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Breastfeeding Indicators and Gastrointestinal Outcomes in Chinese 0-23-Month-Old Infants and Young Children: a National Cross-Sectional Survey Finding

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ABSTRACT: Optimal breastfeeding is critical for infant health. However, data on current breastfeeding status in China and associations between breastfeeding practices and gastrointestinal outcomes remain limited. This cross-sectional study enrolled 2,405 infants and children aged 0–23 months and their mothers from 10 provinces and cities across five regions of China (Southwest, East, Northeast, Northwest, and Central). A standardized questionnaire was used to collect data on breastfeeding practices, non-breast milk feeding status, complementary feeding practice, as well as sociodemographic and perinatal characteristics. Gastrointestinal symptom profiles, including numbers and severity, were assessed using the Infant Gastrointestinal Symptom Questionnaire. The WHO-recommended Infant and Young Child Feeding indicators were used as core indexes to assess breastfeeding practices. Multivariate logistic regression analysis was performed to assess the relationship between each breastfeeding indicator and gastrointestinal symptoms. Among 2,405 infants and children, 29.6%, 32.5%, and 37.9% were aged (0–5) months, (6–11) months, and (12–23) months, respectively. Ninety-five-point two percent (95.2%) had been breastfed, while 49.2% initiated breastfeeding within 1 hour of delivery. 44.5% of children received their first intake of non-breast milk fluids within the first 24 hours of life. For infants under six months, 53.9% were exclusively breastfed, 22.6% were fed mixed milk, and 10.7% were provided additional water while breastfeeding. Breastfeeding continuation rates were 44.7% of children at 1 year of age and 16.8% of those at 2 years of age. Multivariate logistic regression analysis revealed that early initiation of breastfeeding (within 1 hour), exclusive breastfeeding, delayed introduction of non-breast milk fluids (no less than 1 month), and continued breastfeeding (CBF) 6-11 months were significantly associated with fewer gastrointestinal (GI) symptoms and lower GI symptom scores ($P < 0.05$), after adjusting for all covariates, including complementary feeding indicators. No significant associations were observed between number of GI symptoms and GI symptom scores and CBF 12-23 months, age 1 year, or age 2 years ($P > 0.05$). China's breastfeeding status are improving, and the appropriate breastfeeding practices benefit infants' gastrointestinal health. Efforts on supporting and guiding mothers to achieve optimal breastfeeding and research on the benefit of CBF in complex feeding conditions should be conducted in the future to better support child health.

1. Introduction

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Breast milk is an unparalleled natural food for infants and young children, providing a wide range of health benefits for both the mother and child. It contains essential nutrients that are uniquely suited to support rapid infant growth [1]. Breast milk also comprises hundreds of bioactive components—including immunoglobulins (e.g., IgA), antimicrobial proteins (such as lactoferrin and lysozyme), cytokines, cellular components, and miRNAs—which contribute to immune protection, modulate inflammatory responses, and promote the maturation of the infant's immune system[2, 3]. Microbiota in human milk play a critical role in the colonization and development of the infant gut microbiota[4, 5]. Beyond biochemical components, the act of breastfeeding supports infant orofacial, respiratory, and neurological development, while infant-led feeding helps prevent overweight and obesity by avoiding overfeeding[6]. For mothers, breastfeeding aids in postpartum weight loss and reduces the risk of several cancers, hypertension, and diabetes[7]. Population studies indicate that non-breastfed infants have a 14-fold higher risk of death within the first year of life compared to those exclusively breastfed[8], and suboptimal breastfeeding practices increased susceptibility to— and mortality from— respiratory and gastrointestinal infection across all pediatric age groups [9, 10]. Scaling up breastfeeding to a nearly universal level could prevent 11.6% of infant death, 21.9 million disability-adjusted life years, and $300 billion annual economic costs [11-13].

The protective role of breastfeeding against infectious diseases is of particular interest. Evidence suggests that it can prevent half of all diarrhoea episodes and a third of respiratory infections, as well as 72% of hospitalizations for diarrhoea and 57% of those for respiratory infections.[14]. Throughout the first year of life, infants are more likely to experience gastrointestinal (GI) discomfort [15]. A 2020 study reported that gastrointestinal symptoms were present in 24.7% of infants in Europe aged (0–12) months and 11.3% of children aged (1–4) years[16]. In China, 33.9% of infants aged (0–6) months had regurgitation, while 43.8% of infants had colic during the first two months of life[17]. Since newborns are unable to communicate their feelings clearly, the GI symptoms may appear more as signs such as crying, spitting milk, and irregular bowel movements. These conditions not only influence the growth and development of children but also can lead to anxiety and socio-economic pressures in parents[18]. Nevertheless, few studies have looked at breastfeeding's impact on these atypical signs of GI discomfort.

Globally, the optimum breastfeeding practice has not yet been popularized. The 2016 reports stated that just 37% of infants under 6 months old in low- and middle-income countries are exclusively breastfed, and most high-income countries have lower breast feeding durations than resource-poor ones[11]. Since the implementation of monitoring in 2017, the global exclusive breastfeeding rate progressively increased, reaching 48% in 2024, close to the 2025 target of 50%[1].Consistent with global trends, the breastfeeding rate in China is also increasing. According to the 2013 National Nutrition Survey, only 18.6% of infants under six months old were exclusively breastfed[19], and a 2018 nationwide survey reported a rate of 29.5%[20]. The exclusive breastfeeding

rate reported in Shanghai, China, in 2022 was 43.3%[21]. But there is no report on the latest national breastfeeding situation yet.

Beyond exclusive breastfeeding, comprehensive evaluation of breastfeeding practices necessitates multidimensional indicators encompassing early initiation of breastfeeding (EIBF), continued breastfeeding, and the introduction of fluids other than breast milk, etc. According to research, promoting nipple sucking in newborns at an early age is essential to successful exclusive breastfeeding by six months of age[20, 22], and prelacteal feedings can interfere with the early initiation of breastfeeding by delaying the crucial first contact between the mother and the infant, disrupting the achievement of exclusive breastfeeding[23]. These indicators are all closely related to breastfeeding. Furthermore, there are slight differences in understandings of exclusive breastfeeding among different researchers. Some studies define exclusive breastfeeding based on feeding history during the past 24 hours[20, 21], while others base this definition on that since birth[24]. Comparisons across data sets may be impacted by this difference.

This study adopted WHO's 2021 Indicators for Assessing Infant and Young Child Feeding Practices (IYCF) and expanded indicators according to the actual situation to understand the current breastfeeding status in China systematically. Through multivariate analysis, the study further explored the relationship between the paediatric gastrointestinal symptoms/dysregulation manifestation and the multi-dimensioned breastfeeding parameters mentioned above to provide evidence for promoting breastfeeding and optimizing infant feeding protocols.

2. Material and methods

2.1 Study design and participants

This study used multi-stage cluster sampling, which first selected provinces and cities from the five major regions of China and then chose maternal and child care institutions in each of those locations. Ultimately, the study included 21 maternity and child care institutions in 10 provinces and cities spanned over five regions: Southwest China (Sichuan, Yunnan, and Chongqing), East China (Shandong, Jiangsu, and Shanghai), Northeast China (Liaoning and Jilin), Northwest China (Shaanxi), and Central China (Hunan). In each institution, a children's health care doctor was enlisted to assist in the study, and participants were enrolled in the clinic of that doctor. Inclusion criteria for participants were: (1) healthy newborns; (2) between the ages of 0 and 23 months; and (3) parents or other caregivers (18 years of age or older) who were willing to provide informed consent and complete the entire questionnaire. Exclusion criteria included: (1) congenital diseases and/or gastrointestinal disorders or malformations that could interfere with the study parameters; (2) current use of medications for functional gastrointestinal disorders (FGID), such as reflux medications, whether voluntarily or by prescription; (3) siblings of enrolled participants; and (4) participation in other clinical trials. The study protocol was approved by the Ethics Committee of Nanjing Medical University (2021-588).

The sample size was calculated using the following formula:

$$n = Z^2_{1-\frac{\alpha}{2}} \frac{1-p}{d^2 p}$$

where Z is the Z-score corresponding to the desired confidence level, α is the Type I error rate, d is the margin error, and p is the expected breastfeeding rate. We used a Z-value of 1.96 for 95% confidence, an α level of 0.05, and p of 0.1. According to the latest survey and pre-survey results, the exclusive breastfeeding rate was estimated at 40%, while the continued breastfeeding rate was 20%. Accounting for a 10% no response rate, the minimum sample size was set to 640 infants aged 0–5 months and 1,690 infants aged 6–23 months to achieve sufficient statistical power. Finally, the study enrolled 712 infants aged 0-5 months and 1693 infants aged 6-23 months between July 2021 and June 2022, meeting the target sample size.

2.2 Data collection and quality control

After extensive discussion among experts, a standardized questionnaire was created in compliance with the WHO's and Chinese Nutrition Society's breastfeeding recommendations. The following information was collected through the questionnaire: (1) demographic characteristics, including maternal age, education level and employment status, and infants' age in months, gender, ethnicity, and place of residence; (2) pregnancy and delivery variables, including gestational week, parity, and mode of delivery; (3) breastfeeding practices, including breastfeeding, liquid other than breast milk feeding, and the use of supplements, in the last 24 hours and from birth to the present, respectively; (4) Complementary feeding practices: frequency of consuming various solid, semi-solid, or soft foods (per week or day) during the past week; (5) gastrointestinal symptoms in infants and young children. At each survey location, a pre-survey was carried out to gather input and improve the questionnaire. Each doctor thoroughly understood the purpose of the survey, the structure of the questionnaire, and the survey methodology through centralized and uniform training. After the investigator explained the purpose of the survey and the definition of the pertinent indicator, the respondents completed the questionnaire with informed consent. Investigators read aloud the questions and filled out the questionnaire on behalf of individuals who were unable to read or complete it. The questionnaire was quickly encoded and verified for accuracy after the survey.

2.3 Breastfeeding indicators

The study used five indicators among infant and young child feeding (IYCF) indicators recommended by WHO and UNICEF to assess the breastfeeding situation.

(1) Ever breastfeeding (EvBF): percentage of children born in t-he last 24 months who were ever breastfed.

(2) Early initiation of breastfeeding (EIBF): percentage of children born in the last 24 months who were put to the breast with-in one hour of birth.

(3) Exclusive breastfeeding (EBF) under six months: percentage of infants 0–5 months of age who were fed exclusively with breast milk during the previous day. According to the WHO, EBF means giving an infant exclusively breast milk throughout the first six months of life, along with no other foods or liquids other than prescription drugs, vitamin and mineral supplements, and oral rehydration salts[25].

(4) Mixed milk feeding under six months (MixMF): percentage of infants (0–5) months of age who were fed formula and/or animal milk in addition to breast milk during the previous day.

(5) Continued breastfeeding (CBF) beyond 6 months: percentage of children older than 6 months who received breastfeeding during the previous day. The WHO focuses on CBF among children (12-23) months, commonly using CBF in children at 1 year (percentage among children aged (12–15) months) and 2 years (percentage among children aged (20–23) months). In addition to these three indicators (CBF > 6m, at 1y, at 2y), this study also examined CBF in children aged (6-11) months.

In addition to the ones mentioned above, we also employed two extended indicators to describe breastfeeding status comprehensively:

(1) Absolute exclusive breastfeeding under six months: percentage of infants (0–5) months of age who were fed exclusively with breast milk from birth to the present.

(2) Initiation time of liquid feeding other than breast milk: the child's first-time consuming liquids other than breast milk.

Finally, to illustrate the full spectrum of infant and toddler feeding status, including breast milk, water, non-milk liquids, animal milk/formula, and complementary foods throughout the previous day, an infant feeding area (AG) graph was created. Children who received formula were classified as formula feeding (FF), while children who received complementary foods were classified as complementary feeding (CF).

2.4 Gastrointestinal (GI) symptoms assessment

The Infant Gastrointestinal Symptom Questionnaire (IGSQ), designed to obtain parental perceptions regarding the frequency and severity of gastrointestinal symptoms in infants and children [26], has demonstrated validity in assessing their gastrointestinal discomfort across distinct cultural groups. The data were collected via maternal self-report using a structured questionnaire. The questionnaire, which was modified following the pre-test, consists of 10 items that represent the four categories of GI symptoms: fecal consistency, vomiting, crying, and bloating, of which fecal consistency includes both loose and hard feces. The frequency and severity of each symptom were inquired. By assigning a number between 1 and 5 to each of the 10 questions, with except for the crying dimension, which received a score from 1 to 8, a total score range of 10 to 53 was achieved.

To evaluate the GI tolerance of infants and children, the number of GI symptoms and the GI symptom scores were calculated. Three levels were established for the number of gastrointestinal

symptoms: asymptomatic (0), experiencing one symptom (1), and experiencing more than two symptoms (≥ 2). The GI symptom scores were categorized as a binary variable. High scores (≥ 9) indicated the high GI symptoms burden, whereas low scores (< 9) indicated a low gastrointestinal symptoms burden.

2.5 Statistical analysis

General characteristic variables and breastfeeding indicators are represented as frequency and percentages. A weighted rate was calculated by assigning equal weights to the rates for each monthly age group, thereby balancing the influence of individual sample sizes across all groups on the final estimate. The number of gastrointestinal symptoms and scores for gastrointestinal symptoms are expressed as medians and quartiles (Q1-Q3). Univariate logistic regression was initially performed to assess the relationship between each breastfeeding indicator and gastrointestinal outcomes. Subsequently, multivariate logistic regression analysis was conducted to evaluate the independent associations between them after adjusting for potential confounding variables. Adjusted odds ratios (AORs) and 95% confidence intervals (CIs) are reported for all variables. SPSS 25.0 software (IBM Corp., released 2020; IBM SPSS Statistics for Windows, version 25.0., Armonk, NY: IBMCorp.) was used to analyze the data, and a two-sided $P < 0.05$ was considered statistically significant. The graphical presentation was created using GraphPad Prism 8.0 (GraphPad Software, San Diego, CA, USA, https://www.graphpad.com) and R Studio.

3. Result

3.1 Characteristics of the Study Population

2,405 infants and children between the ages of 0 and 23 months were enrolled in this study. Of them, 29.6% were between the ages of 0 and 5 months, 32.5% were between the ages of 6 and 11 months, and 37.9% were between the ages of 12 and 23 months. 52.3% of the children were boys, and 92.4% were Han Chinese. Over 90% of the children resided in urban areas, and 68.9% of them were their parents' firstborn children. Of the moms polled, 95.7% gave birth during normal gestational weeks, 54.5% gave natural birth, and 61.4% of the mothers were unemployed at the time of the study. According to the age distribution of the mothers who participated in the survey, the largest group was of moms in their 30s (40.4%), followed by mothers in their 25s (35.5%). Regarding educational attainment, mothers with a bachelor's degree made up the largest percentage (39.4%), followed by those with a college or vocational university degree (27.3%). Additionally, 21.0% of the children reported taking probiotics the previous day. Table 1 displays the details of the study participants.

Table 1 Characteristics of the participated infants and young children aged 0-23 months and their mothers (N=2405).

Characteristics	N (%)	Characteristics	N (%)
Age (months)		Maternal education level	
0–5	713 (29.6)	Junior high school or	230 (9.6)

6–11	782 (32.5)	below	
12–23	910 (37.9)	Senior high school	419 (17.4)
Gender		Vocational college	656 (27.3)
Male	1257 (52.3)	Undergraduate college	947 (39.4)
Female	1148 (47.7)	Master's degree or above	153 (6.4)
Ethnicity		Maternal parity	
Han	2222 (92.4)	Primipara	1658 (68.9)
Other	183 (7.6)	Multipara	747(31.1)
Region		Gestational age	
District	2204 (91.6)	<37 wk	104 (4.3)
County	201 (8.4)	≥37 wk	2301 (95.7)
Maternal age		Mode of delivery	
< 18	22 (0.9)	Vaginal birth	1311 (54.5)
18–24	163 (6.8)	Cesarean section	1094 (45.5)
		Maternal employment status	
25–29	854 (35.5)	Yes	928 (38.6)
30–34	972 (40.4)	No	1477 (61.4)
35–40	310 (12.9)	Probiotic supplements use	
≥ 40	84 (3.5)	Yes	505 (21.0)
		No	1900 (79.0)

3.2 Breastfeeding situations

In total, 95.2% of 2,405 children aged 0 to 23 months had been breastfed since birth. 49.2% of infants started breastfeeding within an hour of giving birth (Fig. 1C). The breastfeeding patterns of infants under six months old are summarized in Fig. 1A. Exclusive breastfeeding was reported for 53.9% of infants, with 37.8% being absolute exclusive breastfeeding (exclusively breastfeeding since birth). Meanwhile, 22.4% received mixed milk feeding. Importantly, 10.8% of infants were provided additional water during breastfeeding, indicating a need for targeted education on appropriate infant feeding practices and representing a key target population for improving exclusive breastfeeding rates (Fig. 1A). Overall, 50.5% of children aged 6 to 23 months continued to breastfeed, in specific, 72.3% for those aged 6 to 11 months and 31.9% for those aged 12 to 23 months (Fig. 1B). The CBF at 1 year of age was 44.7%, and at 2 years of age the CBF was 16.8%. Tabel 2 shows above crude rates and corresponding month-age-weighted rates.

Table 2 Crude and weighted rates for breastfeeding indicators in 2405 Chinese infants and young children.

Indicators	N	Crude rate [n (%)]	Weighted rate (%)
EvBF	2405	2289 (95.2)	95.2
EIBF	1998	983 (49.2)	50.6
EBF indicators			
aEBF	625	236 (37.8)	39.9
EBF	625	337 (53.9)	54.4
MixMF	625	140 (22.4)	18.7
CBF indicators			
CBF 6–23 months	1692	855 (50.5)	43.3
CBF 6–11 months	782	565 (72.3)	71.2
CBF 12–23 months	910	290 (31.9)	29.4
CBF at 1 year	378	169 (44.7)	44.0
CBF at 2 years	220	37 (16.8)	17.3

EvBF: ever breastfeeding, EIBF: early initiation of breastfeeding, EBF: exclusive breastfeeding under six months, aEBF: absolute exclusive breastfeeding under six months, MixMF: mixed milk feeding under six months, CBF: continued breastfeeding.

3.3 The Initiation time of liquid feeding other than breast milk

Of the 1,543 children who responded to questions on the intake of fluids other than breast milk since birth, 44.5% were introduced to non-breast milk liquids in the first 24 hours after birth, followed by 19.7% between 24 hours and 1 month and 35.8% beyond 1 month (Fig. 1D). Regarding the types of non-breast milk fluids they drank for the first time, 57.7% of respondents drank infant formula, 40.4% drank water, 0.6% drank beverages (including sugar water and fruit juices), and 1.2% drank other liquids.

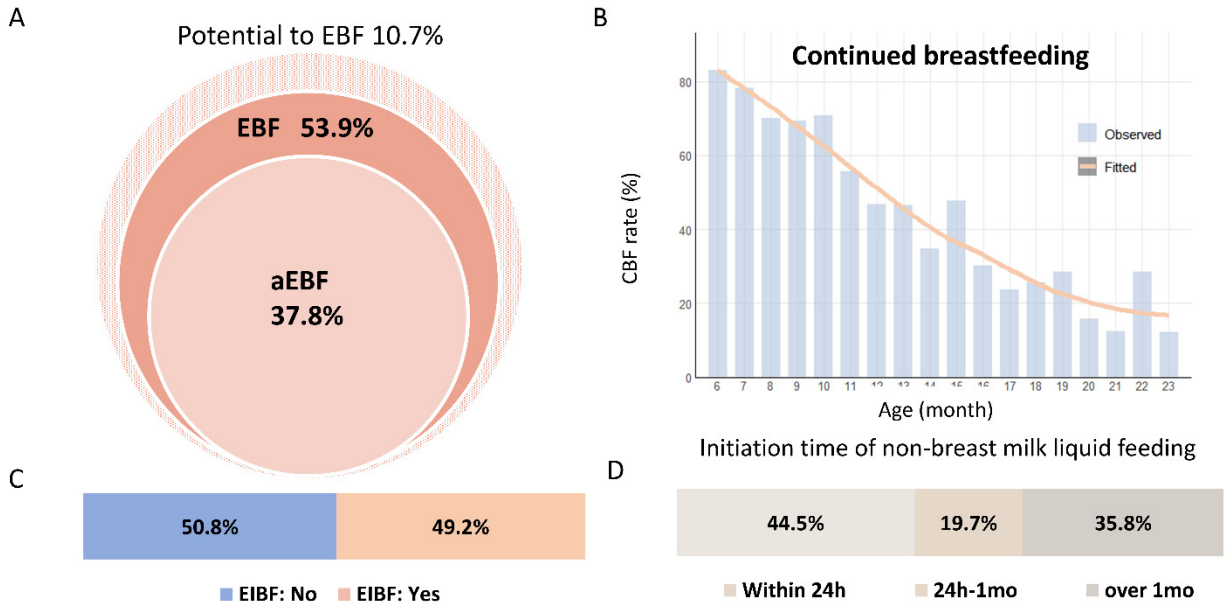

Fig. 1. Breastfeeding rates and the initiation time of non-breast milk liquids feeding.

(A) Absolute exclusive breastfeeding (aEBF) rate, exclusive breastfeeding (EBF) rate, and proportion of the population with the potential to practice EBF for infants aged 0-5 month. (B) Continued breastfeeding (CBF) rates for infants and young child aged 6-23 months. (C) Early initiation of breastfeeding (EIBF) rate for infants and young child aged 0-23 months. (D) Distribution of the initiation time of non-breast milk liquid feeding.

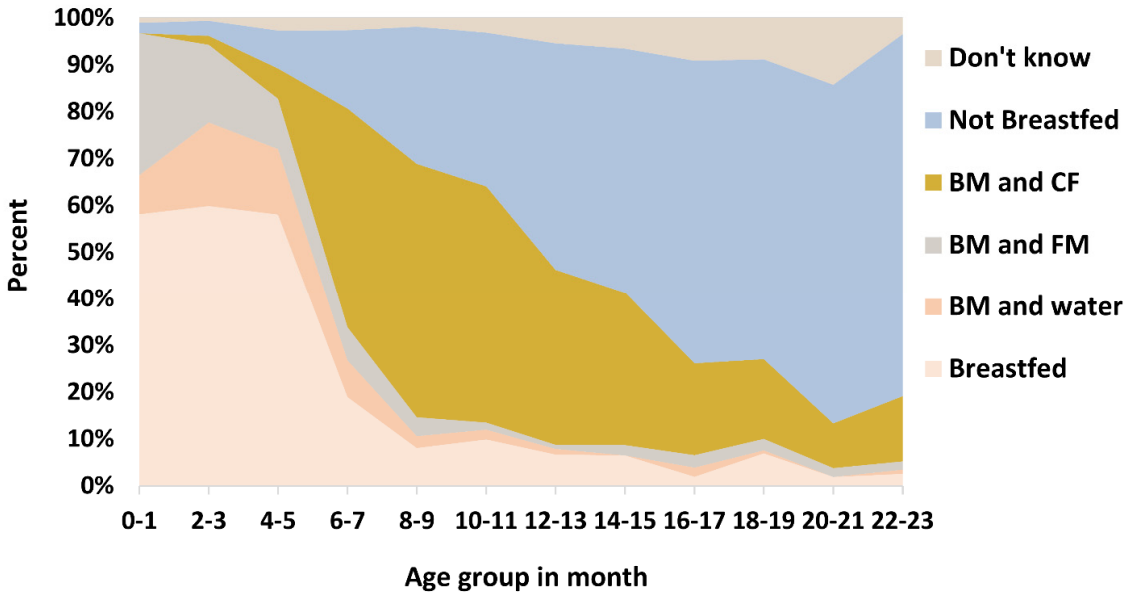

Fig. 2. Area graph patterns of infant and young child feeding practices by age. BM: breast milk, CF: complementary foods, FM: formula milk.

3.4 Map of Feeding Area Size

Additionally, of the 2,256 respondents who answered whether their children had formula-fed in the past 24 hours, parents of 27.3% infants within 6-month-age and 67.8% children aged 6 to 23 months stated they did so. And of the 1,562 respondents who answered whether their child had consumed complementary foods the day before, parents of 84.8% of children aged 6 to 23 months stated they did. Fig. 2 shows the detailed feeding practices of 2405 infants and young children aged (0–23) months.

3.5 Association of Covariates with Breastfeeding Practices and Gastrointestinal Symptoms

To better understand the link between breastfeeding and infant gastrointestinal health, this study incorporated complementary feeding status as covariates. Among 2,405 children aged (0–23) months, 1,923 provided data on complementary food consumption within the preceding 24 hours, with a 70.4% introduction rate of complementary foods among infants aged (6-8) months. The Minimum Milk Feeding Frequency (MMFF) for non-breastfed children aged (6–23) months, defined as the percentage of non-breastfed children (6–23) months of age who consumed at least two milk feeds (including any formula or any animal milk and its products other than human breast milk) during the previous day, was 38.5%. Both the complementary feeding (CF) rate and MMFF were adjusted as covariates in subsequent analyses.

In addition to complementary feeding indicators, the covariates incorporated in this study included infant age (months), gender, ethnicity, region, maternal age, maternal education level, maternal parity, gestational age, mode of delivery, and maternal employment status. The association between maternal-infant demographic characteristics and breastfeeding practices/gastrointestinal symptoms is detailed in Supplementary Table 1 - 5. As shown in Supplementary Table 1, higher odds of EIBF were observed among older infants (AOR = 1.02; $P < 0.001$), multiparous mothers (Adjusted OR = 2.19; $P < 0.001$), or those with gestational ages ≥ 37 wk (AOR = 2.92; $P < 0.001$), whereas ethnic minorities (AOR = 0.49; $P < 0.001$), maternal age at 35-40y (AOR = 0.24; $P = 0.004$; rather than < 18y), or cesarean delivery (AOR = 0.59; $P < 0.001$) were associated with significantly lower EIBF rates. Unemployed mothers had higher odds of EBF (AOR = 2.61; $P < 0.001$) (Supplementary Table 2) and CBF (AOR = 1.43; $P = 0.038$) (Supplementary Table 3) compared to employed mothers. Older infants had lower odds of CBF (AOR = 0.86; $P < 0.001$) (Table S3). Infants in the county exhibited a higher number of GI symptoms and GI symptom scores than those in the district (number AOR = 1.83; scores AOR = 2.22; both $P < 0.001$) (Supplementary Table 4 - 5). Conversely, infant age (number AOR = 0.94; $P < 0.001$; scores AOR = 0.94; both $P < 0.001$) and multiparity (number AOR = 0.77; $P = 0.005$) were associated with reduced GI Symptoms (Supplementary Table 4 - 5).

3.6 Association of breastfeeding with the number of GI symptoms

Of the 2259 respondents, 37.9%, 34.4%, and 27.7% of respondents, respectively, reported having a total of 0, 1, and no less than 2 GI symptoms. Table 3 presents the results of the univariate analysis of the

relationship between breastfeeding indicators and gastrointestinal symptoms. After adjusting for covariates including maternal-infant demographic characteristics, complementary feeding indicators, and probiotic supplementation, infants with EIBF (AOR = 0.48; $P < 0.001$) and those introduced to non-breast milk liquid feeding after 1 month of age (AOR = 0.58; $P < 0.001$) were associated with a reduced number of GI symptoms (Fig. 3).

For infants under 6 months, multivariable regression analysis adjusted for all covariates, including complementary feeding indicators, demonstrated that infants with aEBF (AOR = 0.68; $P = 0.02$), and EBF (AOR = 0.62; $P = 0.003$) were associated with fewer GI symptoms (Fig. 3). Notably, after excluding infants who had initiated complementary feeding, EBF infants were associated with a lower risk of GI symptoms compared to mixed-fed infants receiving breast milk and formula (BF + FF) (AOR = 0.54; $P = 0.003$) (Table 4).

For infants over 6 months, multivariable regression analysis adjusted for all covariates, including complementary feeding indicators, and CBF at 6–11 months was associated with fewer GI symptoms (AOR = 0.54; $P = 0.018$). No significant associations were observed between GI symptoms and CBF at 12–23 months, age 1 year, or age 2 years ($P > 0.05$) (Fig. 3). Subgroup analysis based on feeding practices revealed that unadjusted analysis results indicated that infants fed breast milk plus complementary foods plus formula feeding (BF + CF + FF) may have higher number of gastrointestinal symptoms than infants fed only complementary foods plus formula feeding (CF + FF) (Unadjusted OR = 1.72; $P = 0.006$). After adjustment for all covariates including complementary feeding variables, this association lost statistical significance (Table 4).

3.7 Association of breastfeeding with children's GI symptom scores

The median gastrointestinal symptom score was 8 (7, 10). The prevalence of high gastrointestinal symptom scores was 45.1% (1,018/2,259). Multivariable regression analysis, after adjusting for maternal-infant demographic characteristics, complementary feeding indicators, and probiotic supplement use, revealed that both EIBF (AOR = 0.47; $P < 0.001$) and delayed introduction of non-breast milk liquid (after 1 month of age; AOR = 0.68; $P < 0.001$) were associated with a reduced likelihood of high GI symptom scores (Fig. 4).

For infants under 6 months, multivariable regression analysis, after adjusting for all covariates including complementary feeding indicators, revealed significantly reduced likelihoods of high GI symptom scores among infants receiving aEBF (AOR = 0.58; $P < 0.001$) and EBF (AOR = 0.61; $P = 0.01$) (Fig. 4). Furthermore, in a subgroup analysis excluding infants who had initiated complementary feeding, exclusively breastfed infants (BF) demonstrated a significantly lower likelihood of high GI symptom scores compared to those receiving breast milk and formula (BF + FF; AOR = 0.57; $P = 0.003$) (Table 5).

For infants over 6 months of age, multivariable regression analysis adjusting for maternal/infant characteristics and complementary feeding covariates revealed a significantly reduced likelihood of

high GI symptom scores only among those aged 6–11 months receiving CBF (AOR = 0.53; P = 0.028). However, CBF among infants aged 12-23 months, or at 1 year or 2 years old, was not significantly associated with GI symptom scores ($P > 0.05$). Furthermore, subgroup analyses based on feeding status indicated that infants concurrently receiving breastfeeding, complementary foods, and formula feeding (BF + CF + FF) had a higher likelihood of high GI symptom scores than those receiving only complementary foods and formula feeding (CF + FF) in unadjusted analyses (UOR = 1.50; $P < 0.05$). However, this association became non-significant after adjustment for all covariates including complementary feeding variables (Table 5).

4. Discussion

To our knowledge, this is the first study to describe the status of breastfeeding in China using multi-dimensional indicators and its relationship with children's GI symptoms. In this survey conducted in 2021-2022, 95.2% of Chinese children aged (0-23) months had been breastfed, with an EIBF rate of 49.2%; the EBF rate for infants within 6 months of age was 53.9%, with an absolute EBF rate of 36.2%; continued breastfeeding rates for children 1 year and 2 years were 44.8% and 16.7%, respectively. Meanwhile, EBF, EIBF, and late prelacteal feeding were found to be linked to fewer gastrointestinal symptoms and less severe gastrointestinal symptoms. These findings display the multifaceted situation of breastfeeding in China and provide new insights into the benefit of breastfeeding for child GI health.

The most important indication of breastfeeding status is the rate of exclusive breastfeeding up to six months of age. The EBF rate varies widely among countries worldwide, even under the same geographical and economic conditions; for example, in Asia, it was 58.7% in India[27] while 11% in Lebanon[28]. The global EBF rate for children under 6 months exhibited a gradual increase trend overall, rising from 37.6% in 2017 to 48% by 2022. The same pattern also exists in China. The national EBF rate increased from about 20% in 2010[19] to 30% in 2018[20]. While in regional terms, it was 28.7% in the central and western regions in 2010[29], while 43.4% in Shanghai in 2022[21]. In our study, the crude EBF rate for infants in China under 6 months of age is 53.9%, and the age-weighted rate is 54.4%, both of which are higher than previous research results, showing the upward trend. This is owed to the unremitting efforts made the country to promote breastfeeding, such as ongoing breastfeeding health education, the implementation of baby-friendly hospitals, and the extension of maternity leave. The study sample was predominantly composed of urban residents, who are more likely to benefit from supportive measures. Respondents who are willing to participate in the study might be more concerned about and thus have a greater pre-existing awareness of child feeding issues. These factors may have collectively led to an overestimation of the EBF rate in our survey. Furthermore, the absolute exclusive breastfeeding rate in this study based on the feeding status since birth was 36.2%, similar to Japan's 37.4% in 2021[24].

In addition to exclusive breastfeeding, early initiation of breastfeeding is also regarded as a crucial breastfeeding indicator. Breastfeeding within the first hour helps provide the baby with colostrum that is high in immune-boosting substances. In earlier research, infants who started breastfeeding between two and twenty-three hours after delivery were 33 percent more likely to die than those who started within an hour. The death risk was more than doubled for babies who began breastfeeding a day or more after delivery[30].There are also studies indicating that starting breastfeeding during the first hour of birth can lower the risk of newborn death by up to 15%, even if breastfeeding intensity is maintained[31].Furthermore, EIBF by itself has been connected to nearly two times the odds of EBF at six months[22] and had an impact on the continuation of EBF[24]. The WHO therefore recommends "early breastfeeding within the first hour of life." EIBF was associated with multiple factors, such as maternal parity[32], ethnicity, gestational week[33], mode of delivery[34] and maternal age[35]. The findings of this study align with existing literature.

Delays in breastfeeding initiation are still a global issue, though. Only two-fifths (44%) of children are breastfed within one hour of delivery, according to a 2022 report by the International Federation of Obstetricians and Gynecologists (FIGO). This is a concerning phenomenon that is common in many countries. Our survey showed that about 50.0% (49.2%) of Chinese newborns began breastfeeding within an hour of delivery, which is slightly higher than the global average and the rates in Lebanon (28%)[28], Nepal (16%)[36], and India (43.8%) over the same period, but is lower than the 59.4% reported in China's 2010 survey[29] and 70% of the global target. Efforts to promote early initiation of breastfeeding should be stepped up given its positive impact on exclusive breastfeeding and child health.

Table 3 Univariate analysis on the relationship between breastfeeding indicators and GI symptoms.

Indicators	N	Number of GI symptoms				GI symptom scores		
		0 (%)	1 (%)	≥2 (%)	Unadjusted OR (95%CI)	Low (%)	High (%)	Unadjusted OR (95%CI)
EIBF								
Yes	940	453 (48.2)	305 (32.4)	182 (19.4)	0.44 (0.37-0.52)*	617(65.6)	323 (34.4)	0.45(0.37-0.54)*
No	950	267 (28.1)	359 (37.8)	324 (34.1)	Ref.	439(46.2)	511 (53.8)	Ref.
aEBF								
Yes	234	64 (27.4)	91(38.9)	79 (33.8)	0.53 (0.39-0.72)*	108 (46.2)	126 (53.8)	0.50 (0.36-0.71)*
No	366	60 (16.4)	128 (35.0)	178 (48.6)	Ref.	110 (30.1)	256 (69.9)	Ref.
EBF								
Yes	325	75 (23.1)	136 (41.8)	114 (35.1)	0.56 (0.41-0.76)*	136 (41.8)	189 (58.2)	0.59 (0.42-0.83)*
No	275	49 (17.8)	83 (30.2)	143 (52.0)	Ref.	82 (29.8)	193 (70.2)	Ref.
CBF (6-11 months)								
Yes	538	240 (44.6)	178 (33.1)	120 (22.3)	0.91 (0.67-1.24)	343 (63.8)	195 (36.2)	0.85 (0.60-1.18)

No	194	82 (42.3)	66 (34.0)	46 (23.7)	Ref.	116 (59.8)	78 (40.2)	Ref.
CBF (12-23 months)								
Yes	272	95 (34.9)	119 (43.8)	58 (21.3)	1.46 (1.12-1.98)*	156 (57.4)	116 (42.6)	1.32 (0.98 -1.77)
No	573	279 (48.7)	174 (30.5)	119 (20.8)	Ref.	366 (63.9)	207 (36.1)	Ref.
CBF at 1 year								
Yes	158	57 (36.1)	71 (44.9)	30 (19.0)	1.33 (0.90-1.98)	92 (58.2)	66 (41.8)	1.28 (0.83 -1.97)
No	189	90 (47.6)	60 (31.7)	39 (20.6)	Ref.	121 (64.0)	68 (36.0)	Ref.
CBF at 2 years								
Yes	33	14 (42.4)	13 (39.4)	6 (18.2)	1.19 (0.6-2.33)	20 (60.6)	13 (39.4)	1.29 (0.60-2.78)
No	173	87 (50.3)	51 (29.5)	35 (20.2)	Ref.	115 (66.5)	58 (33.5)	Ref.
Initiation time of non-breast milk liquid								
Within 24h	525	299 (57.0)	142 (27.0)	84 (16.0)	0.40 (0.32-0.50)*	371 (70.7)	154 (29.3)	0.49 (0.38-0.62)*
24h -1mo	289	103 (35.6)	99 (34.3)	87 (30.1)	0.95 (0.74-1.23)	150 (51.9)	139 (48.1)	1.09 (0.82-1.42)
Over 1mo	649	217 (33.4)	237 (36.5)	195 (30.0)	Ref.	350 (53.9)	299 (46.1)	Ref.

*: $P < 0.05$; EIBF: early initiation of breastfeeding, aEBF: absolute exclusive breastfeeding under six months, EBF: exclusive breastfeeding under six months, MixMF: mixed milk feeding under six months, CBF: continued breastfeeding.

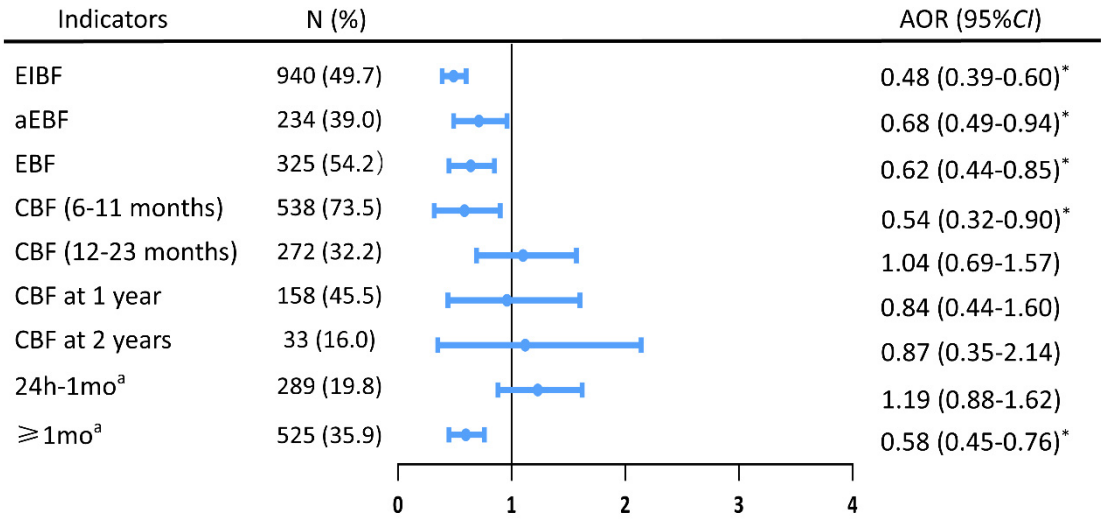

Fig. 3. Adjusted Odds Ratios (AORs) of breastfeeding indicators and number of GI symptoms. Adjusted models controlled for infant age (months), gender, ethnicity, region, maternal age, maternal education level, maternal parity, gestational age, mode of delivery, maternal employment status, probiotic supplement use, and complementary feeding indicators (CF rate for children under 6 months old; CF rate and MMFF for children over 6 months old); *: $P < 0.05$; EIBF: early initiation of breastfeeding, aEBF: absolute exclusive breastfeeding under six months, EBF: exclusive breastfeeding under six month, CBF: continued breastfeeding; a: the time of intake of liquids other than breast milk, compared to within 24h.

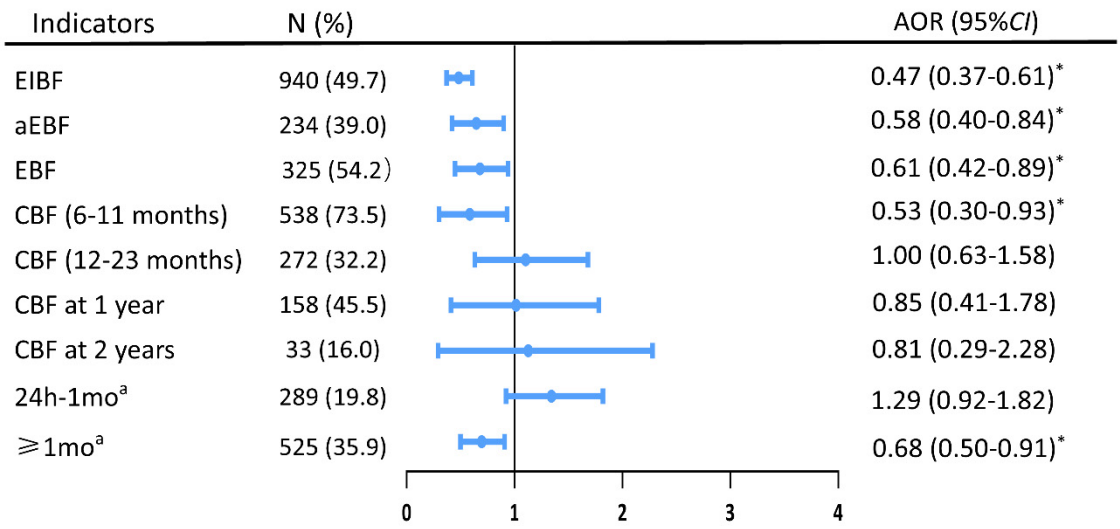

Fig. 4. Adjusted Odds Ratios (AORs) of breastfeeding indicators and GI symptom scores. Adjusted models controlled for infant age (months), gender, ethnicity, region, maternal age, maternal education level, maternal parity, gestational age, mode of delivery, maternal employment status, probiotic supplement use, and complementary feeding indicators (CF rate for children under 6 months old; CF rate and MMFF for children over 6 months old); *: $P < 0.05$. EIBF: early initiation of breastfeeding, aEBF: absolute exclusive breastfeeding under six months, EBF: exclusive breastfeeding under six months, CBF: continued breastfeeding; a: the time of intake of liquids other than breast milk, compared to ≤ 24h.

Table 4 Association between breastfeeding and number of GI symptoms by feeding type (breastfed or not).

Indicators	N	0 (%)	1 (%)	≥2 (%)	Unadjusted OR (95%CI)	Adjusted[α] OR (95%CI)
BF (0–6months)						
BF only	325	75 (23.1)	136 (41.8)	114 (35.1)	0.36 (0.24-0.54)*	0.54 (0.34-0.80)*
BF+FF	137	21 (15.3)	29 (21.2)	87 (63.5)	Ref.	Ref.
CBF (12–23months) : Subgroup 1						
BF + CF	66	24 (36.4)	37 (56.1)	5 (7.6)	1.35 (0.63-2.87)	1.69 (0.58-4.93)
CF	40	20 (50.0)	14 (35.0)	6 (15.0)	Ref.	Ref.
CBF (12–23months) : Subgroup 2						
BF + CF+ FF	133	49 (36.8)	49 (36.8)	35 (26.3)	1.72 (1.20-2.47)*	0.89 (0.52-1.54)
CF +FF	452	232 (51.3)	137 (30.3)	83 (18.4)	Ref.	Ref.
CBF (12–23months) : Subgroup 3						
BF +FF	12	3 (25.0)	3 (25.0)	6 (50.0)	1.84 (0.50-6.82)	4.06 (0.54-30.20)
FF	24	10 (41.7)	5 (20.8)	9 (37.5)	Ref.	Ref.

[α]: Adjusted models controlled for infant age (months), gender, ethnicity, region, maternal age, maternal education level, maternal parity, gestational age, mode of delivery, maternal employment status, probiotic supplement use and complementary feeding indicators (CF rate for children under 6 months old; CF rate and MMFF for children over 6 months old); *:$P < 0.05$. BF: breastfeeding, CF: complementary feeding, FF: formula feeding, Ref: reference.

Feeding liquids other than breast milk, particularly prelacteal feeding, has an impact on the effectiveness of exclusive breastfeeding. According to the reports, prelacteal feeding is substantially connected with delayed breastfeeding beginning[37], and non-prelacteal feeding was linked to 1.6–3.5 higher odds of EBF[38]. Nevertheless, it is typical in many areas for infants to receive liquids other than breast milk during their first few days of life. Prior to being breastfed, about one in three babies gets prelacteal meals, which are primarily water and animal milk[39]. It is often brought on by mothers' worries about their infants going hungry for a limited supply of breast milk. However,

baby-friendly hospitals advise against formula feeding until the infant has lost no more than 7% of their body weight and instead urge the child to suckle the breast to increase milk supply after birth. Our study investigated the initial time of extramammary fluid intake and showed that more than half of parents (63.3%) gave their babies liquids other than breast milk within the first month of life, with formula accounting for half of these cases. This demonstrates the prevalence of liquid feeding outside of breast milk for infants within 6 months of age in China and the urgency for targeted health education. Additionally, although some mothers provide water or glucose water within 24 hours after delivery to help eliminate excess bilirubin, under normal circumstances, breast milk alone can satisfy all nutritional needs (including water) of infants under six months of age. Consequently, the WHO definition of exclusive breastfeeding explicitly excludes the water. However, this study still found a considerable proportion of mothers who supplemented with water during breastfeeding. Correcting this misconception should be a priority for future breastfeeding education, as doing so has the potential to increase the exclusive breastfeeding rate by up to 10.7 percentage points.

Table 5 Association between breastfeeding and GI symptom scores by feeding type (breastfed or not) .

Indicators	N	Low (%)	High (%)	Unadjusted OR (95%CI)	Adjusted[α] OR (95%CI)
BF (0–6 months)					
BF only	325	136 (41.8)	189 (58.2)	0.41 (0.26-0.64)[*]	0.57 (0.35-0.94)[*]
BF+FF	137	31 (22.6)	106 (77.4)	Ref.	Ref.
CBF (12–23months) : Subgroup 1					
BF + CF	66	41 (62.1)	25 (37.9)	1.61 (0.68-3.78)	3.21 (0.84-12.31)
CF	40	29 (72.5)	11 (27.5)	Ref.	Ref.
CBF (12–23months) : Subgroup 2					
BF + CF+ FF	133	75 (56.4)	58 (43.6)	1.50 (1.01-2.22)[*]	0.79 (0.43-1.43)
CF + FF	452	298 (65.9)	154 (34.1)	Ref.	Ref.
CBF (12–23months) : Subgroup 3					
BF + FF	12	5 (41.7)	7 (58.3)	1.40 (0.35-5.67)	2.93 (0.27-31.57)
FF	24	12 (50.0)	12 (50.0)	Ref.	Ref.

[α]: Adjusted models controlled for infant age (months), gender, ethnicity, region, maternal age, maternal education level, maternal parity, gestational age, mode of delivery, maternal employment status, probiotic supplement use and complementary feeding indicators (CF rate for children under 6 months old; CF rate and MMFF for children over 6 months old); [*]: $P < 0.05$. BF: breast feeding, CF: complementary feeding, FF: formula feeding, Ref: reference; -: The number of people here is too small to calculate the value.

Except for EBF for the first six months and EIBF within one hour of life, WHO also recommends infants and young children to continue breastfeeding until 2 years of age[39]. And the Global Breastfeeding Collective sets goals to reach 80% and 60% at the ages of 1 and 2, respectively. However, it has been reported that only 41% of Brazilian newborns[40], and 55% of Chinese infants[29] continued breastfeeding at the age of one year; of China, only 9.4% and 12.4% of Chinese children in the middle-west region[29] and Shanghai[21], respectively, continued breastfeeding at the age of two. The results of our investigation showed that the CBF rate of children at 1-year-old and 2-year-old of age were 44.7% and 16.8%, respectively, which are comparable to

the previous results. Furthermore, the continuous breastfeeding rate in our study dropped by roughly half every 6 months as infants aged, from 95% at 6 months to 11.3% at 23 months. We found in the survey that many mothers plan to determine the weaning time due to the stress and inconvenience of working, and others stopped breastfeeding since they didn't have enough breast milk or thought that breast milk wasn't nutritious at the time. Therefore, it is essential to raise awareness of continuing breastfeeding and take measures to promote breast milk secretion to narrow the significant gap to the target in continuing breastfeeding.

In addition to the breastfeeding profile, a positive association between breastfeeding and gastrointestinal health was observed in this study: children who were exclusively breastfed, those who started breastfeeding within 1h after birth, and those who added fluids other than breast milk late (especially after one month) showed fewer gastrointestinal symptoms and lower scores for gastrointestinal symptoms, even in exclusive breastfeeding populations with additional water (see Supplementary Table 6 - 7). Although earlier studies have shown that children who are exclusively breastfed have a lower incidence of diarrhea [41-43], the relationship between breastfeeding and slight discomfort in the gastrointestinal tract has received less attention. Our findings provide new evidence in this field. Breastfeeding supports infant gastrointestinal digestive and immune homeostasis through both immediate and long-term mechanisms [44-46]. The nutrient components of human milk are well-adapted to the infant's digestive system. Bioactive factors, such as secretory immunoglobulin A (sIgA) and lactoferrin, strengthen the intestinal mucosal barrier by preventing pathogen adhesion or exerting antimicrobial effects[47]. Commensal and potential probiotic bacteria in breast milk (e.g., Staphylococcus, Streptococcus, Lactobacillus, and Bifidobacterium) provide persistent stimulation to the infant gut immune system[4]. Human milk oligosaccharides (HMOs) serve as metabolic substrates for beneficial bacteria such as Bifidobacterium, promoting microbial colonization[48]. Breast milk even directly delivers miRNAs to infant intestinal cells via bacterial extracellular vehicles (EVs), modulating gut inflammation, barrier function, and immune development[49]. Early initiation of breastfeeding promotes the secretion and intake of colostrum, which is especially rich in HMOs, immune-active components, growth factors, and leukocytes[49]. The combined effects of immune barrier enhancement, promotion of beneficial bacterial colonization, and intestinal epithelial maturation likely explain the role of EIBF in infant gastrointestinal health[50].

As reported by Huang et al., the two most common functional gastrointestinal diseases (FGID) in Chinese children were baby regurgitation (33.9%) and functional constipation (7.0%)[51]. However, many children who have GI discomfort may exhibit atypical symptoms like vomiting and hard stools or only express them through crying, causing failure to diagnose in time. Therefore, the incidence of GI symptoms (62.1%) in our study was greater than the previously mentioned FGID prevalence. This study found that infants in county areas may exhibit higher GI symptoms and

scores compared to those in district-level urban settings. This disparity could be attributed to better environmental sanitation in urban areas, which reduces pathogen exposure, and greater maternal access to childcare education resources[52]. However, the urban-dominated sample in this survey may have led to an underestimation of the overall incidence of GI symptoms in Chinese infants. Additionally, experience accumulated through pregnancy and childbirth may enhance maternal feeding practices[53], which could explain the negative association observed between higher maternal parity and the likelihood of GI symptoms.

Continuing breastfeeding beyond 6 months of age is also considered beneficial for the GI health of children. According to a 2011 study conducted in the United Kingdom, children who were breastfed for six months or more had fewer gastrointestinal disorders in comparison to non-breastfed infants. And the prevalence of gastrointestinal symptoms decreased in a graded manner between birth and six months as breastfeeding duration increased [54]. In this study, older infants aged 6-11 months receiving CBF were associated with fewer GI symptoms and lower GI symptom scores. These findings align with existing literature[53, 55]. Even after six months, mature human milk continues to provide balanced nutrients and bioactive components that support infant intestinal health. Notably, increasing concentration of certain components (e.g., lysozyme) in human milk compensate for the gradual declining milk volume[56], while the persistent microbial exposure and dynamic compositional changes promote the continuous maturation of the infant gut microbiome and immune system[57]. Many factors other than breastfeeding also are associated with gastrointestinal health, including the introduction of complementary foods and the use of probiotic supplementation. In our study, breastfeeding demonstrated no significant positive association with GI symptoms among infants aged (12-23) months. This may be because of the introduction of complementary foods and the decline of breast milk intake. Further stratification by feeding modalities revealed that in complex feeding scenarios (i.e., concurrent breastfeeding, formula feeding, and complementary foods), the breastfeeding-exposed group exhibited a higher incidence of GI symptoms and GI symptom scores. However, this association became statistically non-significant after adjusting for maternal-infant characteristics and complementary feeding covariates. These findings suggest that the impact of breastfeeding on the gastrointestinal tract in older infants/young children or under complex feeding conditions warrants further investigation.

Taken together, using the data from 10 provinces and cities spread over five regions of China, this study described the numerous aspects of breastfeeding in China and elucidated the connection between breastfeeding and gastrointestinal symptoms through multi-indicator analysis. The findings highlight the importance of breastfeeding for infant health and offer specific directions for breastfeeding health education, such as the problems with prelacteal feeding and feeding additional water while breastfeeding. Future initiatives should prioritize specific educational and policy support measures on the promotion of EBF and EIBF, delaying the introduction of supplemental fluids, and

extending the duration of continued breastfeeding. This includes encouraging breast milk production before delivery, establishing baby-friendly hospitals, providing consultation and training on breastfeeding practices, etc. Furthermore, given that maternal return to work postpartum is the most significant barrier to sustained breastfeeding, which is also confirmed by our study, implementing workplace lactation support programs is imperative to facilitate breastfeeding continuity consequently.

This study also has some limitations. First, the cross-sectional design weakened causal inference between breastfeeding indicators and gastrointestinal outcomes. Further evidence from cohort studies is needed. Second, gastrointestinal symptoms relied on retrospective maternal reports and inherent methodological constraints, including recall bias, reporting bias, and inter-mother variation in symptom interpretation, potentially introducing measurement error. Third, although the sample size was calculated during the design phase to address primary objectives, the results of subgroup analysis may need to be interpreted with caution. Fourth, potential participation bias may exist: participants mainly from urban areas may lead to an underestimation of GI symptom rates, while volunteers willing to participate likely had greater awareness of infant feeding, potentially leading to the EBF rate overestimates.

volunteers willing to participate likely had superior health literacy, greater health education access, and heightened infant feeding awareness, potentially inflating breastfeeding rate estimates. Nevertheless, this feature also reflects the importance of health education for breastfeeding from the side.

5. Conclusion

In conclusion, this study displayed the current breastfeeding status in China and their beneficial association with the gastrointestinal health of infants. A more proactive and all-encompassing strategy for breastfeeding promotion should be implemented to achieve the global goal of breastfeeding and support the health development of children.

Conflicts of interest

All authors declare no conflicts of interest.

Data availability

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

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References

[1] UNICEF, Global breastfeeding scorecard 2023: Rates of breastfeeding increase around the world through improved protection and support, (2023), https://www.unicef.org/documents/global-breastfeeding-scorecard-2023

[2] W.-Z. Malgorzata, K.-E.-H. Ewa, Cells of human breast milk, Cell Mol Biol Lett. 22 (2017) https://doi.org/10.1186/s11658-017-0042-4.

[3] L. Gatien A G, K. Léonce, S. Anne, et al., Human Breast Milk: From Food to Active Immune Response With Disease Protection in Infants and Mothers, Front Immunol. 13 (2022) https://doi.org/10.3389/fimmu.2022.849012.

[4] K. Su Yeong, Y. Dae Yong, Analysis of the human breast milk microbiome and bacterial extracellular vesicles in healthy mothers, Exp Mol Med. 52 (2020) https://doi.org/10.1038/s12276-020-0470-5.

[5] F. Leónides, L. Susana, M. Virginia, et al., The human milk microbiota: origin and potential roles in health and disease, Pharmacol Res. 69 (2012) https://doi.org/10.1016/j.phrs.2012.09.001.

[6] P.-E. Rafael, T. Cecília, H.-C. Sonia, et al., Breastfeeding: crucially important, but increasingly challenged in a market-driven world, Lancet. 401 (2023) https://doi.org/10.1016/s0140-6736(22)01932-8.

[7] R. Rabel Misbah, S. Divyajot, K. Simrat, et al., Association of Maternal Lactation With Diabetes and Hypertension: A Systematic Review and Meta-analysis, JAMA Netw Open. 2 (2019) https://doi.org/10.1001/jamanetworkopen.2019.13401.

[8] W.H. Organization, Joint statement by UNICEF Executive Director and WHO Director-General on the occasion of World Breastfeeding Week, (2023), https://www.who.int/news/item/01-08-2023-joint-statement-by-unicef-executive-director-catherine-russell-and-who-director-general-dr-tedros-adhanom-ghebreyesus-on-the-occasion-of-world-breastfeeding-week

[9] L. Laura M, Z.-G. Irena, F.W. Christa L, et al., Breastfeeding for reducing the risk of pneumonia morbidity and mortality in children under two: a systematic literature review and meta-analysis, BMC Public Health. (2014) https://doi.org/10.1186/1471-2458-13-s3-s18.

[10] H. Sarah, H. Tran T, S. Julie A, et al., Exclusive breast feeding in early infancy reduces the risk of inpatient admission for diarrhea and suspected pneumonia in rural Vietnam: a prospective cohort study, BMC Public Health. 15 (2015) https://doi.org/10.1186/s12889-015-2431-9.

[11] V. Cesar G, B. Rajiv, B. Aluísio J D, et al., Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effect, Lancet. 387,

[12] R. Nigel C, B. Nita, H. Nemat, et al., Why invest, and what it will take to improve breastfeeding practices?, Lancet. 387,

[13] B. Zulfiqar A, L. Miriam, Scaling up breastfeeding in developing countries, Lancet. 378 (2011) https://doi.org/10.1016/s0140-6736(11)60897-0.

[14] W.H. Organization, Short-term effects of breastfeeding: a systematic review on the benefits of breastfeeding on diarrhoea and pneumonia mortality, (2013), https://www.who.int/publications/i/item/9789241506120

[15] I. G, M. R, D.A. D, et al., Gastrointestinal symptoms in infancy: a population-based prospective study, Dig Liver Dis. 37 (2005) https://doi.org/10.1016/j.dld.2005.01.009.

[16] S. Nina F, Z. Judith, S. Elena, et al., Prevalence of Functional Gastrointestinal Disorders in European Infants and Toddlers, J Pediatr. 221 (2020) https://doi.org/10.1016/j.jpeds.2020.02.076.

[17] H. Ying, T. Serene Yaling, P. Panam, et al., Prevalence of functional gastrointestinal disorders in infants and young children in China, BMC Pediatr. 21 (2021) https://doi.org/10.1186/s12887-021-02610-6.

[18] S.J.-R. Ian, G. Rosemary, P. Charlotte, et al., A support package for parents of excessively crying infants: development and feasibility study, Health Technol Assess. 23 (2019) https://doi.org/10.3310/hta23560.

[19] D. Yifan, Y. Zhenyu, L. Jianqiang, et al., Exclusive Breastfeeding Rate and Complementary Feeding Indicators in China: A National Representative Survey in 2013, Nutrients. 10 (2018) https://doi.org/10.3390/nu10020249.

[20] S. Huifeng, Y. Yumei, Y. Xiaohan, et al., Determinants of exclusive breastfeeding for the first six months in China: a cross-sectional study, Int Breastfeed J. 16 (2021) https://doi.org/10.1186/s13006-021-00388-y.

[21] H. Yanhui, W. Lulu, W. Caifeng, et al., Breastfeeding Practices and Associated Factors in Shanghai: A Cross-Sectional Study, Nutrients. 14 (2022) https://doi.org/10.3390/nu14204429.

[22] Z. Qianling, F. Xing Lin, Breastfeeding practices in Northeast China in 2008 and 2018: cross-sectional surveys to explore determinants over a decade, Int Breastfeed J. 18 (2023) https://doi.org/10.1186/s13006-023-00562-4.

[23] N. Phuong Hong, K. Sunny S, T. Lan Mai, et al., Early breastfeeding practices contribute to exclusive breastfeeding in Bangladesh, Vietnam and Ethiopia, Matern Child Nutr. 16 (2020) https://doi.org/10.1111/mcn.13012.

[24] I. Hitomi, K. Mariko, S. Kyoko, et al., Factors influencing exclusive breastfeeding rates until 6 months postpartum: the Japan Environment and Children's Study, Sci Rep. 11 (2021) https://doi.org/10.1038/s41598-021-85900-4.

[25] K. Agho, O. Ezeh, P. Ghimire, et al., Exclusive Breastfeeding Rates and Associated Factors in 13 "Economic Community of West African States" (ECOWAS) Countries, Nutrients. 11 (2019) https://doi.org/10.3390/nu11123007.

[26] R. Anne W, T. Jillian, Y. Manjiang, et al., Validation of a Parent Report Questionnaire: The Infant Gastrointestinal Symptom Questionnaire, Clin Pediatr (Phila). 54 (2015) https://doi.org/10.1177/0009922815574075.

[27] M. Dhami, F. Ogbo, T. Diallo, et al., Infant and Young Child Feeding Practices among Adolescent Mothers and Associated Factors in India, Nutrients. 13 (2021) https://doi.org/10.3390/nu13072376.

[28] F. Naja, N. Hwalla, F. Chokor, et al., Infant and young child feeding practices in Lebanon: a cross-sectional national study, Public health nutrition. 26 (2023) 143-159. https://doi.org/10.1017/s1368980022000842.

[29] S. Guo, X. Fu, R. Scherpbier, et al., Breastfeeding rates in central and western China in 2010: implications for child and population health, Bulletin of the World Health Organization. 91 (2013) 322-331. https://doi.org/10.2471/blt.12.111310.

[30] UNICEF, 3 in 5 babies not breastfed in the first hour of life：Breastfeeding within an hour after birth is critical for saving newborn lives, (2018), https://www.unicef.org/turkiye/en/press-releases/3-5-babies-not-breastfed-first-hour-life#:~:text=NEW%20YORK%2FGENEVA%2C%2031%20July%202018%20%E2%80%93%20An%20estimated,risk%20of%20death%20and%20disease%20and%20making%20them

[31] D. Phukan, M. Ranjan, L. Dwivedi, Impact of timing of breastfeeding initiation on neonatal mortality in India, International breastfeeding journal. 13 (2018) 27. https://doi.org/10.1186/s13006-018-0162-0.

[32] H. Setho, H. Eka Mishbahatul Marah, S. Susy Katikana, et al., Women's Empowerment and Determinants of Early Initiation of Breastfeeding: A Scoping Review, J Pediatr Nurs. 56 (2020) https://doi.org/10.1016/j.pedn.2020.08.004.

[33] P. Archana, B. Anita, K. Amol, Factors associated with prelacteal feeding and timely initiation of breastfeeding in hospital-delivered infants in India, J Hum Lact. 29 (2013) https://doi.org/10.1177/0890334412474718.

[34] D. Michael J, R. S K, S. Upul, et al., Across-country comparisons of selected infant and young child feeding indicators and associated factors in four South Asian countries, Food Nutr Bull. 31 (2010) https://doi.org/10.1177/156482651003100224.

[35] H. Nuru Mohammed, K. Tigabu Hailu, H. Getnet Mamo, Multilevel analysis of early initiation of breastfeeding in Ethiopia, Front Public Health. 12 (2024) https://doi.org/10.3389/fpubh.2024.1393496.

[36] S. Dulal, A. Prost, S. Karki, et al., Feeding, caregiving practices, and developmental delay among children under five in lowland Nepal: a community-based cross-sectional survey, BMC public health. 22 (2022) 1721. https://doi.org/10.1186/s12889-022-13776-8.

[37] R. Pérez-Escamilla, C. Tomori, S. Hernández-Cordero, et al., Breastfeeding: crucially important, but increasingly challenged in a market-driven world, Lancet (London, England). 401 (2023) 472-485. https://doi.org/10.1016/s0140-6736(22)01932-8.

[38] P. Nguyen, S. Kim, L. Tran, et al., Early breastfeeding practices contribute to exclusive breastfeeding in Bangladesh, Vietnam and Ethiopia, Maternal & child nutrition. 16 (2020) e13012. https://doi.org/10.1111/mcn.13012.

[39] W.H. Organization, Indicators for assessing infant and young child feeding practices: definitions and measurement methods, (2021), https://www.who.int/publications/i/item/9789240018389

[40] I. Santos, F. Barros, B. Horta, et al., Breastfeeding exclusivity and duration: trends and inequalities in four population-based birth cohorts in Pelotas, Brazil, 1982-2015, International journal of epidemiology. 48 (2019) i72-i79. https://doi.org/10.1093/ije/dyy159.

[41] S. Hanieh, T. Ha, J. Simpson, et al., Exclusive breast feeding in early infancy reduces the risk of inpatient admission for diarrhea and suspected pneumonia in rural Vietnam: a prospective cohort study, BMC public health. 15 (2015) 1166. https://doi.org/10.1186/s12889-015-2431-9.

[42] M. Quigley, C. Carson, A. Sacker, et al., Exclusive breastfeeding duration and infant infection, European journal of clinical nutrition. 70 (2016) 1420-1427. https://doi.org/10.1038/ejcn.2016.135.

[43] F. Abdulla, M. Hossain, M. Karimuzzaman, et al., Likelihood of infectious diseases due to lack of exclusive breastfeeding among infants in Bangladesh, PloS one. 17 (2022) e0263890. https://doi.org/10.1371/journal.pone.0263890.

[44] L. Carr, M. Virmani, F. Rosa, et al., Role of Human Milk Bioactives on Infants' Gut and Immune Health, Frontiers in immunology. 12 (2021) 604080. https://doi.org/10.3389/fimmu.2021.604080.

[45] G. Okburan, S. Kızıler, Human milk oligosaccharides as prebiotics, Pediatrics and neonatology. 64 (2023) 231-238. https://doi.org/10.1016/j.pedneo.2022.09.017.

[46] E. Davis, V. Castagna, D. Sela, et al., Gut microbiome and breast-feeding: Implications for early immune development, The Journal of allergy and clinical immunology. 150 (2022) 523-534. https://doi.org/10.1016/j.jaci.2022.07.014.

[47] C. Laura E, V. Misty D, R. Fernanda, et al., Role of Human Milk Bioactives on Infants' Gut and Immune Health, Front Immunol. 12 (2021) https://doi.org/10.3389/fimmu.2021.604080.

[48] B. Cassie R, C. Lucy I, Human milk oligosaccharides and Bifidobacterium species, Trends Microbiol. 32 (2023) https://doi.org/10.1016/j.tim.2023.11.015.

[49] K. Yong Joo, Immunomodulatory Effects of Human Colostrum and Milk, Pediatr Gastroenterol Hepatol Nutr. 24 (2021) https://doi.org/10.5223/pghn.2021.24.4.337.

[50] S. Buket, M. Marta Hanna, R. Christoph Hermann, et al., The Mean of Milk: A Review of Human Milk Oligosaccharide Concentrations throughout Lactation, Nutrients. 13 (2021) https://doi.org/10.3390/nu13082737.

[51] Y. Huang, S. Tan, P. Parikh, et al., Prevalence of functional gastrointestinal disorders in infants and young children in China, BMC pediatrics. 21 (2021) 131. https://doi.org/10.1186/s12887-021-02610-6.

[52] P. Ira, R. R, B. Rini, et al., Enteropathogens and Gut Inflammation in Asymptomatic Infants and Children in Different Environments in Southern India, Am J Trop Med Hyg. 98 (2017) https://doi.org/10.4269/ajtmh.17-0324.

[53] S. Elena, S. Silvia, R. Claudio, et al., Prevalence and Risk Factors of Functional Gastrointestinal Disorders: A Cross-Sectional Study in Italian Infants and Young Children, J Pediatr Gastroenterol Nutr. 76 (2023) https://doi.org/10.1097/mpg.0000000000003653.

[54] C. Fisk, S. Crozier, H. Inskip, et al., Breastfeeding and reported morbidity during infancy: findings from the Southampton Women's Survey, Maternal & child nutrition. 7 (2011) 61-70. https://doi.org/10.1111/j.1740-8709.2010.00241.x.

[55] F. Catherine M, C. Sarah R, I. Hazel M, et al., Breastfeeding and reported morbidity during infancy: findings from the Southampton Women's Survey, Matern Child Nutr. 7 (2010) https://doi.org/10.1111/j.1740-8709.2010.00241.x.

[56] F. Anita, O.-P. Magdalena, Breastfeeding Beyond Six Months: Evidence of Child Health Benefits, Nutrients. 16 (2024) https://doi.org/10.3390/nu16223891.

[57] A. Spencer R, L. Larisa C, A. Meghan B, Comparing early life nutritional sources and human milk feeding practices: personalized and dynamic nutrition supports infant gut microbiome development and immune system maturation, Gut Microbes. 15 (2023) https://doi.org/10.1080/19490976.2023.2190305.