

Assessment of Mothers' Knowledge about Bottle Feeding Sterilization in Tikrit City – Iraq

Emad M. Thaker Al-Hadeethi¹, Hind Mutar Ibrahim², Ahmed Numan Hussein³

^{1,2}Department of Pediatrics, College of Medicine, Tikrit University, Salahaldin, Iraq

³Department of Pediatrics, Tikrit Teaching Hospital, Salahaldin Health Directorate, Iraq

E-mail: dremad2004@tu.edu.iq

Abstract

Infant formula needs to be prepared and handled safely, which involves proper cleaning and sterilization of the feeding equipment. Poor bottle hygiene conditions can contribute to microbial contamination and to the GIT infection of infants who are fed with formula or mixed feeding, especially for diarrhea. The objectives of this study were to determine the level of knowledge and practices of mothers about cleaning and sterilization of infant feeding bottles and to find out the most common methods of sterilization used among mothers in Tikrit City, Iraq. A cross sectional study was carried out for 300 mothers who use infant feeding bottles in the city Tikrit, Iraq. The study was conducted from 15 December 2023 to 1 November 2024 in Tikrit Teaching Hospital (pediatric ward), pediatric private clinics and primary health care centers. Simple random sampling was used for selection of participants. Data were gathered by means of direct interviewing, directed by a structured, self-administered questionnaire, which included the following items: Demographic characteristics, Bottle cleaning, Sterilization of the bottle, Feeding practices and past diarrheal illness. The data were summarized in frequency and percentage and analyzed by chi-square test (if applicable). 37.7% of the mothers participating in this study were illiterate, 75% were residing in urban areas, 92.3% were not working, and 32.7% were between the ages of 26 and 30. The majority of mothers (67.3%) were in the three or fewer children category and 60% were in the middle-income category. The most common ways of cleaning and sterilizing the feeding bottles was boiling (37.3%), using some detergent (25.0%), brushing (12.7%) and combination of both (25.0%). 35% of mothers used 1 or 2 feeding bottles for each category. 95% of mothers used boiled water to prepare infant formula, while 5% used tap water. Most of the plastic bottles were used (95%) and hardly 5% were glass bottles. 57.7% of mothers changed teats on a weekly basis and 42.3% changed them monthly. As for the time for the sterilizing, 26% reported boiling for 2 minutes and 5% for 10 minutes. In previously diarrheic infants, 82.3% reported diarrhea with the highest number being infants aged between 10-12 months (40%). Acute diarrhea was reported in 57.3%, chronic diarrhea was reported in 25% of total sample. The conclusion is that the mothers in Tikrit City were using the boiling method of infant feeding-bottle sterilization most frequently. There was, however, a great deal of variation in cleaning technique, in the length of time for which bottles and teats were sterilized, and in the types of bottles used and the method of teat replacement. This is important to note that the percentage of babies who had previously suffered from diarrhea is high and it is a reminder that maternal and child health education should be structured to improve maternal knowledge and in promoting safe bottle-feeding practices.

Keywords: Infant Feeding; Feeding Bottles; Bottle Sterilization; Maternal Knowledge; Diarrhea

Introduction

Child feeding behavior plays an important role in child health, especially in the first year of childhood when infants are most susceptible to infectious diseases. Although breastfeeding provides substantial nutritional and immunological benefits, some infants are partially or completely dependent on formula feeding [1]. Baby bottles and bottles must always be prepared and handled properly when using formula as there is a risk of contamination in preparation, storage and feeding. Poor cleaning of feeding equipment may then result in a higher risk of infant exposure to potentially pathogenic microorganisms [2].

Diarrhea continues to be a major cause of morbidity and mortality in children, especially in the low- and middle-income countries. Poor water quality, sanitation and food handling practices are key factors in the spread of enteric pathogens. Non-exclusive breastfed children are at a higher risk for infectious diseases such as gastroenteritis, respiratory infections and otitis media [3].

Infant formula doesn't have to be sterile. Microorganisms, such as *Cronobacter sakazakii*, that can cause severe infections in young infants can contaminate powdered infant formula. Infections from this organism are rare, but can be very serious and deadly. So, the right preparation of formula and proper cleaning and sterilization of feeding items are critical aspects of safe infant feeding [4].

The hygiene of feeding bottles is important especially because the bottle, nipple and other feeding parts may leave remnants of milk that can promote the growth of microorganisms if they are not properly cleaned. Mothers may use various methods such as boiling, detergent washing, brushing or a combination of these methods. The effectiveness of these methods may also depend on the type of feeding bottle, the quality of the water that is used, the length of time the bottle is sterilized and how often nipples are changed [5].

Safe water, and proper health education, can be limited in developing communities. Thus, maternal knowledge and household practices can be important factors in the safety of infant formula preparation. Bacterial contamination of prepared infant formula has been previously reported and has been associated with diarrheal disease of infants related to unsafe feeding practices [6,7].

The information available about maternal practices related to infant feeding-bottle cleaning and sterilization is limited in Tikrit City. Knowledge of the practices used by mothers and what practices may be considered to be inappropriate could inform preventive health education and maternal-child health intervention. Thus, the current study aimed to evaluate both knowledge and practices of mothers as regards cleaning and sterilizing their infant feeding bottles and to find out the most commonly used sterilizing methods among the mothers in Tikrit city, Iraq.

Materials and Methods

Study Design and Setting

A descriptive cross-sectional study was carried out to determine the knowledge and practices of mothers in cleaning and sterilizing infant feeding bottles. The study was carried out in the city of Tikrit in Iraq and comprised the pediatric department in Tikrit teaching hospital, pediatric private clinics and primary health care centers. The study period ran from 15th December 2023 to 1st November 2024.

Study Population and Sample Size

A total of 300 mothers, who were bottle feeders of their infants were studied. Simple random sampling technique was used in selecting the participants. Mothers were approached and briefed on the study purpose before getting involved. The original study has been defined as mothers who bottle fed and obtained data from firsthand interviews.

Data Collection Instrument

The data were gathered by direct face-to-face interviews with structured questionnaire specially designed for the study. In addition to information regarding the sociodemographic characteristics of the mother and her infant, the questionnaire contained questions about how mothers cleaned and sterilized feeding bottles. Details of bottle type, number of bottles used, water used to prepare formula, teat replacement, sterilization

times and previous diarrhea were also noted.

Sampling and Data Collection Procedure

After participants were informed of the study's objectives and procedures, eligible mothers were randomly selected and invited to participate in the study. All data collection was voluntary and anonymity of the data was guaranteed. Participating mothers provided verbal informed consent prior to fill out the questionnaire. The questionnaire was filled in directly to enhance the quality and quantity of the information gathered.

Study Variables

The major study variables were: maternal age, maternal education, occupation, area of residence, number of children, and socioeconomic status. Infant related variables: age, feeding pattern, history of previous diarrhea, age at previous diarrheal episode and duration/type of diarrhea.

The bottle-feeding practices assessed were cleaning and disinfection methods, number of feeding bottles used, type of water used to make up the baby's formula, type of feeding bottle, teat changing frequencies and time of boiling or disinfection period.

Statistical Analysis

Data collected were tabulated and presented in tabular form and summarized in the form of frequencies and percentages. Associations between categorical variables were evaluated by the chi-square test, when appropriate. The variables collected with the structured questionnaire were used in the statistical analysis. The original study lists frequency, percentage and chi-square as statistical methods, but does not mention any statistical software package or software version.

Ethical Considerations

Ethical issues were taken into account during the data collection. The mothers who participated in the study were informed of the purpose of the study, they participated voluntarily, and information collected was kept confidential. Data collection was undertaken with verbal consent.

Result and Discussion

Results

Sociodemographic Characteristics of the Mothers

A total of 300 mothers were in the study. 32.7 % of the mothers were aged 26-30 years, while the number of mothers aged 21-25 years was 27.7 %. Mothers aged 31-35 years represented 17.3%, while 12.3% were aged 16-20 years and 10.0% were aged 36-40 years.

When it comes to education, 37.7% of mothers are unable to read or write, 35.0% had only primary school education, 15.0% had secondary school education, and 12.3% had a university or tertiary education. The majority of mothers were employed (7.7%) while the rest were not employed (92.3%). 75% of the mothers were residents of urban areas.

25.5% of mothers had four children or more, while 74.5% had three or fewer children. Socio-economic status was categorized as middle income (60%), low income (37.7%) and high income (2.3%) (Table 1).

Table 1. Sociodemographic Characteristics of the Participating Mothers (n=300)

Variable	Category	Frequency	Percentage (%)
Age (years)	16-20	37	12.3
	21-25	83	27.7
	26-30	98	32.7
	31-35	52	17.3
	36-40	30	10.0
Education	Illiterate	113	37.7
	Primary school	105	35.0
	Secondary school	45	15.0
	University and higher	37	12.3
Occupation	Employed	23	7.7
	Not employed	277	92.3

Variable	Category	Frequency	Percentage (%)
Residence	Urban	225	75.0
	Rural	75	25.0
Number of children	≤3	202	67.3
	>3	98	32.7
Socioeconomic status	High	7	2.3
	Middle	180	60.0
	Low	113	37.7

Methods of Cleaning and Sterilizing Infant Feeding Bottles

Boiling was the most common infant feeding bottle cleaning and sterilizing method reported by 37.3% of mothers. Twenty-five percent used detergent, 12.7 percent used only detergent and brush, and 25 percent used both detergent and brush.

As far as the numbers of feeding bottles utilized, 35% of moms utilized one feeding bottle and another 35% utilized two feeding bottles. Twenty five percent used 3 bottles, 2.7 percent used 4 bottles and 2.3 percent used 10 bottles.

The majority of mothers (95%) boiled water to prepare infant formula while 5% used tap water. Almost all mothers used plastic feeding bottles (95%) and only 5% used glass bottles. In terms of teat replacement, 57.7% of mothers replaced the teat weekly while 42.3% replaced it monthly (Table 2).

Table 2. Methods and Practices Related to Infant Feeding-Bottle Cleaning and Sterilization (n=300)

Variable	Category	Frequency	Percentage (%)
Cleaning/sterilization method	Boiling	112	37.3
	Detergent	75	25.0
	Brushing	38	12.7
	Mixed methods	75	25.0
Number of bottles	1	105	35.0
	2	105	35.0
	3	75	25.0
	4	8	2.7
	10	7	2.3
Water used to prepare milk	Boiled water	285	95.0
	Tap water	15	5.0
Bottle type	Plastic	285	95.0
	Glass	15	5.0
Teat replacement	Weekly	173	57.7
	Monthly	127	42.3

Duration of Bottle Sterilization

The mothers reported different times for boiling the water. The most common duration reported was 2 minutes (26%), 1 minute (20%) and 3 minutes (18%). 13% reported boiling for 6 minutes and 10% reported boiling for 5 minutes. 5% said they boiled the bottles for 10 minutes. 3% of the mothers reported 7 minutes, while 5% reported 4 minutes (Fig. 1).

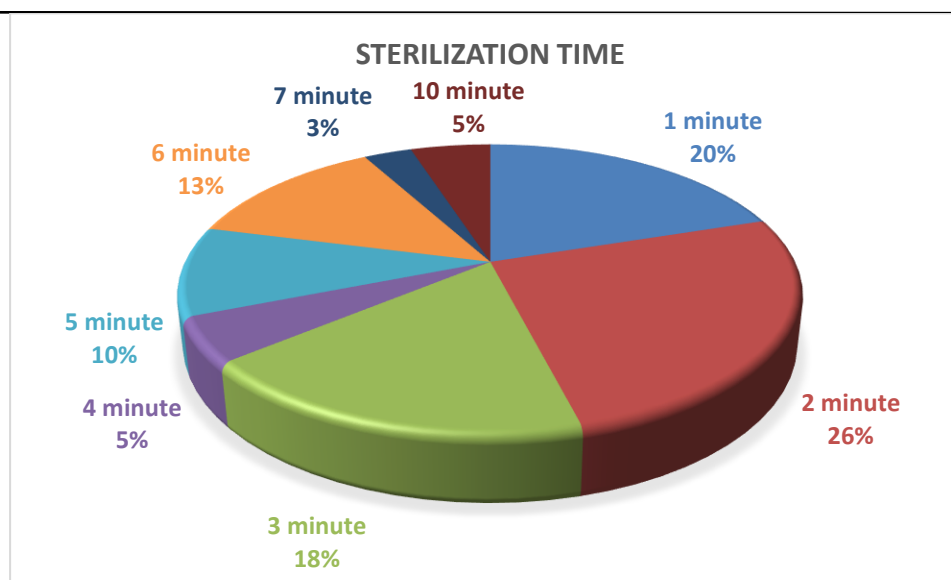


Figure 1. Reported Duration of Boiling for Infant Feeding-Bottle Sterilization

Infant Characteristics and History of Diarrhea

Infants' age distribution revealed that the 10-12-month age group has the highest percentage of 40%. The number of infants aged 4-6 months was 32.7%, 7-9 months 15% and 1-3 months 12.3%.

In terms of feeding pattern, 70% of infants were reported as being bottle fed and 30% as mixed fed. 82.3% infants had a history of previous diarrhea, while the remaining 17.7% infants had no history of previous diarrhea (Table 3).

Table 3. Demographic Characteristics and Feeding-Related History of the Infants (n=300)

Variable	Category	Frequency	Percentage (%)
Infant age	1–3 months	37	12.3
	4–6 months	98	32.7
	7–9 months	45	15.0
	10–12 months	120	40.0
Feeding pattern	Bottle feeding	210	70.0
	Mixed feeding	90	30.0
Previous diarrhea	Yes	247	82.3
	No	53	17.7

Age at Previous Diarrheal Episode

The distribution of previous diarrheal outbreaks reported in the original data revealed that the 4–6-month age group accounted for the highest percentage of infants with a recorded history of diarrheal outbreaks (40%). There was 10% of the infants aged 10-12 months, 17.3% aged 7-9 months and 15% aged 1-3 months. In 17.7% of the total sample no previous diarrhea was reported (Table 4).

Table 4. Age Distribution of Previous Diarrhea Among Infants

Category	Frequency	Percentage (%)
No diarrhea	53	17.7
1–3 months	45	15.0
4–6 months	120	40.0
7–9 months	52	17.3
10–12 months	30	10.0
Total	300	100

Duration and Type of Diarrhea

In total, 172 (57.3%) infants were reported with acute diarrhea and 75 (25.0%) infants with chronic diarrhea from the 300 infants studied. There were 53 infants (17.7%) with no history of diarrhea (Table 5).

Table 5. Distribution of Infants According to History and Type of Diarrhea

Category	Frequency	Percentage (%)
No diarrhea	53	17.7
Acute diarrhea	172	57.3
Chronic diarrhea	75	25.0
Total	300	100

Discussion

The mothers who participated in the present study reported that they would clean and sterilize their feeding bottles mainly by boiling (37.3%), by detergent (25.0%), by brushing (12.7%) or by both (25.0%). The high percentage of boiling is in accordance with the recommendations which acknowledge that suitable heat treatment is an effective means of cleaning feeding equipment [8,12]. Boiling is also one of the recommended methods for sterilizing feeding and preparation equipment as outlined by WHO guidelines [3].

In the present study, however, the boiling time was quite variable. The mothers reported on only boiling the bottle for 10 minutes (5%), while 26% boiled it for 2 minutes and 20% boiled it for 1 minute. This finding indicates that whilst a large proportion of mothers were aware of the boiling process as a method of sterilization, this was not a standardized process. If the duration is less or the cleaning is not complete before boiling, the effectiveness of the process will be less. The original study also highlighted that a significant number of mothers employed relatively short durations of sterilization and associated this with poor maternal knowledge [13].

Evidence has shown that powdered infant formula can be contaminated with pathogenic microorganisms and this is why proper bottle hygiene is important. Infants' formula and infant outbreaks caused by powdered formula have been reported previously indicating the risk of inadequate preparation and handling [14]. WHO/FAO guidelines also stress that powdered formula can also be contaminated with pathogenic microorganisms, and safe preparation, cleaning, sterilization and handling are required to reduce the risk of contamination [3].

The second important study result was the extremely high rate of plastic feeding bottles used by mothers. In this study 95% used plastic bottles and 5% used glass bottles. This increased proportion of plastic bottles could be a result of practical factors such as cost, availability and less breakage risks. The differences between materials of the bottle with respect to cleaning and sterilization procedures have been discussed in previous literature [15,16]. But it is important to remember that the choice of bottle material should not be the only factor taken into consideration; the correct cleaning and sterilization procedures must be followed regardless of bottle material.

The present study also revealed that 57.7% of mothers replaced the teat weekly while 42.3% of mothers replaced the teat monthly. Teats should be regularly checked and replaced as their use may lead to physical deterioration and increased difficulty in cleaning. Damaged and worn teats and feeding equipment are a potential hygiene issue as noted in previous recommendations [17].

In this study, the use of boiled water for preparing formula was relatively favorable, with 95% of mothers using boiled water, and only 5% using tap water. However, this does not negate the importance of safety of water used for infant feeding. If water quality cannot be assured, untreated water could cause microorganisms to be introduced into prepared formula. The recommendations by WHO are to use safe water and to use correct thermal treatment during preparation of powdered infant formula.

A significant observation was the large percentage of infants who had a history of diarrhea. 82.3% of infants had had diarrhea before, while 17.7% did not report any history of diarrhea. In the total sample, 57.3% reported acute diarrhea and 25.0% reported chronic diarrhea. These results show that a significant proportion of individuals in this population were sick with diarrheal disease. Due to the cross-sectional structure of the study, however, it is not possible in the present study to conclude that the direct cause of diarrhea was bottle-cleaning practices.

There is biological plausibility and evidence from previous investigations of the link between unsafe infant feeding and diarrheal disease. Enteric pathogens, such as *E. coli* and *Salmonella*, have been reported in milk-based formula and outbreaks with contaminated powdered infant formula have occurred [5,6]. These results indicate the need for enhancing hygienic behavior of mothers in the preparation of formula feeding. The study also showed that 40% of babies were in the 10 to 12 months age group, 32.7% were in the 4 to 6 months age group, 15% were in the 7 to 9 months age group and 12.3% were in the 1 to 3 months age group. This increase in the older infant group might be due to longer duration of bottle-feeding and other environmental or dietary factors. However, caution should be exercised in interpreting the results as this study was not undertaken to identify age-specific risk factors for diarrhea.

The educational level of the mother is also a factor to be taken into account. 37.7% of mothers were illiterate, 35.0% had primary education, 15.0% had secondary education and 12.3% had university or higher education. The initial results indicated that there was a relation between mother's education level and the effectiveness of the bottle cleaning practices. This finding is in line with the general finding that providing health education and good communication is crucial for promoting successful breastfeeding practices [13,17].

Appropriate instruction is also needed for the use of detergent and brushing. 25.0% of the mothers used detergent and 12.7% used brushes in the present study. Milk residues must be removed by cleaning before sterilizing as organic matter can affect the ability of later disinfection to kill bacteria. Experimental studies carried out on infant feeding bottle cleaning have shown that standard cleaning protocols can significantly decrease microbial contamination [14–16].

Washing feeding equipment with soapy water and then rinsing resulted in significant reductions in pathogen levels in previous studies conducted in Georgia, and appropriate hypochlorite disinfection resulted in significant pathogen reductions as well [16]. This discovery highlights that simply selecting an appropriate cleaning agent is not enough, but rather a proper sequence of cleaning and disinfection procedures is required for these to be effective.

These results therefore suggest that in Tikrit City, mothers' practices in boiling are common but there is a significant variation in cleaning practices and sterilization durations. The prevalence of previous diarrhea is high, which further emphasizes the need for health education. Practical demonstrations are more effective than giving women general advice in education programs. These interventions should include bottle dismantling and cleaning, rinsing, sterilizing, drying, safe water usage, correct formula preparation and routine replacement of broken feeding equipment.

The results of the study are also in line with the earlier reports that emphasize the importance of breastfeeding as an important protective feeding practice and infants who need formula should be fed with properly prepared and hygienically handled equipment [1,12]. WHO recommends that families and caregivers be provided with sufficient information and training on preparation, use, handling and storage of powdered infant formula to reduce health risks.

Conclusion

In this study, the authors showed that there was a high degree of difference in the practices of mothers regarding washing and disinfection of the feeding bottles used for infants in Tikrit City. Boiling was the most common method used for sterilizing, with 37.3% of the mothers saying they boiled them, but there was a wide variation in the length of time they boiled them for, as well as the use of detergent, brushing or a mixture of both. The most common method of preparing formula was boiled water while plastic bottles was most predominant. There was also a difference in the replacement intervals for the teats, with some replaced weekly and others replaced monthly. One of the significant observations was that 82.3% of the sample had a history of diarrhea. The results suggest that there is a lack of standardization in the knowledge and practices associated with the bottle and that maternal education and socioeconomic status can affect these aspects. It is recommended that maternal and child health education be strengthened, especially by providing demonstrations of good infant bottle feeding practices including proper cleaning and sterilization, handling of water, and changes of feeding equipment, to ensure the safety of infant bottle feeding and to reduce preventable gastrointestinal infections.

Recommendations

Based on the results of the present study the following recommendations are offered

1. Maternal and child health services should provide formal education sessions on correct cleaning, disinfecting and sterilization infant feeding bottles.
2. These demonstrations must be given to mothers, health-care workers should do them practically, on how to:
3. Breastfeeding should be encouraged wherever possible, because it has proven health advantages, and has potential to limit exposure to the dangers associated with formula preparation and bottle feeding.
4. Mothers should be counselled to use safe water for infant formula preparation, especially when the microbiological quality of water used in the household cannot be guaranteed.
5. The importance of the correct sterilization time should be further highlighted, and it should not be just advised to boil without specifying the time.
6. Mothers should be given clear instructions about the regular checking and replacement of feeding-bottle nipples, including when they are damaged, discolored, cracked and/or difficult to clean.
7. Since most of the mothers in the study were not highly educated, the health messages should also be presented in simple language and other visual aids, illustrations, and demonstrations instead of just relying on written instructions.
8. Primary health-care centers, pediatric clinics, hospitals, nursing staff, television, radio and community organizations should be used to provide consistent information about the safe infant feeding-bottle hygiene.
9. More research with larger sample sizes and analytic designs are suggested to explore the association between specific bottle-cleaning behaviors and the presence of diarrhea disease in infants.
10. Future studies are needed to include microbiological testing of feeding bottles, nipples, prepared formula and household water to objectively assess the contamination of these materials and the effectiveness of the cleaning and sterilization methods that are used.

References

- [1] A. Stuebe, "The risks of not breastfeeding for mothers and infants," *Reviews in Obstetrics and Gynecology*, vol. 2, no. 4, pp. 222–231, 2009.
- [2] United Nations Children's Fund and World Health Organization, *Diarrhoea: Why Children Are Still Dying and What Can Be Done*. New York, NY, USA: UNICEF, 2009, ISBN: 978-92-806-4462-3.
- [3] United Nations Children's Fund, World Health Organization, World Bank, and United Nations Department of Economic and Social Affairs, Population Division, *Levels and Trends in Child Mortality 2015*. New York, NY, USA: UNICEF, 2015.
- [4] V. Leroy, C. Sakarovich, *et al.*, "Acceptability of formula feeding to prevent HIV postnatal transmission, Abidjan, Côte d'Ivoire: ANRS 1201/1202 Ditrane Plus Study," *Journal of Acquired Immune Deficiency Syndromes*, vol. 44, pp. 77–86, 2007.
- [5] E. Andresen, N. C. Rollins, A. W. Sturm, N. Conana, and T. Greiner, "Bacterial contamination and over-dilution of commercial infant formula prepared by HIV-infected mothers in a prevention of mother-to-child transmission programme, South Africa," *Journal of Tropical Pediatrics*, vol. 53, pp. 409–414, 2007.
- [6] C. Brouard, E. Espié, *et al.*, "Two consecutive large outbreaks of *Salmonella enterica* serotype Agona infections in infants linked to the consumption of powdered infant formula, France," *Pediatric Infectious Disease Journal*, vol. 26, pp. 148–152, 2007.
- [7] T. L. Creek *et al.*, "Hospitalization and mortality among primarily nonbreastfed children during a large outbreak of diarrhea and malnutrition in Botswana," *Journal of Acquired Immune Deficiency Syndromes*, vol. 53, pp. 14–19, 2010.
- [8] J. Jason, "Prevention of invasive *Cronobacter* infections in young infants fed powdered infant formulas," *Pediatrics*, vol. 130, no. 5, pp. e1076–e1084, 2012.
- [9] World Health Organization and Food and Agriculture Organization of the United Nations, *How to*

- Prepare Powdered Infant Formula in Care Settings*. Geneva, Switzerland: World Health Organization, 2007.
- [10] National Health Service, *Guide to Bottle Feeding: How to Prepare Infant Formula and Sterilise Feeding Equipment to Minimise the Risks to Your Baby*. United Kingdom: National Health Service, 2012.
- [11] J. Miller, “How to sterilize baby bottles and nipples,” *Parent Guide*, May 4, 2015.
- [12] L. A. Selke, “Plastic vs. glass baby bottles,” *Livestrong*, 2015.
- [13] National Health and Medical Research Council, *Infant Feeding Guidelines*. Canberra, ACT, Australia: National Health and Medical Research Council, 2012.
- [14] G. Zanche, “Trying to kill germs can backfire,” Gabriel First Corp., Niagara, USA, 2006.
- [15] J. T. Walton, D. J. Hill, R. G. Protheroe, A. Nevill, and H. Gibson, “Investigation into the effect of detergents on disinfectant susceptibility of attached *Escherichia coli* and *Listeria monocytogenes*,” *Journal of Applied Microbiology*, vol. 105, no. 1, pp. 309–315, 2008.
- [16] L. Ma, G. Zhang, B. Swaminathan, M. Doyle, and A. Bowen, “Efficacy of protocols for cleaning and disinfecting infant feeding bottles in less developed communities,” *American Journal of Tropical Medicine and Hygiene*, vol. 81, no. 1, pp. 132–139, 2009.
- [17] S. M. Kassier and F. J. Veldman, “Cry, the beloved bottle: Infant-feeding knowledge and the practices of mothers and caregivers in an urban township outside Bloemfontein, Free State Province,” *South African Journal of Clinical Nutrition*, vol. 26, no. 1, pp. 17–22, 2013.