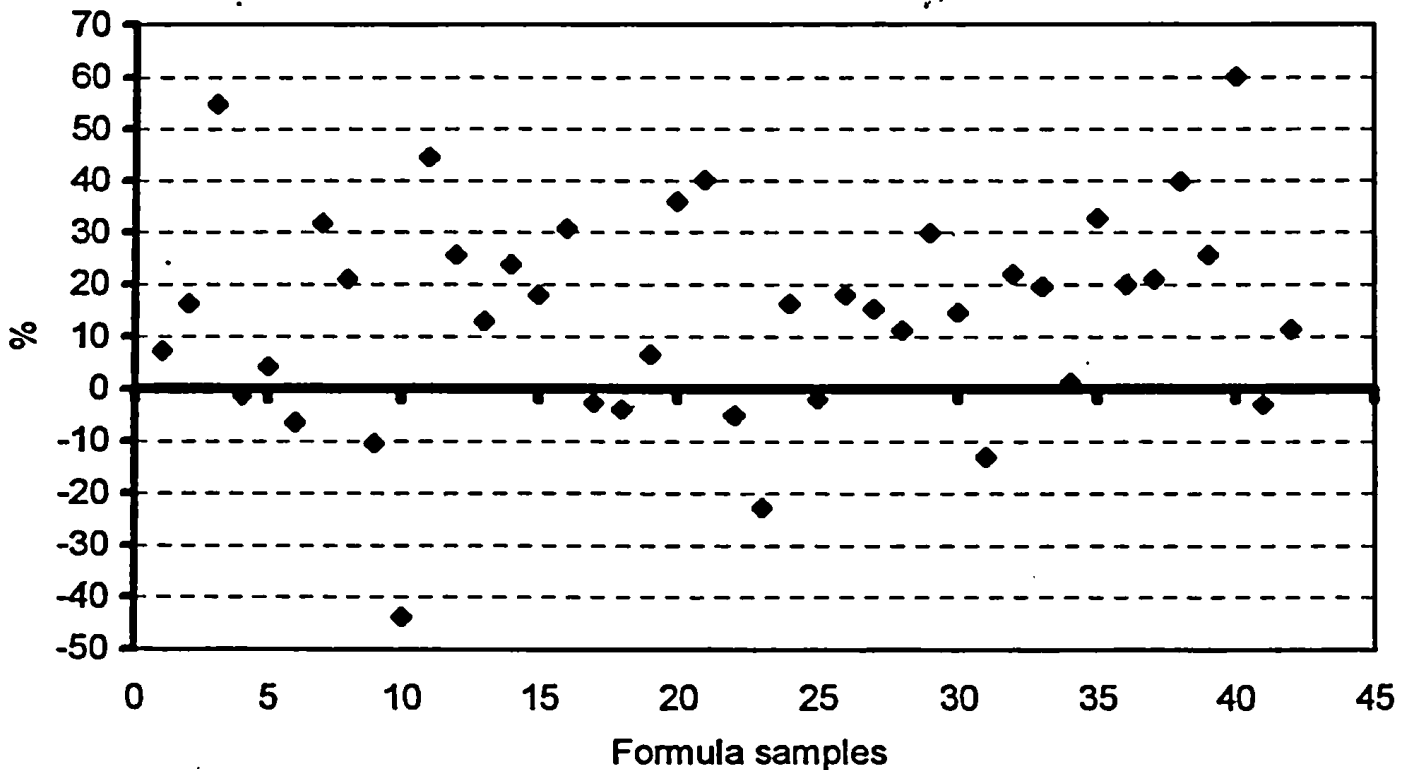


Fig. 2. Dilution differences of the formulae between the first and second meals.

severe health problems such as hypernatremic dehydration or obesity may develop. It may seem contradictory that although most of the babies included in our study were fed with overdiluted formula none of the babies was suffering from malnutrition. This situation can be explained in two ways. First, only two of the 42 babies were exclusively formula-fed; the others were fed breast milk and/or supplementary foods in addition to formula. Therefore, the amount of formula that the babies were given was relatively low, and only 23% of the babies were fed a daily dose of 90 ml of formula or more per kilogram body weight. Secondly, mothers were inconsistent in their food preparation techniques. Thus, any lack of protein or energy caused by overdilution of formula might be compensated by the overconcentration of formula during the next meal.

In literature from the last 20 years, we could find only one study on the dilution of infant formulae¹⁷. According to that study, carried out in Australia, 30% of the mothers diluted formula incorrectly. Half of those mothers made serious mistakes, and formula was usually prepared overconcentrated. A majority of the mothers in our study had average socio-economic status, and 69% were high school or university graduates.

During recent years, intensive research has been conducted to adapt several good qualities of breast milk, including immunological characteristics, to formula through biotechnology¹⁸. However, it should be remembered that no matter how similar formula is to breast milk, the formula will not benefit babies if not prepared correctly. For this reason, pediatricians are responsible for explaining the preparation of formula to mothers at the time they recommend its usage. In this study, 14.3% of mothers indicated that they started to use formula on their own and without a doctor's recommendation, whereas 2.4% followed a pharmacist's advice and 2.4% followed a midwife-nurse recommendation. However, 71.4% of the mothers started formula because they concluded that their breast milk was not enough. For this reason, during routine growth monitoring after birth, evaluations regarding the sufficiency of breast milk of mothers should be made based on the growth curve of their children. Mothers should be fully informed in this regard, and should be prevented from starting formula unnecessarily. Many falsely assume their infant's crying is an indication that their breast milk is not sufficient.

In summary, it should be remembered that breast milk alone can provide all the biological and even physiological needs of babies for four

to six moths. In order not to deprive babies of this unique and useful food, mothers should be fully informed both before and after they give birth. If formula should be used because a mother cannot breastfeed due to health problems or for other reasons, then; mothers should be educated and trained about the preparation and preservation of formula.

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