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Protocol

Complementary feeding practices and the associated risk of childhood obesity among ethnic minority groups living in high income countries: protocol for a systematic review and meta-analysis

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ABSTRACT

Introduction

Complementary feeding (CF) defined as the period beginning when exclusive breast milk and formula are no longer sufficient for meeting the nutritional needs of the infant. The CF period occurs from birth to 23 months of age. Though recommended by guidelines for the introduction of CF from around six months of age, data available indicates some infants are introduced to food earlier than six months which can predispose children to the risk of obesity and overweight. Obesity in ethnic minority group (EMG) children is higher than their native counterparts and often tracks into adulthood. Hence, we aim to conduct a systematic review and meta-analysis on the available literature in high-income countries (HIC) to identify the risk of childhood obesity associated with CF practices in EMG children living in HIC.

Methods and Analysis

A methodological literature search surrounding childhood obesity and overweight (COO) risk associated with complementary feeding (CF) practices will be conducted in May 2021 following PRISMA-P guidelines. The following academic databases will be methodologically searched: PubMed, EMBASE, PsycINFO, CINAHL, SCOPUS, Cochrane Library and the WHO Global Index Medicus. Three independent researchers will be involved in independent screening and will review the included articles based on the pre-defined inclusion and exclusion criteria. Where conflicts arise during the screening process, it will be resolved through discourse until a consensus is reached. Information on CF practices and anthropometric measurements will be extracted to ascertain risk of childhood obesity and overweight. For this study, WHO Body Mass Index (BMI) for age and sex percentiles, Centre for Disease Control (CDC) classification and other recognised country specific classifications will be utilised for the outcome.

Ethics and Dissemination

Formal ethical approval is not needed as the results will be drawn from currently available published literature. Outcomes of the review will be shared through peer-reviewed publications.

Key Words: Complementary feeding practices; infant feeding; childhood overweight; childhood obesity; ethnicity; race; culture; high income countries; ethnic minorities.

PROSPERO registration number: CRD42021246029

Strengths and Limitations of the study

- First systematic review considering extensive analysis of Childhood overweight and obesity and the risk in multiple ethnic minority group children in high income countries pertaining to complementary feeding practices
- Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) and PRISMA 2009 guideline is followed for the systematic review and meta-analysis.
- Expert librarian specialized in database search strategy has developed the search protocol.
- Our review will capture a small number of studies that are likely to meet the inclusion criteria due to language restriction and heterogeneity between studies is expected to be high
- In the reported effect estimates, lack of uniformity may be one of our limitation

.

Background

Childhood obesity and overweight (COO) is a global health problem in high-income countries (HIC) although it has also emerged as a problem in low and middle countries according to the World Health Organization [1]. Evidence implies that COO, feeding practices, and mean nutrient disparities are associated with race and ethnicity and often entangled with income (Davis *et al*., 2021). Due to international migration, disparities in COO should be expected. International migration to HIC has continued to increase globally with 57% of migrants living in HIC, where communities have become more diverse. In 2010, the International Organisation for Migration estimated the worldwide migration was comprised of 214 million people (2010) [2]. However, research on ethnicity related obesity risk in childhood is considerably limited [3]. Given the increasing rate of migration from poorer to HIC it means that COO in ethnic minority groups (EMG) presents a potential public health concern, warranting further research to better contributing factors.

Complementary feeding (CF) is defined as "the process starting when breast milk is no longer sufficient to meet the nutritional requirements of infants, and therefore other foods and liquids are needed, along with breast milk"[4] CF usually occurs from six to 23 months, even when breastfeeding continues over two years of age[4]. CF has always been focused on providing nutritious, clean, safe and adequate food to meet the nutritional requirements of infants and children. CF aims to reduce malnutrition and infections although there have been growing concerns regarding its potential contribution to childhood overweight and obesity (COO) [5]. Poor CF practices and breastfeeding are widespread with just 34.8% infants exclusively breastfed and majority of infants given food or liquids before the recommended 6 months [1]. Some studies suggest that COO is less common in children and adolescents who have been exclusively breastfeed [4,6]. Conversely, introducing solid foods earlier than the recommended six months has been shown to predispose children to overweight/obesity, as highlighted in several reviews [6–8]. Studies have discovered that early rapid weight gain during infancy is related to subsequent COO risk [9,10]. The relationship between rapid weight gain and later childhood obesity further emphasises the potential programming that occurs very early on in life resulting in COO and associated health problems and may be related to CF practices. A cohort study by Ardic *et al*., (2019) found that early feeding habits might be permanent and therefore pose risk to later health outcomes [11].

EMG children are the offspring of migrant families who live in a different country from their parent's country of origin. Immigration can be diverse and varied from country to country. EMG in the USA comprise a third of the population [12]. The immigrant population of Canada is 21% [2] whereas the United Kingdom is comprised of 13% [13]. Although diversity is considered based on country of birth, this can pose problems due to within country diversity from the country of origin [14]. Identifying the causes of COO amongst different EMG can be complex and challenging.

Differences across EMG in relation to CF practices and COO prevalence have been identified in at least two different studies [6,12]. The differences are embedded in social and household contexts in either increasing or decreasing the risk of obesity. However, Kumanyika (2008) has highlighted that available evidence can be sparse, heterogenous and difficult to meaningfully summarise. Two studies have explored cultural influences of CF practices among Chinese and South Asian children[15,16]. However, overweight/obesity risk in relation to CF practices has not yet been collectively analysed in different EMG children. Furthermore, it is known that CF practices are associated with early COO, yet the extent of the problem is unknown for EMG children living in HIC. Considering the substantial global burden of COO, it is important to understand the association between CF practices and COO, specifically amongst EMG children living in HIC. We propose in this protocol to run a systematic review and meta-analysis to address this research question.

Methods/Design

This protocol follows the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) guidelines [17] and has been informed by the Cochrane Handbook for Systematic Reviews of Interventions [18]. The final review will be reported in accordance to the 2020 Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) statement [19]. The prospective review is registered with the PROSPERO (registration no. CRD42021246029). The start date for the review will be June 2021 and the estimated date for completion would be May 2022.

Eligibility criteria

Inclusion Criteria

We will include randomised controlled trials, cohort studies, case-control studies and cross-sectional studies. We will include studies reporting direct and/or indirect effect sizes in children who were exposed to CF from 0-24 months. All studies should have estimates of the association between the measured exposure (CF) and the outcomes (weight gain). Such estimates reported should be calculated, or calculable, The systematic review will be conducted using the PICOS approach (participants, exposure, comparator, outcome(s) and type of study) from which studies are identified. [18,20,21] Inclusion and exclusion criteria are listed according to PICOS in table 1.

Table 1: Pre-defined inclusion and exclusion study criteria according to PICOS

PICOS	Inclusions	Exclusions
Participants	Ethnic minority children aged between 0-2 years; living in HIC	Pre-term and low-birth-weight children; children with medical problems that can affect body weight e.g. Prader Willi Syndrome, failure to thrive, metabolic disorders, Hypothyroidism, Cushing syndrome, growth hormone deficiency etc.
Interventions	CF practices including timing of introduction of semi solid, solid and soft foods, meal frequency and dietary diversity.	Studies reporting exclusively on breastfeeding outcomes alone
Comparisons	Children who followed recommended CF guidelines by WHO/UNICEF	
Outcomes of interest	Risk of obesity and overweight as classified by BMI z -scores and BMI percentiles	Studies that do not include obesity or overweight as an outcome
Study design	Risk of obesity and overweight as classified by BMI z -scores and BMI percentiles	Studies not published in English, Studies with no full text available

HIC = High-Income Countries; CF = Complementary Feeding; RCTs = Randomised Controlled Trials

The study population will be children from ethnic minority groups aged 0-2 years who reside in HIC. The study outcome will investigate the association between CF practices and the risk of COO. The outcomes will include anthropometric measurements including BMI z-scores or BMI percentiles. The results of the review on CF will be evaluated using the recommended optimum CF guidelines by WHO (2008). It is recommended that exclusive breastfeeding continues until six months and up to two years and beyond. Introduction of solids, soft and other liquids, other than breast milk or formula, is recommended from six months onwards. The outcome of the study (COO), will be classified according to WHO BMI for age and sex percentiles and the Centres for Disease Control and Prevention (CDC) classification and other recognised classifications. According to the CDC, overweight is defined as BMI $\geq 85^{th}$ and $<95^{th}$ percentile, while obesity is BMI of $\geq 95^{th}$ percentile for children < 18 years of the same age and sex [22]. These two classifications have previously been compared by Gaffney *et al.,* (2016) who found that 1 standard deviation unit above median of the WHO growth curve population approximates 85^{th} percentile.[23] As BMI does not measure body fat, skinfolds measurements, dual energy x-ray absorptiometry (DXA) and other methods will be used, if available.

Exclusion Criteria

Studies which are not published in English and those that do not present original data will not be included. Other studies that will be excluded are narrative reviews, systematic reviews and meta-analysis, opinion articles, editorials, letters to the editor, published abstracts without a published full-text, student dissertations/theses, and blog posts. Studies that do not include anthropometric measurements in EMG children as part of the outcome will be excluded.

Search Strategy

Developing research question and search query domains

We will search for papers published between 2000 until search date. A systematic search of the literature will be conducted in May 2021 by a specialist medical librarian (LÖ). The electronic databases: PubMed, EMBASE, PsycINFO, CINAHL, SCOPUS, Cochrane Library the WHO Global Index Medicus will be included in the search and covered from 2000 to the search date. No filters or limitations will be applied. A preliminary search in PubMed was carried out in April 2021 to identify relevant search terms and search technical solutions (LÖ).

The search terms were systematically identified with support of PubMed's MeSH, by analysing the indexing of previous, relevant studies which was informed by input from the subject specialists (MT and MK). A copy of the preliminary search strategy in PubMed is available in Supplementary file 1. Hand screening of reference lists of the studies that meet the pre-defined criteria will also be conducted.

Detailed search documentation for all included databases will be appended to the final review to allow search reproducibility and transparent appraisal of the search strategy and results. Finally, Cabell's Predatory Reports in Cabell's Scholarly Analytics will be consulted to ensure that none of the finally selected studies published in open-access journals that are listed as potential predatory journals.

Data Extraction and Management

Screening and study selection

Covidence systematic review software by Veritas Health Innovation (2021), will be used to automatically de-duplicate and blind screen all records identified in the database search. After duplicated studies have been removed, unique records will be screened based on the title and/or abstract by two independent reviewers (MT & MK). Articles which do not meet the criteria will be excluded. Eventual disagreements will be resolved through blinded conflict resolution through Covidence by a third reviewer (LÖ) which will further reduce bias risk. In a similar way, full-text review will be carried by two independent reviewers (MT & MK), resolving conflicts for ambiguous inclusion by a third reviewer (LÖ) through Covidence. Details from the screening and selection process, including reasons for exclusion of the omitted full-text studies, would be documented in a PRISMA 2020 flow diagram.

Data Extraction

For extraction of data, a piloted form will be used. Data will be extracted for each study that meets the eligibility criteria by two researchers and the third researcher will resolve any discrepancies. The following data if available will be extracted: surname of the first author, publication year, HIC, participant's ethnicity, study design, sample size, participant's age, breast-feeding duration, CF timing and frequency, primary outcome, anthropometric

measurements, length of follow-up and types of CF, effect size (OR/RR) and mean difference. HIC list provided in supplementary file 2.

Ethnicity of the child will be determined by the country of birth of the parents although ethnicity identification by country of birth has caveats because diversity of the country-of-origin can differ[14]. In addition, diversity collection practices differ among Organisation for Economic Cooperation and Development (OECD) countries, some countries collect indigenous identity, others race and ethnicity as well as migrant statuses.

Output

The study will present a PRISMA flow diagram including the summary of the search results and study selection. Rated, quality of the included studies will be presented in a comprehensive table of the study characteristics. The risk of COO identified from all studies will be summarised and synthesised to identify the overall risk in multiple EMG children residing in HIC at the time the study was conducted.

Risk of Bias in primary study

Two authors (MT and MK) will assess the quality of studies independently using the Newcastle Ottawa Scale (NOS) and modified NOS for assessing quality of non-randomised studies in the meta-analysis. The tool assesses participant selection, comparability of groups, and outcome or exposure depending on the type of study.[24] A point is given for each item in the three sections if the study meets the criteria. The maximum score for cross-sectional studies is ten and nine for cohort studies. Assessment of internal validity of primary studies is crucial in systematic reviews for identifying the risk of bias. It has been noted that, whilst the NOS quality assessment scale is challenging, and more subjective in non-randomised studies compared to randomised controlled trials (RCTs), there is no other widely accepted tool for non-randomised studies. [25] Grading of Recommendations Assessment, Development and Evaluation (GRADE) quality review tool will be used for RCTs. Disagreements with grading will be resolved through discourse and revisiting the inclusion criteria by both authors.

Analysis and Data Synthesis

Descriptive analysis will be performed to report on the association between COO and breast-feeding duration, timing of CF and frequency, as well as variety of feeds. Both narrative text and table summaries will be presented.

The results of the included studies will be synthesised using pooled estimates and pooled odds ratios or risk ratios applying random effects model with 95% confidence intervals (CI) where data permits to conclude the pooled COO risk. Random effects meta-analysis will be limited to studies that reported on pooled estimates and with at least ten studies with low to moderate heterogeneity for meaningful results. Heterogeneity will be assessed using the I^2 and visual inspection of forest plots. For dichotomous data, risk ratios (RR) and 95% CI will be calculated and for continuous data mean difference (MD) and 95% CI will be used. MD will be converted to RR if possible. Forest plots will be used to visually present the estimated weighted results from different studies.

Bias Minimisation

The review will include multiple databases to ensure all studies published are included if they meet inclusion criteria. Funnel plots, which is a plot of effect size, will be used to assess publication bias and estimated by Begg's or Eggers tests using R package. Assessment of the quality of primary studies by both authors using NOS and GRADE tools will further minimise bias. Disagreements with grading will be resolved through discourse. We will also perform sensitivity analysis for the meta-analysis and repeat to include only studies that are deemed to be good quality. Analyses will be conducted using Stata version 16 (StataCorp).

Patient and public involvement

Patient will not be involved at any stage of the study. The proposed study is primarily a review of published data available in the indicated electronic databases.

Discussion

Our review is unique, and to our knowledge is the only review considering extensive analysis of COO risk in multiple EMG children residing in HIC, pertaining to CF practices. A similar review which explored COO in relation to CF was conducted in the general population without stratification on EMG or HIC. [8] Although another review on CF practices focused on South

Asian children in HIC as a EMG, they did not report on obesity risk but identified significant differences in CF practices that were obesogenic.[15] On the other hand, one earlier review identified a clear association amongst the general population in developed countries.[26] This means that with a combined multiple ethnicities review, there is a possibility to have statistically meaningful results that will identify COO risk in EMG children residing in HIC. Moreover there has been an disparity in bodyweight changes among children and especially among ethnic minorities.[27–29] Our study will contribute to the efforts in the prevention of COO within EMG that are often under-researched and marginalised. Furthermore, we envisage our study to contribute to enhancing reduction in health disparities experienced by EMG through subsequent targeted interventions.

Strengths and Limitations

To our knowledge, is the first review considering extensive analysis of COO risk in multiple EMG children residing in HIC, pertaining to CF practices. COO has been confirmed to be higher in EMG compared to native groups. If CF practices among EMG are a contributory factor in COO, our review will bring evidence for targeted interventions to prevent rather than cure COO by promoting health weight throughout childhood years. It will also highlight the scarcity of research within marginalised EMG by identifying gaps and making recommendations for future studies in CF practices.

The review is not without limitations. First, most studies included will be observational. Second, studies amongst EMG in HIC tend to be limited with ethnic groups making up small samples. Additionally, language barrier difficulties may be present in the host country. It is therefore likely that our review will capture a small number of studies that are likely to meet the inclusion criteria and heterogeneity between studies is expected to be high. Population diversity will further increase heterogeneity risk. There is potential that some studies, which include EMG, may be missed due to countries using varied ethnicity classifications, paired with the subjective nature of ethnicity.

Authors Contribution

MT and MK were involved in all aspects of the study from conceptualization, protocol development and developing the preliminary search strategy. LÖ developed the preliminary search strategy, contributed with text for the methods part of the manuscript and will conduct

the final literature search and the reference management in Covidence. Further screening of literature and data extraction will be carried out by MT and data validated by MK. TA revised the first draft for intellectual content and will assist with drafting and revising content in the final project. OMO will oversee the data extraction process and complete all aspects of the meta-analysis.

Support: Source and sponsor

No funding declared.

Competing interests

None declared.

Patient and Public involvement

No involvement and therefore patient consent not required.

Data Statement

Data will be submitted as a supplementary appendix.

Amendments: In the event of minor amendments of this protocol, the changes will be updated and transparent reported in the online PROSPERO registration for the review: CRD42021246029

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Supplementary materials file 1: preliminary search strategy in PubMed

Source: PubMed

Search date: 2021-04-30

Search specifications: All search terms are searched in the search field "Title/Abstract" and in MeSH (when available). Filters for English language and publication year range: January 1st, 2000- April 30th, 2021 is applied

Result: 2,951 records

Preliminary search strategy:

(((weight*[Title/Abstract] OR obesity[Title/Abstract] OR obese[Title/Abstract] OR obesities[Title/Abstract] OR "Obesity"[Mesh] OR "Body Weight"[Mesh:NoExp] OR BMI[Title/Abstract] OR "body mass index"[Title/Abstract] OR "Body Mass Index"[Mesh] OR "Overweight"[Mesh] OR overweight[Title/Abstract]) AND ("Infant Nutritional Physiological Phenomena"[Mesh] OR "Infant nutrition*"[Title/Abstract] OR "infant feeding*"[Title/Abstract] OR "Infant Food"[Mesh] OR "infant food*"[Title/Abstract] OR "baby nutrition*"[Title/Abstract] OR "baby feeding*"[Title/Abstract] OR "baby food*"[Title/Abstract] OR "supplementary feeding*"[Title/Abstract] OR "complementary feeding*"[Title/Abstract] OR "replacement feeding*"[Title/Abstract] OR "Infant Formula"[Mesh] OR "infant formula*"[Title/Abstract] OR "baby formula*"[Title/Abstract] OR "solid food*"[Title/Abstract] OR "soft food*"[Title/Abstract] OR "complementary food*"[Title/Abstract] OR "Breast Feeding"[Mesh] OR breastfed[Title/Abstract] OR "breast feed*"[Title/Abstract] OR "breast fed" [Title/Abstract] OR "wet nursing"[Title/Abstract] OR "Feeding Behavior"[Mesh] OR "feeding behavior*"[Title/Abstract] OR "feeding-related behavior*"[Title/Abstract] OR "feeding related behavior*"[Title/Abstract] OR "feeding pattern*"[Title/Abstract] OR "feeding habit*"[Title/Abstract] OR "food habit*"[Title/Abstract] OR "feeding behaviour*"[Title/Abstract] OR "feeding-related behaviour*"[Title/Abstract] OR "feeding related behaviour*"[Title/Abstract] OR "food fussiness"[Title/Abstract] OR "food prefer*"[Title/Abstract] OR "Eating Behavior*"[Title/Abstract] OR "Eating Habit*"[Title/Abstract] OR "Dietary Habit*"[Title/Abstract] OR "Diet Habit*"[Title/Abstract] OR "family diet"[Title/Abstract] OR "weaning"[Title/Abstract] OR "Weaning"[Mesh] OR "Bottle Feeding"[Mesh] OR bottlefe*[Title/Abstract] OR "feeding duration*"[Title/Abstract] OR "dietary varia*"[Title/Abstract] OR "breast milk"[Title/Abstract] OR "Milk, Human"[Mesh] OR "human milk"[Title/Abstract] OR "Lactation"[Mesh] OR lactation[Title/Abstract] OR "liquid food*"[Title/Abstract])) AND ("Infant"[Mesh] OR "Child"[Mesh] OR child*[Title/Abstract] OR infant*[Title/Abstract] OR "newborn*"[Title/Abstract] OR baby[Title/Abstract] OR babies[Title/Abstract] OR "toddler*"[Title/Abstract])) AND ("Minority Groups"[Mesh] OR "Ethnic Groups"[Mesh] OR "Population Groups"[Mesh] OR "Continental Population Groups"[Mesh] OR ethnic*[Title/Abstract] OR "population group*"[Title/Abstract] OR nationalit*[Title/Abstract] OR "ethnic minorit*"[Title/Abstract] OR "cultural group*"[Title/Abstract] OR "population minorit*"[Title/Abstract] OR "racial stock*"[Title/Abstract] OR race[Title/Abstract] OR races[Title/Abstract] OR Black[Title/Abstract] OR Blacks[Title/Abstract] OR African*[Title/Abstract] OR "Afro-American*"[Title/Abstract] OR "Afro American*"[Title/Abstract] OR "American Native*"[Title/Abstract] OR "Native American*"[Title/Abstract] OR Indian*[Title/Abstract] OR "American Amerind*"[Title/Abstract] OR "Indigenous Canadian*"[Title/Abstract] OR "Canadian Native*"[Title/Abstract] OR Amish[Title/Abstract] OR Arab[Title/Abstract] OR Arabs[Title/Abstract] OR Arabic[Title/Abstract] OR Palestinian*[Title/Abstract] OR Asian*[Title/Abstract] OR Hispanic*[Title/Abstract] OR Mexican*[Title/Abstract] OR "Spanish American*"[Title/Abstract] OR "Puerto Rican*"[Title/Abstract] OR Latinos[Title/Abstract] OR Latino[Title/Abstract] OR Latinas[Title/Abstract] OR Latina[Title/Abstract] OR Cuban*[Title/Abstract] OR Hispanic*[Title/Abstract] OR Japanese[Title/Abstract] OR Chinese [Title/Abstract] OR Vietnamese[Title/Abstract] OR Cambodian*[Title/Abstract] OR Hmong*[Title/Abstract] OR

Korean*[Title/Abstract] OR Filipino*[Title/Abstract] OR Filipina*[Title/Abstract] OR "Indigenous people*"[Title/Abstract] OR Alaska*[Title/Abstract] OR Inuit[Title/Abstract] OR Inuits[Title/Abstract] OR Kalaallit*[Title/Abstract] OR Inupiat*[Title/Abstract] OR Aleut*[Title/Abstract] OR Eskimo*[Title/Abstract] OR "first nation people*"[Title/Abstract] OR "Native People*"[Title/Abstract] OR Roma[Title/Abstract] OR Romanies[Title/Abstract] OR Romani[Title/Abstract] OR Romany[Title/Abstract] OR Gypsies[Title/Abstract] OR Gipsy[Title/Abstract] OR Hawaiian*[Title/Abstract] OR "Pacific Islander*"[Title/Abstract] OR Maori*[Title/Abstract] OR Aboriginal[Title/Abstract] OR Aborigine*[Title/Abstract] OR Jew[Title/Abstract] OR Jews[Title/Abstract] OR Jewish[Title/Abstract] OR migrant*[Title/Abstract] OR Emigrant*[Title/Abstract] OR immigrant*[Title/Abstract] OR "Emigrants and Immigrants"[Mesh])

List of High-Income economies [1]

Andorra	Greece	Palau
Antigua and Barbuda	Greenland	Panama
Aruba	Guam	Poland
Australia	Hong Kong SAR, China	Portugal
Austria	Hungary	Puerto Rico
Bahamas, The	Iceland	Qatar
Bahrain	Ireland	**Romania**
Barbados	Isle of Man	San Marino
Belgium	Israel	Saudi Arabia
Bermuda	Italy	Seychelles
British Virgin Islands	Japan	Singapore
Brunei Darussalam	Korea, Rep.	Sint Maarten (Dutch part)
Canada	Kuwait	Slovak Republic
Cayman Islands	Latvia	Slovenia
Channel Islands	Liechtenstein	Spain
Chile	Lithuania	St. Kitts and Nevis
Croatia	Luxembourg	St. Martin (French part)

Curaçao	Macao SAR, China	Sweden
Cyprus	Malta	Switzerland
Czech Republic	**Mauritius**	Taiwan, China
Denmark	Monaco	Trinidad and Tobago
Estonia	**Nauru**	Turks and Caicos Islands
Faroe Islands	Netherlands	United Arab Emirates
Finland	New Caledonia	United Kingdom
France	New Zealand	United States
French Polynesia	Northern Mariana Islands	Uruguay
Germany	Norway	Virgin Islands (U.S.)
Gibraltar	Oman	

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Reporting checklist for protocol of a systematic review and meta analysis.

Based on the PRISMA-P guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

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		Reporting Item	Page Number
Title			
Identification	#1a	Identify the report as a protocol of a systematic review	1-4
Update	#1b	If the protocol is for an update of a previous systematic review, identify as such	n/a
Registration			
	#2	If registered, provide the name of the registry (such as PROSPERO) and registration number	3
Authors			
Contact	#3a	Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author	1

Contribution	#3b	Describe contributions of protocol authors and identify the guarantor of the review	12-13
Amendments			
	#4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	n/a
Support			
Sources	#5a	Indicate sources of financial or other support for the review	13
Sponsor	#5b	Provide name for the review funder and / or sponsor	n/a
Role of sponsor or funder	#5c	Describe roles of funder(s), sponsor(s), and / or institution(s), if any, in developing the protocol	n/a
Introduction			
Rationale	#6	Describe the rationale for the review in the context of what is already known	5-8
Objectives	#7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)	7
Methods			
Eligibility criteria	#8	Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review	6-7
Information sources	#9	Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage	8-9
Search strategy	#10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated	16-17

Study records - data management	#11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	8-9
Study records - selection process	#11b	State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis)	9-11
Study records - data collection process	#11c	Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators	9-10
Data items	#12	List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications	7-9
Outcomes and prioritization	#13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale	10-11
Risk of bias in individual studies	#14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis	11
Data synthesis	#15a	Describe criteria under which study data will be quantitatively synthesised	10-11
Data synthesis	#15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as I2, Kendall's τ)	10-11
Data synthesis	#15c	Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression)	10-11
Data synthesis	#15d	If quantitative synthesis is not appropriate, describe the type of summary planned	10-11
Meta-bias(es)	#16	Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies)	10-11

Confidence in cumulative evidence	#17	Describe how the strength of the body of evidence will be assessed (such as GRADE)	10

BMJ Open

Complementary feeding practices and the associated risk of childhood obesity among ethnic minority groups living in high-income countries: protocol for a systematic review and meta-analysis

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Protocol

Complementary feeding practices and the associated risk of childhood obesity among ethnic minority groups living in high-income countries: protocol for a systematic review and meta-analysis

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ABSTRACT

Introduction

Complementary feeding (CF) is defined as the period from when exclusive breast milk and formula are no longer sufficient for meeting the infant's nutritional needs. The CF period occurs from birth to 23 months of age. Though the recommended guidelines for introducing CF is from around six months of age, data indicates that some infants are introduced to food earlier than six months which can predispose children to obesity and overweight. Obesity in ethnic minority groups (EMG) is higher than their native counterparts and often tracks into adulthood. Hence, our aim was to conduct a systematic review and meta-analysis on the available literature to identify the risk of childhood overweight/obesity associated with CF practices concerning their timing, as well as the frequency and type of CF food introduced. We focused specifically on EMG children living in high-income countries (HIC).

Methods and Analysis

A methodological literature search surrounding childhood obesity and overweight (COO) risk associated with complementary feeding (CF) practices will be conducted in May 2021 following PRISMA-P guidelines. The following academic databases will be methodologically searched: PubMed, EMBASE, PsycINFO, CINAHL, SCOPUS, Cochrane Library and the WHO Global Index Medicus. Three independent researchers will be involved in independent screening and review the included articles based on the pre-defined inclusion and exclusion criteria. Where conflicts arise during the screening process, it will be resolved through discourse until a consensus is reached. Information on CF practices and anthropometric measurements will be extracted to ascertain the risk of childhood obesity and overweight. For this study, WHO Body Mass Index (BMI) for age and sex percentiles, Centre for Disease Control (CDC) classification and other recognised country-specific classifications will be utilised for the outcome.

Ethics and Dissemination

Formal ethical approval is not needed as the results will be drawn from currently available published literature. Outcomes of the review will be shared through peer-reviewed publications.

Key Words: Complementary feeding practices; infant feeding; childhood overweight; childhood obesity; ethnicity; race; culture; high-income countries; ethnic minorities.

PROSPERO registration number: CRD42021246029

Strengths and Limitations of the study

- First systematic review considering extensive analysis of Childhood overweight and obesity and the risk in multiple ethnic minority group children in high-income countries on complementary feeding practices
- Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) and PRISMA 2009 guidelines follow the systematic review and meta-analysis.
- Expert librarian specialising in database search strategy has developed the search protocol.
- Our review will capture a small number of studies that are likely to meet the inclusion criteria due to language restriction and heterogeneity between studies is expected to be high
- In the reported effect estimates, lack of uniformity may be one of our limitations

.

Background

Childhood obesity and overweight (COO) is a global health problem in high-income countries (HIC), although it has also emerged as a problem in low and middle-income countries, according to the World Health Organization [1]. Evidence implies that COO, feeding practices, and mean nutrient disparities are associated with race and ethnicity and are often entangled with income (Davis *et al*., 2021). Due to international migration, disparities in COO should be expected. International migration to HIC has continued to increase globally, with 57% of migrants living in HIC, where communities have become more diverse. In 2010, the International Organisation for Migration estimated the worldwide migration was estimated to be 214 million people (2010) [2]. However, research on ethnicity related obesity risk in childhood is considerably limited [3]. Given the increasing migration rate from poorer to HIC, COO in ethnic minority groups (EMG) presents a potential public health concern, warranting further research to better understand and identify contributing factors. Ethnic minorities are parents who are born to two foreign-born parents outside of the current resident HIC and who have migrated to HIC.

Complementary feeding (CF) is defined as "the process starting when breast milk is no longer sufficient to meet the nutritional requirements of infants, and therefore other foods and liquids are needed, along with breast milk"[4] CF usually occurs from six to 23 months, even when breastfeeding continues over two years of age [4]. CF has always been focused on providing nutritious, clean, safe and adequate food to meet the nutritional requirements of infants and children. CF aims to reduce malnutrition and infections, although there have been growing concerns regarding its potential contribution to COO [5]. It is recommended to exclusively breastfeed (EBF) for the first six months of life and continue for up to two years or beyond with appropriate, adequate, and safe CF [6]. Poor CF practices and breastfeeding are widespread, with just 34.8% of infants exclusively breastfed and most infants given food or liquids before the recommended six months [1,7–9]. Some studies suggest that COO is less common in children and adolescents who have been exclusively breastfed [4,9–12] although differences are negligible in other studies or present conflicting findings [8].

The World Health Organisation defines exclusive breastfeeding for the first six months of life to achieve appropriate growth and development [13]. The age of introduction of

complementary feeding varies among different European countries between 4-6 months [14], with studies confirming the early introduction of solid foods in Australia [15], the UK [16] and the USA [17]. One of the reasons for early recommendation by healthcare professionals could be because many of the infants are started early CF are also formula-fed (FF) [18]. Many assumptions have less scientific evidence leading to major variations in the recommendations of CF in different HIC.

Introducing solid foods earlier than the recommended six months has been shown to predispose children to overweight/obesity, as highlighted in several reviews [9,19,20]. Recommendations surrounding the optimal timing of the introduction of solid are limited and vary between countries, cultures, and food availability [21]. For instance, the UK recommends weaning around six months alongside breastfeeding until at least one years old. Other European countries recommend trial foods or small tastes between 4 and 6 months [21]. Composition of diet and how parents' approach CF is closely aligned to culture and other factors. Bangladeshi, Indian or Pakistani mothers prefer introducing sweet food earlier. In contrast, compared to African and Caribbean origin, mothers prefer introducing savoury food-types [22]. Recommendations for starting solid foods by different countries are often in line with the WHO, thus making it plausible to follow the same guidance for our study. Studies have discovered that early rapid weight gain during infancy is related to subsequent COO risk [23,24]. The relationship between rapid weight gain and later childhood obesity further emphasises the potential programming that occurs very early in life, resulting in COO and associated health problems related to CF practices. A cohort study by Ardic *et al*. (2019) found that early feeding habits might be permanent and pose a risk to later health outcomes [25]. In line with this study, Baran (2019), Pearce (2016) and Wang (2013) also found that breastfeeding less than six months and introducing adults' meals before 12 months were contributory factors for the prevalence of overweight and obesity in preschool children.

In at least two different studies, differences across EMG concerning CF practices and COO prevalence have been identified [9,26]. The differences are embedded in social and household contexts in either increasing or decreasing the risk of obesity. However, Kumanyika (2008) has highlighted that available evidence can be sparse, heterogeneous and difficult to meaningfully summarise. Two studies have explored the cultural influences of CF practices among Chinese and South Asian children [27,28]. However, overweight/obesity risk in relation to CF practices has not yet been collectively analysed in different EMG children. Our research will review the

parent-child dyads where the EMG groups parents, who have indicated their ethnicity, have migrated to HIC.

Furthermore, it is known that CF practices are associated with early COO, yet the extent of the problem is unknown for EMG children living in HIC. Considering the substantial global burden of COO, it is important to understand the association between CF practices and COO, specifically amongst EMG children living in HIC. We propose to conduct a comprehensive systematic review and meta-analysis to address this research question in this protocol. Hence, in our systematic review and meta-analysis, we aim to identify the risk of childhood obesity during the complementary feeding period associated with CF timing, frequency, and the type of CF food introduced.

Methods/Design

This protocol follows the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) guidelines [29] and has been informed by the Cochrane Handbook for Systematic Reviews of Interventions [30]. The final review will be reported according to the 2020 Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) statement [31]. The prospective review is registered with the PROSPERO (registration no. CRD42021246029). The start date for the review will be June 2021, and the estimated date for completion will be May 2022.

Eligibility criteria

Inclusion Criteria

We will include randomised controlled trials, cohort studies, case-control studies and cross-sectional studies. We will include studies reporting direct and/or indirect effect sizes in children who were exposed to CF at any age from 0-24 months. All studies should estimate the association between the measured exposure (CF) and the outcomes (weight gain). Such estimates reported should be calculated or calculable. The systematic review will be conducted using the PICOS approach (participants, exposure, comparator, outcome(s) and type of study) from which studies are identified. [30,32,33] Inclusion and exclusion criteria are listed according to PICOS in table 1.

Table 1: Pre-defined inclusion and exclusion study criteria according to PICOS

PICOS	Inclusions	Exclusions
Participants	Ethnic minority children aged between 0-2 years; living in HIC. Ethnicity self-identified by participants including all migrants' generations.	Pre-term and low-birth-weight children; children with medical problems that can affect body weight e.g. Prader Willi Syndrome, failure to thrive, metabolic disorders, Hypothyroidism, Cushing syndrome, growth hormone deficiency etc.
Interventions	CF practices include the timing of introduction of semi-solid, solid and soft foods, meal frequency and dietary diversity.	Studies reporting exclusively on breastfeeding outcomes alone
Comparisons	Children who followed recommended CF guidelines by WHO/UNICEF or country recommendation	
Outcomes of interest	Risk of obesity and overweight as classified by BMI z -scores and BMI percentiles in the 0-24 months age group	Studies that do not include obesity or overweight
Study design	Risk of obesity and overweight as classified by BMI z -scores and BMI percentiles	Studies not published in English, Studies with no full text available

HIC = High-Income Countries; CF = Complementary Feeding; RCTs = Randomised Controlled Trials

The study population will be children from ethnic minority groups aged 0-2 years who reside in HIC. The study outcome will investigate the association between CF practices and the risk of COO. The outcomes will include anthropometric measurements, including BMI z-scores or BMI percentiles. The review results on CF will be evaluated using the recommended optimum CF guidelines by WHO (2008). It is recommended that exclusive breastfeeding continues until six months and up to two years and beyond. Introduction of solids, soft and other liquids, other than breast milk or formula, is recommended from six months onwards. The study's outcome (COO) will be classified according to WHO BMI for age and sex percentiles and the Centres

for Disease Control and Prevention (CDC) classification and other recognised classifications. According to the CDC, overweight is defined as BMI $\geq 85^{th}$ and $<95^{th}$ percentile, while obesity is BMI of $\geq 95^{th}$ percentile for children < 18 years of the same age and sex [34]. These two classifications have previously been compared by Gaffney *et al.* (2016), who found that one standard deviation unit above the median of the WHO growth curve population approximates the 85^{th} percentile [35]. BMI does not measure body fat. If available, skinfolds measurements, dual energy x-ray absorptiometry (DXA), and other methods will be used.

Exclusion Criteria

Studies that are not published in English and do not present original data will not be included. Other studies that will be excluded are narrative reviews, systematic reviews and meta-analyses, opinion articles, editorials, letters to the editor, published abstracts without a published full-text, student dissertations/theses, and blog posts. Studies that do not include anthropometric measurements in EMG children as part of the outcome before the age of two years will be excluded.

Search Strategy

Developing research question and search query domains

We will search for papers published between 2000 until search date. A systematic search of the literature will be conducted in May 2021 by a specialist medical librarian (LÖ). The electronic databases: PubMed, EMBASE, PsycINFO, CINAHL, SCOPUS, Cochrane Library the WHO Global Index Medicus will be included and covered from 2000 to the search date. No filters or limitations will be applied. A preliminary search in PubMed was carried out in April 2021 to identify relevant search terms and search technical solutions (LÖ). The search terms were systematically identified with the support of PubMed's MeSH, by analysing the indexing of previous, relevant studies which was informed by input from the subject specialists (MT and MK). A copy of the preliminary search strategy in PubMed is available in Supplementary file 1. Hand screening of reference lists of the studies that meet the pre-defined criteria will also be conducted.

Detailed search documentation for all included databases will be appended to the final review to allow search reproducibility and transparent appraisal of the search strategy and results.

Finally, Cabell's Predatory Reports in Cabell's Scholarly Analytics will be consulted to ensure that none of the finally selected studies published in open-access journals are listed as potential predatory journals.

Data Extraction and Management

Screening and study selection

Covidence systematic review software by Veritas Health Innovation (2021) will be used to automatically de-duplicate and blind screen all records identified in the database search. After duplicated studies have been removed, unique records will be screened based on the title and/or abstract by two independent reviewers (MT & MK). Articles that do not meet the criteria will be excluded. Eventual disagreements will be resolved through blinded conflict resolution through Covidence by a third reviewer (LÖ), further reducing bias risk. Similarly, full-text review will be carried by two independent reviewers (MT & MK), resolving conflicts for ambiguous inclusion by a third reviewer (LÖ) through Covidence. Details from the screening and selection process, including reasons for exclusion of the omitted full-text studies, will be documented in a PRISMA 2020 flow diagram.

Data Extraction

For extraction of data, a piloted form will be used. Data will be extracted for each study that meets the eligibility criteria by two researchers and the third researcher will resolve any discrepancies. The following data if available will be extracted: surname of the first author, publication year, HIC, participant's ethnicity, study design, sample size, participant's age, breast-feeding duration, CF timing and frequency, primary outcome, anthropometric measurements, length of follow-up and types of CF, effect size (OR/RR) and mean difference. HIC list provided in supplementary file 2.

The child's ethnicity will be determined by the country of birth of the parents, although ethnicity identification by country of birth has caveats because a diversity of the country-of-origin can differ [36]. In addition, diversity collection practices differ among Organisation for

Economic Cooperation and Development (OECD) countries. Some countries collect indigenous identity, others race and ethnicity, and migrant statuses.

Output

The study will present a PRISMA flow diagram, including the search results and study selection summary. Rated quality of the included studies will be presented in a comprehensive table of the study characteristics. The risk of COO identified from all studies will be summarised and synthesised to identify the overall risk in multiple EMG children residing in HIC when the study was conducted.

Risk of Bias in the primary study

Two authors (MT and MK) will assess the quality of studies independently using the Newcastle Ottawa Scale (NOS) and modified NOS for assessing quality of non-randomised studies in the meta-analysis. The tool assesses participant selection, comparability of groups, and outcome or exposure depending on the type of study [37]. A point is given for each item in the three sections if the study meets the criteria. The maximum score for cross-sectional studies is ten and nine for cohort studies. Assessment of the internal validity of primary studies is crucial in systematic reviews to identify the risk of bias. It has been noted that, whilst the NOS quality assessment scale is challenging and more subjective in non-randomised studies compared to randomised controlled trials (RCTs), there is no other widely accepted tool for non-randomised studies. [38] Grading of Recommendations Assessment, Development and Evaluation (GRADE) quality review tool will be used for RCTs. Disagreements with grading will be resolved through discourse and revisiting the inclusion criteria by both authors (MT and MK).

Analysis and Data Synthesis

Descriptive analysis will be performed to report on the association between COO and breastfeeding duration, the timing of CF and frequency, and variety of feeds. Both narrative text and table summaries will be presented.

The results of the included studies will be synthesised using pooled estimates and pooled odds ratios or risk ratios (RR) applying random-effects model with 95% confidence intervals (CI) where data permits to conclude the pooled COO risk. Random-effects meta-analysis will

be limited to studies reported on pooled estimates and at least ten studies with low to moderate heterogeneity for meaningful results. Heterogeneity will be assessed using the I^2 and visual inspection of forest plots. For dichotomous data, RR and 95% CI will be calculated and for continuous data, mean difference (MD) and 95% CI will be used. MD will be converted to RR if possible. Forest plots will be used to visually present the estimated weighted results from different studies.

Bias Minimisation

The review will include multiple databases to ensure all studies published are included if they meet our pre-defined inclusion criteria. Funnel plots, which is a plot of effect size, will be used to assess publication bias and estimated by Begg's or Eggers tests using the R package. Assessment of the quality of primary studies by both authors using NOS and GRADE tools will further minimise bias. Disagreements with grading will be resolved through discourse. We will also perform sensitivity analysis for the meta-analysis and repeat to include only studies deemed to be good quality. Analyses will be conducted using Stata version 16 (StataCorp) and completed by the team's statistician (OMO).

Patient and public involvement

Patients nor public will not be involved at any stage of the study. The proposed study primarily reviews published data available in the indicated electronic databases.

Discussion

Our review is unique, and to our knowledge, is the only review considering extensive analysis of COO risk in multiple EMG children residing in HIC about CF practices. EMG children are the offspring of migrant families who live in a different country from their parent's country of origin. Immigration can be diverse and varied from country to country. EMG in the USA comprises a third of the population [26]. The immigrant population of Canada is 21% [2], whereas the UK is 13% [39]. Although diversity is considered based on country of birth, this can pose problems due to within-country diversity from the country of origin [36].

Identifying the causes of COO amongst different EMG can be complex and challenging. It could be hypothesised from previous studies that there can be multiple reasons for the EMG

families to adopt CF prematurely. FF is more common in HIC and, in contrast to LIC, where FF is expensive, parents are more likely to resort to FF and early CF in HIC. With immigration comes more work responsibilities, increased stress and poor diet. Furthermore, the stress has been exacerbated by the current pandemic. [40,41] This can potentially result in lower breastfeeding rates and reduced production of breast milk which, in turn, may lead to the earlier introduction of CF. [42] Gaining weight, lesser crying and improved sleeping patterns are being seen by parents as being healthier for the baby and a positive choice for earlier CF. The trends of the new immigrating HIC influence these factors. [43]

Reviews have shown that insufficient knowledge, feeding attitude changes due to acculturation and incorrect advice lead to practising earlier CF resulting in COO. [27,43] A similar review that explored COO concerning CF was conducted in the general population without stratification on EMG or HIC. [20] Although another review on CF practices focused on South Asian children in HIC as an EMG, they did not report on obesity risk. Still, they identified significant differences in CF practices that were obesogenic [27]. On the other hand, one earlier review identified a clear association amongst the general population in developed countries [44]. This means that with a combined multiple ethnicities review, there is a possibility of statistically meaningful results identifying COO risk in EMG children residing in HIC. Such risk poses an important need for public health interventions. Evidence suggests adherence to BF and appropriates CF to improve growth and development of child [45]. Moreover, there has been a disparity in bodyweight changes among children, especially among ethnic minorities [46–48]. Our study will contribute to the efforts to prevent COO within EMG that is often under-researched and marginalised. Furthermore, we envisage our study to enhance the reduction in health disparities experienced by EMG through subsequent targeted interventions.

To our knowledge, it is the first review considering an extensive analysis of COO risk in multiple EMG children residing in HIC pertaining to CF practices. COO has been confirmed to be higher in EMG compared to native groups. If CF practices among EMG are a contributory factor in COO, our review will bring evidence for targeted interventions to prevent rather than cure COO by promoting healthy weight throughout childhood years. It will also highlight the scarcity of research within marginalised EMG by identifying gaps and making recommendations for future studies in CF practices.

The review is not without limitations. First, most studies included will be observational. Second, studies amongst EMG in HIC tend to be limited, with ethnic groups making up small samples. Additionally, language barrier difficulties may be present in the host country. Therefore, our review will likely capture a small number of studies likely to meet the inclusion criteria, and heterogeneity between studies is expected to be high. Population diversity will further increase heterogeneity risk. There is potential that some studies, which include EMG, may be missed due to countries using varied ethnicity classifications, paired with the subjective nature of ethnicity.

Conclusion

This systematic review will highlight the CF practices in the EMG regarding frequency, the timing of CF and the identified factors that could have influenced CF. Such a systematic review will increase awareness and guide improvement and create future policies aimed at preventing COO.

Authors Contribution

MT and MK were involved in all aspects of the study, from conceptualisation, protocol development, and the preliminary search strategy. LÖ developed the preliminary search strategy, contributed with text for the methods part of the manuscript and will conduct the final literature search and the reference management in Covidence. Further screening of literature and data extraction will be carried out by MT and data validated by MK. TA revised the first draft for intellectual content and will assist with drafting and revising content in the final project. OMO will oversee the data extraction process and complete all aspects of the meta-analysis.

Support: Source and sponsor

No funding declared.

Competing interests

None declared.

Patient and Public involvement

No involvement and therefore patient consent not required.

Data Statement

Data will be submitted as a supplementary appendix.

Amendments: In the event of minor amendments of this protocol, the changes will be updated and transparent reported in the online PROSPERO registration for the review: CRD42021246029

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Supplementary materials file 1: preliminary search strategy in PubMed

Source: PubMed

Search date: 2021-04-30

Search specifications: All search terms are searched in the search field "Title/Abstract" and in MeSH (when available). Filters for English language and publication year range: January 1st, 2000- April 30th, 2021 is applied

Result: 2,951 records

Preliminary search strategy:

(((weight*[Title/Abstract] OR obesity[Title/Abstract] OR obese[Title/Abstract] OR obesities[Title/Abstract] OR "Obesity"[Mesh] OR "Body Weight"[Mesh:NoExp] OR BMI[Title/Abstract] OR "body mass index"[Title/Abstract] OR "Body Mass Index"[Mesh] OR "Overweight"[Mesh] OR overweight[Title/Abstract]) AND ("Infant Nutritional Physiological Phenomena"[Mesh] OR "Infant nutrition*"[Title/Abstract] OR "infant feeding*"[Title/Abstract] OR "Infant Food"[Mesh] OR "infant food*"[Title/Abstract] OR "baby nutrition*"[Title/Abstract] OR "baby feeding*"[Title/Abstract] OR "baby food*"[Title/Abstract] OR "supplementary feeding*"[Title/Abstract] OR "complementary feeding*"[Title/Abstract] OR "replacement feeding*"[Title/Abstract] OR "Infant Formula"[Mesh] OR "infant formula*"[Title/Abstract] OR "baby formula*"[Title/Abstract] OR "solid food*"[Title/Abstract] OR "soft food*"[Title/Abstract] OR "complementary food*"[Title/Abstract] OR "Breast Feeding"[Mesh] OR breastfed[Title/Abstract] OR "breast feed*"[Title/Abstract] OR "breast fed" [Title/Abstract] OR "wet nursing"[Title/Abstract] OR "Feeding Behavior"[Mesh] OR "feeding behavior*"[Title/Abstract] OR "feeding-related behavior*"[Title/Abstract] OR "feeding related behavior*"[Title/Abstract] OR "feeding pattern*"[Title/Abstract] OR "feeding habit*"[Title/Abstract] OR "food habit*"[Title/Abstract] OR "feeding behaviour*"[Title/Abstract] OR "feeding-related behaviour*"[Title/Abstract] OR "feeding related behaviour*"[Title/Abstract] OR "food fussiness"[Title/Abstract] OR "food prefer*"[Title/Abstract] OR "Eating Behavior*"[Title/Abstract] OR "Eating Habit*"[Title/Abstract] OR "Dietary Habit*"[Title/Abstract] OR "Diet Habit*"[Title/Abstract] OR "family diet"[Title/Abstract] OR "weaning"[Title/Abstract] OR "Weaning"[Mesh] OR "Bottle Feeding"[Mesh] OR bottlefe*[Title/Abstract] OR "feeding duration*"[Title/Abstract] OR "dietary varia*"[Title/Abstract] OR "breast milk"[Title/Abstract] OR "Milk, Human"[Mesh] OR "human milk"[Title/Abstract] OR "Lactation"[Mesh] OR lactation[Title/Abstract] OR "liquid food*"[Title/Abstract])) AND ("Infant"[Mesh] OR "Child"[Mesh] OR child*[Title/Abstract] OR infant*[Title/Abstract] OR "newborn*"[Title/Abstract] OR baby[Title/Abstract] OR babies[Title/Abstract] OR "toddler*"[Title/Abstract])) AND ("Minority Groups"[Mesh] OR "Ethnic Groups"[Mesh] OR "Population Groups"[Mesh] OR "Continental Population Groups"[Mesh] OR ethnic*[Title/Abstract] OR "population group*"[Title/Abstract] OR nationalit*[Title/Abstract] OR "ethnic minorit*"[Title/Abstract] OR "cultural group*"[Title/Abstract] OR "population minorit*"[Title/Abstract] OR "racial stock*"[Title/Abstract] OR race[Title/Abstract] OR races[Title/Abstract] OR Black[Title/Abstract] OR Blacks[Title/Abstract] OR African*[Title/Abstract] OR "Afro-American*"[Title/Abstract] OR "Afro American*"[Title/Abstract] OR "American Native*"[Title/Abstract] OR "Native American*"[Title/Abstract] OR Indian*[Title/Abstract] OR "American Amerind*"[Title/Abstract] OR "Indigenous Canadian*"[Title/Abstract] OR "Canadian Native*"[Title/Abstract] OR Amish[Title/Abstract] OR Arab[Title/Abstract] OR Arabs[Title/Abstract] OR Arabic[Title/Abstract] OR Palestinian*[Title/Abstract] OR Asian*[Title/Abstract] OR Hispanic*[Title/Abstract] OR Mexican*[Title/Abstract] OR "Spanish American*"[Title/Abstract] OR "Puerto Rican*"[Title/Abstract] OR Latinos[Title/Abstract] OR Latino[Title/Abstract] OR Latinas[Title/Abstract] OR Latina[Title/Abstract] OR Cuban*[Title/Abstract] OR Hispanic*[Title/Abstract] OR Japanese[Title/Abstract] OR Chinese [Title/Abstract] OR Vietnamese[Title/Abstract] OR Cambodian*[Title/Abstract] OR Hmong*[Title/Abstract] OR

Korean*[Title/Abstract] OR Filipino*[Title/Abstract] OR Filipina*[Title/Abstract] OR "Indigenous people*"[Title/Abstract] OR Alaska*[Title/Abstract] OR Inuit[Title/Abstract] OR Inuits[Title/Abstract] OR Kalaallit*[Title/Abstract] OR Inupiat*[Title/Abstract] OR Aleut*[Title/Abstract] OR Eskimo*[Title/Abstract] OR "first nation people*"[Title/Abstract] OR "Native People*"[Title/Abstract] OR Roma[Title/Abstract] OR Romanies[Title/Abstract] OR Romani[Title/Abstract] OR Romany[Title/Abstract] OR Gypsies[Title/Abstract] OR Gipsy[Title/Abstract] OR Hawaiian*[Title/Abstract] OR "Pacific Islander*"[Title/Abstract] OR Maori*[Title/Abstract] OR Aboriginal[Title/Abstract] OR Aborigine*[Title/Abstract] OR Jew[Title/Abstract] OR Jews[Title/Abstract] OR Jewish[Title/Abstract] OR migrant*[Title/Abstract] OR Emigrant*[Title/Abstract] OR immigrant*[Title/Abstract] OR "Emigrants and Immigrants"[Mesh])

List of High-Income economies [1]

Andorra	Greece	Palau
Antigua and Barbuda	Greenland	Panama
Aruba	Guam	Poland
Australia	Hong Kong SAR, China	Portugal
Austria	Hungary	Puerto Rico
Bahamas, The	Iceland	Qatar
Bahrain	Ireland	**Romania**
Barbados	Isle of Man	San Marino
Belgium	Israel	Saudi Arabia
Bermuda	Italy	Seychelles
British Virgin Islands	Japan	Singapore
Brunei Darussalam	Korea, Rep.	Sint Maarten (Dutch part)
Canada	Kuwait	Slovak Republic
Cayman Islands	Latvia	Slovenia
Channel Islands	Liechtenstein	Spain
Chile	Lithuania	St. Kitts and Nevis
Croatia	Luxembourg	St. Martin (French part)

Curaçao	Macao SAR, China	Sweden
Cyprus	Malta	Switzerland
Czech Republic	**Mauritius**	Taiwan, China
Denmark	Monaco	Trinidad and Tobago
Estonia	**Nauru**	Turks and Caicos Islands
Faroe Islands	Netherlands	United Arab Emirates
Finland	New Caledonia	United Kingdom
France	New Zealand	United States
French Polynesia	Northern Mariana Islands	Uruguay
Germany	Norway	Virgin Islands (U.S.)
Gibraltar	Oman	

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Reporting checklist for protocol of a systematic review and meta analysis.

Based on the PRISMA-P guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

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In your methods section, say that you used the PRISMA-Preporting guidelines, and cite them as:

Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, Shekelle P, Stewart LA. Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) 2015 statement. Syst Rev. 2015;4(1):1.

		Reporting Item	Page Number
Title			
Identification	#1a	Identify the report as a protocol of a systematic review	1-4
Update	#1b	If the protocol is for an update of a previous systematic review, identify as such	n/a
Registration			
	#2	If registered, provide the name of the registry (such as PROSPERO) and registration number	3
Authors			
Contact	#3a	Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author	1

Contribution	#3b	Describe contributions of protocol authors and identify the guarantor of the review	12-13
Amendments			
	#4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	n/a
Support			
Sources	#5a	Indicate sources of financial or other support for the review	13
Sponsor	#5b	Provide name for the review funder and / or sponsor	n/a
Role of sponsor or funder	#5c	Describe roles of funder(s), sponsor(s), and / or institution(s), if any, in developing the protocol	n/a
Introduction			
Rationale	#6	Describe the rationale for the review in the context of what is already known	5-8
Objectives	#7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)	7
Methods			
Eligibility criteria	#8	Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review	6-7
Information sources	#9	Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage	8-9
Search strategy	#10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated	16-17

Study records - data management	#11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	8-9
Study records - selection process	#11b	State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis)	9-11
Study records - data collection process	#11c	Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators	9-10
Data items	#12	List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications	7-9
Outcomes and prioritization	#13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale	10-11
Risk of bias in individual studies	#14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis	11
Data synthesis	#15a	Describe criteria under which study data will be quantitatively synthesised	10-11
Data synthesis	#15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as I2, Kendall's τ)	10-11
Data synthesis	#15c	Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression)	10-11
Data synthesis	#15d	If quantitative synthesis is not appropriate, describe the type of summary planned	10-11
Meta-bias(es)	#16	Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies)	10-11

Confidence in cumulative evidence	#17	Describe how the strength of the body of evidence will be assessed (such as GRADE)	10

BMJ Open

Complementary feeding practices and the associated risk of childhood obesity among ethnic minority groups living in high-income countries: protocol for a systematic review and meta-analysis

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Protocol

Complementary feeding practices and the associated risk of childhood obesity among ethnic minority groups living in high-income countries: protocol for a systematic review and meta-analysis

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ABSTRACT

Introduction

Complementary feeding (CF) is defined as the period from when exclusive breast milk and formula are no longer sufficient for meeting the infant's nutritional needs. The CF period occurs from birth to 23 months of age. Though the recommended guidelines for introducing CF is from around six months of age, data indicates that some infants are introduced to food earlier than six months which can predispose children to obesity and overweight. Obesity in ethnic minority groups (EMG) is higher than their native counterparts and often tracks into adulthood. Hence, our aim was to conduct a systematic review and meta-analysis on the available literature to identify the risk of childhood overweight/obesity associated with CF practices concerning their timing, as well as the frequency and type of CF food introduced. We focused specifically on EMG children living in high-income countries (HIC).

Methods and Analysis

A methodological literature search surrounding childhood obesity and overweight (COO) risk associated with complementary feeding (CF) practices will be conducted in May 2021 following PRISMA-P guidelines. The following academic databases will be methodologically searched: PubMed, EMBASE, PsycINFO, CINAHL, SCOPUS, Cochrane Library and the WHO Global Index Medicus. Three independent researchers will be involved in independent screening and review the included articles based on the pre-defined inclusion and exclusion criteria. Where conflicts arise during the screening process, it will be resolved through discourse until a consensus is reached. Information on CF practices and anthropometric measurements will be extracted to ascertain the risk of childhood obesity and overweight. For this study, WHO Body Mass Index (BMI) for age and sex percentiles, Centre for Disease Control (CDC) classification and other recognised country-specific classifications will be utilised for the outcome.

Ethics and Dissemination

Formal ethical approval is not needed as the results will be drawn from currently available published literature. Outcomes of the review will be shared through peer-reviewed publications.

Key Words: Complementary feeding practices; infant feeding; childhood overweight; childhood obesity; ethnicity; race; culture; high-income countries; ethnic minorities.

PROSPERO registration number: CRD42021246029

Strengths and Limitations of the study

- First systematic review considering extensive analysis of Childhood overweight and obesity and the risk in multiple ethnic minority group children in high-income countries on complementary feeding practices
- Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) and PRISMA 2009 guidelines follow the systematic review and meta-analysis.
- Expert librarian specialising in database search strategy has developed the search protocol.
- Our review will capture a small number of studies that are likely to meet the inclusion criteria due to language restriction and heterogeneity between studies is expected to be high
- In the reported effect estimates, lack of uniformity may be one of our limitations

.

Background

Childhood obesity and overweight (COO) is a global health problem in high-income countries (HIC), although it has also emerged as a problem in low and middle-income countries, according to the World Health Organization [1]. Evidence implies that COO, feeding practices, and mean nutrient disparities are associated with race and ethnicity and are often entangled with income (Davis *et al*., 2021). Due to international migration, disparities in COO should be expected. International migration to HIC has continued to increase globally, with 57% of migrants living in HIC, where communities have become more diverse. In 2010, the International Organisation for Migration estimated the worldwide migration was estimated to be 214 million people (2010) [2]. However, research on ethnicity related obesity risk in childhood is considerably limited [3]. Given the increasing migration rate from poorer to HIC, COO in ethnic minority groups (EMG) presents a potential public health concern, warranting further research to better understand and identify contributing factors. Ethnic minority children are children who are born to parents identified as ethnic minorities in HIC.

Complementary feeding (CF) is defined as "the process starting when breast milk is no longer sufficient to meet the nutritional requirements of infants, and therefore other foods and liquids are needed, along with breast milk"[4] CF usually occurs from six to 23 months, even when breastfeeding continues over two years of age [4]. CF has always been focused on providing nutritious, clean, safe and adequate food to meet the nutritional requirements of infants and children. CF aims to reduce malnutrition and infections, although there have been growing concerns regarding its potential contribution to COO [5]. It is recommended to exclusively breastfeed (EBF) for the first six months of life and continue for up to two years or beyond with appropriate, adequate, and safe CF [6]. Poor CF practices and breastfeeding are widespread, with just 34.8% of infants exclusively breastfed and most infants given food or liquids before the recommended six months [1,7–9]. Some studies suggest that COO is less common in children and adolescents who have been exclusively breastfed [4,9–12] although differences are negligible in other studies or present conflicting findings [8].

The World Health Organisation defines exclusive breastfeeding for the first six months of life to achieve appropriate growth and development [13]. The age of introduction of complementary feeding varies among different European countries between 4-6 months [14],

with studies confirming the early introduction of solid foods in Australia [15], the UK [16] and the USA [17]. One of the reasons for early recommendation by healthcare professionals could be because many of the infants are started early CF are also formula-fed (FF) [18]. Many assumptions have less scientific evidence leading to major variations in the recommendations of CF in different HIC.

Introducing solid foods earlier than the recommended six months has been shown to predispose children to overweight/obesity, as highlighted in several reviews [9,19,20]. Recommendations surrounding the optimal timing of the introduction of solid are limited and vary between countries, cultures, and food availability [21]. For instance, the UK recommends weaning around six months alongside breastfeeding until at least one years old. Other European countries recommend trial foods or small tastes between 4 and 6 months [21]. Composition of diet and how parents' approach CF is closely aligned to culture and other factors. Bangladeshi, Indian or Pakistani mothers prefer introducing sweet food earlier. In contrast, compared to African and Caribbean origin, mothers prefer introducing savoury food-types [22]. Recommendations for starting solid foods by different countries are often in line with the WHO, thus making it plausible to follow the same guidance for our study. Studies have discovered that early rapid weight gain during infancy is related to subsequent COO risk [23,24]. The relationship between rapid weight gain and later childhood obesity further emphasises the potential programming that occurs very early in life, resulting in COO and associated health problems related to CF practices. A cohort study by Ardic *et al*. (2019) found that early feeding habits might be permanent and pose a risk to later health outcomes [25]. In line with this study, Baran (2019), Pearce (2016) and Wang (2013) also found that breastfeeding less than six months and introducing adults' meals before 12 months were contributory factors for the prevalence of overweight and obesity in preschool children.

In at least two different studies, differences across EMG concerning CF practices and COO prevalence have been identified [9,26]. The differences are embedded in social and household contexts in either increasing or decreasing the risk of obesity. However, Kumanyika (2008) has highlighted that available evidence can be sparse, heterogeneous and difficult to meaningfully summarise. Two studies have explored the cultural influences of CF practices among Chinese and South Asian children [27,28]. However, overweight/obesity risk in relation to CF practices has not yet been collectively analysed in different EMG children. Our research will review those 0-2 years old children who are born to parents identified as ethnic minorities in HIC.

Furthermore, it is known that CF practices are associated with early COO, yet the extent of the problem is unknown for EMG children living in HIC. Considering the substantial global burden of COO, it is important to understand the association between CF practices and COO, specifically amongst EMG children living in HIC. We propose to conduct a comprehensive systematic review and meta-analysis to address this research question in this protocol. Hence, in our systematic review and meta-analysis, we aim to identify the risk of childhood obesity during the complementary feeding period associated with CF timing, frequency, and the type of CF food introduced.

Methods/Design

This protocol follows the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) guidelines [29] and has been informed by the Cochrane Handbook for Systematic Reviews of Interventions [30]. The final review will be reported according to the 2020 Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) statement [31]. The prospective review is registered with the PROSPERO (registration no. CRD42021246029). The start date for the review will be June 2021, and the estimated date for completion will be May 2022.

Eligibility criteria

Inclusion Criteria

We will include randomised controlled trials, cohort studies, case-control studies and cross-sectional studies. We will include studies reporting direct and/or indirect effect sizes in children who were exposed to CF at any age from 0-24 months. All studies should estimate the association between the measured exposure (CF) and the outcomes (weight gain). Such estimates reported should be calculated or calculable. The systematic review will be conducted using the PICOS approach (participants, exposure, comparator, outcome(s) and type of study) from which studies are identified. [30,32,33] Inclusion and exclusion criteria are listed according to PICOS in table 1.

Table 1: Pre-defined inclusion and exclusion study criteria according to PICOS

PICOS	Inclusions	Exclusions

Participants	Ethnic minority children aged between 0-2 years; living in HIC. Ethnicity self-identified by participants including all migrants' generations.	Pre-term and low-birth-weight children; children with medical problems that can affect body weight e.g. Prader Willi Syndrome, failure to thrive, metabolic disorders, Hypothyroidism, Cushing syndrome, growth hormone deficiency etc.
Interventions	CF practices include the timing of introduction of semi-solid, solid and soft foods, meal frequency and dietary diversity.	Studies reporting exclusively on breastfeeding outcomes alone
Comparisons	Children who followed recommended CF guidelines by WHO/UNICEF or country recommendation	
Outcomes of interest	Risk of obesity and overweight as classified by BMI z -scores and BMI percentiles in the 0-24 months age group	Studies that do not include obesity or overweight
Study design	Risk of obesity and overweight as classified by BMI z -scores and BMI percentiles	Studies not published in English, Studies with no full text available

HIC = High-Income Countries; CF = Complementary Feeding; RCTs = Randomised Controlled Trials

The study population will be children from ethnic minority groups aged 0-2 years who reside in HIC. The study outcome will investigate the association between CF practices and the risk of COO. The outcomes will include anthropometric measurements, including BMI z-scores or BMI percentiles. The review results on CF will be evaluated using the recommended optimum CF guidelines by WHO (2008). It is recommended that exclusive breastfeeding continues until six months and up to two years and beyond. Introduction of solids, soft and other liquids, other than breast milk or formula, is recommended from six months onwards. The study's outcome (COO) will be classified according to WHO BMI for age and sex percentiles and the Centres for Disease Control and Prevention (CDC) classification and other recognised classifications. According to the CDC, overweight is defined as BMI $\geq 85^{th}$ and $<95^{th}$ percentile, while obesity

is BMI of $\geq 95^{th}$ percentile for children < 18 years of the same age and sex [34]. These two classifications have previously been compared by Gaffney *et al.* (2016), who found that one standard deviation unit above the median of the WHO growth curve population approximates the 85th percentile [35]. BMI does not measure body fat. If available, skinfolds measurements, dual energy x-ray absorptiometry (DXA), and other methods will be used.

Exclusion Criteria

Studies that are not published in English and do not present original data will not be included. Other studies that will be excluded are narrative reviews, systematic reviews and meta-analyses, opinion articles, editorials, letters to the editor, published abstracts without a published full-text, student dissertations/theses, and blog posts. Studies that do not include anthropometric measurements in EMG children as part of the outcome before the age of two years will be excluded.

Search Strategy

Developing research question and search query domains

We will search for papers published between 2000 until search date. A systematic search of the literature will be conducted in May 2021 by a specialist medical librarian (LÖ). The electronic databases: PubMed, EMBASE, PsycINFO, CINAHL, SCOPUS, Cochrane Library the WHO Global Index Medicus will be included and covered from 2000 to the search date. No filters or limitations will be applied. A preliminary search in PubMed was carried out in April 2021 to identify relevant search terms and search technical solutions (LÖ). The search terms were systematically identified with the support of PubMed's MeSH, by analysing the indexing of previous, relevant studies which was informed by input from the subject specialists (MT and MK). A copy of the preliminary search strategy in PubMed is available in Supplementary file 1. Hand screening of reference lists of the studies that meet the pre-defined criteria will also be conducted.

Detailed search documentation for all included databases will be appended to the final review to allow search reproducibility and transparent appraisal of the search strategy and results. Finally, Cabell's Predatory Reports in Cabell's Scholarly Analytics will be consulted to ensure

that none of the finally selected studies published in open-access journals are listed as potential predatory journals.

Data Extraction and Management

Screening and study selection

Covidence systematic review software by Veritas Health Innovation (2021) will be used to automatically de-duplicate and blind screen all records identified in the database search. After duplicated studies have been removed, unique records will be screened based on the title and/or abstract by two independent reviewers (MT & MK). Articles that do not meet the criteria will be excluded. Eventual disagreements will be resolved through blinded conflict resolution through Covidence by a third reviewer (LÖ), further reducing bias risk. Similarly, full-text review will be carried by two independent reviewers (MT & MK), resolving conflicts for ambiguous inclusion by a third reviewer (LÖ) through Covidence. Details from the screening and selection process, including reasons for exclusion of the omitted full-text studies, will be documented in a PRISMA 2020 flow diagram.

Data Extraction

For extraction of data, a piloted form will be used. Data will be extracted for each study that meets the eligibility criteria by two researchers and the third researcher will resolve any discrepancies. The following data if available will be extracted: surname of the first author, publication year, HIC, participant's ethnicity, study design, sample size, participant's age, breast-feeding duration, CF timing and frequency, primary outcome, anthropometric measurements, length of follow-up and types of CF, effect size (OR/RR) and mean difference. HIC list provided in supplementary file 2.

The child's ethnicity will be determined by the country of birth of the parents, although ethnicity identification by country of birth has caveats because a diversity of the country-of-origin can differ [36]. In addition, diversity collection practices differ among Organisation for Economic Cooperation and Development (OECD) countries. Some countries collect indigenous identity, others race and ethnicity, and migrant statuses.

Output

The study will present a PRISMA flow diagram, including the search results and study selection summary. Rated quality of the included studies will be presented in a comprehensive table of the study characteristics. The risk of COO identified from all studies will be summarised and synthesised to identify the overall risk in multiple EMG children residing in HIC when the study was conducted.

Risk of Bias in the primary study

Two authors (MT and MK) will assess the quality of studies independently using the Newcastle Ottawa Scale (NOS) and modified NOS for assessing quality of non-randomised studies in the meta-analysis. The tool assesses participant selection, comparability of groups, and outcome or exposure depending on the type of study [37]. A point is given for each item in the three sections if the study meets the criteria. The maximum score for cross-sectional studies is ten and nine for cohort studies. Assessment of the internal validity of primary studies is crucial in systematic reviews to identify the risk of bias. It has been noted that, whilst the NOS quality assessment scale is challenging and more subjective in non-randomised studies compared to randomised controlled trials (RCTs), there is no other widely accepted tool for non-randomised studies. [38] Grading of Recommendations Assessment, Development and Evaluation (GRADE) quality review tool will be used for RCTs. Disagreements with grading will be resolved through discourse and revisiting the inclusion criteria by both authors (MT and MK).

Analysis and Data Synthesis

Descriptive analysis will be performed to report on the association between COO and breastfeeding duration, the timing of CF and frequency, and variety of feeds. Both narrative text and table summaries will be presented.

The results of the included studies will be synthesised using pooled estimates and pooled odds ratios or risk ratios (RR) applying random-effects model with 95% confidence intervals (CI) where data permits to conclude the pooled COO risk. Random-effects meta-analysis will be limited to studies reported on pooled estimates and at least ten studies with low to moderate heterogeneity for meaningful results. Heterogeneity will be assessed using the I^2 and visual inspection of forest plots. For dichotomous data, RR and 95% CI will be calculated and for continuous data, mean difference (MD) and 95% CI will be used. MD will be

converted to RR if possible. Forest plots will be used to visually present the estimated weighted results from different studies.

Bias Minimisation

The review will include multiple databases to ensure all studies published are included if they meet our pre-defined inclusion criteria. Funnel plots, which is a plot of effect size, will be used to assess publication bias and estimated by Begg's or Eggers tests using the R package. Assessment of the quality of primary studies by both authors using NOS and GRADE tools will further minimise bias. Disagreements with grading will be resolved through discourse. We will also perform sensitivity analysis for the meta-analysis and repeat to include only studies deemed to be good quality. Analyses will be conducted using Stata version 16 (StataCorp) and completed by the team's statistician (OMO).

Patient and public involvement

Patients nor public will not be involved at any stage of the study. The proposed study primarily reviews published data available in the indicated electronic databases.

Discussion

Our review is unique, and to our knowledge, is the only review considering extensive analysis of COO risk in multiple EMG children residing in HIC about CF practices. EMG children are the offspring of migrant families who live in a different country from their parent's country of origin. Immigration can be diverse and varied from country to country. EMG in the USA comprises a third of the population [26]. The immigrant population of Canada is 21% [2], whereas the UK is 13% [39]. Although diversity is considered based on country of birth, this can pose problems due to within-country diversity from the country of origin [36].

Identifying the causes of COO amongst different EMG can be complex and challenging. It could be hypothesised from previous studies that there can be multiple reasons for the EMG families to adopt CF prematurely. FF is more common in HIC and, in contrast to LIC, where FF is expensive, parents are more likely to resort to FF and early CF in HIC. With immigration comes more work responsibilities, increased stress and poor diet. Furthermore, the stress has been exacerbated by the current pandemic. [40–43] This can potentially result

in lower breastfeeding rates and reduced production of breast milk which, in turn, may lead to the earlier introduction of CF. [44] Gaining weight, lesser crying and improved sleeping patterns are being seen by parents as being healthier for the baby and a positive choice for earlier CF. The trends of the new immigrating HIC influence these factors. [45]

Reviews have shown that insufficient knowledge, feeding attitude changes due to acculturation and incorrect advice lead to practising earlier CF resulting in COO. [27,45] A similar review that explored COO concerning CF was conducted in the general population without stratification on EMG or HIC. [20] Although another review on CF practices focused on South Asian children in HIC as an EMG, they did not report on obesity risk. Still, they identified significant differences in CF practices that were obesogenic [27]. On the other hand, one earlier review identified a clear association amongst the general population in developed countries [46]. This means that with a combined multiple ethnicities review, there is a possibility of statistically meaningful results identifying COO risk in EMG children residing in HIC. Such risk poses an important need for public health interventions. Evidence suggests adherence to BF and appropriates CF to improve growth and development of child [47]. Moreover, there has been a disparity in bodyweight changes among children, especially among ethnic minorities [42,43,48]. Our study will contribute to the efforts to prevent COO within EMG that is often under-researched and marginalised. Furthermore, we envisage our study to enhance the reduction in health disparities experienced by EMG through subsequent targeted interventions.

To our knowledge, it is the first review considering an extensive analysis of COO risk in multiple EMG children residing in HIC pertaining to CF practices. COO has been confirmed to be higher in EMG compared to native groups. If CF practices among EMG are a contributory factor in COO, our review will bring evidence for targeted interventions to prevent rather than cure COO by promoting healthy weight throughout childhood years. It will also highlight the scarcity of research within marginalised EMG by identifying gaps and making recommendations for future studies in CF practices.

The review is not without limitations. First, most studies included will be observational. Second, studies amongst EMG in HIC tend to be limited, with ethnic groups making up small samples. Additionally, language barrier difficulties may be present in the host country. Therefore, our review will likely capture a small number of studies likely to meet the inclusion

criteria, and heterogeneity between studies is expected to be high. Population diversity will further increase heterogeneity risk. There is potential that some studies, which include EMG, may be missed due to countries using varied ethnicity classifications, paired with the subjective nature of ethnicity.

Conclusion

This systematic review will highlight the CF practices in the EMG regarding frequency, the timing of CF and the identified factors that could have influenced CF. Such a systematic review will increase awareness and guide improvement and create future policies aimed at preventing COO.

Authors Contribution

MT and MK were involved in all aspects of the study, from conceptualisation, protocol development, and the preliminary search strategy. LÖ developed the preliminary search strategy, contributed with text for the methods part of the manuscript and will conduct the final literature search and the reference management in Covidence. Further screening of literature and data extraction will be carried out by MT and data validated by MK. TA revised the first draft for intellectual content and will assist with drafting and revising content in the final project. OMO will oversee the data extraction process and complete all aspects of the meta-analysis.

Support: Source and sponsor

No funding declared.

Competing interests

None declared.

Patient and Public involvement

No involvement and therefore patient consent not required.

Data Statement

Data will be submitted as a supplementary appendix.

Amendments: In the event of minor amendments of this protocol, the changes will be updated and transparent reported in the online PROSPERO registration for the review: CRD42021246029

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Supplementary materials file 1: preliminary search strategy in PubMed

Source: PubMed

Search date: 2021-04-30

Search specifications: All search terms are searched in the search field "Title/Abstract" and in MeSH (when available). Filters for English language and publication year range: January 1st, 2000- April 30th, 2021 is applied

Result: 2,951 records

Preliminary search strategy:

(((weight*[Title/Abstract] OR obesity[Title/Abstract] OR obese[Title/Abstract] OR obesities[Title/Abstract] OR "Obesity"[Mesh] OR "Body Weight"[Mesh:NoExp] OR BMI[Title/Abstract] OR "body mass index"[Title/Abstract] OR "Body Mass Index"[Mesh] OR "Overweight"[Mesh] OR overweight[Title/Abstract]) AND ("Infant Nutritional Physiological Phenomena"[Mesh] OR "Infant nutrition*"[Title/Abstract] OR "infant feeding*"[Title/Abstract] OR "Infant Food"[Mesh] OR "infant food*"[Title/Abstract] OR "baby nutrition*"[Title/Abstract] OR "baby feeding*"[Title/Abstract] OR "baby food*"[Title/Abstract] OR "supplementary feeding*"[Title/Abstract] OR "complementary feeding*"[Title/Abstract] OR "replacement feeding*"[Title/Abstract] OR "Infant Formula"[Mesh] OR "infant formula*"[Title/Abstract] OR "baby formula*"[Title/Abstract] OR "solid food*"[Title/Abstract] OR "soft food*"[Title/Abstract] OR "complementary food*"[Title/Abstract] OR "Breast Feeding"[Mesh] OR breastfed[Title/Abstract] OR "breast feed*"[Title/Abstract] OR "breast fed" [Title/Abstract] OR "wet nursing"[Title/Abstract] OR "Feeding Behavior"[Mesh] OR "feeding behavior*"[Title/Abstract] OR "feeding-related behavior*"[Title/Abstract] OR "feeding related behavior*"[Title/Abstract] OR "feeding pattern*"[Title/Abstract] OR "feeding habit*"[Title/Abstract] OR "food habit*"[Title/Abstract] OR "feeding behaviour*"[Title/Abstract] OR "feeding-related behaviour*"[Title/Abstract] OR "feeding related behaviour*"[Title/Abstract] OR "food fussiness"[Title/Abstract] OR "food prefer*"[Title/Abstract] OR "Eating Behavior*"[Title/Abstract] OR "Eating Habit*"[Title/Abstract] OR "Dietary Habit*"[Title/Abstract] OR "Diet Habit*"[Title/Abstract] OR "family diet"[Title/Abstract] OR "weaning"[Title/Abstract] OR "Weaning"[Mesh] OR "Bottle Feeding"[Mesh] OR bottlefe*[Title/Abstract] OR "feeding duration*"[Title/Abstract] OR "dietary varia*"[Title/Abstract] OR "breast milk"[Title/Abstract] OR "Milk, Human"[Mesh] OR "human milk"[Title/Abstract] OR "Lactation"[Mesh] OR lactation[Title/Abstract] OR "liquid food*"[Title/Abstract])) AND ("Infant"[Mesh] OR "Child"[Mesh] OR child*[Title/Abstract] OR infant*[Title/Abstract] OR "newborn*"[Title/Abstract] OR baby[Title/Abstract] OR babies[Title/Abstract] OR "toddler*"[Title/Abstract])) AND ("Minority Groups"[Mesh] OR "Ethnic Groups"[Mesh] OR "Population Groups"[Mesh] OR "Continental Population Groups"[Mesh] OR ethnic*[Title/Abstract] OR "population group*"[Title/Abstract] OR nationalit*[Title/Abstract] OR "ethnic minorit*"[Title/Abstract] OR "cultural group*"[Title/Abstract] OR "population minorit*"[Title/Abstract] OR "racial stock*"[Title/Abstract] OR race[Title/Abstract] OR races[Title/Abstract] OR Black[Title/Abstract] OR Blacks[Title/Abstract] OR African*[Title/Abstract] OR "Afro-American*"[Title/Abstract] OR "Afro American*"[Title/Abstract] OR "American Native*"[Title/Abstract] OR "Native American*"[Title/Abstract] OR Indian*[Title/Abstract] OR "American Amerind*"[Title/Abstract] OR "Indigenous Canadian*"[Title/Abstract] OR "Canadian Native*"[Title/Abstract] OR Amish[Title/Abstract] OR Arab[Title/Abstract] OR Arabs[Title/Abstract] OR Arabic[Title/Abstract] OR Palestinian*[Title/Abstract] OR Asian*[Title/Abstract] OR Hispanic*[Title/Abstract] OR Mexican*[Title/Abstract] OR "Spanish American*"[Title/Abstract] OR "Puerto Rican*"[Title/Abstract] OR Latinos[Title/Abstract] OR Latino[Title/Abstract] OR Latinas[Title/Abstract] OR Latina[Title/Abstract] OR Cuban*[Title/Abstract] OR Hispanic*[Title/Abstract] OR Japanese[Title/Abstract] OR Chinese [Title/Abstract] OR Vietnamese[Title/Abstract] OR Cambodian*[Title/Abstract] OR Hmong*[Title/Abstract] OR

Korean*[Title/Abstract] OR Filipino*[Title/Abstract] OR Filipina*[Title/Abstract] OR "Indigenous people*"[Title/Abstract] OR Alaska*[Title/Abstract] OR Inuit[Title/Abstract] OR Inuits[Title/Abstract] OR Kalaallit*[Title/Abstract] OR Inupiat*[Title/Abstract] OR Aleut*[Title/Abstract] OR Eskimo*[Title/Abstract] OR "first nation people*"[Title/Abstract] OR "Native People*"[Title/Abstract] OR Roma[Title/Abstract] OR Romanies[Title/Abstract] OR Romani[Title/Abstract] OR Romany[Title/Abstract] OR Gypsies[Title/Abstract] OR Gipsy[Title/Abstract] OR Hawaiian*[Title/Abstract] OR "Pacific Islander*"[Title/Abstract] OR Maori*[Title/Abstract] OR Aboriginal[Title/Abstract] OR Aborigine*[Title/Abstract] OR Jew[Title/Abstract] OR Jews[Title/Abstract] OR Jewish[Title/Abstract] OR migrant*[Title/Abstract] OR Emigrant*[Title/Abstract] OR immigrant*[Title/Abstract] OR "Emigrants and Immigrants"[Mesh])

List of High-Income economies [1]

Andorra	Greece	Palau
Antigua and Barbuda	Greenland	Panama
Aruba	Guam	Poland
Australia	Hong Kong SAR, China	Portugal
Austria	Hungary	Puerto Rico
Bahamas, The	Iceland	Qatar
Bahrain	Ireland	**Romania**
Barbados	Isle of Man	San Marino
Belgium	Israel	Saudi Arabia
Bermuda	Italy	Seychelles
British Virgin Islands	Japan	Singapore
Brunei Darussalam	Korea, Rep.	Sint Maarten (Dutch part)
Canada	Kuwait	Slovak Republic
Cayman Islands	Latvia	Slovenia
Channel Islands	Liechtenstein	Spain
Chile	Lithuania	St. Kitts and Nevis
Croatia	Luxembourg	St. Martin (French part)

Curaçao	Macao SAR, China	Sweden
Cyprus	Malta	Switzerland
Czech Republic	**Mauritius**	Taiwan, China
Denmark	Monaco	Trinidad and Tobago
Estonia	**Nauru**	Turks and Caicos Islands
Faroe Islands	Netherlands	United Arab Emirates
Finland	New Caledonia	United Kingdom
France	New Zealand	United States
French Polynesia	Northern Mariana Islands	Uruguay
Germany	Norway	Virgin Islands (U.S.)
Gibraltar	Oman	

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Reporting checklist for protocol of a systematic review and meta analysis.

Based on the PRISMA-P guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the PRISMA-Preporting guidelines, and cite them as:

Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, Shekelle P, Stewart LA. Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) 2015 statement. Syst Rev. 2015;4(1):1.

		Reporting Item	Page Number
Title			
Identification	#1a	Identify the report as a protocol of a systematic review	1-4
Update	#1b	If the protocol is for an update of a previous systematic review, identify as such	n/a
Registration			
	#2	If registered, provide the name of the registry (such as PROSPERO) and registration number	3
Authors			
Contact	#3a	Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author	1

Contribution	#3b	Describe contributions of protocol authors and identify the guarantor of the review	12-13
Amendments			
	#4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	n/a
Support			
Sources	#5a	Indicate sources of financial or other support for the review	13
Sponsor	#5b	Provide name for the review funder and / or sponsor	n/a
Role of sponsor or funder	#5c	Describe roles of funder(s), sponsor(s), and / or institution(s), if any, in developing the protocol	n/a
Introduction			
Rationale	#6	Describe the rationale for the review in the context of what is already known	5-8
Objectives	#7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)	7
Methods			
Eligibility criteria	#8	Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review	6-7
Information sources	#9	Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage	8-9
Search strategy	#10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated	16-17

Study records - data management	#11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	8-9
Study records - selection process	#11b	State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis)	9-11
Study records - data collection process	#11c	Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators	9-10
Data items	#12	List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications	7-9
Outcomes and prioritization	#13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale	10-11
Risk of bias in individual studies	#14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis	11
Data synthesis	#15a	Describe criteria under which study data will be quantitatively synthesised	10-11
Data synthesis	#15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as I2, Kendall's τ)	10-11
Data synthesis	#15c	Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression)	10-11
Data synthesis	#15d	If quantitative synthesis is not appropriate, describe the type of summary planned	10-11
Meta-bias(es)	#16	Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies)	10-11

Confidence in cumulative evidence	#17	Describe how the strength of the body of evidence will be assessed (such as GRADE)	10