UK Health Security Agency

Breast milk alternatives for babies who are not breastfed

A rapid evidence summary

Contents

Main messages

1. This rapid evidence summary (search up to 12 July 2023) identified and summarised evidence relating to the health risks of breast milk alternatives for babies aged under one year of age who are not being breastfed when sanitised water or boiled water is not available, and the hierarchy in which these options should be used (one systematic review and 2 primary studies identified) (1 to 3).

2. The included systematic review searched for studies looking at gastrointestinal blood loss (using the guaiac stool test, 2 studies), diarrhoea (one study), constipation (one study), and pneumonia (no studies found) (3).

3. From this review, for gastrointestinal blood loss, one randomised controlled trial (RCT) suggested more babies consuming cow's milk had gastrointestinal blood loss at 8.3 months (n=9 of 21 babies, 42.9%) than babies consuming infant formula (n=3 of 22 babies, 13.6%, relative risk [RR] = 3.14, 95% confidence interval [CI]: 0.98 to 10.04), considered a 'low certainty of evidence' on Grading of Recommendations Assessment, Development and Evaluation (GRADE) assessment by the review authors. One cohort study had similar results, suggesting more babies consuming cow's milk had gastrointestinal blood loss at 6.5 months (n=26 of 60 babies, 43.3%) than babies consuming infant formula (n=6 of 21 babies, 28.6%, RR = 1.52, 95% CI: 0.73 to 3.16), considered a 'very low certainty of evidence' on GRADE assessment by the review authors.

4. For both constipation and diarrhoea, the review reported results of one cohort study suggesting more babies consuming cow's milk had constipation (n=7 of 69 babies, 10.1%) and diarrhoea (n=21 of 69 babies, 30.4%) than babies consuming infant formula (constipation: n=3 of 98 babies, 3.1%, RR = 3.31, 95% CI: 0.89 to 12.37; diarrhoea: n=16 of 98 babies, 16.8%, RR = 1.86, 95% CI: 1.05 to 33.10), considered a 'very low certainty of evidence' on GRADE assessment by the review authors.

5. Two primary studies suggested babies consuming breast milk substitutes either had similar or higher incidences of diarrhoea, although both studies were small with imprecise results (1, 2).

6. Although not specifically searched for, 2 pieces of official guidance for breast milk alternatives were identified during the searches. Guidance from the emergency nutrition network and UNICEF stated that infant formula is the appropriate breast milk substitute for babies less than 6 months of age, while alternative milks (pasteurised or boiled full fat animal milk, ultra-high temperature milk, reconstituted evaporated milk, fermented milk or yoghurt) may be consumed by babies 6 months and older (4). The World Health Organization, in their guiding principles for feeding infants and young children during emergencies, do not specify which breast milk substitutes

could be used by whom, only that babies under 6 months of age who do not have access to breast milk should be given a nutritionally adequate breast milk substitute formulated in accordance with the relevant Codex Alimentarius standards (5).

7. Overall, there was limited evidence to answer either review question. The risk of bias in each included study was not assessed, although as all studies apart from one RCT in the identified review were observational, other reasons besides consumption of breast milk substitutes may cause different incidences of health risks. All studies were small with imprecise results.

Purpose

The purpose of this rapid evidence summary was to identify and assess the available evidence that discussed breast milk alternatives for non-breastfed babies aged under one year including when sanitised water or boiled water is not available, for example, in the context of a national power outage or following a disaster.

Methods

The review questions were:

1. What are the health risks of breast milk alternatives for babies aged under one year of age who are not being breastfed?
2. What is the hierarchy in which these options should be used?

A rapid evidence summary was completed in July 2023, which identified evidence to answer the research questions above. We searched Medline, Embase, and Web of Science Core Collection to identify any existing evidence related to the review questions, published prior to 12 July 2023. Screening on title and abstracts was undertaken in duplicate by 2 reviewers for all the potentially relevant studies. Screening on full text was undertaken by one reviewer and excludes were checked by a second reviewer. We also searched the UN, World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC) websites for any other relevant evidence, and ran a targeted google search. Health risks included infection and short-term health complications from ingestion of milk alternatives, for example gastrointestinal problems (including diarrhoea) and mortality.

A protocol was produced before the literature search was conducted, including the review questions above, the eligibility criteria, and all other methods, see Annexe A. There were no deviations from the protocol.

Evidence

In total, 607 studies were screened on title and abstract, of which 11 studies were screened on full text, and one study was included in this rapid evidence summary (2). An additional 36 studies were screened from other searches, and 3 studies met the inclusion criteria (1, 3, 6). However, one of these studies (6) only included evidence from another study (with no additional information) (2), and so will not be discussed further.

There were therefore 3 included studies, a 2022 systematic review of the effects of animal milk compared to infant formula consumption (3), and 2 observational studies, one comparing the incidence of diarrhoea in infants who did and did not consume infant formula after the May 2006 earthquake in central Java (2), and one comparing the incidence of diarrhoea in breastfed and formula-fed infants presenting to general practices in England in the 1990s (1).

Erhlich and others conducted a systematic review (search up to 17 November 2021) looking at the effects of animal milk compared to infant formula consumption in healthy infants aged 6 to 11 months (3). Any preparation of any animal milk and any preparation of any formula were included, and relevant outcomes were gastrointestinal blood loss (using the guaiac stool test, 2 studies), diarrhoea (one study), constipation (one study), and pneumonia (no studies found). The time points considered were 7, 9, and 12 months. Anaemia, weight for age, length for age, serum haemoglobin, and neurodevelopment outcome were also reported as outcomes, but were not considered short-term, and so are not reported here.

For gastrointestinal blood loss, one randomised controlled trial (RCT) suggested more babies consuming cow's milk had gastrointestinal blood loss at 8.3 months (n=9 of 21 babies, 42.9%) than babies consuming infant formula (n=3 of 22 babies, 13.6%, relative risk [RR] = 3.14, 95% confidence interval [CI]: 0.98 to 10.04), considered a 'low certainty of evidence' on GRADE assessment by the review authors. One cohort study had similar results, suggesting more babies consuming cow's milk had gastrointestinal blood loss at 6.5 months (n=26 of 60 babies, 43.3%) than babies consuming infant formula (n=6 of 21 babies, 28.6%, RR = 1.52, 95% CI: 0.73 to 3.16), considered a 'very low certainty of evidence' on GRADE assessment by the review authors.

For both constipation and diarrhoea, a cohort study suggested more babies consuming cow's milk had constipation (n=7 of 69 babies, 10.1%) and diarrhoea (n=21 of 69 babies, 30.4%) than babies consuming infant formula (constipation: n=3 of 98 babies, 3.1%, RR = 3.31, 95% CI: 0.89 to 12.37; diarrhoea: n=16 of 98 babies, 16.8%, RR = 1.86, 95% CI: 1.05 to 33.10), considered a 'very low certainty of evidence' on GRADE assessment by the review authors.

Hipgrave and others conducted a cross-sectional survey comparing the incidence of diarrhoea in infants and young children who did and did not drink donated breast milk substitutes after the May 2006 earthquake in central Java (2). For babies under 6 months of age, the incidence of diarrhoea in the 7 days before the survey were similar between babies who consumed infant

formula (n=19, 15% incidence) and those who did not (n=18, 11% incidence, RR = 1.39, 95% CI: 0.74 to 2.61). For babies between 6 and 11 months of age, the incidence of diarrhoea in the 7 days before the survey were higher than for younger babies, but still similar between babies who consumed infant formula (n=40, 28% incidence) and those who did not (n=30, 27% incidence, RR = 1.07, 95% CI: 0.70 to 1.63).

Quigley and others conducted a case-control study of 167 infants with diarrhoea (cases) and 137 age and location stratified infants without diarrhoea (controls) from 34 general practices in the 1990s in England (1). For babies under 6 months of age, the odds of having diarrhoea was higher in babies who were not exclusively breastfed (odds ratio [OR] = 3.64, 95% CI: 0.92 to 14.34, p=0.065), with similar results for babies between 6 and 11 months of age (OR = 4.08, 95% CI: 1.17 to 14.16, p=0.027).

Guidance

Although not specifically searched for, official guidance for breast milk alternatives was identified during the searches. Operational guidance on infant feeding in emergencies from the emergency nutrition network and UNICEF states that infant formula is the appropriate breast milk substitute for babies less than 6 months of age, while alternative milks (pasteurised or boiled full fat animal milk, ultra-high temperature milk, reconstituted evaporated milk, fermented milk or yoghurt) may be consumed by babies 6 months and older (4). This guidance referenced a paper by de Pee and others, although this paper did not look at health outcomes for infants consuming any particular breast milk substitute (7). The World Health Organization, in their guiding principles for feeding infants and young children during emergencies, do not specify which breast milk substitutes could be used by whom, only that babies under 6 months of age who do not have access to breast milk should be given a nutritionally adequate breast milk substitute formulated in accordance with the relevant Codex Alimentarius standards (5).

Health inequalities

The limited evidence available did not provide information to explore inequalities through variations across populations and subgroups, for example cultural variations or differences between ethnic, social or vulnerable groups. As such, it was not possible to examine inequalities in this report.

Limitations

There was limited evidence to answer the first review question on the health risks of breast milk alternatives, and no evidence to comprehensively answer the second review question on establishing a hierarchy of breast milk alternatives. The search was restricted to published articles looking at emergency or disaster situations, which may have limited the sensitivity of the search for relevant evidence, although targeted searching was also used to find additional evidence.

The risk of bias in each included study was not assessed. However, all studies apart from one RCT in the identified review were observational, meaning other reasons besides consumption of breast milk substitutes may cause different incidences of health risks. Other risks of bias may also be present. Additionally, the identified studies were all small, so the results were relatively imprecise.

As with all reviews, the evidence identified may be subject to publication bias, whereby null or negative results are less likely to have been published by the authors.

Evidence gaps

There was limited evidence to answer either review question, meaning both review questions had substantial evidence gaps.

Conclusion

There was limited evidence to answer either review question. Studies included in the review suggested more babies consuming cow's milk had gastrointestinal blood loss (one RCT and one cohort study), as well as constipation and diarrhoea (one cohort study), than babies consuming infant formula, although the certainty of evidence was rated as low or very low for all outcomes. Two additional studies suggested babies consuming breast milk substitutes either had similar or higher incidences of diarrhoea. However, all studies were small with imprecise results.

Acknowledgments

We would like to thank colleagues within the All Hazards Public Health Response division who either reviewed or input into aspects of the review. Search terms for power outage and power cuts were adapted from literature searches developed by Caroline De Brun, Knowledge and Evidence Specialist for UKHSA South West.

Disclaimer

UKHSA's rapid reviews and evidence summaries aim to provide the best available evidence to decision makers in a timely and accessible way, based on published peer-reviewed scientific papers, unpublished reports and papers on preprint servers. Please note that the reviews:

- use accelerated methods and may not be representative of the whole body of evidence publicly available
- have undergone an internal, but not independent, peer review
- are only valid as of the date stated on the review

In the event that this rapid evidence summary is shared externally, please note additionally, to the greatest extent possible under any applicable law, that UKHSA accepts no liability for any claim, loss or damage arising out of, or connected with the use of, this review by the recipient and/or any third party including that arising or resulting from any reliance placed on, or any conclusions drawn from, the review.

References

1. Quigley MA and others. 'How protective is breast feeding against diarrhoeal disease in infants in 1990s England? A case-control study' Archives of Disease in Childhood 2006: volume 91, issue 3, pages 245 to 250
2. Hipgrave DB and others. 'Donated breast milk substitutes and incidence of diarrhoea among infants and young children after the May 2006 earthquake in Yogyakarta and Central Java' Public Health Nutrition 2012: volume 15, issue 2, pages 307 to 315
3. Ehrlich JM and others. 'The effect of consumption of animal milk compared to infant formula for non-breastfed or mixed-fed infants 6- to 11-months of age: a systematic review and meta-analysis' Nutrients 2022: volume 14, issue 3
4. IFE Core Group. 'Infant and young child feeding in emergencies: operational guidance for emergency relief staff and programme managers: version 3.0 October 2017' 2017
5. World Health Organization. 'Guiding principles for feeding infants and young children during emergencies' 2004
6. Binns CW and others. 'Ethical issues in infant feeding after disasters' Asia-Pacific Journal of Public Health 2012: volume 24, issue 4, pages 672 to 680
7. de Pee S and others. 'Current and potential role of specially formulated foods and food supplements for preventing malnutrition among 6- to 23-month-old children and for treating moderate malnutrition among 6 to 59 month old children' Food and Nutrition Bulletin 2009: volume 30, issue 3 supplement, pages S434 to S463

Annexe A. Protocol

Review question

The review questions for this rapid evidence summary are:

1. What are the health risks of breast milk alternatives for babies aged under 1 year of age who are not being breastfed?
2. What is the hierarchy in which these options should be used?

This rapid evidence summary will look for evidence that discussed breast milk alternatives for non-breastfed babies aged under 1 year when sanitised water or boiled water is no longer available, for example, in the context of a national power outage or following a disaster. Only evidence relating to infections or health complications following ingestion of breast milk alternatives will be included.

Eligibility criteria

	Included	**Excluded**
Population	Babies aged under 1 year not breastfeeding	Babies who are being breastfed
Settings	Community	Hospital
Context	National power outage or post-disaster (evidence from other settings that provide useful information may be included)	
Intervention or exposure	Breast milk alternatives, including (but not limited to): • ready-made formula • formula mixed up at home (including considering when boiling is not possible) • cow's milk (including UHT) • cow's milk alternatives (for example, oat, soya, almond) • watered-down fruit juice (Information on appropriate age will be extracted if available)	

	Included	Excluded
Outcomes	Infection and short-term health complications from ingestion of milk alternatives, for example: • gastrointestinal problems, including diarrhoea • mortality	Long-term health complications from milk alternatives, such as malnutrition
Language	English language	Non-English language studies
Date of publication	Any	
Study design	• reviews (rapid, systematic or narrative) • primary studies (of any study design) if insufficient review-level evidence is found	• editorials • letters • opinion pieces
Publication type	Published and pre-print	

Identification of evidence

We will search Medline, Embase, and Web of Science Core Collection to identify any existing evidence related to the review question, published prior to 12 July 2023. See Search strategy below. Search terms for power outage and power cuts were adapted from literature searches developed by Caroline De Brun, Knowledge and Evidence Specialist for UKHSA South West.

Screening on title and abstracts will be undertaken in duplicate by 2 reviewers for all the potentially relevant studies. Screening on full text was undertaken by one reviewer and excludes were checked by a second reviewer. Disagreement was be resolved by discussion.

An information specialist will also run targeted searches on the UN, WHO, and CDC websites for any other relevant evidence not found in the literature search, as well as a google search.

Synthesis of evidence

If reviews providing evidence to answer the research question are identified, these will be summarised. If no reviews are identified, or if the identified reviews are insufficient to answer the review question, identified primary studies will be summarised. Data will be extracted straight into narrative summaries of included studies (reviews or primary studies). All narrative summaries will be written by one reviewer and checked by a second.

Variations across populations and subgroups, for example cultural variations or differences between ethnic or social groups will be considered, where evidence is available.

Search strategy

Database: Ovid MEDLINE(R) ALL (1946 to 11 July 2023)

1. baby.tw,kf. (44,796)
2. babies.tw,kf. (42,060)
3. under 1 year.tw,kf. (1,986)
4. < 1 year.tw,kf (253,955)
5. Infant/ (866,236)
6. exp Infant Newborn/ (673,492)
7. neonat*.tw,kf. (314,347)
8. or/1-7 (1,649,610)
9. breast milk.tw,kf. (15,960)
10. breast fed.tw,kf. (5,934)
11. breast feed*.tw,kf. (15,333)
12. (bottle feed* or bottle fed).tw,kf. (2,947)
13. Milk, Human/ (22,645)
14. exp Breast Feeding/ (43,909)
15. ((milk or breastmilk) adj5 (substitut* or alternative*)).tw,kf. (2,528)
16. formula*.tw,kf. (4,04,595)
17. ready made.tw,kf. (962)
18. "ready to use".tw,kf. (4,422)
19. cow* milk.tw,kf. (11,329)
20. UHT milk.tw,kf. (386)
21. fruit juice*.tw,kf. (4,790)
22. exp Milk Substitutes/ (6,562)
23. Milk/ (63,324)
24. "Fruit and Vegetable Juices"/ (2,778)
25. (infant* adj3 feed*).tw,kf. (12,547)
26. (feeding practice* or feeding threshold*).tw,kf. (6,389)
27. plant based milk*.tw,kf. (119)
28. (almond milk* or oat milk* or soy* milk*).tw,kf. (963)
29. (dairy adj3 alternative*).tw,kf. (255)
30. ((non-dairy or dairy free or lactose free) adj3 milk*).tw,kf. (194)
31. or/9-30 (548,562)
32. Electric Power Supplies/ (8,917)
33. Electricity/ (19,754)
34. 32 or 33 (28,035)
35. (failure* or supply or supplies or cut or cuts or outage* or insecurity or instability or unstable or limited).tw,kf. (2,442,274)
36. 34 and 35 (2,676)

37. (blackout* or ((electric* or power) adj3 (cut* or outage* or failure* or suppl* or insecurity or loss))).tw,kf. (11,302)
38. 36 or 37 (13,140)
39. exp Disasters/ (100,013)
40. ((disaster* or emergency or emergencies) adj5 (plan* or mitigat* or prepar* or stockpil*)).tw,kf. (14,769)
41. (drought* or hurricane* or flood* or forest fire*).tw,kf. (59,092)
42. Geological Phenomena/ or Avalanches/ or Earthquakes/ or Landslides/ or Tidal Waves/ or Tsunamis/ or Volcanic Eruptions/ or Wildfires/ (11,721)
43. (tidal wave* or volcanic eruption* or tsunami* or landslide* or avalanche* or earthquake* or Storm* or wildfire* or Snowstorm* or heat wave* or coldwave* or land fire* or Sandstorm* or cyclone* or typhoon* or extreme heat* or extreme cold* or extreme temperature*).tw,kf. (54,055)
44. (Camp or camps or refugee* or internal* displac*).tw,kf. (110,195)
45. Refugees/ (13,214)
46. Emergency Shelter/ (306)
47. emergency shelter*.tw,kf. (283)
48. evacuation shelter*.tw,kf. (76)
49. 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 (316,052)
50. 8 and 31 and 49 (329)

Database: Embase (1974 to 11 July 2023)

1. baby.tw,kf. (64399)
2. babies.tw,kf. (60726)
3. under 1 year.tw,kf. (2592)
4. < 1 year.tw,kf (396615)
5. exp infant/ (1141048)
6. neonat*.tw,kf. (420972)
7. or/1-6 (1699562)
8. breast milk.tw,kf. (20823)
9. breast fed.tw,kf. (7092)
10. breast feed*.tw,kf. (18350)
11. (bottle feed* or bottle fed).tw,kf. (3165)
12. exp breast milk/ (34267)
13. exp breast feeding/ (66606)
14. ((milk or breastmilk) adj5 (substitut* or alternative*)).tw,kf. (2798)
15. formula*.tw,kf. (573930)
16. ready made.tw,kf. (1257)
17. "ready to use".tw,kf. (6356)
18. cow* milk.tw,kf. (15482)
19. UHT milk.tw,kf. (427)
20. fruit juice*.tw,kf. (6001)
21. exp milk substitute/ (19049)

22. exp milk/ (83030)
23. exp "fruit and vegetable juice"/ (17379)
24. (infant* adj3 feed*).tw,kf. (14653)
25. (feeding practice* or feeding threshold*).tw,kf. (7872)
26. plant based milk*.tw,kf. (114)
27. (almond milk* or oat milk* or soy* milk*).tw,kf. (1162)
28. (dairy adj3 alternative*).tw,kf. (254)
29. ((non-dairy or dairy free or lactose free) adj3 milk*).tw,kf. (257)
30. or/8-29 (772748)
31. power supply/ (10428)
32. electricity/ (36259)
33. 31 or 32 (45777)
34. (failure* or supply or supplies or cut or cuts or outage* or insecurity or instability or unstable or limited).tw,kf. (3436375)
35. 33 and 34 (6200)
36. (blackout* or ((electric* or power) adj3 (cut* or outage* or failure* or suppl* or insecurity or loss))).tw,kf. (13136)
37. 35 or 36 (16614)
38. exp disaster/ (34559)
39. exp disaster planning/ (14559)
40. ((disaster* or emergency or emergencies) adj5 (plan* or mitigat* or prepar* or stockpil*)).tw,kf. (18137)
41. (drought* or hurricane* or flood* or forest fire*).tw,kf. (58246)
42. "geographic and geological phenomena"/ or avalanche/ or earthquake/ or landslide/ or storm surge/ or tsunami/ or volcanic ash/ or volcano/ or exp wildfire/ (24019)
43. (tidal wave* or volcanic eruption* or tsunami* or landslide* or avalanche* or earthquake* or Storm* or wildfire* or Snowstorm* or heat wave* or coldwave* or land fire* or Sandstorm* or cyclone* or typhoon* or extreme heat* or extreme cold* or extreme temperature*).tw,kf. (64459)
44. (Camp or camps or refugee* or internal* displac*).tw,kf. (130478)
45. refugee camp/ or exp forced migrant/ (18358)
46. emergency shelter*.tw,kf. (307)
47. evacuation shelter*.tw,kf. (81)
48. emergency shelter/ (634)
49. 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 (320162)
50. 7 and 30 and 49 (423)

Web of Science Core Collection

Date of search: 12 July 2023

(all editions: Science Citation Index Expanded, Social Sciences Citation Index, Arts and Humanities Citation Index, Conference Proceedings Citation Index – Science, Conference Proceedings Citation Index – Social Science and Humanities, Book Citation Index – Science, Book Citation Index – Social Sciences and Humanities, Emerging Sources Citation Index, Current Chemical Reactions, Index Chemicus)

TS=(baby) OR TS=(babies) OR TS=("under 1 year") OR TS=("<1 year") OR TS=(neonat*)

And:

TS=("breast milk") OR TS=("breast fed") OR TS=("breast feed*") OR TS=(("bottle feed*" or "bottle fed")) OR TS=(((milk or breastmilk) NEAR/4 (substitut* or alternative*))) OR TS=(formula*) OR TS=("ready made") OR TS=("ready to use") OR TS=("cow* milk") OR TS=("UHT milk") OR TS=("fruit juice*") OR TS=((infant* NEAR/2 feed*)) OR TS=(("feeding practice*" or "feeding threshold*")) OR TS=("plant based milk*")
OR TS=(("almond milk*" or "oat milk*" or "soy* milk*")) OR TS=((dairy NEAR/2 alternative*)) OR TS=(((non-dairy or "dairy free" or "lactose free") NEAR/2 milk*))

And:

TS=((blackout* or ((electric* or power) NEAR/2 (cut* or outage* or failure* or suppl* or insecurity or loss or instability or unstable or limited)))) OR TS=(((disaster* or emergency or emergencies) NEAR/4 (plan* or mitigat* or prepar* or stockpil*))) OR TS=((drought* or hurricane* or flood* or "forest fire*")) OR TS=(("tidal wave*" or "volcanic eruption*" or tsunami* or landslide* or avalanche* or earthquake* or Storm* or wildfire* or Snowstorm* or "heat wave*" or coldwave* or "land fire*" or Sandstorm* or cyclone* or typhoon* or "extreme heat*" or "extreme cold*" or "extreme temperature*")) OR TS=((Camp or camps or refugee* or "internal* displac*")) OR TS=("emergency shelter*") OR TS=("evacuation shelter*")

110 results

About the UK Health Security Agency

UKHSA is responsible for protecting every member of every community from the impact of infectious diseases, chemical, biological, radiological and nuclear incidents and other health threats. We provide intellectual, scientific and operational leadership at national and local level, as well as on the global stage, to make the nation heath secure.

UKHSA is an executive agency, sponsored by the Department of Health and Social Care.

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For queries relating to this document, please contact: enquiries@ukhsa.gov.uk

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