




BMJ Open Effect of plant milk consumption on childhood growth: protocol for a systematic review

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ABSTRACT

Introduction There has been considerable debate about whether plant milks can support the nutritional requirements of growing children. The proposed systematic review aims to assess the evidence on the relationship between plant milk consumption and growth and nutritional status in childhood.

Methods and analysis Ovid MEDLINE ALL (1946–present), Ovid EMBASE Classic (1947–present), CINAHL Complete (Cumulative Index to Nursing and Allied Health Literature), Scopus, the Cochrane Library and grey literature will be searched comprehensively (from 2000 to present; English language) to find studies that describe the association between plant milk consumption and growth or nutrition in children 1–18 years of age. Two reviewers will identify eligible articles, extract data and assess the risk of bias in individual studies. If a meta-analysis is not conducted, the evidence will be synthesised narratively and the overall certainty of evidence will be rated using the Grading of Recommendations Assessment, Development and Evaluation approach.

Ethics and dissemination Ethical approval is not required for this study since no data will be collected. Results of the systematic review will be published in a peer-reviewed journal. Findings from this study may be useful in informing future evidence-based recommendations about plant milk consumption in children.

PROSPERO registration number CRD42022367269.

INTRODUCTION

Cow milk has long been recommended for children as it contains important nutrients such as calcium and vitamin D that are necessary for growth.^{1–3} However, with plant milks such as almond and oat milk becoming more widely available many parents are choosing these beverages instead of cow milk for their children.^{4–6} A recent Canadian study found that one-third of parents of preschool-aged children purchased plant milks.⁷ With milk preferences shifting, understanding the nutritional effects of plant milk consumption in children is important.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ A search strategy involving multiple databases and grey literature will provide a comprehensive overview of the existing literature on plant milk consumption in childhood.
- ⇒ The study may be limited by the number of available studies because plant milk consumption in children is a relatively new dietary trend.
- ⇒ Pooling data on various types of plant milks that differ in nutritional content may increase the sample size but potentially limits interpretation of findings.

Although plant milks are gaining popularity among children, it is not clear whether these beverages offer nutritional benefits for children.^{8–11} International guidelines such as those from the American Academy of Pediatrics and the Canadian Pediatric Society advise against plant milk consumption in early childhood.^{12 13} While plant milks may be fortified with essential micronutrients such as calcium and vitamin D, they are generally lower in energy, protein and fat compared with cow milk.^{14 15} There have been over 30 published cases of severe nutritional deficiencies (eg, rickets, failure-to-thrive) reported in children between 2.5 and 22 months of age who consumed rice, almond or soy milk instead of breastmilk, infant formula and cow milk.¹⁶ While these case reports have generated considerable debate about the appropriateness of plant milks for children, it is worth noting that in most of these studies children were given plant milk because of an allergy to cow milk¹⁷ or a pre-existing health condition (eg, atopic dermatitis),¹⁸ which may independently affect growth and nutrient intake.¹⁹

Several recently published viewpoints and commentaries have challenged the new guidelines that suggest children avoid plant



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milks claiming that they are misguided, poorly supported and that plant milks could be beneficial for children (eg, due to their lower saturated fat content).^{20 21} Furthermore, some children may be allergic to dairy, lactose intolerant or follow a vegan diet that may prevent them from consuming cow milk.²² Several studies have emphasised the important role of fortified plant milks in supporting nutritional requirements (eg, calcium) of children who do not consume cow milk.^{19 23 24} Moreover, results of the German Vechi Youth Study have shown that children who follow a vegetarian and vegan diet and consume some or no plant milk still meet their nutritional requirements and attain normal growth.²⁵

Objectives

There is a need for more research to fill the gaps in our knowledge of plant milk consumption in children. The proposed systematic review aims to evaluate the existing evidence on the effects of plant milk consumption on growth and nutrition in children 1–18 years of age.

Rationale for the study

To our knowledge, no systematic reviews have been done to assess the totality of the evidence on plant milk consumption in children. A literature search conducted in September 2022 in Ovid MEDLINE, Ovid Embase, PROSPERO, Open Science Framework, Google Scholar and the Cochrane Database of Systematic Reviews did not identify any ongoing or completed systematic reviews on this topic. Thus, this systematic review will address an important knowledge gap, help strengthen the evidence that informs clinical practice guidelines about childhood plant milk consumption and may be of interest to parents, dietitians, paediatricians and other healthcare professionals when considering plant milk for children.

METHODS AND ANALYSIS

Study registration

The study protocol adheres to the Preferred Reporting Items for Systematic Review and Meta-analysis Protocols (PRISMA-P) guidelines²⁶ and has been registered with the

International Prospective Register of Systematic Reviews (PROSPERO; registration number CRD42022367269). The PRISMA-P checklist is attached in online supplemental appendix 1. The findings of the systematic review will be reported according to the PRISMA statement.²⁷

Inclusion and exclusion criteria

The study will include articles that report the association between plant milk consumption and child growth and nutrition and meet the following inclusion criteria (as described in [table 1](#)).

Study population

Studies that include children aged 1–18 years of age will be considered. Studies involving children <1 year of age will be excluded as plant milks are not recommended during the first year of life.²⁸

Exposure

Studies that report the volume of plant milk consumed (fortified or non-fortified, sweetened or unsweetened) will be included. Plant milk will be defined as any ‘milk’ beverage derived from plant-based ingredients (eg, soy, almond, coconut, cashew, oat, rice or blends of these ingredients). Studies examining plant-based infant and toddler formulas will be excluded as these are specifically formulated to meet the nutritional needs of children and differ from plant milks.²⁸

Outcomes

Studies evaluating growth (weight or height) or nutritional status (eg, dietary intake, micronutrient status) will be eligible. Studies that do not contain information on at least one of the outcome measures will be excluded.

Types of studies and publication type

Cross-sectional, cohort, case-control, longitudinal studies and clinical trials (randomised or non-randomised) published in English in a peer-reviewed journal in the year 2000 or later will be included. Articles published before this time will be excluded as plant milk consumption in children is a recent dietary trend and food fortification

Table 1 Inclusion and exclusion criteria for study selection

	Inclusion criteria	Exclusion criteria
Population	Children aged 1–18 years	Children <1 year
Exposure	Plant milk consumption <ul style="list-style-type: none"> ► Soy, almond, rice, oat, etc ► Fortified or non-fortified ► Sweetened or unsweetened 	Plant-based infant or toddler formula
Outcomes	Primary outcome <ul style="list-style-type: none"> ► Growth (weight or height) Secondary outcome <ul style="list-style-type: none"> ► Nutrition (eg, dietary intake, micronutrient status) 	No data on growth or nutrition
Types of studies	Cross-sectional, cohort, case-control, longitudinal studies and clinical trials	Case reports
Publication type	English language Published in the year 2000 or later	Non-English language Published before the year 2000

practices have changed over the past few decades.²⁹ Only studies available in full-text will be considered (ie, abstracts will be excluded).

Outcomes

Primary outcome

The primary outcome will be child growth which will be assessed using anthropometric measurements such as weight, height, body mass index (BMI) as well as weight and height related z-scores (ie, weight-for-age, weight-for-length, BMI-for-age, length-for-age, height-for-age).

Secondary outcome

The secondary outcome will be nutritional status which will be assessed using the following methods: (1) dietary intake (eg, mean calcium intake assessed using a food frequency questionnaire or diet records collected over multiple days); (2) biochemical measures of micronutrient status (eg, serum levels of vitamin D or ferritin); (3) body composition (eg, waist circumference, body fat mass, lean body mass, body fat percentage, skinfold thickness); (4) bone health (eg, bone mineral density, peak bone mass); (5) prevalence of underweight, overweight and obesity measured according to BMI cut-offs as defined by the WHO,³⁰ Centers for Disease Control and Prevention,³¹ International Obesity Task Force³² or those provided by the author if other growth charts were used and; (6) prevalence of short stature defined as height that falls two SD below the median height for children the same age and sex or height <3rd percentile of the WHO child growth standards.³⁰

Information sources and search strategy

Databases

A comprehensive search strategy will be designed by an Information Specialist (SC) in collaboration with the team. The search will be performed in the following databases: Ovid MEDLINE ALL which includes E-pub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE Daily and Ovid MEDLINE (1946–present), Ovid Embase Classic +Embase (1947–present), EBSCOhost CINAHL Complete (Cumulative Index to Nursing and Allied Health Literature), Scopus and the Cochrane Library, both Cochrane CENTRAL and the Cochrane Database of Systematic Reviews (CDSR). The databases will be searched for studies published in the year 2000 onwards. After the initial search is completed in Ovid MEDLINE ALL, the search will be peer-reviewed by another Information Specialist following CADTH's Peer Review of Electronic Search Strategies (PRESS) checklist.³³ Revisions will be made accordingly and approved by the team before being translated into the other databases. A combination of subject headings and text words will be searched in each database. The search strategy will combine various terms for plant milk (plant-based milk, non-dairy milk, non-dairy beverage, milk alternative, non-cow milk, soy, almond, nut milk) and study population ages 1–18years (ie, infant, preschool, child,

adolescents, youth, paediatrics) using the Ovid Expert Searches Children Filter (Broad).³⁴ A preliminary search strategy in Ovid MEDLINE is provided as an example in online supplemental appendix 2. PRISMA-S will be used to report the search strategies.³⁵

Manual searches

To ensure comprehensiveness, grey literature and reference lists of included studies will be searched to identify any missing or additional articles. We will also contact experts in the field about any unpublished or ongoing studies. The grey literature search strategy will involve searching websites of nutrition and paediatric associations (eg, Canadian Pediatric Society, American Academy of Pediatrics), government organisations (eg, Health Canada) and nutrition databases (eg, Practice-based Evidence in Nutrition developed by Dietitians of Canada) for relevant documents (ie, fact sheets, government reports) about plant milk consumption in children. The same eligibility criteria will be applied as the published literature searches.

Data management

On completing the translation of the search strategy across all selected databases, the Information Specialist (SC) will collate all studies in the bibliographic software program EndNote V.X9 and deduplicate the results using the Bramer method.³⁶ The studies will then be imported into the screening and extraction software Covidence,³⁷ where two stages of screening will take place.

Study selection

The first reviewer (IS) will screen titles and abstracts to identify eligible articles. A second reviewer (CD'H) will confirm the eligibility of the identified articles. The same two authors will independently review and read the full-text of potentially eligible studies. Any disagreements about inclusion will be resolved by discussion or a third senior reviewer (JLM). Publications that used the same cohort but evaluated different outcomes will be included as separate studies. Excluded studies will be reported using a PRISMA flow chart.³⁸

Data extraction

Two reviewers will independently extract the data from included studies. Conflicts will be resolved by a third reviewer, if needed. The following information will be extracted from each study using a standardised data extraction form: the first author, year of publication, country, sample size, age of children, amount of plant milk consumed (number of cups per day, daily mean intake, etc), type of plant milk (soy, almond, rice, coconut, etc), variables adjusted for and results (estimates and corresponding 95% CIs for each outcome of interest and p value). If data on the same populations were reported in multiple articles, both will be considered for analysis. If sufficient information is not available in the full-text publication, the study authors will be contacted via email to obtain additional data.

Risk of bias in individual studies

Risk of bias will be assessed independently by two reviewers. Discrepancies will be resolved by consensus. The Newcastle-Ottawa Scale will be used to assess the risk of bias in individual observational cohort and cross-sectional studies, which expresses risk of bias on a numerical scale ranging from 0 to 9. Scores ≥ 7 will be considered low risk. Risk of bias of included clinical trials will be assessed using the Cochrane Risk of Bias tool.³⁹

Data synthesis

The evidence will be summarised narratively due to anticipated heterogeneity between studies (eg, variability in participants studied, exposure and outcome measures). Data on each outcome will be extracted, tabulated and characteristics of the studies, heterogeneity in study participants, exposure and outcomes, strengths and limitations and key findings will be described in the text. A meta-analysis will be conducted only if the study participants, exposure and outcomes are sufficiently similar. The heterogeneity between studies will be assessed using a forest plot and with the I^2 statistic.³⁹

Additional analyses

If sufficient data are available, we will tabulate the evidence:

1. For each type of plant milk since the nutritional content can vary between different types of products (eg, soy milk is higher in protein content than almond milk).¹⁵ A list of different types of plant milks can be found in [table 2](#).
2. By the age of children since younger children are at higher risk of nutritional deficiencies.^{6 40}
3. Separately for children with food allergies (eg, to cow milk) which can contribute to suboptimal nutrient intake and poor growth in children.¹⁹

Confidence in cumulative evidence

The certainty of evidence will be assessed using the Grading of Recommendations Assessment, Development and Evaluation approach.^{41 42} The grade of the evidence will be downgraded based on study limitations (risk of bias as assessed by the Newcastle-Ottawa Scale or Cochrane Risk of Bias tool), inconsistency of results, imprecision (small sample size, wide CIs), indirectness of evidence (presence of factors that limit the generalisability of the findings) and publication bias.

Table 2 Different types of plant milks⁴³

Legume	Nut	Seed	Grain/cereal
Soy	Almond	Flax	Oat
Pea protein	Cashew	Hemp	Rice
Peanut	Coconut	Pumpkin	Quinoa
	Macadamia	Sunflower	Buckwheat
	Hazelnut	Sesame	

Patient and public involvement

Patients or the public were not involved in the design, conduct, reporting or dissemination plans of our research.

DISCUSSION

Plant milk consumption is becoming increasingly popular among children. Despite this, it is unclear whether plant milks are beneficial for children. To address this, the aim of this review is to review the available evidence on the effect of plant milk consumption on child growth and nutrition. The certainty of the evidence may be limited by the number and quality of studies. Nonetheless, it is expected that the findings of this review will provide valuable insight into what is known about plant milk consumption in children and help to identify gaps and inconsistencies in the existing literature and areas that require further research. In addition, even with limited studies it may still be possible to draw some conclusions or make recommendations about plant milk intake in childhood which may help parents and healthcare professionals make informed decisions when considering plant milk for children.

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Competing interests IS (the first author) has been a vegetarian for over 10 years. DJAJ is a vegan. JLM received an unrestricted research grant for a completed investigator-initiated study from the Dairy Farmers of Canada (2011–2012) and D-drops provided non-financial support (vitamin D supplements) for an investigator initiated study on vitamin D and respiratory tract infections (2011–2015). The other authors have no competing interests to disclose.

Patient and public involvement Patients and/or the public were not involved in the design, conduct, reporting or dissemination plans of this research.

Patient consent for publication Not applicable.

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