

The Current State of Evidence and Thinking on Wasting Prevention

Final Report

7 December 2018

About MQSUN+

MQSUN+ aims to provide the Department for International Development (DFID) with technical services to improve the quality of nutrition-specific and nutrition-sensitive programmes. The project, led by PATH, is resourced by a consortium of five leading non-state organisations working on nutrition.

The group is committed to:

- Expanding the evidence base on the causes of undernutrition;
- Enhancing skills and capacity to support scaling up of nutrition-specific and nutrition-sensitive programmes;
- Providing the best guidance available to support programme design, implementation, monitoring and evaluation;
- Increasing innovation in nutrition programmes;
- Knowledge sharing to ensure lessons are learnt across DFID and beyond.

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About this publication

This report was produced by the Emergency Nutrition Network (ENN), through the MQSUN+ project. It is a synthesis of published, grey literature and stakeholder opinion on what works to prevent wasting. However, it is not based on a systematic review of the published literature. We are grateful to the members of the ENN coordinated Wasting and Stunting (WaSt) and Management of At-risk Mothers and Infants (MAMI) technical groups and all others who gave of their time for the stakeholder interviews.

This document was produced through support provided by UK aid and the UK Government; however, the views expressed do not necessarily reflect the UK Government's official policies.



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Abbreviations

AKU	Aga Khan University
ALIMA	Alliance for International Medical Action
BMI	body mass index
BSFP	blanket supplementary feeding programme
CHAIN	Childhood Acute Illness & Nutrition
CMAM	community-based management of acute malnutrition
ComPAS	Combined Protocol for Acute Malnutrition Study
CRCT	cluster-randomised controlled trial
CSB	Corn-Soya Blend
CSB+	Corn-Soya Blend Plus [now called Supercereal]
CSB++	Corn-Soya Blend Plus Plus [now called Supercereal Plus]
CT	cash transfer
DFID	Department for International Development
EED	environmental enteric dysfunction
ENN	Emergency Nutrition Network
FBF	fortified blended foods
GAM	global acute malnutrition
HAZ	height-for-age Z-scores
HIV	human immunodeficiency virus
HKI	Helen Keller International
IFPRI	International Food Policy Research Institute
IYCF	infant and young child feeding
JHU	Johns Hopkins University
LBW	low birth weight
LNS	lipid-based nutrient supplement
LNS-MQ	medium- or moderate-quantity lipid nutrient supplement
LNS-LQ	large-quantity lipid nutrient supplement
LNS-SQ	small-quantity lipid nutrient supplement
MAM	moderate acute malnutrition
MAMI	management of at-risk mothers and infants
MQSUN+	Maximising the Quality of Scaling Up Nutrition Plus
MSF	Médecins Sans Frontières
MUAC	mid-upper arm circumference
PROMIS	Innovative Approaches for the Prevention of Childhood Malnutrition
RCT	randomised controlled trial
RUSF	ready-to-use supplementary food
RUTF	ready-to-use therapeutic food
SAM	severe acute malnutrition
SBC	social and behaviour change
SC	Supercereal [previously Corn-Soya Blend Plus]
SC+	Supercereal Plus [previously Corn-Soya Blend Plus Plus]
SD	standard deviation
SHINE	Sanitation Hygiene Infant Nutrition Efficacy
UC	University of California
UN	United Nations

UNICEF	United Nations Children's Fund
WASH	water, sanitation and hygiene
WaSt	wasting and stunting
WAZ	weight-for-age Z-scores
WFA	weight-for-age
WFP	World Food Programme
WHZ	weight-for-height Z-scores
WLZ	weight-for-length Z-scores
WHO	World Health Organization

Executive Summary

This report presents the findings from a review of published and grey literature produced between 1990 and 2018, as well as consultation with stakeholders (n=46ⁱ) conducted through individual interviews between December 2017 and March 2018, on the current state of evidence and thinking on wasting prevention. The review answers key questions relating to what is known about wasting prevention in terms of the emerging evidence, evidence gaps, evidence expected to be available in coming years and stakeholder views of programmatic approaches and evidence gaps.

Historically, research has primarily focused on stunting prevention, whilst research on wasting prevention has been somewhat neglected, and wasting as a research outcome has rarely been included beyond the realm of emergency contexts. However, this review found that the volume of studies related to wasting prevention through nutrition-specific and nutrition-sensitive intervention areas has meaningfully increased in recent years. On the other hand, this evidence base is mixed and largely inconclusive. The intervention areas with the largest body of work include the use of supplementary food products, cash-based interventions, behaviour change focused on infant and young child feeding (IYCF) and combinations thereof. Studies on non-product interventions (whether nutrition-specific or nutrition-sensitive) remain very limited. Also noteworthy is the lack of research on wasting prevention through interventions targeted towards women and girls pre-conceptionⁱⁱ and during pregnancy. The review included 57 grey literature documents and 235 articles from a literature search, of which 192 were observational or experimental studies, 23 were protocols/ongoing studies and 20 were systematic reviews.

The consulted stakeholders felt confident in stating that acute periods of food insecurity and/or episodes of disease outbreak contribute to wasting and that well-designed early interventions will have a preventive effect in such contexts. Despite an inconsistent evidence base, stakeholders advocated for a holistic approach, based on the United Nations Children's Fund (UNICEF) Conceptual Framework and context-specific causal analysis, including a range of interventions to tackle the immediate and underlying drivers of undernutrition. Respondents felt that this should be complemented by an improved understanding of the epidemiology and aetiology of wasting to better identify and target highest-risk children. The emerging evidence stakeholders frequently mentioned included observations on: the early onset of wasting and differences in wasting patterns in African versus Asian contexts; a predisposition of previously wasted children to further episodes of wasting and to stunting; the risk of wasting in children with infections such as diarrhoea, measles, malaria and HIV; a high mortality risk in concurrently stunted and wasted children; a burden of wasting and associated heightened mortality risk amongst infants under six months of age; and links between child wasting and maternal mental health.

Stakeholder opinion also suggested that much less is known about the prevention of wasting in non-humanitarian contexts or in areas with persistently high levels of wasting. They highlighted key gaps in the understanding of the aetiology of wasting, including kwashiorkor/nutritional oedema; the relationship/overlap between stunting and wasting; differences relating to age and geography; the role of pre-conception interventions; the relationship between maternal nutrition and health status and child nutrition status; the extent to which wasting in infants under six months of age reflects non-nutritional factors (e.g. low birth weight [LBW]); and mechanisms behind relapse after successful treatment of wasting. Other gaps included the role of infection and the gut microbiota and the longer-term health and developmental impacts of childhood wasting. Furthermore, many stakeholders

ⁱ For some organisations, more than one individual was interviewed.

ⁱⁱ Though no studies on family planning interventions were included, as those reviewed did not have wasting included as a specific outcome.

mentioned an absence of one organisation with an overall leadership role for wasting prevention and expressed concern about siloed efforts to address wasting.

This review identified numerous ongoing studies in wasting prevention, some which are seeking funding. Further evidence is anticipated in the coming years relating to aetiology/epidemiology of wasting and the effectiveness of various nutrition-specific and nutrition-sensitive interventions. Stakeholders stressed the importance of longer-term funding to facilitate research encompassing the full 1000 days and more longitudinal studies, including consideration of where existing data can be used (e.g. retrospective cohort studies). The review highlights the need to improve the evidence base on drivers and effective approaches through well-designed programme monitoring and evaluation activities. Several stakeholders supported the idea of a research prioritisation exercise.

Introduction

Through the Maximising the Quality of Scaling Up Nutrition Plus (MQSUN+) project, the UK Department for International Development (DFID) commissioned a multiphase scope of work on ‘*Adopting a Strategic, Evidence-based Approach to Wasting Prevention*’. MQSUN+ contracted the Emergency Nutrition Network (ENN) to conduct this scope of work. This review updates work DFID funded in 2016 (Coffey, 2016) by: 1) bringing in a more comprehensive repertoire of resources, including emerging and framing literature; 2) broadening the topics of interest due to the complex relationships discussed in the 2016 consultation; and 3) including the perspectives of subject-matter experts on where the gaps are and the way forward.

For this multiphase scope of work under MQSUN+, ENN’s initially produced a briefing paper titled ‘The Aetiology of Wasting’ (MQSUN+, 2018). In summary, that paper outlines the complexity of wasting, with its numerous, interdependent and context-specific factors (Box 1).

Box 1. Summary of ‘The Aetiology of Wasting’.

The origins of wasting occur in utero, and early life factors continue to influence a child’s experience of wasting and associated risk of death and/or poor development. Additional work is needed to consider how social/environmental stresses amplify the risk of becoming wasted. The implications of being wasted and/or becoming increasingly more so can be long lasting and include a heightened risk of concurrent stunting, repeated periods of wasting and impacts on body composition and metabolism, including immunosuppression. Seasonal patterns in risk factors play an important role, both prenatally and during childhood. Levels of wasting amongst boys and girls may not be as would be expected. Concurrent wasting and stunting heighten mortality risk, so programmes focused on one or the other need to consider possible interactions. In general, periods of nutritional vulnerability, including pregnancy and the first six months of life, need to be kept from leading to greater risk in both the short- and long-term. This can be done by addressing the drivers of nutrition vulnerability by reaching adolescent girls and women, as well as infants and young children, to prevent weight loss from turning into wasting and wasting into more severe wasting and/or stunting and with a lethal combination of both driving more childhood deaths. The diagram in Annex 1 highlights different points in the life cycle where wasting can occur.

A subsequent step in this scope of work has been to conduct this review, which looks at published and grey literature on the current evidence on what works to prevent wasting, as well as stakeholder opinion on the current state of thinking on wasting prevention. It set out to answer the following questions:

1. What is known about wasting prevention?
2. What is the emerging evidence?
3. What are the evidence gaps and key questions which cannot currently be answered?
4. What new evidence will be available in coming years?

This report is presented in five main sections: the background on wasting globally; the scope and methodology for the literature review and stakeholder consultation; the results of the literature review; the key outcomes of the literature review by intervention area; and the findings from the stakeholder consultations—including identified knowledge gaps and research questions. A concluding section responds to the four questions and a broad overview of the state of evidence in each intervention area assessed according to three criteria: body of evidence, effect found on wasting prevention and stakeholder opinion.

The Gender Equality Act of 2014 requires meaningful, proportional consideration of gender issues in all DFID investments. This report highlights that gender considerations in interventions can help address wasting and notes some important research questions (Annex 2).

The report aims to synthesise the evidence and reflect a range of key stakeholder views, which at times can be contradictory. It does not represent the opinion or perceptions of DFID, MQSUN+, ENN or any other single agency participating in this review.

Background

Only 29 out of 193 countries are on course to achieve the World Health Assembly 2025 target of maintaining levels of wasting below 5.0 percent (Development Initiatives, 2017). There are an estimated 51 million wasted children (weight-for-height of <-2 standard deviations [SDs] of the World Health Organization [WHO] growth standards) in the world at any point in time, representing 7.5 per cent of all children under five years of age (UNICEF, WHO and World Bank Group, 2018). This figure is likely to be significantly higher if corrected for incidence, which is the standard practice in estimating caseloads for treatment programmes. Even when underestimated, these levels are significant and are not confined to countries in humanitarian crisis. In South Asia, for example, where 15.3 per cent of children under five years of age are wasted, this constitutes an ongoing public health emergency per WHO thresholds (UNICEF, WHO and World Bank Group, 2018). These global estimates are also problematic for the estimation of the burden of wasting in infants under six months of age, due to the exclusion of the smallest infants (<45 cm long). In low-and middle-income countries, the burden of wasting in this group is estimated at 8.5 million (Kerac et al., 2011).

Wasting leads to weakened immunity, susceptibility to long-term developmental delays and an increased risk of death, especially in its most severe form or when combined with stunting (height-for-age <-2 SDs of the WHO growth standards) (McDonald et al., 2013). Different estimates find that severely wasted children 6 to 59 months of age are 9 to 12 times more likely to die than their healthy counterparts (Black et al., 2008; Olofin et al., 2013), and when also stunted, they are 12.3 times more likely to die (Khara and Dolan, 2014). On a population level, it has been calculated that wasting is a cause of death for 12.6 per cent of children between one and 59 months of age (Black et al., 2013), though this is an estimate based on prevalence rather than incidence and does not account for concurrent stunting's effect on mortality.

Where previously the global community tended to focus on wasting in relation to mortality risk and in the context of a humanitarian crisis, there is increasing recognition that wasting's occurrence and impact is much broader and longer term. Wasting occurs in both humanitarian and development settings and is often seen alongside high levels of stunting at the population level (Victora, 1992). Wasting treatment has expanded beyond humanitarian emergencies, and services are now integrated into health systems across Africa and some parts of Asia and the Middle East. Coverage of treatment for severe acute malnutrition (SAM), however, is estimated at less than 20 per cent, reaching an estimated 3 million children per year and leaving a significant deficit (UNICEF, 2015). For infants under six months of age, SAM treatment coverage is likely to be even lower, because whilst WHO guidance recommends community-based management for uncomplicated cases, this has not yet translated into practice (Read and McGrath, 2018). An important complementary strategy to reduce the SAM treatment burden and to avoid lifelong consequences is to improve the effectiveness of interventions to prevent relapse and to prevent moderate wasting from becoming severe. Evidence-based strategies to integrate prevention and treatment at scale need to be developed and implemented (Huybregts et al., 2017). Unfortunately, the effectiveness of nutrition-specific and nutrition-sensitive activities to prevent wasting lacks robust evidence, and concerted effort is required to address this gap. To encourage and further efforts on wasting prevention, in

February 2016, DFID and Children’s Investment Fund Foundation convened a group of practitioners and researchers to reflect on and identify priority actions to accelerate understanding on how to prevent wasting. These experts agreed on three key recommendations as the basis for subsequent action: (1) enhance understanding of how and why wasting evolves from conception onwards, including its interactions with other forms of malnutrition and its differences across contexts; (2) effectively measure changes in wasting and other forms of undernutrition; and (3) prioritise key research questions necessary to accelerate wasting prevention.

Subsequently, there have been several signs of engagement, including secondary data analysis, literature reviews and trials to further understanding around wasting prevention. Additionally, the No Wasted Lives initiative (core partners: Action Against Hunger, European Civil Protection and Humanitarian Aid Operations, DFID, Children’s Investment Fund Foundation, United Nations Children’s Fund [UNICEF] and the World Food Programme [WFP]) has emerged to raise attention and investment globally and accelerate technical advancement, including key research and guidance development, on treatment (No Wasted Lives’ primary focus) and prevention of acute malnutrition. The purpose of this review is to take advantage of this increased focus on wasting prevention efforts and provide a progress report to coordinate efforts and investments towards the most promising strategies and to address the most critical gaps.

Methodology

The review team conducted a detailed examination of the evidence relating to wasting prevention—from both published and grey literature and from semi-structured interviews with stakeholders—between December 2017 and February 2018. In order to adequately review this topic, it was important to understand the definition of wasting and how it is considered in nutrition interventions.

Scope and definitions

Wasting is commonly considered an acute condition when compared to other manifestations of undernutrition, as it can be relatively rapid in onset and resolution. As such, the term acute malnutrition (divided into moderate and severe) is commonly used to describe children who are wasted. However, this term also includes children suffering from other relatively rapid-onset forms of undernutrition and kwashiorkor (characterised by nutritional oedema), as well as those with a low mid-upper arm circumference (MUAC), characterised by a loss of muscle and fat tissue (Box 2).

Box 2113. Definitions related to acute malnutrition (in children 0–59 months of age).

Wasted

Moderately or severely wasted: Weight-for-height < -2 SD of the WHO Child Growth Standards median

Severely wasted: Weight-for-height < -3 SD of the WHO Child Growth Standards median

Acute Malnutrition (including moderate and severe)

Weight-for-height < -2 SD of the WHO Child Growth Standards median

MUAC < 125 mm

Nutritional oedema (Kwashiorkor)

Severe Acute Malnutrition

Weight-for-height < -3 SD of the WHO Child Growth Standards median

MUAC < 115 mm (for infants a smaller cut-off has been suggested)

Nutritional oedema (Kwashiorkor)

Abbreviations: MUAC, mid-upper arm circumference; SD, standard deviation; WHO, World Health Organization.

Source: WHO and UNICEF (2009). WHO child growth standards and the identification of severe acute malnutrition in infants and children: A joint statement. Geneva/New York: WHO/UNICEF.

Above all, it is important to note that malnutrition in general, and wasting in particular, is a functional problem (i.e. ‘a lack of uptake or intake of nutrition leading to altered body composition and diminished physical and mental function’ (Cederholm et al., 2015)) for which anthropometric measures are only proxies. For this reason, kwashiorkor and low MUAC are included in this review, although they are outside of the standard WHO definition of ‘wasted’ (WHO and UNICEF, 2009).

The review also includes some consideration of low weight-for-age (WFA) due to the growing evidence of its relationship with mortality in infants and children and because it partly reflects wasting on an individual level (Pelletier, Frongillo and Habicht, 1993; Myatt et al., 2017). In infants under six months of age, WFA (and MUAC) have also been identified as the best measures for targeting those with the highest risk of subsequent mortality (Mwangome et al., 2017).

This review considers primary prevention (prevention of any wasting), secondary prevention (prevention of worsening of wasting, i.e. from moderate to severe) and prevention of relapse to wasting (Box 3). Stakeholders of several organisations and programmes noted these distinctions during the consultation process. The review, therefore, considers what works to prevent moderate wasting, severe wasting and relapse in children who have been treated for wasting, across intervention contexts (humanitarian and development, high and low burden of wasting and/or stunting) and along a ‘continuum’ of severity.

Box 3. Definitions of wasting prevention adopted for this paper.

Primary prevention: Prevention of all wasting / moderate wasting.

Secondary prevention: Prevention of severe wasting (e.g. through supplementary feeding, clinical management).

Relapse prevention: Prevention of any wasting amongst individuals previously treated and recovered.

Prevention strategies reviewed include both nutrition-specific and nutrition-sensitive actions, which are meant to address the immediate and/or underlying causes of malnutrition, as defined in the UNICEF Conceptual Framework (UNICEF, 1998). Those interventions which interact at the level of basic causes of malnutrition (policy, governance, infrastructure, climate, etc.) were beyond the scope of this review.

Database search

The literature search included materials published from 1 January 1990 through 15 January 2018, the same starting point used in the previous DFID-commissioned rapid review of the issue (Coffey, 2016). This is also the most relevant time frame within which to capture activities implemented for wasting prevention, given the state of work on the topic.

The team then applied a Population, Intervention, Comparison, Outcome process to delineate the questions of focus for the review and to define inclusion and exclusion criteria (Annex 3). The search terms used (Annex 4) aimed to explore every aspect of wasting prevention and to ensure a manageable number of search results, without restricting the search to predefined interventions.

Using the defined inclusion search criteria, the team conducted a broad search of the following online databases (with items #8 and #9 replacing the planned Meta-Register of Controlled Trials, which was under construction during the search):

1. PubMed
2. World Bank E library

3. Population Information Online (POP Line)
4. Cochrane Library
5. Google Scholar
6. International Initiative for Impact Evaluation systematic reviews library
7. International Prospective Register of Systematic Reviews
8. The WHO trial search portal for studies worldwide: <http://apps.who.int/trialsearch>
9. The UKCTG for studies recruiting in the UK (data pooled from ISRCTN [International Standard Randomised Controlled Trials Number] and ClinicalTrials.gov): <http://www.ukctg.nihr.ac.uk/default.aspx>

PubMed yielded a large volume of results (n = 9,066), and therefore the authors adopted a country restriction (low- and middle-income country strings), in addition to the full search terms, to obtain a manageable number of pertinent results (Annex 4). For the next few databases (#2, #3, #4 and #5), the country restriction was dropped. In the International Initiative for Impact Evaluation systematic reviews library (#6), the prospective register of systematic reviews (#7) and other registers for controlled trials (#8 and #9), only the criteria 'child nutrition' was used, as these sites contained fewer items, and therefore, a less restrictive search was adopted to allow capture of all potentially relevant studies.

Adding and updating references from the previous DFID rapid review (Coffey, 2016), coupled with citation tracking, were an additional means of identification of relevant studies. The team also purposively selected large, well-known studies and contacted their coordinators to track those studies' sources, as well.

Before commencing the review and citation tracking, the authors rechecked all studies for their adherence to the inclusion criteria. They considered the type of epidemiological research, the absence of serious biases that could compromise the results and the internal and external validity of these studies to classify the evidence available in each area from weak to strong. From this final stage of the process, they excluded studies which dealt only with stunting or obesity. Furthermore, where necessary, relevant articles that did not yield from the search were added. This review report bases its results and conclusions on all these documents.

Grey literature review

The review of grey literature included materials and research produced by relevant organisations outside of the traditional commercial or academic publishing and distribution channels and included agency evaluation / impact assessment reports, such as before-and-after surveys, case studies or programme reports; dissemination materials; posters and videos; presentations; newspaper articles; organisational strategies and policies; protocols; and information from international meetings.

In addition, the authors launched an appeal on the ENN online forum in January 2018, requesting field and headquarter implementers to contribute relevant materials.

Stakeholder consultations

The authors generated an initial list of relevant stakeholders from existing contact lists of those involved in treatment or prevention of undernutrition (e.g. from ENN ongoing technical groups working on wasting and stunting [WaSt] and on the management of at-risk mothers and infants, conference attendance lists, etc.) and gradually updated and broadened this using a snowball approach to identify further stakeholders. Stakeholders from United Nations (UN) agencies, donors,

the private sector, nongovernmental organisations, academic institutions and think tanks, as well as several regional representatives of UNICEF and WFP and government representatives, were included in the consultations.

An outline of questions was sent to participants in advance of the calls to give them time to prepare for the interview (Annex 5). Structured around the four review questions, discussions provided up-to-date information, expert knowledge, experience and opinion related to approaches to wasting prevention.

Limitations

It is important to note that this is not a systematic literature review and did not include a detailed appraisal of study quality, summary measure, publication bias (towards positive rather than no-effect results) or selective reporting. Primarily, one person screened the articles in the literature review. Although citation tracking brought up older references (as more frequently cited over time versus newer references), this was counterbalanced by recommendations from stakeholders with regards to more recent relevant publications.

Results

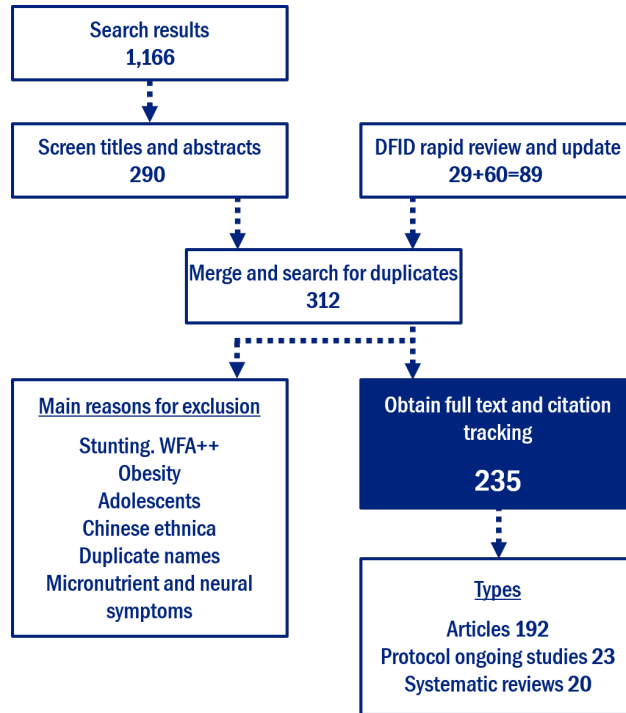
Overall figures

A total of **292 documents were included in this review**. Figure 1 highlights that, after initial screening and removal of duplicates, the team obtained 312 results from the database search. The authors rechecked all these studies for their adherence to the inclusion criteria and thus excluded 77 studies which dealt only with stunting or obesity. In the end, **235 studies** remained as meeting all methodological criteria. Where necessary, relevant articles that did not yield from the search were added. In addition to this, field and headquarters implementers contributed an additional **57 grey literature documents**.

In total, stakeholders provided **46 interviews** over Skype or telephone for the consultation. Annex 6 provides a full list of organisations consulted.ⁱⁱⁱ In the interviews, they outlined the existing knowledge base on the topic, as well as key gaps and research priorities. In addition, participants shared information about ongoing and planned research.

ⁱⁱⁱ The overall response rate was 78.0%: of 59 agencies contacted, 13 (22.0%) did not respond. Five agencies (8.5%) responded that they were either not available or did not feel they had expertise to contribute in this area.

Figure 1. Review of published literature search process.

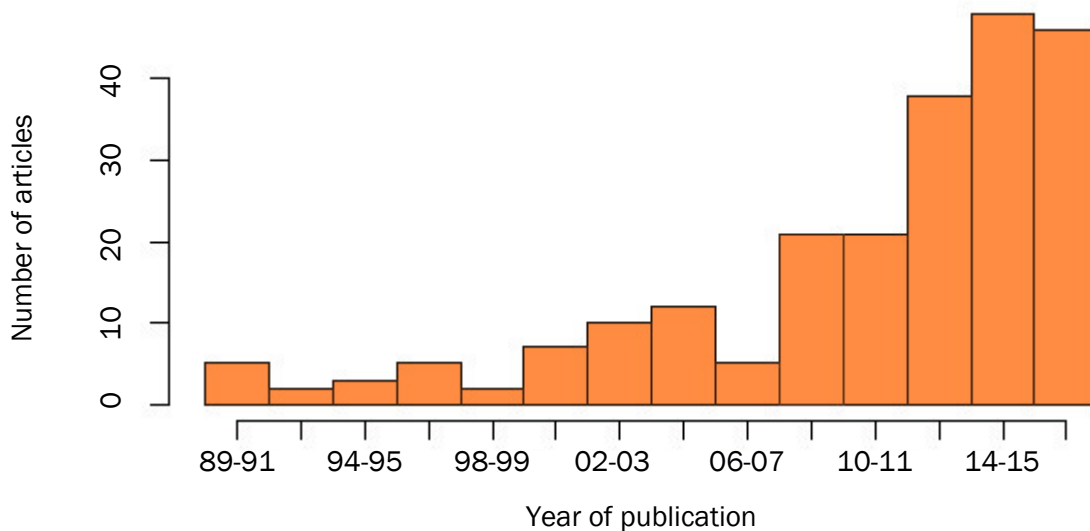


Abbreviations: DFID, Department of International Development; WFA, weight-for-age.

Trends from the database search and grey literature

The results from the database search show that published literature which deals with wasting prevention was scarce in the 1990s; but, encouragingly, this has steadily increased over the last decade. Figure 2 shows this information (presented biennially to avoid extreme values).

Figure 2. Journal articles found in the search by year of publication.



Whilst the literature review considered materials in English, French, Portuguese and Spanish, almost all materials found (except for 7) were available in English. The most common publications containing articles related to wasting prevention were as follows, in order of magnitude: The Journal of Nutrition, BMC Public Health, the Food and Nutrition Bulletin, The Lancet, PLOS ONE and the American Journal of Clinical Nutrition. Most articles were accessible via PubMed (World Bank had a small number of original articles on water, sanitation and hygiene [WASH]), and full texts were often available to readers for free (only 17 required alternative means of access).

During this analysis, the team identified 10 published studies or reviews that would be particularly useful to policymakers or practitioners for consideration in designing and implementing wasting prevention programmes (Table 1). These are well-recognised papers which stakeholders often cite, covering a wide range of interventions and/or summarising key findings in the debate.

Table 1. Top ten articles on wasting prevention.

Authors	Title	Journal	Year
Bhutta et al.	What works? Interventions for Maternal and Child Undernutrition and Survival	The Lancet	2008
Dewey et al.	Systematic Review of the Efficacy and Effectiveness of Complementary Feeding Interventions in Developing Countries	Maternal & Child Nutrition	2008
Hendricks K	Ready-to-Use Therapeutic Food for Prevention of Childhood Undernutrition	Nutrition Reviews	2010
Houngbe et al.	Unconditional Cash Transfers Do Not Prevent Children’s Undernutrition in the Moderate Acute Malnutrition Out (MAM’Out) Cluster-Randomized Controlled Trial in Rural Burkina Faso	The Journal of Nutrition	2017
Humphrey et al.	The Sanitation Hygiene Infant Nutrition Efficacy (SHINE) Trial: Rationale, Design and Methods	Clinical Infectious Diseases	2015
Huybregts et al.	The Impact of Integrated Prevention and Treatment on Child Malnutrition and Health: The PROMIS Project, a Randomised Control Trial in Burkina Faso and Mali	BMC Public Health	2017
Kennedy et al.	Setting the Scene: An Overview of Issues Related to Policies and Programs for Moderate and Severe Acute Malnutrition	Food and Nutrition Bulletin	2015
Majamanda et al.	The Effectiveness of Community-Based Nutrition Education on the Nutrition Status of Under-Five Children in Developing Countries: A Systematic Review	Malawi Medical Journal	2014
Nabwera et al.	The Influence of Maternal Psychosocial Circumstances and Physical Environment on the Risk of Severe Wasting in Rural Gambian Infants: A Mixed Methods Approach	BMC Public Health	2018
Taylor-Robinson et al.	Deworming Drugs for Soil-Transmitted Intestinal Worms in Children: Effects on Nutritional Indicators, Haemoglobin and School Performance	The Cochrane Database of Systematic Reviews	2015

Abbreviation: PROMIS, *Innovative Approaches for the Prevention of Childhood Malnutrition*.

Table 2 presents a summary of the published and grey literature articles by intervention area. Resulting studies that explored multiple risk factors for wasting were not included, as they did not pertain to a specific intervention area. Some intervention areas receive more attention than do others (e.g. food supplementation, health, cash transfer [CT] and WASH). Clinical trials and systematic reviews are needed in some areas. The review found a total lack of research on wasting prevention through pre-conception and pregnancy interventions targeted towards women and girls.^{iv}

^{iv} No family planning interventions are included here as, on review, none was found to have wasting included as a specific outcome.

Table 2. Number of studies/reports identified in each area of intervention.

Intervention area \ # documents per category	Systematic reviews	RCT/CRCT	Cohort and case control studies	Other studies	Unpublished agency reports and grey lit	Total
Food supplementation	3	13	7	10	5	38
Health	2	4	5	12	3	26
WASH	3	5	2	10	5	25
Cash transfers	1	10	3	5	5	24
Nutrition counselling	4	6	3	5	3	21
Agriculture	1	2	3	8	5	19
Breastfeeding	1	2	2	7	6	18
Micronutrient supplementation (0-5)	7	5	2	2	0	16
Women's education and empowerment	0	1	0	11	4	16
Complementary feeding	5	1	0	2	3	11
Other livelihoods / income generation	0	1	1	4	5	11
Deworming	3	2	0	2	1	8
General food distributions	1	1	0	2	1	5
SBC during pregnancy	0	1	0	0	0	1
Other interventions during pregnancy	0	0	0	0	0	0
Interventions preconception	0	0	0	0	0	0
Combination	0	1	2	5	6	14

Abbreviations: SBC, social and behaviour change; CRCT, cluster-randomised controlled trial; RCT, randomised controlled trial; WASH, water, sanitation and hygiene.

In addition to published evidence on interventions that prevent wasting, a wide range of these documents also considered risk factors for wasting, many of which are now well established. Low birth weight (LBW), small for gestational age and preterm births are associated with a twofold increased risk of developing wasting (Christian et al., 2013). Maternal age under 25 years and poverty are also associated with wasting (Pravana et al., 2017), as are poor access to health services, lack of mutual decision making between parents on the care or treatment of children, closer birth intervals and inadequate breastfeeding practices (Egata, Berhane and Worku, 2014). Residence in rural areas and food shared with family members are also associated (Seid, Seyoum and Mesfin, 2017). It is clear that the factors that predispose a child to undernutrition are multifaceted, context-specific and interactive, as literature reviews have shown (Akombi et al., 2017). Despite what is known about the origin of wasting in utero, studying the potential impact of interventions in adolescence, pre-conception and/or pregnancy have not been prioritised—with the exception perhaps of looking at women’s empowerment and education.

Key Findings from the Literature Review

This section presents the key findings from the review of published and grey literature, organised by intervention type, starting with nutrition-specific interventions and followed by nutrition-sensitive interventions. Interventions relating to food assistance (general ration, nutritional supplements and cash) are considered at the end of the section.

Breastfeeding promotion and support

Ideal infant and young child feeding (IYCF) practices include exclusive breastfeeding for the first six months of life and continued breastfeeding up to two years of age or beyond, coupled with the introduction of complementary foods starting from six months of age. The association of IYCF practices with wasting has been reported many times (Mishra *et al.*, 2014; Aheto *et al.*, 2015; Asfaw *et al.*, 2015; Abdurahman *et al.*, 2016), and the association of breastfeeding with prevention of morbidity and mortality is well documented. Breastfeeding and diarrhoea have been associated with, respectively, decreasing or increasing wasting (Fekadu *et al.*, 2015), and breastfeeding has been similarly negatively associated with stunting (Castillo *et al.*, 1996; Fekadu *et al.*, 2015). Appropriate IYCF practices have also been associated with increased gain in weight and length during infancy (Saha *et al.*, 2008), though evidence is sometimes weak. A case-control study in Brazil showed that infants who were not breastfed had a 25-times greater risk of dying of diarrhoea than those who are exclusively breastfed, and mortality due to other common infections was also consistently higher in children who were not exclusively breastfed (Huffman and Combest, 1990). Indeed, it is often quoted from the Lancet series that 10 per cent of the wasting burden is attributable to suboptimal breastfeeding practices, in particular lack of exclusive breastfeeding between birth and six months of age (Bhutta *et al.*, 2008). However, one systematic review and meta-analysis found that promoting breastfeeding, alone or in combination with other strategies, may be associated with a small but significant decrease in weight-for-height Z-scores (WHZ) in children in low- and high-income countries, but no effect was found in middle-income countries (Giugliani *et al.*, 2015). One of the studies highlighted in the literature review found that when the effects of promoting exclusive breastfeeding were explored with a set of randomised controlled trials (RCTs), though applying different approaches, differences in wasting were small, and results were not particularly promising (Engebretsen *et al.*, 2014). The evidence is seen as inconclusive.

A case-control study in Burkina Faso, which controlled for various potentially confounding variables, showed that prolonged breastfeeding, along with consumption of complementary foods, was associated with a 70 per cent reduction in the rate of clinical malnutrition (defined as severe wasting and/or presence of oedema) (Cousens *et al.*, 1993). When considering SAM specifically, breastfeeding practices are often referred to as an important risk factor based on association studies (Ambadekar and Zodpey, 2017). Thus, nutritional education and breastfeeding counselling is recommended when programmes aim to address wasting, but clear evidence of impact does not appear to be available. Innovative approaches in Vietnam—using social franchising (applying commercial franchising concepts so that a brand identity is equated with quality services) to improve the quality of interpersonal counselling for IYCF within the government health system—significantly improved feeding practices but not child growth (Rawat *et al.*, 2017).

Despite consensus on the important role of breastfeeding as a protective factor, there is very little evidence of the impact of interventions promoting exclusive and continued breastfeeding on the prevention of wasting. The results presented here are either modest or difficult to attribute to breastfeeding promotion alone.

Complementary foods

Complementary foods include foods/liquids provided to infants and young children along with breast milk, when breast milk alone is no longer sufficient to meet the nutritional requirements (i.e. from six months of age onwards). Children under two years of age have high nutrient needs and small

consumption capacity, and thus, complementary foods, when introduced, need to be nutrient dense, available in adequate amounts and hygienically prepared. Complementary feeding interventions were shown to have a small but significant impact on weight gain (especially where food is provided) in several of the reviewed studies (Dewey and Adu-Afarwuah, 2008; Imdad, Yakoob and Bhutta, 2011; Krebs et al., 2011; Kristjansson et al., 2015; Panjwani and Heidkamp, 2017), but wasting outcomes were less often proven. The provision of appropriate complementary food, with or without nutrition education, has been found to lead to a significant increase in weight (and height) in children from 6 to 24 months of age in several countries (Imdad, Yakoob and Bhutta, 2011). Similarly, systematic reviews have also concluded that complementary feeding interventions, with or without an education component, can have a small but significant impact on length-for-age Z-score (i.e. HAZ but for children under age 2) and weight-for-length Z-score (WLZ), particularly in food-insecure contexts, but that nutrition education alone might only impact the former (Panjwani and Heidkamp, 2017). Some authors, therefore, argue that complementary feeding interventions can prevent wasting, whereas other authors found no evidence of an effect on mean WHZ (Kristjansson et al., 2015). Conversely, the particular practice of meat consumption, especially during the complementary feeding period, has been associated with reduction in both wasting and stunting (Krebs et al., 2011).

Some of the included systematic literature reviews were undertaken in part to inform the Lives Saved Tool. The earliest completed review recommended including the Lives Saved Tool complementary feeding interventions for their benefits in relation to weight and height (Imdad, Yakoob and Bhutta, 2011). Another review from five years later recommended including them also in terms of their impact on WaSt (Panjwani and Heidkamp, 2017). Another systematic review on the efficacy and effectiveness of complementary feeding interventions highlights that the most effective interventions include well-designed nutrition education and counselling, optimal use of locally available foods, provision of fortified foods and use of micronutrient supplements (Dewey and Adu-Afarwuah, 2008).

There is evidence of small but significant impact of complementary feeding interventions with a food component on weight gain and WLZ, particularly in food-insecure contexts. The potential benefits for wasting prevention have been highlighted, but there is mixed evidence thus far of impact on wasting outcomes.

Micronutrient supplementation

Micronutrient supplementation programmes provide specific micronutrients that are not sufficiently available as part of the regular diet in a given context or population group, including children under five years of age and pregnant and/or lactating women. Some of them may be useful in addressing morbidities that may be associated with child growth indicators. Many studies and literature reviews in the micronutrient supplementation domain reported reductions in mortality, diarrhoea, pneumonia, LBW, anaemia and other morbidities (Patel et al., 2010; Sazawal et al., 2010; Haider, Yakoob and Bhutta, 2011; Yakoob et al., 2011; Bhutta et al., 2013; De-Regil et al., 2013; Hess et al., 2015; Smith et al., 2017), and some of them considered and showed positive impact on wasting, weight gain, arm circumference, stunting and/or linear growth (West et al., 1997; Ramakrishnan et al., 2009; Chhagan et al., 2010; Sazawal et al., 2010; Bhutta et al., 2013; Hess et al., 2015).

According to a meta-analysis of studies in different countries, preventive zinc supplementation has shown a significant positive effect on diarrhoea incidence and pneumonia morbidity (Yakoob et al., 2011) and duration of bouts of diarrhoea (Patel et al., 2010). Some evidence is available for small

effects of micronutrient supplementation on wasting (with zinc) or linear growth (with multiple micronutrients) from a meta-analysis of single and multiple micronutrient interventions (Ramakrishnan, Nguyen and Martorell, 2009). According to an RCT, daily multiple micronutrient supplementation, including vitamin A and zinc, may have ameliorated recurrent diarrhoea's impact on stunting and was beneficial in improving linear growth amongst stunted children (Chhagan et al., 2010). Another RCT showed that micronutrient-fortified milk also improved linear growth and iron status and reduced anaemia but not wasting (Sazawal et al., 2010). An RCT on children who received high-dose vitamin A capsules demonstrated that arm circumference and muscle area growth improved, and those who were severely deficient in vitamin A may benefit in terms of linear growth, weight, muscle and fat (West et al., 1997). It is noteworthy that many studies did not separate populations by level of micronutrient deficiency, which may well influence the ability to discern effects. A number of important reviews are still ongoing (Wazny, Keats and Huynh, 2013).

High-quality systematic reviews and clinical trials have examined the relationship between micronutrient supplementation and prevention of wasting, especially in terms of prevention of morbidities which may contribute to wasting. A small effect on wasting or linear growth has been observed when using preventative zinc supplements or multiple micronutrient supplements or fortified foods.

Nutrition counselling and nutrition education

Nutrition counselling refers to individual sessions with the caretaker to identify and negotiate how to address specific issues, whilst nutrition education activities usually target larger groups with broader messages using a range of different media. These interventions are important because they can help encourage key practices like exclusive breastfeeding, which can then prevent morbidities like diarrhoea (Aidam et al., 2005; Anderson et al., 2005; Leite et al., 2005), ultimately reducing wasting in children (Roy et al., 2007). A positive deviance approach to identifying key growth-promoting behaviours through participatory education was found to reduce child wasting in Vietnam (WHZ) (Mackintosh, Marsh and Schroeder, 2002). A systematic review on education for improved complementary feeding alone observed significantly improved height-for-age Z-scores (HAZ) and weight-for-age Z-scores (WAZ), as well as significantly reduced rates of stunting, but no significant impact was observed for WHZ (Lassi et al., 2013). A couple of studies looking at the outcomes of community-based nutrition education interventions or programmes have shown that education contributed to improved weight gain and WHZ scores in children under five years of age, particularly in urban areas (Walsh, Dannhauser and Joubert, 2002; Penny et al., 2005). Nutrition education improved mothers' ability to feed their children appropriately and practice proper hygiene, which was reflected in significant weight gain in a study in China (Guldan et al., 2000).

Providing group meetings for caregivers and community leaders, education twice a week and cooking demonstrations produced significant findings (Majamanda et al., 2014). Knowledge on key issues were associated with decreases in both wasting and stunting in Uganda (Mukunya et al., 2014). Nutrition counselling provided to mothers of children with moderate acute malnutrition (MAM) to improve the use of household foods has been used successfully by UN agencies and implementers (Ashworth and Ferguson, 2009). A 20-hour training of doctors in nutrition counselling in Brazil improved weight gain amongst children 12 months of age or older (Santos et al., 2001). One randomised trial highlighted that nutrition education may reverse decline in linear growth (Vazir et al., 2013), whilst another stated that nutrition education alone cannot do so (Bhandari et al., 2001).

In Bangladesh, addressing nutrition during pregnancy—by delivering interpersonal counselling, initiating community mobilisation, providing free supplements and ensuring weight-gain monitoring—improved maternal dietary diversity, micronutrient supplement consumption and breastfeeding practices but did not reduce wasting (Nguyen et al., 2017).

There is evidence of an association between nutrition education and wasting reduction, as well as nutrition counselling and wasting reduction. However, a couple of trials in this intervention area did not show significant positive effects. It is anticipated that an increasing number of studies will account for wasting outcomes.

Mother's education and gender equity

This intervention area includes maternal education, maternal literacy and interventions which aim to improve women's financial autonomy and participation in household decision making. Mothers with low literacy levels were less likely to adopt positive complementary feeding practices; mothers with some formal education had children less likely to be stunted or underweight (Ickes, Hurst and Flax, 2015). Maternal education was strongly inversely associated with LBW and stunting (Miller and Rodgers, 2009), and maternal education was associated with lower stunting and underweight (Lakshman et al., 2013). Maternal illiteracy and low levels of maternal and parental education are often described as significant risk factors for undernutrition, including, in some cases, wasting (Mishra et al., 2014; Aheto et al., 2015; Chowdhury et al., 2016; Frozanfar et al., 2016; Man and Guo, 2016; Valente et al., 2016; Seid, Seyoum and Mesfin, 2017), but the evidence is not always clear. However, recent studies have begun looking at larger issues related to empowerment, and some results indicate that mothers with higher financial autonomy and higher levels of participation in household decision making were more likely to breastfeed and had infants that were less underweight and less wasted (Shroff et al., 2011).

Women's empowerment and the promotion of education could have a positive impact on infant feeding and child nutrition—including the potential to reduce wasting—as there is emerging evidence from association studies and programme evaluations.

Health services

Nutrition is a critical element of health, and health approaches to nutrition include a wide range of interventions, from treatment (e.g. of SAM) and prevention (e.g. vaccination) of specific diseases, to access to key health services (e.g. family planning), to maternal mental health. Absence of deworming, incomplete immunisation, lack of family planning, insufficient antenatal visits and delivery outside of a hospital have been associated with wasting (Aheto et al., 2015; Asfaw et al., 2015; Ickes, Hurst and Flax, 2015; Tette, Sifah and Nartey, 2015; Altare, Delbiso and Guha-Sapir, 2016; Chowdhury et al., 2016; Valente et al., 2016; Betebo et al., 2017). According to a 2013 RCT, access to community health is deemed a feasible strategy for improving wasting since it can improve breastfeeding practices, enhance family planning and reduce vertical transmission of HIV, amongst other infections (Le Roux et al., 2013).

One of the included literature reviews addresses several of the above-mentioned health services, as well as others. For example, deworming is the administration of drugs to rid humans of helminths, such as roundworm, flukes and tapeworm. Inflammation and anorexia (the latter of which can decrease intake of all nutrients) are important mechanisms by which these parasites inhibit growth and development (Stephenson, Latham and Ottesen, 2000). There is some evidence that deworming can significantly reduce wasting (Stoltzfus et al., 2004; Hall et al., 2008; McGuire, 2012; Asfaw et al., 2015; Tette, Sifah and Nartey, 2015; Frozanfar et al., 2016). Yet some studies and literature reviews have been inconclusive or found limited evidence of effect. For example, one systematic review concluded that there was no evidence for a direct effect of mass deworming on weight gain (Taylor-Robinson et al., 2015), and a more recent one found that mass deworming for soil-transmitted helminths had little effect on weight gain and for schistosomiasis showed some effect in weight gain (Welch et al., 2017). Both recommended looking at whether deworming a subset of children may make more sense. There is limited evidence that helminth acquisition may occur before six months of age, but whether this has any aetiological impact on malnutrition in this age group has not been investigated, and there is no evidence to support deworming infants of this age.

Infections are often identified as a key risk factor for malnutrition (Patwari, 1999). Though vaccination status is associated with wasting (Quelin et al., 1991; Altare, Delbiso and Guha-Sapir, 2016), there is little evidence of a direct link between vaccination campaigns and wasting except studies that link measles and wasting with mortality (Grais et al., 2011). With regards to malaria interventions, WAZ and MUAC measures were significantly higher amongst infants who used insecticide-treated bed nets (Snow et al., 1997). Paediatric care—including malaria prevention, vaccination, growth monitoring and nutrition support—has been shown to prevent wasting in Médecins Sans Frontières (MSF) pilot projects in Mali (Myrto Schäfer et al., 2014).

Family planning can influence the nutritional status of women and children through increasing birth intervals and preventing unintended pregnancy. Evidence on family planning is limited, but studies have shown a higher risk of child malnutrition where mothers had several children or had children born within 24 months of each other. The contraceptive prevalence rate at the national level in selected South Asian countries was negatively associated with women's anaemia and child underweight and stunting (Rana and Goli, 2017). Some studies show the potential importance of longer birth intervals in reducing malnutrition (Mozumder et al., 2000), but specific impact studies on wasting are not available.

Addressing maternal mental health may be an important strategy to preventing wasting, as it could improve caregiving and health-seeking behaviour (Makoka, 2013; Ruel and Alderman, 2013; Panter-Brick, Grimon and Eggerman, 2014). This is especially relevant for breastfed infants under six months of age whose nutrition and associated care is primarily dependent on the mother. Maternal depression has also been associated with child malnutrition, including wasting (Ashaba et al., 2015). However, a RCT in Cape Town demonstrated that home visits by community health workers to support mothers suffering from antenatal depression improved height gain but not weight gain (Tomlinson et al., 2015). A study of growth faltering over four decades in The Gambia suggests that interventions promoting maternal resilience—through gender empowerment, prioritising psychosocial support and encouraging the involvement of fathers in child care—could be important, regardless of the article's noting no association with severe wasting (Nabwera et al., 2018).

There are few clear studies which look at the relationship between health interventions and prevention of wasting, making it difficult to ascertain the specific contributions. For example, treating children known to have helminth infection may have nutritional benefits for the individual, but mass campaigns have limited evidence in terms of preventing wasting. This is partly due to ethical reasons (e.g. vaccination coverage), the difficulties involved in examining long-term impact (e.g. family planning), having wasting included only as a secondary outcome or the existence of confounding factors (e.g. mental health). Despite the important perceived role of health sector interventions in preventing wasting, only a few well-designed studies found a small impact on wasting reduction.

Water, sanitation and hygiene

WASH interventions include those which aim to improve access to safe drinking water (e.g. management of water from the source to tap and household water treatment and safe storage) and access to improved sanitation facilities and hygiene practices (e.g. promoting hand washing with soap at critical times, such as after toilet use and before the preparation of food). Water and sanitation conditions and hygiene practices have long been considered key drivers of wasting and other forms of undernutrition. Some studies suggested pathways from WASH to acute malnutrition (Black et al., 2008; Humphrey, 2009; Fink et al., 2014; Humphrey et al., 2015; Frozanfar et al., 2016), though some use diarrhoea as proxy for poor water and sanitation and others used WASH indicators as part of a larger socioeconomic status measure (Altare, Delbiso and Guha-Sapir, 2016; Chowdhury et al., 2016; Frozanfar et al., 2016). However, there is no conclusive evidence to date that shows that the integration of water, sanitation and handwashing with nutrition has an impact on the prevalence of wasting (Arnold et al., 2013; Humphrey et al., 2015; Luby et al., 2018). A number of WASH studies observed reductions in diarrhoea but no impact on either wasting or stunting (Curtis and Cairncross, 2003; Ejemot et al., 2008; Ngure et al., 2013; Briceno, Coville and Martinez, 2015).

A more recent study found that hygiene practices and livestock water management were correlated with wasting in Chad. It suggests that the pathogen *Cryptosporidium*—which may be involved in wasting by causing inflammation in the intestine—may be mitigated by good hygienic practices. Infrequent cleaning of the container used for carrying household water was, for instance, significantly associated with acute malnutrition even when using models controlling for relevant confounders (Marshak et al., 2017). An RCT by the Alliance For International Medical Action is evaluating treatment of *Cryptosporidium*-related diarrhoea and deterioration of nutritional status as measured by MUAC (Ruiz, 2017).

Some evidence from studies that focused on stunting suggests that modifying hygiene behaviours through community-based interventions to reduce diarrhoea results in improved child growth (Ahmed et al., 1993; Relman, 2013). Similarly, an impact evaluation by Díaz and Andrade (2015) reported on findings that suggest introduction of latrines reduce the likelihood of stunting (Fink, Gunther and Hill, 2011; Díaz and Andrade, 2015). An analysis of risks to burden of disease listed lack of access to improved sanitation facilities as a major contributor as it leads to contaminated drinking water, leaving individuals vulnerable to infections and diseases—including diarrhoea, repeated periods of acute malnutrition and mortality (Ezzati et al., 2002). Despite lack of strong and significant association results, many studies conclude that efforts to prevent wasting should include improving access to water sources and sanitation (Dorion et al., 2012; Blanc D, 2016).

Many studies endeavour to demonstrate impact, but there is currently little significant evidence as to the direct effect of improved WASH action on the prevention of wasting. Nevertheless, studies continue to conclude that improvement in WASH should remain an integral component of wasting prevention efforts.

Agriculture and livelihoods

There are several pathways through which agriculture can have a preventive impact on wasting—such as increasing food availability, including the availability of diverse foods, and increasing access, including through addressing market prices and empowering women. Agriculture can impact nutrition through increased food production if that, in turn, leads to increased access to quality diets or resources that are used to benefit nutritional status for women and children (Hoddinott, 2011). Identification of these elements are the subject of several research initiatives—in particular, exploring gender- and nutrition-sensitive approaches to agricultural interventions which consider agricultural products, control over resources, time burden and child care considerations. The subsector has been prolific, and yet there is little documented evidence of its having a positive effect on child nutrition. More rigorous and well-designed studies examining wasting outcomes are needed, as is the establishment of agreed-upon standards to guide researchers in this important area (Masset et al., 2012). Women's empowerment in agriculture was significantly associated with HAZ but not WLZ (Cunningham et al., 2015). Household food insecurity is a well-recognised, underlying determinant of child undernutrition. In Bangladesh, household food insecurity was associated with wasting, but generally the evidence is mixed (Ali et al., 2013).

Aquaculture (farming of fish, seafood, aquatic plants, etc.) interventions, to date, have not shown that increased production and intake are significantly associated with improved nutritional status (Aiga et al., 2009; Talukder, Hou and Green, 2014). An intervention coupling poultry as a small business for egg production saw children's egg consumption and, in turn, WHZ and body mass index (BMI) improve (Marquis et al., 2017). Income generation has resulted in a significant increase in nutrition outcomes, particularly in WAZ (Miller et al., 2014). The largest volume of studies in this intervention area related to home gardening projects, which have the potential to increase children's nutrient intake. However, only a few studies documented an association with stunting, underweight and/or wasting (English et al., 1997; Berti, Krusevec and Fitzgerald, 2004). One study that found modest effects on wasting was of insufficient quality, either lacking information on potential confounding variables or not providing a true control group for comparison (Schipani et al., 2002). One RCT in Burkina Faso, which included nutrition and health social behaviour change, found a number of positive impacts of home gardens on agricultural production and health knowledge, as well as a positive impact on haemoglobin concentration, but only a marginally significant impact on the decrease in wasting (Dillon et al., 2014; Olney et al., 2015).

A few ongoing studies with pending results were also identified, including an RCT to investigate the effect of agricultural projects for women's groups on wasting (Gabrysch and FAARM Team, 2018) and a study by the UN's Food and Agriculture Organization on the prevention of food losses and waste (Food and Agriculture Organization, 2011).

Important elements include not only agricultural production support but also other interventions to support livelihoods. Microcredit and nutrition education may decrease stunting, underweight and BMI-for-age, according to an association study in Ghana (Marquis et al., 2015). Additionally, an evaluation in Sri Lanka, which included credit for agricultural inputs, crop insurance and improved cultivation and water management practices, appeared to show a decrease in underweight, but a clear effect on wasting could not be proven (Holmboe-Ottesen, Wandel and Oshaug, 1989). In

Indonesia, a higher proportion of household expenditure on soybeans and a lower proportion of household expenditure on sugar and cooking oil were associated with lower odds of high wasting and high underweight, as decreasing expenditure on sugar and cooking oil enabled increased consumption of more nutritious foods (Mauludyani, Fahmida and Santika, 2014). From a cross-sectional survey, there is some evidence of improved nutritional status (HAZ and WAZ) in dairy farming households' children, though it may have been due to other employment opportunities (Hoorweg, Leegwater and Veerman, 2000). Other similar studies did not show an effect for wasting (Kassa et al., 2003). It bears considering that WHZ improvements might not be due to livelihoods or income and instead be associated more with meat consumption (Rawlins et al., 2014). Robust evidence relating to the impact of livelihood interventions on wasting is lacking to date.

Although pathways are identified by which agricultural production and other livelihood activities can have an impact on preventing wasting, only limited effects have been observed. A small body of evidence is starting to emerge on the positive association between these interventions, such as homestead gardening, and nutritional impact. However, there is a general scarcity of studies measuring wasting outcomes related to these interventions. This suggests that more needs to be done to adequately design, monitor and evaluate interventions to enable documentation of any links between improved agricultural production and/or income with child nutritional status.

Cash transfers

Potential pathways to improved nutritional status through cash transfers (CTs) include, amongst others, promoting health service access (Bliss et al., 2016) and increasing access to quality diets. In Burkina Faso, unconditional, seasonal CTs were shown to increase intake of nutrient-dense food in children 14 to 27 months of age, and families used them to improve food security and health needs (Tonguet-Papucci et al., 2017). Conditional CTs (where recipients need to meet certain criteria, such as attending health promotion sessions, to receive the CT) accomplish similar impacts to those of unconditional CTs (Manley, Gitter and Slavchevska, 2013).

In terms of nutritional impact, studies on the effects of CTs have shown nutritional impact in some cases. Cash payments appear to have an effect on nutritional status and may contribute to the reduction in the prevalence of stunting, underweight and wasting (Renzaho et al., 2017). A widespread CT intervention, the Bolsa Familia Programme in Brazil, found positive effects on mortality rates for malnutrition and diarrhoea and a significantly reduced probability of undernutrition and stunting amongst those who received the CT (Paes-Sousa, Santos and Miazaki, 2011; Rasella et al., 2013). Some studies have also shown a significant reduction in the prevalence of severe wasting (Gilligan et al., 2013) and WHZ and MUAC scores (Fenn et al., 2015). These results are consistent with those of a conditional CT intervention in Mexico, which showed strong associations not only with stunting but also with underweight and a lower BMI-for-age percentile (Fernald, Gertler and Neufeld, 2008). In a study in Pakistan, larger CTs were associated with a significantly lower odds of wasting (Fenn et al., 2017).

On the other hand, there are some studies showing no impact or having mixed results (Merttens et al., 2013; Tonguet-Papucci et al., 2015; Hougbe et al., 2017). Their relative benefits compared to or in combination with food rations are also interesting to consider. For example, CTs accompanied by a ration for children 6 to 23 months of age and pregnant or lactating women were also associated with linear growth in infants (Leroy et al., 2008). However, CTs were effective in preventing wasting but were not as effective compared to large food rations (Pega et al., 2015).

Cash-for-work also has been shown to increase WHZ, MUAC and WAZ (Mascie-Taylor et al., 2010; Nair et al., 2013), though some studies are of low quality.

There is emerging evidence from intervention trials that CTs may in some contexts produce a small but significant effect on wasting. However, due to the variety of CT intervention and study designs and the ways these can impact wasting, there is a need for further and systematic review or meta-analysis to summarise the mixed results that have stemmed from these variations in design and quality of study.

General food distribution and food-for-work

Two studies found that children in households receiving food aid had a lower prevalence of wasting following disasters (Quisumbing, 2003; Hossain, Maggio and Sullivan, 2009). Using quality protein maize in a general food ration has shown weak to moderate evidence of an effect on WHZ (Akalu et al., 2010), though this could be due to many factors. Food-for-work (where participants are provided with rations in return for work on projects to improve community infrastructure) has been shown to have a positive direct impact on WHZ for children from birth to five years of age in low-asset households (Quisumbing, 2003).

Despite several studies which have shown an impact on wasting, it is very difficult to attribute this to a general food aid distribution or food-for-work intervention alone. For example, where this intervention is conducted during or immediately following an emergency, improvements in nutritional status could also be attributed to context stabilisation and the combined effect of a range of emergency response interventions implemented in many sectors.

Supplementation with specialised foods

The provision of specialised food products to supplement the diet of target populations is a common wasting prevention strategy. Though a 2012 Cochrane review found a negligible impact on child growth of supplementary feeding interventions (with products largely in the range of 250 to 500 kcal, some higher, some lower), it acknowledged that the studies were quite heterogenic, and so it was a challenge to draw conclusions (Sguassero et al., 2012). The results below consider findings from different product types and give a sense of the richness of available evidence.

Lipid-based nutrient supplements and fortified blended foods

There is evidence that lipid-based nutrient supplements (LNS) can have an impact on incidence and prevalence of wasting. This is particularly the case for ready-to-use therapeutic food (RUTF)—also known as LNS of large quantity (LNS-LQ)—which usually ranges from 500 to 1500 kcal and is often used for treatment or prevention of severe wasting, as well as for ready-to-use supplementary food (RUSF)—also known as LNS of medium quantity (LNS-MQ)—which usually ranges from about 250 to 500 kcal and is often used for treatment or prevention of moderate wasting.

Studies from Malawi and Niger indicate that RUTF can improve weight gain and/or reduce the incidence or prevalence of wasting (Maleta et al., 2004; Patel et al., 2005; Sayyad-Neerkorn et al., 2015) and that local RUTF may be just as effective as imported (Sandige et al., 2004), though the

product composition would be important. Given success with blanked distributions of RUTF, some have recommended offering a preventive blanket distribution approach to all children in a defined age group (commonly 6 to 24 or 6 to 36 months of age), though others find it controversial (Neufeld, 2009; Hendricks, 2010). In a Niger study doing so, the incidence of wasting reduced by 36 percent and severe wasting by 58 percent (Isanaka et al., 2009).

Similarly, RUSF appeared to be protective against wasting when provided through blanket distribution in Niger. Children 6 to 36 months of age had a reduced incidence of severe wasting as measured by MUAC (Defour et al., 2009). Additionally, children 6 to 23 months of age had a small but still higher WLZ and less loss of MUAC than non-intervention children, though it is worth noting that some of these families also received protective household rations (Grellety et al., 2012). However, in another study, in Chad, where RUSF accompanied household rations, no difference in wasting incidence was seen, though promising results were seen for anaemia and stunting. This could be due to a number of factors, including study quality, as instability limited study enrolment (Huybrechts et al., 2012). A seasonal RUSF distribution for children under five years of age during the hunger gap appears to be sufficient if the main aim is to reduce mortality and limit the burden of SAM, but a year-round RUSF distribution may be preferable if the objective is to improve child development indicators, according to an MSF study in Chad (Broillet and Hattendorf, 2014).

When comparing RUTF and RUSF, studies using a preventive blanket distribution approach to all children in a defined age group found that the two yield similarly positive results in addressing wasting. Two studies in Niger came to interesting conclusions. In one case, researchers found RUTF and RUSF to be similar but with the RUSF being potentially more effective where the community had previously been exposed to such an intervention (Isanaka et al., 2010). In the other case, the researchers found that RUTF is likely more efficient for preventing wasting where diets are poor, whereas RUSF is likely more efficient for preventing wasting where diets are good (Prudhon et al., 2016). This speaks to the value of tailoring interventions to context.

Various studies have compared RUTF or RUSF to fortified blended foods (FBF), such as Corn-Soya Blend (CSB). For example, from the previously mentioned Malawi and Niger studies showing RUTF improved weight gain and/or reduced the incidence or prevalence of wasting, RUTF was compared with FBF and found to be superior—as it promoted better growth in children at risk of wasting and led to successful recovery for at-risk children (Maleta et al., 2004; Patel et al., 2005; Sayyad-Neerkorn et al., 2015). For RUSF, other studies in Malawi compared it to CSB. One found better results with RUSF in terms of underweight as compared to controls; and another found better results with RUSF in terms of weight-for-length (WFL) as compared to controls, but there was no statistical difference between RUSF and CSB (Thakwalakwa et al., 2010, 2012). In general, the effects obtained using FBF are generally not as strong as those of RUTF and RUSF. In fact, evidence is mixed about whether FBF impacts wasting (Pérez-Expósito and Klein, 2009; Mokori et al., 2013).

Along with RUTF and RUSF, there is a third category of LNS. These are LNS of small quantity (LNS-SQ), which generally range from about 110 to 130 kcal. Their dietary contribution is much less. They are often thought of as a fortified spread or a vehicle for providing micronutrients but in a lipid base to help with absorption of fat-soluble vitamins and to provide some caloric content. Children receiving an LNS-SQ had significantly lower prevalence of stunting, underweight and also wasting than did non-intervention children (Hess et al., 2015). Those receiving an LNS-SQ or an LNS-MQ had better weight and/or length gains in comparison to children not receiving any or receiving an LNS-SQ that contained almost no calories (Kuusipalo et al., 2006). In terms of a comparison with FBF, the results for either LNS-SQ or LNS-MQ seem to be protective against severe stunting with greater benefits against an FBF for children who were stunted at enrolment. However, at follow-up, it became apparent that the LNS-MQ might provide more protection (Phuka et al., 2008, 2009). In terms of a comparison with micronutrient powders, in a study in Ghana, those taking LNS-SQ had greater weight- and length-for-age than did micronutrient powders or a crushable micronutrient tablet (Adu-Afarwuah et al., 2007).

Modalities and new products

There is some existing evidence looking directly at the effectiveness of different distribution modalities for these supplements. However, the quality of evidence is not as strong as those on the specific product type. A study in Haiti saw better WHZ, WAZ and HAZ in a preventive model (including FBF and household rations for pregnant and lactating women and children 6 to 23 months of age) over a recuperative model (Ruel et al., 2008), which other implementers have started adopting. For example, studies looking at blanket supplementary feeding programmes (BSFP) targeting all children reported an increase in the mean WHZ amongst the target population (US Centers for Disease Control and Prevention, 2012). According to a study in Chad, the addition of LNS to general food distribution was found to have very little effect on the prevention of wasting, although there were some effects on increasing haemoglobin rates and reducing diarrhoea and fever episodes (Puett et al., 2013). As noted previously, it is difficult to attribute effects to a singular model, such as BSFPs alone, as many other interventions and external factors may be contributing to this at the same time in these settings. There are a number of ongoing studies in this domain, including a Cochrane review to assess the effects and safety of preventive LNS given with complementary foods (Das et al., 2017).

Additionally, new products are seemingly always under development to improve upon existing products or consider cost or cultural appropriateness. For example, positive results have been found in weight gain with a rice-based complementary food including fish and spiders (Skau et al., 2015). Several RCTs have evaluated the effectiveness and cost-effectiveness of different formulations of food supplements and fortificants, including new products being developed for the prevention of wasting (Fernald, no date; North-West University, South Africa, no date; Tufts, no date; UNICEF, no date; University of California, Davis, no date; Rogers, 2014; Webb et al., 2018).

This intervention area is where the highest number of studies was identified and where evidence is growing quickly. Well-designed RCTs and systematic reviews have demonstrated the effect of specialised food products in preventing wasting, but questions around their cost-effectiveness and sustainability remain.

Combinations of interventions

A common and logical perception is that certain combinations of the previously mentioned interventions can supplement and intensify their impact. However, the difficulties in designing trials to measure impact mean that there is a limited number of good, high-quality studies that look at a combination of interventions and their effects on wasting prevention. There have been several detailed evaluations of large programmes with multiple components (rather than single interventions), but these are programme evaluations rather than scientific trials. Combination interventions often include monthly child growth monitoring and promotion, supplementary feeding, micronutrient supplementation, nutrition education, gardening and poultry raising and WASH and community-based management of acute malnutrition, although the evidence for an effect on child anthropometry is inconsistent or modest (Pelletier et al., 2005). The impact of the Bangladesh Integrated Nutrition Project on anthropometric outcomes was also modest (White and Masset, 2007), but these conclusions are mainly drawn from impact evaluations without the rigour of RCTs.

The largest body of evidence in this area is around the preventive effect of CTs in combination with other interventions. For example, there are some quality studies of programmes combining supplementary food and CTs, which demonstrate a better preventive effect on MAM and SAM than strategies relying on CTs or supplementary food alone (Langendorf Céline, 2012; Langendorf C, Grais

R, Roederer T, Abdoul-Aziz M, Laouali MM, 2013; Langendorf et al., 2014). On the other hand, whilst programmes combining CTs and health messages have been found to improve child HAZ and WAZ (Agee, 2010), little or inconclusive impact on wasting has been demonstrated (Padilla and Trujillo, 2015). Moderate evidence of a greater reduction of both wasting and stunting and significantly better outcomes on mean WHZ and HAZ were found for interventions that focused on influential community members, training in environmental health, hygiene, clean drinking water, vaccination, appropriate use of the child growth chart, daily intake of all food groups, appropriate food preparation and essential foods during pregnancy and lactation (Salehi et al., 2004).

Integrated preventative health care programmes—including elements such as treatment of acute malnutrition, LNS supplementation, water provision, improvement in quality of health care, Expanded Programme on Immunisation, seasonal malaria chemoprevention prophylaxis, bed nets and the tracking of all children from birth to two years of age—have reported a larger impact on preventing wasting. Some of these studies are still ongoing (van der Kam, 2017). For example, MSF’s programme in Chad that addresses various needs—including health care access; nutrition (monthly LNS-MQ, community screenings); water and sanitation (hygiene kits for individuals, water source rehabilitation); distribution of mosquito nets; and information, education and communication teams—has had an impact on the prevalence of acute malnutrition (MSF-OCA, 2016).

A study which considered the integration of early child development and nutrition interventions demonstrated that a combination of interventions can be effective when targeted to the same population (DiGirolamo, Stansbery and Lung’aho, 2014). Multisectoral programmes, such as Suaahara in Nepal, are promising examples of this type of approach at scale (Pandey Rana, 2017). Integrated programmes centred on community ownership, such as the Nutrition Impact and Positive Practice project in Sudan, South Sudan, Niger, Malawi and Zimbabwe, report good results: the average dietary diversity of children 6 to 23 months of age was 28 per cent on admission and 78 per cent upon graduation from the programme and maintained at 70 per cent 12 months after graduation (Chishanu et al., 2014). The Community Resilience to Acute Malnutrition programme in Chad, which includes a combination of elements—food income and markets; WASH promotion; nutrition and health; and early warning—is reducing the risk of child wasting (Marshak, Young and Radday, 2016).

A lot of research is still ongoing on multisectoral programming: clinical trials to evaluate community-based interventions to improve feeding, infection control and caregiving practices (Skordis-Worrall et al., 2016); homestead food production, messages and the promotion of practices related to WASH and malaria prevention and the distribution of preventive LNS (Helen Keller International, 2014); comparisons between different combinations of household ration, Supercereal Plus, RUSF 250kcal/day, RUSF 500kcal/day and/or CT in Niger (Epicentre and WFP, 2011); and an integrated approach providing food rations, social behaviour change and preventive health and nutrition services (International Food Policy Research Institute, no date). However, the results in this area are largely from evaluations, grey literature and low-evidence study types (see Table 4 in “Conclusions” section). Cohort studies, RCTs and systematic reviews are still to be implemented; but, as mentioned earlier, they pose challenges.

A combination of interventions may be more effective at preventing wasting than separately implemented interventions, particularly when targeted to the same population. However, further studies should be done on the rigour of these interventions to strengthen the evidence base.

Other interventions: Early identification of wasting / secondary prevention

Mothers provided with low-cost MUAC tapes are able to screen their children frequently—allowing for early diagnosis and treatment of wasting (Blackwell et al., 2015)—and combined protocols to treat SAM and MAM are reported to facilitate the identification of acute malnutrition as a condition which occurs along a continuum (Bailey et al., 2018). Other screening tools allow identification of risk factors that predispose to wasting—such as maternal age, WAZ status, birth weight, feeding status, history of sibling death, multiple births and maternal education level (Hasegawa, Ito and Yamauchi, 2017)—or a simpler household food-access insecurity score (Psaki et al., 2012).

These interventions can be useful for directing prevention efforts by identifying children at risk. Regular weighing remains widespread and offers a potential entry point for this type of preventive action, if interventions/actions are put in place to respond to that identified risk (Fink et al., 2017).

Key Findings from the Stakeholder Consultations

This section presents a synthesis of the results from the 46 stakeholder interviews and is divided into subsections which consider participants' views on the current state of knowledge in relation to wasting, its prevention and the challenges encountered therein. Table 3 summarises the key findings.

Table 3. Selected highlights from the stakeholder consultation.

Current knowledge on aetiology	<ul style="list-style-type: none"> • Good level of knowledge on anticipating high levels of wasting (e.g. due to seasonality) and how to address drivers. • Limited knowledge on wasting risk factors compared to stunting. • Emerging knowledge regarding origins of wasting in foetal period. • Emerging knowledge on high frequency of wasting in infancy. • Agreement that concurrently wasted/stunted children are at higher risk of death. • Agreement that previously wasted children are at increased risk of becoming wasted. • Understanding that maternal status is likely to be a strong risk factor for wasting.
Effectiveness of interventions	<ul style="list-style-type: none"> • Nuanced and often context-specific evidence of what works. • Largest body of evidence to support the use of supplementary foods. • Some evidence on use of cash-based transfers (alone and in combination with other interventions). • Very limited evidence base for other interventions. • Very modest evidence on impact of agricultural interventions in combination with behaviour change on wasting. • Lack of evidence on impact of WASH interventions; some promising results from Chad study on livestock water source management.
Approaches	<ul style="list-style-type: none"> • Similar approaches to preventing all forms of undernutrition and therefore considered difficult and/or unnecessary for practitioners to separate out. • Preference for multisectoral, joint approach to prevention, based on sound understanding of context-specific drivers. • Preference for holistic and comprehensive approach, i.e. package of programmes (WASH, food security, IYCF, health, etc.) to prevent all forms of undernutrition, despite lack of evidence on effectiveness of interventions.

	<ul style="list-style-type: none"> • Maintaining of safety nets understood to be an important approach to respond to peaks of wasting, targeting vulnerable children and families. • Felt need for approaches to detect at-risk children and infants through consideration of different factors (anthropometric, socioeconomic, previous bouts of illness and/or wasting).
Challenges	<ul style="list-style-type: none"> • Lack of coordination and leadership on wasting prevention (as compared with that for the treatment of SAM). • Lack of inclusion of wasting as outcome in stunting-prevention studies. • Limited impact from poor quality of interventions. • Short-term, emergency-focussed funding for research on wasting.
Gaps in knowledge	<ul style="list-style-type: none"> • Aetiology of wasting: kwashiorkor; nutritional status of mother/child pair; wasting aetiology in different contexts; prevention of wasting/relapse in infants under six months of age; causes of relapse after treatment for wasting. • Relationship between wasting and stunting. • Risk factors for becoming wasted. • Role of infection, gut microbiome, EED and metabolomics. • Ways to address persistently high levels of GAM.

Abbreviations: EED, environmental enteric dysfunction; GAM, global acute malnutrition; IYCF, infant and young child feeding; SAM, severe acute malnutrition; WASH, water, sanitation and hygiene.

Current knowledge on aetiology

The existing state of thinking on the aetiology of wasting is highlighted in Box 1 and is detailed in the preceding briefing paper (MQSUN+, 2018), delivered as part of this scope of work. This section highlights observations from the consultation with stakeholders in relation to current and emerging knowledge on aetiology of wasting, with a view of using a more judicious and informed application of this knowledge in designing and targeting preventive strategies.

Patterns of wasting

Many stakeholders expressed the opinion that the global community has a good level of knowledge in terms of anticipating when and where there will be high levels of wasting and how drivers can be addressed in some contexts. These instances include peaks of wasting during the wet or hungry seasons or during emergencies and the risk of a higher incidence of infection at those times. Drivers of persistently high levels of endemic wasting in development settings are less understood, and appropriate strategies to effectively address this are not well defined (Young and Marshak, 2017).

Many interviewees also considered the diverse settings in which wasting occurs, and the differing nature and patterns of wasting within these settings, to be important areas of understanding required to facilitate the development of appropriate preventive strategies. A number of stakeholders highlighted a meta-analysis of birth cohort studies which observed that around 30 per cent of wasting had its origins in the foetal period (Christian et al., 2013), although a direct link has not been demonstrated (Khara and Dolan, 2014). One stakeholder also suggested that the starting point for wasting may occur earlier in children in Asian contexts, where many children have been observed at close to -2SD WFL by the first month of life, linked to maternal nutritional status and prenatal conditions (Victoria et al., 2010). On the other hand, it was suggested that in African contexts, the starting point may be slightly later and linked to breastfeeding / complementary feeding practices and infections, amongst others. This difference has implications for what may be an effective approach to prevent wasting in one context versus another (Nabwera et al., 2018). However, other stakeholders pointed to a paper on wasting in infants under six months of age (Kerac et al., 2011), which found no intercontinental difference in prevalence.

Preliminary analysis from observations of wasting incidence from a longitudinal study of datasets being undertaken by the University of California (UC), Berkley / the Bill & Melinda Gates Foundation was reported to show a significant increase in wasting rates in the latter part of infancy into early years, followed by a reduction. This analysis concurs with some findings from the Innovative Approaches for the Prevention of Childhood Malnutrition (PROMIS) cohort study (Annex 7, J8) in Mali and Burkina Faso, which observed a peak in wasting levels between six and nine months of age and highlights the importance of proactively targeting this group in wasting prevention efforts.

Risk factors for wasting

Stakeholders reported some knowledge of risk factors for wasting whilst acknowledging that this is less advanced than the knowledge base around risk factors for stunting. For example, the relationship between wasting, acute infection, inflammation, morbidity and mortality were perceived to be less understood than the association between stunting and these factors. There also appeared to be an assumption amongst some stakeholders that a smaller set of risk factors exists for wasting than for stunting, although the literature review found many publications describing similar risk factors for both. In contrast to this, some stakeholders highlighted situations where stunting rates have decreased whilst wasting prevalence has remained static (e.g. Vietnam, Sri Lanka) as proof that different drivers must be at play and suggested a need for different intervention approaches.

One academic stakeholder observed that it is known that children who suffer simultaneously from WaSt are at much greater risk of mortality. Therefore, more concerted efforts should be made to identify children who fall into this category and to prioritise prevention of concurrence.

Many stakeholders emphasised the very strong link between wasting and childhood illness, including diarrhoea and malaria, as well as long-term infections, such as HIV. Whilst the literature review found some evidence for these links, interventions tackling childhood illnesses did not demonstrate impacts on wasting. The Alliance For International Medical Action highlighted its work on *Cryptosporidium*—their observation was a higher mortality in children with SAM and *Cryptosporidium* infection, which did not seem to be influenced by degree of wasting, age or HIV coinfection (Ruiz, 2017). Stakeholders agreed that (1) access to quality health care, as well as treatment and control of infectious disease, should be an integral part of any strategy to prevent wasting and (2) nutrition should be an integral component in the management of infectious diseases. As a combination of wasting and disease increases mortality risk, the prevention of this comorbidity should be prioritised. Microbiota and environmental enteric dysfunction (EED) are also thought to play a role in the development of wasting, although there is no clear evidence for this yet.

Kerac and Seal (Kerac and Seal, 2014) observed that, as the prevalence of wasting decreases, medical and social aspects appear to become more significant drivers of wasting in the residual burden of cases. This observation suggests that, in more stable contexts, wasting—and particularly severe wasting—is a potential marker for a ‘hostile home environment’, which highlights aspects of a child’s social situation (for example, maternal mental health issues, domestic violence or absent mother) as wasting risk factors. Anecdotal reports from observation at inpatient/outpatient treatment facilities suggested that the mother’s social/psychological situation and/or nutritional status was a particularly strong risk factor.

Several ongoing and planned studies are looking at factors which cause children to relapse after successful treatment of an episode of wasting, as this is not well understood (Annex 7, J12, K22, K23). However, existing evidence (including a recent analysis of data from The Gambia [Sophie Moore, Personal Communication] and a systematic review on relapse after treatment submitted for publication indicates that children who have previously suffered one or more bouts of wasting or who are at an anthropometric deficit have a predisposition to successive bouts (than if they had never

been wasted). Therefore, these children should be a priority group for follow-up and preventive efforts.

Within the UC Berkley cohort data mentioned previously, one academic stakeholder observed three groups of children—one group which never gets wasted, one group which gets wasted and stays wasted and one which moves in and out of wasting—and noted that this phenomenon merits further investigation. Research on management of at-risk mothers and infants has shown that infants are more likely to have repeated bouts of wasting and that around one-third of cases of SAM in infants under six months of age who had been cured end up dying by one year of age—suggesting other factors at play (Grijalva-Eternod et al., 2017). The aetiology review proposed two possible scenarios: that one episode of wasting leaves a child more vulnerable to being wasted again or that the same risk factors which caused a child to become wasted in the first place are continuing to act on the child's nutritional status.

Kwashiorkor

Although kwashiorkor is used as an indicator for SAM, there was widespread stakeholder agreement on the lack of knowledge on kwashiorkor and its pathophysiology—even though it is understood that its causes are multifactorial and its epidemiology differs by setting and individual. MSF is currently planning a large study on causes and prevention of kwashiorkor (Annex 7, K14).

Effectiveness of wasting prevention interventions

Most stakeholders considered the prevention of stunting to be an area where the evidence base is fairly established for both policy and programming purposes. On the other hand, general consensus across stakeholder groups largely reflected the findings of the literature review—that the evidence of what works in the prevention of wasting is nuanced and often context-specific. They also felt that there is a paucity of evidence on the prevention of wasting and that it is still assumed that nutrition-specific and/or nutrition-sensitive interventions designed to prevent stunting will have a concurrent effect on wasting, despite a lack of evidence for this beyond their broadly sharing risk factors. Considering these two factors, this means that it can be difficult for the existing pool of evidence on wasting prevention to be applied across different contexts and at scale.

The literature review identified many studies on the use of specialised products for the prevention and treatment of wasting—representing the greatest body of evidence compared to other interventions. There was some lack of consensus on the adequacy of evidence in this area, including its applicability at scale. However, some stakeholders expressed confidence in the findings generated from both research and programmatic evaluations, including the effectiveness of supplementary products such as LNS and FBF for the prevention of MAM and SAM. It was noted by one stakeholder that, although the technology exists to bring down high levels of global acute malnutrition (GAM) with a rapid response during crises, rates can then increase again and remain persistently high (Young and Marshak, 2017). Outside of humanitarian settings, there is less evidence of the effectiveness of the specialised foods approach.

Several stakeholders considered different types of LNS to be the most effective products for the prevention (and management) of moderate wasting. The literature review supports this view, but some stakeholders felt the evidence on these products' comparative effectiveness is still not at a stage where confident conclusions can be drawn. Many ongoing studies are considering this issue (Annex 7, E1, E4, E6, E9, J3, J7, J8, J9, J13). Many participants also raised the need to develop and test affordable supplementary and complementary food products—using local ingredients—to be used both in humanitarian response and through a longer-term social marketing approach.

As the literature review also suggests, the effectiveness of CTs—combined or not combined with nutrition-specific interventions, and nutritional supplements in particular—on reducing the incidence of wasting was also thought to be promising amongst the interviewed stakeholders. Agencies (including some donors) reported they are increasingly insisting that cash-based approaches consider nutritionally vulnerable groups and take stock of evidence demonstrating that combined interventions appear to work better than single interventions. Studies on the combinations of interventions are ongoing (Annex 7). However, several interviewees expressed concern about the cost and sustainability of cash-based interventions as a preventive approach. The literature review also identified some well-designed studies which did not show that CTs prevent wasting.

Although considered popular programmatic approaches to the prevention of undernutrition, alternatives to food products and CT interventions—like nutrition-sensitive approaches addressing WASH, agriculture or social behaviour change (including promotion of IYCF practices)—are not viewed by many stakeholders as producing the desired impact or supporting evidence on the prevention of wasting. Several stakeholders referred to a comprehensive study by the Medical Research Council on the effectiveness of strategies to improve growth outcomes (including wasting) in a retrospective cohort in The Gambia (Nabwera et al., 2018). The study followed growth faltering trends in children under two years of age in three rural villages over four decades. The villages benefited from free health care and ‘unprecedented levels of nutrition-specific and nutrition-sensitive interventions compared with other such communities in rural low-income settings’. The study observed significant impacts on mortality and morbidity, including modest improvements in mean maternal height, mean birth weight and child growth. However, the prevalence of LBW, stunting and underweight remained high; the prevalence of wasting was unchanged; and growth faltering from 3 to 21 months of age was only marginally attenuated and was strongly linked to seasonal factors.

On the other hand, a few stakeholders reported promising results from ongoing operational research and programme impact evaluations related to agriculture and food security. A notable intervention was the use of homestead gardening with strong nutrition and social behaviour change components, such as the Nutrition Impact and Positive Practice project in five countries (Malawi, Niger, South Sudan, Sudan and Zimbabwe) and the Helen Keller International homestead gardening project in Burkina Faso. An example of community-run food banks in Senegal was also cited. Although difficult to attribute to one intervention, it was reported to have significantly reduced SAM cases.

A large number of stakeholders were disappointed by the results from the Sanitation Hygiene Infant Nutrition Efficacy (SHINE) study (Humphrey et al., 2015) and the recently published WASH Benefits study in Bangladesh (Luby et al., 2018). Neither showed the impact of WASH interventions on nutritional status, as found by other similar studies. Despite this, many stakeholders were keen to advise that WASH should still be included as an essential component of an intervention package to address undernutrition, including wasting prevention. As remarked by many interviewees, the quality and quantity of WASH programming is likely to be a key issue, as there is a ‘very high threshold for WASH improvements before growth faltering can be eliminated’ (Nabwera et al., 2018). One expert observed that, in the wake of evidence from recent studies, it is likely that the implementation of WASH programming in a field setting is insufficient to have any significant impact. There is a need for a transformative approach whereby adequate water quality at a household/individual level can be assured.

Encouragingly, several stakeholders referred to interesting results from a recent study in Chad (Marshak et al., 2017), which observed better nutrition and mortality outcomes in pastoralist groups as compared with sedentary livestock farmers. This may be attributable to practices (separation of human and animal water sources; housing animals away from settlement areas) to reduce ingestion of pathogens from contaminated water sources and contamination of the home environment by animal excreta.

Several stakeholders noted the limited evidence on reducing the burden of moderate wasting at scale and preventing its deterioration to severe wasting—which leads to poor long-term physical and cognitive development and persistently high levels of mortality. Outside of feeding programmes, there is also limited new evidence relating to alternative approaches to managing moderate wasting. Stakeholders expressed that innovation in addressing moderate wasting has been neglected, with preference being given to SAM treatment, especially since the publication of bleak supplemental feeding results in the Overseas Development Institute review (Navarro-Colorado, Mason and Shoham, 2008). However, there is an increasing focus on preventing the deterioration from moderate to severe wasting with the launch of recent initiatives, such as MUAC for Mothers (Blackwell et al., 2015) and No Wasted Lives. A number of stakeholders also highlighted the combined protocol approach—which treats both moderate and severe wasting in a continuum of care—like in the Combined Protocol for Acute Malnutrition Study (ComPAS) (Bailey et al., 2018).

Approaches to wasting prevention

One of the key questions asked of the consulted stakeholders was what approaches they undertook to prevent wasting and the extent to which they were guided and influenced by the existing evidence base. Overall, stakeholder consensus was that, despite a very inconsistent evidence base, there are basic points which are known and should be applied in a multisectoral, joint approach to preventing wasting. For example, one noted fact was that acute periods of food insecurity and/or episodes of disease and inadequate IYCF practices can contribute to wasting. Several interviewees also noted that the evidence base has little improved in the last 20 years, even though many more studies have been implemented. Because of this, agencies and implementers are continually pressed to make assumptions when trying to understand the ‘who’ and ‘how’ of malnutrition in any given context. Some stakeholders emphasised that an improvement in the evidence base and ‘splitting hairs’ in research may not change the ways of working in the field.

The majority of consulted stakeholders preferred a holistic and comprehensive approach comprising a package of actions to prevent undernutrition in all its forms (stunting, wasting, nutritional oedema and micronutrient deficiencies). This preference is based on the comprehension that the drivers of the different manifestations of undernutrition are the same, as exemplified in the UNICEF Conceptual Framework (UNICEF, 1998) on the determinants of child undernutrition. Implementers continue to use this framework to guide nutrition policies and programming—despite a lack of robust evidence on the effectiveness of interventions addressing the underlying drivers of undernutrition (e.g. food insecurity, inadequate IYCF practices and poor WASH conditions). A recent review (Young and Marshak, 2017) examined the scale, duration and perceived causal pathways of persistent GAM.^v That review noted that UNICEF’s framework may have ‘unintentionally generated a false level of confidence that there is sufficient understanding of causes of malnutrition and how they operate’ and suggested that this ‘potentially discourages efforts to test longstanding assumptions about drivers or better understand cross-cutting elements, like gender, livelihoods and seasonality’ (Young and Marshak, 2017). The authors call for context-specific causal analysis based not only on assumptions but also on the use of longitudinal data to investigate existing pathways.

The stakeholders, particularly the field practitioners, considered approaches to prevent stunting and wasting to be fairly similar. Yet, they also highlighted the complexity of the process for practitioners of separating out and diversely responding to the different forms of undernutrition within interventions. A country-level stakeholder emphasised the potential confusion for community health

^v Persistent GAM is when prevalence rates regularly exceed the emergency threshold of over 15 per cent of children under five years of age.

workers in measuring and identifying different types of undernutrition and referring clients for different interventions, also noting that a single measure of nutritional risk would be much simpler.

The importance of a situational analysis and an understanding of the levels of attribution to the various drivers within a specific context and across different seasons were a recurrent theme. Stakeholders acknowledged that, even though there may be an overarching strategy to prevent undernutrition, the package of interventions provided within this approach must be tailored to respond to context-specific nutritional problems and their primary pathways. This includes responding to seasonal peaks in acute malnutrition and disease outbreaks through humanitarian food assistance (including BSFP), agricultural/livestock interventions, vaccination campaigns and other appropriate public health interventions.

An additional noted approach ([Childhood Acute Illness & Nutrition \[CHAIN\] Network, Kenya Medical Research Institute](#), Annex 7, K9) is the identification of vulnerable children through anthropometric or other factors, such as socioeconomic indicators; previous, chronic, or current illness; and the prevention of the combination of malnutrition and infectious disease. This approach echoes some of the literature proposing models for detecting at-risk children and infants. The outcomes of interest in these approaches are not only anthropometric but also health-related—including demonstrable reductions in child survival risks. Within this approach, improved nutritional status is seen as a point along the pathway; it assumes that interventions aiming to prevent mortality or infection are also likely to have an impact on the prevention of wasting and other forms of undernutrition.

One NGO stakeholder suggested that the responsibility for addressing basic and underlying drivers of malnutrition ultimately lies with governments. In addition, until sufficient economic improvement and development have been reached, nutrition-sensitive approaches cannot be expected to be implemented at the required scale and thus have the intended impact. Therefore, the maintenance of ‘rescue services’ or safety nets within this ‘vacuum’—in the form of supplements, humanitarian food assistance, etc.—was considered crucial. The same stakeholder noted that commonly raised concerns around sustainability and cost need to be balanced with realistic expectations of what can be achieved with alternative solutions in resource-poor settings.

Several stakeholders also highlighted that wasting prevention approaches should sufficiently cover severe wasting, which can be achieved by appropriately handling the moderately wasted caseload. A number of interviewees emphasised that this needs to be taken much more seriously as a preventive approach. Cases of severe wasting should represent a failure in a preventive system that catches and manages cases of moderate wasting (e.g. through a ‘risk stratification’ model) before they deteriorate to severe wasting. This should be seen as a priority as a child may never fully recover physiologically from severe wasting—which is likely to have lifelong implications. Stakeholders also mentioned the importance of investing in wasting prevention at times of crisis.

Challenges in wasting prevention

Coordination and leadership on prevention

Many stakeholders highlighted and applauded a significant shift in understanding on wasting over the last decade—mainly in relation to treatment of severe wasting. Coordination and leadership on treatment of SAM have been well organised, as opposed to the approach to wasting prevention, which was regarded as very disconnected.

In terms of coordination and common vision on wasting prevention, stakeholders appeared to be on the same page in the acknowledgement of the multiple factors and different pathways involved in wasting, the importance of understanding how these operate in specific contexts and the need for a

cross-sectoral response. However, stakeholders agreed that there is poor understanding of what a prevention strategy should contain, what a package of interventions should resemble and how these should be assembled and implemented to have the greatest effect. In this respect, no basis or model exists to support the required coordination and organisation of the various actors involved to address these different elements and, therefore, have maximum impact.

Whilst ongoing conversations on prevention of stunting occur, the same cannot be said for the prevention of wasting. Wasting prevention is mainly considered in the realm of treatment or as an ‘add-on’, with an assumption that what will prevent stunting will also have an impact on wasting. Agencies work on stunting and wasting separately, and different fora deal with different types of undernutrition—with very few linkages between them. This consultation revealed an increasing awareness of the burden of wasting, stunting and at-risk infants under six months of age and associated mortality risk, both immediately and as older children.

Although several organisations were identified as key actors and thought leaders within this domain, most stakeholders considered real leadership on the issue to be lacking. A few highlighted the lack of a combined strategy and harmonised approach to addressing undernutrition amongst UN agencies (WFP, UNICEF, WHO, Food and Agriculture Organization, UN High Commissioner for Refugees). Several expressed the opinion that WHO should take a lead. Interviewees also suggested that WFP could play a more prominent role given their work in food systems and focus on moderate wasting. Fragmentation was also noted in other areas of nutrition—including IYCF—where actors focus on different elements, such as breastfeeding support or IYCF in emergencies. There is also a need for promoting and linking to prevention discussions amongst development partners in areas like SBC, health systems and integrated community case management. Stakeholders also referenced a lack of understanding around the different forms of undernutrition and related ongoing debates amongst actors working in other sectors—economists; social protection agencies; health, food and agriculture specialists; and more. The result is that nutrition outcomes may be misinterpreted or misrepresented in child survival or health-related evaluations.

The interviewees also highlighted several divisions and silos—all of which concern the prevention of wasting (and other forms of undernutrition) and which are considered contributing factors to the disconnect on prevention and the lack of leadership on the issue. These divisions particularly relate to the focus of agency mandates, such as those between UNICEF/WHO for SAM treatment and WFP for MAM treatment. Specifically, they include divisions between moderate and severe wasting; treatment and prevention; WaSt; emergency and development; nutrition-specific and nutrition-sensitive intervention; product and non-product intervention; health and nutrition sectors; and food and nutrition sectors.

Inclusion of wasting as an outcome

Several stakeholders commented that wasting is often neglected as an indicator in preventive interventions, research or evaluation. This need was emphasised, for those working on studies or operational evaluations of stunting prevention: look at wasting as an outcome to better understand the relationship and interactions between stunting and wasting and to build the evidence base on effectiveness of prevention strategies for wasting. Stakeholders also noted that the burden of wasting in infants under six months of age is neglected as an outcome and is not well documented at the country level, despite global attention.

Quality

Many stakeholders raised the issue of quality (or lack of quality) and quantity as a fundamental element affecting wasting intervention outcomes—challenging a perceived assumption that, where

multiple drivers are addressed by a package of relevant interventions, an impact on nutritional status will be observed. For example, some stakeholders pointed to the varying quality and consistency of SBC and nutrition counselling interventions and the potentially very high thresholds required for water quality and quantity before real impact can be observed.

Funding

Short-term funding cycles were regarded by many as an obstacle to both investment in effective programmes to prevent wasting and to in-depth research which tracks the full 1,000-days window. Most wasting-related funding focuses on treatment. Where it is intended for prevention, it is mainly restricted to emergency interventions, such as comparative product efficacy trials and CTs—resulting in an inability to plan and opportunistic and rushed research. Additionally, sectors compete for funds, and therefore, it is difficult to promote cross-sectoral research related to nutrition by actors from multiple sectors.

Gaps in wasting knowledge

Stakeholders highlighted some key gaps in evidence and understanding—considered to be crucial to the design and implementation of interventions to prevent wasting as part of broader strategies to prevent all forms of undernutrition. There was a strong sense that pure research would not provide all the answers. Well-thought-through programmes based on a good understanding of key wasting drivers, along with good quality monitoring and evaluation of trends over time, play a crucial role in building evidence and facilitating improved programme design. A suggestion by one stakeholder—as a complementary approach to research—was to identify where programmes have had an impact on wasting and to ‘work backwards’, forming hypotheses and investigating the pathways along which the effect has been achieved. Several interviewees noted that more knowledge and understanding needs to come from cohort data and epidemiological research—as most data currently come from survey outcomes, which focus on prevalence at certain points in time.

A number of stakeholders suggested that the global nutrition agenda can be driven by a need for evidence, which can distract from establishing multisectoral approaches based on a sound analysis of context. Therefore, it is essential to identify areas requiring investment in research to provide evidence that supports and improves the effectiveness of well-designed multisectoral approaches and to complement results emerging from programme-based monitoring and evaluation and retrospective cohort studies.

Conversely, stakeholders also identified many knowledge gaps related to improving the understanding of the aetiology of wasting, rather than the effect of the various intervention modalities. These gaps include the aetiology/pathophysiology of kwashiorkor; drivers of maternal malnutrition and poor health; the nutritional status of the mother and child pair and their interrelationships, in particular during the prenatal phase; pathways and patterns of wasting and its progression in different contexts; the prevention of wasting/relapse after treatment in infants under six months of age; and the physiological description of recovery from wasting.

One stakeholder highlighted the need to better understand the overlap in different types of anthropometric deficit in both populations and individuals. This is limited by current metrics and a reliance on cross-sectional surveys—which do not allow for measuring the impact of interventions on wasting since they capture prevalence rather than incidence. Many stakeholders mentioned a need for increasing understanding around the relationship between wasting and stunting. Topics highlighted for further investigation included how concurrence of both wasting and stunting can be

captured (potentially revisiting the use of WFA, or WFA/MUAC, for identifying high-risk children), as well as the long term morphological and biological impacts from bouts of childhood WaSt.

Several stakeholders noted the need to better describe the risk factors for becoming moderately and severely wasted, the relationship between these two conditions and the characteristics of those at higher risk of death. One interview advocated for the development of a formula for ‘risk stratification’ to facilitate better targeting of the most vulnerable children and the design of adapted packages according to the nutritional/health-risk profile of the child. Some stakeholders expressed frustration over a lack of decision over the use of weight-for-height versus MUAC. One also highlighted the need to identify the underlying determinants behind static and increasing rates of SAM in some countries.

Many stakeholders mentioned as key gaps: knowledge around the influence—beyond diet—of recurrent infections, the gut microbiome, EED and metabolomics on stunting and wasting.

Both the literature review and stakeholder consultation identified several specific research questions, which are presented in Annex 2. These will feed into a wasting prevention research prioritisation exercise in a subsequent phase of work.

Conclusions

Both the literature review and stakeholder consultations provided a good picture on the current state of thinking in regard to wasting prevention, but it also highlighted existing gaps where further research is needed.

Current knowledge on wasting prevention

From this review of published and grey literature and extensive stakeholder consultation, it can be concluded that acute periods or peaks of food insecurity and/or episodes of disease outbreak contribute to wasting and that well-designed responses to address this will have a preventive effect. Much less is known as regards prevention packages adapted to different contexts—such as those areas experiencing persistently high levels of wasting or annual seasonal peaks—and for which there may be a need for different approaches.

In general, evidence for prevention of wasting was found to be weak in many of the investigated intervention areas. Studies often focus on stunting and do not include wasting outcomes, which could easily be added even as secondary outcomes. Many studies are tailored to a specific context—especially those implemented during emergencies—which raises questions about their applicability/validity in other contexts. Multi-country studies are still needed in most intervention areas. Additionally, it is well known that study design to measure the effect of wasting prevention interventions is difficult, primarily due to ethical considerations, confounding factors and the fact that a diverse range of interventions are often implemented simultaneously. Despite these challenges, there are high-quality studies and a growing body of evidence in some areas. Box 4 presents a summary of the state of evidence for each.

Box 4. Summary of the state of evidence by intervention area.

Breastfeeding

There is very little evidence of the impact of interventions promoting exclusive and continued breastfeeding on the prevention of wasting. Results are modest or difficult to attribute to an increase in breastfeeding alone.

Complementary feeding

There is evidence of a small but significant impact of complementary feeding interventions with a food component. The potential benefits for wasting prevention have been highlighted, but there is mixed evidence thus far of impact on wasting outcomes.

Micronutrient supplementation

Only small impacts on wasting prevention were observed when using zinc supplements, despite some high-quality systematic reviews and clinical trials in this intervention area.

Nutrition counselling and nutrition education

Several randomised controlled trials (RCTs) in this intervention area showed positive effects on the prevention of wasting, although many still fail to demonstrate a clear impact.

Mother's education, women's empowerment and gender

Results predominantly from association studies and programme evaluations suggest that women's empowerment interventions and education could have a positive impact on infant feeding and wasting.

Health

Few clear studies consider the relationship between health interventions and prevention of wasting. Only a few well-designed studies found a small impact on wasting reduction.

Water, sanitation and hygiene (WASH)

There is currently very little evidence as to the direct effect of WASH interventions in the prevention of wasting except for some studies on sanitation.

Agriculture and other livelihoods

Only limited impacts have been observed, suggesting that more needs to be done to link increased agricultural production with improved child nutritional status. Robust evidence relating to the impact of livelihood interventions on wasting prevention is also lacking.

General food distribution

Although several studies have shown an impact of general food distribution on wasting, it is difficult to attribute this to the intervention alone.

Cash transfers (CTs)

There is a growing body of well-designed trials that are demonstrating a strong, positive, preventive effect of CTs on wasting.

Food supplementation

The highest number of studies was identified in this intervention area, and evidence is growing quickly: well-designed RCTs and systematic reviews have demonstrated the effect of food supplementation in preventing wasting, but questions around their cost-effectiveness and sustainability remain.

Combinations of interventions

The review found that a combination of interventions may be more effective for the prevention of wasting than separately implemented interventions, particularly when targeted to the same population.

Table 4 provides a visual overview of the combined findings from the literature review and stakeholder consultations. It highlights the view of the authors on three areas: the strength of the body of evidence, evidence of an effect on wasting prevention and stakeholder opinion on the quality of evidence.

Table 4. State of evidence on wasting prevention by intervention area.

Assessment criteria Intervention area	Body of evidence *1	Evidence of effect on wasting prevention *2	Stakeholder opinion on quality of evidence base *3
Agriculture	Yellow	Yellow	Yellow
Other livelihoods / income generation	Red	Red	Red
Deworming	Red	Red	Red
Complementary feeding	Yellow	Yellow	Red
Breastfeeding	Yellow	Red	Red
WASH	Yellow	Red	Red
Cash transfers	Yellow	Yellow	Green
Nutrition counselling	Yellow	Yellow	Yellow
SBC during pregnancy	Red	Red	Red
Other interventions during pregnancy	Red	Red	Red
Interventions pre-conception	Red	Red	Red
Micronutrient supplementation (0–5)	Green	Red	Red
Women’s education and empowerment	Red	Yellow	Red
Health	Red	Red	Red
General food distributions	Yellow	Red	Red
Food supplementation	Green	Green	Green
Combination	Red	Yellow	Yellow

*1 Green = several quality studies (including systematic reviews, RCTs/CRTs); yellow = medium / limited number of quality studies; red = very few or no quality studies.

*2 Green = significant effects observed on wasting prevention in several studies; yellow = modest effects observed in some trials / effects found but in poor-quality trials; red = no significant effects found.

*3 Green = evidence of significant effect on wasting prevention noted by many stakeholders; yellow = evidence / observations of modest effect noted by a few stakeholders; red = no evidence of effect noted.

Abbreviations: SBC, social and behaviour change; WASH, water, sanitation and hygiene.

The results show that, in most categories, the literature and stakeholders’ perceptions of evidence quality align—suggesting that policymakers, researchers and practitioners are well informed of the research. As one UN stakeholder commented, although a lot is known on health and nutritional needs at an individual level (e.g. recommended daily intake, preventive health, hygiene requirements), the knowledge and evidence of how to apply this at the population level is currently lacking. An insufficiency in the identification and targeting of high-risk groups could be part of the problem. For example, interventions may target SBC interventions in IYCF to all children under two years of age instead of identifying and targeting interventions to higher-risk infants, such as those with feeding problems or with an infection. Although the stakeholder consultations brought out many individual views and opinions, there was a consensus on the state of the evidence base—which matched the findings of the literature review. One exception was the robustness of the evidence regarding the comparative efficacy of food supplements.

Acknowledging that there is an inconsistent evidence base and no single ‘silver bullet’ intervention to wasting prevention, implementers prefer to rely on a multisectoral approach based on the UNICEF

Conceptual Framework (UNICEF, 1998) combined with a careful assessment of context-specific drivers. Many stakeholders emphasised the need to complement this approach with an improved understanding of the epidemiology and aetiology of wasting—ensuring that children most at risk in a given context are a priority for targeted intervention.

In this respect, there is emerging evidence that:

- Wasting can be present at birth and appear very early on in infancy.
- Children with concurrent stunting and wasting are at higher risk of mortality.
- Children who have suffered episodes of wasting are predisposed to further episodes of wasting and are also more likely to become stunted; children in this group who are under six months of age have a particularly high risk of mortality.
- Wasting can be linked to childhood illness, including diarrhoea, malaria, measles and HIV.
- Wasting can be a marker of social problems, such as maternal depression.

This knowledge can be used to improve the design and targeting of intervention packages to address wasting alongside other forms of undernutrition.

The review identified some promising initiatives which may boost knowledge and practice relating to wasting prevention. Examples include:

- Combined protocol for the management of stunting and wasting (CompAS).
- Use of MUAC for Mothers in the early identification and referral of cases of wasting.
- The integration of preventive (SBC and food supplement) components into community-based management of acute malnutrition (PROMIS).
- Management of childhood illness (CHAIN, MSF).
- Rural water source and livestock management (Tufts).
- Enhanced homestead food production (Helen Keller International / International Food Policy Research Institute) and a package of interventions to tackle the underlying multisectoral determinants of malnutrition.

Harnessing these emerging and promising approaches will require increased leadership and coordination of effort, which at the moment is quite absent.

Gaps and needs for further research

As Frongillo, de Onis and Hanson (Frongillo, de Onis and Hanson, 1997) observed 20 years ago, the literature on wasting fails to identify risk factors that are not directly related to stunting—making it difficult to identify specific interventions to prevent wasting. This observation remains largely relevant today. However, wasting is not always included as a primary outcome in research studies, and the way that it is measured and reported can be highly variable—reducing comparability across studies (Cook and Fernández Gabaldón, 2018). A key problem when designing studies to produce robust evidence is the array of confounding factors, as well as the large sample size and the context specificity required to adequately address the many drivers of wasting.

In highlighting key gaps around wasting aetiology knowledge, this review reinforces the conclusions of the preliminary briefing note from this scope of work (MQSUN+, 2018). This includes the aetiology of kwashiorkor / nutritional oedema; the relationship between wasting and stunting and the overlap between the two conditions; differences relating to age, gender and geography; the role of interventions pre-conception (adolescent nutrition, maternal age at first birth, family planning, etc.);

wasting in infants under six months of age; and mechanisms behind relapse after successful treatment for wasting. This review also raises the important need to better understand the relationship between maternal nutrition / health status and child nutritional status.

Both the literature review and several stakeholders highlighted the need for improved understanding around the role of infection, the gut microbiome and inflammation/EED in wasting, over and above dietary factors. Longer-term health impacts of childhood WaSt are also areas where further research is required.

Although there is some existing knowledge around risk factors for wasting in terms of their commonality with stunting, this area is widely viewed as requiring further exploration. This includes understanding the drivers behind wasting in different contexts, as well as the differences in age of onset and how the condition progresses (including from moderate to severe wasting and self-recovery). Stakeholders preferred using cohort data versus cross-sectional survey data to expand knowledge and understanding in this area. However, it was recognised that appropriate tools to investigate and understand these contextual drivers are lacking. Emphasis was put on the need for longer-term funding to enable studies to investigate the entire 1,000-days window. Wasting prevention research funded to date has centred on interventions comparing the efficacy of different products, exploring the impact of CTs, which suit research within a short time frame, and reflecting different funding streams and agency programme cycles. Limited longer-term funding and strategic programming means that critical research in this area—such as how to identify high-risk children to prevent deterioration—has not yet taken place.

Gaps relating to implementation modalities included (1) the need for a more helpful framework to identify the various interventions which operate at different levels to address malnutrition drivers and (2) the need for risk stratification tools which can better identify infants and children at greatest risk. Several stakeholders underlined the importance of consistent terminology in wasting prevention discussions, including specific reference to primary or secondary prevention. A number of stakeholders also identified the prevention of severe wasting and prevention of relapse after successful treatment as key areas where knowledge and practice need to be advanced.

The stakeholder consultation identified several specific research questions—most frequently mentioned as centring around programme design, monitoring and evaluation; patterns of severe and moderate wasting; wasting in infants under six months of age; aetiology of kwashiorkor; prenatal factors/gender; understanding risk; the relationship between stunting and wasting; wasting and infection/inflammation; and the prevention of relapse. Annex 7 presents an extensive (but not exhaustive) list of ongoing and planned research projects related to wasting prevention, which address, to some extent, most of the pertinent identified areas. Some research continues to examine intervention impact, whilst other interventions aim to improve the understanding of aetiology and epidemiology (and other forms of undernutrition, in many cases).

Ultimately, there is a need for balance in defining priority areas for investment in further research. It is important to consider where existing data can be used—like retrospective cohort studies—and where the evidence base on drivers and approaches to wasting prevention can be improved through well-designed programme monitoring and evaluation, investigations on programmatic pathways which have an effect on wasting and the testing of assumptions around the ‘packages’ of intervention and drivers at work. In the next phase of work, a Research Prioritisation exercise will be undertaken, and the findings from this review will directly benefit this process.

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Annex 1: Wasting Throughout the Life Cycle

Figure 3. Wasting throughout the life cycle diagram.

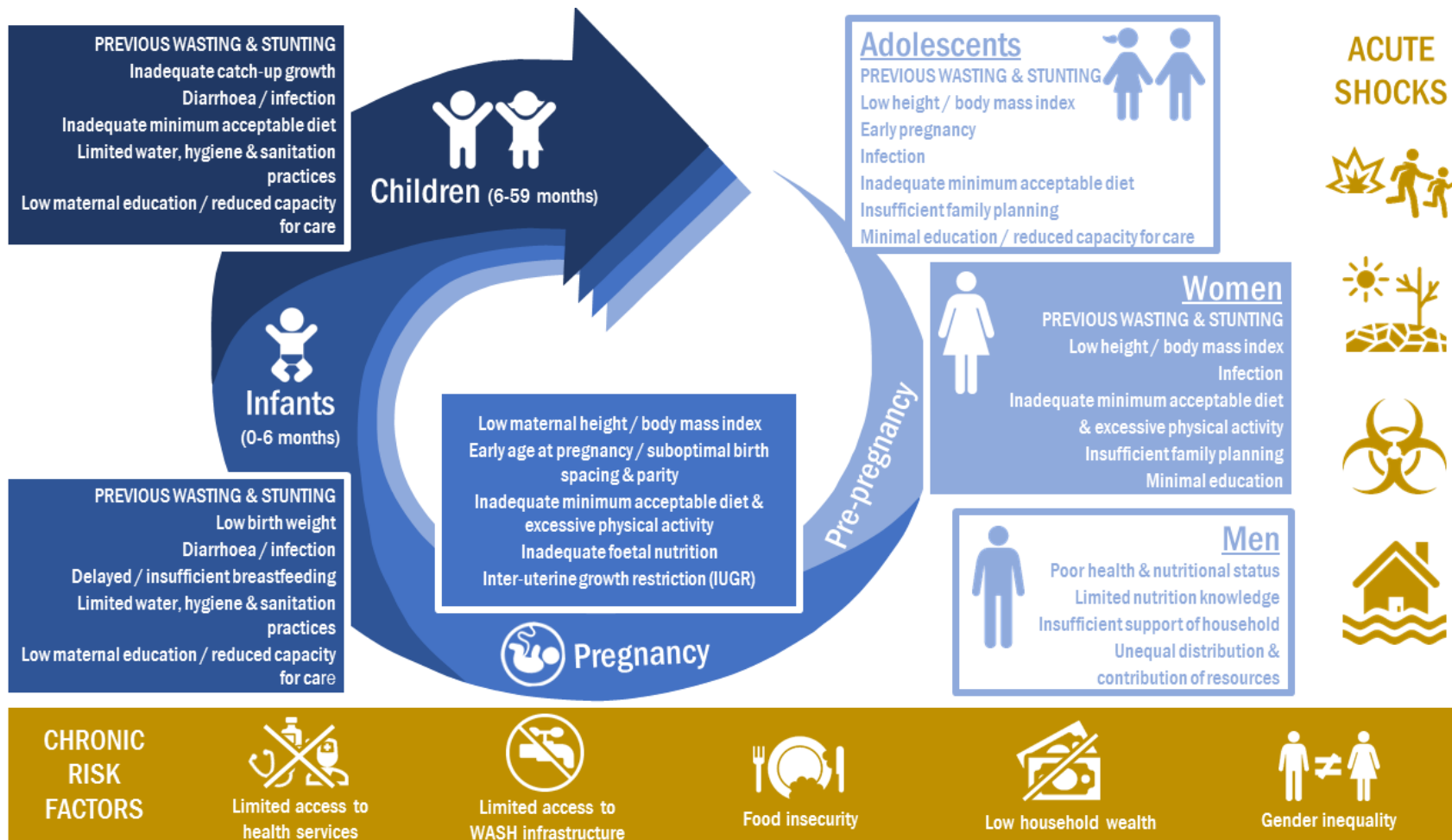


Table 5. Child wasting factors and examples.

Factor	Example
Association with child wasting outcomes	
Maternal status (short) and BMI (thin)	(Subramanian <i>et al.</i> , 2009; Ozaltin, Hill and Subramanian, 2010; Tigga and Sen, 2016; Ali <i>et al.</i> , 2017)
Maternal age (young)	(Fall <i>et al.</i> , 2015; Pravana <i>et al.</i> , 2017)
Family planning	(Fink <i>et al.</i> , 2014; Aheto <i>et al.</i> , 2015; Asfaw <i>et al.</i> , 2015; Tette, Sifah and Nartey, 2015; Betebo <i>et al.</i> , 2017)
Intra-uterine growth restriction, preterm and/or low birth weight	(Christian <i>et al.</i> , 2013; Sania <i>et al.</i> , 2015; Rahman <i>et al.</i> , 2016)
Child stunting	(Victora, 1992; McDonald <i>et al.</i> , 2013)
Inflammation and enteric enteropathy	(Patwari, 1999; Relman, 2013; Genton, Cani and Schrenzel, 2015; Harper <i>et al.</i> , 2018)
Diarrhoea	(Ahmed <i>et al.</i> , 1993; Patwari, 1999; Relman, 2013)
Dietary diversity	(Arimond and Ruel, 2004; Frempong and Annim, 2017)
Food insecurity	(Abdurahman <i>et al.</i> , 2016; Betebo <i>et al.</i> , 2017)
WASH	(Humphrey, 2009; Raihan <i>et al.</i> , 2017)
Household wealth (low)	(Frongillo, de Onis and Hanson, 1997; Martorell and Young, 2012; Bhutta <i>et al.</i> , 2013)
Mother's education/literacy	(Mishra <i>et al.</i> , 2014; Aheto <i>et al.</i> , 2015; Ickes, Hurst and Flax, 2015; Frozanfar <i>et al.</i> , 2016)
Women's empowerment	(Shroff <i>et al.</i> , 2011; Alaofè <i>et al.</i> , 2017)
Male involvement	(Kansiime <i>et al.</i> , 2017)
Multiple risk factors in the life cycle	(Akombi <i>et al.</i> , 2017)
Emergency contexts	(Altare, Delbiso and Guha-Sapir, 2016)
Impact of child wasting	
Multiple impact	(Black <i>et al.</i> , 2008, 2013)
Cognitive development	(Kar, Rao and Chandramouli, 2008)
Morbidity	(Black <i>et al.</i> , 2013)

Abbreviation: BMI, body mass index; WASH, water, sanitation and hygiene.

Annex 2: Wasting Prevention Research Questions Identified by the Review

Table 6. Wasting domain and research questions.

Domain	Research Questions
Programme design, monitoring and evaluation	What are the most appropriate community-based screening tools to identify MAM, including in pregnant women?
	What is the best way(s) to assess situations to enable appropriate multisectoral approaches tailored to different settings?
	How can a good analysis of drivers and improved monitoring and evaluation improve prevention of wasting?
	Quality: what does it mean in different intervention domains?
	How should a programme to prevent wasting be designed so that it can be evaluated for its impact on nutrition? / What does a strong evaluation component look like?
	How should policy and programmes for adolescent nutrition be designed; what can we learn from other sectors (e.g. education, HIV prevention, sports, violence, etc.)?
Moderate and severe wasting	What are the determinants of moderate and severe wasting in different contexts / geographic areas?
	What are current patterns of moderate and severe wasting?
Wasting in infants <6 months	What is the aetiology of wasting in infants under 6 months of age?
	What is the link between low birth weight and early wasting?
	What is the best way(s) to prevent wasting in infants?
	What is the best way(s) to manage wasting in this group?
Kwashiorkor	What is the pathophysiology of severe malnutrition, especially the mechanisms causing kwashiorkor (Bhutta <i>et al.</i> , 2017; Nackers, 2017).
Prenatal factors / gender	What is the link between wasting and maternal undernutrition?
	How does 'upstream' work to improve maternal nutritional status (e.g. delay of first birth, birth spacing, family planning, diet in pregnancy, reducing of infection and workload during pregnancy) reduce risk of wasting?
	How should moderate wasting be diagnosed in pregnant women?
	How does gender play a role in wasting: how many cases of wasting are directly related to maternal factors (more qualitative gender studies needed)?
Understanding of risk	What are the critical factors which tip a family into high levels of exposure to wasting?
	Which children are most at risk, and why are some children more vulnerable to wasting than others?
	Which cohorts of children are more likely to become malnourished?
Stunting and wasting relationship	How do strategies which tackle stunting have an impact on wasting?
	Can the evidence from stunting prevention be applied to wasting?
	What is the interrelationship between stunting and wasting in different contexts? (Investment needed in mechanistic research, cohort and epidemiological research.)
	What is the impact of early wasting / stunting on later outcomes (e.g. using prospective datasets)?
Wasting and infection / inflammation	What is the extent to which illness is a triggering factor for wasting, and what is the impact of early intervention?

Domain	Research Questions
	<p>What is the contribution of background infectious patterns beyond WASH factors?</p> <p>Does improving water quality and reducing exposure to contamination and illness have an impact on wasting?</p> <p>What is the relationship between the microbiome/microbiota and wasting?</p>
Prevention of relapse	<p>What is the impact of social support on preventing relapse (e.g. social work types of interventions—addressing maternal mental health, depression, etc.)?</p> <p>How does relapse occur, including consideration of the environment to which a child returns after treatment in terms of mother’s time, social situation, food security / diet, sanitary environment, etc.?</p> <p>What should the continuum of care look like after a child is discharged from treatment for severe wasting (e.g. linkage to support services, SBC, counselling, etc.)?</p> <p>What does true recovery from wasting mean in physiological terms?</p>
Behaviour change	<p>What factors are important in the quality and effectiveness of SBC for prevention of wasting and other forms of undernutrition, considering how not only knowledge, but moreover how attitudes and behaviour can be changed?</p>
Products	<p>Comparative efficacy of RUSF vs CSB, including alternative, cheaper recipes: more evidence required for agencies to make more informed choices of product.</p> <p>Comparative efficacy of products in different contexts (e.g. why is use of dairy in some products important in some contexts but not in others?).</p> <p>What is the effect of products which enhance the gut microbiota?</p> <p>What is the ideal protein content of RUF to ensure improved growth? Is there a need for supplements higher in protein content?</p>
Cost-effectiveness	<p>What else can be established about cost-effectiveness of prevention of wasting, e.g. similar to what the Rang-Din project has been doing for LNS and stunting (Humber, Jacob et al., 2017; Dewey et al., 2018)</p> <p>What are potential cost benefits of investing in prevention vs. management of wasting?</p>
Longer-term consequences	<p>What are the long-term consequences of wasting (and severity of wasting) and its treatment on growth, cognitive outcomes, lean mass, health? How does treatment replace what was lost?</p> <p>How do prevention programmes impact in double-burden countries?</p>

Abbreviations: CSB, Corn-Soya Blend; LNS, lipid-based nutrient supplement; LNS, lipid-based nutrient supplement; MAM, moderate acute malnutrition; RUF, Ready-to-Use Food; RUSF, ready-to-use supplementary food; SBC, social and behaviour change; WASH, water, sanitation and hygiene.

Annex 3: Inclusion and Exclusion Criteria

Inclusion Criteria

i. Population

Studies limited to those in which participants are:

- Children aged 0 to 59 months of age.
- Those living in low- and middle-income countries.
- Non-acutely malnourished participants in at least one study arm at baseline (i.e. preventative interventions) or moderately acutely malnourished children that are prevented from becoming severely acutely malnourished, pregnant and lactating women and adolescent girls.

ii. Interventions

Any intervention with a clear wasting-prevention objective included.

iii. Comparison

Studies that compared an intervention with an alternative, as well as studies that have no comparison intervention.

iv. Outcome

Changes in weight-for-height Z-scores, mid-upper arm circumference, weight-for-age Z-scores, weight, height and presence of bilateral oedema or changes in prevalence of acute malnutrition in a population.

The following study types were included:

- Systematic reviews or literature reviews using systematic methods to search for and screen included studies.
- Randomised controlled trials.
- Cluster randomised controlled trials.
- Nonrandomised controlled trials using appropriate statistical methods to control for selection bias and confounding.
- Case controls.
- Controlled before-and-after studies.
- Interrupted time series studies, including fixed- or random-effects models with an interaction term between time and intervention at baseline and follow-up.
- Quasi experimental methods, such as regression discontinuity design, instrumental variables, difference-in-differences.
- Cross-sectional or panel studies with an intervention and comparison group which use quasi-experimental methods to control for selection bias and confounding.
- Observational studies.
- Case studies examining impact pathways, barriers, facilitators, etc.

Exclusion Criteria

The following types of study were excluded: full article text not available in English, French, Spanish or Portuguese; hospital-based interventions; interventions for the rehabilitation or treatment of acute malnutrition; and studies on stunting. Other areas of intervention were also excluded: food storage, policy/capacity support, hospital-based studies and interventions addressing basic causes of malnutrition.

Annex 4: Search Strings

Low- and middle-income country search strings

((Afghanistan or Albania or Algeria or Angola or Antigua or Barbuda or Argentina or Armenia or Armenian or Azerbaijan or Bahrain or Bangladesh or Barbados or Benin or Byelarus or Byelorussian or Belarus or Belorussian or Belorussia or Belize or Bhutan or Bolivia or Bosnia or Herzegovina or Hercegovina or Botswana or Brasil or Brazil or Bulgaria or "Burkina Faso" or "Burkina Fasso" or Burundi or Cambodia or Cameroon or Cameroons or Cameroun or "Cape Verde" or

"Cabo Verde" or "Central African Republic" or Chad or Chile or China or Colombia or Comoros or "Comoro Islands" or Comores or Mayotte or Congo or Zaire or "Costa Rica*" or "Cote d'Ivoire" or "Ivory Coast" or Croatia or Cuba or Czechoslovakia or "Czech Republic" or Slovakia or "Slovak Republic" or Djibouti or "French Somaliland" or Dominica or "Dominican Republic" or "East Timor" or "East Timur" or "Timor Leste" or Ecuador or Egypt or "El Salvador" or Eritrea or Estonia or Ethiopia or Fiji or Gabon or "Gabonese Republic" or Gambia or Gaza or "Georgia

Republic" or "Georgian Republic" or Georgia or Ghana or Grenada or Guatemala or Guinea or Guiana or Guyana or Haiti or Honduras or Hungary or India or Maldives or Indonesia or Iran or Iraq or Jamaic

a or Jordan or Kazakhstan or Kazakh or Kenya or Kiribati or Korea or Kosovo or Kyrgyzstan or Kirghizia or "Kyrgyz Republic" or Kirghiz or Kirgizstan or "Lao PDR" or Laos or Latvia or Lebanon or

Lesotho or Liberia or Libya or Lithuania or Macedonia or Madagascar or Malaysia or Malaya or Malay or Malawi or Mali or Malta or "Marshall Islands" or Mauritania or Mauritius or Mexico or Micronesia or "Middle East" or Moldova or Moldovia or Moldovian or Mongolia or Montenegro or Morocco or Mozambique or Myanmar or Myanma or Burma or Namibia or Nepal or "Netherlands Antilles" or Curacao or "Sint Maartin" or Nicaragua or Niger or Nigeria or "Northern Mariana Islands" or Oman or Pakistan or Palau or Palestine or Panama or Paraguay or Peru or Philippines or Philipines or Phillipines or Phillippines or "Puerto Ric*" or Romania or Rumania or Roumania or Russia or "Russian Federation" or Rwanda or Ruanda or "Saint Kitts" or "St Kitts" or Nevis or "Saint Lucia" or "St Lucia" or "Saint Vincent" or "St Vincent" or Grenadines or Samoa or "Samoan Islands" or "Sao Tome" or "Saudi Arabia" or Senegal or Serbia or Montenegro or Seychelles or "Sierra Leone" or Slovenia or "Sri Lanka" or "Solomon Islands" or Somalia or "South Africa" or Sudan or Suriname or Surinam or Swaziland or Syria or "Syrian Arab Republic" or Tajikistan or Tadhikistan or Tadjikistan or Tadhik or Tanzania or Thailand or Togo or "Togolese Republic" or Tonga or Trinidad or Tobago or Tunisia or Turkey or Turkmenistan or Turkmen or Tuvalu or Uganda or Ukraine or Uruguay or Uzbekistan or Uzbek or Vanuatu or Venezuela or Vietnam or "Viet Nam" or "West Bank" or Yemen or Zambia or Zimbabwe or ((developing or "less* developed" or "under developed" or underdeveloped or underdeveloped or "middle income" or "low* income") adj3 (countr* or nation*)) or ((low* adj3 (middle adj3 countr*)) or (Africa or Asia or Caribbean or "West Indies" or "South America" or "Latin America" or "Central America")))) not ("African-American*" or "African-American*" or "Mexican American*" or "American Indian*" or "Asian American*" or "native american*")).ti,ab.

Database search strings

Search terms used in these databases included:

(acute malnutrition) OR (acute undernutrition) OR (weight for height) OR (WHZ) OR (wasting) or (underweight) or (weight for age) or (WAZ) OR (weight for length) OR (MUAC) OR (Nutritional Oedema) OR (Kwashiorkor) AND;

(prevention) OR (social protection) OR (cash transfer) OR (cash and vouchers) OR (safety net) OR (social welfare) OR (food security) OR (livelihood) OR (food access) OR (supplementary feeding) OR (food availability) OR (health care) OR (health) OR (sanitation) OR (water) OR (hygiene) OR (WASH) OR (behaviour change communication) OR (infant young child feeding) OR (IYCF) OR (Breastfeeding) OR (Early Childhood Development) OR (complementary feeding) OR (complementary foods) OR (RUF) OR (RUSF) OR (LNS) OR (family planning) OR (ante natal care) OR (micronutrient supplementation) OR (microcredit) OR (adolescents) OR (pre-conception) OR (pregnancy) OR (income generation) OR (MAM Treatment) OR (boys AND girls) OR (relapse) OR (management of acute malnutrition in infants) OR (MAMI).

Annex 5: Outline of Stakeholder Interview

Table 7. Outline of stakeholder interview.

Agency details	
Name of agency	
Name/role of respondent	
Agency strategy / interventions around prevention of undernutrition	
Do you have a specific focus/strategy on prevention of wasting / nutritional oedema? What is this based on? What activities? Which target populations?	
Research activities	
What published/unpublished research have you done to date?	
What are your current research activities on the prevention of wasting / nutritional oedema: <ul style="list-style-type: none"> • Nutrition-specific? • Nutrition-sensitive? When are the results expected?	
Research planned on wasting prevention	
Do you have research planned (e.g. stunting related) where prevention of wasting could be included as an outcome?	
Current thinking on wasting prevention	
<p>Knowledge What do we know about prevention of wasting / nutritional oedema? What do you see as the most promising approaches?</p> <p>Gaps Have research questions on wasting prevention been adequately and comprehensively examined? What do you think are the key questions which cannot be answered with currently available evidence?</p>	

Annex 6: List of Stakeholder Entities Whose Subject-Matter Expert(s) Were Consulted

Table 8. List of consulted stakeholder entities.

Agency
Action Against Hunger (AAH/ACF)
ALIMA
Centers for Disease Control and Prevention (CDC)
Centre for Humanitarian Change
Children's Investment Fund Foundation
Concern
DFID
European Civil Protection and Humanitarian Aid Operations
Edesia
FAO
Feinstein International Center
Food for Peace
Bill & Melinda Gates Foundation
GOAL
Gorta Africa Self-Help
HKI
Hospital for Sick Children / Aga Khan University
International Food Policy Research Institute
Independent consultant
International Rescue Committee
Johns Hopkins University
Kenya Medical Research Institute
London School of Hygiene and Tropical Medicine
Ministry of Health, Sri Lanka, Dept. of Nutrition
Médecins Sans Frontières
National Institute of Nutrition, Vietnam
No Wasted Lives
Nutriset
SHINE / Queen Mary's University
Strengthening Partnerships, Results, and Innovations in Nutrition Globally (SPRING)
Scaling Up Nutrition (SUN) Movement Secretariat
Tufts University
University of California, Davis
UNICEF
University of Copenhagen/Tampere
Washington University, St. Louis (WUSL)
University College London
United States Agency for International Development (USAID) / Office of Foreign Disaster Assistance
Valid International
Valid Nutrition
World Food Programme
WHO
World Bank

Abbreviations: ALIMA, Alliance for International Medical Action; DFID, Department for International Development; FAO, Food and Agriculture Organization; HKI, Helen Keller International; SHINE, Sanitation Hygiene Infant Nutrition Efficacy; UNICEF, United Nations Children's Fund; WHO, World Health Organization.

Annex 7: Ongoing and Planned Research

Table 9. Ongoing/planned research summary.

	Agency	Research Summary
A	Agriculture	
A1	Food and Agriculture Org (FAO)	Prevention of food losses and waste due to spillage and degradation during handling, storage and transportation between farm and distribution.
A2	Helen Keller Int'l (HKI)	Evaluation of impact of Enhanced Homestead Food Production in Burkina Faso on mother and child nutritional status.
A3	HKI	Fish production in Cambodia: research on homestead food production. Studying dietary diversity and food security.
A4	Heidelberg University	Reducing Young Child Undernutrition Through an Integrated Agricultural Project with Women's Groups: A CRT in Bangladesh.
B	Behaviour change communication (BCC) / social and behaviour change (SBC)	
B1	HKI*	Evaluation of impact of government preventive text messaging programme, Tanzania.
C	Breastfeeding/feeding practices	
C1	Institute of Tropical Medicine, Antwerp	Effectiveness of a nutrition education package in improving feeding practices, dietary adequacy and growth in community settings of rural Tanzania.
C2	UNICEF WCARO	Stock taking of infant and young child feeding (IYCF) practices in region – exclusive breastfeeding and complementary feeding.
C3	Valid*	Measurement of IYCF practices using the Infant and Young Child Feeding Index (ICYFI) indicator.
D	Diet	
D1	UNICEF/FAO	Study to examine whether maintaining access to milk over a year reduces the spike in wasting. Generating of evidence and opening of discussion around targeted livestock interventions for pastoralists.
E	Supplementary feeding	
E1	Aga Khan Univ. (AKU) / WHO	Review to assess the effects and safety of preventive lipid-based nutrient supplements (LNS) given with complementary foods.
E2	FOOD FOR PEACE	Cost-effectiveness of four different types of food in preventing both wasting and stunting (WaSt), with Tufts University.
E3	Johns Hopkins University (JHU)	Evidence review looking at intervention studies which have examined both wasting and stunting (supplementation with/without a nutrition education element).
E4	Nutriset	Ongoing analysis of data from trials—comparison of LNS-SQ compared with LNS-MQ.
E5	Tufts	'Effectiveness and Cost-Effectiveness of Four Formulations of Food Supplements for the Prevention of Wasting and Stunting in Burkina Faso FAQR-Burkina (Four Food Study)'.
E6	UNICEF	Evaluation of the efficacy of LNS in preventing growth faltering and improving micronutrient status, comparing Corn-Soya Blend++, Sprinkle and a control.
E7	UNICEF Kenya	Real-time evaluation of blanket supplementary feeding programme (protection rations for children under 5 years of age) being done in 5 targeted counties of Kenya.
E8	UNICEF WCARO	Organising of technical consultation on locally produced complementary food, with technical advisory group.
E9	University of California	Comprehensive LNS: daily provision of LNS-PLW (pregnant and lactating women) to mothers during pregnancy and postpartum lactation and of LNS developed for infants and young children to their infants.
E10	University of Copenhagen	Milk and growth in moderate acute malnutrition (MAGMAM) study planned in Uganda: evaluation of whether milk in products only had marginal effect in

Agency		Research Summary
		previous study, probably related to breastfeeding, and whether milk is more important than other protein sources.
E11	University North West, South Africa	Comparison of complementary food supplements in South Africa: a fortified fat-based spread that contains essential fatty acids with added docosahexaenoic acid and arachidonic acid and phytase to improve iron and zinc bioavailability and a fortified fat-based product containing essential fatty acids.
E12	US Agency for International Development	Funding research in West Africa on integrated community case management and simplification of services to manage acute malnutrition.
E13	Valid International*	Desire to conduct study on probiotics and effects of enhancing RUTF, RUSF and ready-to-use complementary food.
E14	Valid International*	Test market—potential of low cost, small dose of highly fortified products to ‘base of pyramid’; snacking market—defining of delivery mechanism and product for preventing wasting /stunting.
E15	Valid International*	Delivery innovations, e.g. combining interventions such as animal health delivery, building on Milk Matters work and linked to ComPAS work.
E16	WFP	Study in Burundi comparing a blanket supplementary feeding programme alone as well as in addition to cash provided through Food for Assets.
F	Cash Transfers	
F1	IFPRI	TMRI (Transfer Modality Research Initiative) study Bangladesh: comparing cash and cash / SBC intervention combined.
F2	University College London	Follow-up study to Research on Food Assistance for Nutritional Impact in Somalia, looking at conditionality linked to health screening + mHealth and cash transfers.
F3	Uni. Central-south, Hunan	Randomised controlled trial (RCT) combining a conditional cash transfer with nutrition education.
F4	WFP	Ongoing study in Somalia investigating whether household transfers comprising food vouchers and unconditional cash are more effective than food vouchers alone.
F5	WFP	Joint work with JHU and World Vision International in Somalia as part of a technical advisory group looking at cash vs. vouchers for prevention.
G	Micronutrients	
G1	Campbell Collaboration	Review to evaluate the effectiveness of mass food fortification efforts with key micronutrients (iron, folic acid, iodine, vitamin A, calcium, vitamin D or multiple micronutrients).
G2	JHU	New study starting Feb 2018 with results expected 2019. 6-arm trial in Bangladesh of supplementation of children 9-15 months with various micronutrients, zinc in particular.
H	Social protection and livelihoods	
H1	UNICEF Kenya	Targeting of hunger safety nets to under 2’s—surveys in Jan. 2018 will show whether any significant improvement in this group in terms of protecting against WaSt.
I	Water, sanitation and hygiene (WASH)	
I1	ALIMA / ACF	DiDiMAS [Syndromic Approach to Detection of Infectious Agents in Diarrhoea in Children with SAM]: investigating infectious causes of diarrhoea, looking for simple off-the-shelf diagnostic test and suitable treatment.
I2	Queen Mary’s	Secondary outcomes from SHINE (environmental enteric dysfunction, birth outcomes).
I3	Tufts*	Research on the relationship between acute malnutrition and zoonotic disease and how local water and livestock management practices potentially influence this.
I4	UC Berkley	WASH Benefit trials, mainly looking at stunting but also wasting, Bangladesh and Kenya. Effect of WASH on WFA is clear but not so much on weight-for-height.
J	Combinations of interventions	
J1	Africa Self Help	Ongoing pilot looking at attribution of various factors to undernutrition.

Agency		Research Summary
J2	Sick Kids	Systematic collation of preventive strategies for moderate malnutrition and interventions which prevent both wasting and stunting (for new Lancet Series 2019).
J3	ALIMA	1000 Days Research Niger: delivery of preventive and curative package of care: rapid diagnostic tests, vaccine, paediatric care, zinc, diarrhoea treatment, LNS supplementation.
J4	Epicentre	Comparing RUSF, Supercereal Plus (SC+), RUSF 250 kcal/day, RUSF 500 kcal/day. SC+ and cash transfer, SC+ and household ration and cash transfer in Niger.
J5	FAO*	Cash+ programmes: cash + productive assets + nutrition education activities. Consideration of impacts on dietary diversity.
J6	GOAL	NIPP (Nutrition Impact & Positive Practice) project: aim of tackling underlying multisectoral behavioural determinants of malnutrition (ongoing evaluation).
J7	HKI	Clinical trial including Homestead Food Production, messages and the promotion of practices related to WASH and malaria prevention and distributing preventive LNSs.
J8	IFPRI/HKI	PROMIS study: integration of preventive programmes into the CMAM model. Effect of SBC on child nutrition, including IYCF, complementary feeding and distribution of LNS-SQ.
J9	IFPRI	PM2A study: Guatemala and Burundi study with different arms—WASH, LNS, agriculture—starting in pregnancy and following children up to 18/24 months of age.
J10	IRC	Sprout: primary prevention to avoid onset of malnutrition through livelihoods, cash, SBC in Niger.
J11	JHU	Evaluation of Sequota initiative, Ethiopia (national multisectoral plan to end malnutrition by 2030).
J12	Queen Mary's	HOPE SAM [Health Outcomes, Pathogenesis and Epidemiology of Severe Acute Malnutrition] project: focus on secondary prevention in Zimbabwe and Zambia, to design a package of care to prevent relapse after treatment.
J13	UC Berkeley	MAHAY ('smart' in Malagasy) study: A CRT of nutritional supplementation and promotion of responsive parenting in Madagascar, comparing T1, intensive counselling; T2, intensive counselling + LNS for children; T3, intensive counselling + LNS for PLW + LNS for children; T4, integrated counselling on nutrition and early stimulation/home visiting.
J14	University College London	RCT in India to evaluate a community-based intervention to improve growth and prevent wasting in India (community-based health worker engaged in improving feeding, infection control and caregiving practices).
J15	WHO*	A search for funding for a set of intervention studies in different types of settings: one targeting child with supplementary food; one targeting family; and one counselling and monitoring, treatment of illnesses, back-up nutrition interventions, as required.
J16	Washington Univ. St. Louis	Stunting prevention study (focusing on growth rather than wasting). Different components: how to improve gut health (oligosaccharides), interventions with legumes, milk powder.
K	Others/aetiology/treatment/risk factors and external links	
K1	AKU / Sick Kids**	Analysis of the stunting/wasting interrelationship.
K2	AKU / Sick Kids*	Desire for further study relating to metabolomics and microbiome, how they influence stunting and wasting over and above dietary practices.
K3	AKU / Sick Kids	Cost-effective solutions study addressing social determinants of malnutrition.
K4	AKU / Sick Kids	Completion of Bill & Melinda Gates Foundation study on drivers of stunting; potential to look at drivers of wasting and trends, aetiology pathogenesis,

Agency		Research Summary
		intervention evidence relating to SAM, MAM interactions between two and how relate to stunting trends in same temporal space.
K5	ALIMA	MUAC for Mothers: further expansion of criteria. Also, OPTIMA: MUAC and oedema only, training mothers to identify early and increase early admissions for treatment for wasting
K6	FOOD FOR PEACE	Funding for Tufts' Four Food Study in West Africa.
K7	IRC	ComPAS: combined treatment protocols for SAM/MAM.
K8	IRC	Rise for Nutrition: multicounty consortium, developing and revising CHW tools.
K9	Kenya Medical Research Institute	Childhood Acute Illness & Nutrition (CHAIN) study: Large programme collecting together data from existing studies, measures of a child's anthropometric status and other characteristics and follow-up of survival and health outcomes.
K10	LSHTM*	MAMI
K11	LSHTM	Studies considering risk factors underlying wasting. Studies on associations with anthropometric indicators—WFA, WFL, MUAC.
K12	LSHTM	Research on disability and severe wasting.
K13	MAMI Group	'Informing the Management of Acute Malnutrition in Infants aged <6 Months: Risk Factor Analysis Using Nationally Representative Demographic and Health Survey Secondary Data' (submitted for publication).
K14	MSF-Belgium	Kwashiorkor aetiology—large study in planning stages.
K15	MSF-Belgium*	Potential future study to focus on <6 months, possibly repeating some studies to see if 110 mm cut-off is working.
K16	MSF-Holland	Causes and intervention for prevention of malnutrition in Baluchistan, Pakistan.
K17	MSF-Holland	Causes and prevention of malnutrition in Zamfara state, Nigeria.
K18	MSF-Holland	Causes of and intervention against noma in Sokoto, Nigeria.
K19	MSF-Holland	Assessments and evaluations to prevent illnesses, results 2018.
K20	MSF-Holland*	Wasting and weight as a secondary outcome in research on kala azar, HIV, malaria prevention, water and sanitation, etc.
K21	Nutriset*	Saving of brains from malnutrition: improving products for kids by adding molecules DHA (docosahexaenoic acid), gluten, iodine, vitamin D; looking at neuro-cognitive development as well as brain development.
K22	RTI International (lead)	'Relapse After Recovery From Severe Acute Malnutrition: A Systematic Literature Review and Secondary Data Analysis' (submitted for publication).
K23	Tufts	Third study in Sierra Leone, exploring real nature of recovery relating to relapse, lean mass and cognitive function.
K24	Tufts/Concern	Seasonality of malnutrition and its drivers, as part of the Building Resilience in Chad and Sudan (BRICS).
K25	Tufts/FAO	Case studies—Mind the Gap: Bridging the Research, Practice and Policy Divide.
K26	Tufts/ACF*	Uptake of information and analysis to address persistent GAM in refugee settings.
K27	UNICEF Kenya*	Ongoing work on supply chain to ensure sustainable programme in place.
K28	UNICEF WCARO	Study on predictors of stunting and wasting intended to provide recommendations on more specific approaches to address wasting.
K29	Valid International	ENGINE programme: evaluating outcomes of children with MAM in food-secure woredas, without access to supplementary feeding programmes but access to CMAM, integrated management of childhood illness and health programming.
K30	Valid International	Conducting of analysis on cost implications of moving to new WHO MUAC cut-off in Ethiopia (115 mm). Next step in high-risk areas to relax admission criteria.
K31	Valid International*	Specialised foods and approaches to reduce sharing of these, from the perspective of whether (a) sharing is a big issue re: wasting outcomes and (b) there are cost-effective feasible mechanisms to help reduce it.
K32	Valid International*	Research to improve measurement and assessment of malnutrition for improved prevention, including measurement of IYCF practices using ICFI.

Agency		Research Summary
K33	Valid International*	Potential to continue work on growth monitoring, linking to ENN WaSt work, on most effective way to identify most vulnerable children (e.g. with WFA index): consideration of how to reach the most vulnerable children at combined risk of the WaSt phenomenon and how growth monitoring of both WaSt can be used to target/provide a package of interventions for children who fall off the growth curve, including SBC and short-term supplementation, looking at outcomes on both WaSt.
K34	WHO	Study starting pre-conception following children with continuum of interventions to look at impact of whole package. Large studies on prevention of stunting and on prevention of obesity in India. Consideration of impact on low birth weight and wasting indicators.

*Research marked with an asterisk is planned / pending funding.

Abbreviations: ACF, Action contre la Faim / Action Against Hunger; ALIMA, Alliance for International Medical Action; CHW, community health worker; CMAM, community-based management of acute malnutrition; ComPAS, Combined Protocol for Acute Malnutrition Study; CRT, cluster randomised trial; ENN, Emergency Nutrition Network; GAM, global acute malnutrition; IFPRI, International Food Policy Research Institute; IYCF, infant and young child feeding; LNS-SQ/MQ, small-quantity/medium-quantity lipid nutrient supplement; LSHTM, London School of Hygiene & Tropical Medicine; MAM, moderate acute malnutrition; MAMI, management of at-risk mothers and infants; MSF, Médecins Sans Frontières; MUAC, mid-upper arm circumference; Optima, Optimising Malnutrition treatment; PM2A, preventing malnutrition in children under 2 approach; PROMIS, Innovative Approaches for the Prevention of Childhood Malnutrition; RUSF, ready-to-use supplementary food; RUTF, ready-to-use therapeutic food; SAM, severe acute malnutrition; SHINE, Sanitation Hygiene Infant Nutrition Efficacy; UNICEF, United Nations Children’s Fund; WaSt, wasting and stunting; WCARO, West Central Africa Regional Office; WFA, weight-for-age; WFL, weight-for-length; WFP, World Food Programme; WHO, World Health Organization.