



Research paper

Global prevalence of WHO infant feeding practices in 57 LMICs in 2010–2018 and time trends since 2000 for 44 LMICs

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ABSTRACT

Background: The World Health Assembly set a global target of increasing exclusive breastfeeding for infants under 6 months to at least 50% by year 2025. However, little is known about the current status of breastfeeding practice, as well as the trends in breastfeeding practices during recent years. We examined global prevalence of the World Health Organization (WHO) feeding practices in 57 low- and middle-income countries (LMICs) and time trends since 2000 for 44 selected countries.

Methods: We included 57 eligible LMICs that had completed data on breastfeeding and complementary feeding in 2010–2018 from the Demographic and Health Surveys (DHS) for examining current feeding status. We further selected 44 LMICs that had two standard DHS surveys between 2000 and 2009 and 2010–2018 to examine time trends of feeding status. We calculated global, regional, and national weighted prevalence estimates and 95% confidence intervals (CIs) for five breastfeeding indicators and two complementary feeding indicators.

Findings: In 57 LMICs during 2010–2018, global weighted prevalence was 51.9% for early initiation of breastfeeding, 45.7% for exclusive breastfeeding under 6 months, 32.0% for exclusive breastfeeding at 4–5 months, 83.1% for continued breastfeeding at 1 year, 56.2% for continued breastfeeding at 2 years, 14.9% for introduction of solid, semi-solid or soft foods under 6 months, and 63.1% for introduction of solid, semi-solid or soft foods at 6–8 months. Eastern Mediterranean (34.5%) and European regions (43.7%) (vs. South-East Asia/Western Pacific (55.2%)), and upper middle-income countries (38.4%) (vs. lower middle-income countries (47.4%)) had poorer performance of exclusive breastfeeding under 6 months. South-East Asia/Western Pacific regions (51.0%) (vs. other regions (68.3%–84.1%)) and low-income (66.4%) or lower middle-income countries (58.2%) (vs. upper middle-income countries (81.7%)) had lower prevalence of introduction of solid, semi-solid or soft foods at 6–8 months. In 44 selected LMICs from 2000 to 2009 to 2010–2018, total weighted prevalence presented an increase of 10.1% for exclusive breastfeeding under 6 months, but a 1.7% decrease for continued breastfeeding at 1 year. Over this period, the Eastern Mediterranean region had a 5.3% decrease of exclusive breastfeeding under 6 months, and the European region had a 2.0% increase for introduction of solid, semi-solid or soft foods under 6 months. The prevalence of introduction of solid, semi-solid or soft foods at 6–8 months decreased in South-East Asia/Western Pacific region by 15.2%, and in lower middle-income countries by 24.4%.

Interpretation: Breastfeeding practices in LMICs have continued to improve in the past decade globally, but practices still lag behind the WHO feeding recommendations. Breastfeeding practices differed greatly across WHO regions, with the Eastern Mediterranean and European regions, and upper middle-income countries facing the greatest challenges in meeting targets. Continued efforts are needed to achieve the 2025 global breastfeeding target.

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Research in context

Evidence before this study

Breastfeeding benefits both women and children, but the reality is that breastfeeding is not ideal all over the world. Only 37% of infants younger than 6 months were exclusively breastfed in 46 low- and middle-income (LMICs) from 2002 to 2008. The World Health Assembly set a global target of increasing exclusive breastfeeding for infants under 6 months to at least 50% by year 2025. Little is known about the current status of breastfeeding practice globally since 2010, as well as the trends in breastfeeding practices during recent years. Monitoring progress on breastfeeding practices will help promote global feeding strategy and action.

Added value of this study

We examined the current prevalence of WHO feeding practices in 57 LMICs in 2010–2018, and the time trends of the prevalence for 44 LMICs from 2000 to 2009 to 2010–2018, global weighted prevalence was 45.7% for exclusive breastfeeding under 6 months in 57 LMICs during 2010–2018, with a substantial increase of the prevalence from 36.5% in 2000–2009 to 46.6% in 2010–2018 in 44 available LMICs. Breastfeeding practices differed greatly across WHO regions. Eastern Mediterranean, European regions, and upper middle-income countries faced the greatest challenges of meeting the exclusive breastfeeding targets. The Eastern Mediterranean region was the only region with a decline of the prevalence of exclusive breastfeeding under 6 months. South-East Asia/Western Pacific and lower middle-income countries had poorer performance of complementary feeding at 6–8 months.

Implications of all the available evidence

Breastfeeding practices in LMICs have continued to improve in the past decades globally, but practices still lag behind the WHO feeding recommendations. Continued efforts are needed in LMICs to achieve the 2025 global breastfeeding target. Our data for current prevalence and time trends are helpful to mid-term assessment and sustained investment and action for the United Nations Decade of Action on Nutrition 2016–2025.

1. Introduction

Current research evidence has expanded on the known benefits of breastfeeding for young children and women [1]. It is well-established that breastfeeding has both short- and long-term benefits for young children, such as the reduction of diarrhoea and pneumonia incidence, the reduction of future obesity and diabetes risks, and the improvement of intelligence quotient [2–7]. Breastfeeding also has a larger impact on women's health than was previously appreciated, such that policies on improving optimal breastfeeding practice could result in substantial public health gains (such as reduction of the risk of breast cancer, Type 2 diabetes mellitus, hypertension, myocardial infarction) [8]. Breastfeeding should be addressed as a modifiable health behavior to support lifelong health for the mother and child [9].

Released in 2003, the current World Health Organization (WHO) breastfeeding recommendations advocate that babies should be put to the breast within 1 h after birth, be exclusively breastfed for the first 6 months, continue breastfeeding up to two years of age or beyond, and receive complementary foods after the 6 months [10]. In the early stage after the release of the current WHO breastfeeding

recommendations, only 37% of infants under 6 months of age and 18% of infants at 4–5 months of age exclusively breastfed in 46 LMICs from 2002 to 2008 [11,12]. It was estimated that the number of child deaths attributed to suboptimum breastfeeding in 2011 was about 804,000 (accounting for 11.6% of all deaths) [13]. High-income countries had shorter breastfeeding duration than LMICs [12], for example, only approximately 24% of infants under 6 months of age were exclusively breastfed in the United States in 2009–2012 [14].

Optimal infant and young child feeding is the most important investment for good nutrition in the First 1000 Days [15,16]. In 2012, the World Health Assembly passed the Comprehensive Implementation Plan on Maternal, Infant, and Young Child Nutrition, with one of the six WHO global nutrition targets to increase the rate of exclusive breastfeeding under 6 months to at least 50% by year 2025 [17]. The United Nations Decade of Action on Nutrition 2016–2025 established seven potential action-network areas with the fifth action area comprising adequate breastfeeding and complementary feeding [18]. The World Bank in 2017 created an investment framework for nutrition to reach the 2025 global targets for stunting, anemia, breastfeeding, and wasting [19]. Despite efforts to stop the promotion of breast-milk substitutes, laws to protect breastfeeding were inadequate in most countries [20]. Thus, monitoring progress on infant and young child feeding practices will help support and achieve the 2025 global breastfeeding target. However, current breastfeeding practice since 2010 as well as the trends during recent years, is lacking.

In this study, we examined the global prevalence of the WHO feeding practices in 57 LMICs during 2010–2018 and the time trends since 2000 for 44 available LMICs, in order to provide evidence for promoting infant and young child feeding strategy and action.

2. Methods

2.1. Data source and study design

Data were from the Demographic and Health Surveys (DHS), which are large, cross-sectional and nationally representative surveys, on 92 LMICs that are publicly available from the DHS Program website (<https://dhsprogram.com/>) [21]. The overall responsibility for executing a DHS resides with a single implementing agency in each country (e.g., a National Statistical Office, a family planning organization, or the Ministry of Health). For each survey, the DHS uses a two-stage stratified random sampling design to randomly select enumeration areas and households. Primary sampling units (PSU), consisting of neighborhoods or villages, were randomly sampled from a stratum of regions with a probability proportional to population size. Then, households were randomly sampled from the selected PSUs. For every selected household, all women of reproductive age (15–49 years) are eligible for an individual face-to-face interview. To ensure standardization and comparability across countries and over time, interviewers were well-trained and they used standardized questionnaires and measurement tools to collect data. Model questionnaires were translated into local language where the interviews took place. More details regarding the survey can be seen in the DHS document [22]. The surveys used in this study were extracted from the website in February 2020.

This study is reported as per the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline [23]. We examined the current prevalence of WHO feeding practices in available LMICs in 2010–2018, and the time trends of the prevalence for selected countries from 2000 to 2009 to 2010–2018. First, we included 57 eligible LMICs from the DHS datasets that had completed data on breastfeeding and complementary feeding that allowed current prevalence in 2010–2018 to be determined. Second, to monitor and assess time trends of the prevalence from 2000 to 2009 to 2010–2018, we further selected 44 countries from the 57 eligible countries that had at least two standard DHS surveys conducted

between 2000 and 2009 and 2010–2018. Detailed information of the included 57 LMICs is shown in Table S1.

For the 57 LMICs, a total of 318,112 young children aged 0–23 months who lived with their mother and born as the youngest child were included in our analysis. For the 44 available countries, a total of 408,211 young children (140,250 young children in 2000–2009 and 267,961 young children in 2010–2018) were included in our analysis. Fig. 1 provides a flow chart of inclusion/exclusion of DHS surveys and participants.

2.2. Information on collection of feeding data

Information on breastfeeding and complementary feeding practices were collected by face-to-face interview using a structured questionnaire by asking the mother: “Has (baby’s name) ever been breastfed?”, “Was (baby’s name) breastfed yesterday during the day or at night?”, “Did (baby’s name) have any liquids (item from list) yesterday during the day or at night?”, “Did (baby’s name) eat anything (item from list) yesterday during the day or at night, whether at home or outside the home?”, “How long after birth did you first put (baby’s name) to the breast?”, “Did (baby’s name) eat any solid, semi-solid, or soft foods yesterday during the day or at night?”, and “Did (baby’s name) drink anything from a bottle with a nipple yesterday during the day or night?”

2.3. Definition of breastfeeding and complementary feeding indicators

We chose five breastfeeding indicators and two complementary feeding indicators according to the assessment of infant and young child feeding practices by the WHO [24]. Five breastfeeding indicators included: (1) early initiation of breastfeeding (proportion of young children born in the last 24 months who were put to the breast

within 1 h of birth); (2) exclusive breastfeeding under 6 months (proportion of infants aged 0–5 months who received only breast milk during this period); (3) exclusive breastfeeding at 4–5 months (proportion of infants aged 4–5 months who received only breast milk during this period); (4) continued breastfeeding at 1 year (proportion of young children aged 12–15 months who received breast milk at the first one year); and (5) continued breastfeeding at 2 years (proportion of young children aged 20–23 months who received breast milk during this period). Two complementary feeding indicators included: (1) introduction of solid, semi-solid or soft foods under 6 months (proportion of infants aged 0–5 months who receive solid, semi-solid or soft foods during this period); and (2) introduction of solid, semi-solid or soft foods at 6–8 months (proportion of infants aged 6–8 months who receive solid, semi-solid or soft foods during this period).

2.4. Classification of who region and World Bank income

We reported prevalence of breastfeeding and complementary feeding indicators by WHO region and World Bank income group. For the 57 countries, five WHO regions were divided: African (33 countries), Americas (6), Eastern Mediterranean (5), European (4), and South-East Asia/Western Pacific (9); and three World Bank income groups were classified [25]: low-income countries (27 countries), lower middle-income countries (21), and upper middle-income countries (9). Detailed classification for the 57 countries by WHO region and World Bank income is presented in Table S1.

For the 44 selected countries for time trend analysis, five WHO regions were divided: African (26 countries), Americas (5), Eastern Mediterranean (3), European (2), and South-East Asia/Western Pacific (8); and three World Bank income groups were classified: low-income countries (31 countries in 2000–2009 vs.

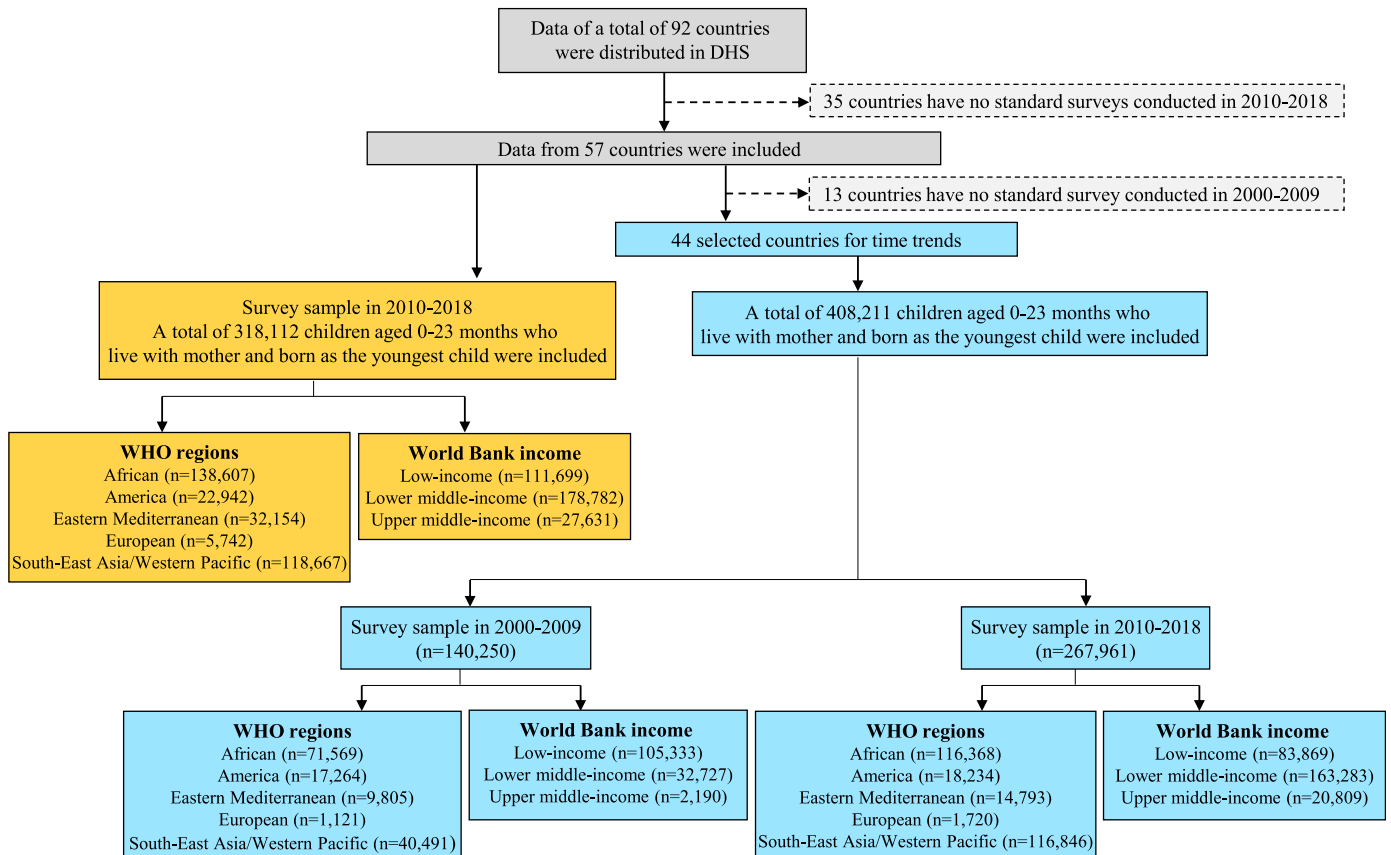


Fig. 1. Flow chart of the sample population contributing to this study.

20 countries in 2010–2018), lower middle-income countries (11 vs. 17), and upper middle-income countries (2 vs. 7). A country may be matched into different World Bank income groups between 2000 and 2009 and 2010–2018 due to its economic development during several or many years. Detailed classification for the 44 selected countries for time trend analysis is presented in Table S1.

2.5. Statistical analysis

We undertook a complete case analysis. Multiple imputation method was not performed because of the heterogeneous study settings. We calculated global, regional, and national weighted prevalence estimates and 95% confidence intervals (CIs) for five breastfeeding indicators and two complementary feeding indicators with consideration of sampling weights, strata and primary sampling unit (PSU) using the SAS PROC SURVEYFREQ procedure performed under SAS version 9.4 (SAS Institute Inc, Cary, North Carolina). Standard sampling weights, cluster, and strata in each survey have been provided by the DHS. The calculation of national weighted prevalence was based on original sampling weights of each survey and *P* for trends between two surveys was calculated by weighted Chi-square test for each country. To calculate the weighted global and regional prevalence in the pooled dataset, sampling weights were rescaled by equal proportional weighting that accounts for arbitrary differences in sample sizes across surveys and reduces the influence of larger survey samples. In consideration of multiple comparisons, for trend test for each breastfeeding indicator between two periods, a two-sided *P*-value of less than 0.0011 (Bonferroni-adjusted alpha level for 44 countries) was considered statistically significant.

2.6. Ethics

The DHS data are de-identified and do not include any protected health information. The data are publicly available and exempt under the ethical board review of the corresponding author's institution. The authors had only access to deidentified data and never had any direct contact with any of the participants in the individual country studies that provided the data.

2.7. Role of the funding source

The source of funding played no role in the study design, data collection, analysis or interpretation, or writing of the paper or the decision to submit the paper for publication.

3. Results

3.1. Prevalence of seven feeding indicators in 57 LMICs, 2010–2018

In 2010–2018, global weighted prevalence was 51.9% (95%CI: 51.6–52.2%) for early initiation of breastfeeding, 45.7% (45.2–46.2%) for exclusive breastfeeding under 6 months, 32.0% (31.3–32.7%) for exclusive breastfeeding at 4–5 months, 83.1% (82.7–83.5%) for continued breastfeeding at 1 year, 56.2% (55.6–56.8%) for continued breastfeeding at 2 years, 14.9% (14.5–15.3%) for introduction of solid, semi-solid or soft foods under 6 months, and 63.1% (62.5–63.7%) for introduction of solid, semi-solid or soft foods at 6–8 months, respectively (Table 1).

Eastern Mediterranean (42.6%) (vs. other regions (47.4%–67.0%)) and lower middle-income countries (47.0%) (vs. upper middle-income (60.2%) or low-income countries (57.4%)) had lower prevalence of early initiation of breastfeeding. Eastern Mediterranean (34.5%) and European regions (43.7%) (vs. South-East Asia/Western Pacific region (55.2%)), and upper middle-income countries (38.4%) (vs. lower middle-income countries (47.4%)) had poorer performance of exclusive breastfeeding under 6 months. South-East Asia/Western Pacific region (51.0%) (vs. other regions (68.3%–84.1%)) and low-income (66.4%) or lower middle-income countries (58.2%) (vs. upper middle-income countries (81.7%)) had lower prevalence of introduction of solid, semi-solid or soft foods at 6–8 months (Table 1).

Fig. 2 displays the national prevalence of exclusive breastfeeding under 6 months and continued breastfeeding at 1 year. We observed substantial between-country differences with only 23 of the 57 countries (40.4%) had the prevalence of exclusively breastfeeding for infants under 6 months of $\geq 50\%$ of a target by year 2025, but the prevalence in some countries (Albania, Philippines, Pakistan, Armenia, Angola, Bangladesh) was less than 15%.

3.2. Trends in the prevalence in 44 selected LMICs, 2000–2009 to 2010–2018

3.2.1. Total trends

In the 44 selected LMICs from 2000 to 2009 to 2010–2018, total weighted prevalence of early initiation of breastfeeding, exclusive breastfeeding under 6 months and at 4–5 months showed an increase of 6.3%, 10.1% and 11.0%, respectively; total weighted prevalence of continued breastfeeding decreased by 1.7% at 1 year but increased by 0.6% at 2 years; total weighted prevalence of introduction of solid, semi-solid or soft foods decreased by 5.9% under 6 months and by 4.2% at 6–8 months (Table S2).

Table 1

Weighted prevalence (95% confidence intervals) of five breastfeeding indicators and two complementary feeding indicators in the 57 LMICs by WHO regions and World Bank income, 2010–2018.

	Early initiation of breastfeeding	Exclusive breastfeeding under 6 months	Exclusive breastfeeding at 4–5 months	Continued breastfeeding at 1 year	Continued breastfeeding at 2 years	Introduction of solid, semi-solid or soft foods under 6 months	Introduction of solid, semi-solid or soft foods at 6–8 months
Global	51.9 (51.6–52.2)	45.7 (45.2–46.2)	32.0 (31.3–32.7)	83.1 (82.7–83.5)	56.2 (55.6–56.8)	14.9 (14.5–15.3)	63.1 (62.5–63.7)
WHO regions							
African	55.8 (55.3–56.3)	41.7 (41.0–42.4)	27.3 (26.4–28.2)	87.2 (86.7–87.7)	50.7 (49.8–51.6)	16.4 (15.8–17.0)	68.5 (67.7–69.3)
Americas	61.2 (60.3–62.1)	43.9 (42.3–45.5)	30.4 (28.1–32.7)	70.4 (68.5–72.3)	40.6 (38.6–42.6)	15.2 (14.0–16.4)	84.1 (82.5–85.7)
Eastern Mediterranean	42.6 (41.4–43.8)	34.5 (33.0–36.0)	22.3 (20.2–24.4)	72.2 (70.5–73.9)	38.7 (36.5–40.9)	17.3 (16.0–18.6)	69.0 (66.8–71.2)
European	67.0 (65.0–69.0)	43.7 (40.5–46.9)	23.5 (19.6–27.4)	66.0 (62.6–69.4)	34.8 (31.2–38.4)	15.1 (12.8–17.4)	68.3 (64.4–72.2)
South-East Asia/Western Pacific	47.4 (46.9–47.9)	55.2 (54.4–56.0)	41.3 (40.0–42.6)	84.8 (84.1–85.5)	69.3 (68.4–70.2)	12.1 (11.5–12.7)	51.0 (49.9–52.1)
World Bank income							
Low-income	57.4 (56.8–58.0)	45.1 (44.3–45.9)	30.1 (29.0–31.2)	87.8 (87.2–88.4)	57.8 (56.8–58.8)	14.7 (14.1–15.3)	66.4 (65.4–67.4)
Lower middle-income	47.0 (46.6–47.4)	47.4 (46.8–48.0)	34.5 (33.5–35.5)	82.7 (82.1–83.3)	58.9 (58.1–59.7)	14.6 (14.1–15.1)	58.2 (57.4–59.0)
Upper middle-income	60.2 (59.2–61.2)	38.4 (36.8–40.0)	24.3 (22.2–26.4)	63.1 (61.3–64.9)	32.0 (30.1–33.9)	17.6 (16.2–19.0)	81.7 (80.0–83.4)

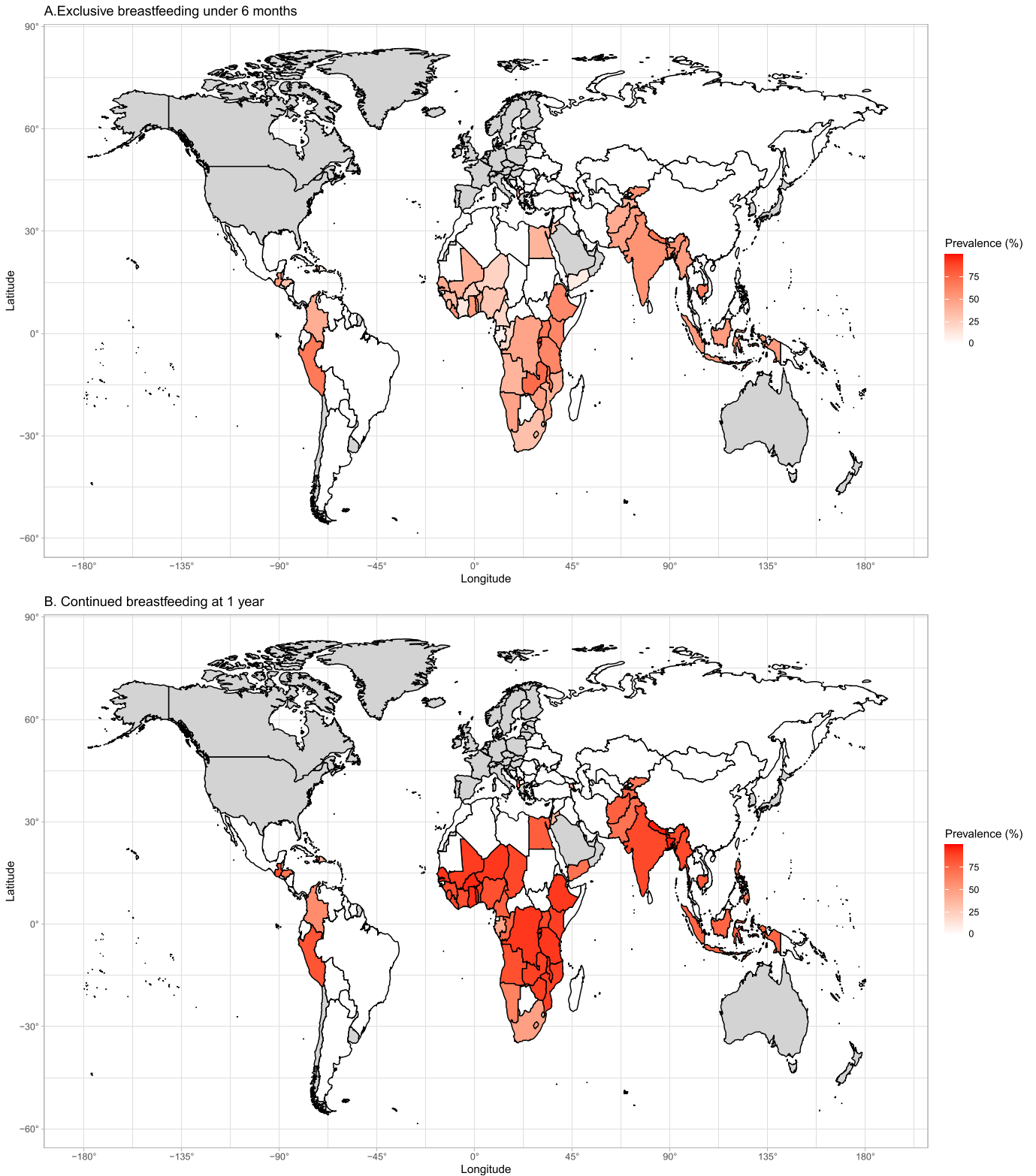


Fig. 2. National prevalence of (A) exclusive breastfeeding under 6 months and (B) continued breastfeeding at 1 year in the 57 LMICs, 2010–2018. Note: The color was light grey for high income countries, and white for LMICs without available data.

3.2.2. Regional trends

The weighted prevalence of exclusive breastfeeding under 6 months showed an increasing trend in African by 8.6%, Americas by 7.3%, European by 6.4%, and South-East Asia/Western Pacific regions by 11.0%, but a downward trend in the Eastern Mediterranean region by 5.3%; and it showed an increase of 7.1% in low-

income, 10.9% in lower middle-income, and 24.1% in upper middle-income countries (Fig. 3 and Table S2). The weighted prevalence of continued breastfeeding at 1 year decreased in the African region by 4.6%, and the Eastern Mediterranean region by 7.7%, but displayed a slight decline in low-income countries by 1.6% (Fig. 3 and Table S2).

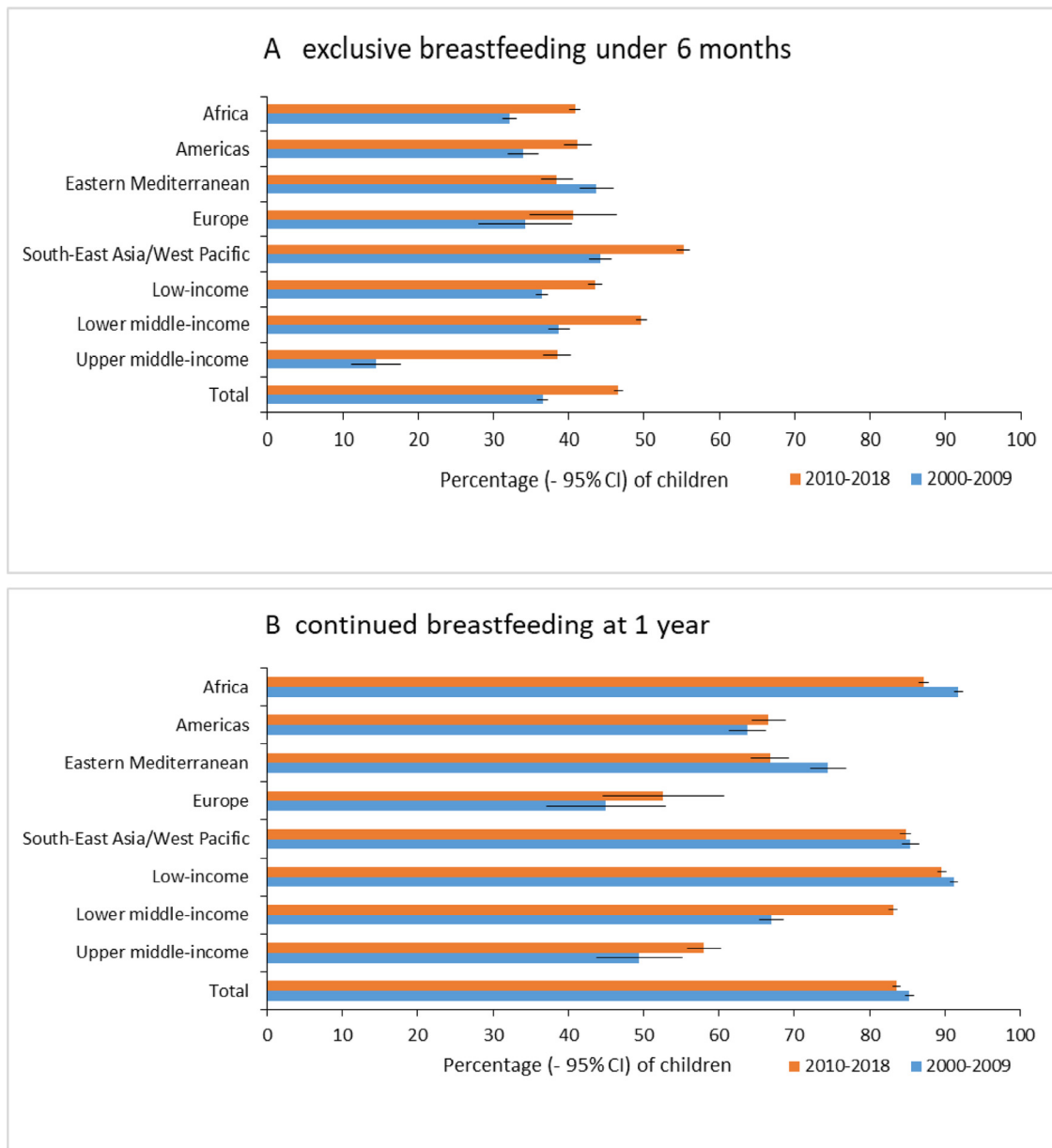


Fig. 3. Trends in regional weighted prevalence of (A) exclusive breastfeeding under 6 months and (B) continued breastfeeding at 1 year in the 44 selected LMICs, by WHO regions and World Bank income, 2000–2009 to 2010–2018.

The weighted prevalence of introduction of solid, semi-solid or soft foods under 6 months decreased in African by 5.7%, Americas by 2.2%, Eastern Mediterranean by 2.6%, South-East Asia/Western Pacific regions by 6.5%, but increased in the European region by 2.0% (Fig. 4 and Table S2); the prevalence at 6–8 months decreased in the South-East Asia/Western Pacific region by 15.2%, and lower middle-income countries by 24.4% (Fig. 4 and Table S2).

3.2.3. National trends

Table S2 shows country-specific prevalence and trends of five breastfeeding indicators and two complementary feeding indicators in 44 selected countries. 12 countries of 44 countries had a downward trend in the prevalence of early initiation of breastfeeding with absolute change/year $< -0.1\%$ and 30 countries had an upward trend with absolute change/year $> 0.1\%$. A downward trend in the prevalence of exclusive breastfeeding under 6 months with absolute change/year $< -0.1\%$ was observed in 6 countries and an upward trend with absolute change/year $> 0.1\%$ in 33 of the 44 countries,

with exclusive breastfeeding at 4–5 months showing a similar trend with exclusive breastfeeding under 6 months. The prevalence of continued breastfeeding at 1 year decreased with absolute change/year $< -0.1\%$ in 27 of the 44 countries and 5 countries had an upward trend with absolute change/year $> 0.1\%$, with continued trends in breastfeeding at 2 years similar to those for continued breastfeeding at 1 year. 31 of the 44 countries had a downward trend in the prevalence of introduction of solid, semi-solid or soft foods under 6 months with the absolute change/year $< -0.1\%$ and 7 countries had an upward trend with the absolute change/year $> 0.1\%$; while the prevalence at 6–8 months increased in 23 of the 44 countries and decreased in 13 of the 44 countries.

4. Discussion

To our knowledge, this is the first study to present recent trends in breastfeeding practices in LMICs from 2000 to 2009 to 2010–2018. Our findings showed that some progress on feeding practices has



Fig. 4. Trends in regional weighted prevalence of (A) introduction of solid, semi-solid or soft foods under 6 months and (B) at 6–8 months in the 44 selected LMICs, by WHO regions and World Bank income, 2000–2009 to 2010–2018.

been made on early initiation of breastfeeding, exclusive breastfeeding under 6 months and introduction of solid, semi-solid or soft foods under 6 months during the period from 2000 to 2009 to 2010–2018. However, we also found a downward trend in both the prevalence of continued breastfeeding at 1 year and introduction of solid, semi-solid or soft foods at 6–8 months. Current feeding practices in LMICs still lag behind WHO recommendations. Eastern Mediterranean, European, and upper middle-income countries were the most distance away from exclusive breastfeeding targets. South-East Asia/Western Pacific and lower middle-income countries have poorer performance of complementary feeding at 6–8 months. In addition, breastfeeding practices show great difference across countries. We are concerned that the 2025 global targets may be disrupted by the COVID-19 pandemic, so we are very supportive of the 2021 Nutrition

for Growth Summit to push maternal and child undernutrition progress [26].

Substantial differences in feeding practices were observed across regions and countries, which may reflect considerable discrepancy in national policy, social culture, maternity services, and maternal education of each country. We observed the lowest prevalence of exclusive breastfeeding under 6 months in the Eastern Mediterranean region in 2010–2018, with the only region showing a decline from 43.7% (95%CI: 41.5–45.9%) in 2000–2009 to 38.4% (36.3–40.5%) in 2010–2018. Multisectoral interventions for possible determinants in this region have been recommended, including the development of effective culture-specific education and communication strategies, and the implementation of national legislation for the International Code of Marketing of Breast-milk Substitutes and relevant World

Health Assembly resolutions [27]. For individual mothers, breastfeeding practices may be influenced by a variety of socio-demographic, socio-cultural and health-related factors, such as maternal employment, maternal perceptions of insufficient breast milk supply, maternal and significant other's beliefs about infant nutrition [28]. Breastfeeding is a major global public health concern, which requires extensive participation and joint efforts of the whole society. Therefore, development of flexible feeding strategies based on national conditions (e.g., national breastfeeding protection and promotion policies, strict application conditions and supervision measures of breast milk substitutes, construction of social and environmental atmosphere suitable for breastfeeding) and surveillance of duration and exclusivity of breastfeeding are suggested for future infant and young child feeding programming.

Being a global feeding recommendation, there is mounting evidence of health benefits in both developed and LMICs of exclusive breastfeeding up to the first 6 months of life [29]. Awareness of breastfeeding should be continuously raised as a double-duty action to prevent under nutrition and overweight/obesity and policy action should be improved to increase breastfeeding [30]. The mid-term review foresight of the United Nations Decade of Action on Nutrition 2016–2025 underlined that counselling on breastfeeding and complementary feeding should be continuously delivered through health systems [31]. Earlier introduction of solid, semi-solid or soft foods may not only lead to exclusive breastfeeding cessation but also a shorter duration of breastfeeding [32]. Although some guidelines recommended introduction of complementary foods between 4 and 5 months for those infants with possible food allergy [33–36], there is no evidence to support the benefits of introduction of complementary foods during this period [37]. Therefore, we propose that future infant and young child feeding guidelines make clear that complementary foods should be introduced at around 6 months of age, and population health risk for introduction timing of complementary foods may need to be reported and assessed in future studies: <4 months for early introduction, 4–5 months for possible risk of early introduction, 6–8 months for (appropriate) timely introduction, and ≥9 months for delayed introduction.

Implementing flexible comprehensive breastfeeding interventions will aid in attaining the 2025 global breastfeeding target. An updated systematic review showed that successful interventions, such as long-duration postpartum intervention, prenatal education, and in-hospital breastfeeding support, can significantly increase the duration of exclusive breastfeeding in high-income countries [38]. Another recent systematic review showed that intervention group infants were more likely to be exclusively breastfed than their control counterparts at 6 months in LMICs [39]. Current effective interventions from LMICs (1) improving counseling skills of health workers, (2) increasing community support, (3) legislation and regulations on marketing of breast-milk substitutes, and (4) paid maternity leave and breast-feeding breaks for working mothers [40], might be useful to improve and further develop future feeding intervention programs for more LMICs.

Our study has several strengths. First, we included as many countries as possible (57 LMICs) that had standard DHS surveys from 2010 onward to obtain more representative current global and regional prevalence. Second, we selected 44 countries from the 57 LMICs that also had two standard DHS surveys during the period of 2000–2009 and 2010–2018 for trend analysis. Third, we assessed regional prevalence and time trends by both WHO region and World Bank income group. However, our study also had limitations. First, global and regional weighted prevalence was calculated based on only the 57 LMICs (time trends based on only the 44 selected countries) rather than all LMICs. We did not use mixed data sources in order to reduce potential bias. Second, Breastfeeding rates per se is not the only important issue, other factors such as the quality of breast milk and complementary foods is of importance that was not included in this

study. Third, breastfeeding histories were self-reported by mothers and are prone to recall bias. Fourth, we focused on the feeding prevalence in global, regional and national level, but there may be some disparity between rural and urban areas in an individual country. A structured questionnaire, strictly trained investigators, standardized interviews were recommended to the participating countries or regions to faithfully obtain information on breastfeeding and complementary foods.

Overall, breastfeeding practice in LMICs has continued to improve in the past decade, but there is still a big gap compared with WHO feeding recommendations. Breastfeeding practices differed greatly across WHO regions, with LMICs in the Eastern Mediterranean and European regions, and upper middle-income countries facing the greatest challenges of meeting the targets. The Eastern Mediterranean region was the only region with a decline of the prevalence of exclusive breastfeeding under 6 months. South-East Asia/Western Pacific and lower middle-income countries had poorer performance of complementary feeding at 6–8 months. Our data suggest that continued efforts are still needed in LMICs to achieve the 2025 global breastfeeding target.

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Data sharing

Data were from the Demographic and Health Surveys (DHS), which are large, cross-sectional and nationally representative surveys, on 92 LMICs that are publicly available from the DHS Program website (<https://dhsprogram.com/>). We have received the permission from the DHS Program after submitting a research plan regarding this study.

Declaration of Competing Interest

The authors have declared that no competing interests exist.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:[10.1016/j.eclinm.2021.100971](https://doi.org/10.1016/j.eclinm.2021.100971).

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