Cry, the beloved bottle: infant-feeding knowledge and the practices of mothers and caregivers in an urban township outside Bloemfontein, Free State province

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Abstract

Objectives: To investigate knowledge of and practices regarding bottle-feeding preparation, as well as the nutrient content and microbial safety of bottles that are prepared by mothers and caregivers for infants aged 0-24 months.

Design: Cross-sectional descriptive survey.

Setting: Urban township, Mangaung, outside Bloemfontein.

Subjects: A sample of 189 mothers or caregivers of healthy infants aged 0-24 months, who were exclusively formula fed or mixed fed with breast milk and infant formula or cow's milk, were randomly selected in a household survey.

Outcome measures: An interviewer-administered questionnaire and/or observed practices were used for data collection. Bottle-feed samples were also collected and analysed for nutrient and microbial content.

Results: Mother and caregiver knowledge on infant feeding was poor. An acceptable method for preparing a bottle feed in five steps was evaluated. Only 4.2% of the total sample applied all five steps. A total of 84.5% (n = 160) of all the collected feeds was contaminated with *E coli*. A lower level of maternal education was associated with a greater likelihood of feed contamination. The predominant source of bottle-feeding preparation information was clinic staff (28%).

Conclusion: The findings were indicative of a lack of knowledge, and possibly resource limitations, to facilitate safe bottle-feeding practices. Acknowledgement of clinic staff as a source of infant-feeding information highlights the role of healthcare workers as facilitators of appropriate infant-feeding practices.

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Introduction

Infant and child mortality, a universal indicator of a nation's health and level of development,[1] is exacerbated by a lack of access to basic health services.[2,3] Although under-five global child mortality has decreased by nearly two thirds, the South African infant mortality rate only decreased by 2% between 1994 and 2010. However, in 2012, it was shown to be on the increase in some provinces.[4] According to the Human Sciences Research Council,[1] the majority of these deaths were caused by conditions that are preventable or treatable, such as acquired immune deficiency syndrome (AIDS), pneumonia, diarrhoea and neonatal causes. Furthermore, 60% of under-five mortality is reported to be associated with malnutrition. Seventy-five per cent children with severe malnutrition presented signs of advanced HIV/AIDS.[5] Statistics South Africa[4] reports an upward trend in the under-five mortality rate (59 in 1998 and 104 in 2007). In view of these figures, the achievement of Millennium Development Goal 4 (MDG 4) by 2015, with the South African target of a reduction in child and infant mortality to 20 in under-fives and to 18 in infants per 1 000 live births, is "unlikely".[4] These sentiments have also been echoed by the National Breastfeeding Consultative Meeting.[6]

To bring about a reduction in the infant and under-five mortality and morbidity rates, the South African government has to overcome challenges such as the provision of clean water, optimal nutrition, sanitation and household food security.[4] Chopra et al[7] suggest that the lives of nearly 50 000 newborn babies and children could be saved by 2015 if South Africa implements effective, widespread measures to prevent transmission from mother to child and provides successful intrapartum and neonatal care.[8] However, they further add that the HIV/AIDS crisis should not overshadow other neglected interventions, such as promotion of exclusive breastfeeding.

According to the World Health Organization (WHO) and the United Nations Children's Fund,[9] lack of breastfeeding, especially exclusive breastfeeding during the first six months of life, is a risk factor for morbidity and mortality among young children. Breastfeeding reduces the risk of acute infections. However, in the absence of antiretroviral (ARV) treatment, breast milk is an important transmission route of HIV from mother to child.[10] As a result, formula feeding has been recommended as one of the strategies to prevent HIV transmission,[1] and subsequently offered as an option to mothers in the South African Prevention of Mother To Child Transmission (PMTCT) HIV programme.[11] Since formula feeding with contaminated water is estimated to be responsible for 1.5 million childhood deaths per annum,[12] it is clear that the most suitable infant-feeding choice to prevent HIV transmission and ensure optimal health is complicated.

Increasing evidence, especially from South Africa,[13] indicates that a combination of exclusive breastfeeding and the use of ARV therapy by either the HIV-positive mother or infant who is exposed to HIV, can significantly reduce the risk of mother-to-child-transmission. Subsequent infant feeding recommendations by the WHO[11] therefore state that if ARV treatment is available, an HIV-positive mother should be encouraged to exclusively breastfeed her infant until six months of age. In accordance, the National Breastfeeding Consultative Meeting[6] resolved that South Africa should adopt the 2010 WHO guidelines on HIV and infant feeding.

Despite the abovementioned findings and recommendations, it is a challenge to change the entrenched culture of formula feeding.[14,15] In addition, some health workers are still not convinced that breastfeeding is advantageous, even in the case of mothers who are not HIV-positive[16] but who lack the necessary lactation management skills.[17] Yet, it is suspected that in Africa, an estimated 52 315 HIV-negative infants born to HIV-positive mothers (or 9.6% of total deaths) could be saved annually by exclusive breastfeeding, whereas it is estimated that 21 638 lives (or 4% of total deaths) could be saved annually by introducing safe formula feeding.[8]

Furthermore, the provision of promotional support has the potential to double these figures.[13,15,17] The risk of death that is attributed to formula feeding often goes unnoticed, as the majority of children with HIV-positive mothers who are formula fed die, not as a result of AIDS, but as a result of malnutrition, diarrhoea, pneumonia or other indirect causes that do not relate to HIV.[16] High-quality evidence from non-HIV settings also indicates that poor feeding practices and malnutrition greatly increase the risk of infant deaths.[15]

The ability of mothers to select an appropriate feeding practice is significantly influenced by the support that is provided through formal health services and other community-based groups. This requires health authorities to invest in and provide sufficient resources to support and improve infant-feeding practices among the entire infant population.[15]

In South Africa, at the end of 2011, a decision was made that free formula should only be issued at public health facilities on prescription by designated healthcare professionals, when formula feeding is medically indicated.[6] This decision was taken to support, protect and promote breastfeeding as the optimal form of nutrition for all babies. In order to strengthen strategies to promote optimal infant-feeding practices, factors that are known to affect the duration of exclusive breastfeeding should be explored (against the backdrop of cultural beliefs and practices in specific settings). This should include knowledge on appropriate bottle-feed preparation techniques and sources of bottle-feed preparation knowledge, together with the actual nutrient content and microbial safety of bottle feeds.

Method

Study objectives

The aim of this study was to investigate knowledge of and practices regarding bottle-feed preparation, as well as the nutrient content and microbial safety of bottles that are prepared by mothers and caregivers for infants aged 0-24 months in an urban township outside Bloemfontein.

Study population, design and methods

A pilot study was conducted at crèches in the Mangaung area to test the study questionnaire. The questionnaire was developed to test knowledge and practices for the purpose of this study. It included open- and closed-ended questions. Prior to piloting, it was assessed for content validity by relevant experts in the field of infant and young child nutrition. The pilot study tested the questionnaire for understanding and was subsequently shortened and simplified. Questionnaires were administered by female fieldworkers, recruited from primary healthcare clinics in the direct vicinity of the study, and trained by a registered dietitian. Finally, the questionnaires were completed by the mothers or primary caregivers of the infants in their mother tongue. Knowledge test scores were categorised as poor, average or good.

Bottle-feed preparation practices were then compared against the following checklist of acceptable bottle-feed preparation practices:

- Wash hands with soap and water before commencing.
- Sterilise bottles with boiling water.
- Sterilise teats with boiling water.
- Boil water and allow it to cool down before adding formula.
- Prepare bottles on demand.

The preparation of a bottle feed was deemed to be acceptable if the mother or caregiver adhered to at least four of the five steps of the acceptable method.

A randomised descriptive study design was used for the main study. Mangaung was selected as the study location because of the prevailing socio-economic status of the community. Subsequently, four areas were selected by means of proportionate stratified sampling. Randomly selected starting points were then marked on maps provided by the Mangaung municipality. From these starting points, the trained field workers visited each home until a household was found in which an infant lived who satisfied the inclusion criteria of the study.

A sample of 189 apparently healthy infants, based on a clinical examination, aged 0-24 months, who were exclusively formula fed or mixed fed with breast milk and infant formula or cow's milk, were randomly selected (Table I). No households had more than one infant who met the inclusion criteria of the study sample. Subsequently, the mothers or caregivers who were responsible for preparing the infant's bottle feeds for more than five days per week were included in the study sample.

Table I: Areas included in the survey and number of interviewed caregivers in each area

Phahameng	Joe Slovo	Bochabela	Namibia
41 (20.5%)	32 (16%)	55 (27.5%)	72 (36%)

Fifty-millilitre samples were collected from the feeding bottles by the same trained fieldworkers. Samples were stored in sterilised containers and placed in a cooler box. At the time of the study, the bottle content included cereal mixtures, infant formula, gruels, pasteurised and unpasteurised cow's milk, tea, coffee and fruit juices. All of the samples were immediately analysed for microbial content. The remaining sample (40 ml) was also analysed by the laboratory of Dairy Belle, Bloemfontein, for nutrient content using a standardised laboratory operating procedure.

If a bottle feed was not available for sampling at the time of the survey, the mother or caregiver was asked to prepare a feed. In such a case, the preparation was observed by the fieldworker who subsequently completed the checklist on appropriate bottle-feed preparation practices. If pre-prepared bottles were available, the fieldworker asked the caregiver to describe the process that was undertaken using standard phrases. The checklist was then completed accordingly. For the purpose of this study, the protein, fat and lactose contents of bottle milk feeds were determined using an ultraviolet Milk-O-Scan® 104 Type 19900 automatic analyser (similar to an infrared spectrometer).

Subsequently, the macronutrient composition was interpreted as a percentage of the minimum and maximum nutritional content of milk (formula and cow's milk) according to the Codex Alimentarius standards. Total daily nutrient intake was not assessed since it was not part of the scope of this study.

Of the 50-ml sample, 40 ml was used to determine bacterial contamination, including total organism count, total *Escherichia coli (E. coli)* count and total coliform count, by means of standard microbial analysis. If the content exceeded 10 000 counts (> 10 colony-forming units/ml) the feed was deemed to be unfit for human consumption, according to standards set by the WHO.[17] If any *E. coli* was detected in the feed, it was considered to be unfit for human consumption.

The SAS® statistical package was used to conduct the statistical analysis of data. Descriptive statistics for categorical and continuous variables were included. Pearson correlation coefficients were calculated between selected variables by means of standard statistical techniques.

Ethics approval was granted by the medical officer of the Bloemfontein municipality and chief director of the Department of Health, Orange Free State. The study proposal was served before the ethics committee of the University of the Free State (ETOVS NR 33/99). All participants signed an informed consent form before participating in the study.

Results

Socio-demographic characteristics

The socio-demographic characteristics of the study sample are summarised in Table II. The infants had a mean age of 10.8 months. Gender was evenly distributed. In the majority of cases, the mother was the caregiver and had completed secondary school. The majority of respondents lived in formal housing and had access to running water.

Bottle-feed preparation

Only 8 (4.2%) of mothers and caregivers complied with all the preparation steps (Table III). Almost a third (n = 58) complied with only four of the five steps. Hence, only 66 (34.9%) of mothers or caregivers used an acceptable method to prepare bottle feeds.

Bacterial contamination of bottle feeds

Of the bottles tested, 84.6% were found to be contaminated, with a total coliform count > 10/ml. No association was found between the coliform count and whether or not a mother or caregiver used

Table II: Socio-demographic characteristics of infants, mothers and caregivers

Infants (n = 189)				
Age distribution	0-6 months 55 (29%)	6-12 months 58 (31%)	12-18 months 40 (21%)	18-24 months 36 (19%)
Gender distribution	Male: 96 (51%)		Female: 93 (49%)	
Mothers and caregivers (n = 189)				
Relationship to infant	Mother: 158 (83%)	Grandmother: 16 (19%)	Other family members: 15 (8%)	
Completed level of education*	Primary school: 47 (25%)	Secondary school: 130 (69%)	Matric: 47 (25%)	Tertiary education: 4 (2%)
Housing	Formal housing: 123 (65%)	Informal housing:** 66 (35%)	Access to running water: 183 (96.8%)	Running tap in house: 16 (8.5%)

*: Eight mothers or caregivers had no formal education
**: Made of wood or metal sheets

Table III: Caregiver compliance with hygienic bottle-feed preparation steps

Study-specific steps	Affirmative responses
Wash hands with soap and water	79 (41.8%)
Sterilise bottles with boiling water	123 (65.1%)
Sterilise teats with boiling water	122 (64.7%)
Boil water before adding formula	181 (95.8%)
Prepare bottles on demand	125 (66.1%)

the correct bottle-feeding preparation techniques. However, the associations between total coliform count and level of education of the mother or caregiver were significant (p-value < 0.05). The probability of having a coliform count that was unfit for human consumption was 1.6 times higher when mothers or caregivers had no formal education, compared to those who had a primary school education [confidence interval (CI): 1.16-2.30]. When mothers or caregivers with no education were compared to those with a secondary or tertiary level of education, the probability of having a bottle with an unfit coliform count was found to be 1.5 times higher (CI: 1.17-1.86) for those who had no education.

Infant-feeding practices and knowledge of mother and caregiver

Assessment of mother and caregiver infant-feeding knowledge was based on basic infant-feeding practices (Table IV). Half of those who were interviewed reported that they believed that breastfeeding had nutritional benefits. The other half stated that it was a source of comfort for the infant. The main reason for giving an infant coffee or tea was that he or she enjoyed it. It was also given as a substitute for infant formula when formula could not be afforded.

The relative probability that a mother with no education did not breastfeed was 1.5 times higher, compared with mothers who had secondary or tertiary education (CI: 0.40-5.93). There was a lack of association between mothers with primary versus secondary or tertiary education and breastfeeding practices.

Macronutrient content of bottles containing infant formula and cow's milk

The macronutrient content of bottles containing infant formula and cow's milk are reported in Table V.

The mean protein, fat and lactose content met the minimum, but not the maximum, Codex Alimentarius values for the macronutrient content of the milk.

Discussion

In the current study, the infant-feeding practices and knowledge of mothers and caregivers were found to be poor based on the introduction of complementary foods and liquids at the incorrect age, inappropriate reasons for breastfeeding cessation and lack of knowledge on the causes of diarrhoea. In addition, the bottle-feeding preparation techniques of the majority of mothers and caregivers were not appropriate. The majority of bottle feeds that were tested in this study were contaminated. It was clear that a lack of formal education contributed to the findings. However, education

Table IV: Infant-feeding practices and knowledge* of mothers and caregivers

Infant-feeding variable	No (%)
Reason for giving formula	
Promotes growth	31 (23.2%)
Insufficient breast milk	28 (21.4%)
Mother returned to work	21 (16.1%)
Satisfies baby's appetite	13 (9.8%)
No reason	9 (7.1%)
Formula prescribed by clinic	5 (3.6%)
Age at which cow's milk was introduced	
6 months	5 (2.6%)
8 months	3 (1.6%)
Median age	6 months
Earliest age	2 months
Latest age	1 year
Age at which tea and coffee were introduced**	
Median age	6 months
Earliest age	1 month
Latet age	12 months
Breastfeeding practices	
Receiving breast milk in addition to the bottle	103 (54.3%)
Previously breastfed	62 (33.0%)
Never breastfed	24 (12.7%)
Reason for breastfeeding cessation	
Insufficient breast milk	31 (18.9%)
Mother returned to work	27 (16.1%))
To make sure the baby gets enough	16 (9.8%)
Age when solid food was introduced	
2 months	35 (18.3%)
3 months	61 (32.5%)
4 months	28 (14.8%)
Recommended age for introducing solid food	
2 months	24 (12.7%)
3 months	112 (59.2%)
4 months	27 (14.1%)
5-6 months	26 (13.8%)
Self-reported causes of diarrhoea ("loose tummy")	
Do not know	64 (33.9%)
Contaminated food	28 (14.8%)
Dirty bottles and teats	25 (13.2%)
Teething	25 (13.2%)
Eating wrong food	15 (7.9%)
Other***	32 (16.9%)
Source of bottle-feed preparation information	
Clinic staff	53 (28.2%)
Family and friends	38 (20.0%)
Reading label on infant formula tin	30 (16.0%)
Clinic staff and family/friends	22 (11.7%)

*: Knowledge related to reasons for breastfeeding, the age at which complementary foods and liquids were introduced and causes of diarrhoea
**: The majority of samples were given with added sugar, but no milk.
***: Hot weather, a change of formula, expired Purity©, Milk of Magnesia®, an ill baby or too much milk with the tea

Table V: Macronutrient content of bottles

Milk (formula and cow's milk) (n = 148)						
Macronutrients	Mean	Median	Codex values		Mean as % of Codex value	
			Minimum	Maximum	Minimum	Maximum
Protein (g/100 ml)	1.57	1.3	0.839	1.874	187%	84%
Fat (g/100 ml)	2.18	2.04	1.562	2.928	139%	75%
Lactose (g/100 ml)	5.04	4.855	3.064	7.153	164%	70%

by members of the healthcare system on aspects of hygienic bottle-feeding preparation techniques, appropriate complementary practices and more favourable living conditions could contribute to better practices.

Similar to the findings of the current study, the results of a study carried out in rural Thailand showed that only 41% of caregivers washed their hands with soap before preparing infant feeds. Inadequately sterilised bottles and teats were significantly associated with higher bacterial counts.[18] A study that was conducted among mothers attending a PMTCT of HIV programme at a South African clinic revealed that 68% of mothers always or often washed their hands before feed preparation, but 32% sometimes or never did.[19]

In the same study, the majority (81%) of samples from already prepared feeds that were obtained during home visits, as well as 67% (n = 63) of the samples that were obtained at the clinic were contaminated with faecal bacteria (*E. coli and Enterococcus* spp.) compared to 38% (n = 8) of feeds prepared under observation. Nearly two thirds (62%) of the clinic samples that contained *E. coli* and 24% (n = 23) of those containing *Enterococcus* spp. were contaminated with more than the limit of 10 counts/ml[19] that is recommended by the USA government.

According to Morais et al,[20] who conducted a study in São Paulo, Brazil, use of unpasteurised milk, the addition of ingredients other than milk to the feeding bottle, use of tap water to clean bottles, as well as a lower level of maternal education, were identified as risk factors for higher coliform counts in lacteal feeding bottles. Unpublished results by Braaf also highlighted the relationship between contaminated bottles and a lower level of maternal education. In the current study, the association between increased total coliform count and little or no formal education of the mother or caregiver was evident. These findings stress the importance of maternal education and its relationship with appropriate infant-feeding practices,[21] which, in turn, illustrate how female education can contribute to the achievement of MDG 4, i.e. to reduce infant mortality.

In this study, the predominant sources of bottle-feed preparation information were clinic staff (28.2%) and family and friends (20%). Research conducted in KwaZulu-Natal by Swarts et al[22] on factors that influenced infant-feeding decisions showed that 33% of mothers were guided by healthcare professionals, while 44% of mothers made their own decisions. Research that was carried out in South Africa[23,24] has emphasised the important role that clinic staff play in shaping mothers' infant-feeding decisions. The main reasons for breastfeeding cessation were insufficient breast milk and the fact that the mothers returned to work. Similar findings have been reported by other researchers.[23,25]

The hazards that are associated with bottle feeding[26,27] relate to over-dilution and under-dilution of infant formula or unhygienic bottle-feeding preparation techniques. In this study, macronutrient analysis of bottles that contained formula or cow's milk showed that the mean macronutrient content exceeded the minimum Codex Alimentarius standards for age, while samples met 70-84% of the maximum value for macronutrients. Therefore, it is possible that some of the bottles that contained infant formula were not reconstituted to the desired concentration. However, the significant and positive association between the fat content and microbial count of the bottle feeds poses a problem as it is possibly indicates that bottle feeds that were correctly reconstituted were more prone to contamination. A possible scientific explanation for this could be that the nutrients in the bottle feeds provided an appropriate growth medium for the microbacteria to reproduce.[20]

Over-dilution of bottle feeds could be attributed to the cost of infant formula as some respondents reported using coffee or tea as substitutes when infant formula was not available. A local study that was conducted by Andresen et al[19] found that 28% (n = 26) of samples obtained at the clinic, 47% (n = 8) of home-collected samples, and 14% (n = 3) of samples prepared under observation were over-diluted. Over-dilution of bottle feeds poses a risk with regard to nutrient content, as it can lead to under-nutrition. Yet, as mentioned earlier, bottle feeds with sufficient nutrient content pose an increased risk of bacterial contamination.

More than half of the infants and young children in the current study received infant formula and/or cow's milk in addition to breast milk, and the majority of mothers introduced solids before six months of age. In addition, only 14% (n = 26) of mothers and caregivers reported the age of 5-6 months as appropriate for the introduction of solids. Mixed feeding can expose an infant to the HIV virus and interfere with the anti-infective properties of breast milk.[1,28,29] Bottle feeding can also cause diarrhoea as a result of contaminated bottles or feeds,[27,30] and over- or under-nutrition, if feeds are not reconstituted appropriately. According to Fowler,[28] the lessons to be learned from the Zambia Exclusive Breastfeeding study[29] are that exclusive breastfeeding should be advocated for all mothers in resource-limited settings, irrespective of their HIV status, and where alternatives such as formula feeding are not safe, feasible or culturally acceptable.

In this study, the majority of mothers and caregivers reported introducing solids at three months. Almost one fifth introduced solids at two months. McLorg and Bryant[31] found that 44.4% of black mothers started introducing solid foods within the first or second month after birth. The premature introduction of solids is one of the factors that contributes to malnutrition, growth retardation and high mortality among infants in developing countries.[30]

Conclusion

The results of this study indicate that bottle feeding does not provide a safe alternative to breastfeeding, even in cases where the nutrient content of such feeds is sufficient. In fact, where the nutrient content of bottle feeds was sufficient, raised microbial contamination was detected, which posed an additional health risk. The age for introducing solids, the prevalence of mixed feeding, and insufficient knowledge on the causes of infant diarrhoea, all support the findings that caregivers lack adequate knowledge on appropriate infant-feeding practices. Inappropriate bottle-feeding preparation techniques and the high level of bacterial contamination of feeds were also indicative of a lack of knowledge and a possible absence of resources through which to facilitate safe bottle-feeding practices.

The relationship between the contamination of bottle feeds and a low level of formal education among mothers and caregivers emphasises the importance of relevant education strategies to target these groups. Acknowledgement of clinic staff as a source of infant-feeding information highlights the fact that the role of healthcare workers as facilitators of appropriate infant-feeding practices should not be underestimated. This also applies in cases in which the mother makes an informed decision to formula feed her infant, especially in resource-poor settings. Therefore, strategies to promote optimal infant-feeding practices should identify factors that are known to affect the duration of exclusive breastfeeding against the backdrop of cultural beliefs and practices in specific settings.

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