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Original Article

Association between Breastfeeding and Respiratory Tract Infections and Gastroenteritis in Children Aged 2–3 Years

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Abstract
Breastfeeding supports childhood nutrition, growth, and immune protection, and WHO recommends exclusive breastfeeding for six months, with continued breastfeeding up to two years or beyond. Respiratory tract infections and gastroenteritis remain major causes of childhood morbidity and healthcare use. Evidence on the role of breastfeeding in children aged 2–3 years is still limited. This research sought to investigate the association between breastfeeding history and respiratory tract infections and gastroenteritis among children aged 2–3 years attending Misurata Medical Centre, Libya. A cross-sectional study was conducted from April 1 to May 1, 2026, including children aged 24–36 months. Information was gathered through face-to-face interviews with parents or caregivers using a self-developed questionnaire covering feeding practices, infection history, household exposures, vitamin supplementation, and vaccination status. Associations were assessed using the chi-square or Monte-Carlo exact test, and crude odds ratios were estimated by binary logistic regression. The data included 101 children (53 boys [52.5%] and 48 girls [47.5%]). The survey indicated that 88.1% of the children had been breastfed, while only 39.6% were exclusively breastfed during the first six months and 42.4% received complementary foods before six months. During the first two years of life, 87.0% had at least one upper respiratory tract infection, 54.0% had at least one lower respiratory tract infection, and 68.4% had at least one episode of gastroenteritis. Formula-fed children showed the highest frequency of every infection outcome (e.g., any lower respiratory tract infection 76.9% versus 51.3% in exclusively breastfed children), and longer breastfeeding was accompanied by fewer recurrent infections. However, no significant association ($p \geq 0.05$) was found between feeding pattern or breastfeeding duration and any infection outcome. Household cigarette smoke exposure was the only factor significantly associated with an outcome, with about three times the odds of lower respiratory tract infection (OR 3.15; 95% CI 1.05–9.50; $p = 0.041$). The findings are consistent in direction with a protective role of breastfeeding but do not provide statistical evidence of it in this sample, which may reflect the small sample size. They emphasize the need to promote exclusive breastfeeding, timely complementary feeding, smoke-free homes, and vaccination. Larger multicenter, preferably prospective studies are needed to confirm these findings.
Keywords. Breastfeeding, Respiratory Tract Infections, Gastroenteritis, Preschool Age, Misurata.

Introduction

Breastfeeding supports childhood nutrition, growth, development, and immune protection. Human milk contains immunoglobulins, lactoferrin, and oligosaccharides that support immunity and intestinal microbiota. WHO and UNICEF recommend exclusive breastfeeding for six months, followed by complementary foods, with breastfeeding continuing until two years or beyond [1,2]. Evidence suggests breastfeeding reduces childhood infections, although protection varies by infection, feeding pattern and duration, and age [3].

Respiratory tract infections are causes of childhood morbidity. Young children are susceptible because of developing immunity and pathogen exposure; prematurity, nutritional status, household crowding, and tobacco smoke may increase risk. Maternal antibodies and antimicrobial components in human milk may protect. A systematic review supports breastfeeding's protective role against respiratory infections [3], while a WHO-commissioned review associated breastfeeding with lower hospitalization and mortality from respiratory infections [4]. Protection may vary by breastfeeding duration, infection type, and age, and effects during infancy may not extend to later childhood.

Gastroenteritis causes diarrhea, vomiting, abdominal discomfort, and dehydration requiring hospitalization. Risk is influenced by pathogens, sanitation, food and water safety, hygiene, and nutrition. Secretory immunoglobulin A, lactoferrin, and human milk oligosaccharides may inhibit pathogens, support intestinal integrity, and promote gut microbiota [5]. Breastfeeding may also reduce exposure to contaminated water, utensils, and unsafe food preparation. Reviews associate breastfeeding with lower diarrheal illness risk and severity [3,4]. However, protection may vary with exclusivity, duration, complementary feeding, and sanitation.

Evidence among children aged 2–3 years remains limited because studies mostly focus on younger children. Continued breastfeeding during the second year has been associated with lower risks of acute gastroenteritis and respiratory infections than no breastfeeding [6]. However, these findings may not explain associations at ages 2–3 years. Differences in populations, outcome definitions, feeding practices, and confounding factors warrant investigation. These infections increase healthcare use. Population-specific evidence may inform feeding counseling and prevention. Socioeconomic status, household smoking, siblings, childcare attendance, and birth characteristics should be considered; cross-sectional findings indicate associations, not causation.

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This study aimed to investigate associations between breastfeeding history and respiratory tract infections and gastroenteritis among children aged 2–3 years. Assessing both outcomes may clarify relationships between feeding practices and infectious morbidity. We hypothesized that breastfeeding history would be associated with outcomes, with direction and magnitude determined by study findings.

Methods

Research Design and Setting

A cross-sectional study was conducted at Misurata Medical Centre, Libya. The study framework assessed sociodemographic characteristics, household exposures, feeding practices, infection history, vitamin supplementation, and vaccination status in relation to respiratory tract infections and gastroenteritis during the first 24 months of life.

Study Population

The sample comprised 101 children aged 24–36 months attending Misurata Medical Centre during the study period. Parental/caregiver informed consent was obtained prior to data acquisition.

Inclusion criteria: Children aged 24–36 months; attendance at Misurata Medical Centre during the study period; a parent or caregiver able to report feeding and infection history from birth to 24 months; and informed consent obtained from the parent or caregiver.

Exclusion criteria: Children with a diagnosed chronic illness (e.g., congenital heart disease, chronic lung disease, immunodeficiency); caregivers unable to recall the child's history reliably; incomplete questionnaires; and refusal to participate.

Study Duration

The investigation spanned April 1 to May 1, 2026.

Data Collection Procedures

Data were acquired through face-to-face interviews with parents/caregivers, using a structured questionnaire completed by the authors. The instrument covered sociodemographic characteristics, household exposures (including cigarette smoke), feeding practices, infection history, vitamin supplementation, vaccination status, and general health.

Exposure Variables

Breastfeeding-related variables were:

- Ever breastfed.
- Feeding pattern during the first 6 months of life (exclusive breastfeeding, mixed feeding, or formula feeding only).
- Total breastfeeding duration (<6, 6–12, 13–24, or >24 months).
- Age at introduction of complementary foods (before 6 months, at 6 months, or after 6 months).

For regression analyses, exclusive breastfeeding was compared with mixed or formula feeding, and breastfeeding for ≥6 months (6–12, 13–24, and >24 months combined) was compared with <6 months.

Study Outcomes

The primary outcomes were the occurrence and frequency of upper respiratory tract infections (URTIs), lower respiratory tract infections (LRTIs), and gastroenteritis during the first 24 months of life.

- URTI and gastroenteritis episodes were categorized as none, 1–2, 3–4, or ≥5.
- Recurrent URTI was defined as ≥5 episodes and recurrent gastroenteritis as ≥3 episodes (≥5 episodes where stated).
- LRTIs were assessed according to their reported occurrence, number of episodes (1, 2, or ≥3), and hospitalization.
- Additional indicators of illness burden were physician visits and antibiotic treatment after URTI, hospital admission and oral rehydration solution (ORS) use after gastroenteritis, and hospitalization after LRTI. These indicators were assessed only among children who had at least one episode of the relevant infection.

Potential Confounding Factors

Potential confounding factors were child age and sex, number of children in the household, household cigarette smoke exposure, daycare attendance, chronic illness, vitamin supplementation, and vaccination status, including pneumococcal and rotavirus vaccination.

Data Quality Control

The structured interview questionnaire was developed through a comprehensive review of World Health Organization (WHO) infant and young child feeding guidelines and validated pediatric respiratory and gastrointestinal infection assessment instruments. The tool was initially designed in English, translated into Arabic by bilingual pediatric and clinical nutrition specialists, and back-translated into English to verify semantic and conceptual equivalence. To evaluate clarity, cultural acceptability, and face validity, the questionnaire was pre-tested in a pilot sample of 15 mothers of

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children aged 24–36 months attending Misurata Medical Centre (these pilot records were excluded from the final analytical sample). Minor wording adjustments were incorporated based on caregiver feedback to optimize comprehension and recall accuracy. During the survey, face-to-face interviews were conducted by trained clinical researchers who reviewed health booklets and immunization cards whenever available to cross-verify caregiver recall. Incomplete questionnaires were excluded, and percentages were calculated from valid responses; the exact number of valid responses is stated in all tables and text wherever it deviates from the total sample due to unrecorded items.

Statistical Analysis

Data were coded, entered, and analyzed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Categorical variables were summarized as absolute frequencies (n) and percentages (%). Proportions across feeding groups and breastfeeding duration strata were compared using Pearson's Chi-Square (χ^2) test, or the Monte-Carlo exact test (Fisher–Freeman–Halton type, based on 10,000 resamples) when more than 20% of contingency table cells had expected counts below 5. To assess the strength of associations with infection outcomes, crude odds ratios (ORs) and 95% confidence intervals (CIs) were estimated using binary logistic regression with a single predictor, applying a continuity correction of 0.5 for zero-frequency cells. Multivariable regression models were not fitted because only 19 children had recurrent URTI and 24 had recurrent gastroenteritis, which would have led to statistical over-fitting given the sample size. All statistical tests were two-sided, and significance was set at $p < 0.05$.

Ethical Considerations

The study received ethical approval from the Institutional Review Board of the National Center for Disease Control, Libya, on 2 Dec 2025 (Ref no: NBC:002.H.25.20).

Consent to Participate

We obtained written informed consent from all participants or their legal guardians before data collection, and recorded witnessed verbal consent when written consent was not possible. Consent procedures clearly outlined the study's objectives, protocols, and risks. Patient anonymity and data confidentiality were strictly preserved throughout.

Results

Participant Characteristics

Data from 101 children aged 24–36 months were analyzed (Table 1). Thirty-nine children (38.6%) were aged 30–35 months, 32 (31.7%) were 36 months, and 30 (29.7%) were 24–29 months; 52.5% were boys. Most families lived in Misurata (85.1%), and 86 children (85.1%) lived in households with two or more children. One in five children (19.8%) was exposed to household cigarette smoke (Figure 1).

Table 1. Socio-demographic and household characteristics (N = 101)

Variable	Category	N	%
Age	24–29 months	30	29.7
	30–35 months	39	38.6
	36 months	32	31.7
Sex	Male	53	52.5
	Female	48	47.5
Residence	Misurata	86	85.1
	Other	15	14.9
Number of children in household	1	15	14.9
	2–3	42	41.6
	≥4	44	43.6
Household cigarette smoke exposure	Yes	20	19.8
	No	81	80.2

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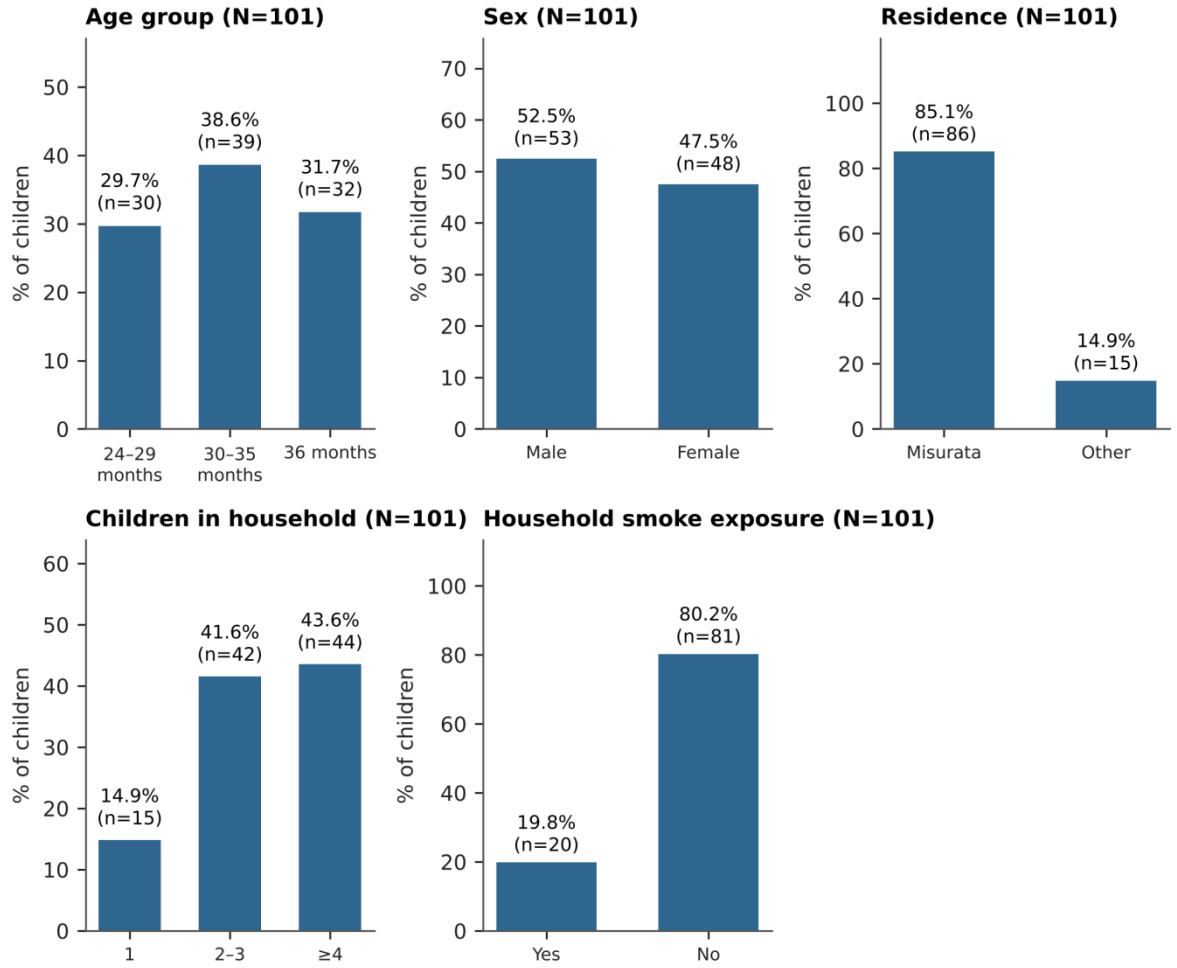


Figure 1. Sociodemographic and household characteristics of the children (N = 101).

Breastfeeding and Feeding Practices

Most children (88.1%) had been breastfed at some point (Table 2). During the first 6 months, 40 children (39.6%) were exclusively breastfed, 48 (47.5%) received mixed feeding, and 13 (12.9%) received formula only. Among the 96 children with recorded duration, 43 (44.8%) were breastfed for more than 12 months and 18 (18.8%) for less than 6 months. Complementary foods were introduced before 6 months in 42.4% of children, earlier than recommended (Figure 2).

Table 2. Breastfeeding and feeding characteristics.

Variable	Category	N	%
Ever breastfed (N = 101)	Yes	89	88.1
	No	12	11.9
Feeding during first 6 months (N = 101)	Exclusive breastfeeding	40	39.6
	Mixed feeding	48	47.5
	Formula only	13	12.9
Breastfeeding duration (n = 96)	<6 months	18	18.8
	6–12 months	35	36.5
	13–24 months	32	33.3
	>24 months	11	11.5
Complementary feeding (n = 99)	Before 6 months	42	42.4
	At 6 months	37	37.4
	After 6 months	20	20.2

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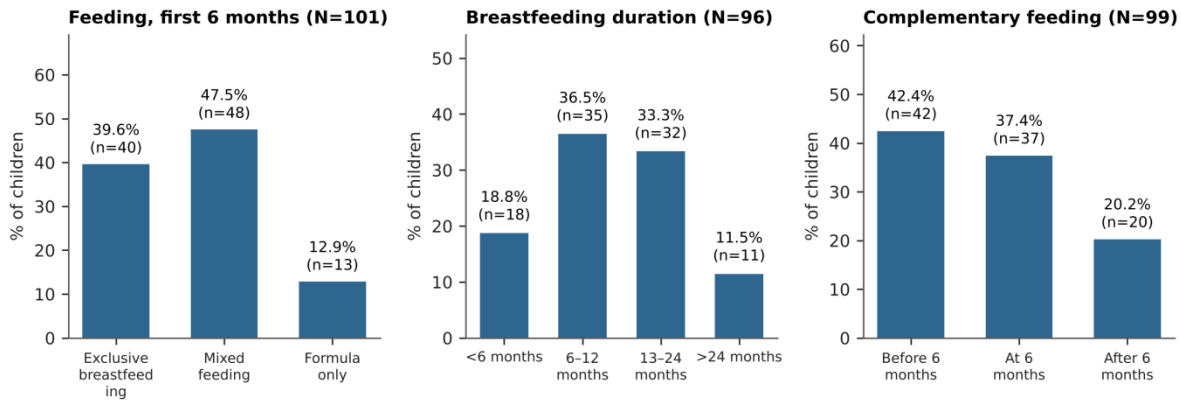


Figure 2. Feeding patterns in the first 6 months, total breastfeeding duration, and timing of complementary feeding.

Infection Outcomes

Infections during the first two years were common (Table 3, Figure 3). URTI was nearly universal: 87 children (87.0%) had at least one episode and 19 (19.0%) had five or more. Among children with URTI, 81.4% required a doctor visit, and 64.0% received antibiotics. More than half of the children (54.0%) had at least one LRTI; of these, 28.3% had three or more episodes and 29 of 54 (53.7%) had been hospitalized. About two-thirds of the children (68.4%) had at least one episode of gastroenteritis and 7.4% had five or more. Among affected children, ORS was required in 88.9% and 45.3% had been admitted to hospital.

Table 3. Upper respiratory tract infection, lower respiratory tract infection, and gastroenteritis during the first 2 years of life

Variable	Category	N	%
Upper respiratory tract infection			
URTI episodes (N = 100)	None	13	13.0
	1–2	31	31.0
	3–4	37	37.0
	≥5	19	19.0
Doctor visit (n = 86)*	Yes	70	81.4
	No	16	18.6
Antibiotic treatment (n = 86)*	Yes	55	64.0
	No	31	36.0
Lower respiratory tract infection			
Any LRTI (N = 100)	Yes	54	54.0
	No	46	46.0
LRTI episodes (n = 53)‡	1	23	43.4
	2	15	28.3
	≥3	15	28.3
LRTI hospitalization (n = 54)‡	Yes	29	53.7
	No	25	46.3
Gastroenteritis			
Gastroenteritis episodes (N = 95)	None	30	31.6
	1–2	41	43.2
	3–4	17	17.9
	≥5	7	7.4
ORS required (n = 63)‡	Yes	56	88.9
	No	7	11.1
Hospital admission (n = 64)‡	Yes	29	45.3
	No	35	54.7

**Among children with ≥1 URTI and recorded data. ‡Among children with ≥1 episode of the relevant infection. Percentages are based on valid responses.*

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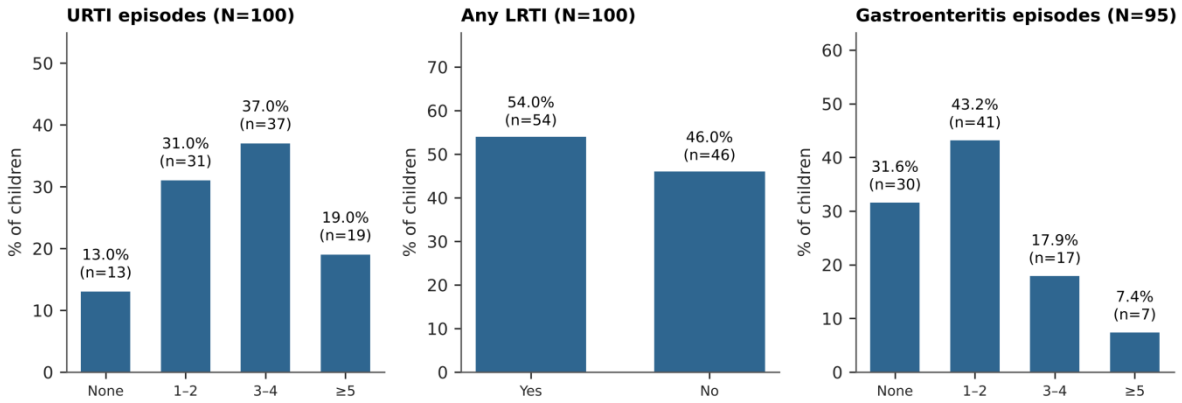


Figure 3. Frequency of URTI episodes, any LRTI, and gastroenteritis episodes.

Vitamin Supplementation and Vaccination

Vitamin supplementation was reported for 88.0% of children, usually for 6–12 months (54.5%) (Table 4). Two-thirds of the children (68.7%) were fully vaccinated, and only 4 (4.0%) were unvaccinated. Pneumococcal and rotavirus vaccination were reported by 81.2% and 78.6% of parents, respectively, while 13.9% and 17.3% were unsure.

Table 4. Vitamin supplementation and vaccination status

Variable	Category	N	%
Vitamin D and A supplementation (n = 100)	Yes	88	88.0
	No	12	12.0
Duration of vitamin D supplementation (n = 88)	<6 months	25	28.4
	6–12 months	48	54.5
	>12 months	15	17.0
Vaccination status (n = 99)	Fully vaccinated	68	68.7
	Partially vaccinated	27	27.3
	Not vaccinated	4	4.0
Pneumococcal vaccine (n = 101)	Yes	82	81.2
	No	5	5.0
	Not sure	14	13.9
Rotavirus vaccine (n = 98)	Yes	77	78.6
	No	4	4.1
	Not sure	17	17.3

Assessed only among children with ≥1 episode of the relevant infection and valid caregiver responses. Out of 87 children with at least one URTI episode, doctor visits and antibiotic treatment were documented for n = 86 (1 caregiver did not recall clinic/antibiotic history; N = 86 vs N = 87). Similarly, among children with ≥1 LRTI, n = 53 had recorded episode counts and n = 54 had recorded hospitalization data. Among children with ≥1 gastroenteritis episode (N = 65), n = 63 had recorded ORS use and n = 64 had recorded hospitalization data. Percentages are based strictly on valid responses.

Association Between Breastfeeding Pattern and Infections

Recurrent URTI (≥5 episodes) was reported in 15.4% of exclusively breastfed children, 18.8% of those with mixed feeding, and 30.8% of formula-fed children (p = 0.529; Table 5). Any LRTI occurred in 51.3%, 50.0%, and 76.9%, respectively (p = 0.204), and LRTI hospitalization in 30.8%, 20.8%, and 53.8% (p = 0.064). Recurrent gastroenteritis (≥3 episodes) followed the same direction (46.2% in formula-fed children versus 23.7% in exclusively breastfed and 20.5% in mixed-fed children; p = 0.178). Formula-only feeding therefore had the highest frequency of every outcome, but none of the differences reached statistical significance, which should be read in light of the small formula-fed group (n = 13) (Figure 4).

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Table 5. Infection outcomes by feeding pattern during the first 6 months

Feeding pattern	n	Recurrent URTI (≥5), n (%)	Any LRTI, n (%)	LRTI hospitalization, n (%)	Recurrent gastro-enteritis (≥3), n/N (%)
Exclusive breastfeeding	39	6 (15.4)	20 (51.3)	12 (30.8)	9/38 (23.7)
Mixed feeding	48	9 (18.8)	24 (50.0)	10 (20.8)	9/44 (20.5)
Formula only	13	4 (30.8)	10 (76.9)	7 (53.8)	6/13 (46.2)
Total	100	19 (19.0)	54 (54.0)	29 (29.0)	24/95 (25.3)
p value		0.529	0.204	0.064	0.178

Percentages are calculated from valid responses within each feeding category. Minor sample size shifts reflect missing caregiver recall responses across specific infection domains: total valid responses were N = 100 for URTI and LRTI outcomes (EBF n=39, mixed n=48, formula n=13; 1 missing in EBF), and N = 95 for gastroenteritis outcomes (EBF n=38, mixed n=44, formula n=13; 6 missing total: 2 in EBF, 4 in mixed feeding). p values: Monte-Carlo exact test for URTI, LRTI hospitalization, and gastroenteritis (due to small expected cell counts < 5); Pearson's chi-square test for Any LRTI.

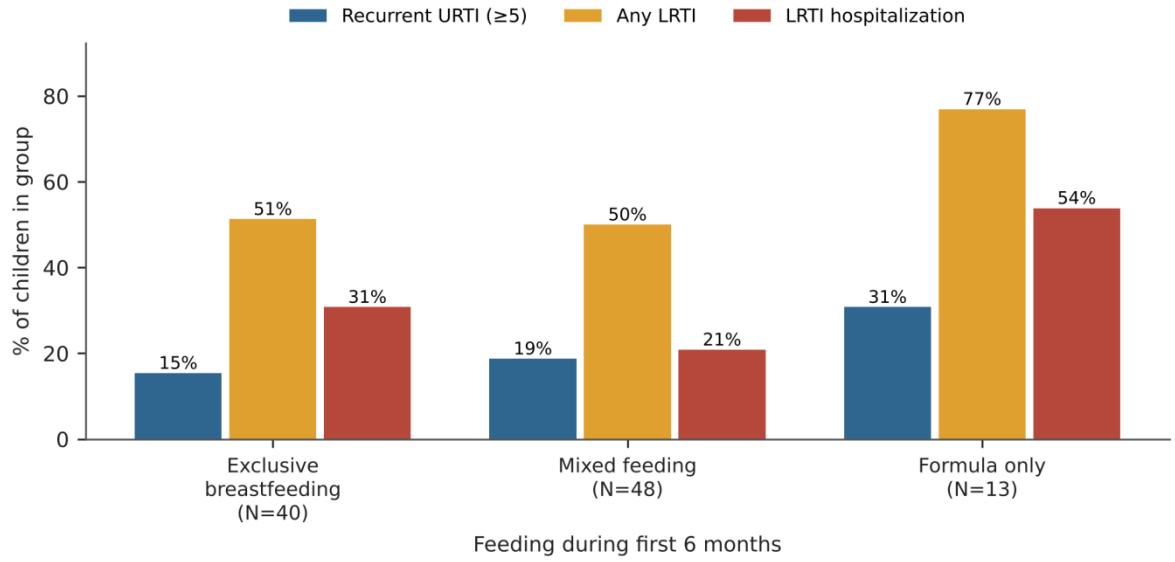


Figure 4. Recurrent URTI, any LRTI, and LRTI hospitalization by feeding pattern during the first 6 months.

Association Between Breastfeeding Duration and Infections

The proportion of children with ≥5 URTI episodes fell with longer breastfeeding (22.2%, 17.1%, 16.1%, and 9.1% from <6 months to >24 months; p = 0.834; Table 6). Recurrent gastroenteritis (≥5 episodes) was seen in 22.2% of children breastfed for <6 months, compared with 5.9%, 3.7%, and 0% in the longer-duration groups (p = 0.091). Any LRTI showed no consistent trend (p = 0.210). None of these tests was significant at the 5% level (Figure 5).

Table 6. Infection outcomes by total duration of breastfeeding

Breastfeeding duration	URTI ≥5 episodes, n/N (%)	Any LRTI, n/N (%)	Gastroenteritis ≥5 episodes, n/N (%)
<6 months	4/18 (22.2)	7/18 (38.9)	4/18 (22.2)
6–12 months	6/35 (17.1)	22/34 (64.7)	2/34 (5.9)
13–24 months	5/31 (16.1)	17/32 (53.1)	1/27 (3.7)
>24 months	1/11 (9.1)	4/11 (36.4)	0/11 (0.0)
Total	**16/95 (16.8)**	50/95 (52.6)	**7/90 (7.8)**
p value	0.834	0.210	0.091

Data are restricted to the 96 children with recorded total breastfeeding duration. Denominators (N) vary slightly across individual outcomes due to unrecorded caregiver responses: URTI N = 95 (<6 mo: n=18; 6–12 mo: n=35; 13–24 mo: n=31; >24 mo: n=11; 1 missing in 13–24 mo); Any LRTI N = 95 (<6 mo: n=18; 6–12 mo: n=34; 13–24 mo: n=32; >24 mo: n=11; 1

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missing in 6–12 mo); and Gastroenteritis N = 90 (<6 mo: n=18; 6–12 mo: n=34; 13–24 mo: n=27; >24 mo: n=11; 6 missing total: 1 in 6–12 mo, 5 in 13–24 mo). p-values: Monte-Carlo exact test for URTI and gastroenteritis (sparse cells); Pearson's chi-square test for LRTI.

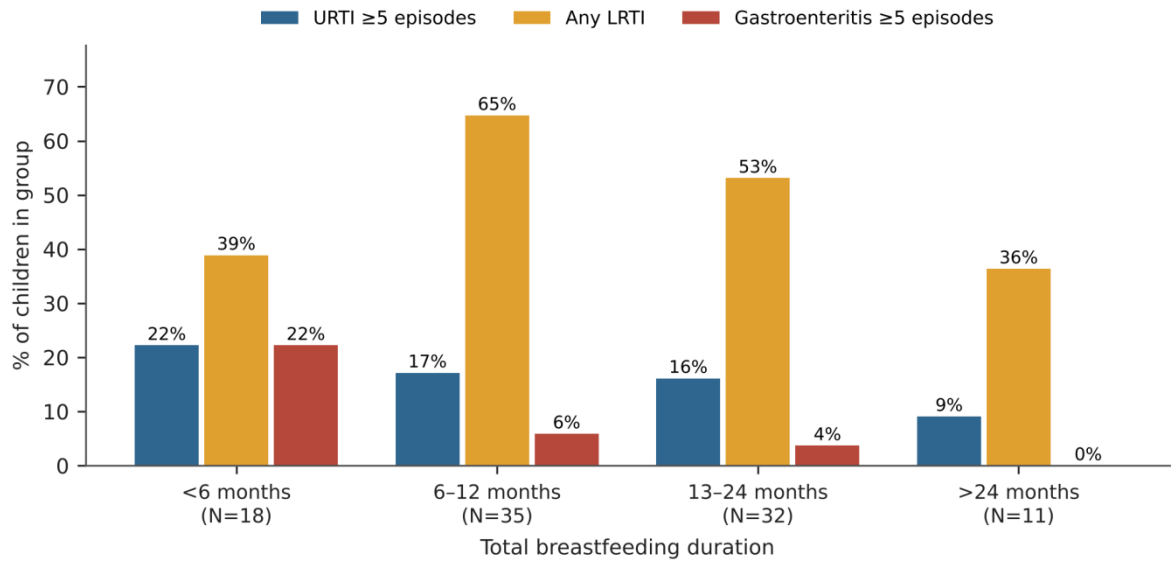


Figure 5. Infection outcomes by total duration of breastfeeding.

Factors Associated with Recurrent Infections

Household smoking was the only factor significantly associated with an outcome: exposed children had about three times the odds of any LRTI (OR 3.15; 95% CI 1.05–9.50; p = 0.041; Table 7, Figure 6). Exclusive breastfeeding (OR 0.67 for recurrent URTI; OR 0.84 for LRTI) and breastfeeding for ≥6 months (OR 0.65 for recurrent URTI) were associated with lower odds of infection, but the confidence intervals were wide and included 1. Daycare attendance showed a non-significant increase in LRTI odds (OR 1.86), and full vaccination a non-significant reduction in recurrent gastroenteritis (OR 0.43; p = 0.086).

Table 7. Factors associated with recurrent infections (crude odds ratios)

Factor	Outcome	OR	95% CI	p value
Exclusive breastfeeding	Recurrent URTI (≥5 episodes)	0.67	0.23–1.95	0.463
Breastfeeding ≥6 months	Recurrent URTI (≥5 episodes)	0.65	0.18–2.30	0.500
Exclusive breastfeeding	Any LRTI	0.84	0.37–1.87	0.663
Daycare attendance	Any LRTI	1.86	0.64–5.43	0.258
Household smoking	Any LRTI	3.15	1.05–9.50	0.041
Full vaccination	Recurrent gastroenteritis (≥3 episodes)	0.43	0.17–1.13	0.086

OR = odds ratio from simple (single-predictor) logistic regression; p-values are Wald tests. The reference group is absence of the factor (exclusive breastfeeding vs mixed/formula feeding; breastfeeding ≥6 vs <6 months; daycare, smoking, and full vaccination vs none).

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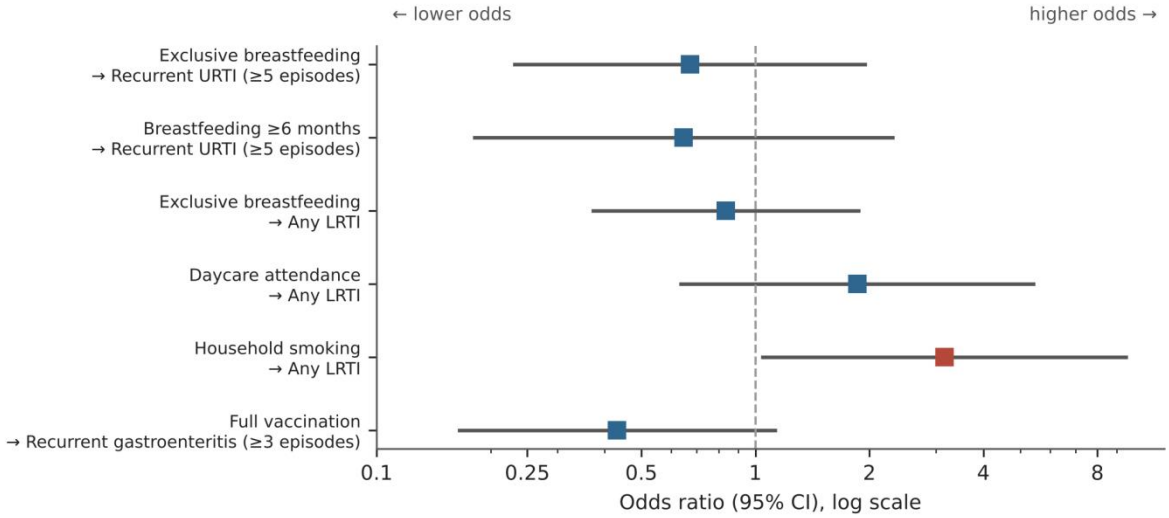


Figure 6. Crude odds ratios (95% CI) for factors associated with recurrent infections.

Discussion

In this cross-sectional study of 101 children aged 24–36 months in Misurata, infections during the first two years of life were very common: 87.0% had at least one URTI, 54.0% had at least one LRTI, and 68.4% had at least one episode of gastroenteritis. Children fed formula only during the first six months had the highest frequency of every infection outcome examined, and recurrent URTI and gastroenteritis tended to be less frequent with longer breastfeeding. However, none of the differences by feeding pattern or duration were statistically significant, and household cigarette smoke exposure was the only factor significantly associated with an outcome (any LRTI). The findings are therefore consistent in direction with a protective role of breastfeeding but do not provide statistical evidence of it in this sample.

Differences in infectious morbidity between breast-fed and formula-fed infants have been described for decades; in an early comparison, breast-fed infants had less gastrointestinal illness and fewer ear infections than formula-fed infants [7]. A meta-analysis later confirmed a lower risk of acute otitis media in breastfed children [8], a related upper-airway condition that was not assessed in the present study, and a pooled analysis reported lower diarrheal morbidity and mortality among breastfed infants, with the strongest protection in early infancy [9].

Although most children (88.1%) had been breastfed, only 39.6% were exclusively breastfed during the first six months and 42.4% received complementary foods before six months. This falls short of the WHO and UNICEF recommendation of exclusive breastfeeding for six months, followed by complementary foods and continued breastfeeding up to two years or beyond [10], a recommendation also endorsed by the American Academy of Pediatrics [11]. Mixed feeding was the most common pattern (47.5%), which suggests that counseling should address not only the initiation of breastfeeding but also its exclusivity and the timing of complementary feeding. Encouragingly, nearly half of the children (44.8%) were still breastfed beyond 12 months. Continued breastfeeding matters beyond infection control, since it has also been linked to longer-term health outcomes [12].

The direction of our findings, with formula-only feeding showing the highest frequency of every outcome, is consistent with systematic review evidence from developed countries linking breastfeeding to fewer infections and fewer hospitalizations [13], and with evidence from higher-burden settings of excess deaths from diarrhea among non-breastfed infants [14]. The evidence is not uniform, however. In the PROBIT trial, a breastfeeding promotion intervention reduced gastrointestinal infections but did not significantly reduce respiratory tract infections [15]. Our non-significant results are therefore compatible both with a modest true effect that the study was too small to detect and with the absence of an effect.

Formula-only feeding was accompanied by the highest proportions of recurrent URTI (30.8%), any LRTI (76.9%), and LRTI hospitalization (53.8%), compared with 15.4%, 51.3%, and 30.8% in exclusively breastfed children. The comparison for LRTI hospitalization approached significance ($p = 0.064$). This agrees with birth cohort studies reporting less respiratory morbidity in breastfed infants [16] and fewer infections with prolonged and exclusive breastfeeding [17], and with the association between longer full breastfeeding and fewer respiratory infections in US children [5]. By contrast, the Cochrane review of exclusive breastfeeding duration did not identify a clear respiratory benefit of extending exclusive breastfeeding to six months [3].

Longer breastfeeding was accompanied by fewer children with recurrent URTI (22.2% for <6 months to 9.1% for >24 months), but the pattern for any LRTI was not consistent: it was highest (64.7%) in children breastfed for 6–12 months and lowest in those breastfed >24 months (36.4%) or <6 months (38.9%). Such non-monotonic patterns, together with the small numbers in each category, argue against over-interpreting these gradients. They may reflect chance, recall error, or reverse causation, for example, if breastfeeding was stopped because of illness. Most existing evidence also concerns

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infancy, whereas our outcomes were recorded over the first 24 months in children now aged 2–3 years, and protection in infancy may not extend to later childhood.

Recurrent gastroenteritis (≥3 episodes) was more frequent in formula-fed children (46.2%) than in exclusively breastfed (23.7%) or mixed-fed children (20.5%), and ≥5 episodes occurred in 22.2% of children breastfed for less than 6 months compared with 0–5.9% of those breastfed longer (p = 0.091). Although not statistically significant, these differences are in line with reviews reporting lower diarrheal morbidity and mortality among breastfed infants [4,9] and with the reduction in gastrointestinal infection seen in PROBIT [15]. Because protection against diarrhea appears to be greatest in early infancy [9], the gradient in our data may be concentrated in children breastfed for less than six months. The mechanisms described in the Introduction, including secretory immunoglobulin A, lactoferrin, and human milk oligosaccharides, and a lower exposure to contaminated water and utensils provide biological plausibility for this direction of association.

The healthcare burden of these infections was substantial: among children with URTI, 81.4% had a doctor visit and 64.0% received antibiotics; 53.7% of children with LRTI had been hospitalized; and among those with gastroenteritis, 88.9% needed ORS and 45.3% were admitted. Cohort data from the United Kingdom [6] and systematic reviews [13,18] have linked breastfeeding with lower hospitalization for diarrheal and respiratory infections, which underlines the potential public health importance of feeding practices. These proportions should, however, be interpreted cautiously, because the data were parent-reported and were collected at a single medical Centre, where attendees may have had more severe illness than children in the general population. Because most URTIs are viral, the high proportion treated with antibiotics also points to an opportunity for antimicrobial stewardship and parental education.

Household smoke exposure, present in 19.8% of children, was associated with about threefold higher odds of any LRTI (crude OR 3.15; 95% CI 1.05–9.50), the only significant association in this study. This is consistent with tobacco smoke being a recognized risk factor for childhood respiratory infection, as noted in the Introduction. The wide confidence interval reflects the small number of exposed children, and the crude estimate may be confounded by factors such as household crowding and socioeconomic status. Daycare attendance (OR 1.86) and full vaccination (OR 0.43 for recurrent gastroenteritis; p = 0.086) were not significantly associated with outcomes, although their directions are biologically plausible. Reducing smoke exposure at home should be part of counseling alongside breastfeeding promotion and vaccination.

Strengths and Limitations

The strengths of this study include the simultaneous assessment of respiratory and gastrointestinal outcomes, the collection of detailed feeding variables (pattern, duration, and timing of complementary feeding), the recording of potential confounders such as smoke exposure, daycare attendance, and vaccination, and the focus on children aged 2–3 years, for whom evidence is limited.

Several limitations should be acknowledged. First, the cross-sectional design permits the identification of associations only and cannot establish causation or temporal order. Second, the sample was small and drawn from a single centre, and only 13 children were fed formula only, so estimates were imprecise, and the study had limited power; non-significant findings should not be interpreted as evidence of no effect. Third, infection history and feeding practices were reported by parents over a period of up to 36 months and were not verified against medical records, so recall and reporting bias are possible. Fourth, some variables had missing or uncertain responses, including breastfeeding duration (n = 96), gastroenteritis episodes (n = 95), and pneumococcal and rotavirus vaccination (“not sure” in 13.9% and 17.3%). Fifth, only crude associations are reported because multivariable models would have been overfitted, so residual confounding, for example by socioeconomic status, cannot be excluded, and multiple comparisons were not adjusted for. Finally, the outcome cut-offs for recurrent infection were defined for this study, which limits direct comparison with other reports.

These findings support continued promotion of exclusive breastfeeding for six months and continued breastfeeding thereafter [10,11], together with timely complementary feeding, smoke-free homes, and vaccination. Larger, multicenter, preferably prospective studies with verified outcome data and multivariable analysis are needed to quantify the independent effect of breastfeeding on infections in children aged 2–3 years in Libya.

Conclusion

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Author Contributions

Study conception and design: MI; data collection: ABM, MI; analysis and interpretation of results: MI and ABM; draft manuscript preparation: MI, ABM. All authors reviewed the results and approved the final version of the article.

Conflicts of Interest

The authors declare that there is no conflict of interest to disclose.

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Data Availability Statement
The primary cross-sectional survey dataset collected and analyzed during the current study is available from the corresponding author upon reasonable academic request, subject to institutional ethical review and data protection regulations.

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