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Research article

Infant formula feeding and associated factors in Debre Berhan City: A community based cross-sectional study

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ABSTRACT

Introduction: Globally, there is rising concern over the growing reliance on breast milk substitutes (BMSs). However, limited studies have been conducted to explore this issue in Ethiopia.
Objective: To assess infant formula feeding and associated factors among mothers of infants aged 0–6 months in Debre Berhan City, 2023.
Methods and materials: This cross-sectional study used a multistage sampling technique to select 656 mothers residing in Debre Berhan city. The data was collected through face-to-face interviews using a semi-structured questionnaire. Bivariable and multivariable logistic regression models were employed to identify the factors associated with infant formula feeding. The findings are then presented as frequencies, percentages, and odds ratios.
Results: The prevalence of infant formula feeding in Debre Berhan city was 39.7 %. In addition, having a female child [AOR = 1.75, 95 % CI: 1.08–2.86], receiving a college education or higher [AOR = 5.79, 95 % CI: 2.38–14.08], being in the age category of 25–34 [AOR = 2.38, 95 % CI: 1.10–5.15] or 35–45 [AOR = 3.43, 95 % CI: 1.35–8.69], being a prime mother [AOR = 1.81, 95 % CI: 1.12–2.94], receiving breastfeeding advice [AOR = 4.64, 95 % CI: 2.78–7.75], delivering via a C-section [AOR = 5.39, 95 % CI: 2.54–11.42], initiating breastfeeding late [AOR = 2.26, (95 % CI: 1.41–3.64)], or being unaware of the risks associated with infant formula feeding [AOR = 5.48, 95 % CI: 3.20–9.39] were the factors that drove mothers towards infant formula feeding.
Conclusion: In Debre Berhan city, the prevalence of infant formula feeding was high. Fortunately, with appropriate interventions, most of the factors that led to infant formula feeding could be effectively addressed.

1. Introduction

Exclusively breastfed infants experience more rapid growth in the first 6 months than infants who are not exclusively breastfed [1].

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This is because exclusive breastfeeding offers infants a food source (breast milk) packed with essential nutrients, immune-boosting elements, and other biologically active compounds that are crucial for optimal growth and development [2,3].

On the other hand, formula feeding exposes children to malnutrition by delaying the initiation and shortening the duration of breastfeeding, as well as by increasing the chance of feeding incorrectly diluted, industrially or pathogenically contaminated, and inappropriate amounts of food for infants [4,5]. Additionally, formula feeding contributes to the growth of the baby food industry, which can lead to air pollution and environmental degradation [6,7].

Thus, to curb the expansion of the formula market, the World Health Organization (WHO) introduced the International Code of Marketing of Breastmilk Substitutes in 1981 [8]. However, despite such efforts, global formula sales have increased by 115 % between 2005 and 2019 [4]. This increase can be attributed to changes in birth rates, income, urbanization, media influence, the medicalization of infant feed, the globalization of baby food industries, the nature of women's work, and sociocultural norms, particularly occurred in low- and middle-income countries (LMICs) within the past two decades [4,9].

In addition, various individual factors, such as maternal age, weight, educational level, socioeconomic status, infant sex, and well-being, as well as the perceived amount of breast milk and infant satisfaction, can influence the chosen child feeding approach [4,5]. Additionally, the level of breastfeeding support available in healthcare facilities, homes, and workplaces, along with the availability, pricing, convenience, and exposure to marketing of BMSs have been found to influence mothers' decisions regarding the use of infant formula [4,5].

Globally, there is rising concern over the growing reliance on BMSs. In 2018 alone, 11 % of infants worldwide were fed infant formula [10]. Even more concerning is the fact that between 2009 and 2018, 27.7 % of infants in low- and middle-income countries were given infant formula [9].

In Ethiopia, to encourage breastfeeding and reduce reliance on breast milk substitutes, the government introduced the *Infant Formula and Follow-up Formula Directive and the Food Advertisement Directive* in 2016 [11]. However, despite these efforts, the percentage of children under the age of two who were fed formula increased from 1.4 % in 2016 to 3.3 % in 2019 [12,13]. Additionally, 41 % of infants in the country are not currently exclusively breastfed, and in 2019, approximately 16.5 % and 10 % of children were given prelacteal and mixed feed (formula and/or animal milk in addition to breast milk), respectively [13,14].

In addition, several studies conducted in various towns and cities in Ethiopia have reported varying levels of infant formula feeding, ranging from 7.8 % to 68.8 % [15–21]. These studies have also highlighted several factors that contribute to infant formula feeding in Ethiopia, such as maternal age, educational status, income, occupation, mode of delivery, number of parities, utilization of antenatal care, prelacteal feeding, breastfeeding initiation time, source of formula information, and mothers' knowledge and attitudes towards formula feeding [15–21].

Taken together, the evidence in Ethiopia indicates that the prevalence of infant formula feeding is rapidly increasing. Despite this, limited studies have been conducted to explore the issue in Ethiopia. Therefore, to provide contextual insights and strengthen the existing knowledge regarding the factors influencing infant formula feeding, the present study was conducted in Debre Berhan, a city where no similar investigations have been conducted before.

2. Methods and Materials

2.1. Study area and period

The study took place between May 10th and May 20th, 2023, in Debre Berhan city, which is located 130 km far from Addis Ababa, the capital city of Ethiopia, and 695 km far from Bahir Dar, the regional capital city. Debre Berhan is situated in the North Showa Zone of the Amhara regional state in Ethiopia. According to the 2015 population projection, the city had a total population of 202,226, 106,388 of whom were females. To accommodate the health needs of the residents, the city is equipped with two hospitals, eight health centers, and eighteen health posts.

2.2. Populations

This study included mothers of infants aged 0–6 months who had been living in the study area for at least six months as the source population. The study population consisted of mothers of infants aged 0–6 months who were living in the selected kebeles. Mothers who were diagnosed with a medical condition (Hep B, C, or HIV) or who were taking medications that were contraindicated during breastfeeding, as well as mothers of infants born with birth defects that would interfere with breastfeeding (cleft palate), were excluded from the study.

2.3. Sample size determination

A sufficient number of participants needed to accurately estimate the prevalence of infant formula feeding in Debre Berhan city was calculated using a single population proportion formula. During the calculation, the assumptions were a 28.4 % prevalence of infant formula feeding [15], a 5 % margin of error, and a 95 % CI. Furthermore, the same size was adjusted for possible design effects (multiplied by 2) and nonresponses (5 % added), which increased the sample size to 656.

2.4. Sampling procedure

The study used a multistage sampling technique to select participants. Initially, three out of the five sub-cities in Debre Berhan were randomly selected. Then, within each selected sub-city, four kebeles were randomly chosen. The number of eligible mothers in the selected kebeles was obtained from the health extension worker, who recorded the information in the expanded program of immunization (EPI) registration book. Based on these data, a proportional allocation was performed. Finally, participants for the study were selected using a systematic random sampling technique from the EPI registration book (Fig. 1).

2.5. Data collection tool, technique, and quality control

To minimize bias, three days of training was given to the data collectors, who were hospital staff working as nurses before engaging in this study. Then, the data collectors conducted the interviews using a carefully designed semi-structured questionnaire, which was developed based on insights gained from reviewing previous studies that had objectives akin to our study's objectives [15–21]. The questionnaire was comprehensive and covered various topics, including sociodemographic characteristics, obstetric history, infant feeding practices, and maternal knowledge about breastfeeding. To ensure the reliability and consistency of the questionnaire, it was initially drafted in English, then translated into Amharic (the local language), and finally retranslated back into English. To further validate the questionnaire, a pretest involving mothers, who accounted for 5 % of the sample, was conducted in a nearby town. In addition, each completed questionnaire was carefully reviewed for completeness before proceeding with data entry.

2.6. Data processing and analysis

After completing the interviews, the data was entered into Epi-data version 4.6 and then exported to the Statistical Package for Social Sciences (SPSS) version 25 for detailed statistical analysis. Within SPSS, the goodness of fit for the model and the presence of multicollinearity were assessed using the Hosmer–Lemeshow test (0.82) and the variance inflation factor (VIF <5), respectively.

To prepare the data for statistical analysis, the outcome variable was categorized as '1′ for infant formula feeding and '2′ for exclusive breastfeeding. The indicator for infant formula feeding was providing infant formula as a supplement or substitute for breast milk within the last 24 h [18]. Additionally, mothers' knowledge of breastfeeding was measured using a set of seven questions. Mothers who correctly answered four or more of these questions were considered to have sufficient knowledge about breastfeeding.

Descriptive analysis was then performed, and the findings are presented as frequencies, percentages, and graphs. Furthermore, bivariate and multivariable logistic regression models were used to identify predictors of infant formula feeding. In the bivariate logistic regression analysis, variables with a p value less than 0.25 were selected for inclusion in the multivariable regression model. Finally, in the multivariable logistic regression analysis, variables with a p value less than 0.05 were deemed statistically significant predictors of infant formula feeding. The adjusted odds ratio (AOR) with a 95 % confidence interval (CI) was used to indicate the strength of the association between the predictor variables and infant formula feeding.

2.7. Ethical consideration

Ethical approval was obtained from the ethical review board of the Asrat Woldeyes Health Science campus, Debre Berhan

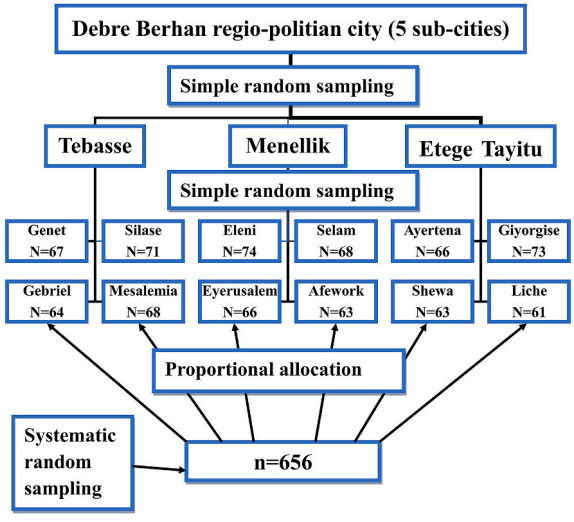

Fig. 1. Schematic representation of the sampling procedure used to select mothers of infants aged 0–6 months in Debre Berhan city, North Showa Zone, Ethiopia, 2023.

University, in 2023 (**protocol number: IRB-147**). Additionally, the city health office wrote a letter of cooperation, which was subsequently submitted to the responsible bodies. Furthermore, both verbal and written informed consent were obtained from the study participants before each interview. For illiterate participants, informed written consent was obtained from their legal guardian or local area representative. Finally, to maintain the anonymity of the study participants, all their personal information was kept confidential.

3. Results

In this study, a total of 635 mothers aged between 18 and 45 years were interviewed, resulting in a 96 % response rate.

3.1. Sociodemographic characteristics

Nearly all of the mothers (97.3 %) were married, and the majority (93.4 %) followed the Orthodox religion. In terms of education, over half (53.9 %) had received a college education or higher. However, approximately 37 % of the mothers were unemployed. Among their children, a significant proportion (51.3 %) were males, and most (78.4 %) were yunger than two and older than four months of age. Additionally, 54.2 % of the mothers' spouses had a college education or higher, and the majority (41 %) were employed in private institutions (Table 1).

3.2. Obstetric and infant feeding-related characteristics

A high proportion (91.0 %) of the mothers had at least one antenatal care (ANC) visit during their pregnancy. However, a noteworthy percentage (82.7 %) of the mothers missed postnatal care (PNC) appointments. The majority of mothers (94.6 %) opted for childbirth in public health facilities, while a minority (5.4 %) chose private health institutions or home births. During delivery, more than three-quarters (78.7 %) had undergone spontaneous vaginal delivery (SVD), while approximately 18 % chose C-section.

Table 1
Sociodemographic characteristics of mothers of infants aged 0–6 months in Debre Berhan City, North Shewa Zone, Ethiopia, 2023.

Variables	Categories	Formula fed n (%)	Breastfed n (%)
Sex of the current child	**Male**	111 (17.5 %)	215 (33.8 %)
	Female	141 (22.2 %)	168 (26.5 %)
Age of the current child in months	**<2**	102 (16.1 %)	147 (23.1 %)
	2–3	61 (9.6 %)	76 (12.0 %)
	>4	89 (14.0 %)	160 (25.2 %)
Age gap between the current and the previous child in years (n=371)	**< 2**	15 (4.0 %)	7 (1.9 %)
	≥ 2	102 (27.5 %)	247 (66.6 %)
Age of the mother in years	**15–24**	14 (2.2 %)	71 (11.2 %)
	25–34	184 (29.0 %)	250 (39.4 %)
	35–45	54 (8.5 %)	62 (9.8 %)
Marital status	**Married**	248 (39.1 %)	370 (58.3 %)
	Unmarried	4 (0.6 %)	13 (2.0 %)
Religion of the mother	**Orthodox**	238 (37.5 %)	355 (55.9 %)
	Protestant	0	16 (2.5 %)
	Muslim	14 (2.2 %)	12 (1.9 %)
Literacy status of the mother	**Illiterate**	9 (14.1 %)	35 (54.7 %)
	Literate	10 (15.6 %)	10 (15.6 %)
Educational status of the mother	**Primary**	19 (3.3 %)	66 (11.6 %)
	Secondary	34 (6.0 %)	110 (19.3 %)
	College or above	180 (31.5 %)	162 (28.4 %)
Occupation of the mother	**Private employee**	74 (11.7 %)	84 (13.2 %)
	Gov't employee	91 (14.3 %)	92 (14.5 %)
	Daily laborer	10 (1.6 %)	5 (0.8 %)
	Marchant	5 (0.8 %)	34 (5.4 %)
	Farmer	0	5 (0.8 %)
	Housewife	72 (11.3 %)	163 (25.7 %)
Literacy status of the father	**Illiterate**	0	15 (50.0 %)
	Literate	0	15 (50.0 %)
Educational status of the father	**Primary**	21 (3.5 %)	50 (8.3 %)
	Secondary	56 (9.3 %)	134 (22.1 %)
	College or above	175 (28.9 %)	169 (27.9 %)
Occupation of the father	**Private employee**	94 (14.8 %)	170 (26.8 %)
	Gov't employee	108 (17.0 %)	92(14.5 %)
	Daily laborer	16 (2.5 %)	39 (6.1 %)
	Marchant	24 (3.8 %)	39 (6.1 %)
	Farmer	4 (0.6 %)	28 (4.4 %)
	unemployed	6 (0.9 %)	15 (2.4 %)
Residence	**Urban**	247 (38.9 %)	362 (57.0 %)
	Rural	5 (0.8 %)	21 (3.3 %)

Moreover, slightly more than half (60.6 %) of the mothers had initiated breastfeeding within the first hour after their child's birth (Table 2).

3.3. Mothers' knowledge of breastfeeding

The majority of the mothers (77.3 %) believed that breast milk alone was sufficient for the first six months. However, approximately one-quarter of them (22.7 %) thought otherwise. In general, close to 27 % of the mothers who participated in this study had poor knowledge of breastfeeding (Table 3, Fig. 2).

3.4. Prevalence of infant formula feeding

According to our study, 39.7 % (95 % CI: 35.6, 43.65) of the mothers in Debre Berhan city formula-fed their child, and the majority had done so because of insufficient breast milk (Figs. 2 and 3).

3.5. Factors associated with infant formula feeding

In this study, the associations of approximately thirty variables with infant formula feeding were investigated. According to the bivariate logistic regression analysis, twelve variables were significantly associated (p value < 0.25) with infant formula feeding. However, after accounting for confounding variables in the multivariable logistic regression model, only eight of the variables were found to be significantly associated with infant formula feeding (p value < 0.05).

Specifically, the odds of practicing infant formula feeding were 1.75 times greater [AOR = 1.75, 95 % CI: 1.08–2.86] among female

Table 2
Obstetric and infant feeding practices of mothers of infants 0–6 months of age in Debre Berhan City, North Shewa Zone, Ethiopia, 2023.

Variables	Categories	Formula fed n (%)	Breastfed n (%)
Number of babies born at a time	**Single**	240 (37.8 %)	380 (59.8 %)
	Twin	8 (1.3 %)	2 (0.3 %)
	Triple	4 (0.6 %)	1 (0.2 %)
Parity	**Primipara**	136 (21.4 %)	128 (20.2 %)
	Multipara	116 (18.3 %)	255 (40.2 %)
Weight of the current child at birth	**< 2 kg**	24 (3.9 %)	37 (5.8 %)
	≥ 2 kg	228 (35.9 %)	346 (54.5 %)
ANC	**Yes**	235 (37.0 %)	343 (54.0 %)
	No	17 (2.7 %)	40 (6.3 %)
Number of ANC visits (n=578)	**One**	0	4 (0.7 %)
	Two	4 (0.7 %)	0
	Three	6 (1.0 %)	27 (4.7 %)
	Four and above	225 (38.9 %)	312 (54.0 %)
Place of ANC visit (n=578)	**Public health institution**	199 (34.4 %)	277 (47.8 %)
	Private health institution	36 (6.2 %)	67 (11.6 %)
Place of delivery	**Public health institution**	230 (36.2 %)	371 (58.4 %)
	Private health institution	18 (2.8 %)	10 (1.6 %))
	At home	4 (0.7 %)	2 (0.3 %)
Mode of delivery	**SVD**	158 (24.9 %)	342 53.9 %)
	C-section	88 (13.9 %)	26 (2.4 %)
	Instrumental	6 (0.9 %)	15 (2.4 %)
PNC	**Yes**	60 (9.4 %)	50 (7.9 %)
	No	192 (30.2 %)	333 (52.4 %)
Breastfeeding initiation	**Within an hour**	112 (17.6 %)	273 (43.0 %)
	After an hour	140 (22.0 %)	110 (17.3 %)
Source of infant formula information (n=252)	**Health professional**	162 (64.3 %)	0
	Friend or neighbor	55 (21.8 %)	0
	Mass media	35 (16.9 %)	0
Recommend infant formula for others	**Yes**	28 (4.4 %)	24 (3.8 %)
	No	224 (35.3 %)	359 (56.5 %)
Aware of the risks of formula feeding	**Yes**	43 (6.8 %)	178 (28.0 %)
	No	209 (32.9 %)	205 (32.3 %)
Perceived risks of infant formula feeding (n=221)	**Causes anemia**	5 (0.8 %)	1 (0.2 %)
	Can be easily contaminated	0	26 (4.1 %)
	Causes obesity	18 (2.8 %)	51 (8.0 %)
	Contains unhealthy chemicals	3 (0.5 %)	22 (3.5 %)
	Creates loss of appetite	0	31 (4.9 %)
	Low in water content & causes stool dryness	5 (0.8 %)	29 (4.6 %)
	Low nutritional value	9 (1.5 %)	18 (2.8 %)
	Weakens children immunity	3 (0.5 %)	0
Family pro infant formula feeding	**Yes**	38 (6.0 %)	37 (5.8 %)
	No	214 (33.7 %)	346 (54.5 %)

Table 3
Breastfeeding knowledge of mothers of infants aged 0–6 months in Debre Berhan City, North Shewa Zone, Ethiopia, 2023.

Variables	Categories	Formula fed n (%)	Breastfed n (%)
Breast milk alone is enough for the first six months	**True**	177 (27.9 %)	314 (49.4 %)
	False	75 (11.8 %)	69 (10.9 %)
Children who are fed breast milk have a lower risk of contracting a disease	**True**	243 (38.3 %)	356 (56.1 %)
	False	9 (1.4 %)	22 (3.5 %)
	I don't know	0	5 (0.8 %)
Formula feeding incurs more cost than breastfeeding	**True**	246 (38.7 %)	325 (51.2 %)
	False	0	31 (4.9 %)
	I don't know	6 (0.9 %)	27 (4.3 %)
Breast milk contains all the nutrients necessary for optimal infant growth	**True**	237 (37.3 %)	349 (55.0 %)
	False	5 (0.8 %)	11 (1.7 %)
	I don't know	10 (1.6 %)	23 (3.6 %)
Breastfeeding promotes mother-to-child bond	**True**	240 (37.8 %)	325 (51.2 %)
	False	4 (0.6 %)	22 (3.5 %)
	I don't know	8 (1.3 %)	36 (5.7 %)
Breastfeeding delays the next pregnancy	**True**	145 (22.8 %)	177 (27.9 %)
	False	51 (8.0 %)	102 (16.1 %)
	I don't know	56 (8.8 %)	104 (16.4 %)
Breast milk has more benefits for children than formula milk	**True**	225 (35.4 %)	336 (52.9 %)
	False	5 (0.8 %)	10 (1.6 %)
	I don't know	22 (3.5 %)	37 (5.8 %)

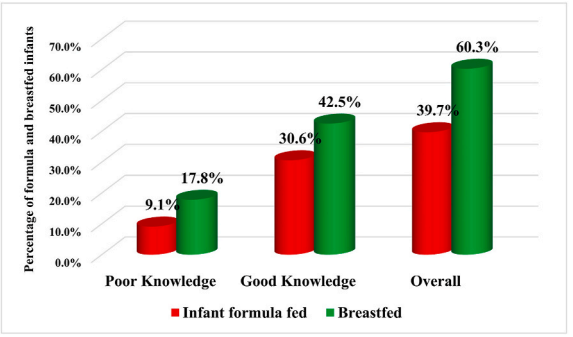

Fig. 2. Prevalence of infant formula feeding among mothers with poor knowledge and good knowledge of breastfeeding in Debre Berhan city, North Showa Zone, Ethiopia, 2023.

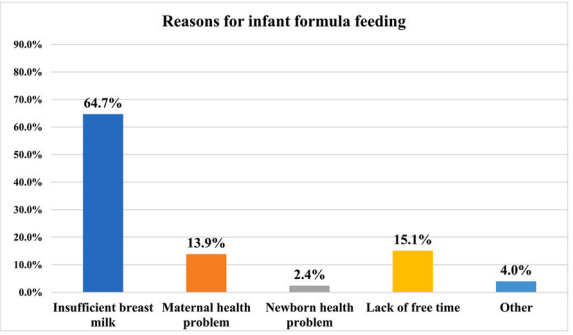

Fig. 3. Reasons for infant formula feeding among mothers of infants aged 0–6 months in Debre Berhan city, North Showa Zone, Ethiopia, 2023.

infants than among male infants. Additionally, the odds of practicing infant formula feeding were 2.38 times greater [AOR = 2.38, 95 % CI: 1.10–5.15] and 3.43 times greater [AOR = 3.43, 95 % CI: 1.35–8.69] among mothers aged 25–34 and 35–45, respectively, than among mothers aged 15–24. Moreover, the odds of practicing infant formula feeding were 5.79 times greater [AOR = 5.79, (95 % CI: 2.38–14.08)] among mothers with a college education or above than among those with a primary education. Furthermore, compared with multipara mothers and mothers who delivered via SVD, prime mothers and mothers who delivered via C-section were 1.81 times [AOR = 1.81, 95 % CI: 1.12–2.94] and 5.39 times [AOR = 5.39, 95 % CI: 2.54–11.42] more likely to practice infant formula feeding, respectively. The odds of practicing infant formula feeding were 2.26 times greater [AOR = 2.26, (95 % CI: 1.41–3.64)] among

mothers who initiated breastfeeding after an hour of birth and 4.64 times greater [AOR = 4.64, (95 % CI: 2.78–7.75)] among mothers who were consulted about breastfeeding than among their counterparts. Finally, mothers who were unaware of the risks of infant formula feeding were 5.48 times more likely [AOR = 5.48, (95 % CI: 3.20–9.39)] to practice infant formula feeding than mothers who were fully aware of the risks (Table 4).

4. Discussion

In Debre Berhan city, 39.7 % (95 % CI: 35.6–43.65) of mothers practiced infant formula feeding. Moreover, mothers aged 25-34 or 35–45 years, with a female child, who received college or higher education, initiated breastfeeding late, unaware of formula risks, delivered via C-section, primiparous, and those who received breastfeeding advice during ANC visits were more likely to practice infant formula feeding.

The prevalence of infant formula feeding in Debre Berhan city was greater than that in Offa town (7.8 %), Mettu town (28.4 %), and Bahir Dar city (25 %) [15,17,18]. However, it was lower than the prevalence in Dire Dawa city (42.6 %), Addis Ababa city (46.2 %), and the Jimma Zone (47.2 %) [16,20,22]. The discrepancy between our study and the referenced studies may be due to differences in the socioeconomic characteristics of the populations and the study areas. For instance, large metropolitan cities such as Dire Dawa, Addis Ababa, and Jimma house a large number of infant formula distributors and affluent customers, which makes the market for BMS highly competitive. In such cases, aggressive marketing and the dissemination of misleading information about formula feeding may influence clueless mothers with the means to purchase these products. However, smaller cities such as Debre Berhan may have fewer such competitive pressures. Therefore, variations in the prevalence of formula feeding could be influenced by other factors, such as differences in mothers' education, income, and healthcare utilization.

In addition, compared to the prevalence reported from other countries, such as from Egypt (47 %), Poland (42 %), China (88 %), the United Stats (65 %), and Malaysia (73.7 %), the prevalence of infant formula feeding in Debre Berhan city was relatively low [23–26]. These differences might be caused by differences in culture, income, education, and access to high-quality healthcare services between the people living in Ethiopia and the countries mentioned above.

In terms of the factors associated with infant formula feeding, our study revealed that female infants are more likely to be fed infant formula than male infants are. In contrast, a study conducted in Egypt revealed higher rates of infant formula feeding among male infants than among female infants [23]. This phenomenon can be explained by gender-based preferences that are present in certain cultures, influencing the level of care and type of food provided to infants. In Ethiopian society, male children are often considered to bring more pride to the household than female children. As a result, mothers may give more attention to their male children intentionally or unintentionally. Such acts of discrimination are also reflected in the amount of time, level of affection, and frequency of breastfeeding offered to male children compared to female children. This might have exposed female infants located in Debre Berhan city to infant formula.

In addition to the sex of the infant, the mother's educational status was found to affect the decision to utilize infant formula.

Table 4
Factors associated with infant formula feeding among mothers of infants aged 0–6 months in Debre Berhan City, North Shewa Zone, Ethiopia, 2023.

Variables	Categories	AOR at 95 % CI	P -Value
Infant sex	**Male**	1	1
	Female	1.75 (1.08, 2.86)	0.024*
Maternal age	**15–24**	1	
	25–34	2.38 (1.10, 5.15)	0.028*
	35–45	3.43 (1.35, 8.69)	0.009*
Educational status (mother)	**Primary**	1	1
	Secondary	0.70 (0.30, 1.65)	0.415
	College and above	5.79 (2.38, 14.08)	<0.001*
Educational status (Father)	**Primary**	1	1
	Secondary	1.32 (0.52, 3.38)	0.556
	College and above	0.79 (0.31, 2.01)	0.623
Parity	**Primipara**	1.81 (1.12, 2.94)	0.016*
	Multipara	1	1
Mode of delivery	**SVD**	1	1
	C-section	5.39 (2.54, 11.42)	<0.001*
	Instrumental	2.91 (0.85, 10.02)	0.090
Consulted about breastfeeding during ANC visit	**Yes**	4.64 (2.78, 7.75)	<0.001*
	No	1	1
PNC	**Yes**	1	1
	No	1.38 (0.70, 2.72)	0.346
Breastfeeding initiation	**Within an hour**	1	1
	After an hour	2.26 (1.41, 3.64)	<0.001*
Aware of the risks of infant formula feeding	**Yes**	1	1
	No	5.48 (3.20, 9.39)	<0.001*
Knowledge of breastfeeding	**Poor**	1.19 (0.69, 2.03)	0.534
	Good	1	1

* Significant at $p < 0.05$.

Mothers with advanced education (college education or above) were more likely to engage in infant formula feeding than those with only a primary education. A similar association was also observed by the studies conducted in Addis Ababa city, Agaro town, and the Jimma zone, as well as by the studies conducted in Namibia, Indonesia, and western Nepal [16,22,27–29,35]. One possible explanation is that highly educated mothers are more likely to have jobs, which may leave them with little time for breastfeeding. Additionally, having a job may allow mothers to afford the high cost of infant formula feeding. These factors may contribute to the inclination of highly educated mothers towards infant formula feeding compared to mothers with primary education.

Our study also demonstrated that mothers who initiated breastfeeding more than 1 h after giving birth were more likely to practice infant formula feeding than their counterparts. This finding aligns with studies conducted in Addis Ababa city, Mettu town, and Bahir Dar city, as well as a study conducted in Nigeria [15,16,18,30]. One possible explanation for this is that early initiation of breastfeeding establishes a strong bond between a mother and her baby, leading to more time spent together and prompt breastfeeding. Additionally, multiple studies have shown that early initiation of breastfeeding significantly reduces the likelihood of prelacteal feeding in newborns, and one type of prelacteal feeding that is frequently practiced in hospital settings is infant formula feeding [5,9]. Therefore, by promoting early breastfeeding, the number of newborns receiving infant formula can be significantly decreased.

In addition to the factors mentioned above, a lack of awareness about the risks of infant formula feeding increases the likelihood of practicing infant formula feeding by more than fivefold. Similarly, a study in Mettu Town reported greater odds of practicing infant formula feeding among mothers with insufficient knowledge about infant formula than among mothers with sufficient knowledge about infant formula [15]. This result can be explained by the established scientific fact that having sufficient knowledge about the risks and benefits of using a product can shape one's attitude towards it, which in turn influences the decision to use it. In our case, mothers who were well informed about the dangers of infant formula may have developed negative feelings towards the product.

Our study also revealed that mothers in the 25–34 and 35–45 age groups were more likely to provide infant formula to their babies than mothers in the 15 to 24 age group. This finding aligns with a study conducted in Bahir Dar city, which also revealed a similar link between maternal age and infant formula feeding [18]. In both cases, older mothers are more likely to practice infant formula feeding than younger mothers are. This may be because younger mothers are less likely to have stable jobs, a steady source of income, or a spouse who can afford the high cost of infant formula feeding. These factors may have prevented younger mothers in Debre Berhan city from providing infant formula to their babies.

Another variable that our study found to be associated with infant formula feeding is parity. Compared with multiparous mothers, primiparous mothers were more likely to feed their babies infant formula. This finding is consistent with studies conducted in Mettu town in Ethiopia, Taiwan, and Egypt [15,23,31]. This may be due to multiple reasons. First, in terms of experience, first-time mothers may lack the knowledge and skills needed for successful breastfeeding. Without proper support, first-time mothers are more likely to face difficulties with breastfeeding, such as difficulties with proper breast attachment. As a result, they may be drawn to the simpler option of infant formula feeding compared to the more complex and demanding option of breastfeeding. Second, from an economic standpoint, it may be more difficult for multiparous mothers to afford infant formula for one child while also taking care of the needs of their other children.

Unfortunately, our study revealed that mothers who were consulted about breastfeeding during ANC visits were more likely to practice infant formula feeding than mothers who were not. This finding is consistent with a study conducted in Dire Dawa city [32]. This is not surprising, as there is a known link between healthcare providers and breast milk substitute manufacturing companies [33]. One aggressive promotional tactic used by these companies is to engage healthcare providers as salespeople. They often urge healthcare providers to distribute free samples of infant formula to mothers during ANC visits, leading to unnecessary exposure to infant formula [34]. However, these tactics contradict the WHO international code of marketing breast milk substitutes and compromise the trust mothers have in their doctors.

Finally, the odds of infant formula feeding were greater among mothers who delivered via C-section than among those who delivered via SVD. Similar findings have been reported by the studies conducted in Addis Ababa city, Dire Dawa city, western Nepal, and Indonesia, showing that mothers who undergo C-section deliveries are more likely to practice infant formula feeding than are those who deliver via SVD [16,27,32,35]. This may be attributed to the significant postoperative pain and fatigue experienced by mothers who underwent C-sections. Inadequate pain management systems, especially in developing countries, often result in considerable pain, which hinders mothers from engaging in skin-to-skin contact and promptly breastfeeding their babies. The separation of mothers from their babies following the operation could also contribute to the hindrance of breastfeeding, as mothers are unable to be near their babies and provide them with the necessary nourishment.

4.1. Limitations of the study

Although our study was conducted on a larger sample of mothers than the studies conducted in other areas in Ethiopia, the cross-sectional nature of the study means that we cannot completely rule out the "chicken-egg dilemma". Additionally, the quantitative approach and use of a semi-structured questionnaire might have limited the range and depth of responses the participants could provide during the interviews, potentially limiting the ability of the study to assess unexplored determinants of infant formula feeding in Ethiopia. Therefore, future researchers should follow a mixed or purely qualitative approach to further explore the determinants of infant formula feeding.

5. Conclusion

In Debre Berhan city, a significant number of mothers practiced infant formula feeding. Moreover, infant sex, maternal age,

education level, parity, consultation about breastfeeding during ANC visits, mode of delivery, awareness of the risks of infant formula feeding, and breastfeeding initiation time were important factors associated with infant formula feeding among mothers living in the city.

According to the study findings, the majority of the factors that led to infant formula feeding could be effectively addressed if proper interventions were designed and implemented. The proposed interventions should focus on improving mothers' and healthcare providers' knowledge about the perils of infant formula feeding, sex-based discrimination, C-section delivery, and suboptimal breastfeeding to bring meaningful changes. Furthermore, significant attention must also be directed toward breast milk substitute-producing companies, distributors, and healthcare providers to ensure that they abide by the rules and regulations governing the promotion, sales, and recommendation of breast milk substitutes in Ethiopia and worldwide.

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Data availability statement

The datasets generated and/or analysed during the current study are available from the corresponding author upon reasonable request.

CRediT authorship contribution statement

Fitsum Zekarias Mohammed: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Alemtsehaye Gashu:** Validation, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Agmasie Damtew Walle:** Writing – review & editing, Software, Methodology. **Michael Amera Tizazu:** Writing – review & editing, Visualization, Methodology. **Besufekad Mulugeta Urgie:** Writing – review & editing, Validation. **Solomon Hailemeskel Beshah:** Writing – review & editing, Validation, Supervision, Software, Methodology, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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