WHO Systematic Review for Complementary Feeding for ASF

Zohra S Lassi[1], Komal Abdul Rahim[2], Leila Harrison[3], Christina Oh[3], Kimberly Charbonneaue[3], Aatekah Owais[3], Emily Keats[3], Zulfiqar A Bhutta[3]
[1]Robinson Research Institute, the University of Adelaide, Australia
[2]Department of GI & Surgery, Aga Khan University, Pakistan
[3]Centre for Global Child Health, The Hospital for Sick Children, Toronto, Canada

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ABSTRACT

Background: The introduction of complementary feeding in the formative years is important to build and maintain the nutritional status of the infants; failure to introduce complementary feeding in the 6-23 month period can lead to malnutrition. The World Health Organization (WHO) recommends feeding a variety of complementary foods, including fruits and vegetables (FV), animal-source foods (ASF), and nuts, pulses, and seeds (NPS) to meet nutritional demands during this period of rapid growth and development. Amongst these nutritional sources, animal-source foods are very important. ASF are rich in both micro and macro-nutrients and provide high-quality proteins and growth-stimulating hormones in children. Thus, the purpose of this systematic review is to assess the health, development, and dietary effects of more frequent vs less frequent, greater amount vs lesser amount, and more varied vs less varied consumption of ASF during the complementary feeding period.

Objectives: To compare: i) the effect of more frequent versus less/no frequent consumption of ASF, ii) the effect of more amount versus less/no amount consumption of ASF, and iii) the effect of more varied versus less/no varied consumption of ASF among infants 6-23 months on dietary and health outcomes. In addition, to determine differences between processed/commercial versus fresh/home-prepared ASF on dietary and health outcomes.

Search Methods: The search strategy was formulated using the PICO methodology based on medical subject headings and keywords and run in the following electronic databases: MEDLINE, Embase, CINAHL, African Index Medicus, LILACS, Cochrane CENTRAL, and eLENA (WHO). Searches were also conducted for non-indexed, grey literature using Google Scholar and key organizational websites, as well as reference lists of all relevant systematic reviews captured in the search strategy. All search results were screened in duplicate.

Individual studies were critically appraised using the Cochrane Risk of Bias-2 (ROB-2) tool for randomized controlled trials and cluster-randomized controlled trials, the NIH tool for observational cohort and cross-sectional studies, and the ROBINS-I Tool for non-randomized studies. GRADE certainty assessment was done for the outcomes that were meta-analysed and the ones reported the 6 critical outcomes including stunting or HAZ, wasting or WAZ, underweight of WHZ, change in head circumference, change in triceps skinfold, and anemia or hemoglobin.

Selection Criteria: The criteria for considering studies for this review were as follows: healthy male and female children aged 6-23 months from any low-, middle-, or high-income country; consumption of ASF that has been reported in terms of frequency, variety, or amount; and the study must have measured a primary or secondary outcome of interest. We excluded studies with the recruitment of “unhealthy” child populations; and qualitative studies or reviews.

Data collection and analysis: Four review authors independently extracted data into a piloted excel sheet and completed risk of bias assessments for each included study (in duplicate). Any disagreements were resolved through discussion or by a third reviewer.

All experimental and observational study data were analyzed separately. Conducting meta-analysis was only possible for three outcomes (WAZ, HAZ, WHZ), given the heterogeneity across studies in food

group item consumed, outcome metrics, and frequency categories. As such, a narrative synthesis was conducted across all exposures and outcomes.

Results: We included 31 studies that analyzed the data from 278,358 children that ranged from 0-12 years at the time of enrollment. The included studies took place in Europe (n=9), Africa (n=7), Asia (n=5), North America (n=3), South America (n=1), and one multi-center study. Of the included studies, 17 were observational studies, 15 were randomized experimental studies and one was non-randomized experimental study. Out of these, 13 looked at the frequency of consumption of ASF, 18 looked at the amount of ASF and two looked at the variety of ASF.

Most of the time, the outcomes were only reported from a single study; hence no proper conclusions were made regarding the effects of different frequencies, amounts, and varieties of ASF consumed.

Frequency of the ASF

Randmomized Interventional Studies

None of the studies used RCTs in reporting the frequency of the ASF.

Non-Randomized Interventional Studies

None of the studies used quasi-RCTs in reporting the frequency of the ASF.

Observational Studies

The ASF including meat, organ meat (liver), eggs, and fish showed no significant difference in between greater and lesser amounts with a GRADE rating in between very low to moderate. However, a significant 48% reduction in wasting was reported among children who consumed fish ≥4 times/week compared to those who consumed fish 1-3 times/week (GRADE= moderate)

Amount of the ASF

Randmomized Interventional Studies

The review found no difference in the growth and nutritional outcomes amongst children who were given different types of meat including red meat, organ meat, pork, eggs, dairy, seafood, and insects. However, the findings from two of the studies that measured different amounts of ASF were meta-analyzed for the following outcomes: weight-for-age z-score (WAZ), height-for-age z-score (HAZ), and weight-for-height z-score (WHZ). The age range of the children was 6-9 months, and the children were followed for 6 months after giving 1 egg per day vs no egg consumption. The pooled analysis demonstrated a potential difference in the mean WAZ score in greater amount than lesser amount groups (mean difference (MD): 0.15; 95% confidence intervals (CI) 0.00, 0.30; 2 studies n= 743 participants; heterogeneity= I^2 0%, Chi^2 p= 0.20; GRADE= moderate quality). However, there was no significant difference in mean HAZ between both the groups (MD 0.06; 95% CI -0.10, 0.22; 2 studies n= 753 participants; heterogeneity= I^2 39%, Chi^2 = 1.64; GRADE=low quality), or in mean WHZ (MD -0.10; 95% CI -0.24, 0.04; 2 studies n= 743 participants; heterogeneity= I^2 63%, Chi^2 2.68; GRADE= low quality).

Non-Randomized Interventional Studies

There was only one study that assessed the different amount of ASF impact on the micro-nutrients including iron, magnesium, copper, and many more. Given the single study included, the details are not given in this report. However, the details can be taken from the data extraction sheet appended.

Observational Studies

The study assessing the varied amount of cow's milk on hemoglobin, serum ferritin, transferrin receptors, and mean corpuscular volume showed no significant difference with a GRADE-very low for hemoglobin.

Variety of the ASF

Randmomized Interventional Studies

None of the studies used RCTs in reporting the variety of the ASF.

Non-Randomized Interventional Studies

None of the studies used quasi-RCTs in reporting the variety of the ASF.

Observational Studies

No difference was reported in stunting in children who consume 3 types of ASF or 2 types of ASF compared to those who consume 0 types of ASF. Similarly, no difference in stunting was reported in children who consume 3 types vs 1 type of ASF or 2 types vs 1 type of ASF. Furthermore, no difference in stunting was reported in children who consume 3 types of ASF vs those who consume 2 types of ASF. However, a potential 1% reduction in stunting was reported in children who consume 1 type of ASF when compared to those who consume 0 types of ASF (GRADE= very low)

Quality Assessment

Overall, for observational studies, we rated the quality of two studies as good, nine studies as fair, and six studies as poor. For randomized experimental studies, we rated the quality of one study as high-risk of bias, nine studies as moderate-risk of bias, and three studies as low risk of bias. For the non-randomized experimental study, we rated the quality as low to moderate-risk of bias.

Author's conclusions

The findings from this systematic review aimed to inform the development of the updated WHO infant and young child feeding guidelines along with country-specific policies and programs relating to complementary feeding. There was high heterogeneity amongst the studies, because of which most of the findings cannot be meta-analyzed. Only three outcomes (WAZ, HAZ, WHZ) from two of the studies were meta-analyzed with a GRADE of low to moderate. This systematic review identified a big data gap in terms of the evidence and the quality of the studies. This shows that there is a need to conduct more consistent studies, and higher-quality studies so that the findings can be pooled and appropriate guidelines can be made.

1 BACKGROUND

1.1 The Problem, Condition, or Issue

Adequate nutrition during infancy is essential to the development of a child's full potential later in life (1). The initial two years of life are very crucial for the infant's growth including both physical and cognitive growth; this is the time when the development of the child is vulnerable to insults as a result of poor dietary intake and diseases. Therefore, this is considered a "critical window" for the children (1, 2). Longitudinal studies have consistently shown that poor dietary intake during these formative years can put the infant at risk of different morbidities, increased mortality, and delayed motor and mental development in the short-term (1, 3). In the long-term, the risk of impaired intellectual performance, work capacity, poor reproductive and overall health outcomes increases leading to significant loss of human capital in the later years of life (4).

The introduction of complementary feeding in the formative years is important to build and maintain the nutritional status of the infants; failure to the introduction of complementary feeding in the initial can lead to malnutrition (1). Malnutrition in children is comprised of both undernutrition (stunting and wasting) and overnutrition (overweight and obesity). Both under- and over-nutrition may be associated with micronutrient deficiencies. Undernutrition is associated with up to 45% of deaths among children under the age of 5; as of 2020, 47 million children under the age of 5 are wasted, 14.3 million are severely wasted, and 144 million are stunted (5). Additionally, 38.3 million children under the age of 5 are overweight or obese (5). Of the major micronutrient deficiencies, vitamin A, zinc, iron, and iodine are of most concern, as they have been linked to the largest proportions of years of life lost and disability-adjusted life years (6, 7).

Malnutrition during the initial two years of life can be directly linked to poor breastfeeding and complementary feeding practices; the result is even amplified in the presence of the infectious disease (1). Exclusive breastfeeding is recommended until an infant is 6 months of age. By the time the child reaches 6 months, the nutritional demand of the growing infant increases; to meet those requirements, the initiation of complementary feeding at 6 months is needed alongside breastmilk to achieve optimal growth and development (1). There are two types of complementary foods: specially prepared foods and typical family foods that have been modified for the infant (8). For example, a caregiver may especially prepare a porridge dish for the infant, while the rest of the family consumes a nut stew. When the infant is a bit older, the caregiver may mash the nut stew into a different consistency and texture, making it easier for the infant to consume the family food (8). Although breastfeeding may continue past 2 years of age, complementary feeding is typically targeted to infants from 6 to 23 months, after which they are expected to consume family foods. While the numerous benefits of continued breastfeeding (>6 months) are well understood, there is less consensus on certain aspects of complementary feeding, including the timing of initiation, pattern of introduction, and amount and frequency of provision of different types of complementary foods (1).

1.2 The Intervention

Based on an average intake of breastmilk among healthy infants, the energy needs from complementary foods are estimated to be about 200 kcal per day for infants aged 6-8 months, 300 kcal per day for infants 9-11 months, and 550 kcal per day for infants 12-23 months (1). This translates into a meal frequency of 2-3 times per day for the youngest infants (6-8 months) and 3-4 times per day through the rest of the complementary feeding period (1). For non-breastfed infants, the energy needs from complementary foods are estimated to be about 600 kcal per day for infants 6-8 months, 700 kcal per day for infants 9-11 months, and 900 kcal per day for infants 12-23 months (9). For non-breastfed infants, the meal frequency is defined as 4-5 times per day throughout the entire complementary feeding period (6-23 months) (9, 10). However, needs will vary depending on breastmilk intake, growth rates, and other factors, such as illness and environmental conditions. The World Health Organization (WHO) also recommends feeding a variety of complementary foods, including fruits and vegetables (FV), animal source foods (ASF) (e.g., meat, poultry, dairy products, eggs), as well as nuts, pulses, and seeds (NPS) to meet nutritional demands during this period of rapid growth and development (1).

1.3 How the intervention might work

The nutritional sources taken by the children during the initial five years of life directly impact the growth and developmental patterns (11). Amongst these nutritional sources, animal-source foods are very important. It has been observed that infants who are exclusively breastfed are taking lesser ASF (12). ASF is rich in certain nutrients which cannot be obtained from plant-source foods alone. Nutrition Collaboration Research Support Program in the 1980s conducted their study where they highlighted that micronutrients which are low in plant-sourced food, but rich in ASF (13-15). These include Vitamin A and B-12, calcium, zinc, iron, and riboflavin. If the intake of these nutrients is reduced for any reason, this s Corrected may lead to anemia, growth-related abnormalities including rickets, cognitive function decline, neuromuscular issues and can even lead to death (13-15).

ASF is rich in both micro and macro-nutrients and provides high-quality proteins and growth-stimulating hormones in children (16). Two studies reported that children who consume less ASF during their infancy are at increased risk of stunting (16), and therefore children who are given ASF during infancy have shown better growth and cognitive outcomes, and are less likely to be nutrition deprived (17, 18). In addition to this, one study highlighted that the consumption of ASF by pregnant mothers also provides benefits to the fetus by hindering the “inter-gestational cycle of undernutrition” which might occur as a result of food insecurity (17).

Similarly, proteins, fats, saturated fats, along with minerals, vitamins, iron, and carotenoids from the egg consumed are important for children’s growth. Findings from a study conducted in 18 rural villages in Burkina Faso showed that infants who were given eggs in their complementary diet showed lesser incidences of wasting and underweight (19). Another study reported that protein coming from animal-source foods is found to be positively associated with the growth of infants (20). A literature review was conducted to identify the effect of complementary feeding particularly ASF on the growth and risk of obesity in infants; findings suggested that consumption of meat improves the growth outcomes of the children, and is less likely to cause overweight (20). Even a modest inclusion of meat in the infant’s diet can greatly improve the overall nutritional status, functional status, and health (21), suggested by one of the studies. In addition to this, Small freshwater fish and rabbits are also two important ASF that can help combat the nutritional deficiencies in infants, but they never got enough attention (21). Insects are also to be nutrient-rich and an integral part of the complementary diet of the infants; a study conducted was conducted in Ghana to assess the nutrient content of raw vs mixed insect-fortified food which reported that mixed insect-fortified foods can be a great source of micronutrients (magnesium, zinc), vitamins and proteins (22).

While it is important to consume ASF during the early years of life, many parents tend to avoid giving ASF to their children. The Feeding Infants and Toddlers Study (FITS) is the largest and expanded food survey in the world. The findings from the FITS 2008 showed that there were only 10% of the older infant in the United States who consumed meat accounting for only 5% of the total energy (23). The recent FITS 2016 showed that the numbers of meat consumption amongst older infants have decreased even more to 5% in the United States (24). Many parents believe that the consistency of the ASF is very thick and may cause problems in digestion increase the likelihood of causing “heaviness” in the gut which may lead to dysphagia, and choking (25). The other reasons for not giving ASF to children during infancy especially in LMICs include lack of awareness and knowledge on the importance of ASF as part of the complementary feeding, the high price of the products coming from an animal source, increased workload of the mothers in the herd livestock, and certain social and religious norms and beliefs (26-28).

1.4 Why it is important to do this review

Complementary feeding is a critical time of transition for an infant, and inappropriate complementary feeding practices are associated with adverse short- and long-term health and nutrition outcomes. ASF is considered an essential source for growth and other nutrients such as iron, zinc, and fat that is very beneficial for infants during their initial years of life (15). According to the global guidelines by PAHO/ WHO, the quality diets which are consumed by the children as part of their complementary feeding, there should be diverse in frequency, amount, and types (25). However, to date, there have been no reviews assessing the effect of more frequent or varied or greater amount consumption of ASF to less frequent, varied, or amounts of ASF consumption, during the complementary feeding period on dietary and health outcomes. What literature does exist on reports on the incidence of ASF intake, or interventions to improve consumption of this food group during the complementary feeding period (i.e., educational interventions aimed at improving complementary feeding practices)? Specific guidance around the optimal frequency and variation in types of ASF that should be consumed is lacking. We, therefore, seek to assess the dietary and health outcomes that are associated with more versus less frequent and varied consumption of ASF. Findings from this review will help to inform the development of the updated WHO Infant and Young Child Feeding (IYCF) guidelines, along with future policies and programs that relate to complementary feeding. This will have important implications for the health and wellbeing of infants, with lasting effects throughout the life course.

2. OBJECTIVES

The primary objectives of this systematic review are to compare: i) the effect of more frequent versus less frequent consumption of ASF, ii) the effect of more amount versus less amount consumption of ASF, and iii) the effect of more varied versus less varied consumption of ASF among infants 6-23 months on dietary and health outcomes later in life.

The secondary objectives of this review are to determine differences between processed/commercial versus fresh/home-prepared ASF on dietary and health outcomes.

3. METHODS

3.1 Criteria for considering studies for this review

3.1.1 Types of Studies

The types of studies included were primary studies of experimental design and observational design. Eligible study designs included randomized controlled trials (RCTs; cluster or individually randomized), non-randomized controlled trials, cohort studies (prospective and retrospective), cross-sectional studies, and case-control studies. Qualitative studies and reviews were excluded from this review.

3.1.2 Types of Participants

Healthy male and female children aged 6-23 months, living in any low-, middle-, or high-income country. Studies were excluded if the infant population was considered unhealthy and infants were recruited based on this criterion. This includes, but is not limited to, infants with acute or chronic conditions/diseases, such as malnutrition, diarrhea, or human immunodeficiency virus (HIV), and infants born preterm, small-for-gestational-age (SGA), or low birth weight (LBW). Though we aimed to include healthy infants under two years of age, given the high burden of some of these conditions in certain populations globally, we recognize that malnourished infants and infants born preterm, SGA, or LBW are most likely included in the overall sample.

3.1.3 Types of Interventions

Studies were eligible for inclusion if they: i) measured and reported data on consumption practices (reported as frequency, variety, and/or quantity of food consumed) during the complementary feeding period; ii) examined the consumption of animal-source foods; and iii) reported a relevant primary or secondary outcome (noted below).

We aimed to define frequency, variety, and quantity exposures for ASF as follows:

- Frequency: none, once daily, 2-3 times per day, 3-4 times per day, >4 times per day, 1-3 times weekly, 4-6 times weekly, served either as meals or snacks.
- Variety: one type of food item per day, 2 different types per day, 3 different types per day or, >3 different types per day. These same variety exposures were evaluated on a per-week basis as well.
- Quantity, based on energy requirements by age:
    - 6-8 months: <137 grams (g) per day, 137-187 g/day, >187 g/day, OR <200kcal/day, ≥200 kcal/day
    - 9-11 months: <206 g/day, 206-281 g/day, >281 g/day, OR 9-11 months: <300 kcal/day, ≥300 kcal/day
    - 12-23 months: <378 g/day, 378-515 g/day, >515 g/day, OR <550 kcal/day, ≥550 kcal/day

The type of milk provided during the complementary feeding period was not a consideration for study selection (e.g., breast milk, animal milk, infant formula, or mixed).

The comparison for frequency, variety, and quantity exposures for ASF was as follows:

- Less frequent Vs more frequent consumption of ASF

- Less varied Vs more varied consumption of ASF
- Lesser amount Vs greater amount of ASF

3.1.4 Types of Outcome Measures

Primary outcomes:

1. Subsequent consumption of food items across the two food groups at 1 year, 2 years, 3 years, 4 years, 5 years, and beyond 5 years of age.
2. Nutrient adequacy (e.g., protein intake and quality, micronutrient intake, choline, and essential fatty acids) or nutrient excess (e.g., saturated fat, protein, sodium, fiber/phytate by type, fats), as reported by the study authors.
3. Nutrient status at study endline (blood concentration of vitamin A, vitamin C, vitamin D, vitamin E, B vitamins, zinc, iron, folate, selenium, lutein, carotenoids, iodine, fatty acids (omega 3 and 6); anemia; antioxidants.
4. Anthropometric outcomes, including stunting (height-for-age z-score < -2 SD), wasting (weight-for-age < -2 SD), underweight (height-for-weight z-score < -2 SD), overweight (weight-for-height > 2 SD), and obesity (weight-for-height > 3 SD), as defined by the WHO Growth Standards (29). Anthropometric indices as continuous outcomes were also included and evaluated.
5. Child development (as defined by authors).
6. Contaminants within foods consumed (e.g., aflatoxins), as reported by the study authors.
7. Displacement of other foods/dietary adequacy, as reported by study authors.

Secondary outcomes:

1. Food/taste preferences later in life.
2. Markers of lipid profiles (e.g., total cholesterol, triglyceride, low-density lipoprotein, high-density lipoprotein) at the end line or latest follow-up.
3. Markers of inflammation (e.g., C-reactive protein, plasminogen activator inhibitor-1) at the study end line or latest follow-up.
4. Markers of gut health (e.g., Bifid bacterium, Clostridia, short-chain fatty acids, environmental enteric dysfunction, microbiome) at the study end line or latest follow-up.
5. Adverse effects, as reported by the study authors.
6. Morbidity (infectious).
7. Food-borne illness (not related to storage and handling).
8. Bone health, as defined by authors.
9. Oral health, as defined by authors.
10. Adverse events (e.g., choking).

3.1.5 Types of Settings

All settings within any low-, middle-, or high-income country were considered for this review.

3.2 Search Methods for Identification of Studies

3.2.1 Reporting and Protocol

The protocol for this review was registered with the International Prospective Register of Systematic Reviews (PROSPERO #: 203655).

Electronic searches

Our search strategy was formulated using the PICO methodology based on medical subject headings (MeSH) and keywords. The search strategy was designed to capture studies evaluating the two food groups of interest (FV and NSP), along with animal-source foods (ASF). Studies were screened together until the analysis stage, at which point included studies were analyzed separately for each food group. This report will focus on the ASF. Synthesis and findings from the FV and NSP studies will be reported in a separate report.

Electronic searches were conducted in the following databases:

- MEDLINE
- Embase
- CINAHL
- African Index Medicus (AIM)
- LILACS
- The Cochrane Central Register of Controlled Trials (CENTRAL)
  eLENA (WHO)

Searches were also conducted in non-indexed, grey literature using Google Scholar and key organizational websites including UNICEF, Nutrition International, the Global Alliance for Improved Nutrition, Hellen Keller International, and the CDC. There were no restrictions on publication date or language. The date of the final search was October 7, 2020. The search strategy can be found in box 1 in the appendix.

3.2.2 Searching other sources

We searched the reference lists of all relevant systematic reviews captured during our electronic search for other studies that may not have been captured through this search strategy.

3.3 Data Collection and Analysis

3.3.1 Selection of studies

Studies for the title and abstract screening and full-text screening were managed using Covidence, a web-based software platform for systematic reviews. At both title/abstract and full-text screening stages, two review authors independently scanned and screened all records retrieved by the searches for relevance based on selection criteria (Table 1). Any disagreements were resolved through discussion or by a third review author when necessary. The selection process can be viewed in a flow diagram (Figure 1).

3.3.2 Data extraction and management

Two review authors independently extracted data from each included study onto a standardized data extraction form in Excel that had been piloted. All studies were matched between the two review authors, and any disagreements or discrepancies were resolved through discussion, or by a third independent reviewer.

We extracted the following information from each included study: source (e.g., contact details); study characteristics (e.g., study design, location of study, years of data collection, etc.); population characteristics (e.g., age, sample size, nutritional information at baseline, etc.); intervention/comparison characteristics (e.g., exposure, tools used for measurement, etc.); outcomes (e.g., food frequency data, methods/tools used, age at outcome assessment, etc.); data analysis methods; control of confounding; funding obtained, and any conflict of interests.

Non-English language studies that were included in this review were translated from Portuguese (n=1) and Chinese (n=1) to English. Where any information was unclear, seemed incorrect, or missing, we contacted the authors for missing details (n=5).

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria
● Low-, middle-, or high-income country
● Healthy male and female children aged 6-23 months who have consumed ASF
● Types of interventions ○ Consumption must have been reported in terms of frequency or variety or amount of ASF
● Relevant study designs: ○ Randomized controlled trials (RCTs) ○ Non-randomized controlled trials (NRTs) ○ Cohort studies ○ Case-control studies ○ Cross-sectional studies
● The study measures a primary or secondary outcome of interest
Exclusion Criteria
● Recruitment of ”unhealthy” child populations, including but not limited to acute or chronic conditions/diseases, genetic diseases, malnutrition, diarrhea, or human immunodeficiency virus (HIV)
● Irrelevant study designs: reviews, qualitative studies

3.3.3 Assessment of risk of bias in included studies

Quality assessments of included studies were conducted independently by two review authors (CO, KC, KR, LH). Any discrepancies between reviewers were resolved through discussion or by a third reviewer. Individual studies were critically appraised using the Cochrane Risk of Bias-2 (ROB-2) tool for randomized controlled trials and cluster-randomized controlled trials (27), the NIH tool for observational cohort, and cross-sectional studies (28), and the ROBINS-I Tool for non-randomized studies (29).

The Cochrane Risk of Bias-2 tool assesses RCT studies for risk of bias in the following domains: randomization process, deviations from the intended interventions, missing outcome data, outcome measurement, and the selection of the reported results. The overall risk of bias judgment was given to each study (low, high, some concerns).

Using the NIH tool, observational studies were rated good, fair, or poor, based on fourteen criteria covering the research question, participant population, analyses, timeframe, independent and dependent variables, attrition, and control of confounding variables.

The ROBINS-I tool assessed non-randomized trials in the following domains: bias due to confounding, bias in the selection of study participants, bias in classification of interventions, bias due to deviations from intended interventions, bias due to missing data, bias in the measurement of outcomes, and bias in the selection of the reported results. Each study was given an overall risk of bias judgment (low, moderate, serious, critical). See Appendix for further details about the quality assessment tools utilized in this review.

3.3.4 Data Synthesis

All experimental and observational study data were analyzed separately. Conducting meta-analysis was possible for only three outcomes, given the heterogeneity across studies, including food group items, outcome metrics, and frequency categories. The meta-analysis was done using Review Manager 5.4 with applied random effects. As such, a narrative synthesis was conducted for the ASF groups.

3.3.5 GRADE Certainty Assessment

The intention was to assess the quality of the evidence for each primary and secondary outcome through the GRADE assessment. This was only done for the studies that were included in the meta-analysis. Two studies fall under the section of meta-analysis; thus the outcomes of these studies were pooled. The outcomes which were pooled included weight-for-age-score (WAZ), height-for-age score (HAZ), and weight-for-height-score (WHZ) (30, 31).

However, for the 6 critical outcomes, the GRADE certainty assessment was also performed. These outcomes included stunting or HAZ, wasting or WAZ, underweight or WHZ, change in head circumference, change in triceps skinfolds, and anemia or hemoglobin.

3.3.6 Sub-group analysis

We planned the sub-group analysis based on the age (6-8 months, 9-11 months, and 12-23 months), the type of the ASF consumed, and the socio-economic status of the participants. Some studies mentioned the household income in the socio-demographic data (32-41). However, we could not perform the sub-group analysis given the sparse and heterogeneous data that did not allow for meta-analysis.

4. RESULTS

Our searches generated 31,124 records, of which 6 studies could not be retrieved from the CINAHL database. After removal of duplicates, we title/abstract screened 21,609 records, of which 535 studies were found to be potentially eligible for inclusion. 502 were excluded with the reasons highlighted in **Figure 1**. Finally, 31 were found eligible for the data synthesis of ASF.

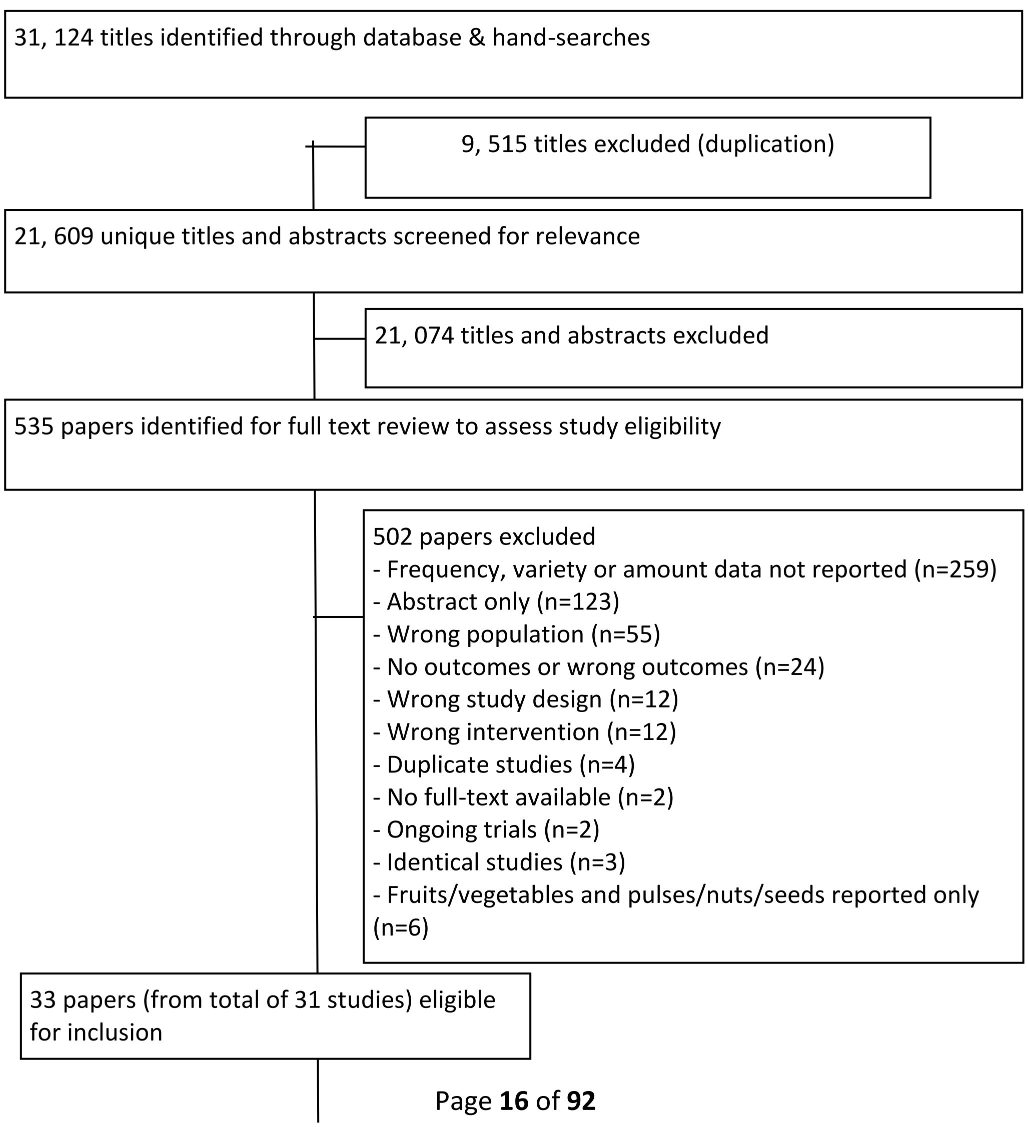
4.1 Description of Studies

4.1.1 Focus of Included Studies

Studies included were published between 1998 and 2020. Of the total studies, 13 compared the frequencies of ASF (32-39, 42-48), 16 compared amounts of ASF (30, 31, 40, 41, 49-60), and 2 compared the variety of ASF (35, 47).

Two included studies had other associated published papers; therefore, Stewart et al. (31) and Iannotti et al. (30) were taken as primary studies for data extraction.

Figure 1: Search flow diagram



4.1.2 Study Design of Included studies

Of the included studies, 17 were observational (32-39, 42-48, 58, 59), 13 were randomized controlled trials (30, 31, 40, 41, 49-57, 61, 62), and one was non-randomized experimental (60).

4.1.3 Location of included studies

Of the included studies, nine were conducted in Europe: two each in England (58, 60) and Germany (41, 49), one each in Denmark (50), Iceland (59), Israel (44), the Netherlands (38) and Sweden (39). Seven studies were conducted in Africa: one each in the Democratic Republic of Congo (DRC) (51), Ghana (52), Malawi (31), Senegal (37), Somalia (34), South Africa (33), and Zambia (35). Five studies were carried out in Asia: two each in Indonesia (32, 46) and Japan (36, 43); and one in Myanmar (45). One study was conducted in Australia (56), and one study in Cambodia from the Western Pacific region (57). Three studies took place in North America: the countries included two studies generalized as United States of America (54, 55) and one study from Ecuador (30). One study was from Brazil, South America (42). There was one multi-country study that took place in 39 countries from varied WHO regions including Africa, the Americas, Eastern Mediterranean, and Europe (47).

4.1.4 Participants in Included studies

There were a total of 278,358 children in the included studies, that ranged from 6 months to 12 years of age. Children were 0 months to 12 years of age at the time of enrollment in the included studies. This wide age range is because, there was one study that enrolled study participants from the age range of 0-12 months (33), and there was another study that enrolled study participants from the age range of 1-12 years (39). However, data was only extracted for children 6-23 months of age.

Regarding the breastfeeding status, 22 studies mentioned the breastfeeding status of children (31, 33, 34, 36-46, 49-52, 54, 56-58). However, 9 studies did not report the breastfeeding status of children (30, 32, 35, 47, 48, 53, 55, 59, 60). Studies that reported the breastfeeding status did not readily compare it with the outcomes of the studies, except in one study (57).

4.1.5 Description of Intervention in Included studies

Thirteen studies reported the frequency of ASF, 18 reported the amount of ASF, and 2 reported the variety of ASF.

The frequency, amount, and variety were defined differently in all the studies. For assessing the frequency of the ASF, 3 studies used 24-hour recall (32, 37, 46), 7 studies used food frequency questionnaires (FFQ) (33, 36, 38, 39, 43-45), 1 study used data from the food survey (48), 1 study used both 24-hour recall and FFQ (42), and 1 study collected data during face-to-face interviews using a structured questionnaire (34).

To assess the amount of the ASF consumed by the children, 3 studies used 24-hour recall frequency of dietary intake of foods commonly consumed (30, 31, 59), 3 studies utilized weekly visits to count empty food packets and record mothers' reports (40, 51, 54), 2 studies used three-day diet records that were completed by mothers (55, 58), 2 used a 24-hour dietary record (49, 50) before monthly visits, 2 studies checked the compliance with feeding by the community doctors through weekly histories and by observation of feeding of the supplement (53, 57), 1 study used weight dietary method (41), 2 studies provided a discrete amount of complementary foods to the study participants: the participants were supplied ASF in cartons coded A or B (depending on the type of egg, normal vs DHA enriched (56), and prepackaged complementary foods to mothers an recording food intake by monthly 24-h recalls for 3-days (500 g/wk) without charge; however, the mothers were also free to feed other foods to the children too (52). One study reported the amount of ASF consumed using a 7-day weighed food intake (60).

To assess the variety of ASF, 2 studies used a 24-hour recall to collect data on amounts of specific foods consumed in the preceding 24 hours (35, 47).

4.1.6 Outcomes in Included studies

The outcomes of all the included studies have been shown in **Table 4.1.6**. The breadth of the data obtained from the included studies shows that because of the heterogeneity, the data cannot be meta-analyzed.

There were varied forms of fatty acids reported in the study. Details of these are given as follows: three studies reported linoleic acid (LA) (41, 54, 62), 2 studies reported alpha-linoleic acid (ALA) (41, 62), 3 studies reported docosahexaenoic acid (DHA) (54, 56, 62), and 2 studies reported Eicosapentaenoic acid (EPA) (41, 54).

Home-based food Vs Processed or commercial Food

Of all the studies, 1 reported that the ASF was a mix of both unprocessed and processed meat (33). One study used commercial food (49), and 1 study used processed food (57).

4.1.7 Excluded Studies

We excluded 502 studies. The most common reason for exclusion was the frequency, variety, or the amount that was not measured or reported in the data (n=259).

4.2 Risk of Bias of the Included Studies

4.2.1 Randomized Interventional studies

There were 13 randomized intervention studies. Overall, we rated the quality of 1 study as high risk of bias (40), 9 studies as the moderate risk of bias (30, 31, 41, 50-53, 55, 57), and 3 studies as low risk of bias (49, 54, 56).

See figure 2 for risk of bias ratings for each included study.

Randomization Process: Out of 13 of the included studies, 10 studies performed random allocation of the intervention in the children (30, 31, 41, 49-52, 54, 56, 57); thus these studies were regarded as having low risk in this domain. However, there were concerns for 2 studies, as the authors did not mention the concealment process (53) or information on the allocation of the intervention (55); thus, these studies were regarded as medium risk of bias. There was 1 study in which the allocation sequence was not concealed (40); thus we rated this study as a high risk of bias.

Effect of Assignment and Adhering to Intervention: Out of 13 included studies, 5 studies had no deviations from the intended intervention in terms of assignment and compliance (40, 41, 49, 54, 56); thus these studies were rated as low risk of bias. However, 8 studies deviated from the intended

Table 4.1.6: Summary of the Outcomes in Included Studies									
Outcomes	**Frequency**			**Amount**			**Variety**		
	RCTs	**Q-RCTs**	**Observational**	**RCTs**	**Q-RCTs**	**Observational**	**RCTs**	**Q- RCT**	**Observational**
Stunting	-	-	Two studies (32, 45)	Three studies (30) (40) (51)	-	-	-	-	One study (47)
Wasting	-	-	Two studies (32, 45)	Two studies (40) (51)	-	-	-	-	-
Underwight	-	-	Two studies (32, 45)	-	-	-	-	-	-
WAZ	-	-	-	Five studies (30, 31, 40, 51, 55)	-	-	-	-	-
HAZ	-	-	-	Five studies (30, 31, 40, 51, 55)	-	-	-	-	-
WHZ	-	-	-	Five studies (30, 31, 40, 51, 55)	-	-	-	-	-
HCAZ	-	-	-	Three studies (31, 40, 55)	-	-	-	-	-
Change in height	-	-	-	Two studies (50, 55)	-	-	-	-	-
Change in weight	-	-	-	Two studies (50, 55)	-	-	-	-	-
Change in head circumference	-	-	-	Two studies (55, 57)	-	-	-	-	-
Change in triceps skinfold	-	-	-	Two studies (50, 57)	-	-	-	-	-
Anemia	-	-	One study (42)	Two studies (51, 56)	-	-	-	-	-
Hemoglobin concentration	-	-	-	Four studies (50, 51, 56, 57)	-	One study (59)	-	-	-
Vit. B concentration	-	-	-	Two studies (30, 40)	-	-	-	-	-
Serum Ferritin	-	-	-	Four studies (40, 49-51, 56, 57)	-	One study (59)	-	-	-
Mean corpuscular volume	-	-	-	-	-	One study (59)	-	-	-
Transferrin Receptors	-	-	-	Five studies (40, 50, 51, 56, 57)	-	One study (59)	-	-	-
Zinc Intake	-	-	-	Two studies (40, 50)	-	-	-	-	-
Fatty Acids	-	-	-	(41, 54, 56, 61)	-	-	-	-	-
Others*	*Few of the studies reported single outcomes which were not commonly measured (please refer to Annex 1)								

intervention (30, 31, 50-53, 55, 57). These studies were rated as having a medium risk of bias in this domain. The reasons included no mention of the blinding strategies despite giving the methodology the name as "blind parallel interventional study" (50), 7 additional eggs given to the family per week increases the likelihood that other family members may eat intervention egg (31), and participants not blinded given the intervention (30, 51-53, 55, 57).

Missing Data: Out of 13 studies, 5 studies had no problems in reporting the data (30, 31, 52, 54, 56); thus these studies were rated as having a low risk of bias in this domain. However, 8 studies had moderate levels of missing data (40, 41, 49-51, 53, 55, 57); thus these were rated as having a moderate risk of bias.

Measurement Outcome: Out of 13 studies, 10 studies measured the outcomes correctly (30, 31, 40, 41, 49, 53-57); thus these studies were at low risk of bias in this domain. However, 2 studies had some concerns in measuring the outcomes (51, 52); 1 study does not provide baseline prevalence making it difficult to measure the magnitude of the effect (51), and the other study does not report if the outcome assessors were blind of the intervention enrollment status (52). Thus these studies were rated as having a moderate risk of bias in this domain. In addition to this, there was 1 study that did not measure the outcomes correctly (50), and was rated as having a high risk of bias in this domain; there is no mention of blinding in this intervention study, thus it is possible that bias arose from the influence of the intervention. Additionally, a significant number of infants were unable to have blood sampled by venipuncture and it is reported that there may be significant differences in blood results based on the method of venipuncture compared to finger prick, potentially causing a significant source of bias (50).

Reporting the Results: Out of 13 studies, 10 studies had no concerns reporting the results (30, 31, 40, 41, 49, 52, 54-57); thus these were rated as having a low risk of bias in this domain. However, 3 studies had some concerns in reporting the results (50, 51, 53), and were rated as the moderate risk of bias in this domain. This is because, 2 of the studies do not define a pre-specified analysis plan (51, 53), and one did not use the same method of blood collection for all the participants which could have led to results being reported differently (50).

4.2.2 Non-randomized Interventional studies: There was only 1 study that followed a non-randomized study design (60). This study had a low to moderate risk of bias overall. There were some concerns around potential bias from deviation from the intended intervention, however, the study reported only a small number of participants who changed intervention groups throughout the study. Additionally, there is quite a bit (~25%) of missing data which could harm the internal validity of the study. Lastly, there are some concerns around the measurement of outcomes due to no mention of blinding.

See Table 3 for the risk of bias of the included study.

Bias Due to Confounding: In this study, the confounders were taken by the authors during analyses and ANCOVA was used to assess the effects of the confounders; thus, the study has a low risk of bias in this domain.

Selection Bias: In this study, participant selection occurred before the intervention started and the start of the intervention occurred at the same time frame for all participants; thus posing a low risk of bias in this domain.

Bias Due to Deviations from Intended Intervention: In this study, there were some concerns relating to the intended intervention. An examination of the meat intakes at each time point was made to determine whether a child moved from one group to another for the study. It was found that only a small number did so, thus confirming the integrity of the categorization and giving a moderate risk of bias in this domain.

Bias Due to Missing Data: In this study, there was a moderate to high risk of bias in this domain. This is because approximately 25% of the total sample of infants withdrew before the end of the study due to domestic and logistical reasons. The study reports that where these subjects had completed at least 1 year of the study, their results were included. No further information is provided on these subjects whose data was not captured thus it's challenging to tell if the study may be biased in a certain direction.

Bias in Measurement of Outcomes: In this study, it was not mentioned whether the outcome assessors were aware of which intervention the infants received. Thus it is challenging to say whether there was bias in this domain. However, outcome assessment methods were unanimous across all groups and since the outcome methods were assessed via blood sampling and laboratory techniques there should be no differences in the intervention groups.

Bias in Selection of Reporting the Results: In this study, there were not multiple outcome measurements within the outcome domain possible. Since the outcome is assessed through blood collection, hematology, and biochemistry analysis, there should be no bias in the selection of reported results; thus, giving a low risk of bias in this domain.

4.2.3 Observational studies

Sufficient timeframe to see an effect: Given that the majority of our included studies are observational study designs, 11 studies did not allow time to see an effect but rather measured the exposure and outcome simultaneously (32, 34-37, 42, 44-48). The remaining study allotted a time frame to detect an effect (33, 38, 39, 43, 58, 59) in changes and stability of ASF consumption, thus presents a low risk of bias in this domain.

Different levels of the exposure of interest: One of the eligibility criteria for this review was the consumption of ASF reported in terms of frequency, variety, or amount. Because of this, all 17 studies report different levels (different frequencies) of the exposure of interest. Thus, there is a low risk of bias for all included studies in this domain.

Exposure measures and assessment: For 13 of our included studies, the exposure measure was clearly defined, valid, reliable, and implemented consistently across all study participants using either a 24hr recall or an FFQ, or both (32-39, 43, 46, 47, 58, 59). The remaining studies did not provide any detail on the exposure measures (42, 48), or the exposure measure could not be determined (44, 45). Thus, without detailed information on these tools, it must be assumed that they are not valid or accurate, and so we conclude a high risk of bias for these 4 studies in this domain.

Repeated exposure assessment: For 4 of the included studies, the exposure was assessed more than once over time (32, 33, 58, 59). This allowed for a more detailed look at changes in the exposure over time and more robust findings from the analyses conducted, providing a low risk of bias for these 4 studies in this domain. For 12 of the included studies, the exposure was assessed only at a one-time point (34-39, 42-45, 47, 48). For 1 study, it was hard to determine if the exposure was assessed more than once over time (46). However, since these studies followed a cross-sectional study design, this was not considered a significant limitation or major source of bias.

Outcome measures: For 16 of our included studies, the outcome measures were clearly defined, valid, reliable, and implemented consistently across all study participants (32-39, 42-48, 58, 59). For these studies, there is a low risk of bias in this domain. There was only 1 study that had limited details provided on the outcome measure (48) and it was challenging to determine whether there was validity. Given the lack of detail provided, this study was rated as high risk in this domain.

Blinding of outcome assessors: In all 17 studies, no details are provided in the methodology of the paper regarding the potential blinding or masking of outcome assessors. For this reason, it must be assumed that there is no blinding. This could be a major concern for those completing the data analysis portion of the study, as it is possible that bias could arise from knowing the exposure status of the study participant while looking for relationships with the outcome. Hence, these studies were rated as medium to high risk of bias in this domain.

Follow-up rate: Bias arising due to loss to follow-up was not applicable for 13 of our included studies (35-39, 42-48, 58), given they were observational by design. However, 4 studies had a loss to follow-up rate of 20% or less (32-34, 59); thus these were rated as having a low risk of bias

Statistical analyses: Twelve of the included studies mentioned that they have accounted for confounding variables (33-39, 42, 43, 45, 47, 58); thus these studies were rated as low risk of bias in this category. There were 2 studies for which we cannot determine the confounding variables (32, 59); thus these were rated a medium risk of bias. However, 3 studies reported no confounding variables (44, 46, 48); thus these studies were at high risk of bias in this domain.

4.3 FREQUENCY OF ANIMAL-SOURCE FOOD

4.3 Characteristics of the included studies

4.3.1 Study Design

Altogether, 12 studies reported the frequency of the ASF being consumed by the children. All of these studies were observational (32-34, 36-39, 42-46). Of these, 7 studies followed a cross-sectional study design (32-34, 36, 37, 42, 45), 3 studies used prospective cohort study designs (38, 43, 44), and 2 studies used longitudinal study design (39, 46).

4.3.2 Study Population

These studies included the age range of 0-12 years. Populations varied by study: 6-23 months (32, 34), 0-12 months (33), 1 year of age (36), 6-42 months (37), 1-12 years (39), 6-12 months (42), 0-48 months (38), 12 months and 5 years (43), 12-24 months (44), 6-36 months (45), and 12-23 months (46).

4.3.3 Location

These studies were carried out in different geographical locations. 5 studies were carried out in Asia; out of these, 2 each in Indonesia (32, 46), and Japan (36, 43), and 1 in Myanmar (45). Three studies were carried out in Africa: 1 each in Senegal (37), Somalia (34), and South Africa (33). Three studies were carried out in Europe: 1 each in Israel (44), the Netherlands (38), and Sweden (39). One study took place in South America: Brazil (42).

4.3.4 Type of intervention/exposure

Two studies reported the consumption of any type of meat (32, 45) and the consumption of eggs (32, 45); one each on red meat (42), organ meat i.e. liver (42), and fish (32).

4.3.5 Outcomes

The outcomes which were reported in the studies were stunting (32, 45), wasting (32, 45), underweight (32, 45), and anemia (42, 44).

4.3.6 Narrative Synthesis of Results

Randomized Interventional Studies

There were no studies that used this study design in reporting varied frequencies.

Non-Randmozied Interventional Studies

There were no studies that used this study design in reporting varied frequencies.

Observational Studies

The GRADE table of the critical outcomes is mentioned in appendix 1.

4.3.6.1 Meat: Two studies reported the consumption of any type of meat in children (32, 45). However, the findings from these studies cannot be meta-analyzed because of the difference in the type of frequency reported, and age groups of children included.

Stunting: Ahmad et al. (2018) assessed stunting in children aged 6-23 months who were given meat (32). No difference in stunting was reported among children who consumed meat ≥3 times/week or 1-2 times a week compared to those who never consumed meat. Similarly, no difference in stunting was reported among children who consumed meat ≥3 times/week compared to those who consumed meat 1-2 times/ week (GRADE= very low) (Table 4).

Zhao et al. (2016) also assessed stunting in children aged 6-36 months who were given a greater frequency of meat and compared with those who were given no meat and found no difference in stunting (45) (GRADE= very low) (Table 4).

Wasting: Ahmad et al. (2018) assessed wasting in children aged 6-23 months who were given meat (32). No difference in wasting was reported among children who consumed meat ≥3 times/week or 1-2 times a week compared to those who never consumed meat. Similarly, no difference in wasting was reported among children who consumed meat ≥3 times/week compared to those who consumed meat 1-2 times/ week (GRADE= very low) (Table 4).

Zhao et al. (2016) also assessed wasting in children aged 6-36 months with the greater frequency defined as any meat consumption and lesser frequency as no meat consumption and found no difference in wasting (45) (GRADE= very low) (Table 4).

Underweight: Ahmad et al. (2018) assessed being underweight in children aged 6-23 months who were given meat (32). A significantly higher difference in underweight was observed in children who consumed meat ≥3 times/week compared to those who never consumed meat. No difference in underweight was reported among children who consumed meat ≥3 times/week compared to those who consumed meat 1-2 times/ week. However, there was a significantly higher risk of underweight in children who were given meat 1-2 times/week than those who never consumed meat (GRADE= very low) (Table 4).

Table 4: Frequency of ASF in children aged 6-36 months

Study	**Type of ASF**	**Outcome**	**Frequency**	**Estimate (RR)**	**GRADE Certainty**
Ahmad et al. (2018) (32)	Meat	Stunting	≥3 times/week vs 1-2 times/week	1.10 [0.61, 1.96]	Very Low
			≥3 times/week vs Never	1.21 [0.72, 2.04]	Very Low
			1-2 times/week vs Never	1.10 [0.76, 1.61]	Very Low
		Wasting	≥3 times/week vs 1-2 times/week	1.28 [0.64, 2.56]	Very Low
			≥3 times/week vs Never	1.17 [0.64, 2.14]	Very Low
			1-2 times/week vs Never	0.92 [0.57, 1.46]	Very Low
		Underweight	≥3 times/week vs 1-2 times/week	1.65 [0.96, 2.83]	Very Low
			≥3 times/week vs Never	**1.66 [1.06, 2.61]**	Very Low
			1-2 times/week vs Never	1.01 [0.66, 1.53]	Very Low
Zhao et al. (2016) (45)		Stunting	Meat consumption VS no meat consumption	1.01 [0.86, 1.20]	Very Low
		Wasting	Meat consumption VS no meat consumption	1.01 [0.63, 1.62]	Very Low
		Underweight	Meat consumption VS no meat consumption	1.09 [0.86, 1.38]	Very Low

Zhao et al. (2016) also assessed underweight in children aged 6-36 months, with the greater frequency defined as any meat consumption and lesser frequency as no meat consumption, and found no difference in underweight (45) (GRADE= very low) (Table 4).

Urkin et al. (2007) reported anemia, but the findings from this study are non-estimable due to the data gap which they missed to report/measure in their study; they only provided the effect estimates leading to inability to measure the outcome. They reported greater frequency as 4 times per week and lower frequency of 0-3 times per week for consuming meat and used non-comparative prospective study. Thus the findings for this particular study cannot be extracted (GRADE= very low).

4.3.6.2 Red meat: There was only one study that reported the consumption of red meat in children (42).

Anemia (hemoglobin <11 g/dL): Silva et al. (2007) assessed anemia in children aged 6-12 months who were given red meat (42). A potential reduction in anemia was observed in children who consumed red meat daily or weekly when compared to those who consumed red meat less than weekly. In addition, was a significantly lower risk of anemia in children who consumed red meat in the past 24 hours than those who did not consume red meat in the past 24 hours (GRADE= very low) (Table 5).

Table 5: Frequency of red meat in children aged 6-12 months

Study	Outcome	Daily or weekly vs less than weekly (RR)	Consumed red meat vs do not consume red meat in the past 24 hours (RR)	GRADE Certainty
Silva et al. (2007) (42)	**Anemia**	0.80 [0.63, 1.00]	**0.74 [0.59, 0.94]**	Very low

4.3.6.3 Organ meat (Liver): There was only one study that reported the consumption of organ meat i.e. liver in children (42).

Anemia (hemoglobin <11 g/dL): Silva et al. (2007) assessed anemia in children aged 6-12 months who were given organ meat (liver) (42). No difference in anemia was reported in children who consumed liver daily or weekly than those who consumed liver less than weekly. Similarly, no difference in anemia was reported in children who consumed liver in the past 24 hours than those who did not consume liver in the past 24 hours (GRADE= very low) (Table 6).

Table 6: Frequency of organ meat (liver) in children aged 6-12 months

Study Name	Outcome	Daily or weekly vs less than weekly (RR)	Consumed liver vs do not consume liver in the past 24 hours (RR)	GRADE Certainty
Silva et al. (2007) (42)	**Anaemia**	0.64 [0.39, 1.05]	0.94 [0.74, 1.20]	Very low

4.3.6.4 Egg: Two studies reported the consumption of eggs in children (32, 45). However, the findings from these studies cannot be meta-analyzed because of the difference in the type of frequency reported, and different age groups.

Stunting: Ahmad et al. (2018) assessed stunting in children aged 6-23 months who were given eggs (32). No difference in stunting was reported in children who were given eggs ≥4 times/week or 1-3 times/week compared to those who never consumed eggs. Similarly, no difference in stunting was reported among children who consumed eggs ≥4 times/week compared to those who consumed eggs 1-3 times/week (GRADE= very low) (Table 7).

Zhao et al. (2016) assessed stunting in children aged 6-36 months who were given eggs. Greater frequency was defined as any egg consumption and lesser frequency as no egg consumption; authors found no difference between the two groups (45) (GRADE= very low) (Table 7).

<u>Wasting:</u> Ahmad et al. (2018) assessed wasting in children aged 6-23 months who were given eggs (32). No difference in wasting was reported in children who were given eggs ≥4 times/week or 1-3 times/week compared to those who never consumed eggs. Similarly, no difference in wasting was reported among children who consumed eggs ≥4 times/week compared to those who consumed eggs 1-3 times/week (GRADE= Very low) (Table 7).

Zhao et al. (2016) assessed wasting in children aged 6-36 months who were given eggs. Greater frequency was defined as any egg consumption and lesser frequency as no egg consumption; authors found no difference in wasting between the two groups (45) (GRADE= very low) (Table 7).

<u>Underweight:</u> Ahmad et al. (2018) assessed underweight in children aged 6-23 months who were given eggs (32). No difference in underweight was reported in children who were given eggs ≥4 times/week or 1-3 times/week compared to those who never consumed eggs. Similarly, no difference in underweight was reported among children who consumed eggs ≥4 times/week compared to those who consumed eggs 1-3 times/week (GRADE= Very low) (Table 7).

Zhao et al. (2016) assessed underweight in children aged 6-36 months who were given eggs. Greater frequency was defined as any egg consumption and lesser frequency as no egg consumption; authors found no difference in underweight between the two groups (45) (GRADE= very low) (Table 7).

Table 7: Frequency of ASF in children aged 6-36 months

Study	Type of ASF	Outcome	Frequency	Estimate (RR)	GRADE Certainty
Ahmad et al. (2018) (32)	Egg	Stunting	≥4 times/week vs 1-3 times/week	1.14 [0.79, 1.65]	Very Low
			≥4 times/week vs Never	1.16 [0.77, 1.74]	Very Low
			1-3 times/week vs Never	1.01 [0.66, 1.54]	Very Low
		Wasting	≥4 times/week vs 1-3 times/week	1.07 [0.70, 1.62]	Very Low
			≥4 times/week vs Never	1.17 [0.73, 1.90]	Very Low
			1-3 times/week vs Never	1.10 [0.68, 1.79]	Very Low
		Underweight	≥4 times/week vs 1-3 times/week	1.34 [0.91, 1.97]	Very Low
			≥4 times/week vs Never	1.28 [0.84, 1.94]	Very Low
			1-3 times/week vs Never	0.95 [0.61, 1.50]	Very Low
Zhao et al. (2018) (45)		Stunting	Egg consumption vs no egg consumption	1.01 [0.87, 1.17]	Very Low
		Wasting	Egg consumption vs no egg consumption	1.01 [0.87, 1.17]	Very Low
		Underweight	Egg consumption vs no egg consumption	1.06 [0.86, 1.30]	Very Low

4.3.6.5 Fish: There was only one study that reported the consumption of fish in children (32).

Stunting: Ahmad et al. (2018) assessed stunting in children aged 6-23 months who were given fish (32). No difference in stunting was reported in children who were given fish ≥4 times/week or 1-3 times/week compared to those who never consumed fish. Similarly, no difference in stunting was reported among children who consumed fish ≥4 times/week compared to those who consumed fish 1-3 times/week (GRADE= very low) (Table 8).

Wasting: Ahmad et al. (2018) assessed wasting in children aged 6-23 months who were given fish (32). No difference in wasting was reported in children who were given fish ≥4 times/week or 1-3 times/week compared to those who never consumed fish. However, a significant 48% reduction in wasting was reported among children who consumed fish ≥4 times/week compared to those who consumed fish 1-3 times/week (GRADE= very low) (Table 8).

Table 8: Frequency of ASF in children aged 6-23 months

Study	Type of ASF	Outcome	Frequency	Estimate (RR)	GRADE Certainty
Ahmad et al. (2018) (32)	Fish	Stunting	≥4 times/week vs 1-3 times/week	1.22 [0.77, 1.91]	Very Low
			≥4 times/week vs Never	1.17 [0.80, 1.71]	Very Low
			1-3 times/week vs Never	0.96 [0.57, 1.60]	Very Low
		Wasting	≥4 times/week vs 1-3 times/week	**0.52 [0.34, 0.80]**	**Low**
			≥4 times/week vs Never	0.73 [0.50, 1.04]	Low
			1-3 times/week vs Never	1.39 [0.94, 2.03]	Low
		Underweight	≥4 times/week vs 1-3 times/week	0.82 [0.54, 1.23]	Low
			≥4 times/week vs Never	1.07 [0.71, 1.60]	Low
			1-3 times/week vs Never	1.31 [0.81, 2.11]	Low

Underweight: Ahmad et al. (2018) assessed underweight in children aged 6-23 months who were given fish (32). No difference in underweight was reported in children who were given fish ≥4 times/week or 1-3 times/week compared to those who never consumed fish. Similarly, no difference in underweight was reported among children who consumed fish ≥4 times/week compared to those who consumed fish 1-3 times/week (GRADE= very low) (Table 8).

4.4. AMOUNT OF ANIMAL-SOURCE FOOD:-

4.4. Characteristics of the included studies

4.4.1 Study Design

Altogether, 18 studies reported the consumption of different types of ASF food in terms of quantity and used different study designs. There were 12 studies that used randomized controlled study designs (RCT) (30, 31, 41, 49, 50, 52, 54-57, 61, 62). Three studies used cluster RCT study designs (40, 51, 53), 2 studies used observational cohort longitudinal study designs (58, 59), and 1 study used a non-randomized experimental study design (60).

4.4.2 Participants

Overall, studies included the age range of 0-24 months. However, these age groups varied in the included studies and were categorized as 8-12 months (58), 0-12 months (59), 4-10 months (41, 49), 4-24 months (60), 8-10 months (50), 6-9.9 months (31, 61), 6-9 months (30, 62), 6-18 months (51, 53), 6-12 months (52, 54, 56), 5-9 months (40, 55), 12-24 months (40), and 6-15 months (57).

4.4.3 Location

Out of these 18 studies, 6 studies took place in the continent of Europe: 2 studies from England (58, 60), 2 studies from Germany (41, 49), 1 study from Denmark (50), and 1 study from Iceland (59). Three studies took place in the region of Africa: 1 study from DRC (51), 1 study from Ghana (52), and 1 study from Malawi (31). Three studies took place in the region of North America: the countries included 1 study from Ecuador (30), and 2 studies generalized as United States of America (54, 55). One study was conducted in Australia (56) and 1 study in Cambodia from the Western Pacific region (57). There was 1 multi-country study that covered Africa, America, and Eastern Mediterranean and included 4 countries: DRC, Guatemala, Pakistan, and Zambia (63).

4.4.4 Type of ASF

Two studies reported the consumption of meat generally (49, 50), while 1 study reported the consumption of lyophilized beef (40), 1 study reported the consumption of pork (53), 5 studies reported the consumption of eggs in children (30, 31, 54, 56, 62), 1 study reported cow's milk consumption (59), 1 study reported skimmed milk consumption (57), 1 study reported fish consumption (41), 1 study reported fish and spider concoction consumption (57), and 1 study reported the consumption of caterpillar in children (51).

4.4.5 Outcomes

There were 3 studies which reported stunting (30, 40, 51), 2 studies reported wasting (40, 51), 5 studies reported WAZ, HAZ and WHZ (30, 31, 40, 51, 53), 3 studies reported HCAZ (31, 40, 53), 2 studies reported change in height (50, 53), 2 studies reported change in weight (50, 53), 2 studies reported triceps skinfold (50, 57), 2 studies reported change in head circumference (53, 57), 2 studies reported anemia (51, 56), 5 studies reported hemoglobin concentration (50, 51, 56, 57, 59), 2 studies reported vitamin B-12 concentration (30, 40), 6 reported serum ferritin (40, 49-51, 56, 57, 59), 6 reported transferrin receptors (40, 50, 51, 56, 57, 59), 2 studies reported zinc intake (40, 50), 3 studies reported LA (41, 54, 62), 2 studies reported ALA (41, 62), 3 studies reported DHA (54, 56, 62), 2 studies reported EPA (41, 54) and 1 study reported mean corpuscular volume (59).

There was 1 study that reported the ASF grouped in outcome analysis containing both un-processed and processed types of meat (33). In one study, the ASF used was all commercial in nature (49) and another study used processed complementary ASF food groups (57). All of these studies were interventional and accounted for the amount of ASF foods being consumed by the children.

4.4.6 Narrative Synthesis of Results

Randomized Interventional Studies

The GRADE table of the critical outcomes is mentioned in appendix 2.

4.4.6.1 Meat: Two studies reported on meat consumption generally. One study did not report the type of meat used (49) and 1 study reported the type of meat as beef, pork, lamb, turkey, and/or cod (50). The findings from these studies could not be meta-analyzed because of the variation in the type of ASF and different populations.

Change in Height: Engelmann et al. (1998) assessed change in height (cm) in children aged 8-10 months who were given meat (beef, pork, lamb, turkey, and/or cod) and followed them for 2 months (50). Results showed that those who consumed 27g/day of meat had a similar change in height when compared to those who consumed 10g/day of meat (GRADE= very low) (Table 9).

Change in Weight: Engelmann et al. (1998) assessed change in weight (g) in children aged 8-10 months who were given meat (beef, pork, lamb, turkey, and/or cod) and followed them for 2 months (50). Results showed that those who consumed 27g/day of meat had a similar change in weight when compared to those who consumed 10g/day of meat (GRADE= very low) (Table 9).

Change in Triceps Skinfolds: Engelmann et al. (1998) assessed change in triceps skinfold (mm) in children aged 8-10 months who were given meat (beef, pork, lamb, turkey, and/or cod) and followed them for 2 months (50). Results showed that those who consumed 27g/day of meat have a similar change in triceps skinfold when compared to those who consumed 10g/day of meat (GRADE= very low) (Table 9).

Hemoglobin concentration: Engelmann et al. (1998) assessed hemoglobin in g/l in children aged 8-10 months who were given meat (beef, pork, lamb, turkey, and/or cod) and followed them for 2 months (50). Results showed that those who consumed 27g/day of meat have a similar hemoglobin concentration when compared to those who consumed 10g/day of meat (GRADE= low) (Table 9).

Serum Ferritin Levels: Dube et al. (2010) assessed ferritin (ng/ml) in children aged 7 months (49). The greater amount was defined as meat content of 12% by weight and the lesser amount was defined as meat content of 8% by weight. Results showed no significant difference in the ferritin concentration between groups (Table 9).

Engelmann et al. (1998) assessed ferritin (µg/l) in children aged 8-10 months who consumed meat (beef, pork, lamb, turkey, and/or cod) and followed them for 2 months (50). Results showed that those who consumed 27g/day of meat have a similar ferritin concentration when compared to those who consumed 10g/day of meat. Ferritin levels were also assessed in healthy children aged 8-10 months and followed for 2 months. Results showed that those who consumed 27g/day of meat have a similar ferritin concentration when compared to those who consumed 10g/day of meat (Table 9).

Transferrin Receptor: Engelmann et al. (1998) assessed transferrin receptor (μg/l) in children aged 8-10 months who were given meat (beef, pork, lamb, turkey, and/or cod) and followed them for 2 months (50). Results showed that those who consumed 27g/day of meat have a similar transferrin receptor concentration when compared to those who consumed 10g/day of meat (Table 9).

Zinc Intake: Engelmann et al. (1998) assessed zinc intake (μmol/l) in children aged 8-10 months who were given meat (beef, pork, lamb, turkey, and/or cod) and followed them for 2 months (50). Results showed that those who consumed 27g/day of meat have a similar zinc intake when compared to those who consumed 10g/day of meat (Table 9).

Energy: Dube et al. (2010) assessed energy in kcal/day in children aged 5-7 months who were given meat (49). Results showed that those who consumed a meat content of 12% by weight have a similar energy output when compared to those who consumed meat content of 8% by weight. No significant difference in energy by the group was noted for children aged 8-10 months of age also (Table 9).

Engelmann et al. (1998) also assessed energy in KJ/day in children aged 8-10 months who were given meat (beef, pork, lamb, turkey, and/or cod) and followed them for 2 months (50). Results showed that those who consumed 27g/day of meat have a similar energy output when compared to those who consumed 10g/day of meat (Table 9). The plot of the outcome can be seen in figure 3.

Figure 3: Plot Diagram for Energy

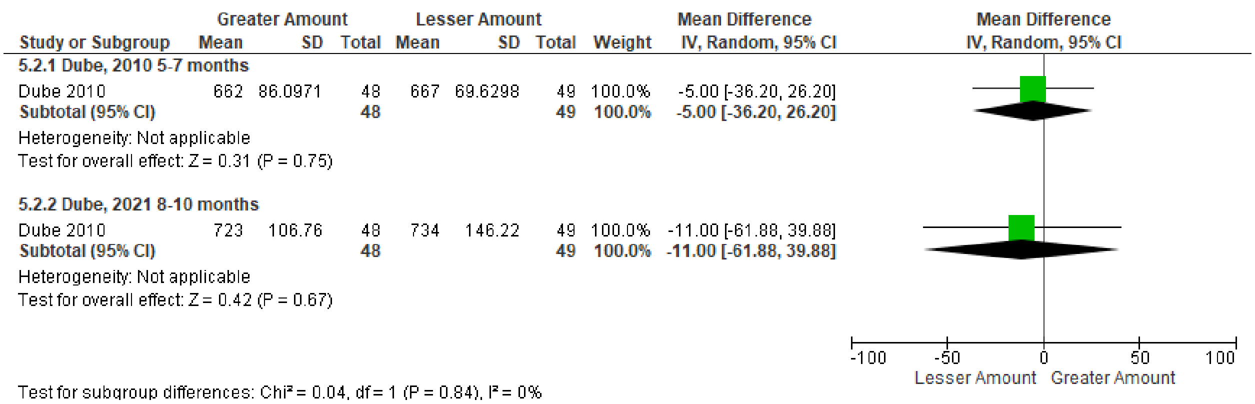


Table 9: Amount of ASF in children 5-10 months					
Name of the Study	**Type of ASF**	**Outcome**	**Amount**	**Estimates (MD, SMD)**	**GRADE Certainty**
Dube et al. (2010) (49)	Meat	Energy (5-7 months)	meat content of 12% VS 8% by weight	SMD -0.06 [-0.46, 0.33]	
		Energy (8-10 months)		SMD -0.09 [-0.48, 0.31]	
		Ferritin (7 months)		SMD -0.09 [-0.49, 0.31]	
Engelmann et al. (1998) (50)	Meat (beef, pork, lamb, turkey, and/ or cod)	Energy	27g/day VS 10g/day	SMD -0.13 [-0.74, 0.49]	
		Hemoglobin		SMD 0.21 [-0.40, 0.83]	Low
		Ferritin		SMD 0.01 [-1.03, 1.04]	
		Ferritin (infants with illness excluded)		SMD 0.01 [-1.03, 1.04]	
		Transferrin receptor		SMD -0.10 [-5.23, 5.03]	
		Change in height		MD -0.10 [-1.77, 1.57]	Very Low
		Change in weight		MD 0.08 [-0.53, 0.70]	Very Low
		Zinc intake		SMD -0.11 [-0.83, 0.60]	

		Change in Triceps skinfold		SMD -0.10 [-5.39, 5.19]	Very Low

4.4.6.2 Lyophilized Beef: There was only one study that reported the consumption of lyophilized beef (40). Lyophilized beef is a by-product of lyophilization in which the water is taken out of the meat via the process of sublimation (64).

Stunting: Kreb et al. (2012) assessed stunting in children of different age groups who were given lyophilized beef (40). Children aged 9 months were followed up at midline, after 3 months of giving lyophilized beef. Results showed that children who were given 30 g cooked meat/day had no significant difference in stunting than those who consumed 70 kcal/d of cereal. Similarly, children aged 12 and 18 months were followed up at midline, after 6 months, and at endline, after 12 months of giving lyophilized beef. Results showed that children who were given 45 g cooked meat/day had no significant difference in stunting than those who consumed 105kcal/d of cereal (GRADE= very low) (Table 10).

Wasting: Kreb et al. (2012) assessed wasting in children of different age groups who were given lyophilized beef (40). Children aged 9 months were followed up at midline, after 3 months of giving lyophilized beef. Results showed that children who were given 30 g cooked meat/day had no significant difference in wasting than those who consumed 70 kcal/d of cereal. Similarly, children aged 12 and 18 months were followed up at midline, after 6 months, and endline, after 12 months of giving lyophilized beef. Results showed that children who were given 45 g cooked meat/day had no significant difference in wasting than those who consumed 105 kcal/d of cereal (GRADE= very low) (Table 10).

WAZ: Kreb et al. (2012) assessed WAZ in children of different age groups who were given lyophilized beef (40). Children aged 9 months were followed up at midline, after 3 months of giving lyophilized beef. Results showed that children who were given 30 g cooked meat/day had no significant difference in WAZ than those who consumed 70 kcal/d of cereal. Similarly, children aged 12 were followed up at midline, after 6 months of giving lyophilized beef. Results showed that children who were given 45 g cooked meat/day had no significant difference in WAZ than those who consumed 105 kcal/d of cereal. Children aged 18 months were followed up at endline, after 12 months of giving lyophilized beef. A greater amount (45 g cooked meat/day) was compared with the lesser amount (105 kcal/d of cereal). Results showed that the greater amount group had a significantly lower mean WAZ than the lesser amount group (GRADE= low) (Table 10).

HAZ: Kreb et al. (2012) assessed HAZ in children of different age groups who were given lyophilized beef (40). Children aged 9 months were followed up at midline, after 3 months of giving lyophilized beef. Results showed that children who were given 30 g cooked meat/day had no significant difference in HAZ than those who consumed 70 kcal/d of cereal. Similarly, children aged 12 and 18 months were followed up at midline, after 6 months, and endline, after 12 months of giving lyophilized beef. Results showed that children who were given 45 g cooked meat/day had no significant difference in HAZ than those who consumed 105 kcal/d of cereal (GRADE= low) (Table 10).

WHZ: Kreb et al. (2012) assessed WHZ in children of different age groups who were given lyophilized beef (40). Children aged 9 months were followed up at midline, after 3 months of giving lyophilized beef. Results showed that children who were given 30 g cooked meat/day had no significant difference in WHZ than those who consumed 70 kcal/d of cereal. Similarly, children aged 12 and 18 months were followed up at midline, after 6 months, and endline, after 12 months of giving lyophilized beef. Results showed that children who were given 45 g cooked meat/day had no significant difference in WHZ than those who consumed 105 kcal/d of cereal (GRADE= low) (Table 10).

HCAZ: Kreb et al. (2012) assessed HCAZ in children of different age groups who were given lyophilized beef (40). Children aged 9 months were followed up at midline, after 3 months of giving lyophilized beef. Results showed that children who were given 30 g cooked meat/day had no significant difference in HCAZ than those who consumed 70 kcal/d of cereal. Similarly, children aged 12 were followed up at midline, after 6 months of giving lyophilized beef. Results showed that children who were given 45 g cooked meat/day had no significant difference in HCAZ than those who consumed 105 kcal/d of cereal. Children aged 18 months were followed up endline, after 12 months of giving lyophilized beef. A greater amount (45 g cooked meat/day) was compared with the lesser amount (105kcal/d of cereal). Results showed that the greater amount group has a significantly lower mean HCAZ than the lesser amount group (GRADE= low) (Table 10).

Table 10: Amount of ASF in children aged 9-18 months

Study	**Type of ASF**	**Outcome**	**Months**	**Frequency**	**Estimate (MD, SMD, RR)**	**GRADE Ceratinty**
Kreb et al. (2012) (40)	Lyophilized Beef	Stunting	9 months	30g of cooked meat/day VS 70Kcal/day of cereal	RR 1.02 [0.87, 1.21]	Very Low
			12 months	45g of cooked meat/day VS 105Kcal/day of cereal	RR 1.04 [0.90, 1.21]	Very low
			18 months	45g of cooked meat/day VS 105Kcal/day of cereal	RR 1.14 [1.00, 1.29]	Very low
		Wasting	9 months	30g of cooked meat/day VS 70Kcal/day of cereal	RR 0.70 [0.47, 1.04]	Very Low
			12 months	45g of cooked meat/day VS 105Kcal/day of cereal	RR 0.72 [0.50, 1.04]	Very Low
			18 months	45g of cooked meat/day VS 105Kcal/day of cereal	RR 0.72 [0.45, 1.14]	Very Low
		WAZ	9 months	30g of cooked meat/day VS 70Kcal/day of cereal	MD -0.02 [-0.16, 0.12]	Low
			12 months	45g of cooked meat/day VS 105Kcal/day of cereal	MD -0.06 [-0.20, 0.08]	Low
			18 months	45g of cooked meat/day VS 105Kcal/day of cereal	**MD -0.13 [-0.25, -0.01]**	Low
		HAZ	9 months	30g of cooked meat/day VS 70Kcal/day of cereal	MD -0.06 [-0.23, 0.11]	Low
			12 months	45g of cooked meat/day VS 105Kcal/day of cereal	MD -0.02 [-0.18, 0.14]	Low
			18 months	45g of cooked meat/day VS 105Kcal/day of cereal	MD -0.15 [-0.32, 0.02]	Low
		WHZ	9 months	30g of cooked meat/day VS 70Kcal/day of cereal	MD 0.01 [-0.14, 0.16]	Low
			12 months	45g of cooked meat/day VS 105Kcal/day of cereal	MD -0.06 [-0.20, 0.08]	Low
			18 months	45g of cooked meat/day VS 105Kcal/day of cereal	MD -0.09 [-0.23, 0.05]	Low
		Transferrin receptor	6-11 mon	30g of cooked meat/day VS 70Kcal/day of cereal	**SMD: 1.60, [0.69, 2.51]**	-
			12-18 mon	45g of cooked meat/day VS 105Kcal/day of cereal		-
		HCAZ	9 months	30g of cooked meat/day VS 70Kcal/day of cereal	MD -0.07 [-0.20, 0.06]	Low
			12 months	45g of cooked meat/day VS 105Kcal/day of cereal	MD -0.03 [-0.16, 0.10]	Low
			18 months	45g of cooked meat/day VS 105Kcal/day of cereal	**MD -0.19 [-0.34, -0.04]**	Low
			6-11 mon	30g of cooked meat/day VS 70Kcal/day of cereal		-

		Vitamin B-12	12-18 mon	45g of cooked meat/day VS 105Kcal/day of cereal	SMD: : -0.01 [-0.17, 0.15]	-
		Zinc Intake	6-11 mon	30g of cooked meat/day VS 70Kcal/day of cereal	SMD: : 0.08 [-0.09, 0.25]	-
			12-18 mon	45g of cooked meat/day VS 105Kcal/day of cereal		-

<u>Vitamin B-12 concentration:</u> Kreb et al. (2012) assessed vitamin B-12 (pg/mL) in children who were given lyophilized beef (40). For children aged 6-11 months, a greater amount was defined as 30 g cooked lyophilized beef/day and a lesser amount was defined as 70 kcal/day of cereal. For children aged 12-18 months, a greater amount was defined as 45 g cooked lyophilized beef/day and a lesser amount was defined as 105 kcal/day of cereal. Results suggested a non-significant difference in vitamin B-12 status between groups for both the age groups examined (Table 10).

<u>Transferrin Receptors:</u> Kreb et al. (2012) assessed transferrin receptor (mg/l) in children who were given lyophilized beef (40). For 6-11 month children, a greater amount was defined as 30 g cooked lyophilized beef/day and a lesser amount was defined as 70 kcal/day of cereal. For children 12-18 months, a greater amount was defined as 45 g cooked lyophilized beef/day and a lesser amount was defined as 105 kcal/day of cereal. Results showed a significantly increased concentration of transferrin receptors among children in greater versus lesser amounts for both age groups (Table 10).

<u>Zinc Intake:</u> Kreb et al. (2012) assessed zinc intake (mg/dL) in children who were given lyophilized beef (40). For children aged 6-11 months, a greater amount was defined as 30 g cooked lyophilized beef/day and a lesser amount was defined as 70 kcal/day of cereal. For children aged 12-18 months, a greater amount was defined as 45 g cooked lyophilized beef/day and a lesser amount was defined as 105 kcal/day of cereal. Results suggested a non-significant difference in zinc intake in greater and lesser amount groups for both the age groups (Table 10).

4.4.6.3 Pork: There was only one study that reported the consumption of pork in children (53).

<u>WAZ:</u> Tang et al. (2014) assessed WAZ in children aged 6-18 months and followed them for 12 months of the intervention (53). Results showed that those who consumed 60 g of pork daily have a significantly increased WAZ when compared to those who consumed no pork and ate cereals daily (GRADE= low) (Table 11).

<u>HAZ:</u> Tang et al. (2014) assessed HAZ in children aged 6-18 months and followed them for 12 months of the intervention (53). Results showed that those who consumed 60 g of pork daily have a significantly increased HAZ when compared to those who consumed no pork and ate cereals daily (GRADE= moderate) (Table 11).

<u>WHZ:</u> Tang et al. (2014) assessed WHZ in children aged 6-18 months and followed them for 12 months of an intervention (53). Results showed that those who consumed 60 g of pork daily have a non-significant difference in WHZ when compared to those who consumed no pork and ate cereals daily (GRADE= moderate) (Table 11).

<u>HCAZ:</u> Tang et al. (2014) assessed HCAZ in children aged 6-18 months and followed them for 12 months of an intervention (53). Results showed that those who consumed 60 g of pork daily have a non-significant difference in HCAZ when compared to those who consumed no pork and ate cereals daily (GRADE= moderate) (Table 11).

Change in Height: Tang et al. (2014) assessed change in height (cm) in children aged 6-18 months and followed them for 12 months of the intervention (53). Results showed that those who consumed 60 g of pork daily have a significantly increased change in height when compared to those who consumed no pork and ate cereals daily (GRADE= moderate) (Table 11).

Change in Weight: Tang et al. (2014) assessed change in weight (kg) in children aged 6-18 months and followed them for 12 months of the intervention (53). Results showed that those who consumed 60 g of pork daily have a similar change in weight when compared to those who consumed no pork and ate cereals daily (GRADE= moderate) (Table 11).

Change in Head Circumference: Tang et al. (2014) assessed change in head circumference (cm) in children aged 6-18 months and followed them for 12 months of the intervention (53). Results showed that those who consumed 60 g of pork daily have a significantly increased change in head circumference when compared to those who consumed no pork and ate cereals daily (GRADE= moderate) (Table 11).

Table 11: Amount of ASF in children aged 6-18 months

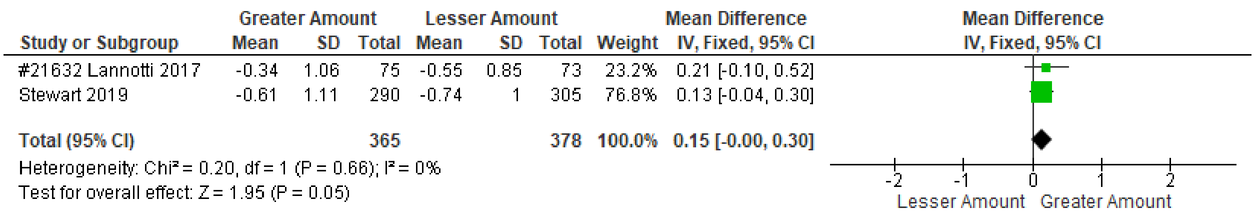
Study	Type of ASF	Outcome	Amount	Estimate (MD)	GRADE Certainty
Tang et al. (2014) (53)	Pork	WAZ	60g Vs no pork daily	**0.08 [0.01, 0.15]**	moderate
		HAZ	60g Vs no pork daily	**0.11 [0.03, 0.19]**	moderate
		WHZ	60g Vs no pork daily	0.03 [-0.06, 0.12]	moderate
		HCAZ	60g Vs no pork daily	-0.01 [-0.07, 0.05]	moderate
		Change in height	60g Vs no pork daily	**0.26 [0.05, 0.47]**	moderate
		Change in weight	60g Vs no pork daily	0.07 [0.00, 0.14]	moderate
		Change in head circumference	60g Vs no pork daily	**2.98 [2.90, 3.06]**	moderate

4.4.6.4 Eggs: Five studies reported varied consumption of eggs in children. Three studies reported the consumption of the egg as a whole (30, 31, 62) whereas 2 studies reported the egg consumption in regards to the egg yolk (54, 56). Out of these 5 studies, 2 studies were meta-analyzed for the outcomes of WAZ, HAZ and WHZ as both of the studies targeted the same population (6-9 months), children were given the same amount of egg intervention, and were followed up to the same time (6 months) (30, 31). The GRADE table of the meta-analyzed outcomes is mentioned in appendix 3.

WAZ: Iannotti et al. (2017) and Stewart et al. (2019) both assessed WAZ in children aged 6-9 months who consumed eggs, and followed them for 6 months (30, 31). A greater amount was defined as consuming 1 egg per day for 6 months and a lesser amount was defined as no eggs for 6 months (Table 12).

Both of these studies had the same age population for children (6-9 months), the same follow-up time of 6 months, the same intervention/type of ASF (an egg), and the study design was also the same (RCT), allowing meta-analysis. The pooled analysis showed that children who consumed 1 egg per day over 6 months had a potential difference in WAZ when compared with children who were given no eggs per day over 6 months (MD: 0.15; 95% CI 0.00, 0.30; 2 studies n= 743 participants; heterogeneity= I^2 0%, Chi^2 P 0.66; GRADE= moderate quality) (Figure 4).

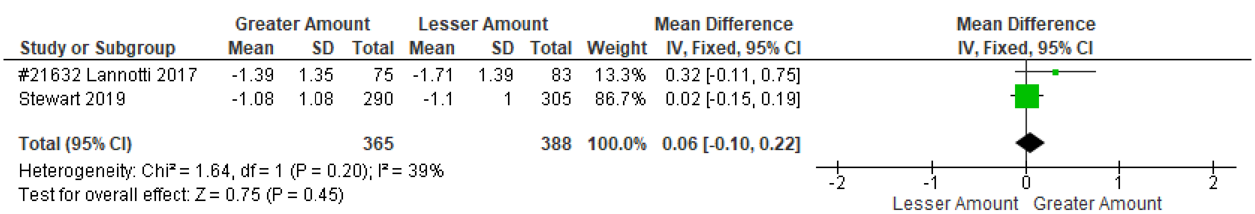
Figure 4: Meta-analysis for WAZ score in children given eggs



HAZ: Iannotti et al. (2017) and Stewart et al. (2019) both assessed HAZ in children aged 6-9 months who consumed eggs and followed them for 6 months (30, 31). A greater amount was defined as consuming 1 egg per day for 6 months and a lesser amount was defined as no eggs for 6 months (Table 12).

Both of these studies had the same age population for children (6-9 months), the same follow-up time of 6 months, the same intervention/type of ASF (an egg), and the study design was also the same (RCT), allowing meta-analysis. The pooled analysis showed that children who consumed 1 egg per day over 6 months had no significant difference in WAZ when compared with children who were given no eggs per day over 6 months (MD 0.06; 95% CI -0.10, 0.22; 2 studies n= 753 participants; heterogeneity= I^2 39%, Chi^2 P 0.20; GRADE=low quality) (Figure 5).

Figure 5: Meta-analysis for HAZ score in children given eggs



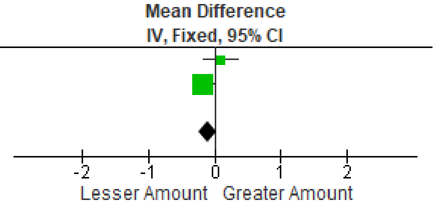
WHZ: Iannotti et al. (2017) and Stewart et al. (2019) both assessed WHZ in children aged 6-9 months who consumed eggs and followed them for 6 months (30, 31). A greater amount was defined as consuming 1 egg per day for 6 months and a lesser amount was defined as no eggs for 6 months (Table 12).

Both of these studies had the same age population for children (6-9 months), the same follow-up time of 6 months, the same intervention/type of ASF (an egg), and the study design was also the same (RCT), allowing meta-analysis. The pooled analysis showed that children who consumed 1 egg per day over 6 months had no significant difference in WAZ when compared with children who were given no eggs per day over 6 months (MD -0.10; 95% CI -0.24, 0.04; 2 studies n= 743 participants; heterogeneity= I^2 63%, Chi^2 P 0.10; GRADE= low quality) (Figure 6).

Figure 6: Meta-analysis for WHZ score in children given eggs

Study or Subgroup	Greater Amount Mean	SD	Total	Lesser Amount Mean	SD	Total	Weight	Mean Difference IV, Fixed, 95% CI
#21632 Lannotti 2017	0.45	0.84	75	0.36	0.81	73	27.0%	0.09 [-0.18, 0.36]
Stewart 2019	-0.3	0.97	290	-0.13	1.04	305	73.0%	-0.17 [-0.33, -0.01]
Total (95% CI)			**365**			**378**	**100.0%**	**-0.10 [-0.24, 0.04]**

Heterogeneity: Chi² = 2.68, df = 1 (P = 0.10); I² = 63%
Test for overall effect: Z = 1.42 (P = 0.16)



<u>HCAZ:</u> Stewart et al. (2019) assessed HCAZ in children 6-9.9 months who consumed eggs and followed them for 6 months (31). A greater amount was defined as consuming 1 egg per day for 6 months and a lesser amount was defined as no eggs for 6 months. Results showed a significant improvement in mean HCAZ among the children who consumed eggs versus those who didn't (GRADE- low) (Table 12).

<u>Stunting:</u> Iannotti et al. (2017) assessed stunting in children aged 6-9.9 months and followed them to the end-point of 6 months (30). A greater amount was defined as 1 egg per day over 6 months and a lesser amount was defined as no egg consumption. No difference in stunting was reported between the groups (GRADE- Very low) (Table 12).

<u>Anemia:</u> Makrides et al. (2002) assessed anemia in children who were breastfed and formula-fed and followed them for 6 months alongside the egg intervention (56). For both breastfed and formula-fed children, those who consumed 4 egg yolks/week (normal egg and enriched egg yolk intervention groups) had no difference in anemia when compared to those who did not consume egg (GRADE- low) (Table 12).

<u>Hemoglobin concentration:</u> Makrides et al. (2002) assessed hemoglobin concentration in children who were breastfed and formula-fed and followed them for 6 months alongside the egg intervention (56). For both breastfed and formula-fed children, those who consumed 4 egg yolks/week (normal egg and enriched egg yolk intervention groups) had no difference in hemoglobin concentration when compared to those who did not consume egg (GRADE- moderate) (Table 12).

<u>Serum Ferritin Levels:</u> Makrides et al. (2002) assessed ferritin (μg/L) in children who were breastfed and formula-fed and followed them for 6 months alongside the egg intervention (56). For both breastfed and formula-fed children, those who consumed 4 egg yolks/week (normal egg and enriched egg yolk intervention groups) had no difference in serum ferritin levels when compared to those who did not consume egg (Table 12).

<u>Transferrin Receptors:</u> Makrides et al. (2002) assessed transferrin receptor (g/L) in children who were breastfed and formula-fed and followed them for 6 months alongside the egg intervention (56). For both breastfed and formula-fed children, those who consumed 4 egg yolks/week (normal egg and enriched egg yolk intervention groups) had no difference in transferrin receptors when compared to those who did not consume egg (Table 12).

<u>Vitamin B-12 concentration:</u> Iannotti et al. (2017) assessed vitamin B-12 (pmol/L) in children aged 6-9 months who consumed eggs and followed them for 6 months (30). A greater amount was defined as consuming 1 egg per day for 6 months and a lesser amount was defined as no eggs for 6 months. Results showed a non-significant difference in vitamin B-12 concentration between groups (Table 12).

Linoleic Acid (LA): Hoffman et al. (2004) assessed LA in children aged 12 months who were given egg yolk and followed them to the endline of the study, which was 12 months (54). The greater amount was defined as 1 jar of study food/day containing dried egg yolks at 120 g/kg food (12%); the lesser amount was defined as 1 jar of control study food/day containing no dried egg yolks. Results showed no significant difference in the mean LA between groups (Table 12).

Docosahexaenoic Acid (DHA): Hoffman et al. (2004) assessed DHA in children aged 12 months who were given egg yolk and followed them to the endline of the study, which was 12 months (54). The greater amount was defined as 1 jar of study food/day containing dried egg yolks at 120 g/kg food (12%) and the lesser amount was defined as 1 jar of control study food/day containing no dried egg yolks. There were two definitions for DHA: (1) Mass concentration: µmol DHA/L Red Blood Cells (2) (n-3) Fatty acids: g/100g total fatty acids. A significant increase in DHA was reported (for both types of DHA) when considering the greater versus lesser quantity groups (Table 12).

Makrides et al. (2002) assessed DHA (% of total phospholipid fatty acid) in children who were breastfed and formula-fed and were given egg yolks, following them for 6 months (56). Results showed a significant increase in DHA for both breastfed and formula-fed children among those who consumed 4 egg yolks/week (n-3) compared to those who did not consume them. However, no difference in DHA was reported in both breastfed and formula-fed children who were given 4 egg yolks/week (regular) than those who did not consume them (Table 12).

Eicosapentaenoic Acid (EPA): Hoffman et al. (2004) assessed EPA in children aged 12 months and followed them to the endline of the study at 12 months (54). The greater amount was defined as 1 jar of study food/day containing dried egg yolks at 120 g/kg food (12%) and the lesser amount was defined as 1 jar of control study food/day containing no dried egg yolks. The results showed no significant difference in the mean EPA between groups (Table 12).

Table 12: Amount of ASF in children

Study	Type of ASF	Outcome	Frequency	Estimate (RR, MD, SMD)	GRADE Certainty
Iannotti et al. (2017) (30)	Egg	Stunting	1 egg per day VS no egg consumption	RR 0.70 [0.44,1.12]	Very low
		WAZ	1 egg per day VS no egg consumption	MD 0.21 [-0.10, 0.52]	Moderate
		HAZ	1 egg per day VS no egg consumption	MD 0.32 [-0.11, 0.75]	Low
		WHZ	1 egg per day VS no egg consumption	MD 0.09 [-0.18, 0.36]	Low
		Vitamin B-12	1 egg per day VS no egg consumption	SMD 13.75 [-22.85, 50.35]	-
Makrides et al. (2002) (56)	Egg yolk	Anemia (breastfed)	4 egg yolks per week VS no egg consumption	RR 0.98 [0.33, 2.92]	low
		Anemia (Formula Fed)	4 egg yolks per week VS no egg consumption	RR 0.78 [0.14, 4.36]	low
		Hemoglobin (breastfed)	4 egg yolks per week VS no egg consumption	SMD 0.01 [-0.49, 0.51]	moderate
		Hemoglobin (Formula Fed)	4 egg yolks per week VS no egg consumption	SMD 0.20 [-0.31, 0.71]	moderate

		Serum Ferritin Levels (Breastfed)	4 egg yolks per week VS no egg consumption	SMD 0.36 [-0.14, 0.86]	-
		Serum Ferritin Levels (Formulafed)	4 egg yolks per week VS no egg consumption	SMD 0.11 [-0.39, 0.62]	-
		Serum Transferrin Receptors (Breastfed)	4 egg yolks per week VS no egg consumption	SMD 0.00 [-0.20, 0.20]	-
		Serum Transferrin Receptors (Formulafed)	4 egg yolks per week VS no egg consumption	SMD 0.00 [-0.20, 0.20]	-
		DHA (Breastfed)	4 egg yolks (n-3) per week VS no egg consumption	**1.72 [1.04, 2.40]**	**-**
		DHA (formula fed)	4 egg yolks (n-3) per week VS no egg consumption	**1.21 [CI 0.55, 1.86]**	**-**
		DHA (Breastfed)	4 egg yolks (regular) per week VS no egg consumption	SMD 0.35 [-0.24, 0.93]	-
		DHA (formula fed)	4 egg yolks (regular) per week VS no egg consumption	SMD 0.48 [-0.10, 1.06]	-
Stewart et al. (2019) (31)	Egg	WAZ	1 egg per day VS no egg consumption	MD 0.13 [-0.04, 0.30]	Moderate
		HAZ	1 egg per day VS no egg consumption	MD 0.02 [-0.15, 0.19]	Low
		WHZ	1 egg per day VS no egg consumption	MD -0.17 [-0.33, -0.01]	Low
		HCAZ	1 egg per day VS no egg consumption	MD 0.23 [0.05, 0.41]	low
Hoffman et al. (2004) (54)	Dried Egg yolk	LA	1 jar of study food/ day containing dried egg yolks at 120 g/kg food (12%) VS 1 jar of control study food/ day containing no dried egg yolks	SMD -0.13 [-0.68, 0.42]	-
		EPA		SMD 0.19 [-0.36, 0.74]	-
		DHA (Mass concentration: µmol DHA/L RBC (2) (n-3)		**SMD 2.00 [1.32, 2.69]**	**-**
		DHA ((n-3) Fatty acids: g/100g total fatty acids)		**SMD 1.67 [1.03, 2.32]**	**-**

4.4.6.5 Skimmed milk: There was only one study that reported skimmed milk consumption in children (57).

<u>Change in Triceps Skinfold</u>: Skau et al. (2015) assessed change in triceps skinfold (mm) in children aged 6 and 15 months who consumed different skimmed milk products (57). The greater amount was defined as corn-soy blend plus (CSB++) with 8% dried skimmed milk and the lesser amount was defined as corn-soy blend plus (CSB+) without skimmed milk. Results showed no significant difference in the mean change in triceps skinfold between groups for either child aged 6 or 15 months (GRADE= moderate) (Table 13).

Change in Head Circumference: Skau et al. (2015) assessed change in head circumference (cm) in children aged 6 and 15 months using different skimmed milk products (57). The greater amount was defined as corn-soy blend plus (CSB++) with 8% dried skimmed milk and the lesser amount was defined as corn-soy blend plus (CSB+) without skimmed milk. Results showed a significantly lower mean change in head circumference for 6 and 15-month-old children who had consumed CSB++ with skimmed milk compared to CSB++ without (GRADE moderate) (Table 13).

Table 13: Amount of ASF in Children aged 6-15 months					
Name of the Study	**Type of ASF**	**Outcome**	**Amount**	**Estimates (MD)**	**GRADE Certainty**
Skau et al. (2015) **(57)**	**Skimmed Milk**	**Change in Triceps Skinfold (6 months)**	Corn-soy blend plus (CSB++) with 8% dried skimmed milk VS Corn-soy blend plus (CSB+)	0.00 [-0.22, 0.22]	moderate
		Change in Triceps Skinfold (15 months)		-0.10 [-0.38, 0.18]	moderate
		Change in head circumference (6 months)		**-0.30 [-0.58, -0.02]**	moderate
		Change in head circumference (15 months)		**-0.40 [-0.76, -0.04]**	moderate

4.4.6.6 Fish: There was only one study that reported fish consumption in children (41).

Linoleic Acid (LA): Libuda et al. (2016) assessed LA in children aged 10 months and followed them for 6 months (41). The greater amount was defined as fish (mean content: 13.0 g/100gthe vegetable-potato-meat meal) and the lesser amount was defined as no fish (children consumed corn oil). Results showed that mean LA was significantly lower among children consuming fish vs no fish (Table 14).

Alpha Linoleic Acid (ALA): Libuda et al. (2016) assessed ALA in children aged 10 months and followed them for 6 months (41). The greater amount was defined as fish (mean content: 13.0 g/100g) and the lesser amount was defined as no fish. Results showed a similar mean LA between groups (Table 14).

Eicosapentaenoic Acid (EPA): Libuda et al. (2016) assessed EPA in children aged 10 months and followed them for 6 months (41). The greater amount was defined as fish (mean content: 13.0 g/100g) and the lesser amount was defined as no fish. Results showed that mean EPA was significantly higher among children consuming fish vs no fish (Table 14).

Table 14: Amount of ASF in children aged 10 months					
Study	**Type of ASF**	**Outcome**	**Age**	**Amount**	**Estimates (SMD)**
Libuda et al. (2016) (41)	Fish	LA	10 months	fish (mean content: 13.0 g/100g) VS corn oil	**-0.41 [-0.80, -0.02]**
		ALA	10 months	fish (mean content: 13.0 g/100g) VS corn oil	0.00 [-0.01, 0.01]
		EPA	10 months	fish (mean content: 13.0 g/100g) VS corn oil	**2.43 [1.91, 2.94]**

4.4.6.7 Fish and spider concoction: There was only one study that reported fish and spider concoction consumption in children (57).

Change in Head Circumference: Skau et al. (2015) assessed change in head circumference (mm) in children aged 6-15 months consuming fish and spiders with Winfood (WF) and Winfood-Lite (WF-L) and followed them for 9 months (57). For children aged 6 months and 15 months, a greater amount was defined as consumed WF (14% dry weight ASF) and a lesser amount was defined as consumed WF-L (10% dry weight ASF). Results showed that in children aged 6 months and 15 months, there was no significant difference in change in head circumference between groups. When the change in head circumference after 9 months of the intervention was compared with the standard CSB+ and CSB ++ product for high-compliance sample (6 months) and full sample (15 months), the results still showed no significant difference in the change in head circumference (GRADE= moderate) (Table 15).

Change in Triceps Skinfold: Skau et al. (2015) assessed change in triceps skinfold (mm) in children aged 6-15 months consuming fish and spiders with Winfood (WF) and Winfood-Lite (WF-L) and followed them for 9 months (57). For children aged 6 months and 15 months, a greater amount was defined as consumed WF (14% dry weight ASF) and a lesser amount was defined as consumed WF-L (10% dry weight ASF). Results showed that in children aged 6 months and 15 months, there was no significant mean difference in change in triceps skinfold between groups. When the change in head circumference after 9 months of the intervention was compared with the standard CSB+ and CSB++ product for high-compliance sample (6 months) and full sample (15 months), the results showed no significant difference in the change in triceps skinfold (GRADE= moderate) (Table 15).

Hemoglobin concentration: Skau et al. (2015) assessed hemoglobin (g/l) in children aged 6-15 months consuming fish and spiders with Winfood (WF) and Winfood-Lite (WF-L) and followed them for 9 months (57). For children aged 6 months and 15 months, a greater amount was defined as consumed WF (14% dry weight ASF) and a lesser amount was defined as consumed WF-L (10% dry weight ASF). Results showed that in children aged 6 months and 15 months, there was no significant mean difference in hemoglobin concentration between groups. When the mean difference of change in head circumference after 9 months of the intervention was compared with the standard CSB+ and CSB++ product for high-compliance sample (6 months) and full sample (15 months), the results showed no significant difference in the hemoglobin concentration (GRADE= moderate) (Table 15).

Serum Ferritin Levels: Skau et al. (2015) assessed ferritin (µg/L) in children aged 6-15 months consuming fish and spiders with Winfood (WF) and Winfood-Lite (WF-L) and followed them for 9 months (57). For children aged 6 months and 15 months, a greater amount was defined as consumed WF (14% dry weight ASF) and a lesser amount was defined as consumed WF-L (10% dry weight ASF). Results showed that in children aged 6 months and 15 months, there was no significant mean difference in change in serum ferritin levels between groups When the mean difference of change in ferritin levels after 9 months of the intervention was compared with the standard CSB+ and CSB++ product for high-compliance sample (6 months) and full sample (15 months), the results showed no significant difference in the serum ferritin levels (Table 15).

Transferrin Receptors: Skau et al. (2015) assessed transferrin receptors (mg/L) in children aged 6-15 months consuming fish and spiders with Winfood (WF) and Winfood-Lite (WF-L) and followed them for 9 months (57). For children aged 6 months and 15 months, a greater amount was defined as consumed WF (14% dry weight ASF) and a lesser amount was defined as consumed WF-L (10% dry weight ASF).

Results showed that in children aged 6 months and 15 months, there was no significant mean difference in change in transferrin receptors between groups. When the mean difference of change in transferrin receptors after 9 months of the intervention was compared with the standard CSB+ and CSB++ product for high-compliance sample (6 months) and full sample (15 months), the results showed no significant difference in the transferrin receptors (Table 15).

Table 15: Amount of ASF in children aged 6-15 months						
Study	**Type of ASF**	**Outcome**	**Age**	**Amount**	**Estimate (MD, SMD)**	**GRADE Certainty**
-Skau et al. (2015) (57)	Fish and spider	Haemoglobin	6 months	WF (14% dry weight) VS WF-L (10% dry weight ASF)	SMD -0.28[-0.58, 0.02]	moderate
			15 months	WF (14% dry weight) VS WF-L (10% dry weight ASF)	SMD -0.28 [-0.58, 0.02]	moderate
			6 months	Mean difference of haemoglobin VS standard CSB+ product	SMD -0.26 [-0.59, 0.07]	moderate
			15 months	Mean difference of haemoglobin VS standard CSB+ product	SMD -0.25 [-0.55, 0.06]	moderate
			6 months	Mean difference of haemoglobin VS standard CSB++ product	SMD -0.21 [-0.54, 0.12]	moderate
			15 months	Mean difference of haemoglobin VS standard CSB++ product	SMD -0.22 [-0.52, 0.09]	moderate
		Serum Ferritin Levels	6 months	WF (14% dry weight) VS WF-L (10% dry weight ASF)	SMD -0.12 [-0.45, 0.21]	-
			15 months	WF (14% dry weight) VS WF-L (10% dry weight ASF)	SMD -0.12 [-0.45, 0.21]	-
			6 months	Mean difference of haemoglobin VS standard CSB+ product	SMD -0.05 [-0.40, 0.29]	-
			15 months	Mean difference of haemoglobin VS standard CSB+ product	SMD -0.05 [-0.36, 0.27]	-
			6 months	Mean difference of haemoglobin VS standard CSB++ product	SMD -0.05 [-0.40, 0.29]	-
			15 months	Mean difference of haemoglobin VS	SMD -0.05 [-0.36, 0.27]	-

				standard CSB++ product		
		Transferrin Receptors	6 months	WF (14% dry weight) VS WF-L (10% dry weight ASF)	SMD 0.80 [-0.54, 2.14]	-
			15 months	WF (14% dry weight) VS WF-L (10% dry weight ASF)	SMD - 0.60 [-0.52, 1.72]	-
			6 months	Mean difference of haemoglobin VS standard CSB+ product	SMD 0.60 [-1.21, 2.41]	-
			15 months	Mean difference of haemoglobin VS standard CSB+ product	SMD 0.40 [-1.20, 2.00]	-
			6 months	Mean difference of haemoglobin VS standard CSB++ product	SMD 0.50 [-1.24, 2.24]	-
			15 months	Mean difference of haemoglobin VS standard CSB++ product	SMD 0.50 [-1.03, 2.03]	-
		Change in Triceps Skinfold	6 months	WF (14% dry weight) VS WF-L (10% dry weight ASF)	MD -0.10 [-0.59, 0.39]	moderate
			15 months	WF (14% dry weight) VS WF-L (10% dry weight ASF)	MD -0.20 [-0.48, 0.08]	moderate
			6 months	Mean difference of haemoglobin VS standard CSB+ product	MD 0.15 [-0.25, 0.55]	moderate
			15 months	Mean difference of haemoglobin VS standard CSB+ product	MD -0.10 [-0.59, 0.39]	moderate
			6 months	Mean difference of haemoglobin VS standard CSB++ product	MD 0.00 [-0.42, 0.42]	moderate
			15 months	Mean difference of haemoglobin VS standard CSB++ product	MD -0.10 [-0.59, 0.39]	moderate
		Change in head circumference	6 months	WF (14% dry weight) VS WF-L (10% dry weight ASF)	MD -0.10 [-0.52, 0.32]	moderate
			15 months	WF (14% dry weight) VS WF-L (10% dry weight ASF)	MD -0.10 [-0.52, 0.32]	moderate

			6 months	Mean difference of haemoglobin VS standard CSB+ product	MD -0.10 [-0.52, 0.32]	moderate
			15 months	Mean difference of haemoglobin VS standard CSB+ product	MD 0.00 [-0.42, 0.42]	moderate
			6 months	Mean difference of haemoglobin VS standard CSB++ product	MD -0.10 [-0.59, 0.39]	moderate
			15 months	Mean difference of hemoglobin VS standard CSB++ product	MD 0.00 [-0.42, 0.42]	moderate

4.4.6.8 Caterpillar: There was only one study that reported the consumption of caterpillar in children (51).

Stunting: Bauserman et al. (2015) assessed stunting in children aged 6-18 months who were given caterpillars (51). The children aged 9 months were followed up after 3 months; a greater amount was defined as 30 g daily caterpillar cereal and a lesser amount was defined as no caterpillar cereal. The children aged 12 and 18 months were followed up after 6 and 12 months, respectively?; a greater amount was defined as 45 g daily caterpillar cereal and a lesser amount was defined as no caterpillar cereal. No difference in stunting was reported between groups at any age (GRADE= very low) (Table 16).

Wasting: Bauserman et al. (2015) assessed wasting in children aged 6-18 months who were given caterpillars (51). The children aged 9 months were followed up after 3 months; a greater amount was defined as 30 g daily caterpillar cereal and a lesser amount was defined as no caterpillar cereal. The children aged 12 and 18 months were followed up after 6 and 12 months; a greater amount was defined as 45 g daily caterpillar cereal and a lesser amount was defined as no caterpillar cereal. No difference in wasting was reported between groups at any age (GRADE= very low) (Table 16).

Weight-for-age-score (WAZ): Bauserman et al. (2015) assessed WAZ in children aged 6-18 months who were given caterpillars (51). The children aged 9 months were followed up after 3 months; a greater amount was defined as 30 g daily caterpillar cereal and a lesser amount was defined as no caterpillar cereal. The children aged 12 and 18 months were followed up after 6 and 12 months; a greater amount was defined as 45 g daily caterpillar cereal and a lesser amount was defined as no caterpillar cereal. No difference in WAZ was reported between groups at any age (GRADE= very low) (Table 16).

HAZ: Bauserman et al. (2015) assessed HAZ in children aged 6-18 months who were given caterpillars (51). The children aged 9 months were followed up after 3 months; a greater amount was defined as 30 g daily caterpillar cereal and a lesser amount was defined as no caterpillar cereal. The children aged 12 and 18 months were followed up after 6 and 12 months; a greater amount was defined as 45 g daily caterpillar cereal and a lesser amount was defined as no caterpillar cereal. No difference in HAZ was reported between groups at any age (GRADE= very low) (Table 16).

<u>WHZ:</u> Bauserman et al. (2015) assessed WHZ in children aged 6-18 months who were given caterpillars (51). The children aged 9 months were followed up after 3 months; a greater amount was defined as 30 g daily caterpillar cereal and a lesser amount was defined as no caterpillar cereal. The children aged 12 and 18 months were followed up after 6 and 12 months; a greater amount was defined as 45 g daily caterpillar cereal and a lesser amount was defined as no caterpillar cereal. No difference in WHZ was reported between groups at any age (GRADE= very low) (Table 16).

<u>Anemia (Hemoglobin ≤ 10 g/dL):</u> Bauserman et al. (2015) assessed anemia in children aged 6-18 months who were given caterpillars (51). The greater amount for 6-12 months old children was 30 g of caterpillar cereal and for 12-18 months was 45 g of caterpillar cereal and the lesser amount was defined as no caterpillar cereal; they were followed up at the study endline after 12 months. Results showed that those who consumed caterpillar had a significant reduction in anemia when compared to those who did not consume caterpillar cereal (GRADE= very low) (Table 16).

<u>Hemoglobin concentration:</u> Bauserman et al. (2015) assessed hemoglobin (g/dL) in children aged 6-18 months who were given caterpillars (51). For 6-12 months, a greater amount was defined as 30 g of caterpillar cereal and for 12-18 months, a greater amount was defined as 45 g of caterpillar cereal; the lesser amount was defined as no caterpillar cereal. Results showed that those who consumed greater amounts of caterpillar had significantly increased hemoglobin concentrations when compared to those who did not consume caterpillar cereal (GRADE= very low) (Table 16).

Table 16: Amount of ASF in children aged 9-18 months

Study	Type of ASF	Outcome	Months	Frequency	Estimate (RR, MD, SMD)	GRADE Certainty
Bauserman et al. (2015) (51)	Caterpillar	Stunting	9 months	30g of caterpillar daily VS no Caterpillar	RR 0.95 [0.69, 1.30]	Very low
			12 months	45g of caterpillar daily VS no Caterpillar	RR 1.04 [0.77, 1.41]	Very low
			18 months	45g of caterpillar daily VS no Caterpillar	RR 0.94 [0.77, 1.16]	Very low
		Wasting	9 months	30g of caterpillar daily VS no Caterpillar	RR 1.89 [0.66, 5.45]	Very low
			12 months	45g of caterpillar daily VS no Caterpillar	RR 0.89 [0.31, 2.53]	Very low
			18 months	45g of caterpillar daily VS no Caterpillar	RR 0.75 [0.27, 2.06]	Very low
		WAZ	9 months	30g of caterpillar daily VS no Caterpillar	MD -0.20 [-0.56, 0.16]	Very low
			12 months	45g of caterpillar daily VS no Caterpillar	MD -0.10 [-0.45, 0.25]	Very low
			18 months	45g of caterpillar daily VS no Caterpillar	MD -0.20 [-0.57, 0.17]	Very low
		HAZ	9 months	30g of caterpillar daily VS no Caterpillar	MD 0.10 [-0.28, 0.48]	Very low
			12 months	45g of caterpillar daily VS no Caterpillar	MD 0.10 [-0.28, 0.48]	Very low
			18 months	45g of caterpillar daily VS no Caterpillar	MD 0.10 [-0.35, 0.55]	Very low
		WHZ	9 months	30g of caterpillar daily VS no Caterpillar	MD -0.30 [-0.66, 0.06]	Very low

			12 months	45g of caterpillar daily VS no Caterpillar	MD -0.30 [-0.66, 0.06]	Very low
			18 months	45g of caterpillar daily VS no Caterpillar	MD -0.20 [-0.62, 0.22]	Very low
		Anaemia	6-12 months	30g of caterpillar daily VS no Caterpillar	**RR: 0.52 [0.33, 0.81]**	Very low
			12-18 months	45g of caterpillar daily VS no Caterpillar		Very low
		Haemoglo bin	6-12 months	30g of caterpillar daily VS no Caterpillar	**SMD: 0.35, [0.02, 0.69]**	Very low
			12-18 months	45g of caterpillar daily VS no Caterpillar		Very low
		Serum Ferritin	6-12 months	30g of caterpillar daily VS no Caterpillar	**SMD: -0.39 [-0.73, -0.05]**	**-**
			12-18 months	45g of caterpillar daily VS no Caterpillar		-
		Transferrin Receptors	6-12 months	30g of caterpillar daily VS no Caterpillar	SMD: -1.10 [-2.62, 0.42]	-
			12-18 months	45g of caterpillar daily VS no Caterpillar		-

Serum Ferritin Levels: Bauserman et al. (2015) assessed ferritin (ng/ml) in children aged 6-18 months who were given caterpillars and followed them up at the study endline at 12 months (51). For 6-12 months, a greater amount was defined as 30 g of caterpillar cereal and for 12-18 months, a greater amount was defined as 45 g of caterpillar cereal; the lesser amount was defined as no caterpillar cereal. Results showed that those who consumed a greater amount of caterpillar had significantly lower serum ferritin levels than those who did not consume caterpillar cereal (Table 17).

Transferrin Receptor: Bauserman et al. (2015) assessed transferrin receptor (mg/l) in children aged 6-18 months and followed them up at the study endline at 12 months (51). For 6-12 months, the greater amount was defined as 30 g of caterpillar cereal and for 12-18 months, the greater amount was defined as 45 g of caterpillar cereal; the lesser amount was defined as no caterpillar cereal. Results showed that those who consumed greater amounts of caterpillar had similar transferrin receptor concentrations when compared to those who did not consume caterpillar cereal (Table 17).

Non-Randomized Interventional Studies

There was only one study that assessed the different amounts of ASF impact on the micro-nutrients including iron, magnesium, copper, and many more (60). Given the single study included, the details are not given in this report. However, the details can be taken from the data extraction sheet appended.

Observational Studies

The GRADE table of the outcome is mentioned in appendix 4.

4.4.6.9 Cow's milk: There was only one study that reported cow's milk consumption in children (59).

Hemoglobin concentration: Thorsdottir et al. (2003) assessed hemoglobin of children aged 9-12 months who consumed cow's milk (59). The greater amount was defined as >500g and the lesser amount was defined as <500 g of cow's milk; the follow-up duration was not clear and this study was observational. Findings reported no significant difference in mean hemoglobin between groups (GRADE= very low) (Table 17).

Serum Ferritin Levels: Thorsdottir et al. (2003) assessed ferritin (μg/l) of children aged 9-12 months who consumed cow's milk (59). The greater amount was defined as >500g and the lesser amount was defined as <500 g or cow's milk. Findings suggested no significant difference in mean ferritin levels between groups (Table 17).

Transferrin Receptors: Thorsdottir et al. (2003) assessed transferrin receptor (mg/l) of children aged 9-12 months who consumed cow's milk (59). The greater amount was defined as >500g and the lesser amount was defined as <500 g or cow's milk. Findings reported no significant difference in mean transferrin receptors between groups (Table 17).

Mean Corpuscular Volume (MCV): Thorsdottir et al. (2003) assessed MCV (fl) of children aged 9-12 months who consumed cow's milk (59). The greater amount was defined as >500g and the lesser amount was defined as <500 g or cow's milk. Findings reported no significant difference in MCV between groups (Table 17).

Table 17: Amount of ASF in Children aged 9-12 months

Name of the Study	**Type of ASF**	**Outcome**	**Amount**	**Estimates (MD)**	**GRADE Certainty**
Thorsdottir et al. (2003) **(59)**	**Cow's Milk**	**Haemoglobin**	>500g VS <500	0.00 [-0.52, 0.52]	Very low
		Serum Ferritin	>500g VS <500	0.43 [-0.12, 0.97]	-
		Transferrin Receptor	>500g VS <500	-1.20 [-11.03, 8.63]	-
		Mean Corpuscular Volume	>500g VS <500	-4.20 [-61.10, 52.70]	-

4.5. VARIETY OF ANIMAL-SOURCE FOOD

4.5 Characteristics of the included studies

4.5.1 Study design

Two studies reported consumption of ASF in terms of variety: Krasevec et al. (2017) and Marinda et al. (2018). Both of these studies were non-comparative cross-sectional study designs.

4.5.2 Participants

The age range for both of these studies was 6-23 months.

4.5.3 Location

There was one study that was multi-country and took place in 39 countries from varied WHO regions, including Africa, the Americas, Eastern Mediterranean, and Europe (47), and one study was from Zambia (35).

4.5.4 Type of ASF

The type of ASF was not mentioned by Krasevec et al. in their study; rather, they mentioned the variety as 0 types of ASF, 1 type of ASF, 2 types of ASF, and 3 types of ASF consumed. Marinda et al. (2018) compared to fish with milk/milk products.

4.5.5 Outcomes

The outcomes reported in these two studies were stunting only.

4.5.6 Narrative Synthesis of Results

Randomized Interventional Studies

There were no studies that used this study design in reporting a variety of ASF.

Non-Randmozied Interventional Studies

There were no studies that used this study design in reporting a variety of ASF.

Observational Studies

The GRADE table of the outcome is mentioned in appendix 5.

4.5.6.1 Different types of ASF

The type of ASF was not mentioned by Krasevec et al. (2017) in their study; rather, they mentioned the variety as 0 types of ASF, 1 type of ASF, 2 types of ASF, and 3 types of ASF consumed.

Stunting: Krasevec et al. (2017) assessed stunting in children aged 6-23 months who were given different types of ASF (47). Significant difference was reported in stunting in children who consume 3 types of ASF or 2 types of ASF compared to those who consume 0 types of ASF (GRADE= low). Similarly, significant difference in stunting was reported in children who consume 3 types vs 1 type of ASF or 2 types vs 1 type of ASF (GRADE= low). Furthermore, significant difference in stunting was reported in children who consume 3 types of ASF vs those who consume 2 types of ASF (GRADE= low). However, no difference was reported in children who consume 1 type of ASF when compared to those who consume 0 types of ASF (Table 18).

Fish Vs Milk/milk products: The study conducted by Marinda et al. (2018) compared two ASF: Fish consumed in the preceding 24 hours and Milk/milk products consumed in the preceding 24 hours. However, they only provided the total population (N) and did not report any number of events (n) or effect estimates for stunting (GRADE= moderate).

Table 18: Variety of ASF in children aged 6-23 months					
Study	**Outcome**	**Type of ASF**	**Frequency**	**Estimate**	**GRADE Certainty**
Krasevec et al. (2017) (47)	Stunting	Not mentioned	3 ASF versus 2 ASF	**0.39 [0.38, 0.40]**	Low
			3 ASF versus 1 ASF	**0.17 [0.17, 0.18]**	Low
			3 ASF versus 0 ASF	**0.17 [0.16, 0.17]**	Low
			2 ASF versus 1 ASF	**0.43 [0.42, 0.44]**	Low
			2 ASF versus 0 ASF	**0.43 [0.42, 0.44]**	Low
			1 ASF versus 0 ASF	0.99 [0.97, 1.01]	Low

5. DISCUSSION

5.1 Summary of Main Results

Our review aimed to assess the effects of differing frequencies, amounts, and varieties of ASF on the dietary and health outcomes of children. In total, we found 31 studies, out of which 13 were for frequency, 18 were for amount, and two were for the variety. Of these 31 studies, 17 were observational and 14 were experimental (13 randomized and one non-randomized). The most reported outcomes were stunting, wasting, underweight, WAZ, HAZ, WHZ, HCAZ, anemia, hemoglobin, vitamin B-12 concentration, transferrin receptors, and ferritin levels. Of all the included studies, only two could be meta-analyzed. The type of ASF consumed by the children included any type of meat, seafood, dairy, eggs, and insects.

The review found no/or potential difference in growth outcomes when infants consumed varied (greater vs lesser or none) frequencies, amounts, and varieties of meat including red meat, organ meat, pork, eggs, dairy, seafood, and insects. However, most of the time the evidence was coming from a single study only, and the quality of included studies was poor to moderate.

5.2 Overall Completeness and Applicability of Evidence

In this review, we sought to determine the effects of differing frequencies, amounts, and varieties of ASF on dietary and health outcomes. Our secondary objective was to review what differences exist between processed/commercial ASF versus fresh/home prepared ASF on dietary and health outcomes. There were only three studies that mentioned the type of ASF in terms of the processing; however, these studies could not be compared with other studies. Overall, there was high heterogeneity amongst the studies, because of which most of the findings cannot be meta-analyzed. Only three outcomes (WAZ, HAZ, WHZ) from two of the studies were meta-analyzed with a GRADE of low to moderate. This systematic review identified a big data gap in terms of the evidence and the quality of the studies and we found low-quality evidence examining differing frequencies of ASF on nutritional status, anemia prevalence, and no reports of changes/stability in ASF intake later in life. We found low-quality evidence examining differing amounts of ASF on nutritional status and anemia prevalence. Similarly, the evidence for the growth outcomes ranged from low to high-quality evidence, but only came from one or two studies at maximum.

Most studies were excluded based on their consumption data not being reported in terms of frequency or variety (n=259). However, it should be noted that there were a substantial number of studies that did report frequency or variety data for ASF consumption but were not linked to any health or dietary outcomes (n=24). This left us with only 31 included studies. Given the heterogeneity of these 31 studies – differing outcomes and metrics of frequency – the results were highly inconsistent, and we were unable to meta-analyze for the majority of the outcomes, except three outcomes from only two studies examining egg vs no egg consumption by the children aged 6-9 months.

5.3 Quality of the Evidence

Overall, the quality of evidence coming from all these studies was very mixed. While in assessing the effects of differing amounts of ASF, 13 out of 16 studies used either randomized controlled trials or cluster randomized control trials as their study designs, suggesting that the evidence coming from these studies would be good. However, all the studies in the frequency (n=13), 2 studies in the amount (n=2), and all the studies in the variety (n=2) domains were all observational/cross-sectional/longitudinal. The findings from these studies showed that the association may only be established without the possibility of causal inference.

In the observational studies, many of the important details were missed. Eight out of 17 studies did not specify or define the population of interest, 14 did not provide the sample size justification, 6 of them either did not report the measure of exposure completely or the information was so unclear that the team could not decide this, and none of the studies reported if the assessors were blinded to the exposure of the participants; however, this was not considered a major risk of bias because of the observational nature of these studies. Five studies either did not account for the confounding variables or the information was so incomplete that we could not determine if they included the confounders in their studies. As a whole, only 2 studies were rated as good while the rest were rated as being fair or poor.

For the interventional studies, there were only 3 studies that had a low risk of bias, 1 study had a high risk of bias, while the remaining had some concerns relating to the studies. The concerns for the randomization process were highlighted by 2 of the studies, while 1 study did not adhere to the randomization at all. However, the majority of the studies adhered to the randomization process. There were only 5 studies that had no deviations from the intended intervention both for the assignment and the adhering, while the rest had some concerns. Similarly, 8 of the studies had some concerns regarding missing data. The majority of the studies measured and reported the outcomes correctly. The quality of evidence coming from these studies was then quite varied.

Our rating of the overall quality of the evidence as low, as indicated by our Risk of Bias assessments and lack of ability to conduct GRADE assessments in not more than two studies included in the meta-analysis, means that future research in this area might alter the findings of our study. We found very little consistency or uniformity in the studies related to complementary feeding of ASF in children. However, a GRADE certainty assessment was performed for the 6 critical outcomes i.e., stunting or HAZ. Wasting or WAZ. Underweight or WHZ, change in head circumference, change in triceps skinfold, and anemia/ hemoglobin.

5.4 Limitations and Potential Biases in the Review Process

Of important note, while importing references from the database CINAHL into Endnote, 6 of the identified references would not import. Several tactics were attempted to recover these 6 studies (e.g., splitting the set of references up into smaller chunks for importation, etc.); however, we were unsuccessful in doing so. Given that we searched a large number of databases, including CINAHL, it is likely that these 6 studies would have been captured by another database. Nonetheless, it’s possible that these studies were missed and could have biased our findings. We were also unable to retrieve full texts from 12 studies that may have qualified for inclusion in this review.

A key limitation in this review process was the lack of standardized metrics for frequency, as each author-defined frequency in their way. Given the heterogeneity and lack of consistent outcomes and frequency metrics, we were only able to include two studies for the meta-analysis, resulting in minimal to no evidence to answer our research questions.

Another limitation arose from the use of different measurement tools to determine consumption patterns of ASF. Currently, the gold standard for such assessments is the use of a weighed food record, rather than 24-hr recalls or FFQs. The 24-hr recall and FFQ increase the likelihood of recall. Moreover, some studies mixed the use of 24-hr recalls in addition to the use of FFQs. This gave mixed results which were not consistent with the other studies. Of those who used the same tools, the findings from these were also not reliable either because of the recall bias and the low quality of evidence.

Given our search strategy was comprehensive (a complex mixture of keywords, multiple databases, no language restrictions, and grey literature searched) it is very unlikely that search bias occurred in our review. Furthermore, detailed and defined selection criteria were outlined and decided before beginning this review, thus selection bias is also unlikely to have occurred.

Although publication bias is hard to avoid, several of our included studies reported inconsistent findings with the literature or no association (no statistical relevance) found between exposure and outcome. For this reason, it seems relatively unlikely that there is major publication bias in this review. In addition to this, a study that compared the home-based prepared ASF foods to that of processed or commercial foods which one of the objectives of this review; thus, we have identified research gaps and the need to conduct more studies that could answer this question.

5.5 Agreements and Disagreements with Other Studies or Reviews

This systematic review is the first to compare the more frequent, larger quantity, and more varied ASF food consumption with the less frequent, lower quantity, and less varied ASF food consumption during the complementary feeding period; thus we have no other systematic reviews to compare our findings with. However, we compared our findings with the already established guidelines.

It is recommended that complementary feeding should be started in the initial years of life i.e. from 6 months and continued upto 23 months. WHO recommends that complementary feeding in infants should be started from 6 months of age (65). Initially, the frequency of complementary feeding should be 2-3 times/day (for infants aged 6-8 months), which should then be increased to 3-4 times/day with increasing age (9-24 months) (65). A report from WHO (2000) highlighted that animal flesh meat and organ (liver, heart, and blood), in addition to milk, yogurt, and cheese are very protein-rich (67). Furthermore, flesh meat and organs from animals, birds, and fish that are prepared with blood are an excellent source of iron and zinc. Thus, animal-source food must be given in conjunction with the fruits and vegetables, and pulses and seeds (67).

However, all the previous guidelines lack the information of different frequencies, amounts, and varieties of ASF to be consumed. Until there are enough studies from which the findings can be meta-analyzed and guidelines can be made, we need to follow the recommendations which were previously made.

6. AUTHOR'S CONCLUSIONS

6.1 Implications for Practice and Policy

The findings from this study provided non-conclusive evidence on the effects of differing frequencies, amounts, and varieties of ASF used for complementary feeding. Moreover, most of the comparisons included single studies, highlighting the need for more studies comparing similar types of ASF and similarly addressing exposures and outcomes. Currently, studies were too heterogenous to make synthesized outcomes assessment through meta-analysis possible.

6.2 Implications for Research

As mentioned earlier, the review includes studies that were very heterogeneous in terms of the age of infants included, amount, frequency, and variety of ASF provided, and outcomes measured. Therefore, more homogenous studies are required. Similarly, there is a need to distinguish the type of ASF, whether fresh/home-prepared or processed, in relation to the outcome so that the transparency of the findings can be guaranteed and a proper guideline can be made. In addition to this, there is a need to integrate the breastfeeding status when reporting the outcomes; in order to determine whether the type of milk received has an impact on complementary feeding outcomes.

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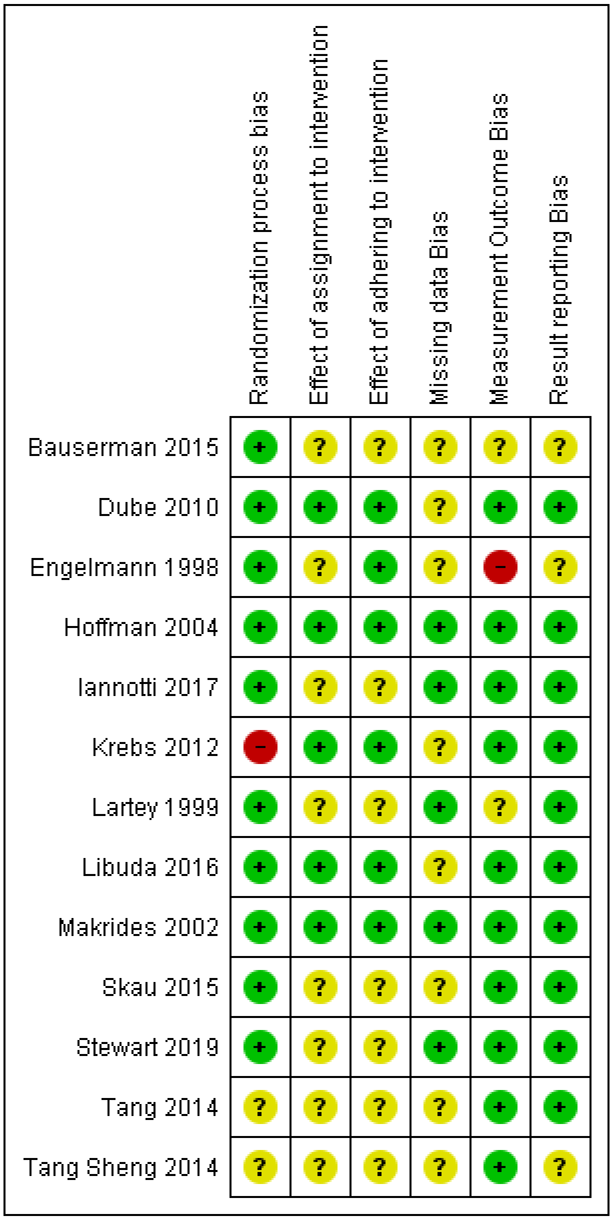

Figure 2: Risk of Bias for Randomized Interventional Studies

Table 2: Risk of Bias for Observational Studies

Table 2: Quality Assessment for Observational Cohort and Cross-Sectional Studies (NIH Tool)

Name of the Study	Was the research question or objective in this paper clearly stated?	Was the study population clearly specified and defined?	Was the participation rate of eligible persons at least 50%?	Were all the subjects selected or recruited from the same or similar populations	Was a sample size justification, power description, or variance and effect estimates provided?	For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?	Was the timeframe sufficient ?	Did the study examine different levels of the exposure as related to the outcome ?	**Exposure** clearly defined, valid, reliable, and implemented consistently across all study participants?	Was the exposure(s) assessed more than once over time?	**Were outcomes** clearly defined, valid, reliable, and implemented consistently across all study participants	Were the outcome assessors blinded to the exposure status of participants?	Was loss to follow-up after baseline 20% or less?	Were key potential confounding variables measured	Overall quality
Ahmad (2018)	Yes	Yes	Yes	Yes	Yes	Cannot determine	Not applicable	Yes	Yes	Yes	Yes	Not reported	Yes	Cannot determine	Good
Budree (2017)	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Cannot determine	Yes	Yes	Good
Di Marcantonio (2020)	Yes	Yes	Yes	No	Yes	No	Not applicable	Yes	Yes	No	Yes	No	Yes	Yes	Fair
Marinda (2018)	Yes	Yes	Yes	Yes	Yes	No	Not applicable	Yes	Yes	No	Yes	No	Not reported	Yes	Fair
Hopkins (2007)	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Cannot determine	Not reported	Yes	Fair
Thorsdottir (2003)	Yes	No	Yes	Yes	No	Cannot determine	Yes	Yes	Yes	Yes	Yes	Not reported	Yes	Not reported	Fair
Krasevec (2017)	Yes	No	Yes	No	Yes	No	Not applicable	Yes	Yes	No	Yes	Not reported	No	Yes	Fair
Nakamura (2019)	Yes	Yes	Cannot determine	Cannot determine	No	No	Not applicable	Yes	Yes	No	Yes	No	Cannot determine	Yes	Fair
Ntab (2005)	Yes	Yes	Yes	Yes	No	No	Cannot determine	Yes	Yes	No	Yes	No	Not applicable	Yes	Fair
Kiefte de-Jong (2012)	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	No	Not applicable	Yes	Fair

Magnusson (2013)	Yes	Yes	Yes	Not reported	No	Yes	Yes	Yes	Yes	No	Yes	Not reported	Not applicable	Yes	Fair
Silva (2007)	Yes	No	Cannot determine	Yes	No	No	Not applicable	Yes	Not reported	No	Yes	No	Cannot determine	Yes	Poor
De Pee (1998)	Yes	No	Yes	Cannot determine	Yes	Cannot determine	Cannot determine	Yes	Yes	Cannot determine	Yes	No	Cannot determine	No	Poor
Zhao (2016)	Yes	Yes	Yes	Yes	No	Not applicable	Not applicable	Yes	Cannot determine	Not applicable	Yes	Not applicable	Cannot determine	Yes	Poor
Urkin (2007)	Yes	Yes	Cannot determine	Yes	No	Cannot determine	Cannot determine	Yes	Cannot determine	No	Yes	No	Cannot determine	No	Poor
Shoda (2017)	Yes	No	Yes	Cannot determine	No	Yes	Yes	Yes	Yes	No	Yes	Cannot determine	No	Yes	Poor
Chang	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	Poor

Table 3: Risk of Bias for Non-Randomized Interventional Studies

Table 3: Quality Assessment for Non-Randomized Studies (ROBINS-I Tool)

Study name	Bias due to confounding		Bias in selection of participants into the study		Bias in classification of interventions		Bias due to deviations from intended interventions		Bias due to missing data		Bias in measurement of outcomes		Bias in selection of the reported result		Overall Bias	
	Author's Judgement	**Support to Judgement**	**Author's Judgement**	**Support to Judgement**	**Author's Judgement**	**Support to Judgement**	**Author's Judgement**	**Support to Judgement**	**Author's Judgement**	**Support to Judgement**	**Author's Judgement**	**Support to Judgement**	**Author's Judgement**	**Support to Judgement**	**Author's Judgement**	**Support to Judgement**
Taylor et al. (2004)	Low risk	Confounding variables were taken into consideration during analyses and ANCOVA was used to assess the effects of the confounders.	Low risk	Participant selection occurred before the intervention started and the start of the intervention occurred at the same age time frame for all participants.	Low risk	Participants were categorized into four intervention groups at the beginning of the study that were clearly defined. No possibility of classification being affected by the knowledge from the outcome, as the outcome was assessed prospectively later on.	Moderate risk	An examination of the meat intakes at each time-point was made to determine whether a child moved from one group to another over the course of the study. It was found that only a small number did so, thus confirming the integrity of the categorization.	Moderate risk	Moderate to serious risk as ~25% of total sample of infants withdrew before the end of the study due to domestic and logistical reasons. Study reports that where these subjects had completed at least 1 year of the study, their results were included. No further information is provided on these subjects whose data was not captured thus it's challenging to tell if the study may be biased in a certain direction.	Moderate risk	It is not mentioned whether the outcome assessors were aware of which intervention the infants received. Thus it is challenging to say whether there was bias in this domain. However, outcome assessment methods were unanimous across all groups and since the outcome methods were assessed via blood sampling and laboratory techniques there should be no differences in the intervention groups.	Low Risk	There are not multiple outcome measurements within the outcome domain possible. Since the outcome is assessed through blood collection, hematology and biochemistry analysis, there should be no bias in the selection of reported results.	Low risk	Low to moderate r overall. So concerns around potential b from devia from the intented interventio however th study seem confident t was a smal number of participant who chang interventio groups throughout study. Additional there is qui bit (~25%) missing da which coul harm the internal va of the stud Lastly, son concerns around measureme of outcome due to no mention of blinding.

GRADE Certainty Tables for Complementary Feeding (Animal Source Food): WHO Study

Appendix 1

Question: Greater frequency of ASF compared to lesser frequency of ASF for 6-23 months (Observational Studies)

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	**Study design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**greater frequency of ASF**	**lesser frequency of ASF**	**Relative (95% CI)**	**Absolute (95% CI)**		
Stunting in Children Consuming Meat: Assessed by Ahmad et al. 2018; Age at outcomes 6-23 months; Follow-up NA												
1	observational studies (non-comparative cross-sectional study)	serious [a]	not serious [b]	not serious	very serious [c]	none	11/392 (2.8%)	26/392 (6.6%)	**RR 1.10** (0.61 to 1.96)	**7 more per 1,000** (from 26 fewer to 64 more)	⊕◯◯◯ VERY LOW	CRITICAL
Stunting in Children Consuming Meat: Assessed by Zhao et al. 2016; Age at outcomes not reported; Follow-up NA												
1	observational studies (cross-sectional study)	very serious [d]	not serious [b]	serious [e]	not serious	none	370/668 (55.4%)	76/139 (54.7%)	**RR 1.01** (0.86 to 1.20)	**5 more per 1,000** (from 77 fewer to 109 more)	⊕◯◯◯ VERY LOW	CRITICAL

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater frequency of ASF	lesser frequency of ASF	Relative (95% CI)	Absolute (95% CI)		
Wasting in Children Consuming Meat: Assessed by Ahmad et al. 2018; Age at outcomes 6-23 months; Follow-up NA												
1	observational studies (non-comparative cross-sectional study)	serious [a]	not serious [b]	not serious	very serious [f]	none	9/392 (2.3%)	18/392 (4.6%)	**RR 1.28** (0.64 to 2.56)	**13 more per 1,000** (from 17 fewer to 72 more)	⨁◯◯◯ VERY LOW	CRITICAL
Wasting in Children Consuming Meat: Assessed by Zhao et al. 2016; Age at outcomes not reported; Follow-up NA												
1	observational studies (cross-sectional study)	very serious [d]	not serious [b]	serious [e]	very serious [f]	none	88/660 (13.3%)	18/136 (13.2%)	**RR 1.01** (0.63 to 1.62)	**1 more per 1,000** (from 49 fewer to 82 more)	⨁◯◯◯ VERY LOW	CRITICAL
Underweight in Children Consuming Meat: Assessed by Ahmad et al. 2018; Age at outcomes 6-23 months; Follow-up NA												

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater frequency of ASF	lesser frequency of ASF	Relative (95% CI)	Absolute (95% CI)		
1	observational studies (non-comparative cross-sectional study)	serious [a]	not serious [b]	not serious	very serious [g]	none	14/392 (3.6%)	22/392 (5.6%)	**RR 1.65** (0.96 to 2.83)	**36 more per 1,000** (from 2 fewer to 103 more)	⊕◯◯◯ VERY LOW	CRITICAL

Underweight in Children Consuming Meat: Assessed by Zhao et al. 2016; Age at outcomes not reported

1	observational studies (cross-sectional study)	very serious [d]	not serious [b]	serious [e]	very serious [g]	none	269/668 (40.3%)	51/138 (37.0%)	**RR 1.09** (0.86 to 1.38)	**33 more per 1,000** (from 52 fewer to 140 more)	⊕◯◯◯ VERY LOW	CRITICAL

Anemia in Children Consuming Meat: Urkin et al. 2007; Follow up 1-2 months after enrollment, children aged 12-months were the study population

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater frequency of ASF	lesser frequency of ASF	Relative (95% CI)	Absolute (95% CI)		
1	observational studies (non-comparative prospective study)	very serious [h]	not serious [b]	serious [e]	not serious	none			not estimable	not estimable	⊕◯◯◯ VERY LOW	IMPORTANT
Anemia in Children Consuming Red Meat; Assessed by Silva et al, 2007; children aged 6-12 months were study population; Follow-up NA												
1	observational studies (cross-sectional study)	very serious [i]	not serious [b]	not serious [j]	serious [f]	none	81/153 (52.9%)	37/52 (71.2%)	**RR 0.74** (0.59 to 0.94)	**185 fewer per 1,000** (from 292 fewer to 43 fewer)	⊕◯◯◯ VERY LOW	IMPORTANT
Anemia in Children Consuming Organ Meat i.e.. Liver: Assessed by Silva et al, 2007; children aged 6-12 months were study population; Follow-up NA												

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater frequency of ASF	lesser frequency of ASF	Relative (95% CI)	Absolute (95% CI)		
1	observational studies (cross-sectional study)	very serious [i]	not serious [b]	not serious [j]	very serious [c]	none	46/83 (55.4%)	72/122 (59.0%)	**RR 0.94** (0.74 to 1.20)	**35 fewer per 1,000** (from 153 fewer to 118 more)	⨁◯◯◯ VERY LOW	IMPORTANT

Stunting in children Consuming Eggs: Assessed by Ahmad et al. 2018; Age at outcomes 6-23 months; Follow-up NA

1	observational studies (non-comparative cross-sectional study)	serious [a]	not serious [b]	not serious	very serious [g]	none	43/392 (11.0%)	39/392 (9.9%)	**RR 1.14** (0.79 to 1.65)	**14 more per 1,000** (from 21 fewer to 65 more)	⨁◯◯◯ VERY LOW	CRITICAL

Stunting in Children Consuming Eggs: Assessed by Zhao et al. 2016; Age at outcomes not reported; Follow-up NA

1	observational studies (cross-sectional study)	very serious [e]	not serious [b]	serious [e]	not serious	none	346/623 (55.5%)	100/182 (54.9%)	**RR 1.01** (0.87 to 1.17)	**5 more per 1,000** (from 71 fewer to 93 more)	⨁◯◯◯ VERY LOW	CRITICAL

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater frequency of ASF	lesser frequency of ASF	Relative (95% CI)	Absolute (95% CI)		
Wasting in Children Consuming Eggs: Assessed by Ahmad et al. 2018; Age at outcomes 6-23 months; Follow-up NA												
1	observational studies (non-comparative cross-sectional study)	serious [a]	not serious [b]	not serious	very serious [g]	none	34/392 (8.7%)	33/392 (8.4%)	**RR 1.07** (0.70 to 1.62)	**6 more per 1,000** (from 25 fewer to 52 more)	⊕◯◯◯ VERY LOW	CRITICAL

Wasting in Children Consuming Eggs: Assessed by Zhao et al. 2016; Age at outcomes not reported; Follow-up NA

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater frequency of ASF	lesser frequency of ASF	Relative (95% CI)	Absolute (95% CI)		
1	observational studies (cross-sectional study)	very serious [e]	not serious [b]	serious [e]	not serious	none	346/625 (55.4%)	100/182 (54.9%)	**RR 1.01** (0.87 to 1.17)	**5 more per 1,000** (from 71 fewer to 93 more)	⊕◯◯◯ VERY LOW	CRITICAL
Underweight in Children Consuming Eggs: Assessed by Ahmad et al. 2018; Age at outcomes 6-23 months; Follow-up NA												
1	observational studies (non-comparative cross-sectional study)	serious [a]	not serious [b]	not serious	very serious [g]	none	44/392 (11.2%)	34/392 (8.7%)	**RR 1.34** (0.91 to 1.97)	**29 more per 1,000** (from 8 fewer to 84 more)	⊕◯◯◯ VERY LOW	CRITICAL
Underweight in Children Consuming Eggs: Assessed by Zhao et al. 2016; Age at outcomes not reported; Follow-up NA												
1	observational studies (cross-sectional study)	very serious [e]	not serious [b]	serious [e]	serious [k]	none	251/623 (40.3%)	69/181 (38.1%)	**RR 1.06** (0.86 to 1.30)	**23 more per 1,000** (from 53 fewer to 114 more)	⊕◯◯◯ VERY LOW	CRITICAL

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater frequency of ASF	lesser frequency of ASF	Relative (95% CI)	Absolute (95% CI)		
Stunting in Children Consuming Fish: Assessed by Ahmad et al. 2018; Age at outcomes 6-23 months; Follow-up NA												
1	observational studies (non-comparative cross-sectional study)	serious [a]	not serious [b]	not serious	very serious [g]	none	63/392 (16.1%)	18/392 (4.6%)	**RR 1.22** (0.77 to 1.91)	**10 more per 1,000** (from 11 fewer to 42 more)	⨁◯◯◯ VERY LOW	CRITICAL
Wasting in Children Consuming Fish: Assessed by Ahmad et al. 2018; Age at outcomes 6-23 months; Follow-up NA												
1	observational studies (non-comparative cross-sectional study)	serious [a]	not serious [b]	not serious	serious [k]	none	39/392 (9.9%)	26/392 (6.6%)	**RR 0.52** (0.34 to 0.80)	**32 fewer per 1,000** (from 44 fewer to 13 fewer)	⨁⨁◯◯ LOW	CRITICAL
Underweight in Children Consuming Fish: Assessed by Ahmad et al. 2018; Age at outcomes 6-23 months; Follow-up NA												

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater frequency of ASF	lesser frequency of ASF	Relative (95% CI)	Absolute (95% CI)		
1	observational studies (non-comparative cross-sectional study)	serious [a]	not serious [b]	not serious	serious [k]	none	54/392 (13.8%)	23/392 (5.9%)	**RR 0.82** (0.54 to 1.23)	**11 fewer per 1,000** (from 27 fewer to 13 more)	⊕⊕◯◯ LOW	CRITICAL

CI: Confidence interval; **RR:** Risk ratio

Explanations

a. Downgraded once- The use of observational study design increases the risk of biases in the study.

b. It is a single study. Thus, inconsistency cannot be determined.

c. Downgraded twice. The sample size is very low and the number of events are also < 300.

d. Downgraded twice- Lacks the mentioning of sample size justification and the exposures were also not mentioned clearly.

e. Downgraded once. No proper sample size justification and representativeness

f. Downgraded twice. Number of events < 300.

g. Downgraded twice. CI is very broad and the number of events are < 300

h. Downgraded twice- This study lacks many details on methodology making it very hard to determine whether there is internal validity. In addition, the study is described as an interventional study when it actually appears to be observational in nature. Food exposures are assessed by a questionnaire and blood samples tested for anemia outcome/ iron stores. There is no assigning of food as an intervention but rather observation of what is eaten by questionnaire.

i. Downgraded twice- Very limited detail in the methodology makes it challenging to tell if there was internal validity of study. No sample size justification provided or mention of loss to follow up or participation rate of eligible participants. Small sample size with no information provided for baseline characteristics of study sample of children.

j. Lack of sample size justification and loss to follow-up of the participants from the baseline.

k. Downgraded once. Number of events <300

Appendix 2

Question: Greater amount of ASF compared to Lesser amount for 6-23 months (RCTs)

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater amount of ASF	Lesser amount	Relative (95% CI)	Absolute (95% CI)		
Change in Height in Children Consuming Meat (assessed with: Higher MD indicates improvement.): Assessed by Engelmann et al. 1998; children aged 8-10 months were study population; Follow-up at 8 and 10 months after intervention												
1	randomised trials	serious [a]	not serious [b]	serious [c]	serious [d]	none	21	20	-	MD **0.1 SD lower** (1.77 lower to 1.57 higher)	⊕◯◯◯ VERY LOW	CRITICAL
Change in Weight in Children Consuming Meat: (assessed with: Higher MD indicates improvement.): Assessed by Engelmann et al. 1998; children aged 8-10 months were study population; Follow-up at 8 and 10 months after intervention												

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater amount of ASF	Lesser amount	Relative (95% CI)	Absolute (95% CI)		
1	randomised trials	serious [a]	not serious [b]	serious [c]	serious [e]	none	21	20	-	MD **0.08 higher** (0.53 lower to 0.7 higher)	⊕◯◯◯ VERY LOW	CRITICAL

Change in Triceps Skinfolds in Children Consuming Meat: (assessed with: Higher MD indicates improvement.): Assessed by Engelmann et al. 1998; children aged 8-10 months were study population; Follow-up at 8 and 10 months after intervention

1	randomised trials	serious [a]	not serious [b]	serious [c]	serious [d]	none	21	20	-	MD **0.1 lower** (5.39 lower to 5.19 higher)	⊕◯◯◯ VERY LOW	CRITICAL

Hemoglobin in Children Consuming Meat: (assessed with: Higher MD indicates improvement.): Assessed by Engelmann et al. 1998; children aged 8-10 months were study population; Follow-up at 8 and 10 months after intervention

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	**Study design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**greater amount of ASF**	**Lesser amount**	**Relative (95% CI)**	**Absolute (95% CI)**		
1	randomised trials	serious [a]	not serious [b]	serious [c]	not serious	none	21	20	-	SMD **0.21 SD higher** (0.4 lower to 0.83 higher)	⊕⊕◯◯ LOW	IMPORTANT
Stunting in Children Consuming Lyophilized Beef: Assessed by Kreb et al. 2012; children aged 6-18 months were the study population; Follow-up at 6, 9, 12 and 18 months												
1	randomised trials	serious [f]	not serious [b]	serious [g]	serious [e]	none	184/532 (34.6%)	179/530 (33.8%)	**RR 1.02** (0.87 to 1.21)	**7 more per 1,000** (from 44 fewer to 71 more)	⊕◯◯◯ VERY LOW	CRITICAL
Wasting in Children Consuming Lyophilized Beef: Assessed by Kreb et al. 2012; children aged 6-18 months were the study population; Follow-up at 6, 9, 12 and 18 months												

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater amount of ASF	Lesser amount	Relative (95% CI)	Absolute (95% CI)		
1	randomised trials	serious [f]	not serious [b]	serious [g]	very serious [d,e]	none	38/532 (7.1%)	54/530 (10.2%)	**RR 0.70** (0.47 to 1.04)	**31 fewer per 1,000** (from 54 fewer to 4 more)	⊕◯◯◯ VERY LOW	CRITICAL

WAZ in Children Consuming Lyophilized Beef (assessed with: Higher MD indicates improvement.) : Assessed by Kreb et al. 2012; children aged 6-18 months were the study population; Follow-up at 6, 9, 12 and 18 months

1	randomised trials	serious [f]	not serious [b]	serious [g]	not serious	none	532	530	-	MD **0.02 lower** (0.16 lower to 0.12 higher)	⊕⊕◯◯ LOW	CRITICAL

HAZ in Children Consuming Lyophilized Beef (assessed with: Higher MD indicates improvement.) : Assessed by Kreb et al. 2012; children aged 6-18 months were the study population; Follow-up at 6, 9, 12 and 18 months

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater amount of ASF	Lesser amount	Relative (95% CI)	Absolute (95% CI)		
1	randomised trials	serious [f]	not serious [b]	serious [g]	not serious	none	532	530	-	MD **0.06 lower** (0.23 lower to 0.11 higher)	⊕⊕◯◯ LOW	CRITICAL

WHZ in Children Consuming Lyophilized Beef (assessed with: Higher MD indicates improvement.) : Assessed by Kreb et al. 2012; children aged 6-18 months were the study population; Follow-up at 6, 9, 12 and 18 months

1	randomised trials	serious [f]	not serious [b]	serious [g]	not serious	none	532	530	-	MD **0.01 SD higher** (1.04 lower to 0.16 higher)	⊕⊕◯◯ LOW	CRITICAL

HCAZ in Children Consuming Lyophilized Beef (assessed with: Higher MD indicates improvement.) : Assessed by Kreb et al. 2012; children aged 6-18 months were the study population; Follow-up at 6, 9, 12 and 18 months

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater amount of ASF	Lesser amount	Relative (95% CI)	Absolute (95% CI)		
1	randomised trials	serious [f]	not serious [b]	serious [g]	not serious	none	532	530	-	MD **0.07 lower** (0.2 lower to 0.06 higher)	⨁⨁◯◯ LOW	CRITICAL
WAZ in Children Consuming Pork (assessed with: Higher MD indicates improvement.): Assessed by Tang et al, 2014; children aged 6-18 months were the population; Follow-up at 6, 7, 9, 12, 15 and 18 months of age												
1	randomised trials	serious [h]	not serious [b]	not serious	not serious	none	462	856	-	MD **0.08 higher** (0.01 higher to 0.15 higher)	⨁⨁⨁◯ MODERATE	CRITICAL
HAZ in Children consuming Pork (assessed with: Higher MD indicates improvement.): Assessed by Tang et al, 2014; children aged 6-18 months were the population; Follow-up at 6, 7, 9, 12, 15 and 18 months of age												
1	randomised trials	serious [h]	not serious [b]	not serious	not serious	none	462	856	-	MD **0.11 higher** (0.03 higher to 0.19 higher)	⨁⨁⨁◯ MODERATE	CRITICAL

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater amount of ASF	Lesser amount	Relative (95% CI)	Absolute (95% CI)		
WHZ in Children Consuming Pork (assessed with: Higher MD indicates improvement.): Assessed by Tang et al, 2014; children aged 6-18 months were the population; Follow-up at 6, 7, 9, 12, 15 and 18 months of age												
1	randomised trials	serious [h]	not serious [b]	not serious	not serious	none	462	856	-	MD **0.03 higher** (0.06 lower to 0.12 higher)	⊕⊕⊕◯ MODERATE	CRITICAL
HCAZ in Children Consuming Pork ((assessed with: Higher MD indicates improvement.): Assessed by Tang et al, 2014; children aged 6-18 months were the population; Follow-up at 6, 7, 9, 12, 15 and 18 months of age												
1	randomised trials	serious [h]	not serious [b]	not serious	not serious	none	462	856	-	MD **0.01 lower** (0.07 lower to 0.05 higher)	⊕⊕⊕◯ MODERATE	CRITICAL
Change in Height in Children Consuming Pork (assessed with: Higher MD indicates improvement.): Assessed by Tang et al, 2014; children aged 6-18 months were the population; Follow-up at 6, 7, 9, 12, 15 and 18 months of age												

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater amount of ASF	Lesser amount	Relative (95% CI)	Absolute (95% CI)		
1	randomised trials	serious [h]	not serious [b]	not serious	not serious	none	462	856	-	MD **0.26 higher** (0.05 higher to 0.47 higher)	⨁⨁⨁◯ MODERATE	CRITICAL

Change in Weight in Children Consuming Pork (assessed with: Higher MD indicates improvement.): Assessed by Tang et al, 2014; children aged 6-18 months were the population; Follow-up at 6, 7, 9, 12, 15 and 18 months of age

1	randomised trials	serious [h]	not serious [b]	not serious	not serious	none	462	856	-	MD **0.07 SD higher** (0 to 0.14 higher)	⨁⨁⨁◯ MODERATE	CRITICAL

Change in Head Circumference in Children Consuming Pork (Tang) ((assessed with: Higher MD indicates improvement.): Assessed by Tang et al, 2014; children aged 6-18 months were the population; Follow-up at 6, 7, 9, 12, 15 and 18 months of age

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater amount of ASF	Lesser amount	Relative (95% CI)	Absolute (95% CI)		
1	randomised trials	serious [h]	not serious [b]	not serious	not serious	none	462	856	-	MD **2.98 higher** (2.9 higher to 3.06 higher)	⊕⊕⊕◯ MODERATE	CRITICAL

HCAZ in Children Consuming Eggs (assessed with: Higher MD indicates improvement.): Assessed by Stewart et al. 2019; children aged 6-9.9 months were the study population; Follow-up 6 months

1	randomised trials	serious [i]	not serious [b]	serious [j]	not serious	none	290	305	-	MD **0.23 higher** (0.05 higher to 0.41 higher)	⊕⊕◯◯ LOW	CRITICAL

Stunting in Children Consuming Eggs: Assessed by Ianotti et al. 2017; children aged 6-9 months were the study population; Follow-up 6 months

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater amount of ASF	Lesser amount	Relative (95% CI)	Absolute (95% CI)		
1	randomised trials	serious [i]	not serious [b]	serious [k]	very serious [d,e]	none	21/75 (28.0%)	29/73 (39.7%)	**RR 0.70** (0.44 to 1.12)	**119 fewer per 1,000** (from 222 fewer to 48 more)	⊕◯◯◯ VERY LOW	CRITICAL

Anemia in Children Consuming Eggs: Assessed by Makrides et al, 2002; children aged 6-12 months were the study population; Follow-up at 6,9 and 12 months

1	randomised trials	not serious	not serious [b]	not serious	very serious [d,e]	none	3/44 (6.8%)	2/23 (8.7%)	**RR 0.78** (0.14 to 4.36)	**19 fewer per 1,000** (from 75 fewer to 292 more)	⊕⊕◯◯ LOW	IMPORTANT

Hemoglobin in Children Consuming Eggs (assessed with: Higher MD indicates improvement.): Assessed by Makrides et al, 2002; children aged 6-12 months were the study population; Follow-up at 6,9 and 12 months

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	**Study design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**greater amount of ASF**	**Lesser amount**	**Relative (95% CI)**	**Absolute (95% CI)**		
1	randomised trials	not serious	not serious [b]	not serious	serious [e]	none	44	23	-	SMD **0.2 SD higher** (0.31 lower to 0.71 higher)	⨁⨁⨁◯ MODERATE	IMPORTANT

Change in Triceps Skinfold in Children Consuming Skimmed Milk (assessed with: Higher MD indicates improvement.): Assessed by Skau et al, 2015; children aged 6-15 months were study population; Follow-up at 9 months of intervention [15 months]

1	randomised trials	not serious [l]	not serious [b]	not serious	serious [e]	none	106	102	-	MD **0.1 lower** (0.38 lower to 0.18 higher)	⨁⨁⨁◯ MODERATE	CRITICAL

Change in Head Circumference in Children Consuming Skimmed Milk (assessed with: Higher MD indicates improvement.): Assessed by Skau et al, 2015; children aged 6-15 months were study population; Follow-up at 9 months of intervention [15 months]

1	randomised trials	not serious [l]	not serious [b]	not serious	serious [e]	none	106	102	-	MD **0.4 lower** (0.76 lower to 0.04 higher)	⨁⨁⨁◯ MODERATE	CRITICAL

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater amount of ASF	Lesser amount	Relative (95% CI)	Absolute (95% CI)		
Change in Triceps Skinfold in Children Consuming Fish and Concoction (assessed with: Higher MD indicates improvement.): Assessed by Skau et al, 2015; children aged 6-15 months were study population; Follow-up at 9 months of intervention [15 months]												
1	randomised trials	not serious [l]	not serious [b]	not serious	serious [e]	none	85	93	-	MD **0.2 lower** (0.48 lower to 0.08 higher)	⨁⨁⨁◯ MODERATE	CRITICAL
Change in Head Circumference in Children Consuming Fish and Concoction (assessed with: Higher MD indicates improvement.): Assessed by Skau et al, 2015; children aged 6-15 months were study population; Follow-up at 9 months of intervention [15 months]												
1	randomised trials	not serious [l]	not serious [b]	not serious	serious [e]	none	85	93	-	MD **0.1 lower** (0.52 lower to 0.32 higher)	⨁⨁⨁◯ MODERATE	CRITICAL
Hemoglobin in Children Consuming Fish and Concoction (assessed with: Higher MD indicates improvement.): Assessed by Skau et al, 2015; children aged 6-15 months were study population; Follow-up at 9 months of intervention [15 months]												

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater amount of ASF	Lesser amount	Relative (95% CI)	Absolute (95% CI)		
1	randomised trials	not serious [l]	not serious [b]	not serious	serious [e]	none	69	73	-	SMD **0.28 SD lower** (0.58 lower to 0.02 higher)	⊕⊕⊕◯ MODERATE	IMPORTANT

Stunting in Children Consuming Caterpillars: Assessed by Bauserman et al. 2015; children aged 6-18 months were the study population; Follow-up at 9, 12 and 18 months

1	randomised trials	serious [m]	not serious [b]	serious [n]	very serious [d,e]	none	54/81 (66.7%)	58/82 (70.7%)	**RR 0.94** (0.77 to 1.16)	**42 fewer per 1,000** (from 163 fewer to 113 more)	⊕◯◯◯ VERY LOW	CRITICAL

Wasting in Children Consuming Caterpillar: Assessed by Bauserman et al. 2015; children aged 6-18 months were the study population; Follow-up at 9, 12 and 18 months

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater amount of ASF	Lesser amount	Relative (95% CI)	Absolute (95% CI)		
1	randomised trials	serious [m]	not serious [b]	serious [n]	very serious [d,e]	none	6/80 (7.5%)	8/80 (10.0%)	**RR 0.75** (0.27 to 2.06)	**25 fewer per 1,000** (from 73 fewer to 106 more)	⨁◯◯◯ VERY LOW	CRITICAL

WAZ in Children Consuming Caterpillar (assessed with: Higher MD indicates improvement.): Assessed by Bauserman et al. 2015; children aged 6-18 months were the study population; Follow-up at 9, 12 and 18 months

1	randomised trials	serious [m]	not serious [b]	serious [n]	very serious [d,e]	none	80	82	-	MD **0.2 lower** (0.57 lower to 0.17 higher)	⨁◯◯◯ VERY LOW	CRITICAL

HAZ in Children Consuming Caterpillar (assessed with: Higher MD indicates improvement.): Assessed by Bauserman et al. 2015; children aged 6-18 months were the study population; Follow-up at 9, 12 and 18 months

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater amount of ASF	Lesser amount	Relative (95% CI)	Absolute (95% CI)		
1	randomised trials	serious [m]	not serious [b]	serious [n]	serious [e]	none	81	82	-	MD **0.1 higher** (0.35 lower to 0.55 higher)	⨁◯◯◯ VERY LOW	CRITICAL
WHZ in Children Consuming Caterpillar (assessed with: Higher MD indicates improvement.): Assessed by Bauserman et al. 2015; children aged 6-18 months were the study population; Follow-up at 9, 12 and 18 months												
1	randomised trials	serious [m]	not serious [b]	serious [n]	serious [e]	none	79	80	-	MD **0.2 lower** (0.62 lower to 0.22 higher)	⨁◯◯◯ VERY LOW	CRITICAL
Anemia in Children Consuming Caterpillar: Assessed by Bauserman et al. 2015; children aged 6-18 months were the study population; Follow-up at 18 months												
1	randomised trials	serious [m]	not serious [b]	serious [n]	serious [e]	none	20/77 (26.0%)	32/64 (50.0%)	**RR 0.52** (0.33 to 0.81)	**240 fewer per 1,000** (from 335 fewer to 95 fewer)	⨁◯◯◯ VERY LOW	IMPORTANT

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater amount of ASF	Lesser amount	Relative (95% CI)	Absolute (95% CI)		

Hemoglobin in Children Consuming Caterpillar Assessed by Bauserman et al. 2015; children aged 6-18 months were the study population; Follow-up at 18 months

1	randomised trials	serious [m]	not serious [b]	serious [n]	serious [e]	none	77	64	-	SMD **0.35 SD lower** (0.02 higher to 0.69 higher)	⨁◯◯◯ VERY LOW	IMPORTANT

CI: Confidence interval; **MD:** Mean difference; **SMD:** Standardised mean difference; **RR:** Risk ratio

Explanations

a. Downgraded once- Some major concerns over bias that may have arose from using different blood collection methods. Venous blood vs capillary blood have been shown previously to have significantly different levels of hemoglobin and serum ferritin levels. However, the number of infants who received venipuncture vs finger pricks was not significantly different (p=0.9) between the two intervention groups.

b. It is a single study. Thus, inconsistency cannot be determined.

c. Downgraded once. Inability to generalize the findings because of low sample size.

d. Downgraded once. Very broad Confidence interval

e. Downgraded once. Number of events < 300

f. Downgraded once- Allocation sequence not concealed and thus increases the likelihood of bias

g. Downgraded once. The external validity is not guaranteed since the sample size is low and the risk of bias related to poor randomisation reduces the applicability.

h. Downgraded once- Study participants were randomized to an intervention arm. There is no mention of concealment

i. Downgraded once- Lack of blinding in intervention allocation.

j. Downgraded once. The sample size is appropriate. However, lack of blinding is one factor that affects the applicability of the research findings.

k. Downgraded once. The sample size is very low to make conclusions for the entire population.

l. Participants seem to have been blinded as the food packages were identical. However, one study staff member who was responsible for distribution knew intervention type in order to distribute food appropriately. Does not appear to be any deviations from intented intervention.

m. Downgraded once- No mention of blinding towards participants or those delivering the caterpillar cereal to participants.

n. Downgraded once. Lost an undesirably high percentage of infants to follow-up because many of the participants relocated and therefore outcome data were incomplete.

n. Downgraded once. Lost an undesirably high percentage of infants to follow-up because many of the participants relocated and therefore outcome data were incomplete.

Appendix 3

Question: Greater amount of ASF compared to lesser amount of ASF for children aged 6-23 months (meta-analysis GRAE Certainty)

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater amount of ASF	lesser amount of ASF	Relative (95% CI)	Absolute (95% CI)		

WAZ (assessed with: Higher MD indicates improvement.): Assessed by Ianotti et al. 2017 and Stewart et al. 2019; children aged 6-9 months; Follow-up 6 months

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater amount of ASF	lesser amount of ASF	Relative (95% CI)	Absolute (95% CI)		
2	randomised trials	serious [a]	not serious	not serious	not serious	none	365	378	-	MD **0.15 higher** (0 to 0.3 higher)	⊕⊕⊕◯ MODERATE	CRITICAL
HAZ (assessed with: Higher MD indicates improvement.): Assessed by Ianotti et al. 2017 and Stewart et al. 2019; children aged 6-9 months; Follow-up 6 months												
2	randomised trials	serious [a]	serious [b]	not serious	not serious	none	365	388	-	MD **0.06 higher** (0.1 lower to 0.22 higher)	⊕⊕◯◯ LOW	CRITICAL
WHZ (assessed with: Higher MD indicates improvement.): Assessed by Ianotti et al. 2017 and Stewart et al. 2019; children aged 6-9 months; Follow-up 6 months												
2	randomised trials	serious [a]	very serious [c]	not serious	not serious	none	365	378	-	MD **0.06 lower** (0.31 lower to 0.19 higher)	⊕◯◯◯ VERY LOW	CRITICAL

CI: Confidence interval; **MD:** Mean difference

Explanations

a. Downgraded once- Both the studies had some concerns in regards to the blinding.

b. Downgraded once. The studies had the heterogeneity which can be seen by I2 that is more than 30%% and the p-value which is more than 0.10.

c. Downgraded twice. The studies had the heterogeneity of 63% which can be seen by I2 which is more than 30% and the p-value which is 0.10.

Appendix 4

Question: Greater amount compared to lesser amount ASF for 6-23 months (Observational)

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater amount	lesser amount ASF	Relative (95% CI)	Absolute (95% CI)		
Hemoglobin in Children Consuming Cow Milk: Assessed by Thorsdottir et al. 2003; children aged 0-12 months were the study population; Follow-up at 9-12 months												

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	greater amount	lesser amount ASF	Relative (95% CI)	Absolute (95% CI)		
1	observational studies (Observational cohort longitudinal study)	very serious [a]	not serious [b]	serious [c]	very serious [d]		17	80	-	**0** (0 to 0)	⨁◯◯◯ VERY LOW	IMPORTANT

CI: Confidence interval

Explanations

a. Downgraded twice- Lacked sample size justification, and power description

b. It is a single study. Thus, inconsistency cannot be determined.

c. confounders not taken into consideration, nor identified.

d. No absolute values can be calculated and the number of events are < 300

Appendix 5

Question: More varied ASF compared to less varied ASF for 6-23 months (observational studies)

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	more varied ASF	less varied ASF	Relative (95% CI)	Absolute (95% CI)		
Stunting in Children Consuming varied ASF: Assessed by Krasevec at al. 2017; children aged 6-23 months were the study population; Follow-up NA												
1	observational studies (non-comparative cross-sectional study)	serious [a]	not serious [b]	serious [c]	not serious		6.467/74.548 (8.7%)	26.818/74.548 (36.0%)	**RR 0.17** (0.16 to 0.17)	**299 fewer per 1,000** (from 302 fewer to 299 fewer)	⨁⨁◯◯ LOW	CRITICAL
Stunting in Children Consuming Milk/ Milk Products: Assessed by Marinda et al. 2018; children aged 6-59 months were the study population; Follow-up NA												
1	observational studies (non-comparative cross-sectional study)	serious [d]	not serious [b]	not serious	not serious	none			not estimable		⨁⨁⨁◯ MOERATE	CRITICAL

CI: Confidence interval; **RR:** Risk ratio

Explanations

a. Downgraded once- All the participants were not selected from the same population increasing the risk of bias

b. It is a single study. Thus, inconsistency cannot be determined.

c. Downgraded once. The sample was different and not consistent; thus, it is hard to look for the sample representativeness.

d. Downgraded once- Funding for this study was provided to WorldFish by the German Federal Ministry for Economic Cooperation and Devel. Wondering if there could be some bias or advertising towards consuming fish based on the funder?