Family and community factors shaping the eating behaviour of preschool-aged children in low and middle-income countries: A systematic review of interventions

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Abstract

Low and middle-income countries are experiencing the dual burden of malnutrition which is, at least in part, attributable to changes in eating behaviours of children under age five. Development of food choices is influenced by multiple factors and understanding the interplay of these factors in early childhood in these countries is necessary to promote healthy food choices. We conducted a systematic review to examine the evidence of family and community factors targeted in interventions to influence the eating behaviour of preschool-aged children in low and middle-income countries. A search for peer-reviewed papers was conducted using CINAHL, MEDLINE, PsycINFO, Scopus and ProQuest Health Management published prior to September 2018, in English language including preschool-aged children (PROSPERO registration CRD42018108474). Fourteen studies published between 1994 and 2017 were eligible for inclusion. Factors that were consistently and positively associated with children's healthy food consumption were household food availability, nutritional knowledge of family or caregivers and family income. Unhealthy food consumption in children was inversely associated with family or caregivers' nutritional knowledge. Children's micronutrient intake was positively associated with household food availability, nutritional knowledge of family or caregivers and food availability in the surrounding environment. Findings highlight the importance of targeting nutritional knowledge of family or caregivers to facilitate healthy eating behaviours in children. In addition, creating a supportive family environment via increasing household food availability and family income should be considered when designing interventions to promote healthy eating behaviours in preschool-aged children living in low and middle-income countries.

Keywords: Family; Child; Preschool; Food; Eating; Low income; Middle income

1. Introduction

Childhood malnutrition, including under and over nutrition, is a significant global challenge. According to 2017 data, 22.2% of children under five years of age worldwide had stunted growth, 7.5% were wasted and 5.6% were overweight (UNICEF/WHO/World Bank, 2018). This situation is worse in low and middle income countries with the prevalence of stunting reported as 35.2% and 22.4% respectively (UNICEF/WHO/World Bank, 2018). While of less pressing concern, it is important to note that 77% of all overweight children live in middle income countries and 76% of all wasted children live in lower middle-income countries (UNICEF/WHO/World Bank, 2018). This dual burden of malnutrition has been attributed to the changes in eating behaviours and food choices of children under age five (Haddad et al., 2015). Thus, examining the factors that influence eating behaviours of young children is essential to effectively develop interventions to target malnutrition.

Eating behaviour is highly complex and influenced by multiple factors across different contexts. It has been conceptualized as a function of the social and physical environment (Story et al., 2002). Beyond the individual child characteristics, family and community factors affect children's eating patterns (Østbye et al., 2013; Patrick and Nicklas, 2005). Young children depend on their families to support their well-being and promote positive development, including eating behaviours. The family eating environment is the most fundamental context in which children's eating behaviours are socialized and food preferences are formed (Davison and Birch, 2001).

There are numerous pathways by which children's home environments shape their dietary practices including: availability of foods in the home (the types of foods parents make available to children); accessibility to foods (food kept in an accessible place at home); parental modeling of particular eating behaviours; parental feeding style and parenting practices (including regularity of meal times and frequency of family meals); and introducing or providing exposure to foods at early ages (Dovey et al., 2008; Østbye et al., 2013; Story et al., 2008). Family situations such as socioeconomic status of the family, education and employment level of parents interacted with home environment have also been shown to influence the child's eating (Østbye et al., 2013).

A variety of community factors also influence children's eating patterns. Children from different cultures and ethnic groups have been shown to consume different food groups at

varying amounts (Asfour et al., 2015). Exposure to television advertisements on unhealthy foods increase overall consumption of unhealthy food categories in children (Andreyeva et al., 2011). Moreover, availability and accessibility to food stores and the economic system (food pricing), also influence children's eating patterns (Patrick and Nicklas, 2005; Story et al., 2008).

Improving healthy eating in preschool-aged children in low and middle-income countries is a growing concern. There is increasing emphasis on the roles of family and community factors to promote healthy eating habits. To date, no reviews have examined the roles of family and community factors in influencing the eating behaviour of preschool-aged children in these countries. Therefore, the current review aims to systematically examine the interventions that specifically target family and community factors to influence the eating behaviour of preschool-aged children in this context.

Improving healthy eating in preschool-aged children in low and middle-income countries is a growing concern. There is increasing emphasis on the roles of family and community factors to promote healthy eating habits of children with various interventions targeting these factors in low and middle-income countries. To date, no reviews have examined interventions targeting the roles of family and community factors in influencing the eating behaviour of preschool-aged children in these countries. Therefore, the current review aims to systematically examine the interventions that specifically target family and community factors to influence the eating behaviour of preschool-aged children in this context.

2. Methods

2.1. Protocol and registration

The protocol for this review was registered with PROSPERO International Prospective Register of Systematic Reviews (registration number: CRD42018108474). The review was conducted in accordance with Preferred Reported Items for Systematic Review and Meta-Analyses (PRISMA) statement checklist (Moher et al., 2010).

2.2. Search strategy

Articles were sourced from five relevant online databases: CINAHL Plus with Full Text (via EBSCOhost), MEDLINE (via EBSCOhost), PsycINFO (via Ovid), Scopus and ProQuest

Health Management (via ProQuest). The searches were performed in January 2017 and updated in September 2018. No date restrictions were applied. A sample search strategy for MEDLINE is shown in Table 1.

Table 1
Search strategy used in MEDLINE database

Inclusion/ exclusion criteria

Peer-reviewed studies published in the English language were included in the review. Study inclusion criteria were created using the PICOS (Participants, Intervention, Comparison, Outcome and Study design) approach (Table 2).

Table 2
Study inclusion/exclusion criteria using PICOS approach

2.3. Study selection

After removing duplicates, first author (FS) screened titles and abstracts for relevancy which were independently checked by a second reviewer. Potential full texts were assessed using the inclusion criteria for selection of studies by two authors (FS and RR). Reference lists of included papers were reviewed for the potential inclusion of studies. When multiple publications on the same study participants or data source were available, the paper with the most detailed information for both outcome and exposure was included. If the papers reported different outcomes and/or exposures both papers were included. Co-authors were consulted to make decisions where necessary (NH and LM).

2.4. Quality assessment and data extraction

The methodological quality of each study was assessed by two authors (FS and RR) using the Academy of Nutrition and Dietetics (AND) Quality Criteria Checklist for Primary Research (QCC) (Academy of Nutrition and Dietetics, 2016). The QCC tool is commonly used to assess scientific validity and applicability of the studies in the field of nutrition. This checklist assesses 10 criteria, which include: 1) clear research question; 2) free from selection bias of study participants; 3) comparable study groups; 4) methods for handling withdrawals described; 5) use of blinding to prevent introduction of bias; 6) clear description of intervention/ exposure and comparison; 7) clearly defined outcomes determined by valid and reliable measurements; 8) appropriate statistical analyses; 9) conclusions supported by results with consideration to biases and limitations; and 10) unlikely funding or sponsorship bias. Studies were considered to be positive quality if ranked as 'yes' for criteria 2, 3, 6, 7, and one other, neutral if criteria 2, 3, 6 and/or 7 were 'no' or 'unclear', or negative if six or more criteria were 'no'.

Data were extracted by the first author (FS) on standardised forms developed for this review and reviewed by the other authors (LM, NH and RR). Extracted data included information on publication details (author, year of publication and country of study), study aims, study design, characteristics of the participants (sample size, age), description of the intervention/ exposure, data provider, eating behaviour outcomes (i.e. healthy food consumption/ unhealthy food consumption/ healthy diet related behaviours/ unhealthy diet related behaviours/ energy and macro nutrient intake/ micronutrient intake), measure of eating behaviour outcome and

reliability and validity of dietary measures. A summary of this information is presented based on three broad aims of the studies (Table 3). Quality assessment of the included studies are presented in Table 4. Study findings were tabulated to highlight the state of the literature for identified potentially modifiable family and/ community factors of preschool-aged children's eating behaviours (Table 5).

2.5. Coding associations with eating behaviour outcomes

Studies that found significant associations between family and community factors and eating behaviour outcomes were recorded in the 'related to eating behaviour outcomes' column and the directions of the associations were coded as '+' for positive association/ impacts or '-' for inverse association/ impacts (Table 5). Studies finding no significant associations were entered in the 'unrelated to eating behaviour outcomes' column (Table 5). All identified factors are displayed in the summary tables, but only those reported in three or more samples are considered to compute associations based on Sallis et al. (2000). Conceptually similar factors were combined (e.g. nutritional knowledge of mother, parents and caregivers to nutritional knowledge of family/ caregivers). Eating behaviour outcomes were categorised into three main groups: food consumption (includes consumptions of different foods, food groups and diet quality indices); diet related behaviours (includes routines followed during eating, way of eating and preferences to foods); and nutrient intake (includes energy, macro and micronutrient intakes). Food consumption and diet related behaviours were further classified as healthy and unhealthy. Based on MyPlate model for preschool children (United States Department of Agriculture, 2011), foods promoted for consumption were categorised as healthy, whereas foods restricted for consumption were categorised as unhealthy. Diet related behaviours promoted and associated with good health were classified as healthy and other diet related behaviours were classified as unhealthy. Comparison with recommendation is important to classify the intake of nutrients as healthy or unhealthy. Given the diversity of analytical methods of papers included in the review, and the slightly different recommendations for children's age groups and genders, it was not practicable to compare nutrient intakes with recommended intakes. Instead, nutrient intakes were dichotomously classified as energy, macronutrient intake or micronutrient intake.

2.6. Summary codes

An independent sample was used as the unit of analysis. If analysis was conducted separately for girls and boys or for different groups, they were considered as independent sub-samples. The column 'number of samples' displays the number of samples that have been studied for each identified factor (Table 5). The 'summary' column contains the number of samples finding positive (+), inverse (-) and no/ neutral (0) associations for each factor. Based on the percent of findings supporting the association (number of supporting associations divided by the total number of associations for that variable), the variable was classified as no association (0–33 %), indeterminate/inconsistent (34–59 %) and positive or negative association (60–100 %). These coding rules were reported in previous literature (Hinkley et al., 2008; Pearson et al., 2009a; Sallis et al., 2000).

3. Results

The review identified 10709 records through the search of five databases, and 37 records through other sources. A total of 187 articles were retrieved for full text review, 14 of which met the inclusion criteria (see Fig. 1). More than half of the records were excluded due to not being original research papers with quantitative analysis as a comparative study with concurrent controls or pre-post study design. Other key reasons for exclusion were incorrect target population and not measuring an association between family/ community factor and the eating behaviour of the child.

A summary of the characteristics of the eligible studies is presented in Table 3. The fourteen papers comprising 13 interventions, included RCTs (n = 6 papers) (da Costa Louzada et al., 2012; Hu et al., 2009; Kusuma et al., 2017; Lin et al., 2016; Ramírez-Silva et al., 2013; Vitolo et al., 2010), NRCTs (n = 5 papers) (Knueppel et al., 2010; Low et al., 2007; Mascie-Taylor et al., 2010; Mujibur Rahman et al., 1994; Olney et al., 2009), and pre-post studies (n = 3 papers) (Darrouzet-Nardi et al., 2016; Noradilah and Zahara, 2012; Sirikulchayanonta et al., 2010). The majority of studies were conducted in Asian countries (n = 9 papers) (Darrouzet-Nardi et al., 2016; Hu et al., 2009; Kusuma et al., 2017; Lin et al., 2016; Mascie-Taylor et al., 2010; Mujibur Rahman et al., 1994; Noradilah and Zahara, 2012; Olney et al., 2009; Sirikulchayanonta et al., 2010). Studies predominantly targeted children's healthy food consumption (n = 11 papers) (da Costa Louzada et al., 2012; Darrouzet-Nardi et al., 2016; Hu et al., 2009; Knueppel et al., 2010; Kusuma et al., 2017; Low et al., 2007; Mascie-Taylor et al., 2010; Mujibur Rahman et al., 1994; Noradilah and Zahara, 2012; Olney et al., 2009; Sirikulchayanonta et al., 2010). Eating behaviour outcomes were assessed through parent/ caregiver report in all studies and an additional researcher report (spot checking) was conducted in two studies (Mujibur Rahman et al., 1994; Noradilah and Zahara, 2012). Questionnaires were the most frequently used measure (n = 7 papers) (Hu et al., 2009; Kusuma et al., 2017; Lin et al., 2016; Mascie-Taylor et al., 2010; Mujibur Rahman et al., 1994; Olney et al., 2009; Sirikulchayanonta et al., 2010) followed by single 24-hr recall (n = 2 papers) (Darrouzet-Nardi et al., 2016; Ramírez-Silva et al., 2013), multiple 24-hr recalls (n = 2 papers) (da Costa Louzada et al., 2012; Vitolo et al., 2010), FFQ (n = 1 paper) (Knueppel et al., 2010), FFQ and a 24-hr recall (n = 1 paper) (Low et al., 2007) and researcher recorded food record (n = 1 paper) (Noradilah and Zahara, 2012) . The study sample size ranged from 26 to 2876 children, with an age of birth to 8 years. Only two studies reported the validity elsewhere (Lin et al., 2016;

Sirikulchayanonta et al., 2010) and one study reported reliability of dietary intake measurements (Lin et al., 2016).

3.1. Description of intervention/ exposure of included studies and methodological quality

Interventions included in this review were classified into three categories based on their general study aim (Table 3). Four interventions (5 papers) (da Costa Louzada et al., 2012; Hu et al., 2009; Lin et al., 2016; Mujibur Rahman et al., 1994; Vitolo et al., 2010) aimed to assess the effect of nutrition education to parents, two of which (Hu et al., 2009; Lin et al., 2016) also included child nutrition education. The duration of intervention exposure was not adequate to obtain an outcome in one intervention (Mujibur Rahman et al., 1994). In category two, evaluating the impact of food experience and role modeling was the aim of two studies, both pre-post studies (Noradilah and Zahara, 2012; Sirikulchayanonta et al., 2010). One of these studies assessed the impact of repeated exposure over a 3-day period to a test food, which was not preferred by children (Noradilah and Zahara, 2012). The second study examined an interactive food experience for children, using multimedia and the support of role models such as teacher, peers and parents (Sirikulchayanonta et al., 2010). The final category of studies included seven interventions (Darrouzet-Nardi et al., 2016; Knueppel et al., 2010; Kusuma et al., 2017; Low et al., 2007; Mascie-Taylor et al., 2010; Olney et al., 2009; Ramírez-Silva et al., 2013) that aimed to assess the impact of community development programs. Four of these (Darrouzet-Nardi et al., 2016; Low et al., 2007; Olney et al., 2009; Ramírez-Silva et al., 2013) were multi-component interventions targeting different aspects such as household food production, nutrition education to parents and family income.

Each study underwent quality assessment according to the QCC of AND and quality attributes with overall quality is presented in Table 4. Three studies (Lin et al., 2016; Noradilah and Zahara, 2012; Sirikulchayanonta et al., 2010) were rated as positive quality, with the remaining (n = 11 papers) rated as neutral. The main criteria impacting study quality was absence of reporting validity and reliability of measurements although they clearly defined the outcomes. For the three studies with a pre-post studies (Darrouzet-Nardi et al., 2016; Noradilah and Zahara, 2012; Sirikulchayanonta et al., 2010) the criteria of ‘comparable study groups’ and ‘use of blinding to prevent introduction of bias’ were not applicable.

Fig. 1. PRISMA flow diagram for the systematic review of family and community factors shaping the eating behaviours of preschool-aged children in low and middle-income countries

Table 3
Characteristics of studies included in the review of family and community factors shaping the eating behaviours of preschool-aged children in low and middle-income countries

Table 4
Quality assessment of included studies using the Quality Criteria Checklist (QCC)

3.2. Factors influencing the eating behaviour of preschool-aged children

Associations between potential family and community factors and child eating behaviour outcomes are summarised in Table 5.

3.2.1. Children's healthy food consumption

This review identified six family factors related to children's healthy food consumption, three of which were studied three or more times. Nutritional knowledge of family or caregivers was studied frequently and was positively and consistently associated with children's healthy food consumption. Maternal nutritional knowledge was identified as a sub-factor of nutritional knowledge of family or caregivers, showing positive associations. Household food availability and family income were also positively and consistently associated with children's healthy food consumption. An additional four factors were linked with children's healthy food consumption, however were insufficiently associated as they were not studied three or more times. These were: exposure to food by family or preschool; role modeling; food budget; and the community factor of food availability within the surrounding environment.

3.2.2. Children's unhealthy food consumption

Nutritional knowledge of family or caregivers (including maternal knowledge) was the only family factor assessed under unhealthy food consumption and was inversely associated with this. No community factors were identified related to this eating behaviour outcome.

3.2.3. Children's healthy and unhealthy diet related behaviours

The family factor of nutritional knowledge of family or caregivers was identified as related to both healthy and unhealthy diet related behaviours of children. However, the association was insufficient as it was studied in only one sample. No community factors were identified related to healthy or unhealthy diet related behaviours of children.

3.2.4. Children's energy and macronutrient intake

Three family factors related to energy and macronutrient intake were identified, with two being studied three or more times. Nutritional knowledge of family or caregivers was studied frequently, but inconsistent associations were found. Two out of five samples (40%) showed some positive associations with children's energy and macronutrient intake and four samples showed elements with no association. Household food availability was not associated with children's energy and macronutrient intake, while family income showed insufficient associations. One community factor (food availability within surrounding environment) was linked to children's energy and macronutrient intake. Although it was studied three or more times, no associations were found.

3.2.5. Children's micronutrient intake

Three family factors were identified as being related to micronutrient intake, with two studied three or more times. Household food availability and nutritional knowledge of family or caregivers showed positive consistent associations with children's micronutrient intake. Food availability within the surrounding environment was the only community factor identified. This was studied three or more times and was positively associated with children's micronutrient intake.

Table 5
Summary of factors influencing eating behaviour outcomes among preschool-aged children

4. Discussion

To our knowledge, this is the first systematic review of the literature on modifiable family and community factors influencing the eating behaviours of preschool-aged children across low and middle-income countries. The review reported support for three family factors and one community factor which influenced child eating behaviour outcomes: household food availability, nutritional knowledge of family or caregivers, family income and food availability within the surrounding environment.

Household food availability was found to be positively and consistently associated with children's healthy food consumption and micronutrient intake. This was reported in four community development related studies through increasing the relevant food production at household level. Significant positive associations were identified between animal sourced food production and their consumption in three studies (Darrouzet-Nardi et al., 2016; Knueppel et al., 2010; Olney et al., 2009). One study reported that increased production of vegetables (sweet potatoes) increased the consumption of that vegetable in intervention households compared with control households (Low et al., 2007). Previous studies conducted in Ghana (Christian et al., 2012) (for animal source food consumption) and Tanzania (Wandel and Holmboe-Ottesen, 1992) (for maize and beans consumption), reported that parents or caregivers engagement in a particular type of food production activity increased the likelihood of parent or caregiver feeding his/her young child more of that food. This suggests that production of a particular food group increases its availability to children at the household level and thereby enables increased consumption of that particular food group in children. Our findings support the previous reviews focused on fruit and vegetables intake in children (age range 4-11 years) (Blanchette and Brug, 2005; Paes et al., 2015; Pearson et al., 2009b; Rasmussen et al., 2006; Van Der Horst et al., 2006).

Our review confirms that nutritional knowledge of the family and caregivers plays an important role in modifying the eating behaviour of children in low and middle-income contexts. Positive consistent associations were obtained for nutritional knowledge of the family and caregivers with healthy food consumption and micronutrient intake. In particular, maternal nutritional knowledge is strongly related to children's healthy food consumption. This adds further support to an existing review based on qualitative evidence (Paes et al., 2015). When parents and caregivers are educated about child nutrition, importance of nutrition, nutrient

requirements of a child and how to nourish their children properly, they can apply this knowledge in feeding their child. As the main gatekeepers responsible for what young children are offered to eat, parents have tremendous influence over shaping their children's food preferences (Birch, 2006; Faith, 2005; Spruijt-Metz et al., 2002).

Moreover, a consistent inverse association with nutritional knowledge of the family or caregivers was found for consumption of unhealthy foods including unhealthy aspects of diet quality (unhealthy snacks, western fast food, sweetened beverages and fried food and HEI component score for cholesterol) (Hu et al., 2009; Lin et al., 2016; Vitolo et al., 2010). This suggests parental nutritional education can be used in interventions either promoting healthy eating or discouraging unhealthy eating in preschool-aged children.

This review did not find support for other parent related factors, such as parental intake, family rules and parental encouragement around fruit and vegetable consumption together with parental education as were reported in previous reviews that focused on fruit and vegetable consumption in children (Pearson et al., 2009b; Rasmussen et al., 2006; Van Der Horst et al., 2006). Nevertheless, two studies (Noradilah and Zahara, 2012; Sirikulchayanonta et al., 2010) reported positive associations between food exposure in the home and preschool environment with children's healthy food consumption (fruits and vegetables). Increased food acceptance and consumption of vegetables after a set of particular food experiences was found to be significant in recent RCTs (Anzman-Frasca et al., 2012; Fildes et al., 2014). However, a clear association between food exposure and children's healthy food consumption was not possible to establish through this review due to low number of samples reporting that particular factor.

Family income was positively associated with healthy food consumption in preschool-aged children. This finding is somewhat contradictory for different food groups within the healthy food category. Positive associations with family income were found for healthy food consumption in all five samples, especially for animal sourced foods (n = 3 samples). This association was expected in low and middle income countries and reinforces the work of Zhang et al. (2017), who found that children from higher-income families consumed significantly higher proportion of animal sourced foods compared to children from lower-income families. Christian et al. (2012) offers a possible explanation for this finding as increased family income is often used to purchase the relatively more expensive food items like animal sourced foods for the consumption of preschool-aged children. Consumption of fruit and vegetables was not associated with family income with no association found in three out of five samples. This

finding is similar to results reported previously in reviews targeting children living in all countries without restricting to income levels of the countries (Pearson et al., 2009b; Van Der Horst et al., 2006).

This review adds support for positive consistent association between food availability within the surrounding environment and children's micronutrient intake. Two community development studies (three samples) reported this community factor. These studies did not explain the impact pathways of food availability in the surrounding environment for children's micronutrient intake. In Low et al. (2007), it is possible that food availability in surrounding environment was improved by sending the homestead food produce to the market for sale and making the produce more available in the environment. This may have also been achieved by providing fortified food supplement to the children through the intervention program in the Ramírez-Silva et al. (2013) study. Beyond the association, our review noted that community factor-targeted interventions have a follow-on effect on other factors. When an intervention is planned to modify a community factor, it also tends to impact on an interrelated family factor or close environmental factor, and thereby support the expected outcome of promoting healthy eating in children. Our review did not find evidence for any other community factors which influence child food consumption. This may be due to the low number of studies focusing on community aspects and eating behaviour outcomes in low and middle-income countries and the difficulty in differentiation of specific community factors from other interrelated factors influencing child food consumption.

Further, positive associations were found for role modeling and food availability in the surrounding environment to children's healthy food consumption; nutritional knowledge of the family or caregivers to children's healthy diet related behaviours; and family income to children's energy, macronutrients and micronutrients intakes. A negative association was found for nutritional knowledge of the family or caregivers to children's unhealthy diet related behaviours such as adult assistance during meals and playing or watching television during dinner. Both positive (for protein rich foods, green leafy vegetables and fruit) and inverse (for cereals) associations were observed between food budget and children's healthy food consumption within one study (Mascie-Taylor et al., 2010). Intervention households spent more money on food and consumed a greater amount of protein-rich food after the intervention provided by Mascie-Taylor et al. (2010). This finding indirectly linked with an outcome of our review that family income was related to animal sourced food consumption in children.

However, these associations were examined in only one or two samples, and the basis to draw firm conclusions regarding the consistency of associations is limited. More studies are needed to investigate these understudied factors to generate more conclusive evidence for associations between these factors and eating behaviour outcomes.

Few studies identified diet quality indices: Dietary Diversity Score (DDS); Minimum Dietary Diversity (MDD); Animal Sourced Foods (ASF); Healthy Eating Index (HEI); and fruits and vegetable eating behaviour score as eating behaviour outcomes. Although the diet quality indices represent both aspects of food consumption and diet related eating behaviour, they were categorised as an outcome of food consumption in our review. These diet quality indices showed only positive relationships with the studied factors. Household food availability, nutritional knowledge of family or caregivers, family income and food availability in surrounding environment were positively related to DDS of children. Household food availability and family income were positively related to MDD and ASF of children. Nutritional knowledge of family or caregivers was positively related to HEI. Finally, exposure to food by family or preschool and role modeling were positively related to fruit and vegetable eating behaviour score. Though it is universal to use a composite score to evaluate the quality of diets, individual component scores of a diet quality index will give a better insight to the quality of diet. Only one study in our review evaluated individual components of a diet quality index which is HEI (Vitolo et al., 2010). Vitolo and colleagues reported positive relationships for healthy aspects (vegetables, fruits and variety) and inverse relationship for unhealthy aspect (cholesterol) of HEI component scores with nutritional knowledge of parents or caregivers. Additionally, nutritional knowledge of parents or caregivers showed neutral relationships for HEI component scores for meat group, milk, grains, sodium, total fat and saturated fat. These findings suggest that examination of individual elements of diet quality indices may provide important insights for overall diet quality and need to be considered in future studies. However, these relationships were not considered for analysis of consistent associations, as all the diet quality indices were reported in single studies or samples.

4.1. Strengths and limitations

Our review includes a thorough systematic search of five databases using clearly defined selection criteria to synthesise all available data. Use of coding associations to examine the factors influencing different eating behaviour outcomes in children adds strength to our review.

The level of evidence of the studies included in our review is satisfactory (Level III-2) (National Health and Medical Research Council, 2009) and the quality of the included studies was generally positive across quality criteria components although overall quality was neutral for most.

This review has several limitations. Only published articles in English language were included, potentially limiting the relevant studies. The variety of eating behaviour outcomes observed in included studies made it difficult to effectively organise the findings by exposure outcome effect. This concern was addressed by categorising conceptually similar eating behaviour outcomes to a broader eating behaviour outcome category. Most studies included in the review depend on parent or caregiver reported data and there is the potential of over-estimation since the reliability and validity of most of the dietary measures were unknown or not reported.

Few studies examined multiple factors together for different eating behaviour outcomes. All these studies were community development based intervention studies focused on addressing multiple factors for considerably long periods (12 – 18 months). Most of these studies did not assess the change in the targeted factors after the intervention/ exposure. Also, adjustments for confounding factors were done for limited demographic factors including age and gender. This indicates that the eating behaviour outcomes may be due to a combined effect of multiple factors and the associations are not independent.

Conclusion

Several key family factors and a single community factor have been found to be important in relation to different eating behaviour outcomes in preschool-aged children across low and middle-income countries. Household food availability, nutritional knowledge of family or caregivers, family income and food availability in the surrounding environment were found to have positive consistent associations with different healthy eating behaviour outcomes. In contrast, an inverse association was identified for nutritional knowledge of family or caregivers with children's unhealthy food consumption. Findings of the current review highlight the importance of targeting nutritional knowledge of family and caregivers to facilitate healthy eating behaviours among children. In addition, creating a supportive family environment via increased household food availability and family income should be prioritised when designing

interventions to promote healthy eating behaviours in preschool-aged children living in low and middle-income countries.

Declaration of interest

The authors declare no conflict of interest

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Table 6

Search strategy used in MEDLINE database

Steps	MeSH Headings and key words
1	"preschool child*" OR "early childhood" OR "young child*" OR kindergarten
2	"family factor*" OR "community factor*" OR "family structure*" OR (family AND "socioeconomic status") OR (family AND education) OR (family AND income) OR ("parental age") OR (family AND (ethnicity OR race OR culture))
3	"food choice*" OR "food preference*" OR "eating bahavio?r" OR nutrition OR diet* OR "dietary pattern*" OR "food habit*" OR "eating habit*"
4	1 AND 2 AND 3

*Asterisk used in database search to capture multiple word endings (e.g. child, children)

Table 7
Study inclusion/exclusion criteria using PICOS approach

	Inclusion criteria	Exclusion criteria
Participants	Preschool-aged children (2-6 years) or mean age of the study participants between 2.0 years – 5.5 years. Healthy children. Living in low and/ or middle-income countries. The country classification was made according to the 2017 per capita gross national income (GNI), calculated using the World Bank Atlas method (World Bank, 2017).	Infants (< 2 years) and children aged more than 6 years. Children with any clinical conditions (unhealthy) Living in high income countries.
Interventions	Interventions involving strategies to change a family and/ or community factor to influence eating behaviour in participants	Interventions that do not target to change a family and/ or community factor
Comparator	Compared with a concurrent control (no intervention) or a within subject (in pre-post design)	No control
Outcomes	Eating behaviours which included food consumption (includes consumptions of different foods, food groups and food consumption relevant diet quality indices), diet related behaviours and nutrient intake (includes energy, macro and micronutrient intakes).	Studies that report non-relevant eating behaviour outcomes such as household level food / food group consumption or nutrient intake, weaning/ complementary feeding or introduction of solid foods
Study designs	Peer-reviewed, original research works. Carried out quantitative analysis. Comparative studies with concurrent controls (randomized controlled trials (RCT), non-randomized controlled trials (NRCT), cohort study, case-control study, interrupted time series with a control group) and pre-post study designs.	Non-peer reviewed (dissertations, conference proceedings, abstracts, letters to the editor, editorial, commentary, magazine articles and not original research works (reviews). Carried out qualitative analysis. Comparative studies without concurrent controls (historical control study, two or more single arm study, interrupted time series without a parallel control group) and non-comparative studies (cross-sectional study, case series).

Table 8
Characteristics of studies included in the review of family and community factors shaping the eating behaviours of preschool-aged children in low and middle-income countries

Reference, country	Study characteristics		Intervention description	Data source, Outcome measure	Outcome measured					
	Study design	Population, sample size			Food consumption		Diet related behaviours		Nutrient intake	
					H	UH	H	UH	E & Mac	Mic
Aim: To assess the effect of nutrition education										
(da Costa Louzada et al., 2012) Brazil	RCT	3-4 years N = 344 I: n = 149 C: n = 195	**Intervention:** Breastfeeding and complementary feeding advice provided at 10 days post birth, monthly for 6 months, and with subsequent visits at 8, 10, and 12 months. **Control:** No counselling. Interviewed twice during the first year. **Duration:** 1 year (10 visits, each ~40 minutes)	Mother or caregiver Two 24-hr recalls	X				X	
(Hu et al., 2009) China	RCT	4-6 years N = 1755 I: n = 1042 C: n = 713	**Intervention:** Nutrition education sessions: Children – flexible curriculum for in-kindergarten education delivered monthly, an illustrated book with a nutritional theme; teachers read the book and told related stories and two series of promotional pictures (most common unhealthy dietary behaviours and good lifestyle behaviours) displayed in the kindergartens, one series per semester. Parents – periodical nutrition education and pamphlets giving nutritional information and healthy lifestyle behaviours. **Control:** Children – book of general picture stories. Parents – no intervention. **Duration:** 12 months (10 monthly sessions for a school year)	Parents Self-administered questionnaire	X	X	X	X		
(Lin et al., 2016) China	RCT	3-6 years N = 1138 I: n = 450 C: n = 688	**Intervention:** Behavioural intervention program: Children – received four behaviour cards. Parents – received a series of educational sheets and two lectures.	Parents Questionnaire		X				

Reference, country	Study characteristics		Intervention description	Data source, Outcome measure	Outcome measured					
	Study design	Population, sample size			Food consumption		Diet related behaviours		Nutrient intake	
					H	UH	H	UH	E & Mac	Mic
			Control: Children – usual health education curriculum. Parents – not mentioned. **Duration:** 4 months							
(Mujibur Rahman et al., 1994) Bangladesh	NRCT	6-35 months N = 160 Group 1: I: n = 44 C: n = 44 Group 2: I: n = 36 C: n = 36	**Intervention:** Group 1 – Health and nutrition education mainly on green leafy vegetables and a feeding demonstration by offering a single meal of cooked green leafy vegetables. Mothers were advised to feed in a similar way at least once a day. Group 2 – Health and nutrition education mainly on green leafy vegetables only. **Control:** No intervention. **Duration:** 1-day session	Mother and spot checking Interviewer administered questionnaire	X					
(Vitolo et al., 2010) Brazil	RCT	3-4 years N = 345 I: n = 145 C: n = 200	Same intervention mentioned in da Costa Louzada et al. (2012)	Mother or caregiver Two 24-hr recalls			X	X		
Aim: To evaluate the food experience and role modeling										
(Noradilah and Zahara, 2012) Malaysia	Pre-post	5-6 years N = 42	**Intervention:** Packed lunches that incorporated stir-fried round cabbage (test vegetable) served during lunch time for three consecutive days (three standard recipes- one for each day). Teachers ensured that food was not thrown out or shared with their friends and any leftovers were kept inside the container. **Control:** No control group. **Duration:** 3 days	Researcher and parents Observer or researcher recorded food record	X					
(Sirikulchayanonta et al., 2010)	Pre-post	4-5 years N = 26	**Intervention:** A food experience program: Eleven activities (e.g. cartoon, games, gardening, cooking) on health benefits of fruits and vegetables to improve familiarity with and acceptance of the	Parents	X					

Reference, country	Study characteristics		Intervention description	Data source, Outcome measure	Outcome measured					
	Study design	Population, sample size			Food consumption		Diet related behaviours		Nutrient intake	
					H	UH	H	UH	E & Mac	Mic
Thailand			concept. Teachers, peers and parents were used as role models while eating together. Guidelines to motivate and encourage the children to eat fruits and vegetables of recommended variety and quantity sent to parents at the fourth week. **Control:** No control group. **Duration:** 8 weeks	Interviewer administered questionnaire						
Aim: To assess the impact of community development programs										
(Darrouzet-Nardi et al., 2016) Nepal	Pre-post	6 months -8 years N = 589	**Intervention:** Participatory community-level, nutrition related development intervention: Activities focused on resource sharing, sustainable agriculture practices, effective animal management, household income and gender awareness. Group1 – Intervention started immediately. Group 2 – Intervention started after 12 months period. **Control:** No control group. **Duration:** 12 months Data from both groups were merged and analysed in results	Female head of household or her designee 24-hr recall	X					
(Knueppel et al., 2010) Tanzania	NRCT	1-5 years Round 1: N = 237 households I: n = 119 C: n = 118 Round 2:	**Intervention:** Vaccination of chickens at multiple time points. Sample in year 2008 – vaccinated 3 times (2 free and 1 pay). Sample in year 2009 – vaccinated 2 times (1 free and 1 pay). **Control:** No vaccination of chickens. **Duration:** 18 months	Mother or caregiver FFQ	X					

Reference, country	Study characteristics		Intervention description	Data source, Outcome measure	Outcome measured					
	Study design	Population, sample size			Food consumption		Diet related behaviours		Nutrient intake	
					H	UH	H	UH	E & Mac	Mic
		N = 261 households I: n = 134 C: n = 127								
(Kusuma et al., 2017) Indonesia	RCT	24-36 months N = 2876 I (Intervention 1): n = 1394 I (Intervention 2): n = 1481 C: n = not mentioned	**Intervention:** Cash transfer programs to reduce poverty, maternal and child mortality, and to ensure universal basic education. Intervention 1 – Household cash transfer – directly to mother. Intervention 2 – Community cash transfer – to the village. **Control:** No intervention. **Duration:** 24months	Mother or caregiver Questionnaire	X					
(Low et al., 2007) Mozambique	NRCT	Young children mean age 35 months (mean age at recruitment = 17.4 months) N = 741	**Intervention:** Integrated farmer extension includes agricultural topics and nutrition extension activities through group education sessions. **Control:** No intervention. **Duration:** 1 year (9 to 12 sessions)	Caregiver FFQ and a 24-hr recall	X				X	X
(Mascie-Taylor et al., 2010) Bangladesh	NRCT	<5 years N= 1816 I: n = 895 C: n = 921	**Intervention:** Cash-for-work program to improve nutritional status of women and children aged less than 5 years. **Control:** No intervention. **Duration:** 10 weeks	Adult female in the households Interviewer administered questionnaire	X					
(Olney et al., 2009) Cambodia	NRCT	< 5 years N = 500 I: n = 300 C: n = 200	**Intervention:** Homestead food production program, received homestead food production inputs, training in homestead food production activities, and nutrition education. **Control:** No intervention. **Duration:** 18 months	Mothers Interviewer administered questionnaire	X					

Reference, country	Study characteristics		Intervention description	Data source, Outcome measure	Outcome measured					
	Study design	Population, sample size			Food consumption		Diet related behaviours		Nutrient intake	
					H	UH	H	UH	E & Mac	Mic
(Ramírez-Silva et al., 2013) Mexico	RCT	12-59 months N = 1601 I (Group 1): n = 147 I (Group 2): n = 807 C: n = 647	**Intervention:** Households received a cash transfer intended to improve the quantity and quality of food in the household; a fortified food supplement (Nutrisano) and a food supplement for pregnant and lactating women (Nutrivida); health and nutrition education; and access to primary health care. Group 1 – received all intervention components. Group 2 – received all components except fortified food supplement. **Control:** No intervention. **Duration:** 12 months	Mother or caregiver 24-hr recall					X	X

RCT - Randomized Controlled Trial; NRCT - Non-Randomized Controlled Trial; I - Intervention; C - Control; FFQ - Food Frequency Questionnaire; H - Healthy; UH - Unhealthy; E & Mac - Energy and macronutrients; Mic - Micronutrients.

Table 9
Quality assessment of included studies using the Quality Criteria Checklist (QCC)

Study	Criteria scores										**Overall Quality rating**[a]
	Clear research question	Selection of study participants free from bias	Comparable study groups	Handling withdrawals or response rate described	Use of blinding to prevent introduction of bias	Intervention/exposure factor or procedure described in detail	Outcomes clearly defined and the measurements valid and reliable	Appropriate statistical analysis	Conclusions supported by results	Unlikely funding or sponsorship bias	
Mujibur Rahman et al. (1994)	+	+	+	+	-	+	Unclear	+	+	+	Ø
Hu et al. (2009)	+	+	+	+	+	+	Unclear	+	+	+	Ø
Vitolo et al. (2010)	+	+	+	+	+	+	Unclear	+	+	+	Ø
da Costa Louzada et al. (2012)	+	+	+	+	+	+	Unclear	+	+	+	Ø
Lin et al. (2016)	+	+	+	+	+	+	+	+	+	+	+
Noradilah and Zahara (2012)	+	+	NA	+	NA	+	+	+	+	+	+
Sirikulchayanonta et al. (2010)	+	+	NA	+	NA	+	+	+	+	+	+
Knueppel et al. (2010)	+	+	+	NA	-	+	Unclear	+	+	+	Ø
Mascie-Taylor et al. (2010)	+	+	+	+	-	+	Unclear	+	+	+	Ø
Darrouzet-Nardi et al. (2016)	+	+	NA	-	NA	+	Unclear	+	+	+	Ø
Kusuma et al. (2017)	+	Unclear	+	-	-	+	Unclear	+	+	+	Ø
Low et al. (2007)	+	+	+	+	-	+	Unclear	+	+	+	Ø
Olney et al. (2009)	+	+	+	+	-	+	Unclear	+	+	NR	Ø
Ramírez-Silva et al. (2013)	+	+	+	+	+	+	Unclear	+	+	+	Ø

Unclear - not clearly described; NA - not applicable (mostly due to pre-post study design of the study); NR - not reported
[a]A positive (+) overall score is given if criteria 2, 3, 6 and 7 of the QCC and one additional criterion have received a positive score; neutral (Ø) overall score is given if more criteria are met than for a negative overall score but an overall positive score is not reached; negative (-) overall score is given if six or more QCC criteria are not met

Table 10
Summary of factors influencing eating behaviour outcomes among preschool-aged children

Eating behaviour outcome - factors	Related to eating behaviour outcomes	Association (+/-)	Unrelated to eating behaviour outcomes	No. of samples	Summary (n)		
	Bibliography no.		Bibliography no.		+	-	0
Food consumption - healthy							
Family factor							
Household food availability	9 (additional food group, MDD and ASF), 17 I (eggs), 20 (sweet potato), 26 (egg, liver, meat and DDS)	+	17 I (chicken), 17 II (chicken and eggs), 26 (dark green leafy vegetables, carrot and orange or yellow fruit, fish, chicken and milk)	5	4	0	3
Nutrition knowledge of family/ caregivers	16 (milk, meat, seafood and seaweed), 20 (sweet potato), 23 I II (green leafy vegetables), 26 (egg, liver, meat and DDS), 42 (HEI and HEI component scores for vegetables, fruits and variety)	+	8 B/G (fruit & vegetable), 16 (grain crops), 26 (dark green leafy vegetables, carrot and orange or yellow fruit, fish, chicken and milk), 42 (HEI component scores for meat group, milk and grains)	8	6	0	5
Maternal nutrition knowledge	23 I II (green leafy vegetables), 26 (egg, liver, meat and DDS), 42 (HEI and HEI component scores for vegetables, fruits and variety)	+	8 B/G (fruit & vegetable), 26 (dark green leafy vegetables, carrot and orange or yellow fruit, fish, chicken and milk), 42 (HEI component scores for meat group, milk and grains)	6	4	0	4
Exposure to food by family or preschool	25 (test food-round cabbage), 35 (fruit and vegetables, different types of vegetables and fruit and vegetable eating behaviour score)	+	35 (different types of fruits)	2	2	0	2
Role modeling	35 (fruit and vegetables, different types of vegetables and fruit and vegetable eating behaviour score)	+	35 (different types of fruits)	1	1	0	1
Family income	9 (additional food group, MDD and ASF), 18 I II (milk and fish), 20 (sweet potato), 26 (egg, liver, meat and DDS)	+	18 I II (grain, roots, tubers, meat, eggs, fruit and vegetables), 26 (dark green leafy vegetables, carrot and orange or yellow fruit, fish, chicken and milk)	5	5	0	3
Food budget	21 (protein rich foods, green leafy vegetables and fruit)	+		1	1[a]	1[a]	0
	21 (cereals)	-					
Community factor							
Food availability within the surrounding environment	20 (sweet potato), 26 (egg, liver, meat and DDS)	+	26 (dark green leafy vegetables, carrot and orange or yellow fruit, fish, chicken and milk)	2	2	0	1

Eating behaviour outcome - factors	Related to eating behaviour outcomes	Association (+/-)	Unrelated to eating behaviour outcomes	No. of samples	Summary (n)		
	Bibliography no.		Bibliography no.		+	-	0
Food consumption - unhealthy							
Family factor							
Nutrition knowledge of family/ caregivers	16 (unhealthy snacks)	-	16 (western-style high-energy foods), 42 (HEI component scores for sodium, total fat and saturated fat)	3	1[b]	3[b]	1
	16 (fast foods)	+					
	19 (western fast food, sweetened beverages and fried food), 42 (HEI component score for cholesterol)	-					
Maternal nutrition knowledge	42 (HEI component score for cholesterol)	-	42 (HEI component scores for sodium, total fat and saturated fat)	1	1	0	1
Diet related behaviours - healthy							
Family factor							
Nutrition knowledge of family/ caregivers	16 (eating breakfast)	+		1	1	0	0
Diet related behaviours - unhealthy							
Family factor							
Nutrition knowledge of family/ caregivers	16 (monotonous diet, adult assistance during meals, playing during dinner and watching television during dinner)	-	16 (preference for salty foods, consumption of candy before meal and consumption of candy before going to bed)	1	0	1	1
Nutrient intake - energy and macro nutrients							
Family factor							
Household food availability	20 (energy)	+	20 (protein and lipids), 32 I II (energy)	3	1	0	3
Nutrition knowledge of family/ caregivers	8 B (energy), 20 (energy)	+	8 G (energy), 20 (protein and lipids), 32 I II (energy)	5	2	0	4
Maternal nutrition knowledge	8 B (energy)		8 G (energy)	2	1	0	1
Family income	20 (energy)	+	20 (protein and lipids)	1	1	0	1
Community factor							
Food availability within the surrounding environment	20 (energy)	+	20 (protein and lipids), 32 I II (energy)	3	1	0	3

Eating behaviour outcome - factors	Related to eating behaviour outcomes	Association (+/-)	Unrelated to eating behaviour outcomes	No. of samples	Summary (n)		
	Bibliography no.		Bibliography no.		+	-	0
Nutrient intake - micronutrients							
Family factor							
Household food availability	20 (vitamin A, β-carotene, thiamine, riboflavin, niacin, vitamin B-6, folate and vitamin C), 32 I (iron, zinc and vitamin A)	+	20 (retinol, calcium, iron, zinc and vitamin B 12), 32 II (iron, zinc and vitamin A)	3	2	0	2
Nutrition knowledge of family/ caregivers	20 (vitamin A, β-carotene, thiamine, riboflavin, niacin, vitamin B-6, folate and vitamin C), 32 I (iron, zinc and vitamin A)	+	20 (retinol, calcium, iron, zinc and vitamin B 12), 32 II (iron, zinc and vitamin A)	3	2	0	2
Family income	20 (vitamin A, β-carotene, thiamine, riboflavin, niacin, vitamin B-6, folate and vitamin C)	+	20 (retinol, calcium, iron, zinc and vitamin B 12)	1	1	0	1
Community factor							
Food availability within the surrounding environment	20 (vitamin A, β-carotene, thiamine, riboflavin, niacin, vitamin B-6, folate and vitamin C), 32 I (iron, zinc and vitamin A)	+	20 (retinol, calcium, iron, zinc and vitamin B 12), 32 II (iron, zinc and vitamin A)	3	2	0	2

B/G - boys and girls analysed separately in bibliography no. 8

I II - two separate samples, for bibliography no. 17, I - sample at time point 1, II - sample at time point 2; for bibliography no. 18, I - sample received household cash transfer, II - sample received community cash transfer; for bibliography no. 22, I - sample received all intervention components, II - sample received single intervention component; and for bibliography no. 31, I - sample received all intervention components, II - sample received all intervention components except one.

DDS - Dietary Diversity score; HEI - Healthy Eating Index; MDD - Minimum Dietary Diversity; ASF - Animal Sourced Foods

[a] If in one study, a factor is examined in relation to multiple outcomes, (e.g. protein rich foods, green leafy vegetables, fruit and cereals) and the results differ in two directions for the outcomes (e.g. a positive (+) association was found for protein rich foods, green leafy vegetables and fruit and an inverse (-) association was found for cereals) the study is counted once in the 'No. of samples' column, and twice in the 'Summary' column.

[b] If in one study, a factor is examined in relation to two outcomes, (e.g. unhealthy snacks and fast foods) and the results differ for the outcomes (e.g. a positive (+) association was found for fast foods and an inverse (-) association was found for unhealthy snacks) the study is counted once in the 'No. of samples' column, and twice in the 'Summary' column.

Bibliography numbers: 8. da Costa Louzada et al. (2012); 9. Darrouzet-Nardi et al. (2016); 16. Hu et al. (2009); 17. Knueppel et al. (2010); 18. Kusuma et al. (2017); 19. Lin et al. (2016); 20. Low et al. (2007); 21. Mascie-Taylor et al. (2010); 23. Mujibur Rahman et al. (1994); 25. Noradilah and Zahara (2012); 26. Olney et al. (2009); 32. Ramírez-Silva et al. (2013); 35. Sirikulchayanonta et al. (2010); 42. Vitolo et al. (2010)