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Review Article

Systematic review of infant and young child complementary feeding practices in South Asian families: the India perspective

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Abstract

Objective: Suboptimal nutrition among children remains a problem among South Asian (SA) families. Appropriate complementary feeding (CF) practices can greatly reduce this risk. Thus, we undertook a systematic review of studies assessing CF (timing, dietary diversity, meal frequency and influencing factors) in children aged <2 years in India.

Design: Searches between January 2000 and June 2016 in MEDLINE, EMBASE, Global Health, Web of Science, OVID Maternity & Infant Care, CINAHL, Cochrane Library, BanglaJOL, POPLINE and WHO Global Health Library. Eligibility criteria: primary research on CF practices in SA children aged 0–2 years and/or their families. Search terms: 'children', 'feeding' and 'Asians' and derivatives. Two researchers undertook study selection, data extraction and quality appraisal (EPPI-Centre Weight of Evidence).

Results: From 45 712 abstracts screened, sixty-four cross-sectional, seven cohort, one qualitative and one case–control studies were included. Despite adopting the WHO Infant and Young Child Feeding guidelines, suboptimal CF practices were found in all studies. In twenty-nine of fifty-nine studies, CF was introduced between 6 and 9 months, with eight studies finding minimum dietary diversity was achieved in 6–33 %, and ten of seventeen studies noting minimum meal frequency in only 25–50 % of the study populations. Influencing factors included cultural influences, poor knowledge on appropriate CF practices and parental educational status.

Conclusions: This is the first systematic review to evaluate CF practices in SA in India. Campaigns to change health and nutrition behaviour and revision of nationwide child health nutrition programmes are needed to meet the substantial unmet needs of these children.

Keywords
Infant
Child
Nutrition
Complementary feeding
India

Undernutrition including stunting and suboptimal breast-feeding accounts for 45 % of all childhood deaths[1]. It is estimated that 30 % of the world's stunted children live in Asia, with more than 60 million living in India; 31 % of the developing world's total[1,2]. Inadequate complementary feeding (CF) has been linked to these outcomes.

The WHO defines CF as: 'The process starting when breast milk alone is no longer sufficient to meet the nutritional requirements of infants, and therefore other foods and liquids are needed, along with breast milk'[3]. CF therefore focuses on bridging the gradual transition between 6 and 24 months from exclusive breast-feeding to solid foods eaten by the whole family alongside breast-feeding.

Poor complementary feeding practices (CFP) have been linked to increased risks of respiratory and gastrointestinal infections, underweight and mortality[4–6]. CF is also important for reducing stunting, which is a current policy priority in India[7–9]. Despite this, in two published non-systematic reviews on CFP in India, Ramji and Engle noted that CF was often started at inappropriate times[10,11].

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There was also inappropriate quantities and diversity of complementary foods, with only 55 % of South Asian (SA) infants consuming appropriate complementary foods by 6–8 months of age and growth retardation notable by 2 years of age[12,13].

In policy, there has been recent increasing focus on CF. The 2010 WHO Infant and Young Child Feeding (IYCF) guidelines, an internationally ratified framework adopted in India, emphasize as a global public health recommendation that infants should be exclusively breast-fed for the first 6 months of life to achieve optimal growth, development and health[14]. Thereafter, infants should receive safe and nutritionally adequate complementary foods while breast-feeding continues for up to 2 years of age or beyond.

With no previously published systematic review identified, we aimed to assess the adequacy of CFP based on IYCF recommended criteria for minimum dietary diversity, meal frequency and timing of CF introduction. We also aimed to investigate barriers and promoters for appropriate CFP in SA children under 2 years old. By doing so, we hope to inform future work in developing and assessing the effectiveness of culturally appropriate interventions to improve CFP across these communities.

To limit the scope of our review, we focused on SA families residing in India, Pakistan, Bangladesh and high-income countries.

Methods

Due to the vast number of publications identified, the present review (PROSPERO registration number CRD42014014025) summarizes publications on CFP in SA families in India only, with concurrent reviews summarizing publications on CFP in SA families in high-income countries (L Manikam, R Lingam, I Lever *et al.*, unpublished results), Pakistan[15] and Bangladesh[16], respectively. High-income countries were included to investigate any differences in practice for SA who may have emigrated.

Eligibility criteria

Studies were included if they met the following criteria.

- Participants: children aged 0–2 years, parents, carers and/or their families.
- Outcomes: adequacy of CF (based on minimum dietary diversity and meal frequency), timing of introduction of CF and barriers/promoters to incorporating WHO recommended CFP.
- Language: studies published in English, or with translation available.
- Year: published from 2000 or later.

We excluded studies focusing solely on exclusive breast-feeding and interventional studies. Studies focusing on subgroups, such as children with co-morbidities, were considered eligible in principle.

In the IYCF indicators, introduction of CF is assessed as the proportion of infants aged 6–8 months who receive solid, semi-solid or soft foods. In contrast, minimum dietary diversity (MDD) is assessed by the proportion of children 6–23 months of age who receive foods from four or more food groups. The seven WHO IYCF recommended food groups are[14]:

1. grains, roots and tubers;
2. legumes and nuts;
3. dairy products (e.g. milk, yoghurt, cheese);
4. flesh foods (e.g. meat, fish, poultry and liver/organ meats);
5. eggs;
6. vitamin A-rich fruits and vegetables; and
7. other fruits and vegetables.

While the consumption of Fe-rich or Fe-fortified foods is commonly assessed as a separate IYCF indicator, this was incorporated within dietary diversity for ease of interpretation in the current review.

Finally, minimum meal frequency (MMF) is assessed by the proportion of breast-fed and non-breast-fed children 6–23 months of age who receive solid, semi-solid or soft foods (also including milk feeds for non-breast-fed children) the minimum number of times or more per day: two times for 6–8 months, three times for 9–23 months and four times for 6–23 months (if not breast-fed).

Due to the nature of the topic, all study types (qualitative, quantitative or mixed) were included to ensure the diversity of evidence was captured and summarized, to be of relevance to both policy makers and health and social care professionals.

Information sources

A search strategy was devised to search the following databases: MEDLINE, BanglaJOL, EMBASE, CINAHL, Global Health, Web of Science, OVID Maternity & Infant Care, The Cochrane Library, POPLINE and WHO Global Health Library. The WHO ICTRP (International Clinical Trials Registry Platform) was also searched. Searches were conducted in December 2014 and updated in June 2016.

Members of electronic networks on @jiscmail.ac.uk including minority-ethnic-health and networks (e.g. South Asian Health Foundation) developed from the Specialist Electronic Library for Ethnicity and Health were contacted to request any additional or unpublished material from members of the networks. We sought information specialist assistance to attempt to acquire unpublished material from each paper itself, and contacted study authors where possible. Bibliographies of included articles were also hand-searched for possible additional publications.

Search strategy

The search strategy included terms for 'feeding', 'South Asian' (including terms specifying all major subgroups) and 'children'. For example, the search strings used for MEDLINE were the following.

Term 1: children <2 years

Infant OR Baby OR Babies OR Toddler OR Newborn OR Neonat* OR Child OR Preschool OR Nursery school OR Kid OR Pediatri* OR Minors OR Boy OR Girl

Term 2: feeding

Nutritional Physiological Phenomena OR Food OR Feeding behavior OR Feed OR Nutrition OR Wean OR fortif* OR Milk

Term 3: Asians

Ethni* OR India* OR Pakista* OR Banglades* OR Sri Lanka OR Islam OR Hinduism OR Muslim OR Indian subcontinent OR South Asia

Study selection and data extraction

In total, 45 712 titles and abstracts were screened against inclusion criteria. Two reviewers assessed these papers independently, with conflicts resolved by discussion with the team. In view of the large number of articles deemed eligible for full-text review, articles published before the year 2000 were excluded. In total, 44 852 titles and abstracts were excluded.

This left 860 potentially eligible full-text articles describing CFP in SA children, which were independently reviewed by two reviewers. One hundred and thirty-one full-text articles were ultimately extracted, of which seventy-three were relevant to India, seventeen were relevant to Pakistan, thirty-six were relevant to Bangladesh and ten were relevant to high-income countries.

Data were extracted by a single reviewer using a piloted modified worksheet including: country of study; study type; study year; study objectives; population studied, eligibility criteria and illness diagnosis; study design; ethical approval; sampling; data collection and analysis; feeding behaviours; adequacy of CFP; timing of initiation of CF; bias; value of the research; and weight of evidence. A second member of the research team checked each extraction, with further checking taking place as necessary.

Result synthesis

The eligible studies tended to address very broad research questions, were conducted using qualitative and/or quantitative and/or descriptive methods, and were not presented following standardized reporting guidelines (e.g. STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) for observational studies or COREQ (Consolidated Criteria for Reporting Qualitative Research) for qualitative research). Meta-analyses were therefore not undertaken.

To standardize study classifications, the formal definitions below were utilized and applied[17,18].

1. Intervention study: a study in which patients are assigned to a treatment or comparison group and followed prospectively.
2. Cohort study: an observational study in which a group of patients are followed over time. These may be prospective or retrospective.
3. Cross-sectional study: an observational study that examines the relationship between health-related characteristics and other variables of interest in a defined population at one particular time.
4. Case–control study: a study that compares patients who have a disease or outcome of interest (cases) with patients who do not have the disease or outcome (controls).
5. Qualitative: a study which aims to explore the experiences or opinions of families through interviews, focus groups, reflective field notes and other non-quantitative approaches.
6. Mixed methods: a study that combines both quantitative and qualitative methodology.

In view of the considerable heterogeneity among the studies identified in terms of methods, participants, interventions and outcomes, a narrative approach to synthesis was utilized using guidance developed from the University of York Centre for Reviews and Dissemination (CRD) and the Economic and Social Research Council (ESRC)[19–22].

The evidence reviewed is presented as a narrative report, with results broadly categorized following IYFP indicators on: (i) adequacy of CFP, comprising dietary diversity, meal frequency, timing of introduction of CFP, consumption of Fe-rich foods and sources of advice for feeding; and (ii) barriers/promoters influencing CFP.

Barriers were defined as obstacles or impediments to achieving correct CFP[23], while promoters were defined as supporters to achieving correct CFP[24]. These were sub-categorized into factors influencing at the family level (e.g. family members) and the organizational level (e.g. health-care providers, hospitals, political bodies).

Quality assurance

The CRD guidance emphasizes the importance of using a structured approach to quality assessment when assessing descriptive or qualitative studies for inclusion in reviews. However, it acknowledges the lack of consensus on the definition of poor quality with some arguing that using rigid quality criteria leads to the unnecessary exclusion of papers[19].

In our review, the EPPI-Centre Weight of Evidence Framework was used to allow objective judgements about each study's value in answering the review question. It examines three study aspects: quality of methodology, relevance of methodology and relevance of evidence to the review question, and categorizes them into 'low' (L), 'medium' (M) or 'high' (H)[25]. An average of these weightings is taken to establish the study's overall weight of evidence (WOE), also rated as L, M or H. Two independent reviewers performed this evaluation, with

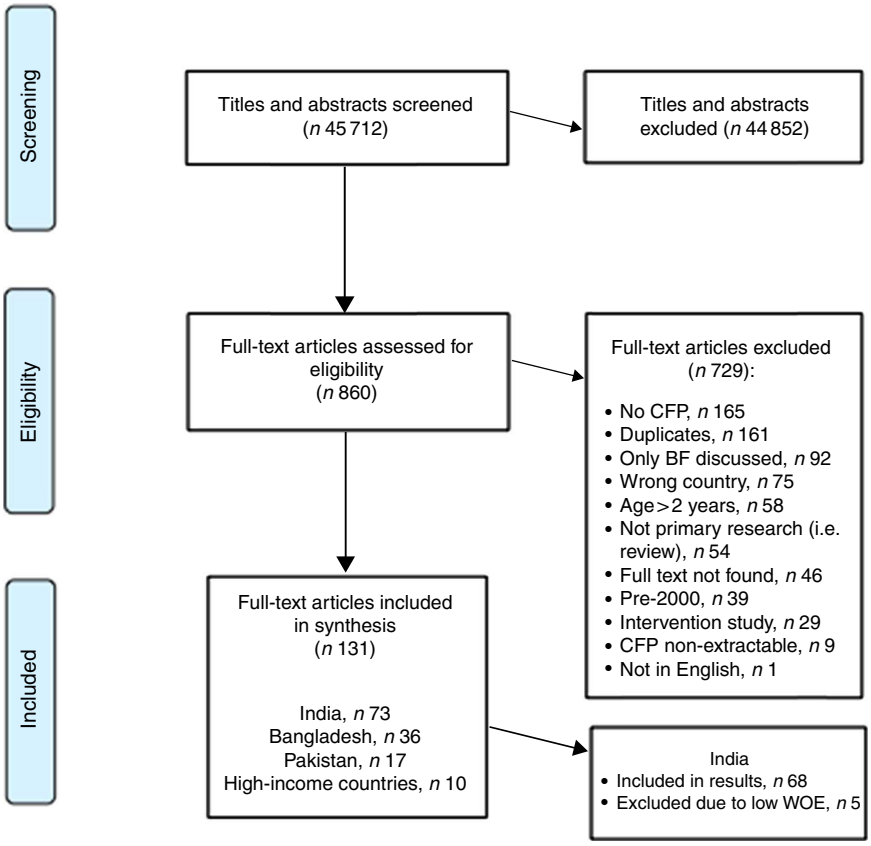

Fig. 1 Study selection process for the current systematic review (CFP, complementary feeding practices; BF, breast-feeding; WOE, weight of evidence)

additional arbitration by other team members where required. Studies with an overall WOE = L are included in the table summarizing included studies but are not discussed further within the 'Results' or 'Discussion' section below.

Results

Of the 45 712 studies identified, seventy-three studies focusing on CFP in SA families in India were ultimately included in the current systematic review. The study selection process is denoted in Fig. 1.

Study and participant characteristics

These seventy-three studies consisted of sixty-four cross-sectional, seven cohort, one qualitative and one case–control. Sixty-eight studies met Weight of Evidence criteria and were included in the main results. Their participants included a total of 125 326 children and 5705 mothers or caregivers when infants were not reported. Twenty-one studies reported details of the religion of participants, which was Hindu majority in nineteen samples and Muslim majority in two samples.

Table 1 summarizes all included studies. Figure 2 illustrates the study locations of sixty-three of these seventy-three included studies; the remaining nine do not detail precise study locations due to being described as 'national', 'various', 'urban' or 'rural' without specifics. Table 1 contains further details of study locations.

Table 2 presents the Weight of Evidence awarded to each of the studies. Thirteen studies had an overall WOE rating of H, fifty-five studies an overall WOE rating of M, and five studies had an overall WOE rating of L.

The core narrative themes extracted from the papers are presented under the following headings: (i) adequacy of CFP and (ii) factors influencing CFP. The former is categorized further into dietary diversity, meal frequency, timing of introducing CF and advice providers.

Adequacy of complementary feeding

As per the WHO IYCF indicators, adequacy of CFP is assessed according to dietary diversity, meal frequency and timing of introducing CFP. These are detailed in the subsections below with a further subsection discussing advice providers.

Dietary diversity

Dietary diversity was measured in some form in fourteen studies. Rates of achieved MDD varied throughout studies but were generally low, with MDD achieved by between 6 and 33 % of infants in eight studies that reported this

Table 1 Summary of studies included in the current systematic review

Study	Study type	Location	Population	Sample size	Adequacy of and factors influencing CFP
Aggarwal *et al.* (2008)[57]	Cross-sectional	Delhi, India	Mothers of infants 6 months to 2 years old attending outpatient paediatric hospital	200	Frequency: Frequency of complementary feeds was less than recommended in about 75 % of children Factors: Maternal and paternal education, lack of knowledge regarding CF, child vomiting, advice from family elders Timing: 34 % started up to 1 year
Aguayo *et al.* (2016)[50]	Cross-sectional	Maharashtra, India	Children under 23 months old	2561	Diversity: 6 % of 6–23-month-olds were fed 4+ food groups Frequency: 77 % of 6–23-month-olds met MMF. When sick, many children (up to 75 %) see their complementary foods restricted in frequency Factors: Poor sanitation, mother's nutrition status, poverty Timing: 59 % of 6–8-month-olds had CFP introduced
Aruldas *et al.* (2010)[26]	Cross-sectional	Rural India	Children aged 0–23 months	4472	Diversity: 30 % were fed at least three types of food as recommended Frequency: 63 % of children aged 6–23 months were given the minimum recommended number of feeds in a day Factors: 56 % of mothers commenced CF before 6 months of age because they felt that their breast milk was not sufficient for the child. Other factors include high standard of living, education, media exposure and ANC check-ups Timing: 46 % at 7–9 months
Bagul and Supare (2012)[66]	Cross-sectional	Urban slum of Nagpur, Maharashtra, India	Children under 1 year old	384	Factors: Literacy Timing: 51 % under 6 months
Bahuguna *et al.* (2013)[98]	Case–control	Uttar Pradesh, India	Children aged 1–18 years	800	Diversity: Milk, sweets, fruits were eaten, but this was not broken down by age
Bentley *et al.* (2015)[27]	Cross-sectional	Informal settlements, Mumbai, India	Children under 5 years	7450	Diversity: Dietary diversity was limited (13 %) Frequency: MMF was met by less than half of infants Timing: 41 % commenced at 6–8 months
Bhandari *et al.* (2002)[49]	Cross-sectional	Delhi, India	Children aged 12–23 months	395	Factors: Education Timing: Animal milk given at mean age of 3 months
Bhanderi and Choudhary (2011)[64]	Cross-sectional	Petlad town, a semi-urban area of Anand district, Gujarat, India	Children under 5 years old	300	Diversity: Rice, *daal*, curd, butter milk, ice creams, fruits Factors: Educated mothers were more receptive to the message of proper weaning passed to them during antenatal visits. Other factors include maternal education, place of delivery and sociocultural beliefs Timing: 52 % at 4–6 months
Caleyachetty *et al.* (2013)[63]	Cohort	Mysore city or surrounding rural villages, India	Mothers attending the ANC of the Holdsworth Memorial Hospital	830	Factors: Hindu mothers commenced CF later *v.* Islam or 'other' religions. Other factors include higher education and lower socio-economic status Timing: 38 % at 4 months, 27 % at 5 months
Chandwani *et al.* (2015)[28]	Cross-sectional	Rural Health Training Centre at Dabhoda, Gujarat, India	Children 0–24 months old	300	Diversity: 28·3 % were given food from four or more groups Frequency: MMF was adequate in 95·6 % Timing: 60 % at 6 months
Chhabra and Gupta (2015)[87]	Cross-sectional	Urbanized village of East Delhi, India	Children aged 0–23 months	194	Factors: Wealth and gender of infant, born in government institution Timing: 6–9 months for 54 %
Chhabra *et al.* (2010)[53]	Cross-sectional	Ludhiana, India	Children under 12 months old	204	Diversity: *Dal* soup, juice, tea, *kheer*, banana, *khichri* all used Factors: Mothers believing size was a more important indicator than age Timing: Less than 3 months
Collison *et al.* (2015)[55]	Cross-sectional	One urban and one rural community in Samastipur district, Bihar, India	Children preterm to 18 months old	60	Diversity: Eggs, meat, fish, fruits, vegetables were used Frequency: Mothers 'generally' feed infants two or three times each day Factors: Urban and rural status affected feeding practices
D'Alimonte *et al.* (2016)[35]	Cross-sectional	Slum, Dharavi, Mumbai, India	Mothers of children under 3 years old	22	Diversity: Listed 7 IYCF groups. Gave MDD details stratified by positive deviance. MDD achieved by majority at 6 months Factors: Advice sources included female elders, relatives, community health workers, the media Timing: Positive deviants mostly around 6 months
Dahiya and Sehgal (2002)[86]	Cross-sectional	Haryana, India	Mothers of children aged 6–18 months	100	Diversity: *Khichri*, *dalia*, rice, *kheer*, fruit and vegetables were used Factors: Only a few mothers belonging to high socio-economic status give ready-made foods to their infants Timing: Working mothers started before 6 months, non-working mothers after

Table 1 *Continued*

Study	Study type	Location	Population	Sample size	Adequacy of and factors influencing CFP
Dakshayani and Gangadhar (2008)[99]	Cross-sectional	Karnataka, India	Mothers of children aged 0–60 months	125	Factors: The practice of giving the infants some special type of feeds before initiating breast milk is widespread in tribal areas Timing: 48 % at 6–9 months
Damayanthi *et al.* (2013)[72]	Cross-sectional	Bangalore, India	Mothers of children under 24 months	300	Factors: Earlier initiation when literate Timing: 70 % at 3–6 months
de Onis (2006)[34]	Cross-sectional	India	Children aged 0–24 months	8440	Diversity: MDD at different ages among compliant Indian children was: 2·8 foods at 6 months, 4·1 at 9 months, 4·6 at 12 months, 4·9 at 18 months, 5·1 at 24 months Frequency: Frequency was around a mean of 2 non-milk meals per day among compliant children in India at 5 months, rising to 2·8 at 6 months, 4 at 8 months, 4·9 at 12 months, 5·4 at 18 months and 5·5 at 24 months Timing: Mean timing was 5 months
Dibley *et al.* (2010)[91]	Cross-sectional	29 unnamed states in India	Last-born children aged 0 to 23 months living with the respondent	20 108	Factors: Antenatal visits, media, living North, East or South Timing: 57 % timely CF rate
Fall *et al.* (2010)[100]	Cohort	Brazil/Guatemala/ India/Philippines/ South Africa; New Delhi in India	Babies born to women in an area of Delhi	1526	Timing: 42 % at 9–12 months
Farzani and Devi (2011)[68]	Cross-sectional	Parbhani district, India	Mothers of children aged 3–18 months	130	Diversity: Cow's milk, honey, castor oil, *dhal*, fruit and vegetables Factors: Literacy and maternal education Timing: 52 % at 3–6 months
Fazilli *et al.* (2011)[40]	Cross-sectional	Kashmir, India	Multiparous women attending the ANC of the maternity hospital of Sheri Kashmir Institute of Medical Sciences	585	Diversity: Cereals, fruits, banana were used Factors: Many harmful infant feeding practices still hold ground in the community, having their roots in cultural influences and lack of knowledge regarding CFP timing Timing: 38 % at 6–12 months, 32 % at 6 months
Garg and Chadha (2009)[36]	Cross-sectional	Six villages of Ghaziabad district, Uttar Pradesh, India	Mothers of children aged 6–12 months	151	Diversity: 31 and 18 % of the mothers of the 6–8- and 9–12-month-old infants reported feeding ≥3 and ≥4 food groups, respectively, to their infants in the preceding 24 h. Mothers used starchy staples, legumes, milk eggs, others Frequency: 60 % of the mothers fed their infants the recommended number of meals in the previous 24 h Factors: Wealth led to better practices. More children led to worse parity. Other factors include socio-economic factors and maternal education
Goswami *et al.* (2012)[76]	Cross-sectional	5 villages of the Nuapadhi Gram Panchayat, Remuna block of Balasore district of Orissa, India	Mothers of children aged 0–60 months	121	Timing: 61 % initiate at 6–9 months
Holambe and Thakur (2014)[101]	Cross-sectional	Maharashtra, India	Mothers attending immunization OPD with their infants (age of baby <12 months)	197	Factors: Maternal age, education, siblings Timing: 46 % started CF at appropriate age
Jayant *et al.* (2010)[67]	Cross-sectional	Loni, India	Mothers of children aged 0–5 years attending immunization clinic and paediatric OPD	300	Diversity: Milk and water mentioned Factors: Knowledge and support, education on CFP timing Timing: 42 % at 6–8 months
Jindal (2009)[102]	Cross-sectional	Mangalore, India	Mothers of infants aged 6–12 months during their visits at the OPD of two hospitals	104	Diversity: Fruit juice and *ragi* porridge Factors: Early, inadequate expressing. Late = child refusing to eat Timing: Majority weaned before 6 months with fruit juice
Kapur *et al.* (2005)[43]	Cross-sectional	Urban slum, Delhi, India	Children 9–36 months of age, in an urban slum Integrated Child Development Services project	545	Diversity: Cereals, pulses, flesh foods, milk, vegetables, others mentioned Factors: Gender of child

Table 1 *Continued*

Study	Study type	Location	Population	Sample size	Adequacy of and factors influencing CFP
Katara *et al.* (2013)[37]	Cross-sectional	Urban slums, India	Children aged 6–24 months	561	Diversity: 64·7 % were given an appropriate number of food groups. Cereals, pulses, fruits/vegetables, milk mentioned Frequency: 25 % of children were receiving adequate frequency of CF and its association with gender was significant Factors: Parents thinking their child is too old for breast milk after 6 months, high birth order, gender, maternal literacy, young mothers Timing: 60·5 % after 6 months
Khan *et al.* (2012)[33]	Cross-sectional	Urban health centres of the Department of Community Medicine of UCMS, East Delhi, India	Children less 24 months old who were attending an immunization clinic	374	Diversity: MDD was observed in 32·6 % of the children aged 6–23 months Frequency: MMF was observed in 48·6 % of the children
Kumar *et al.* (2006)[103]	Cross-sectional	4 *anganwari* areas of urban Allahbad, Uttar Pradesh, India	Children aged under 60 months	217	Diversity: WHO recommended food was used Factors: Knowledge Timing: 48 % practised CF during 6–9 months
Kumar *et al.* (2013)[46]	Cross-sectional	Rural Tumkur, India	Lactating mothers	110	Diversity: *Ragi sari*, biscuits, Cerelac, cow's milk, Farex, goat's milk Frequency: 46 % given weaning food twice daily and 31 % once daily Factors: Rural areas
Kuriakose (2010)[59]	Cross-sectional	Karnataka, India	Randomly selected infants from Karnataka	112	Frequency: 47 % given CF four times daily Factors: Number of children inversely proportional to quality of CFP, educational status of mother improved Timing: 31 % started CF at 4 months
Lingam *et al.* (2014)[52]	Qualitative	Rural Rajasthan, India	Children aged 0–24 months	87	Diversity: Cerelac, porridge, biscuits, *roti*, milk, rice, almonds, lentils were used Factors: Lack of advice, poor families Timing: Often a delay until 7–12 months of age
Lohia and Udipi (2014)[39]	Cohort	6 urban slums in 3 western suburbs, Mumbai, India	Children aged 6–24 months	446	Diversity: Scores provided by age, IYCF groups measured Frequency: Over half of males (54·8 %) <12 months of age had a higher feeding frequency score *v.* one-third of females (32·7 %) at the same age Factors: Maternal education, male child, age, BMI of mother
Malhotra (2013)[38]	Cross-sectional	India – national	Children aged 6–18 months	9241	Diversity: MDD at 6–8 months 3 %, at 9–11 months 9 %, at 12–18 months 17 % Frequency: MMF at 6–8 months 25 %, at 9–11 months 39 %, at 12–18 months 54 % Factors: Illness, siblings, health-care professionals' advice, media, mother working from home Timing: 63 % had commenced weaning by 6–8 months
Mayuri *et al.* (2012)[79]	Cross-sectional	India–four zones	Infants from eight centres from different states across four zones (North, East, South and West) in India	800	Diversity: Milk, biscuits, fennel seeds, cardamom, cereals Factors: Perception of insufficient milk, being tired after labour, convenience and as per elders' advice
Menon *et al.* (2015)[29]	Cross-sectional	India–national	Children 0–24 months old	18 463	Diversity: Grains, legumes, eggs, meat, fish. 16 % of 6–23-month-olds met MDD Frequency: 45 % met MMF Factors: Education, delaying age of marriage, poverty, illiteracy Timing: 58 % used CF before 6 months
Meshram *et al.* (2012)[42]	Cross-sectional	Andhra Pradesh, India	Child–mother pairs were included using systematic random sampling	805	Diversity: Cow/buffalo milk, home-made semi-solid foods e.g. cereals Frequency: 95 % received CF three times daily Factors: Timely initiation was more likely among certain castes and tribes Timing: Classified as 6–9 months
Meshram *et al.* (2013)[69]	Cross-sectional	Rural Madhya Pradesh, India	Children under 1 year old	5457	Factors: Caste, literacy, wealth Timing: 50 % at 6–8 months
Mukhopadhyay *et al.* (2013)[30]	Cross-sectional	2 slums, West Bengal, India	Children aged 0–23 months from 2 slums via two-stage random sampling technique	245	Diversity: MDD was 24·4 % Frequency: Age-appropriate MMF was found in 67·0 % children Timing: 12 % were before 6 months

Table 1 *Continued*

Study	Study type	Location	Population	Sample size	Adequacy of and factors influencing CFP
Narayanappa *et al.* (2015)[54]	Cross-sectional	Rural Karnataka, India	Children 9–10 months old	957	Diversity: *Janam ghutti*, peanuts, Cerelac, animal milk, biscuits, rice with lentils, others Factors: Education on how to maintain sufficient breast milk production and appropriate age for weaning Timing: 66 % before 6 months
Neog and Baruah (2012)[41]	Cross-sectional	Jorhat district, Assam, India	Children aged 1- 12 months	120	Diversity: Milk, *dal*, rice, Cerelac, banana, *luthri*, *khichri*, cooked rice Factors: Community norms, education Timing: 26 % given CF early
Padhy and Choudhury (2004)[78]	Cross-sectional	Orissa, India	Mothers of children under 12 months	131	Factors: Poverty, tradition, knowledge Timing: 63 % between 3 and 6 months
Padmadas *et al.* (2002)[62]	Cross-sectional	6 regions of India	Children 24–47 months	6285	Factors: Later start in Central and East (except West Bengal) India, maternal education Timing: 53·5 % weaned at <6 months
Pasricha *et al.* (2011)[44]	Cross-sectional	2 rural districts of Karnataka, India	Children aged 12–23 months	396	Diversity: *Idli* and *dosa* with rice and lentils, *sambar*, rice, *ragi* Factors: Poverty and food insecurity increase breast-feeding
Passi and Shad (2004)[104]	Cross-sectional	Tea garden in Assam, India	Children aged 0–12 months	110	Factors: Poverty and illiteracy Timing: Commenced by 9–10 months for 56 %
Patel *et al.* (2012)[31]	Cross-sectional	India – national	Last-born children aged 6–23 months	15 028	Diversity: Among children aged 6–23 months, MDD rate was 15·2 %. Foods included potatoes, bread, noodles, milk, flesh foods, chicken, grains, roots, tubers Frequency: When sick, many children (up to 75 %) see their complementary foods restricted in frequency. 41·5 % of 6–23-month-olds met MMF Factors: North and West India had higher odds of suffering from poor CFP; education, antenatal care Timing: 55 % aged 6–8 months were introduced to solid foods
Pathi *et al.* (2003)[73]	Cross-sectional	Rural block of Orissa, India	Children aged under 1 year	383	Factors: Lack of awareness regarding proper weaning practices, education Timing: 36 % at 8–12 months
Rangaswamy *et al.* (2013)[45]	Cross-sectional	Nagavalli in Tumkur, India	Children under 1 year of age	110	Diversity: Biscuits, Cerelac, cow's milk, Farex, *ragi* porridge, rice, *dhal*, others Factors: Elderly family members were prominent influencers in decision when to add CF Timing: 46 % at 4–6 months
Rao *et al.* (2011)[80]	Cross-sectional	Mangalore, India	Mothers of children aged 6–24 months	200	Diversity: *Ragi*, wheat and rice Factors: Number of children inversely proportional to quality of CFP. Education, birth location Timing: 78 % had started CF at recommended time
Rasania and Sachdev (2001)[58]	Cross-sectional	Mehrauli, Delhi, India	Children aged under 5 years old	354	Diversity: Top milk was given Frequency: 46 % received 5–8 meals/d Factors: Education Timing: Weaning times ranged from before 4 months to after 12 months
Roy *et al.* (2009)[56]	Cross-sectional	Urban health centre, Chetla, Kolkata, India	Children aged 6–24 months	121	Diversity: Rice, *dal*, mashed potato, *suji* Factors: Health facility, guardian and peer groups Timing: 71·7 % at 6 months
Samuel *et al.* (2012)[51]	Cohort	Bangalore, India	Mothers of children aged 0–6 months	50	Diversity: Commercial cereal and milk, biscuits, mixed-grain porridges, rice and lentil cakes, others Factors: Reasons for the early introduction of CF included a crying infant, employment, elders Timing: 64 % by 6 months
Sanjeev and Anuradha (2012)[70]	Cross-sectional	Delhi, India	Children under 6 years	462	Factors: Lack of education Timing: Majority started before 6 months or after 8 months
Saxena and Kumar (2014)[61]	Cross-sectional	Doiwala block, Dehradun, India	Mothers of children under 24 months	336	Diversity: Egg, vegetarian food Frequency: 31 % more than 3 times/d Factors: Employment and lack of expressing, lack of knowledge, vomiting, child cries Timing: 13 % delayed, 25 % early
Saxena and Kumari (2014)[77]	Cross-sectional	Doiwala block, India	ASHA who consented to participate and had a child	168	Diversity: Cow's milk, water, sugar, honey Factors: Insufficient mother's milk (55·4 %), caesarean section (20·2 %), coercion from elders in the family to start top milk, led to cessation of exclusive breast-feeding Timing: Early for 55 %

Table 1 *Continued*

Study	Study type	Location	Population	Sample size	Adequacy of and factors influencing CFP
Senarath *et al.* (2012)[32]	Cross-sectional	Bangladesh/Nepal/ India/Sri Lanka/ Pakistan	Children aged between 6 and 23 months old	15 028	Diversity: MDD for 6–23-month-olds was 15·2 % Frequency: MMF was 41·5 % Factors: Lack of maternal education and lower household wealth, limited exposure to media, inadequate antenatal care and lack of postnatal contacts by health workers Timing: 6–8 months for 55 %
Shahrawat and Joon (2013)[105]	Cross-sectional	Delhi, India	Children aged 0–24 months	5	Diversity: Grains, pulses, milk, fish, fruits Factors: Better access to advice from health-care professionals
Sharan *et al.* (2001)[47]	Cross-sectional	Bangalore, India	Farming women were randomly selected	306	Diversity: *Ragi sari*, rice with *daal* and *ghee*, vegetables, commercial baby food Factors: Subsequent pregnancy, insufficient milk, child deemed old enough to wean
Sharma and Sharma (2003)[82]	Cross-sectional	Baijnath block of Kangra district of Himachal Pradesh, India	Mothers of children under the age of 2 years	100	Diversity: *Kheer*, *dalia*, *dal*, *khichri*, rice, fruits, vegetables, others Factors: Knowledge, traditions, health status of mother, sanitation, education Timing: 70 % by 4–6 months
Shroff *et al.* (2011)[74]	Cross-sectional	Andhra Pradesh, India	Mothers of children aged 3–15 months	600	Factors: Autonomy of mother, tradition Timing: 24·9 % were taking foods or liquids other than breast milk at 3–5 months
Singh and Vaidya (2015)[106]	Cross-sectional	Abalpur district of Madhya Pradesh, India	Children aged 6 months to 3 years	300	Diversity: Cereals, pulses, millets, *khichadi chawal*, *kudai bhat*, *latchaka*, *rejgeera ladoo* Factors: Working mothers were more likely to introduce complementary foods earlier than non-working mothers
Sinha and Pandey 2000[83]	Cross-sectional	Bihar, India	Mothers of children under 72 months	200	Diversity: *Mandi*, papaya, potatoes, rice, *dhal*, fish and fowl, rice Factors: Lack of knowledge of mothers and health workers was a barrier to appropriate CF
Sinhababu *et al.* (2010)[84]	Cross-sectional	Bankura town, West Bengal, India	Children aged 0–23 months	647	Factors: Insufficient knowledge, inappropriate practices Timing: 56 % by 6–8 months
Sreedhara and Banapurmath (2014)[65]	Cross-sectional	Urban slum community of central Karnataka, India	Infants aged 9–12 months	100	Frequency: 29 % were given CF feeds less than 3 times/d Timing: 55 % between 7–9 months
Subbiah and Jeganathan (2012)[81]	Cross-sectional	Delhi, India	Postnatal mothers who had a normal delivery	405	Diversity: Sugar water and honey Factors: Mothers need more support and information about breast-feeding and optimal times to begin CF
Tyagi and Bhan (2009)[75]	Cross-sectional	Hisar, India	Mothers of children aged 0–60 months	380	Factors: Maternal employment, lack of milk
Veena *et al.* (2010)[88]	Cohort	Mysore, India	Mothers who delivered babies at the Holdsworth Memorial Hospital	514	Factors: Familial socio-economic status, maternal education, primiparity Timing: Majority started at or after 4 months
Verma and Gupta (2015)[71]	Cohort	Uttar Pradesh, India	Children aged below 9 months; vast majority were under 6 months	186	Diversity: Animal milk, cow's milk, porridge Timing: Evidence of commencement at 3–6 months
Vyas *et al.* (2014)[48]	Cross-sectional	Uttarakhand, India	Mothers with children within 3 years of age were included	500	Diversity: Rice water (*mand*), coarse grains, *jhingora*, barley, maize, pulses, *gahat*, fruits, nuts Factors: Lack of advice-seeking, cultural influences, education, socio-economic factors Timing: 52 % after 6 months
Yasmin (2008)[60]	Cross-sectional	6 different villages of Chandaulia district, Uttar Pradesh, India	Mothers of children 0–9 months	120	Diversity: Carrots, pumpkin, cauliflower, spinach, milk, buttermilk, potato, rice, pulses, porridge, *kheer*, banana Frequency: 90 % at 6–9 months Factors: Perception of poor-quality breast milk Timing: 60 % at <3 months
Yousafzai *et al.* (2003)[85]	Cohort	Mumbai, India	Carers of disabled and non-disabled child	41	Factors: Erroneous belief that a disability is curable takes the focus away from nutrition and its importance for the well-being of children with disabilities. Unaffordability of food

CFP, complementary feeding practices; ANC, antenatal clinic; OPD, outpatient department; ASHA, Accredited Social Health Activist; CF, complementary feeding; MMF, minimum meal frequency; IYCF, infant and young child feeding; MDD, minimum dietary diversity.

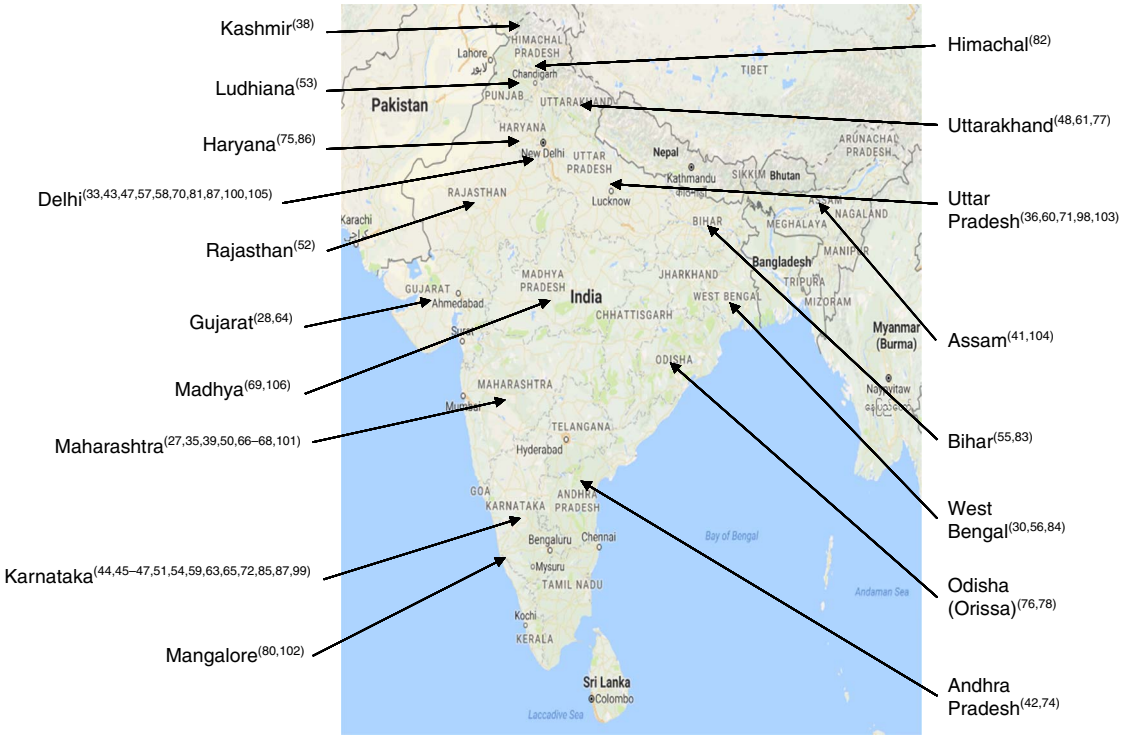

Fig. 2 (colour online) Location map of sixty-three studies included in the current systematic review (map courtesy of Google Maps; data © 2017 Google)

outcome for 6–23-month-olds[26–33]. In de Onis (WOE = M), infants were fed a mean of 2·8 food groups at 6 months, rising to 5·1 at 24 months[34]. Five other studies reported some information on diversity[35–39].

Table 3 denotes a summary of all complementary food groups identified from the studies, categorized according to the WHO IYCF food groups defined above. Foods utilized for CF were identified in fifty-three included studies, of which nine had overall WOE = H and forty-four had overall WOE = M.

Thirty-one studies identified 'grains, roots and tubers' being used for CFP. Legumes and nuts were used in twenty-nine, and twenty-six studies identified 'dairy products' (e.g. milk, cheese, yoghurt) being used. In contrast, 'eggs' were identified in twelve studies, 'flesh foods' (e.g. meat, fish, poultry and liver/organ meats)' in ten studies, 'vitamin A-rich fruits and vegetables' in eight studies and 'other fruits and vegetables' in twenty-two studies.

Bentley *et al.* (WOE = H) found that grains were consumed by 63·8 % of infants in the past 24 h[27]. In Fazilli *et al.* (WOE = M), Neog and Baruah (WOE = M) and Meshram *et al.* (WOE = H), cereals were also widely used[40–42]. In Katara *et al.* (WOE = M), cereals were the most frequently used food group, by 96 % of infants[37]. In contrast, in Kapur *et al.* (WOE = M) cereal intake in an urban slum in Delhi was noted as grossly inadequate[43]. *Ragi*, a traditional Indian grain, was identified in four studies as a common cereal type utilized in South India[44–47].

The use of 'other fruits and vegetables', namely fruits and vegetables not specified as vitamin A-rich, varied across India, from 95·4 % among study populations in rural Andhra Pradesh to 1·45 % in Uttarakhand when given alone[42,48]. Interestingly, in Garg and Chadha (WOE = M) in rural India, fruits and vegetables were excluded from an infant's diet despite being part of the family diet due to beliefs that infants could not tolerate spice-cooked fruits and vegetables[36]. In Vyas *et al.* (WOE = M), seasonal fruits such as guava and citrus were introduced before the addition of staples (e.g. cereals, rice), with gross undernutrition noted in the study population[48].

In the WHO Multicentre Growth Reference Study, less than 11 % of children were noted to consume flesh foods[34]. In an affluent Delhi district, Bhandari *et al.* (WOE = M) found that only 2·4 % of infants consumed non-vegetarian foods despite 57·5 % of their families being non-vegetarian[49]. Consumption of Fe-rich or Fe-fortified foods (e.g. flesh foods) was poorly reported. Kapur *et al.* (WOE = M) found that children consumed only 46 % of the RDA for Fe in their diets, and Pashricha *et al.* (WOE = M) found that delayed CF increased the risk of low dietary Fe intake[43,44]. Bentley *et al.* (WOE = H) found that 15 % of 6–23-month-olds consumed Fe-rich foods, which is similar to the 12·1 % reported by Aguayo *et al.* (WOE = H)[27,50].

Regarding commercial complementary foods, Sharan *et al.* (WOE = M) and Samuel *et al.* (WOE = H) noted use of commercial foods[47,51]. Cerelac was the most frequently mentioned commercial food[41,46,52–54]. Additionally, Ananda Kumar *et al.* (WOE = M), Lingam *et al.* (WOE = H) and Chhabra *et al.* (WOE = M) mentioned Farex, and Narayanappa *et al.* mentioned Nestum[46,52–54].

Table 2 Weight of evidence awarded to each study in the current systematic review

Study	Weight of Evidence A	Weight of Evidence B	Weight of Evidence C	Weight of Evidence D
	Quality of methodology (accuracy, coherency and transparency of evidence)	Relevance of methodology (appropriateness of the methodology for answering the review question)	Relevance of evidence to the review question (relevance of the focus of the evidence for answering the review question)	Overall weight of evidence (overall assessment of the extent to which the study provides evidence to answer the review question)
Aggarwal *et al.*[57]	L	M	M	M
Aguayo *et al.*[50]	H	H	H	H
Aruldas *et al.*[26]	H	H	H	H
Bagul and Supare[66]	M	M	M	M
Bahuguna *et al.*[98]	M	M	L	L
Bentley *et al.*[27]	H	M	M	H
Bhandari *et al.*[49]	H	M	L	M
Bhanderi and Choudhary[64]	L	M	M	M
Caleyachetty *et al.*[63]	H	M	M	M
Chandwani *et al.*[28]	M	M	M	M
Chhabra and Gupta[87]	M	M	M	M
Chhabra *et al.*[53]	L	M	H	M
Collison *et al.*[55]	H	M	M	H
D'Alimonte *et al.*[35]	H	M	M	M
Dahiya and Sehgal[86]	L	M	M	M
Dakshayani and Gangadhar[99]	L	M	M	M
Damayanthi *et al.*[72]	M	M	M	M
de Onis[34]	M	H	M	M
Dibley *et al.*[91]	H	H	M	H
Fall *et al.*[100]	M	H	H	M
Farzana and Devi[68]	M	M	M	M
Fazilli *et al.*[40]	M	M	M	M
Garg and Chadha[36]	M	M	M	M
Goswami *et al.*[76]	M	M	M	M
Holambe and Thakur[101]	M	H	H	M
Jayant *et al.*[67]	M	M	M	M
Jindal[102]	L	M	L	L
Kapur *et al.*[43]	M	M	M	M
Katara *et al.*[37]	M	M	M	M
Khan *et al.*[33]	M	M	M	M
Kumar *et al.*[103]	M	M	L	L
Kumar *et al.*[46]	L	M	M	M
Kuriakose[59]	L	M	M	M
Lingam *et al.*[52]	H	M	H	H
Lohia and Udipi[39]	M	M	M	M
Malhotra[38]	H	M	M	M
Mayuri *et al.*[79]	H	M	M	M
Menon *et al.*[29]	H	M	M	M
Meshram *et al.*[42]	H	M	H	H
Meshram *et al.*[69]	M	M	L	M
Mukhopadhyay *et al.*[30]	M	L	M	M
Narayanappa *et al.*[54]	H	H	H	H
Neog and Baruah[41]	L	M	M	M
Padhy and Choudhury[78]	M	M	M	M
Padmadas *et al.*[62]	H	M	L	M
Pasricha *et al.*[44]	H	M	M	M
Passi and Shad[104]	L	M	L	L
Patel *et al.*[31]	H	H	H	H
Pathi *et al.*[73]	L	M	M	M
Rangaswamy *et al.*[45]	M	M	H	M
Rao *et al.*[80]	M	H	H	H
Rasania and Sachdev[58]	H	H	H	H
Roy *et al.*[56]	M	M	M	M
Samuel *et al.*[51]	H	H	H	H
Sanjeev and Anuradha[70]	M	M	M	M
Saxena and Kumar[61]	M	M	M	M
Saxena and Kumari[77]	M	M	H	M
Senarath *et al.*[32]	H	H	M	H
Shahrawat and Joon[105]	M	L	M	L
Sharan *et al.*[47]	M	M	M	M
Sharma and Sharma[82]	M	M	M	M
Shroff *et al.*[74]	M	M	L	M
Singh and Vaidya[106]	M	M	H	M
Sinha and Pandey[83]	L	M	M	M
Sinhababu *et al.*[84]	M	M	M	M
Sreedhara and Banapurmath[65]	L	M	M	M
Subbiah and Jeganathan[81]	M	M	M	M
Tyagi and Bhan[75]	M	M	L	M
Veena *et al.*[88]	M	M	M	M
Verma and Gupta[71]	H	M	M	M
Vyas *et al.*[48]	M	M	M	M
Yasmin[60]	M	M	M	M
Yousafzai *et al.*[85]	M	H	L	M

L, low; M, medium; H, high.

Table 3 Foods utilized for complementary feeding in India, categorized into WHO food groups

WHO classified food groups	Number of studies and references
Grains, roots and tubers	Thirty-one studies[26–29,31,34,36,37,40,42,43,45–48,50,52–54,56,60,64,68,71,79,80,82–84,86,106]
Legumes and nuts	Twenty-nine studies[26–29,31,34,37,40,43,45–48,50,52–54,56,60,64,68,69,79,80,82–84,86,106]
Dairy products (e.g. milk, cheese, yoghurt)	Twenty-six studies[26–28,31,34,36,37,41–43,45–47,49,50,53,54,60,64,68,71,77,79,82,84,86]
Flesh foods (e.g. meat, fish, poultry and liver/organ meats)	Eleven studies[26–29,34,43,49,50,54,55,83]
Other fruits and vegetables	Twenty-two studies[26–28,31,33,36,37,40,41,43,47–50,53–55,60,64,68,83,86]
Vitamin A-rich fruits and vegetables (e.g. pumpkin)	Eight studies[27,28,31,33,42,50,60,61]
Eggs	Twelve studies[26–29,31,34,36,49,50,54,55,61]

Chhabra *et al.* also mentioned Nutramul[53]. In Sharan *et al.* only 15 % of infants were given commercial complementary food, with use concentrated among the highest socio-economic group[47], in keeping with Lingam *et al.* (WOE = H) who noted higher utilization rates in urban compared with rural areas[52].

Generally, micronutrient intake was not discussed in the included studies. In Pasricha *et al.* (WOE = M), 66 % of children were found to be deficient in at least one micronutrient, with micronutrient deficiencies particularly common in those who breast-fed longer[44]. The high use of grains and legumes by included infants may be beneficial, as Menon *et al.* found that intakes of these foods were associated with positive anthropometric outcomes relative to higher-nutrient foods like eggs or flesh foods[29].

Meal frequency

Meal frequency was explored in twenty-one studies[26,27,30,31,33,34,36–39,42,46,50,51,55–61]. In ten studies, MMF was attained by between 25 and 50 % of the study population[27,31,33,37,38,46,57–59,61]. In contrast, between 50 and 96 % of the population achieved MMF in seven studies[26,30,36,39,42,50,60]. Seven included studies had overall WOE = H and fourteen had overall WOE = M.

Senarath *et al.* (WOE = H) noted that the rate of MMF was 42 % in children aged 6–23 months[32]. Patel *et al.* (WOE = H) and Khan *et al.* (WOE = M) observed MMF in 41·5 and 48·6 % of children, respectively[31,33]. In contrast, Chandwani *et al.* (WOE = M) noted that 96 % of breast-fed children were fed at least the minimum number of times recommended[28].

Malhotra (WOE = M) noted a correlation between education and meal frequency in infants aged 9–18 months[38]. Finally, Lohia and Udipi (WOE = M) noted that male infants tended to have a higher feeding frequency than female infants[39].

Timing of introducing complementary feeding

Table 4 denotes a summary of timing when CF was most commonly introduced across the fifty-nine included studies that investigated timing. The most common age for the introduction of CF was between 6 and 9 months (twenty-nine studies), followed by 3 to 6 months (twenty-two studies). Four studies noted that CF was started between 9 and 12 months for the majority of infants, while one study noted that CF was started at an age younger than 3 months for most infants. Twelve studies had overall WOE = H and forty-seven had overall WOE = M.

CF was noted to be delayed among children particularly in central and eastern India[62]. Inappropriate timing of initiation of CF was noted in both urban and rural regions of India, with timely CF achieved by as low as 3·5 % and as late as over 1 year of age[47,49,56,63]. In ten out of fifteen studies in urban areas, the majority of children started CF at 6–9 months[27,33,37,50,53,55,56,65,80,84]. Eight out of eighteen studies in rural areas noted that CF started during 6–9 months of age[26,28,42,48,52,61,67,69], and seven out of eighteen noted that CF initiated at 3–6 months[45,54,63,68,71,72,74].

In addition, Yasmin (WOE = M) noted that CF was initiated as early as 1 week[60]. However, in Mukhopadhyay *et al.* (WOE = M), CF timing was noted to be inappropriately early in 12·5 % of the study population in West Bengal slums[30]. Similar findings were also noted in Goswami *et al.* (WOE = M), where only 13·2 % of the infants were introduced to CF at the age of 4–6 months[76], and in Roy *et al.* (WOE = M) in an urban slum in Kolkata where 72 % of infants were given CF at 6 months[56].

Sources of advice for feeding

Twenty-seven studies described advice providers for CFP, of which nine had overall WOE = H and eighteen had overall WOE = M. The commonest source of feeding advice were health-care professionals, including doctors, auxillary nurse midwives, lady health visitors and *anganwadi* health workers, usually at antenatal visits or during immunizations (twenty-one studies[26,35,38,45,46,50,51,53–57,60,61,64,66,68,77–80]). The next most common source of advice was a family member, usually the grandmother or mother-in-law (eleven studies[26,35,45,46,48,52,54,55,60,67,81]), with nine further studies specifically mentioning elders[35,40,42,45,51,61,66,77,79]. Further sources of feeding advice were the media (four studies[31,35,38,45]) and friends (three studies[45,56,60]).

Factors associated with complementary feeding practices

We identified numerous factors that influenced CFP. These are summarized in Table 5 as either a barrier or a promoter, and sub-categorized as acting at either family or organizational level. Due to conflicting study findings,

Table 4 Timing of introduction of complementary feeding in India

Infant age	Number of studies and references
<3 months	One study[60]
3–6 months	Twenty-two studies[29,34,45,46,49,51,54,58,59,62–64,66,68,71,72,77,78,82,86,88,106]
6–9 months	Twenty-nine studies[26–28,30–33,35,37,38,40–42,48,50,52,53,56,65,67,69,76,80,84,86,87,91,99,101]
9–12 months	Four studies[40,57,73,100]
>12 months	Zero studies

factors may appear as both a barrier and a promoter. Twenty-four promoters and thirty barriers influencing CFP were identified. Promoters and barriers were further divided into factors influencing at the family and organizational level. In total, fifty-five studies identified factors associated with CF practices, of which twelve had overall WOE = H and forty-three had overall WOE = M.

Barriers

Thirty-five studies identified barriers at the organizational level. Barriers were: cultural influences, employment, food insecurity, gender, inadequate antenatal care, lack of knowledge on optimal CFP, lack of media exposure, lack of parental education, location: Northern India and West India, focus on disability, low literacy, poor sanitation, poverty, birth in a public hospital and price of food. The most commonly cited barrier at the organizational level was cultural influences[40,41,45,48,51,53,55,57,61,64,74,77–79,82]. Infant feeding practices in India appear to be strongly influenced by elderly women such as the mother-in-law[48,67].

Thirty-one studies identified barriers at the family level. Barriers were: caesarean section, child's age, concern about weight gain, crying infant, difficulty feeding child, inadequate breast milk production, lack of support, maternal age, maternal nutrition status, mothers from joint families, recent illness, religion, siblings, subsequent pregnancy and primiparity. The most commonly cited barriers at the family level were lack of knowledge on optimal CFP[26,40,48,53,61,67,77,81–85] and inadequate breast milk production[45,47,54,60,61,75,77].

Promoters

Thirty-two studies identified promoters at the organizational level. Promoters were: advice from a health-care professional, birth within a government institute, certain caste or tribe, education of parent, effective antenatal care, family support, Hindu mothers, literacy status of mother, location: north-eastern, southern or western, media exposure, social support group, socio-economic status, support system at work and wealth. The most commonly cited promoters at the organizational level were education of parent[26,29,31,36,39,41,42,44,48,63,64,68,73], literacy status of mother[37,66,68,72,80,86] and wealth[26,36,52,87,88].

Twelve studies identified promoters at the family level. Promoters were: acknowledged importance of maternal health, advice seeking, autonomy of mother, BMI of mother, delivery with doctor present, high birth order, knowledge of optimal CFP, mother who works from home, older age at marriage and valuing nutrition. The most commonly cited promoter at the family level was knowledge of optimal CF[35,56,67,78].

Discussion

To our knowledge, the present is the first systematic review to assess CFP in India. We identified that in many SA families in India, WHO IYCF standards on minimum dietary diversity, meal frequency and timing of introducing CF were not being met.

Implications of key findings

Legumes, rice, wheat and cereals appear to be the mainstay of complementary foods in Southern India. While this is in keeping with other low- and middle-income countries, these foods have low nutrient density and mineral bioavailability, and the use of other food groups is essential to satisfy the nutrient and mineral requirements of infants[89]. Consumption of dietary Fe was infrequently mentioned except in the context of flesh foods, and was inadequate, considering that Fe has such an important role in infant health[43,44].

Dietary diversity was found to be inadequate in almost all groups studied, with MDD achieved in only 6 to 33 % of 6–23-month-olds. Some have argued for use of media sources to influence this, with further research and interventions needed[39].

It was found that MMF was not met by the majority of the populations sampled. Educational interventions may be useful to improve MMF going forward; Collison *et al.* found that frequency of feeds increased when families were given a feeding toolkit[55]. In a previous review, educational interventions were also shown to be effective[90]. Further research is required to uncover why MMF is so rarely met by caregivers.

The majority of studies found that CF was started during months 6–9 of life, with most studies noting limited maternal awareness on recommended CFP. By improving antenatal care and education on caring for an infant alongside decreasing barriers faced by mothers when restarting employment, optimal timing of CF may improve. Mass communication using ICT and mobile apps is a strategy that has been advocated by the Ministry of Women and Child Development[92], and could be used to disseminate information on this topic.

Table 5 Factors influencing complementary feeding practices (CFP) in India

Family level			
Promoters	Number of studies and references	Barriers	Number of studies and references
Knowledge of optimal CFP	Four studies[35,56,67,78]	Lack of knowledge of optimal CFP	Twelve studies[26,40,48,53,61,67,77,81–85]
Autonomy of mother	Two studies[74,82]	Inadequate breast milk production	Seven studies[45,47,54,60,61,75,77]
Older age at marriage	Two studies[29,39]	Siblings	Five studies[36,38,59,80,101]
Valuing nutrition	Two studies[35,78]	Recent illness	Three studies[38,61,82]
BMI of mother	One study[39]	Difficulty feeding child	Two studies[57,61]
Delivery with doctor present	One study[42]	Crying infant	Two studies[51,61]
High birth order	One study[37]	Lack of support	Two studies[26,52]
Acknowledged importance of maternal health	One study[35]	Maternal age	Two studies[37,101]
Advice-seeking	One study[35]	Religion	Two studies[72,73]
Mother who works from home	One study[38]	Caesarean section	One study[77]
		Child's age	One study[39]
		Concern about weight gain	One study[55]
		Maternal nutrition status	One study[50]
		Mothers from joint families	One study[72]
		Primiparity	One study[88]
		Subsequent pregnancy	One study[47]
Organizational level			
Promoters	Number of studies and references	Barriers	Number of studies and references
Education of parent	Fourteen studies[26,29,31,36,39,41,42,44,48,63,64,68,73,88]	Cultural influences	Fifteen studies[40,41,45,48,51,54,55,57,61,64,74,77–79,82]
Literacy status of mother	Six studies[37,66,68,72,80,86]	Poverty	Six studies[29,32,50,52,69,78]
Wealth	Five studies[26,36,52,87,88]	Lack of parental education	Six studies[32,57,62,70,82,101]
Socio-economic status	Five studies[36,54,63,72,86]	Low literacy	Five studies[29,32,66,69,79]
Media exposure	Four studies[26,38,63,91]	Employment	Four studies[51,61,75,86]
Social support group	Three studies[35,67,72]	Gender	Four studies[37,39,43,87]
Advice from a health-care professional	Three studies[38,56,70]	Poor sanitation	Three studies[50,82,88]
Effective antenatal care	Three studies[26,64,91]	Inadequate antenatal care	Two studies[31,32]
Location	Three studies[62,64,91]	Food insecurity	Two studies[44,82]
Certain caste or tribe	Two studies[42,69]	Price of food	Two studies[55,85]
Support system at work	One study[77]	Focus on disability	One study[85]
Family support	One study[81]	Birth in a public hospital rather than a private hospital	One study[80]
Hindu mothers	One study[63]	Location: Northern India, West India	One study[31]
Birth within a government institute	One study[87]	Lack of media exposure	One study[32]

Of the studies that identified sources of feeding advice, health-care professionals were the most commonly cited. Antenatal check-ups especially were a popular time for feeding advice to be given to mothers by health-care professionals[31,32,38,58,76,84]. Family members, particularly a mother-in-law or grandmother, were also very commonly cited sources of feeding advice. However, the advice given by them is often inappropriate. Saxena and Kumar noted that some female elders insisted mothers only started CF after 1 year[61]. There is a suggestion that family members can adversely influence mothers through conveying traditional beliefs, for example that colostrum is 'dirty', and that children cannot tolerate animal-based proteins until 18 months of age[45,55,67]. Similar advice may also be conveyed by friends and peer groups. Media, including radio, newspapers and magazines, was an important but less commonly cited source of advice. Malhotra found that increased frequency of listening to the radio or of reading newspapers and magazines carried an increased likelihood of mothers having better feeding practices[38].

Several studies identified cultural norms introduced by female elders that are barriers to appropriate CFP, such as preferential treatment of male infants. It is therefore key that opinion leaders are equally targeted in any intervention to improve CFP in communities. Studies by Senarath *et al.*[32] and Dewey and Brown[93] noted the effectiveness of systematic, participatory and coordinated approaches to improve CFP through peers and community facilitators, in keeping with UNICEF guidance on applying best practices and design in interventions[94].

We hope our identification of barriers and promoters will provide inspiration for further interventions to improve CFP. Existing interventions in India have been educational in nature, including counselling[95], resulting in increased energy intake and length; and education in complementary and responsive feeding[96], resulting in increased energy intake and reduced stunting. *The Lancet* 2008 series on maternal and child nutrition included a piece on successful interventions across countries[97].

Strengths and limitations

The strengths of our systematic review are derived by searching a large number of databases utilizing very broad search strings, performing an updated search in June 2016, and having two reviewers undertake study selection, data extraction and quality assessment.

Key limitations include exclusion of: (i) papers which focused solely on children over 2 years of age, where CFP described in their younger years may have been missed; (ii) papers published before the year 2000 at full-text review; and (iii) papers not published in English, which would have added to the diversity of CFP described.

In several studies where there was overlap between children under and over 2 years and/or SA by Indian, Pakistani and Bangladeshi origin, CFP described and attributed to the whole study population may be incorrect. Furthermore, we did not assess the quantities of the foods used, only the frequency with which they appeared in the studies.

While we excluded interventional studies that may have described CFP in their study population, this is unlikely to be the primary focus of such studies and therefore unlikely to have affected our systematic review significantly. Additionally, if we had included strict exclusion criteria for study design, this may have meant there was less of a need to exclude studies due to low overall WOE rating; however, on the other hand, we may have missed some useful studies by being more prescriptive.

Regarding bias, while we attempted to contact numerous authors to identify relevant grey literature for our review, due to the breadth and depth of the field of nutritional research, this is unlikely to have been exhaustive and publication bias is likely to be present. Additionally, the vast majority of studies (n 64) were cross-sectional, commonly using recall methods, with only seven cohort studies. This may mean reported results are biased towards time points when it is convenient to collect single sets of data, such as during medical visits.

Conclusion

Despite adoption of the WHO IYCF guidelines, inadequate CFP remain in SA communities across India. While India has made giant strides in decreasing child mortality over the last two decades, more must be done to improve CFP to further this aim. The present systematic review has highlighted CFP and the factors that influence them, providing knowledge of current behaviours; we recommend this information be used for context-tailored interventions that can be assessed and adopted according to their achievements.

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