

WHO guideline:

**USE OF MULTIPLE MICRONUTRIENT POWDERS**  
FOR POINT-OF-USE FORTIFICATION OF FOODS CONSUMED BY  
INFANTS AND YOUNG CHILDREN AGED 6–23 MONTHS AND CHILDREN AGED 2–12 YEARS



World Health  
Organization



**WHO guideline:**

**USE OF MULTIPLE MICRONUTRIENT  
POWDERS FOR POINT-OF-USE  
FORTIFICATION OF FOODS CONSUMED  
BY INFANTS AND YOUNG CHILDREN  
AGED 6–23 MONTHS AND  
CHILDREN AGED 2–12 YEARS**



**World Health  
Organization**

WHO guideline: Use of multiple micronutrient powders for point-of-use fortification of foods consumed by infants and young children aged 6–23 months and children aged 2–12 years

ISBN 978-92-4-154994-3

© World Health Organization 2016

Some rights reserved. This work is available under the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 IGO licence (CC BY-NC-SA 3.0 IGO; <https://creativecommons.org/licenses/by-nc-sa/3.0/igo>).

Under the terms of this licence, you may copy, redistribute and adapt the work for non-commercial purposes, provided the work is appropriately cited, as indicated below. In any use of this work, there should be no suggestion that WHO endorses any specific organization, products or services. The use of the WHO logo is not permitted. If you adapt the work, then you must license your work under the same or equivalent Creative Commons licence. If you create a translation of this work, you should add the following disclaimer along with the suggested citation: “This translation was not created by the World Health Organization (WHO). WHO is not responsible for the content or accuracy of this translation. The original English edition shall be the binding and authentic edition”.

Any mediation relating to disputes arising under the licence shall be conducted in accordance with the mediation rules of the World Intellectual Property Organization (<http://www.wipo.int/amc/en/mediation/rules>).

**Cataloguing-in-Publication (CIP) data.** CIP data are available at <http://apps.who.int/iris>.

**Sales, rights and licensing.** To purchase WHO publications, see <http://apps.who.int/bookorders>. To submit requests for commercial use and queries on rights and licensing, see <http://www.who.int/about/licensing>.

**Third-party materials.** If you wish to reuse material from this work that is attributed to a third party, such as tables, figures or images, it is your responsibility to determine whether permission is needed for that reuse and to obtain permission from the copyright holder. The risk of claims resulting from infringement of any third-party-owned component in the work rests solely with the user.

**General disclaimers.** The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of WHO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by WHO in preference to others of a similar nature that are not mentioned. Errors and omissions excepted, the names of proprietary products are distinguished by initial capital letters.

All reasonable precautions have been taken by WHO to verify the information contained in this publication. However, the published material is being distributed without warranty of any kind, either expressed or implied. The responsibility for the interpretation and use of the material lies with the reader. In no event shall WHO be liable for damages arising from its use.

Design and layout: Alberto March (Barcelona, Spain).

Cover photo by Nicole Rodriguez Neufeld and Alberto March.

Baby's model: Jason Kamperis.

## SUGGESTED CITATION:

WHO guideline: Use of multiple micronutrient powders for point-of-use fortification of foods consumed by infants and young children aged 6–23 months and children aged 2–12 years. Geneva: World Health Organization; 2016. Licence: [CC BY-NC-SA 3.0 IGO](https://creativecommons.org/licenses/by-nc-sa/3.0/igo).

## TABLE OF CONTENTS

<b>PUBLICATION HISTORY</b>		<b>viii</b>
<b>ACKNOWLEDGEMENTS</b>		<b>viii</b>
	Financial support	<b>viii</b>
<b>EXECUTIVE SUMMARY</b>		<b>1</b>
	Background	1
	Purpose of the guideline	2
	Guideline development methodology	2
	Available evidence	2
	Recommendations	3
	Recommendation 1	3
	Recommendation 2	4
	Remarks	5
	Research gaps	6
	Plans for updating the guideline	7
<b>WHO GUIDELINE:</b>	Use of multiple micronutrient powders for point-of-use fortification of foods consumed by infants and young children aged 6–23 months and children aged 2–12 years	8
<b>SCOPE AND PURPOSE</b>		<b>8</b>
<b>BACKGROUND</b>		<b>8</b>
<b>SUMMARY OF EVIDENCE</b>		<b>10</b>
	Multiple micronutrient powders in infants and young children aged 6–23 months	10
	Multiple micronutrient powders in children aged 2–12 years	12
<b>RECOMMENDATIONS</b>		<b>13</b>
	Recommendation 1	13
	Recommendation 2	14
<b>REMARKS</b>		<b>14</b>
<b>RESEARCH GAPS</b>		<b>16</b>
<b>DISSEMINATION AND IMPLEMENTATION</b>		<b>16</b>
	Dissemination of this guideline	16
	Equity, human rights and implementation considerations	17
	Ethical considerations	19
	Monitoring and evaluation	20

<b>GUIDELINE DEVELOPMENT PROCESS</b>	<b>21</b>
Advisory groups	21
Scope of the guideline	22
Evidence appraisal and decision-making	22
<b>MANAGEMENT OF CONFLICTS OF INTEREST</b>	<b>23</b>
<b>PLANS FOR UPDATING THE GUIDELINE</b>	<b>25</b>
<b>REFERENCES</b>	<b>26</b>
<b>ANNEX 1.</b>	
<b>Forest plots on effect estimates and confidence intervals for some critical outcomes, for both individual studies and meta-analyses</b>	<b>32</b>
A. Effects of the provision of multiple micronutrient powders on anaemia (defined as haemoglobin values lower than 110 g/L) in comparison to no intervention or placebo in infants and young children aged 6–23 months	32
B. Effects of the provision of multiple micronutrient powders on iron deficiency (as defined by trialists) in comparison to no intervention or placebo in infants and young children aged 6–23 months	33
C. Effects of the provision of multiple micronutrient powders on haemoglobin concentration (g/L) in comparison to no intervention or placebo in infants and young children aged 6–23 months	34
D. Effects of point-of-use fortification of foods with micronutrient powders containing iron on anaemia (defined as haemoglobin lower than 110 g/L for children aged 24–59 months and lower than 115 g/L for children aged 5–11.9 years, adjusted by altitude where appropriate) in comparison to no intervention or placebo in children of preschool and school age	35
E. Effects of point-of-use fortification of foods with micronutrient powders containing iron on haemoglobin (g/L) in comparison to no intervention or placebo in children of preschool and school age	36
F. Effects of point-of-use fortification of foods with micronutrient powders containing iron on iron deficiency (as defined by trialists) in comparison to no intervention or placebo in children of preschool and school age.	37
<b>ANNEX 2.</b>	
<b>GRADE summary of findings tables</b>	<b>38</b>
A. Micronutrient powders for point-of-use fortification of foods versus placebo/no intervention in infants and young children aged 6–23 months	38
B. Micronutrient powders for point-of-use fortification of foods versus iron supplements in infants and young children aged 6–23 months	39
C. Iron-containing micronutrient powders for point-of-use fortification of foods versus placebo/no intervention in children aged 2–12 years	40

<b>ANNEX 3.</b>	<b>Systematic review teams</b>	<b>41</b>
	Systematic review 1	41
	Systematic review 1	41
<b>ANNEX 4.</b>	<b>QUESTIONS IN POPULATION, INTERVENTION, CONTROL, OUTCOMES (PICO) FORMAT</b>	<b>42</b>
	Effects and safety of multiple micronutrient powders for infants and young children aged 6–23 months and children aged 2–12 years	42
<b>ANNEX 5.</b>	<b>Summary of the considerations of the members of the guideline development group for determining the strength of the recommendations for use of multiple micronutrient powders for point-of-use fortification of foods consumed by infants and young children aged 6–23 months and children aged 2–12 years</b>	<b>43</b>
<b>ANNEX 6.</b>	<b>WHO Steering Committee for Nutrition Guidelines Development</b>	<b>44</b>
<b>ANNEX 7.</b>	<b>WHO guideline development group – nutrition actions 2013–2014</b>	<b>46</b>
<b>ANNEX 8.</b>	<b>WHO Secretariat</b>	<b>48</b>
	WHO headquarters	48
	WHO regional offices	48
<b>ANNEX 9.</b>	<b>External resource experts</b>	<b>49</b>
<b>ANNEX 10.</b>	<b>Peer-reviewers</b>	<b>50</b>



## PUBLICATION HISTORY

This guideline, *Use of multiple micronutrient powders for point-of-use fortification of foods consumed by infants and young children aged 6–23 months and children aged 2–12 years* is an update of the 2011 WHO guideline, *Use of multiple micronutrient powders for home fortification of foods consumed by infants and children 6–23 months of age*. The present guideline supersedes the previous publication.

The word “home” has been substituted by “point-of-use”, to reflect the variety of settings where this intervention may take place. The population groups covered in the guideline have been expanded to include preschool and school-age children (i.e. children aged 2–12 years).

In order to produce this current guideline, the standard guideline development process was followed, according to the [WHO handbook for guideline development](#).

## ACKNOWLEDGEMENTS

This guideline was coordinated by Mr Gerardo Zamora and Dr Lisa Rogers, under the supervision of Dr Juan Pablo Peña-Rosas. Thanks are due to Dr Susan Norris, Ms Myriam Felber and staff from the World Health Organization (WHO) Guidelines Review Committee Secretariat for their support throughout the process and to Ms Alma Alic from the WHO Compliance, Risk Management and Ethics Office for her support in the management of conflicts-of-interest procedures. Thanks are also due to the office of the Deputy Minister for the Prevention and Promotion of Health, Ministry of Health, Mexico, for their support in the preparation of one of the consultative meetings where this guideline was discussed. WHO acknowledges the technical contribution from the following individuals (in alphabetical order): Ms Evelyn Boy, Ms Mónica Flores-Urrutia, Ms Hala Boukerdenna, Dr Maria Nieves Garcia-Casal, Dr Pura Rayco-Solon, Ms Rebekah Thomas Bosco and the peer-reviewers. Ms Jennifer Volonnino from the Evidence and Programme Guidance Unit, Department of Nutrition for Health and Development, provided logistic support.

WHO gratefully acknowledges the technical input of the members of the Nutrition Steering Committee and the WHO guidelines development group – nutrition actions 2013–2014, especially the chairs of the meetings, Dr Rebecca Stoltzfus and Ms Rusidah Selamat. WHO is also grateful to the staff of the Cochrane Developmental, Psychosocial and Learning Problems Group, for their support during the development of the systematic review used to inform this guideline.

The International Micronutrient Malnutrition Prevention and Control Programme (IMMPaCt) of the Centers for Disease Control and Prevention (CDC), United States of America and the Micronutrient Initiative, Canada provided technical support to the Evidence and Programme Guidance Unit for the commissioning and update of systematic reviews informing this guideline.

## FINANCIAL SUPPORT

WHO thanks the Bill & Melinda Gates Foundation for providing financial support for the preparation of this guideline. Donors do not fund specific guidelines and do not participate in any decision related to the guideline development process, including the composition of research questions, membership of the guideline groups, conduct and interpretation of systematic reviews, or formulation of recommendations.



## WHO GUIDELINE<sup>1</sup>:

# USE OF MULTIPLE MICRONUTRIENT POWDERS FOR POINT-OF-USE FORTIFICATION OF FOODS CONSUMED BY INFANTS AND YOUNG CHILDREN AGED 6–23 MONTHS AND CHILDREN AGED 2–12 YEARS

## EXECUTIVE SUMMARY

### Background

Approximately 300 million children globally had anaemia in 2011.<sup>2,3</sup> The WHO African, South-East Asia, and Eastern Mediterranean Regions have the highest burden of anaemia, with approximately 62%, 54% and 48%, respectively, of children aged 6–59 months suffering from anaemia. Iron deficiency is thought to be the most common cause of anaemia. It is also estimated that 29% of preschool-age children in low- and middle-income countries are affected by vitamin A deficiency. The highest burden occurs in Saharan Africa and South Asia, with approximately 48% and 44% of children aged 6–59 months being vitamin A deficient.<sup>4</sup> To date, no direct estimates of zinc deficiency are available for these age groups, but it is thought that it may be also widespread.

### Purpose of the guideline

Member States have requested guidance from WHO on the effects and safety of the use of multiple micronutrient powders for point-of-use<sup>5</sup> fortification of foods consumed by infants and young children aged 6–23 months and children aged 2–12 years. Point-of-use fortification is often referred to as “home fortification”; the word “home” has been substituted by “point-of-use”, to reflect the variety of settings where this intervention may take place.<sup>7</sup> This guideline is intended to help Member States and their partners in their efforts to make evidence-informed decisions on the appropriate nutrition actions to improve the nutritional status of infants and children aged 6 months to 12 years. It will also support their efforts to achieve the [Sustainable Development Goals](#),<sup>6</sup> the global targets set by the [Comprehensive implementation plan on maternal, infant and young child nutrition](#),<sup>7</sup> and the [Global strategy for women’s, children’s and adolescents’ health 2016–2030](#).<sup>8</sup>

The guideline is intended for a wide audience, including governments, nongovernmental organizations, health-care workers, scientists and donors involved in the design and implementation of micronutrient programmes and their integration into national and subnational public health strategies and programmes.

<sup>1</sup> A World Health Organization (WHO) guideline is any document, whatever its title, containing WHO recommendations about health interventions, whether they be clinical, public health or policy interventions. A recommendation provides information about what policy-makers, health-care providers or patients should do. It implies a choice between different interventions that have an impact on health and that have ramifications for the use of resources. All publications containing WHO recommendations are approved by the WHO guidelines Review Committee.

<sup>2</sup> The global prevalence of anaemia in 2011. Geneva: World Health Organization; 2015 ([http://apps.who.int/iris/bitstream/10665/177094/1/9789241564960\\_eng.pdf?ua=1&ua=1](http://apps.who.int/iris/bitstream/10665/177094/1/9789241564960_eng.pdf?ua=1&ua=1)).

<sup>3</sup> Stevens GA, Finucane MM, De-Regil LM, Paciorek CJ, Flaxman SR, Branca F et al. Global, regional, and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995–2011: a systematic analysis of population-representative data. *Lancet Glob Health*. 2013;1(1):e16–25. doi:10.1016/S2214-109X(13)70001-9.

<sup>4</sup> Stevens GA, Bennett JE, Hennocq Q, Lu Y, De-Regil LM, Rogers L et al. Trends and mortality effects of vitamin A deficiency in children in 138 low-income and middle-income countries between 1991 and 2013: a pooled analysis of population-based surveys. *Lancet Glob Health*. 2015;3:e528–36. doi: 10.1016/S2214-109X(15)00039-X. (<http://www.sciencedirect.com/science/article/pii/S2214109X1500039X>).

<sup>5</sup> Point-of-use fortification with multiple micronutrient powders refers to the addition of powders containing vitamins and minerals to energy-containing foods at home or in any other place where meals are to be consumed, such as schools, nurseries and refugee camps

<sup>6</sup> United Nations Sustainable Development Knowledge Platform. Sustainable Development Goals (<https://sustainabledevelopment.un.org/sdgs>).

<sup>7</sup> Comprehensive implementation plan on maternal, infant and young child nutrition. In: Sixty-fifth World Health Assembly, Geneva, 21–26 May 2012. Resolutions and decisions, annexes. Geneva: World Health Organization; 2012:12–13 (WHA65/2012/REC/1; [http://apps.who.int/gb/ebwha/pdf\\_files/WHA65-REC1/A65\\_REC1-en.pdf](http://apps.who.int/gb/ebwha/pdf_files/WHA65-REC1/A65_REC1-en.pdf)).

<sup>8</sup> The global strategy for women’s, children’s and adolescents’ health (2016–2023). Survive, thrive transform. Geneva: World Health Organization; 2015 (<http://www.who.int/life-course/partners/global-strategy/global-strategy-2016-2030/en/>).

The guideline is an update of the 2011 WHO guideline on [Use of multiple micronutrient powders for home fortification of foods consumed by infants and children 6–23 months of age](#). The present guideline supersedes the previous one for infants and young children aged 6–23 months and provides new recommendations for children aged 2–12 years.

## Guideline development methodology

WHO developed the present evidence-informed recommendations using the procedures outlined in the [WHO handbook for guideline development](#).<sup>1</sup> The steps in this process included: (i) identification of priority questions and outcomes; (ii) retrieval of the evidence; (iii) assessment and synthesis of the evidence; (iv) formulation of recommendations, including research priorities; and (v) planning for dissemination implementation; (vi) impact evaluation and updating of the guideline. The [Grading of Recommendations Assessment, Development and Evaluation](#) (GRADE) methodology was followed,<sup>2</sup> to prepare evidence profiles related to prioritized questions, determine the quality of the evidence based on up-to-date systematic reviews.

The guideline development group – nutrition actions 2013–2014 consisted of content and method experts, representatives of potential stakeholders and beneficiaries. The names and biographies of the members of the guideline development group are made available on the WHO nutrition website during 14 days prior to holding any guideline development group meeting, in order to promote transparency and allow the public to provide WHO with information and comments on these individuals. The first meeting to scope the guideline was held on 18–21 February 2013, Geneva, Switzerland. The second meeting held on 23–26 June 2014, Geneva Switzerland, aimed to examine the evidence and assess the results of the systematic reviews. The third and final meeting on 3–6 November 2014, Cancun, Mexico, was held to finalize the formulation of the recommendations, including their direction and strength and discussion of the research gaps. External experts, as resource persons, assisted the guideline development group during the guideline development process, in presenting the evidence and contributing to the identification of research gaps. All meeting participants completed a declaration-of-interests form before each meeting. The final guideline document was peer-reviewed by eight experts.

## Available evidence

Two systematic reviews<sup>3,4</sup> following the [Cochrane handbook for systematic reviews of interventions](#)<sup>5</sup> were conducted to assess the effects and safety of point-of-use fortification of foods with multiple micronutrient powders.

Infants and young children from 6 to 23 months of age<sup>1</sup> who consumed foods fortified at the point-of use with multiple micronutrients powders had a lower risk for the critical outcome of anaemia, with a 26% reduction compared to placebo or no intervention (risk ratio [RR]: 0.74; 95% confidence interval [CI]: 0.66 to 0.83; 10 studies; 2802 participants, *high-quality evidence*). They also had a lower risk for the critical outcome of iron deficiency, with a 52% reduction (RR: 0.48; 95% CI: 0.36 to 0.62; 5 studies; 796 participants, *moderate-quality evidence*). Compared to no treatment or placebo, children receiving multiple micronutrient powders had a 5.12 g/L higher haemoglobin concentration at follow-up (mean difference [MD]: 5.12 g/L; 95% CI: 2.70 to 7.54 g/L; 12 studies; 3565 participants, *low-quality evidence*).

<sup>1</sup> WHO handbook for guideline development, 2nd ed. Geneva: World Health Organization; 2014 ([http://www.who.int/kms/handbook\\_2nd\\_ed.pdf?ua=1](http://www.who.int/kms/handbook_2nd_ed.pdf?ua=1)).

<sup>2</sup> GRADE working group (<http://www.gradeworkinggroup.org/>).

<sup>3</sup> De-Regil LM, Suchdev PS, Jefferds MED, Ota E. Home fortification of foods with multiple micronutrient powders for health and nutrition in children under two years of age (personal communication)

<sup>4</sup> De-Regil LM, Jefferds MED, Peña-Rosas JP. Point-of-use fortification of foods with micronutrient powders containing iron in children of preschool and school age (personal communication)

<sup>5</sup> Higgins JPT, Green S, editors. Cochrane handbook for systematic reviews of interventions. York: The Cochrane Collaboration; 2011 (<http://handbook.cochrane.org/>).

With respect to iron status, compared to no treatment or placebo, children receiving multiple micronutrient powders had an average increase in serum ferritin concentration of 16.47 µg/L at follow-up (MD: 16.47 µg/L; 95% CI: 3.03 to 29.91 µg/L; 3 studies; 694 participants, *very low-quality evidence*). Regarding weight-for-age z-score, the mean difference was minimal (MD: 0.04 in z-score; 95% CI: -0.13 to 0.21; 4 studies; 606 participants, *low-quality evidence*). None of the trials reported on the outcome of all-cause mortality.

Children aged 2–12 years receiving iron-containing multiple micronutrient powders for point-of-use fortification of foods were significantly less likely to have anaemia at follow-up than those children receiving no intervention or a placebo (prevalence ratio [PR]: 0.66; 95% CI: 0.49 to 0.88; 10 studies, 2448 participants, *moderate-quality evidence*). These children also had a 3.37 g/L higher haemoglobin concentration at follow-up (MD: 3.37 g/L; 95% CI: 0.94 to 5.80 g/L; 11 studies; 2746 participants, *low-quality evidence*). Also, children receiving iron-containing multiple micronutrient powders for point-of-use fortification of foods were significantly less likely to have iron deficiency at follow-up than those children receiving no intervention or a placebo (PR: 0.35; 95% CI: 0.27 to 0.47; 5 studies; 1364 participants, *moderate-quality evidence*). With respect to ferritin concentrations, children receiving iron-containing multiple micronutrient powders had, on average, 0.42 µg of ferritin more per litre at follow-up than those children receiving no intervention or a placebo (standardized mean difference [SMD]: 0.42 µg/L; 95% CI: -4.36 to 5.19 µg/L; 3 studies; 1066 participants, *very low-quality evidence*). Regarding all-cause mortality, only one trial reported on this outcome and there were no deaths reported during this trial (MD: 0; 95% CI: -0.03 to 0.03; 1 study; 115 participants, *low-quality evidence*). Finally, diarrhoea (three liquid stools or more per day) was reported by two trials and children receiving iron-containing multiple micronutrient powders for point-of-use fortification of foods were as likely to have diarrhoea at follow-up as those children receiving no intervention or a placebo (RR: 0.97; 95% CI: 0.53 to 1.78; 2 studies; 366 participants, *moderate-quality evidence*).

## Recommendations

### Recommendation 1

- In populations where anaemia is a public health problem,<sup>1</sup> point-of-use fortification of complementary foods<sup>2</sup> with iron-containing micronutrient powders in infants and young children aged 6–23 months is recommended, to improve iron status and reduce anaemia (*strong recommendation, moderate-quality evidence*).

Table 1 includes a suggested scheme for point-of-use fortification of complementary foods with iron-containing micronutrient powders in infants and young children aged 6–23 months.

<sup>1</sup> Populations where the prevalence of anaemia in infants and young children under 2 years of age or children under 5 years of age is 20% or higher.

<sup>2</sup> According to the WHO 2003 publication, Complementary feeding: report of the global consultation (<http://www.who.int/nutrition/publications/infantfeeding/924154614X/en/>), appropriate complementary feeding should start from the age of 6 months, with continued breast feeding up to 2 years or beyond. Further guidance on complementary feeding may assist the implementation of this guideline, including the WHO/Pan American Health Organization document, Guiding principles for complementary feeding of the breastfed child ([http://www.who.int/nutrition/publications/guiding\\_principles\\_compfeeding\\_breastfed.pdf](http://www.who.int/nutrition/publications/guiding_principles_compfeeding_breastfed.pdf)) and the WHO publication, Guiding principles for feeding non-breastfed children 6–24 months of age ([http://www.who.int/maternal\\_child\\_adolescent/documents/9241593431/en/](http://www.who.int/maternal_child_adolescent/documents/9241593431/en/))

**TABLE 1. Suggested scheme for point-of-use fortification of foods with multiple micronutrient powders consumed by infants and young children aged 6–23 months**

Scheme for fortification	Target group: infants and young children aged 6–23 months
Composition per sachet	<ul style="list-style-type: none"> <li>• Iron: 10 to 12.5 mg of elemental iron<sup>a</sup></li> <li>• Vitamin A: 300 µg retinol</li> <li>• Zinc: 5 mg elemental zinc</li> <li>• With or without other micronutrients to achieve 100% of the RNI<sup>b,c</sup></li> </ul>
Regimen	Programme target of 90 sachets/doses over a 6-month period
Settings	Areas where the prevalence of anaemia in children aged under 2 years or under 5 years is 20% or higher

<sup>a</sup> 12.5 mg of elemental iron equals 37.5 mg of ferrous fumarate or 62.5 mg of ferrous sulfate heptahydrate or equivalent amounts in other iron compounds. In children aged 6–12 months, sodium iron EDTA (NaFeEDTA) is generally not recommended. If NaFeEDTA is selected as a source of iron, the EDTA intake (including other dietary sources) should not exceed 1.9 mg EDTA/kg/day.

<sup>b</sup> Recommended nutrient intake (RNI). Multiple micronutrient powders can be formulated with or without other vitamins and minerals in addition to iron, vitamin A and zinc, to achieve 100% of the RNI,<sup>1</sup> and also taking into consideration the technical and sensory properties.

<sup>c</sup> Where feasible, likely consumption from other sources, including home diet and fortified foods, should be taken into consideration for establishing the composition of the sachet.

## Recommendation 2

- In populations where anaemia is a public health problem,<sup>2</sup> point-of-use fortification of foods with iron-containing micronutrient powders in children aged 2–12 years is recommended, to improve iron status and reduce anaemia (*strong recommendation, moderate-quality evidence*).

Table 2 includes a suggested scheme for point-of-use fortification of foods with iron-containing micronutrient powders in children aged 2–12 years.

**TABLE 2. Suggested scheme for point-of-use fortification of foods with iron-containing micronutrient powders in children aged 2–12 years**

Scheme for fortification	Target group: children aged 2–12 years
Composition per sachet	<ul style="list-style-type: none"> <li>• Iron: 10 to 12.5 mg of elemental iron for children aged 2–4 years; and 12.5 to 30 mg elemental iron for children aged 5–12 years<sup>a</sup></li> <li>• Vitamin A: 300 µg retinol</li> <li>• Zinc: 5 mg elemental zinc</li> <li>• With or without other micronutrients to achieve 100% of the RNI<sup>b,c</sup></li> </ul>
Regimen	Programme target of 90 sachets/doses over a 6-month period
Settings	Areas where the prevalence of anaemia in children under 5 years of age, is 20% or higher

<sup>a</sup> 12.5 mg of elemental iron equals 37.5 mg of ferrous fumarate or 62.5 mg of ferrous sulfate heptahydrate or equivalent amounts in other iron compounds. If sodium iron EDTA (NaFeEDTA) is selected as a source of iron, the dose of elemental iron should be reduced by 3–6 mg due to its higher bioavailability. The appropriate range of NaFeEDTA is an area of research need.

<sup>b</sup> Recommended nutrient intake (RNI). Multiple micronutrient powders can be formulated with or without other vitamin and minerals in addition to iron, vitamin A and zinc to achieve 100% of the RNI,<sup>3</sup> and also taking into consideration the technical and sensory properties.

<sup>c</sup> Where feasible, likely consumption from other sources, including home diet and fortified foods, should be taken into consideration for establishing the composition of the sachet.

<sup>1</sup> World Health Organization and Food and Agriculture Organization of the United Nations. Vitamin and mineral requirements in human nutrition, 2nd ed. Geneva: World Health Organization; 2004 (<http://apps.who.int/iris/bitstream/10665/42716/1/9241546123.pdf?ua=1>).

<sup>2</sup> Populations where the prevalence of anaemia in school-age children is 20% or higher.

<sup>3</sup> World Health Organization and Food and Agriculture Organization of the United Nations. Vitamin and mineral requirements in human nutrition, 2nd ed. Geneva: World Health Organization; 2004 (<http://apps.who.int/iris/bitstream/10665/42716/1/9241546123.pdf?ua=1>).

## Remarks

The remarks are intended to assist in the implementation of these recommendations in the context of programmes towards improving infant and child health and nutritional status

- The term “home fortification” has been substituted by the term “point-of-use fortification” because the process of fortification occurs not only at home but also at schools, nurseries, refugee camps or other places, where appropriate.
- The use of multiple micronutrient powders is a preventive strategy for implementation at population level without screening for any condition or disease. Children diagnosed with anaemia should be treated appropriately, according to WHO and national guidelines.<sup>1</sup>
- Anaemia is frequently caused by iron deficiency, but other factors may contribute to anaemia, including other micronutrient deficiencies (e.g. folic acid, zinc, vitamins A and B<sub>12</sub>), malaria, soil-transmitted helminths, other infections, and blood disorders (e.g. thalassaemias, sickle cell). The use of multiple micronutrient powders for the age groups indicated in the recommendations should be part of an integrated approach to address anaemia, which should explicitly address inequities in the causes of micronutrient deficiencies (i.e. some population groups are more affected and/or vulnerable to micronutrient deficiencies than other groups when stratifying by, for instance, income level, place of residence or educational level, as well as when taking into account cultural practices, social norms around gender, or stigma suffered by groups that are discriminated against in each specific context).
- The evidence considered in the systematic reviews<sup>2,3</sup> included trials with intakes of multiple micronutrient powders ranging from 60 to 360 sachets (or doses) in a 12-month period. The recommendation of providing 90 sachets (or doses) was based on the judgment of the members of the guideline development group, considering the quality of the diet in low- and middle-income countries, as well as desirable and undesirable effects of the intervention, values and preferences, and costs. The number of sachets or doses may be adjusted if data on iron status or other micronutrient status of the vulnerable population is known. Implementers should also consider the number of sachets that are provided to the caregiver each time, in order to promote adherence and proper use.
- Countries should have a national strategy for prevention and control of micronutrient malnutrition. The choice of intervention (e.g. point-of-use fortification with multiple micronutrient powders, fortified foods, iron supplements, lipid-based nutrient supplements) should be considered in the context of a national strategy for control and prevention of micronutrient deficiency, including consideration of costs, cost effectiveness, feasibility and acceptability.
- Programmes of point-of-use fortification with micronutrient powders should include a behaviour-change strategy that promotes awareness and correct use of this product, proper and hygienic preparation, feeding of complementary foods for children older than 6 months and a healthy diet for children older than 2 years. Recommended breastfeeding practices, hand washing with soap, prompt attention to fever in malaria settings, and measures to manage diarrhoea should also be included. Further, these programmes should include training for health-care workers or other types of workers to adequately provide nutrition counselling and demonstrate the correct use of multiple micronutrient powders.

<sup>1</sup> Guideline: Daily iron supplementation in infants and children. Geneva: World Health Organization; 2016. ([http://apps.who.int/iris/bitstream/10665/204712/1/9789241549523\\_eng.pdf?ua=1&ua=1](http://apps.who.int/iris/bitstream/10665/204712/1/9789241549523_eng.pdf?ua=1&ua=1))

<sup>2</sup> De-Regil LM, Suchdev PS, Jefferds MED, Ota E. Home fortification of foods with multiple micronutrient powders for health and nutrition in children under two years of age (personal communication).

<sup>3</sup> De-Regil LM, Jefferds MED, Peña-Rosas JP. Point-of-use fortification of foods with micronutrient powders containing iron in children of preschool and school age (personal communication).

- In malaria-endemic areas, the provision of iron in any form, including micronutrient powders for point-of-use fortification, should be implemented in conjunction with measures to prevent, diagnose and treat malaria.<sup>1</sup> Provision of iron through these interventions should not be made to children who do not have access to malaria-prevention strategies (e.g. provision of insecticide-treated bednets and vector-control programmes), prompt diagnosis of malaria illness, and treatment with effective antimalarial drug therapy.
- If sugar is fortified with vitamin A, vitamin A should be excluded from the multiple micronutrient powders. If other staple foods regularly consumed by children (e.g. oil) are fortified with vitamin A, the risk of inadequate and high intakes of vitamin A should be assessed and the decision to include or exclude vitamin A from the multiple micronutrient powders should be based on that assessment prior to programme implementation, with regular review to permit adjustment of vitamin A as needed. Ideally, any public health nutrition interventions distributing micronutrients (e.g. food fortification and micronutrient supplementation) should be designed and implemented in a coordinated manner.
- High-dose vitamin A supplements are a child-survival intervention in populations at risk of vitamin A deficiency,<sup>2</sup> and do not provide a regular source of vitamin A in the diet. Therefore, multiple micronutrient powders are not a replacement for this programme. The appropriate combination of interventions to address vitamin A and other deficiencies should be based on the local context and articulated in a national micronutrient strategy.
- For comparability, it is important that outcomes are measured and reported using standard definitions where they exist, e.g. diarrhoea, as defined by WHO.

### *Research gaps*

Discussions within the WHO guideline development group – nutrition actions 2013–2014 highlighted the need for further research in the areas listed next.

- Potential short- and long-term functional, developmental, and adverse outcomes of the use of multiple micronutrient powders, particularly for morbidity in various settings, and factors that might modify these effects, such as high rates of infectious diseases, baseline nutritional status, and poor access to and utilization of primary health-care services.
- The lowest effective dose of NaFeEDTA in multiple micronutrient powders and local complementary foods.
- Nutritional improvement of complementary foods in the context of locally accessible and acceptable foods.
- The composition of the sachets of multiple micronutrient powders and the dose, to determine the most effective and cost-effective dose for anaemia reduction and other outcomes.
- Selection of the best combination/number of nutrients included in the multiple micronutrient powders.
- Risks and benefits of daily versus other frequencies of use of multiple micronutrient powders. In this view, it is also important to increase research efforts on identifying the feasibility and ease (or difficulty) of implementing various schemes (e.g. daily, flexible) and factors affecting the acceptability of these schemes.

1 Guidelines for the treatment of malaria, 3rd ed. Geneva: World Health Organization; 2015 ([http://apps.who.int/iris/bitstream/10665/162441/1/9789241549127\\_eng.pdf?ua=1&ua=1](http://apps.who.int/iris/bitstream/10665/162441/1/9789241549127_eng.pdf?ua=1&ua=1)).

2 Vitamin A supplementation for infants and children 6–59 months of age. Geneva: World Health Organization; 2011 ([http://apps.who.int/iris/bitstream/10665/44664/1/9789241501767\\_eng.pdf?ua=1&ua=1](http://apps.who.int/iris/bitstream/10665/44664/1/9789241501767_eng.pdf?ua=1&ua=1)).

- Identification of the minimal requirements for formative research, to guide the design of programmes distributing multiple micronutrient powders. Also, further research is needed to understand how such research results should be fully taken into consideration in the development of the behaviour-change intervention strategies. Similarly, research priorities should include focused efforts to identify the minimum behaviour-change intervention strategies that effectively support the adoption and appropriate use of multiple micronutrient powders.
- Identification of the effects of multiple micronutrient powders on outcomes beyond anaemia and iron deficiency, including potential negative effects and factors that modify them (e.g. micronutrient status, functional outcomes, morbidity).
- Assessment of values and preferences regarding the multiple micronutrient powders, from parents, health-care workers and local subnational authorities where the intervention is implemented. Further, this research should look at the link between values and preferences, acceptability, perceived side-effects and use of multiple micronutrient powders.
- How contexts and cultural factors are taken into account in the design and implementation of interventions.

### *Plans for updating the guideline*

The WHO Secretariat will continue to follow the research development in the area of micronutrient interventions aimed at infants and young children aged 6–23 months and children aged 2–12 years. If the guideline merits an update, or if there are concerns about the validity of the guideline, the Department of Nutrition for Health and Development will coordinate the guideline update, following the formal procedures of the [WHO handbook for guideline development](#).<sup>1</sup>

---

<sup>1</sup> WHO handbook for guideline development, 2nd ed. Geneva: World Health Organization; 2014 ([http://www.who.int/kms/handbook\\_2nd\\_ed.pdf?ua=1](http://www.who.int/kms/handbook_2nd_ed.pdf?ua=1)).



## WHO GUIDELINE<sup>1</sup>:

# USE OF MULTIPLE MICRONUTRIENT POWDERS FOR POINT-OF-USE FORTIFICATION OF FOODS CONSUMED BY INFANTS AND YOUNG CHILDREN AGED 6–23 MONTHS AND CHILDREN AGED 2–12 YEARS

## SCOPE AND PURPOSE

This guideline provides global, evidence-informed recommendations on the use of multiple micronutrient powders for point-of-use fortification of foods consumed by infants and young children aged 6–23 months and children aged 2–12 years.

Member States have requested guidance from WHO on the effects and safety of the use of multiple micronutrient powders for point-of-use fortification of foods consumed by infants and young children aged 6–23 months and children aged 2–12 years. The guideline is intended to help Member States and their partners in their efforts to make evidence-informed decisions on the appropriate nutrition actions to improve the nutritional status of infants and children aged 6 months to 12 years. It will also support their efforts to achieve the [Sustainable Development Goals](#) (1), in particular, ending hunger and improving nutrition (SDG 2) and ensuring healthy lives and promoting well-being (SDG 3). It will also help Member States and their efforts to achieve the global targets set by the [Comprehensive implementation plan on maternal, infant and young child nutrition](#) as endorsed by the Sixty-fifth World Health Assembly (2) and the [Global strategy for women's, children's and adolescents' health 2016–2030](#) (3).

The guideline is intended for a wide audience, including governments, nongovernmental organizations, health-care workers, scientists and donors involved in the design and implementation of micronutrient programmes and their integration into national and subnational public health strategies and programmes.

This document presents the key recommendations. Further details of the evidence base supporting the recommendations are provided in [Annex 1](#) and [Annex 2](#) and in the documents listed in the references.

This guideline is an update of the 2011 WHO guideline on [Use of multiple micronutrient powders for home fortification of foods consumed by infants and children 6–23 months of age](#) (4). The current guideline updates the evidence on the use of multiple micronutrient powders by infants and young children aged 6–23 months and includes the group of children aged 2–12 years. This document expands the sections on dissemination and updates the summary of evidence used for this guideline, based on the most recent systematic reviews on the topic.

## BACKGROUND

Deficiencies of iron and vitamin A have the largest documented disease burden among micronutrients (5, 6), particularly in low- and middle-income countries. Infants and children are the groups that are most vulnerable to micronutrient malnutrition, given the high vitamin and mineral intake they need to support their rapid growth and adequate development (7). Diets that are predominantly plant based generally provide

<sup>1</sup> A World Health Organization (WHO) guideline is any document, whatever its title, containing WHO recommendations about health interventions, whether they be clinical, public health or policy interventions. A recommendation provides information about what policy-makers, health-care providers or patients should do. It implies a choice between different interventions that have an impact on health and that have ramifications for the use of resources. All publications containing WHO recommendations are approved by the WHO guidelines Review Committee.

insufficient amounts of key micronutrients (particularly vitamin A, zinc and iron) to meet the recommended nutrient intakes. The inclusion of animal-source foods that could meet the nutrient gap increases the cost and may be not affordable for the lowest-income groups (8, 9).

Approximately 300 million children globally had anaemia in 2011 (10, 11). The WHO African, South-East Asia and Eastern Mediterranean Regions have the highest burden of anaemia, with approximately 62%, 54% and 48%, respectively, of children aged 6–59 months suffering from anaemia. Iron deficiency is thought to be the most common cause of anaemia. Iron is a mineral that is necessary to carry oxygen in haemoglobin, and iron deficiency is thought to be the most common cause of anaemia. Iron deficiency can result from inadequate intake or absorption of dietary iron, increased need in periods of growth, or infection by intestinal helminths, such as schistosomiasis or hookworm infestation, in areas endemic to these parasites, among other causes of infection (12).

It is also estimated that 29% of preschool-age children in low- and middle-income countries are affected by vitamin A deficiency. The highest burden occurs in Saharan Africa and South Asia, with approximately 48% and 44% of children aged 6–59 months being vitamin A deficient (13). Vitamin A is required in infants and children to support rapid growth and to combat infections.

To date, no direct estimates of zinc deficiency are available for these age groups, but inadequate intakes of dietary zinc is considered to be fairly common, particularly in Sub-Saharan Africa and South Asia. Multiple vitamin and mineral deficiencies frequently occur simultaneously and their joint effects during the critical period from preconception to 23 months of age may be associated with irreversible physical and cognitive consequences and increased neonatal mortality and morbidity (14–16), leading to lifelong detrimental consequences on health, productivity and economic growth. It has been estimated that nutritional risk factors, including underweight, suboptimal breastfeeding, and vitamin and mineral deficiencies, particularly of vitamin A, iron and zinc, are responsible for 3.9 million deaths (35% of total deaths) and 144 million disability-adjusted life-years (DALYs; 33% of total DALYs) in children aged less than 5 years (6).

Interventions to prevent and/or treat micronutrient malnutrition typically include exclusive breastfeeding during the first 6 months of life, dietary diversification to include foods with highly absorbable vitamins and minerals, fortification of staple and complementary foods, and provision of supplements (2). Micronutrient interventions, particularly vitamin A and zinc supplementation for children, and fortification of foods with iron and iodine, are considered to be among the most cost-effective global development efforts (17). Despite the well-recognized benefits of micronutrient interventions, implementation bottlenecks and barriers (e.g. poor adherence to dosing regimens, low acceptability, prevailing social norms and values, poor distribution channels, low-skilled health workers, geographical barriers and low availability of resources) may reduce the effectiveness and impact of micronutrient interventions (18).

Interest in alternative ways of providing micronutrients to populations where supplementation has been difficult to implement, or where the target group is difficult to reach through mass fortification, has led to the development of multiple micronutrient powders, which are a mixture of vitamins and minerals in powder form (19). The powders are supplied as small, single-serving packets, the contents of which can be mixed into semi-solid food before consumption (20). Fortification of foods using these micronutrient powders can take place in several settings, such as home or any other place where meals are to be consumed, such as schools, nurseries and refugee camps (21).

The use of multiple micronutrient powders for point-of-use fortification of foods has been suggested as an alternative to mitigate or overcome the constraints associated with supplementation and mass fortification. They are intended to increase the vitamin and mineral intake of infants and young children aged 6 to 23

months as well as preschool and school-age children aged 2–12 years. The use of multiple micronutrient powders for point-of-use fortification has been tested and implemented for other population groups such as pregnant women, although WHO guidelines do not recommend the use of multiple micronutrient powders in lieu of the standard iron and folic acid supplementation during pregnancy (22).

Multiple micronutrient powders are not food or a breast-milk substitute and do not mix well with liquids. In line with the existing WHO recommendation, children under the age of 6 months should be exclusively breastfed and then have timely introduction of adequate and safe complementary foods, while continuing breastfeeding up to 2 years of age (23).

Several countries are implementing or planning to implement point-of-use fortification programmes that provide multiple micronutrient powders to infants older than 6 months of age and children up to 12 years of age (24).

Countries should have a national strategy for control and prevention of micronutrient deficiency. For the specific case of prevention and control of iron deficiency, the following are suggested elements to be included in a national strategy: (i) set national goals for anaemia reduction; (ii) coordinate public health programmes distributing iron in the population, i.e. supplementation and food fortification; (iii) promote intersectoral action within, for instance, health, agriculture and education; (iv) engage national and subnational authorities and civil society organizations in the strategy; (v) secure financing for the prevention and control actions; (vi) increase the accessibility of iron-rich foods; and (vi) link research and policy so public health programmes are designed using the best available evidence, and promote availability, acceptability and use of micronutrient supplements and fortified foods where needed.

## SUMMARY OF EVIDENCE

Point-of-use fortification with multiple micronutrient powders refers to the addition of powders containing vitamins and minerals to energy-containing foods, at home or in any other place where meals are to be consumed, such as schools, nurseries and refugee camps (21).

Two systematic reviews (25, 26) following the [Cochrane handbook for systematic reviews of interventions](#) (27) were prepared to assess the effects and safety of point-of-use fortification of foods with multiple micronutrient powders. The systematic review teams can be found in [Annex 3](#). The systematic reviews responded to the questions in PICO format, i.e. population, intervention, control and outcomes (see [Annex 4](#)), which were formulated by the corresponding steering committee and guideline development group. Forest plots for the main comparisons, displaying the effect estimates and confidence intervals for both individual included studies and meta-analyses for some of the critical outcomes in the reviews, are presented in [Annex 1](#).

### *Multiple micronutrient powders in infants and young children aged 6–23 months*

The first systematic review (25) was updated to assess the effects and safety of point-of-use fortification of foods with multiple micronutrient powders for infants and young children from 6 to 23 months of age. The review included randomized and quasi-randomized trials with either individual or cluster randomization. The population of interest was infants and young children aged 6–23 months at the start of the intervention, with no specific health problems, although some of the participating children may have been at risk of having highly prevalent diseases such as malaria, HIV, diarrhoea or even undernutrition. The intervention was consumption of foods fortified at the point-of-use with multiple micronutrient powders formulated with at least iron, zinc and vitamin A, for any dose, frequency or duration. The intervention was compared with: (i) no intervention or placebo; (ii) iron-only supplement; (iii) iron and folic acid supplements; and (iv) the same multiple micronutrients as supplements. The critical outcomes measured were anaemia (defined as haemoglobin values lower than 110 g/L, adjusted for altitude where appropriate), iron deficiency (as defined

by trialists), and haemoglobin concentration (g/L). Additionally, iron status (as defined by trialists) and weight-for-age (z-scores) were also measured. For populations in malaria-endemic areas, two additional outcomes were considered: malaria incidence and malaria severity.

A total of 15 trials (28–48)<sup>1</sup> were included, with 12 239 participants in low- and middle-income countries in Asia, Africa and the Americas (Bangladesh, Cambodia, Colombia, Ghana, Haiti, India, Indonesia, Kenya, Kyrgyzstan, Lao People's Democratic Republic and Pakistan). The interventions lasted between 2 and 18 months and the powder formulations contained between 5 and 19 micronutrients. Most of the included trials were assessed as at low risk of bias. Six of the studies were conducted in malaria-endemic areas (29, 30, 33, 34, 36–38, 40, 42–45).

For the first comparison (i.e. multiple micronutrient powders versus no intervention or a placebo), infants and children who consumed foods fortified at the point-of-use with multiple micronutrient powders had a lower risk for the critical outcome of anaemia, with a 26% reduction compared to placebo or no intervention (risk ratio [RR]: 0.74; 95% confidence interval [CI]: 0.66 to 0.83; 10 studies; 2802 participants, *high-quality evidence*). They also had a lower risk for the critical outcome of iron deficiency, with a 52% reduction (RR: 0.48; 95% CI: 0.36 to 0.62; 5 studies; 796 participants, *moderate-quality evidence*). Compared to no treatment or placebo, children receiving multiple micronutrient powders had a 5.12 g/L higher haemoglobin concentration at follow-up (mean difference [MD]: 5.12 g/L; 95% CI: 2.70 g/L to 7.54 g/L; 10 studies; 3565 participants, *low-quality evidence*). With respect to iron status, compared to no treatment or placebo, children receiving multiple micronutrient powders had on average 16.47 µg of ferritin more per litre at follow-up (MD: 16.47 µg/L; 95% CI: 3.03 µg/L to 29.91 µg/L; 3 studies; 694 participants, *very low-quality evidence*). Regarding weight-for-age z-score, the mean difference was minimal (MD: 0.04 in z-score; 95% CI: –0.13 to 0.21; 4 studies; 606 participants, *low-quality evidence*). None of the trials reported on the outcome of all-cause mortality.

Although six studies (29, 30, 32, 33, 36, 37, 42, 43, 45) were conducted in settings considered as malaria-endemic, only one study (29, 30) reported results related to malaria and found that there was no difference in the presence of positive malaria smears between the groups (RR 0.24; 95% CI 0.05 to 1.12; 194 children).

The quality of the evidence was assessed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology (49–51). The GRADE summary of findings table can be found in [Annex 2A](#).

For the second comparison (i.e. multiple micronutrient powders versus iron-only supplement), the trials reported only anaemia (RR: 0.89; 95% CI: 0.58 to 1.39; 1 study; 145 participants, *low-quality evidence*) and haemoglobin concentration (MD: –2.81 g/L; 95% CI: –10.84 g/L to 5.22 g/L; 2 studies; 278 participants, *very low-quality evidence*). The GRADE summary of findings table can be found in [Annex 2B](#).

No studies compared provision of multiple micronutrient powders versus iron and folic acid supplements. Likewise, no studies compared provision of multiple micronutrient powders versus multiple vitamin and mineral supplements.

In general, the use of multiple micronutrient powders was well accepted by the study participants; however, acceptance of the intervention did not always translate into better adherence. In fact, adherence to the intervention varied among studies and high adherence was more likely when the product was provided on an intermittent basis, probably because this regime creates less pressure and anxiety on caregivers (please see section “[Dissemination and implementation](#)” for considerations on adherence).

<sup>1</sup> These 21 references list the published articles for the 18 trials included in the first systematic review.

In conclusion, the use of multiple micronutrient powders for point-of-use fortification of foods is an effective intervention to reduce anaemia and iron deficiency in infants and young children aged 6–23 months. The intervention is equally efficacious in settings with different prevalence rates of anaemia and malaria endemicity versus areas with sporadic malarial cases, and regardless of the duration of the intervention (2 to 18 months).

### ***Multiple micronutrient powders in children aged 2–12 years***

The second systematic review (26) was conducted to assess the effects and safety of point-of-use fortification of foods with multiple micronutrient powders for children from 2 to 12 years of age (i.e. preschool and school-age children). The review included randomized and quasi-randomized trials with either individual or cluster randomization. The population of interest was children aged 2 to 12 years at the start of the intervention, with no specific health problems, although some of the participating children may have been at risk of suffering from anaemia or iron deficiency at baseline, owing to the high prevalence of these conditions in the settings where the trials took place. The intervention was consumption of foods fortified at the point of use with multiple micronutrient powders formulated with at least iron, for any dose, frequency or duration. The intervention was compared with: (i) no intervention or placebo, (ii) iron-only supplement, (iii) iron and folic acid supplements, and (iv) the same multiple micronutrients as supplements. The critical outcomes measured were anaemia (defined as haemoglobin lower than 110 g/L for children aged 24 to 59 months and lower than 115 g/L for children aged 5 to 11.9 years, adjusted by altitude where appropriate), haemoglobin (g/L), iron deficiency (as defined by using ferritin concentrations of less than 15 µg/L), ferritin (µg/L), all-cause mortality (number of deaths during the trial) and diarrhoea (three liquid stools or more per day). Subgroup analyses included malaria status.

A total of 12 trials (36–38, 40–43, 52–60)<sup>1</sup> were included, with 5720 participants in low- and middle-income countries in Asia, Africa and the Americas (China, Honduras, India, Indonesia, Kenya, Kyrgyz Republic, Lao People's Democratic Republic, South Africa). Five trials included participants aged with less than 5 years only, four included only children aged 5 years or older, and three trials included children both younger and older than 5 years. The interventions lasted between 2 and 12 months and the powder formulations contained between 2 and 18 micronutrients. The settings included schools, feeding centres and communities. Most of the included trials were assessed as being at low risk of bias.

For the first comparison (i.e. multiple micronutrient powders versus no intervention or a placebo), children receiving iron-containing multiple micronutrient powders for point-of-use fortification of foods were significantly less likely to have anaemia at follow-up than those children receiving no intervention or a placebo (prevalence ratio [PR]: 0.66; 95% CI: 0.49 to 0.88; 10 studies, 2448 participants, *moderate-quality evidence*). These children also had a 3.37 g/L higher haemoglobin concentration at follow-up (MD: 3.37 g/L; 95% CI: 0.94 to 5.80 g/L; 11 studies; 2746 participants, *low-quality evidence*). Also, children receiving iron-containing multiple micronutrient powders for point-of-use fortification of foods were significantly less likely to have iron deficiency at follow-up than those children receiving no intervention or a placebo (PR: 0.35; 95% CI: 0.27 to 0.47; 5 studies; 1364 participants, *moderate-quality evidence*). With respect to ferritin concentrations, children receiving iron-containing multiple micronutrient powders had, on average, 0.42 µg of ferritin more per litre at follow-up than those children receiving no intervention or a placebo (standardized mean difference [SMD]: 0.42 µg/L; 95% CI: –4.36 µg/L to 5.19 µg/L; 3 studies; 1066 participants, *very low-quality evidence*). Regarding all-cause mortality, only one trial reported on this outcome and there were no deaths reported during this trial (MD: 0; 95% CI: –0.03 to 0.03; 1 study; 115 participants, *low-quality evidence*). Finally, diarrhoea (three liquid stools or more per day) was reported by two trials and children receiving iron-containing multiple micronutrient powders for point-of-use fortification of foods were as likely to have diarrhoea at follow-up as those children receiving no intervention or a placebo (RR: 0.97; 95% CI: 0.53 to 1.78; two studies; 366 participants, *moderate-quality evidence*).

<sup>1</sup> These 16 references list the published articles for the 12 trials included in the second systematic review.

The quality of the evidence was assessed using the [GRADE](#) methodology (49–51). The GRADE summary of findings table can be found in [Annex 2C](#). No trial reported on the three other comparisons.

Only one trial (53) reported on adherence; the analysis suggested that children receiving iron-containing multiple micronutrient powders for point-of-use fortification of foods were as likely to adhere to the intervention as those children receiving no intervention or a placebo (RR 1.00; 95% CI: 0.87 to 1.16; 1 study; 131 participants). Acceptability was not consistently considered in the trials and therefore could not be assessed in this review.

In conclusion, the use of iron-containing micronutrient powders for point-of-use fortification of foods can help control anaemia and iron deficiency in preschool and school-age children (i.e. 2–12 years of age).

## RECOMMENDATIONS

### Recommendation 1

- In populations where anaemia is a public health problem,<sup>1</sup> point-of-use fortification of complementary foods<sup>2</sup> with iron-containing micronutrient powders in infants and young children aged 6–23 months is recommended, to improve iron status and reduce anaemia. (*strong recommendation, moderate quality evidence*)

Table 1 includes a suggested scheme for point-of-use fortification of complementary foods with iron containing micronutrient powders in children aged 6–23 months.

**TABLE 1. Suggested scheme for point-of-use fortification of foods with multiple micronutrient powders consumed by infants and young children aged 6–23 months**

Scheme for fortification	Target group: infants and young children aged 6–23 months
Composition per sachet	<ul style="list-style-type: none"> <li>• Iron: 10 to 12.5 mg of elemental iron</li> <li>• Vitamin A: 300 µg retinol</li> <li>• Zinc: 5 mg elemental zinc</li> <li>• With or without other micronutrients to achieve 100% of the RNI<sup>b,c</sup></li> </ul>
Regimen	Programme target of 90 sachets/doses over a 6-month period
Settings	Areas where the prevalence of anaemia in children aged under 2 years or under 5 years is 20% or higher

<sup>a</sup> 12.5 mg of elemental iron equals 37.5 mg of ferrous fumarate or 62.5 mg of ferrous sulfate heptahydrate or equivalent amounts in other iron compounds. In children aged 6–12 months, sodium iron EDTA (NaFeEDTA) is generally not recommended. If NaFeEDTA is selected as a source of iron, the EDTA intake (including other dietary sources) should not exceed 1.9 mg EDTA/kg/day.

<sup>b</sup> Recommended nutrient intake (RNI). Multiple micronutrient powders can be formulated with or without other vitamin and minerals in addition to iron, vitamin A and zinc to achieve 100% of the RNI (61), and also taking into consideration the technical and sensory properties.

<sup>c</sup> Where feasible, likely consumption from other sources, including home diet and fortified foods, should be taken into consideration for establishing the composition of the sachet.

<sup>1</sup> Populations where the prevalence of anaemia in infants and young children under 2 years of age or children under 5 years of age is 20% or higher.

<sup>2</sup> According to the WHO publication, Complementary feeding: report of the global consultation (62), appropriate complementary feedings should start from the age of 6 months, with continued breast feeding up to 2 years or beyond. Further guidance on complementary feeding may assist the implementation of this guideline, including the WHO/Pan American Health organization publication, Guiding principles for complementary feeding of the breastfed child (8) and the WHO publication, Guiding principles for feeding non-breastfed children 6–24 months of age (9).



## Recommendation 2

- In populations where anaemia is a public health problem,<sup>1</sup> point-of-use fortification of foods with iron-containing micronutrient powders in children aged 2–12 years is recommended, to improve iron status and reduce anaemia. (*strong recommendation, moderate-quality evidence*)

Table 2 includes a suggested scheme for point-of-use fortification of foods with iron-containing micronutrient powders in children aged 2–12 years.

**TABLE 2. Suggested scheme for point-of-use fortification of foods with iron-containing micronutrient powders in children aged 2–12 years**

Scheme for fortification	Target group: children 2–12 years of age
Composition per sachet	<ul style="list-style-type: none"><li>• Iron: 10 to 12.5 mg of elemental iron for children aged 2–4 years; and 12.5 to 30 mg elemental iron for children aged 5–12 years<sup>a</sup></li><li>• Vitamin A: 300 µg retinol</li><li>• Zinc: 5 mg elemental zinc</li><li>• With or without other micronutrients to achieve 100% of the RNI<sup>b,c</sup></li></ul>
Regimen	Programme target of 90 sachets/doses over a 6-month period
Settings	Areas where the prevalence of anaemia in children aged under 5 years is 20% or higher

<sup>a</sup> 12.5 mg of elemental iron equals 37.5 mg of ferrous fumarate or 62.5 mg of ferrous sulfate heptahydrate or equivalent amounts in other iron compounds. If sodium iron EDTA (NaFeEDTA) is selected as a source of iron, the dose of elemental iron should be reduced by 3–6 mg due to its higher bioavailability. The appropriate range of NaFeEDTA is an area of research need.

<sup>b</sup> Recommended nutrient intake (RNI). Multiple micronutrient powders can be formulated with or without other vitamin and minerals in addition to iron, vitamin A and zinc to achieve 100% of the RNI (61), and also taking into consideration the technical and sensory properties.

<sup>c</sup> Where feasible, likely consumption from other sources, including home diet and fortified foods, should be taken into consideration for establishing the composition of the sachet.

## REMARKS

This section presents the remarks of the guideline development group with respect to the implementation of the recommendation. The remarks are intended to assist in the implementation of these recommendations in the context of programmes towards improving infant and child health and nutrition status.

- The term “home fortification” has been substituted by the term “point-of-use fortification” because the process of fortification occurs not only at home but also at schools, nurseries, refugee camps or other places, where appropriate.
- The use of multiple micronutrient powders is a preventive strategy for implementation at population level without screening. Children diagnosed with anaemia should be treated appropriately, according to WHO and national guidelines (63).
- Anaemia is frequently caused by iron deficiency, but other factors may contribute to anaemia, including other micronutrient deficiencies (e.g. folic acid, zinc, vitamins A and B<sub>12</sub>), malaria, soil-transmitted helminths, other infections, and blood disorders (e.g. thalassaemias, sickle cell). The use of multiple micronutrient powders for the age groups indicated in the recommendations should be part of an integrated approach to address anaemia which should explicitly address inequities in the causes of micronutrient deficiencies (i.e. some population groups are more affected and/or vulnerable to micronutrient deficiencies than other

<sup>1</sup> Populations where the prevalence of anaemia in school-age children is 20% or higher.



groups when stratifying by, for instance, income level, place of residence or educational level, as well as when taking into account cultural practices, social norms around gender, or stigma suffered by groups that are discriminated against in each specific context).

- The evidence considered in the systematic reviews (25, 26) included trials with intakes of multiple micronutrient powders ranging from 60 to 360 sachets (or doses) in a 12-month period. The recommendation of providing 90 sachets (or doses) was based on the judgment of the members of the guideline development group, considering the quality of the diet in low- and middle-income countries, as well as desirable and undesirable effects of the intervention, values and preferences, and costs. The number of sachets or doses may be adjusted if data on iron status or other micronutrient status of the vulnerable population are known. Implementers should also consider the number of sachets that are provided to the caretaker each time, in order to promote adherence and proper use.
- Countries should have a national strategy for prevention and control of micronutrient malnutrition. The choice of intervention (e.g. point-of-use fortification with multiple micronutrient powders, fortified foods, iron supplements, lipid-based nutrient supplements) should be considered in the context of a national strategy for control and prevention of micronutrient deficiency, including consideration of costs, cost effectiveness, feasibility and acceptability.
- Programmes of point-of-use fortification with micronutrient powders should include a behaviour-change strategy that promotes awareness and correct use of this product, proper and hygienic preparation, feeding of complementary foods for children older than 6 months and a healthy diet for children older than 2 years of age. Recommended breastfeeding practices, hand washing with soap, prompt attention to fever in malaria settings, and measures to manage diarrhoea should also be included. Further, these programmes should include training for health-care workers on how to adequately provide nutrition counselling and demonstrate the correct use of multiple micronutrient powders.
- In malaria-endemic areas, the provision of iron in any form, including micronutrient powders for point-of-use fortification, should be implemented in conjunction with measures to prevent, diagnose and treat malaria (64). Provision of iron through these interventions should not be made to children who do not have access to malaria-prevention strategies (e.g. provision of insecticide-treated bednets and vector-control programmes), prompt diagnosis of malaria illness, and treatment with effective antimalarial drug therapy.
- If sugar is fortified with vitamin A, vitamin A should be excluded from the multiple micronutrient powders. If other staple foods regularly consumed by children (e.g. oil) are fortified with vitamin A, the risk of inadequate and high intakes of vitamin A should be assessed and the decision to include or exclude vitamin A from the multiple micronutrient powders should be based on that assessment prior to programme implementation, with regular review to permit adjustment of vitamin A as needed. Ideally, any public health nutrition interventions distributing micronutrients (e.g. food fortification and micronutrient supplementation) should be designed and implemented in a coordinated manner
- High-dose vitamin A supplements are a child-survival intervention in populations at risk of vitamin A deficiency (65), and do not provide a regular source of vitamin A in the diet. Therefore, multiple micronutrient powders are not a replacement for this programme. The appropriate combination of interventions to address vitamin A and other deficiencies should be based on the local context and articulated in a national micronutrient strategy.
- For comparability, it is important that outcomes are measured and reported using standard definitions where they exist, e.g. diarrhoea, as defined by WHO (66, 67).

## RESEARCH GAPS

Discussions within the WHO guideline development group – nutrition actions 2013–2014 highlighted the need for further research in the areas listed next.

- Potential short- and long-term functional, developmental, and adverse outcomes of the use of multiple micronutrient powders, particularly for morbidity in various settings, and factors that might modify these effects, such as high rates of infectious diseases, baseline nutritional status, and poor access to and utilization of primary health-care services.
- The lowest effective dose of NaFeEDTA in multiple micronutrient powders and local complementary foods.
- Nutritional improvement of complementary foods in the context of locally accessible and acceptable foods.
- The composition of the sachets of multiple micronutrient powders and the dose, to determine the most effective and cost-effective dose for anaemia reduction and other outcomes.
- Selection of the best combination/number of nutrients included in the multiple micronutrient powders.
- The risks and benefits of daily versus other frequencies of use of multiple micronutrient powders. In this view, it is also important to increase research efforts on identifying the feasibility and ease (or difficulty) of implementing various schemes (e.g. daily, flexible) and factors affecting the acceptability of these schemes.
- Identification of the minimal requirements for formative research, to guide that design of programmes distributing multiple micronutrient powders. Also, further research is needed to understand how such research results should be fully taken into consideration in the development of the behaviour-change intervention strategies. Similarly, research priorities should include focused efforts to identify the minimum behaviour-change intervention strategies that effectively support the adoption and appropriate use of multiple micronutrient powders.
- Identification of the effects of multiple micronutrient powders on outcomes beyond anaemia and iron deficiency, including potential negative effects, and factors that modify them (e.g. micronutrient status, functional outcomes, morbidity).
- Assessment of values and preferences regarding the multiple micronutrient powders, from parents, health-care workers and local subnational authorities where the intervention is implemented. Further, this research should look at the link between values and preferences, acceptability, perceived side-effects and use of multiple micronutrient powders.
- How contexts and cultural factors are taken into account in the design and implementation of interventions.

## DISSEMINATION AND IMPLEMENTATION

### *Dissemination of this guideline*

The current guideline will be disseminated through electronic media such as slide presentations and the World Wide Web, either through the WHO Nutrition or the United Nations Standing Committee on Nutrition (SCN) mailing lists (68), social media, the [WHO nutrition web site](#) (69) or the WHO e-Library of Evidence for Nutrition Actions (eLENA) (70). eLENA compiles and displays WHO guidelines related to nutrition, along with complementary documents such as systematic reviews and other evidence that informed the guidelines; biological and behavioural rationales; and additional resources produced by Member States and global

partners. In addition, the guideline will be disseminated through a broad network of international partners, including WHO country and regional offices, ministries of health, WHO collaborating centres, universities, other United Nations agencies and nongovernmental organizations. It will also be published in the [WHO Reproductive Health Library](#) (71). Further, the WHO Department of Nutrition for Health and Development disseminates guidelines through coordinated work with the six WHO regional offices, through training workshops for health workers at national and regional level, as well as through dissemination through scientific fora at national and international levels.

### ***Equity, human rights and implementation considerations***

This guideline provides Member States with evidence-informed recommendations on the effects and safety of the use of multiple micronutrient powders for point-of-use fortification of foods consumed by infants and young children aged 6–23 months and children aged 2–12 years. It is intended to help Member States make informed decisions on what interventions are best suited to their context, needs, resources and ongoing programmes. Currently, Member States already run public health programmes aimed at preventing anaemia and iron deficiency in the age groups of concern in this guideline (i.e. 6–23 months and 2–12 years). If Member States decide to adopt the recommendations contained in this guideline at either the national or subnational level, they must assess the policy implications concerning this decision. The following are illustrative implications, termed as implementation considerations, which Member States can appraise when considering the use of multiple micronutrient powders for point-of-use fortification of foods consumed by infants and young children aged 6–23 months and children aged 2–12 years.

The adoption and adaptation of these recommendations should be framed under the existing national strategy on prevention and control of micronutrient deficiencies. The choice of intervention to prevent micronutrient deficiencies (e.g. point-of-use fortification with multiple micronutrient powders, fortified foods, iron supplements, lipid-based nutrient supplements) should be considered in the context of that strategy, including consideration of costs, feasibility and acceptability among the different stakeholder (e.g. decision-makers, programme managers, school system if needed, health centres, children and their caregivers). It is also important to assess baseline caregivers' awareness and knowledge of multiple micronutrient powders for point-of-use fortification of foods, before implementation, in order to identify potential misconceptions and prevent misuse of multiple micronutrient powders (72). Behaviour-change communication strategies should take into account that multiple micronutrient powders are a product and individuals may take some time to adopt the use of such products in their daily lives. Household visits are likely to support the reinforcement of accurate information and messages regarding the use of multiple micronutrient powders, and clarify questions about preparation and perceived side-effects, which in turn promote acceptability and adherence. A robust baseline survey or database on the prevalence of micronutrient deficiencies across the population is the optimal foundation for any programme, along with sound data on dietary intake. Data should be disaggregated as much as possible, in order to identify health inequities across population groups, which is also needed for monitoring. WHO has developed guidance on health equity in order to support Member States in this respect: the WHO [Handbook on health inequality monitoring: with a special focus on low- and middle-income countries](#) (73) and the WHO [Health Equity Assessment Toolkit](#) (HEAT) (74) will assist them in the assessment of within-country health inequalities and can inform Member States adopting this guideline in the process of adaptation. Further reference on how to embrace a human rights-based approach during the implementation of this guideline, and protect the rights of children, can be found in the report from the United Nations Human Rights Council [Technical guidance on the application of a human rights-based approach to the implementation of policies and programmes to reduce and eliminate preventable mortality and morbidity of children under 5 years of age](#) (75) and in the United Nations Children's Fund publication [Gender influences on child survival, health and nutrition: a narrative review](#) (76).

This guideline can be adapted to the specific national or subnational context of the Member States, as long as the suggested scheme for point-of-use fortification with multiple micronutrient powders of foods for these two age groups (see [Table 1](#) and [Table 2](#) in the Recommendations section) is followed and the expected effect of the intervention is met by the actions being implemented. Policy-makers and programme managers may consider appropriate measures to guarantee that the intervention is implemented as it was designed, and to measure the fidelity to monitoring purposes.

Likewise, during pre-implementation stages a careful analysis of the suppliers, cost and resource implications is recommended.<sup>1</sup> Ideally, accurate and high-quality data on the prevalence of micronutrient deficiencies in the target population groups should be used for cost estimates, as this will inform the decision on how many micronutrients are needed in the powder formulation,<sup>2</sup> how many sachets are to be given during what period of time to the target groups, and what distribution strategy and platform (e.g. schools, health centres) is best suited to meet the expected programme results and health outcomes. Careful identification of the strategy to reach the target populations and the required distribution channels is also recommended, in order to ensure an uninterrupted supply. In low-resource settings where such accurate information is not up to date, the use of multiple micronutrient powders for point-of-use fortification is also feasible, provided that adequate planning and implementation strategies are observed, as suggested in the following points. In this case, policy-makers may consider actions that allow for this information to be gathered and developed into robust data over the course of implementation.

Further, appropriate and updated regulations should be in place for the adoption of multiple micronutrient powders for point-of-use fortification as the intervention. Member States may need to examine their regulatory framework, if necessary, and also make sure that, if the intervention is adopted, the product is available in the local language(s), and provide appropriate information and education campaigns or training to health workers and other staff (e.g. school staff) involved in the implementation. Such actions should be accessible and culturally adapted (78), to increase the likelihood of acceptability and adherence, and to observe the existing human rights standards on the right to health (79).

Although sachets of multiple micronutrient powders are lightweight and relatively simple to store, transport and distribute for end-users, appropriate measures for stocking and management of supplies and waste disposal of used sachets need to be considered by policy-makers and authorities in charge of the programme, in order to avoid deterioration of the sachets and affect the environment.

The use of multiple micronutrient powders for point-of use fortification must be coordinated with other, if existing, public health nutrition programmes distributing micronutrients in the populations of concern, as well as with other nutrition-specific and nutrition-sensitive interventions (23). Further, intersectoral action and coordination is also suggested, as this intervention may be implemented through the school system, other platforms or development organizations. Using other platforms in addition to the health system may contribute to expanding coverage rates (80).

For technical considerations, tools and guides on how to develop appropriate and sound implementation strategies for this intervention, Member States and their partners may examine the [Implementation research toolkit](#) (81) developed by the WHO-hosted Special Programme for Research and training in Tropical Diseases (TDR) programme, as well as the practical guide available for this matter (82). Additionally, the Home Fortification Technical Advisory Group ([HF-TAG](#)) (83) has developed several programme-oriented tools on multiple micronutrient powders for point-of-use fortification, which are also accessible for WHO

<sup>1</sup> Based on the current prices, the product cost of one child receiving 180 sachets of multiple micronutrient powders in one year (i.e. two cycles according to the current recommendation) is US\$ 4.50 (77). The programming costs are likely to vary according to each setting; however, estimates based on programmes in Kenya and Rwanda suggest an addition of US\$ 4.00 to US\$ 5.00 per child per year (77). The primary cost of this intervention is packaging.

<sup>2</sup> Multiple micronutrient powders are usually formulated in sachets of 15 micronutrients; however, specific information may be available if needed.

Member States and partners to use when implementing this intervention: a [HF-TAG manual on micronutrient powder \(MNP\) composition](#) (84), [A manual for developing and implementing monitoring systems for home fortification interventions](#) (85), a [Toolkit: program planning, policy, program management, procurement, supply and distribution, behavior change interventions and monitoring](#) (86), [Planning for program implementation of home fortification with micronutrient powders \(MNP\): a step-by-step manual](#) (87) and [HF-TAG quality manual on micronutrient powders – a guiding document](#) (88), which was produced in collaboration with the United Nations Industrial Development Organization.

Ideally, interventions with multiple micronutrient powders for point-of-use fortification should be implemented as part of the national infant and young child feeding programme and of a children's health and nutrition programme. These programmes may commence as a pilot and scale up as learning and resources allow (4). If Member States decide to scale up a programme on multiple micronutrient powders for point-of-use fortification, a thorough and carefully-planned strategy for scale-up must be developed. The WHO [Nine steps for developing a scaling-up strategy](#) (89) may be useful for this effort, as well as the aforementioned materials from [HF-TAG](#) (83).

### ***Ethical considerations***

Ethics refers to standards of what is right or wrong and fair or unfair, which can advise people on what to do and not do in terms of rights, obligations and benefits to society and individuals. Ethics is central to science, research, policy-making and implementation. Every field of human action, including public health nutrition, is subject to facing ethical challenges.

The delivery of micronutrients to infants and children with micronutrient deficiencies must be informed by the right to health of children and the duty-bearers should take into account the corresponding human rights instruments when designing the intervention and also during the intervention.

For this reason, an assessment of the ethical implications of implementing this intervention is pertinent in malaria-endemic settings, owing to the possible interactions and potential adverse effects of increased iron intake by children affected by malaria. Children who live in malaria-endemic settings should indeed receive adequate iron. However, the provision of iron-containing micronutrient powders should be done in conjunction with public health measures to prevent, diagnose and treat malaria. Otherwise, a nutrition programme working in isolation and not coordinated with a malaria-prevention and treatment programme may lead to unintentional harm, absence of benefit and increased health inequities.

Coordination with public health measures to prevent, diagnose and treat malaria is not just a sound implementation decision, but also an ethics-informed decision. Such coordination should comprise appropriate training for health workers in public health nutrition, so they are knowledgeable of the particular requirements of an iron-supplementation programme for infants and children that should be observed in malaria-endemic areas. If needed, such training should also be provided to education staff co-working in the implementation of this intervention in school-age children and educational settings.

These considerations by no means imply that iron-containing multiple micronutrient powders should not be provided to children in malaria-endemic settings. On the contrary, children in these settings should receive iron supplementation, inasmuch as they suffer greater vulnerability to ill health, including malnutrition. It requires, however, that appropriate coordination between nutrition and malaria programmes is in place, so the intervention can actually produce health benefits.

With respect to the monitoring system (see next subsection), it is recommended that existing regulations and norms on ethical rules and procedures are observed when collecting information from human subjects. This is recommended at early stages of programme implementation, and also for small-scale projects carried

out by development organizations. The procedures for ethical assessment and approval vary from country to country, in order that appropriate understanding of these issues will support implementation and monitoring.

### ***Monitoring and evaluation***

A specific manual for setting up a monitoring system for multiple micronutrient powders has been developed by [HF-TAG](#) (83, 85).

A plan for monitoring and evaluation with appropriate indicators, including disaggregated data for health-equity monitoring, is encouraged at all stages. The impact of this guideline can be evaluated within countries (i.e. monitoring and evaluation of the programmes implemented at national or regional scale) and across countries (i.e. adoption and adaptation of the guideline globally). The WHO Department of Nutrition for Health and Development, Evidence and Programme Guidance Unit, jointly with the United States Centers for Disease Control and Prevention (CDC) International Micronutrient Malnutrition Prevention and Control (IMMPaCt) programme, and with input from international partners, has developed a generic logic model for micronutrient interventions in public health (90), to depict the plausible relationships between inputs and the [Sustainable Development Goals](#) (1), by applying the micronutrient programme evaluation theory. Member States can adjust the model and use it in combination with appropriate indicators, for designing, implementing, monitoring and evaluating the successful escalation of nutrition actions in public health programmes. Additionally, the WHO/CDC [eCatalogue of indicators for micronutrient programmes](#) (91), which utilizes the logic model, has been developed as a user-friendly and non-comprehensive web resource for those actively engaged in providing technical assistance in monitoring, evaluation and surveillance of public health programmes implementing micronutrient interventions. The eCatalogue will serve as a repository of indicators to monitor and evaluate micronutrient interventions. While it does not provide guidance for designing or implementing a monitoring or evaluation system in public health, some key indicators may include useful references for that purpose.

Since 1991, WHO has hosted the Vitamin and Mineral Nutrition Information Service ([VMNIS](#)) micronutrients database (92). Part of WHO's mandate is to assess the micronutrient status of populations, monitor and evaluate the impact of strategies for the prevention and control of micronutrient malnutrition, and track related trends over time. The Evidence and Programme Guidance Unit of the Department of Nutrition for Health and Development manages the VMNIS micronutrient database, through a network of regional and country offices, and in close collaboration with national health authorities.

For evaluation at the global level, the WHO Department of Nutrition for Health and Development has developed a centralized platform for sharing information on nutrition actions in public health practice implemented around the world. By sharing programmatic details, specific country adaptations and lessons learnt, this platform will provide examples of how guidelines are being translated into actions. The [Global database on the Implementation of Nutrition Action \(GINA\)](#) (93) provides valuable information on the implementation of numerous nutrition policies and interventions. The use of GINA has grown steadily since its launch in November 2012.

An efficient system for the routine collection of relevant data, including relevant determinants of health, therapeutic adherence, and measures of programme performance, is critical to ensure programmes distributing micronutrients are effective and sustained, and drivers to the achievement of the right to health for all population groups. Monitoring differences across groups in terms of accessibility, availability, acceptability and the quality of the interventions contributes to the design of better public health programmes. The creation of indicators for monitoring can be informed by the approaches of social determinants of health (94), so inequities can be identified and tackled. It is particularly important to design sound implementation



strategies to serve as the base for scaling up efforts. Appropriate monitoring requires suitable data, so efforts to collect and organize information on the implementation are also fundamental.

Further, ethical considerations for the monitoring system are provided in the previous section.

## GUIDELINE DEVELOPMENT PROCESS

This guideline was developed in accordance with the WHO evidence-informed guideline development procedures, as outlined in the [WHO handbook for guideline development](#) (95).

### *Advisory groups*

The WHO Steering Committee For Nutrition Guidelines Development (see [Annex 6](#)), led by the Department of Nutrition for Health and Development, was established in 2009 with representatives from all WHO departments with an interest in the provision of scientific nutrition advice, including the Department of Maternal, Neonatal, Child and Adolescent Health and Development and the Department of Reproductive Health and Research. The WHO Steering Committee for Nutrition Guidelines Development meets twice yearly and both guided and provided overall supervision of the guideline development process.

The guideline development group, called Guideline development group – nutrition actions, was established for the biennium 2013–2014 (see [Annex 7](#)). Its role was to advise WHO on the choice of important outcomes for decision-making and in the interpretation of the evidence and formulation of the recommendation. The group included experts from various [WHO expert advisory panels](#) (96) and those identified through open calls for specialists, taking into consideration a balanced mix of sex, multiple disciplinary areas of expertise, and representation from all WHO regions. Efforts were made to include content experts, methodologists, representatives of potential stakeholders (such as managers and other health professionals involved in the health-care process), and technical staff from ministries of health from Member States. Representatives of commercial organizations are not allowed to be members of a WHO guideline development group. The names and biographies of the members of the guideline development group were available on the WHO nutrition website during 14 days prior to holding any guideline development meeting, in order to promote transparency and allow the public to provide WHO with information and comments on these individuals.

An external group of resource experts was also formed (see [Annex 9](#)), in order to assist the guideline development group – nutrition actions 2013–2014 in the assessment of the evidence, the identification of research priorities and programme considerations. Members of the external group of resource experts did not participate in or vote for final formulation of the recommendation.

The final draft guideline was peer-reviewed by eight experts who provided technical feedback. These peer-reviewers were identified through various expert panels within and outside WHO (see [Annex 9](#)). Peer-reviewers received a finalized version of the guideline and were requested to comment or suggest changes restricted to errors of fact, clarifications, or considerations related to implementation, adaptation and the conditions in which the recommendation apply. External peer-reviewers are not involved in the guideline development process (95) and are only asked to provide comments on the final draft guideline. Their role is to identify any errors or missing data and to comment on clarity, setting-specific issues and implications for implementation – not to change the recommendations formulated by the guideline development group. Reviews from such individuals or organizations on a draft guideline may be helpful in anticipating and dealing with controversy, improving the clarity of the final document and promoting engagement with all stakeholders. Peer-reviewers acting in their individual capacity need to complete a declaration-of interests form, while reviewers representing organizations do not need to complete this form.



The names and affiliations of peer-reviewers are provided here as an acknowledgement and by no means indicate their endorsement of the recommendations in this guideline. The acknowledgement of the peer-reviewers does not necessarily represent the views, decisions or policies of the institutions with which they are affiliated. This document is a WHO guideline and, after executive clearance, represents the decisions, policy or views of WHO. If guideline users and readers wish to assess the methodological rigour for developing this global guideline, the Appraisal of Guidelines, Research and Evaluation II ([AGREE II](#)) Instrument (97) can be used for this purpose.

### ***Scope of the guideline***

An initial set of questions (and the components of the questions) to be addressed in the guidelines was the critical starting point for formulating the recommendation. The questions were drafted by technical staff at the Evidence and Programme Guidance Unit, Department of Nutrition for Health and Development, based on policy and programme guidance needs of Member States and their partners. The population, intervention, control, outcomes (PICO) format was used (see [Annex 4](#)). The questions were discussed and reviewed by the WHO Steering Committee for Nutrition Guidelines Development.

A meeting of the guideline development group – nutrition actions 2013–2014 was held on 18–21 February, 2013, in Geneva, Switzerland, to scope the guideline and rank the critical outcomes and populations of interest for the recommendation on the use of multiple micronutrient powders for point-of-use fortification of foods consumed by infants and young children aged 6–23 months and children aged 2–12 years. The guideline development group discussed the relevance of the questions and modified them as needed. The group scored the relative importance of each outcome from 1 to 9 (where 7–9 indicated that the outcome was critical for a decision, 4–6 indicated that it was important and 1–3 indicated that it was not important). The final key questions on the use of multiple micronutrient powders, along with the outcomes that were identified as critical and important for decision-making, are listed in PICO format in Annex 4.

A second meeting of the guideline development group – nutrition actions 2013–2014 was held on 23–26 June 2014, in Geneva, Switzerland, to review programmatic experiences, a presentation on the preliminary results of the two systematic reviews, implementation considerations and research gaps.

A third meeting of the guideline development group – nutrition actions 2013–2014 was held on 3–6 November 2014, in Cancun, Mexico. In this meeting, the members of the guideline development group were able to agree on the recommendation and its remarks, as well as on research priorities.

### ***Evidence appraisal and decision-making***

Two systematic reviews (25, 26) were used to summarize and appraise the evidence using the [Cochrane handbook for systematic reviews of interventions](#) (27) for randomized controlled trials and observational studies. This systematic review matched the PICO questions appropriately. Evidence profiles were prepared according to the [GRADE](#) approach to assess the overall quality of the evidence (49–51). GRADE considers: the study design; the limitations of the studies in terms of their conduct and analysis; the consistency of the results across the available studies; the directness (or applicability and external validity) of the evidence with respect to the populations, interventions and settings where the proposed intervention may be used; and the precision of the summary estimate of the effect.

Both the systematic reviews (25, 26) and the GRADE evidence profiles for each of the critical outcomes were used for drafting this guideline. The draft recommendations were discussed by the WHO Steering Committee for Nutrition Guidelines Development and with the guideline development group, at a meeting held on 3–6 November 2014 in Cancun, Mexico.

The procedures for decision-making were established at the beginning of the meetings, including a minimal set of rules for agreement and decision-making documentation. The members of the guideline development group secretly noted the direction and strength of the recommendations, using a form designed for this purpose, which also included a section for documenting their views on (i) the desirable and undesirable effects of the intervention; (ii) the quality of the available evidence; (iii) values and preferences related to the intervention in different settings; and (iv) the cost of options available to health-care workers in different settings (see [Annex 5](#)). These aspects were discussed openly in the meeting, followed by notation of each member's primary considerations in these areas on individual forms. Each member used one form, if not advised otherwise after managing any potential conflict of interests. Abstentions were not allowed. The process was improved with the availability of a predefined link to an online form, which used survey software. Subsequent deliberations among the members of the guideline development group were of private character, i.e. only members of the guideline development group were allowed to be present during these deliberations and the external resource people had to leave the room. The WHO Secretariat collected the forms and disclosed a summary of the results to the guideline development group. If there was no unanimous consensus (primary decision rule), more time was given for deliberations and a second round of online voting took place. If no unanimous agreement was reached, a two-thirds vote of the guideline development group members present was required for the approval of the proposed recommendations (secondary decision rule). Divergent opinions could be recorded in the guideline. The results from voting forms are kept on file by WHO for 5 years. Although there was no unanimous consensus, more than 75% of the voting members of the guideline development group decided each of the recommendations were strong.

WHO staff present at the meeting, as well as other external technical experts involved in the collection and grading of the evidence, were not allowed to participate in the decision-making process. Two co-chairs with expertise in managing group processes and interpreting evidence were nominated at the opening of the consultation, and the nomination was approved by the guideline development group. Members of the WHO Secretariat were available at all times to help guide the overall meeting process, but did not vote and did not have veto power.

## MANAGEMENT OF CONFLICTS OF INTEREST

According to the rules in the WHO [Basic documents](#) (98) and the processes recommended in the [WHO handbook for guideline development](#) (95), all experts participating in WHO meetings must declare any interest relevant to the meeting prior to their participation. The conflicts-of-interest statements for all guideline group members were reviewed by the responsible technical officer and the relevant departments before finalization of the group composition and invitation to attend a guideline group meeting. All guideline group members and participants of the guideline development meetings submitted a declaration-of-interests form, along with their curriculum vitae, before each meeting. Participants of the guideline development group meetings participated in their individual capacity and not as institutional representatives. In addition, they verbally declared potential conflicts of interest at the beginning of each meeting. The procedures for management of conflicts of interests strictly followed the [Declaration of interests for WHO experts](#) (99). The interests declared by members of the guideline group are summarized next.<sup>1</sup>

<sup>1</sup> A conflict-of-interest analysis must be performed whenever WHO relies on the independent advice of an expert in order to take a decision or to provide recommendations to Member States or other stakeholders. The term "conflict of interest" means any interest declared by an expert that may affect or be reasonably perceived to affect the expert's objectivity and independence in providing advice to WHO. WHO's conflict-of-interest rules are designed to avoid potentially compromising situations that could undermine or otherwise affect the work of the expert, the committee or the activity in which the expert is involved, or WHO as a whole. Consequently, the scope of the inquiry is any interest that could reasonably be perceived to affect the functions that the expert is performing.

**Dr Mary Chea** is employed by the National Maternal and Child Health Centre, Ministry of Health of Cambodia. Dr Chea declared having carried out research and work on projects related to multiple micronutrient powders. First, she has carried out operational research for the Good Food for Children Project, which compared infant and young child feeding education and Sprinkles for infants and young children in poor settings in Svay Rieng District, Svay Rieng Province, Cambodia. Second, she has coordinated, managed and implemented the Good Food for Children Study (Sprinkle Project) for the whole project period (2007–2010). It was agreed that she could participate fully in the deliberations and decision-making on this recommendation.

**Dr Luz Maria De-Regil** declared that her present employer is an international nongovernmental organization devoted to the improvement of micronutrient status among infants, children and women. These activities are primarily financed by the government of Canada. The Micronutrient Initiative is a leading organization working exclusively to eliminate vitamin and mineral deficiencies in the world's most vulnerable populations, including work on and support for multiple micronutrient powders. Dr De-Regil declared that she is a co-author of systematic reviews on: (a) point-of-use fortification of foods with micronutrient powders containing iron in children of preschool and school age; (b) multiple micronutrient powders for point-of-use fortification of foods in pregnant women; and (c) point-of-use fortification of foods with multiple micronutrient powders for health and nutrition in children under 2 years of age. Dr De-Regil also declared that she was involved in the preparation of the guideline on point-of-use fortification with multiple micronutrient powders as a former member of WHO staff. Dr De-Regil was allowed to be a member of the guideline development group and could participate in the deliberations related to recommendations, but recused herself from voting on this recommendation.

**Dr Rukhsana Haider** is employed by the Training and Assistance for Health and Nutrition Foundation, Dhaka, Bangladesh. Dr Haider declared that, at the time of the meeting, she was a member of the Technical Advisory Group for Helen Keller International's Assessment and Research on Child Feeding (ARCH) Project. It was agreed that she could participate fully in the deliberations and decision-making on this recommendation.

**Dr Maria Elena del Socorro Jefferds** is employed by United States Centers for Disease Control and Prevention (CDC). She declared that she was a co-investigator on a CDC-funded study on the effectiveness of micronutrient powders in Kenya and is lead author and co-author of several publications on this topic, including being co-author and editor of a special *Sight and Life* supplement on micronutrient powders published in 2013. She also declared that she participated in a United Nations Children's Fund/CDC workshop on scaling up micronutrient-powder interventions for infants and young children aged 6–23 months. She also declared that she was the coordinator and writer of a monitoring manual for home-fortification interventions, including micronutrient powders, for the Home Fortification Technical Advisory Group; that she was an investigator on the first global assessment of home-fortification interventions and the lead author of the corresponding report and of a related journal article, both published in 2013; and that she is a co-author of a Cochrane systematic review of micronutrient powders intervention in infants and children aged 6–23 months and 2–12 years. She was allowed to participate in the deliberations on recommendations related to multiple micronutrient powders but she recused herself from decision-making (voting) on the recommendations related to the use of multiple micronutrient powders for point-of-use fortification of foods.

**Dr Lynnette Neufeld** declared that her current employer has received funding in the past 4 years for research and programming related to micronutrient powders, but that she is not leading any of these initiatives. She also declared that, in her previous position with a different employer, she was involved in research studies related to micronutrient powders. She declared her membership on the Steering Committee of the Home Fortification Technical Advisory Group. She was allowed to participate in the deliberations on recommendations related to multiple micronutrient powders but she recused herself

from decision-making (voting) on the recommendations relating to the use of multiple micronutrient powders for point-of-use fortification of foods.

All other members completed and signed a written declaration of interests before the meeting and also made a verbal declaration of their interest during the meeting. It was considered that these interests were not relevant for this guideline on the use of multiple micronutrient powders for point-of-use fortification of foods consumed by infants and young children aged 6–23 months and children aged 2–12 years. External experts also declared their interest but did not participate in the deliberations or decision-making process.

## PLANS FOR UPDATING THE GUIDELINE

The WHO Secretariat will continue to follow the research development in the area of micronutrient interventions aimed at infants and young children aged 6–23 months and children aged 2–12 years. If the guideline merits an update, or if there are concerns about the validity of the guideline, the Department of Nutrition for Health and Development will coordinate the guideline update, following the formal procedures of the [WHO handbook for guideline development](#) (95).

## REFERENCES

1. United Nations Sustainable Development Knowledge Platform. Sustainable Development Goals (<https://sustainabledevelopment.un.org/sdgs>, accessed 1 December 2016).
2. Comprehensive implementation plan on maternal, infant and young child nutrition. In: Sixty-fifth World Health Assembly, Geneva, 21–26 May 2012. Resolutions and decisions, annexes. Geneva: World Health Organization; 2012:12–13 (WHA65/2012/REC/1; [http://apps.who.int/gb/ebwha/pdf\\_files/WHA65-REC1/A65\\_REC1-en.pdf](http://apps.who.int/gb/ebwha/pdf_files/WHA65-REC1/A65_REC1-en.pdf), accessed 1 December 2016).
3. The global strategy for women's, children's and adolescents' health (2016–2023). Survive, thrive transform. Geneva: World Health Organization; 2015 (<http://www.who.int/life-course/partners/global-strategy/global-strategy-2016-2030/en/>, accessed 1 December 2016).
4. Guideline: Use of multiple micronutrient powders for home fortification of foods consumed by infants and children 6–23 months of age. Geneva: World Health Organization; 2011 ([http://apps.who.int/iris/bitstream/10665/44651/1/9789241502047\\_eng.pdf](http://apps.who.int/iris/bitstream/10665/44651/1/9789241502047_eng.pdf), accessed 1 December 2016).
5. Black RE, Allen LH, Bhutta ZA, Caulfield LE, de Onis M, Ezzati M et al.; Maternal and Child Undernutrition Study Group. Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet*. 2008;371(9608):243–60. doi:10.1016/S0140-6736(07)61690-0.
6. Global health risk. Mortality and burden of disease attributable to selected major risks [Internet]. Geneva: World Health Organization; 2009 ([http://www.who.int/healthinfo/global\\_burden\\_disease/GlobalHealthRisks\\_report\\_full.pdf](http://www.who.int/healthinfo/global_burden_disease/GlobalHealthRisks_report_full.pdf), accessed 1 December 2016).
7. Dewey KG, Brown KH. Update on technical issues concerning complementary feeding of young children in developing countries and implications for intervention programs. *Food Nutr Bull*. 2003;24(1):5–28.
8. World Health Organization/Pan American Health Organization. Guiding principles for complementary feeding of the breastfed child. Washington, DC: Pan American Health Organization; 2003 ([http://www.who.int/nutrition/publications/guiding\\_principles\\_compfeeding\\_breastfed.pdf](http://www.who.int/nutrition/publications/guiding_principles_compfeeding_breastfed.pdf), accessed 1 December 2016).
9. Guiding principles for feeding non-breastfed children 6–24 months of age. Geneva: World Health Organization; 2005 (<http://apps.who.int/iris/bitstream/10665/43281/1/9241593431.pdf?ua=1&ua=1>, accessed 1 December 2016).
10. The global prevalence of anaemia in 2011. Geneva: World Health Organization; 2015 ([http://apps.who.int/iris/bitstream/10665/177094/1/9789241564960\\_eng.pdf?ua=1&ua=1](http://apps.who.int/iris/bitstream/10665/177094/1/9789241564960_eng.pdf?ua=1&ua=1), accessed 1 December 2016).
11. Stevens GA, Finucane MM, De-Regil LM, Paciorek CJ, Flaxman SR, Branca F et al. Global, regional, and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995–2011: a systematic analysis of population-representative data. *Lancet Glob Health*. 2013;1(1):e16–25. doi:10.1016/S2214-109X(13)70001-9.
12. Cardoso MA, Scopel KKG, Muniz PT, Villamor E, Ferreira MU. Underlying factors associated with anemia in amazonian children: a population-based, cross-sectional study. *PLoS One*. 2012;7(5):e36341. doi:10.1371/journal.pone.0036341.
13. Stevens GA, Bennett JE, Hennocq Q, Lu Y, De-Regil LM, Rogers L et al. Trends and mortality effects of vitamin A deficiency in children in 138 low-income and middle-income countries between 1991 and 2013: a pooled analysis of population-based surveys. *Lancet Glob Health*. 2015;3:e528–36. doi: 10.1016/S2214-109X(15)00039-X. ([http://www.thelancet.com/journals/langlo/article/PIIS2214-109X\(15\)00039-X/abstract](http://www.thelancet.com/journals/langlo/article/PIIS2214-109X(15)00039-X/abstract), accessed 1 December 2016).
14. Lozoff B. Iron deficiency and child development. *Food Nutr Bull*. 2007;28(4 Suppl.):S560–71.
15. Sanghvi T, Ross J, Heymann H. Why is reducing vitamin and mineral deficiencies critical for development? The links between VMDs and survival, health, education, and productivity. *Food Nutr Bull*. 2007;28(1 Suppl.):S167–73.
16. Iron deficiency anaemia: assessment, prevention and control. A guide for programme managers. Geneva: World Health Organization; 2001 (WHO/NHD/01.3; [www.who.int/iris/bitstream/10665/66914/http://apps.who.int/iris/bitstream/10665/66914/1/WHO\\_NHD\\_01.3.pdf?ua=1](http://www.who.int/iris/bitstream/10665/66914/http://apps.who.int/iris/bitstream/10665/66914/1/WHO_NHD_01.3.pdf?ua=1), accessed 1 December 2016).
17. Horton S, Shekar M, McDonald C, Mahal A, Brooks JK. Scaling up nutrition: what will it cost? Washington, DC: World Bank; 2010 (<http://siteresources.worldbank.org/HEALTHNUTRITIONANDPOPULATION/Resources/Peer-Reviewed-Publications/ScalingUpNutrition.pdf>, accessed 1 December 2016).

18. de Barros SF, Cardoso MA. Adherence to and acceptability of home fortification with vitamins and minerals in children aged 6 to 23 months: a systematic review. *BMC Public Health*. 2016;16:299. doi:10.1186/s12889-016-2978-0.
19. de Pee S, Kraemer K, van den Briel T, Boy E, Grasset C, Moench-Pfanner R et al. Quality criteria for micronutrient powder products: report of a meeting organized by the World Food Programme and Sprinkles Global Health Initiative. *Food Nutr Bull*. 2008;29(3):232–41.
20. Zlotkin SH, Schauer C, Christofides A, Sharieff W, Tondeur MC, Hyder SMZ. Micronutrient sprinkles to control childhood anaemia. *PLoS Med*. 2005;2(1):e1.
21. Suchdev PS, Peña-Rosas JP, De-Regil LM. Multiple micronutrient powders for home (point-of-use) fortification of foods in pregnant women. *Cochrane Database Syst Rev*. 2015;(6):CD011158. doi:10.1002/14651858.CD011158.pub2.
22. Use of multiple micronutrient powders for point-of-use fortification of foods consumed by pregnant women. Geneva: World Health Organization; 2016 ([http://apps.who.int/iris/bitstream/10665/204639/1/9789241549516\\_eng.pdf?ua=1&ua=1&ua=1](http://apps.who.int/iris/bitstream/10665/204639/1/9789241549516_eng.pdf?ua=1&ua=1&ua=1), accessed 1 December 2016).
23. Essential nutrition actions: improving maternal, newborn, infant and young child health and nutrition. Geneva: World Health Organization; 2013 ([http://apps.who.int/iris/bitstream/10665/84409/1/9789241505550\\_eng.pdf](http://apps.who.int/iris/bitstream/10665/84409/1/9789241505550_eng.pdf), accessed 1 December 2016).
24. Home Fortification Technical Advisory Group (HF-TAG). Projects ([http://www.hftag.org/2157\\_Projects.asp](http://www.hftag.org/2157_Projects.asp), accessed 1 December 2016).
25. De-Regil LM, Suchdev PS, Vist GE, Walleser S, Peña-Rosas JP. Home fortification of foods with multiple micronutrient powders for health and nutrition in children under two years of age. *Cochrane Database Syst Rev*. 2011;(9):CD008959. doi:10.1002/14651858.CD008959.pub2.
26. De-Regil LM, Jefferds MED, Peña-Rosas JP. Point-of-use fortification of foods with micronutrient powders containing iron in children of preschool and school age. *Cochrane Database Syst Rev*. 2012;(2):CD009666. doi:10.1002/14651858.CD009666.
27. Higgins JPT, Green S, editors. *Cochrane handbook for systematic reviews of interventions*. York: The Cochrane Collaboration; 2011 (<http://handbook.cochrane.org/>, accessed 1 December 2016).
28. Aboud FE, Akhter S. A cluster-randomized evaluation of a responsive stimulation and feeding intervention in Bangladesh. *Pediatrics*. 2011;127(5):e1191–7. doi:10.1542/peds.2010-2160.
29. Adu-Afarwuah S, Lartey A, Brown KH, Zlotkin S, Briend A, Dewey KG. Randomized comparison of 3 types of micronutrient supplements for home fortification of complementary foods in Ghana: effects on growth and motor development. *Am J Clin Nutr*. 2007;86(2):412–20.
30. Adu-Afarwuah S, Lartey A, Brown KH, Zlotkin S, Briend A, Dewey KG. Home fortification of complementary foods with micronutrient supplements is well accepted and has positive effects on infant iron status in Ghana. *Am J Clin Nutr*. 2008;87(4):929–38.
31. Attanasio OP, Fernández C, Fitzsimons EOA, Grantham-McGregor SM, Meghir C, Rubio-Codina M. Using the infrastructure of a conditional cash transfer program to deliver a scalable integrated early child development program in Colombia: cluster randomized controlled trial. *BMJ*. 2014;349:g5785. doi:10.1136/bmj.g5785.
32. Christofides A, Asante KP, Schauer C, Sharieff W, Owusu-Agyei S, Zlotkin S. Multi-micronutrient Sprinkles including a low dose of iron provided as microencapsulated ferrous fumarate improves haematologic indices in anaemic children: a randomized clinical trial. *Matern Child Nutr*. 2006;2(3):169–80.
33. Giovannini M, Sala D, Usuelli M, Livio L, Francescato G, Braga M et al. Double-blind, placebo-controlled trial comparing effects of supplementation with two different combinations of micronutrients delivered as sprinkles on growth, anemia, and iron deficiency in Cambodian infants. *J Pediatr Gastroenterol Nutr*. 2006;42(3):306–12.
34. Agostoni C, Giovannini M, Sala D, Usuelli M, Livio L, Francescato G et al. Double-blind, placebo-controlled trial comparing effects of supplementation of two micronutrient sprinkles on fatty acid status in Cambodian infants. *J Pediatr Gastroenterol Nutr*. 2007;44(1):136–42.
35. Hirve S, Bhave S, Bavdekar A, Naik S, Pandit A, Schauer C et al. Low dose 'Sprinkles'-- an innovative approach to treat iron deficiency anemia in infants and young children. *Indian Pediatr*. 2007;44(2):91–100.



36. Inayati DA, Scherbaum V, Purwestri RC, Wirawan NN, Suryantan J, Hartono S et al. Combined intensive nutrition education and micronutrient powder supplementation improved nutritional status of mildly wasted children on Nias Island, Indonesia. *Asia Pac J Clin Nutr.* 2012;21(3):361–73.
37. Inayati DA, Scherbaum V, Purwestri RC, Wirawan NN, Suryantan J, Hartono S et al. Improved nutrition knowledge and practice through intensive nutrition education: a study among caregivers of mildly wasted children on Nias Island, Indonesia. *Food Nutr Bull.* 2012;33(2):117–27.
38. Purwestri RC, Scherbaum V, Inayati DA, Wirawan NN, Suryantan J, Bloem MA et al. Supplementary feeding with locally-produced ready-to-use food (RUF) for mildly wasted children on Nias Island, Indonesia: comparison of daily and weekly program outcomes. *Asia Pac J Clin Nutr.* 2012;21(3):374–9.
39. Jack SJ, Ou K, Chea M, Chhin L, Devenish R, Dunbar M et al. Effect of micronutrient sprinkles on reducing anemia: a cluster-randomized effectiveness trial. *Arch Pediatr Adolesc Med.* 2012;166(9):842–50. doi:10.1001/archpediatrics.2012.1003.
40. Kounnavong S, Sunahara T, Mascie-Taylor CGN, Hashizume M, Okumura J, Moji K et al. Effect of daily versus weekly home fortification with multiple micronutrient powder on haemoglobin concentration of young children in a rural area, Lao People's Democratic Republic: a randomised trial. *Nutr J.* 2011;10(129):1–11. doi:10.1186/1475-2891-10-129.
41. Lundeen E, Schueth T, Toktobaev N, Zlotkin S, Hyder SMZ, Houser R. Daily use of Sprinkles micronutrient powder for 2 months reduces anemia among children 6 to 36 months of age in the Kyrgyz Republic: a cluster-randomized trial. *Food Nutr Bull.* 2010;31(3):446–60.
42. Macharia-Mutie CW, Moretti D, Briel NV den, Omusundi AM, Mwangi AM, Kok FJ et al. Maize porridge enriched with a micronutrient powder containing low-dose iron as NaFeEDTA but not amaranth grain flour reduces anemia and iron deficiency in Kenyan preschool children. *J Nutr.* 2012;142(9):1756–63. doi:10.3945/jn.112.157578
43. Macharia-Mutie CW, Omusundi AM, Mwai JM, Mwangi AM, Brouwer ID. Simulation of the effect of maize porridge fortified with grain amaranth or micronutrient powder containing NaFeEDTA on iron intake and status in Kenyan children. *Public Health Nutr.* 2013;16(09):1605–13. doi:10.1017/S1368980012005174.
44. Loechl CU, Menon P, Arimond M, Ruel MT, Pelto G, Habicht J-P et al. Using programme theory to assess the feasibility of delivering micronutrient Sprinkles through a food-assisted maternal and child health and nutrition programme in rural Haiti. *Matern Child Nutr.* 2009;5(1):33–48. doi:10.1111/j.1740-8709.2008.00154.x.
45. Menon P, Ruel MT, Loechl CU, Arimond M, Habicht J-P, Pelto G et al. Micronutrient Sprinkles reduce anemia among 9- to 24-mo-old children when delivered through an integrated health and nutrition program in rural Haiti. *J Nutr.* 2007;137(4):1023–30.
46. Sazawal S, Dhingra P, Dhingra U, Gupta S, Iyengar V, Menon VP et al. Compliance with home-based fortification strategies for delivery of iron and zinc: its effect on haematological and growth markers among 6–24 months old children in North India. *J Health Popul Nutr.* 2014;32(2):217–26.
47. Sharieff W, Bhutta Z, Schauer C, Tomlinson G, Zlotkin S. Micronutrients (including zinc) reduce diarrhoea in children: The Pakistan Sprinkles Diarrhoea Study. *Arch Dis Child.* 2006;91(7):573–9.
48. Soofi S, Cousens S, Iqbal SP, Akhund T, Khan J, Ahmed I et al. Effect of provision of daily zinc and iron with several micronutrients on growth and morbidity among young children in Pakistan: a cluster-randomised trial. *Lancet.* 2013;382(9886):29–40. doi:10.1016/S0140-6736(13)60437-7.
49. GRADE working group (<http://www.gradeworkinggroup.org/>, accessed 1 December 2016).
50. Guyatt GH, Oxman AD, Vist GE, Kunz R, Falck-Ytter Y, Alonso-Coello P et al. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. *BMJ.* 2008;336(7650):924–6.
51. Guyatt G, Oxman AD, Akl EA, Kunz R, Vist G, Brozek J et al. GRADE guidelines: 1. Introduction–GRADE evidence profiles and summary of findings tables. *J Clin Epidemiol.* 2011;64(4):383–94. doi:10.1016/j.jclinepi.2010.04.026.
52. Kemmer TM, Omer PS, Gidvani-Diaz VK, Coello M, Silverberg D. Acceptance and effect of ferrous fumarate containing micronutrient sprinkles on anemia, iron deficiency and anthropometrics in Honduran children. In: Silverberg D, editor. *Anemia.* Rijeka: InTech; 2012:192–210 (<http://cdn.intechopen.com/pdfs/30547.pdf>, accessed 1 December 2016).
53. Ogunlade AO, Kruger HS, Jerling JC, Smuts CM, Covic N, Hanekom SM et al. Point-of-use micronutrient fortification: lessons learned in implementing a preschool-based pilot trial in South Africa. *Int J Food Sci Nutr.* 2011;62(1):1–16. doi:10.3109/09637486.2010.495710.



54. Osei AK, Houser RF, Bulusu S, Hamer DH. Acceptability of micronutrient fortified school meals by schoolchildren in rural Himalayan villages of India. *J Food Sci.* 2008;73(7):S354–8. doi:10.1111/j.1750-3841.2008.00878.x.
55. Osei AK, Rosenberg IH, Houser RF, Bulusu S, Mathews M, Hamer DH. Community-level micronutrient fortification of school lunch meals improved vitamin a, folate, and iron status of schoolchildren in Himalayan villages of India. *J Nutr.* 2010;140(6):1146–54. doi:10.3945/jn.109.114751.
56. Sharieff W, Yin S-A, Wu M, Yang Q, Schauer C, Tomlinson G et al. Short-term daily or weekly administration of micronutrient Sprinkles has high compliance and does not cause iron overload in Chinese schoolchildren: a cluster-randomised trial. *Public Health Nutr.* 2006;9(3):336–44.
57. Troesch B, Stuijvenberg ME van, Smuts CM, Kruger HS, Biebinger R, Hurrell RF et al. A micronutrient powder with low doses of highly absorbable iron and zinc reduces iron and zinc deficiency and improves weight-for-age Z-Scores in South African children. *J Nutr.* 2011;141(2):237–42. doi:10.3945/jn.110.129247.
58. Varma JL, Das S, Sankar R, Mannar MG, Levinson FJ, Hamer DH. Community-level micronutrient fortification of a food supplement in India: a controlled trial in preschool children aged 36–66 mo. *Am J Clin Nutr.* 2007;85(4):1127–33.
59. Vinodkumar M, Rajagopalan S. Impact of a multiple-micronutrient food supplement on the nutritional status of schoolchildren. *Food Nutr Bull.* 2006;27(3):203–10.
60. Vinodkumar M, Rajagopalan S. Efficacy of fortification of school meals with ferrous glycine phosphate and riboflavin against anemia and angular stomatitis in schoolchildren. *Food Nutr Bull.* 2009;30(3):260–4.
61. World Health Organization and Food and Agriculture Organization of the United Nations. *Vitamin and mineral requirements in human nutrition*, 2nd ed. Geneva: World Health Organization; 2004 (<http://apps.who.int/iris/bitstream/10665/42716/1/9241546123.pdf?ua=1>, accessed 1 December 2016).
62. *Complementary feeding: report of the global consultation*. Geneva: World Health Organization; 2003 (<http://www.who.int/nutrition/publications/infantfeeding/924154614X/en/>, accessed 1 December 2016).
63. *Guideline: Daily iron supplementation in infants and children*. Geneva: World Health Organization; 2016. ([http://apps.who.int/iris/bitstream/10665/204712/1/9789241549523\\_eng.pdf?ua=1&ua=1](http://apps.who.int/iris/bitstream/10665/204712/1/9789241549523_eng.pdf?ua=1&ua=1), accessed 1 December 2016).
64. *Guidelines for the treatment of malaria*, 3rd ed. Geneva: World Health Organization; 2015 ([http://apps.who.int/iris/bitstream/10665/162441/1/9789241549127\\_eng.pdf?ua=1&ua=1](http://apps.who.int/iris/bitstream/10665/162441/1/9789241549127_eng.pdf?ua=1&ua=1), accessed 1 December 2016).
65. *Vitamin A supplementation for infants and children 6–59 months of age*. Geneva: World Health Organization; 2011 ([http://apps.who.int/iris/bitstream/10665/44664/1/9789241501767\\_eng.pdf?ua=1&ua=1](http://apps.who.int/iris/bitstream/10665/44664/1/9789241501767_eng.pdf?ua=1&ua=1), accessed 1 December 2016).
66. *The treatment of diarrhoea. A manual for physicians and other senior health workers*. Geneva: World Health Organization; 2005 (<http://apps.who.int/iris/bitstream/10665/43209/1/9241593180.pdf>, accessed 1 December 2016).
67. *Ending preventable child deaths from pneumonia and diarrhoea by 2025. The Integrated Global Action Plan for Pneumonia and Diarrhoea (GAPPD)*. Geneva: World Health Organization/United Nations Children's Fund; 2013 ([http://apps.who.int/iris/bitstream/10665/79200/1/9789241505239\\_eng.pdf?ua=1](http://apps.who.int/iris/bitstream/10665/79200/1/9789241505239_eng.pdf?ua=1), accessed 1 December 2016).
68. United Nations Standing Committee on Nutrition. UNSCN (<http://www.unscn.org/>, accessed 1 December 2016).
69. World Health Organization. *Nutrition* (<http://www.who.int/nutrition/en/>, accessed 1 December 2016).
70. World Health Organization. *e-Library of Evidence for Nutrition Actions (eLENA)* (<http://www.who.int/elena/en/>, accessed 1 December 2016).
71. World Health Organization. *The WHO Reproductive Health Library* (<http://www.who.int/rhl/en/>, accessed 1 December 2016).
72. Jefferds MED, Ogange L, Owuor M, Cruz K, Person B, Obure A et al. Formative research exploring acceptability, utilization, and promotion in order to develop a micronutrient powder (Sprinkles) intervention among Luo families in western Kenya. *Food Nutr Bull.* 2010;31(2 Suppl.):S179–85.
73. *Handbook on health inequality monitoring: with a special focus on low- and middle-income countries*. Geneva: World Health Organization; 2013 ([http://apps.who.int/iris/bitstream/10665/85345/1/9789241548632\\_eng.pdf](http://apps.who.int/iris/bitstream/10665/85345/1/9789241548632_eng.pdf), accessed 1 December 2016).
74. World Health Organization. *Global Health Observatory (GHO) data. Health Equity Assessment Toolkit (HEAT)* ([http://www.who.int/gho/health\\_equity/assessment\\_toolkit/en/](http://www.who.int/gho/health_equity/assessment_toolkit/en/), accessed 1 December 2016).

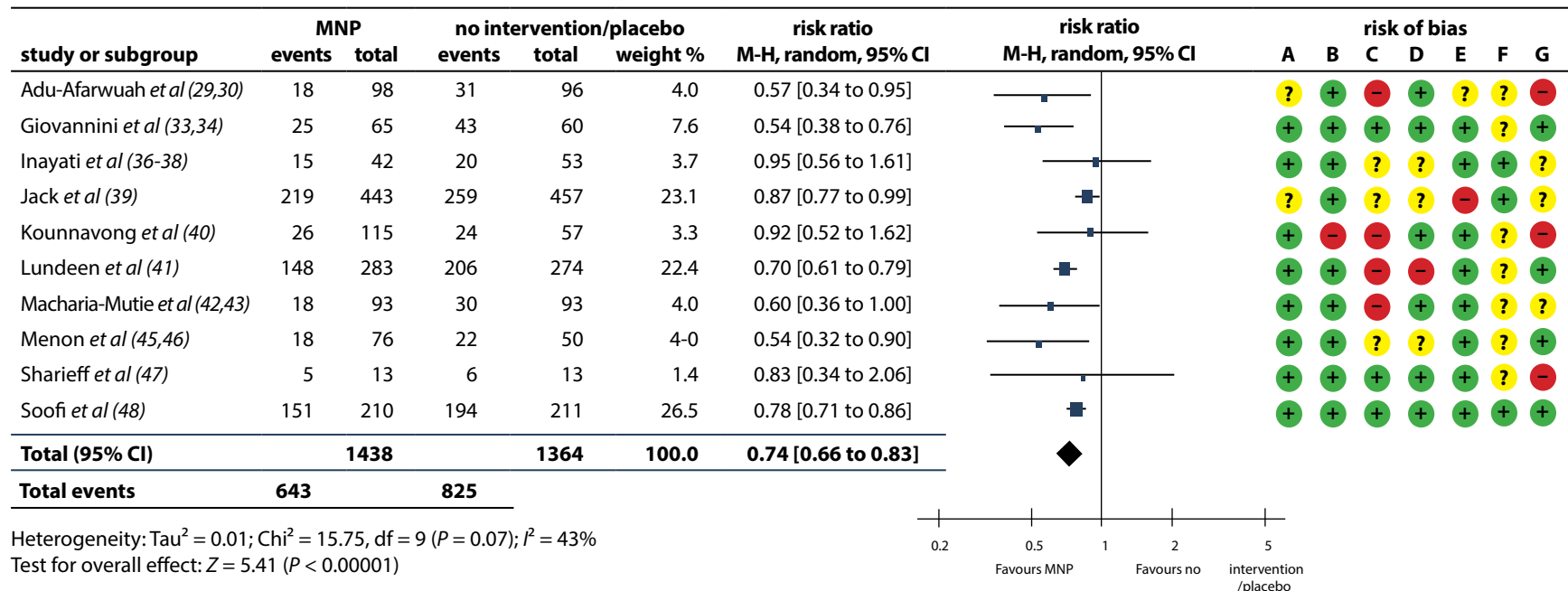
75. OHCHR. Technical guidance on the application of a human rights-based approach to the implementation of policies and programmes to reduce and eliminate preventable mortality and morbidity of children under 5 years of age. Report of the Office of the United Nations High Commissioner for Human Rights. Geneva: United Nations Human Rights Council; 2014 (A/HRC/27/31; <http://www.refworld.org/docid/53ff2b0c4.html>, accessed 1 December 2016).
76. Gender influences on child survival, health and nutrition: a narrative review. New York: United Nations Children's Fund; 2011 ([http://library.pcw.gov.ph/sites/default/files/Gender Influences on Child Survival a Narrative review.pdf](http://library.pcw.gov.ph/sites/default/files/Gender%20Influences%20on%20Child%20Survival%20a%20Narrative%20review.pdf), accessed 1 December 2016).
77. de Pee S, Flores-Ayala R, van Hees J, Jefferds MED, Irizarry L, Kraemer K et al. Home fortification with micronutrient powders (MNP). *Eur J Food Res Rev.* 2014;4:10–11.
78. World Health Organization. Health and human rights (<http://www.who.int/mediacentre/factsheets/fs323/en/>, accessed 1 December 2016).
79. Office of the High Commissioner for Human Rights. General Comment No. 14: The right to the highest attainable standard of health (Art. 12). Adopted at the Twenty-second Session of the Committee on Economic, Social and Cultural Rights, on 11 August 2000 (Contained in Document E/C.12/2000/4). Geneva: United Nations Economic and Social Council; 2000 (<http://www.refworld.org/pdfid/4538838d0.pdf>, accessed 1 December 2016).
80. Osei AK, Pandey P, Spiro D, Adhikari D, Haselow N, De Morais C et al. Adding multiple micronutrient powders to a homestead food production programme yields marginally significant benefit on anaemia reduction among young children in Nepal. *Matern Child Nutr.* 2015;11:188–202. doi:10.1111/mcn.12173.
81. Special Programme for Research and Training in Tropical Diseases (TDR). Implementation research toolkit (<http://www.who.int/tdr/publications/topics/ir-toolkit/en/>, accessed 1 December 2016).
83. Peters DH, Tran NT, Adam T. Implementation research in health: a practical guide. Geneva: World Health Organization; 2013 ([http://apps.who.int/iris/bitstream/10665/91758/1/9789241506212\\_eng.pdf?ua=1](http://apps.who.int/iris/bitstream/10665/91758/1/9789241506212_eng.pdf?ua=1), accessed 1 December 2016).
83. Home Fortification Technical Advisory Group ([http://www.hftag.org/page.asp?s=hftag&content\\_id=33988](http://www.hftag.org/page.asp?s=hftag&content_id=33988), accessed 2 December 2016).
84. HF-TAG manual on micronutrient powder (MNP) composition: guidelines and specifications for defining the micronutrient composition of single serve sachets for specified target populations in low- and middle-income countries with high prevalence of anaemia and micronutrient deficiencies. Geneva: Home Fortification Technical Advisory Group; 2013 ([https://www.dsm.com/content/dam/dsm/nip/en\\_US/documents/HF-TAG%20MNP%20Composition%20Manual.pdf](https://www.dsm.com/content/dam/dsm/nip/en_US/documents/HF-TAG%20MNP%20Composition%20Manual.pdf), accessed 1 December 2016).
85. A manual for developing and implementing monitoring systems for home fortification interventions. Geneva: Home Fortification Technical Advisory Group; 2013 (<http://www.hftag.org/assets/downloads/hftag/HF-TAG%20Monitoring%20Manual%2014%20AUG%202013.pdf>, accessed 1 December 2016).
86. Home Fortification Technical Advisory Group. Toolkit: program planning, policy, program management, procurement, supply and distribution, behavior change interventions and monitoring (<http://www.hftag.org/downloads.asp?s=hftag>, accessed 1 December 2016).
87. HF-TAG. Planning for program implementation of home fortification with mmicronutrient powders (MNP): a step-by-step manual. Geneva: Home Fortification Technical Advisory Group; 2015 (<http://www.hftag.org/assets/downloads/hftag/HF-TAG%20Planning%20for%20Implementation%20Manual%20May%202015.pdf>, accessed 1 December 2016).
88. HF-TAG quality manual on micronutrient powders – a guiding document | Home Fortification Technical Advisory Group (HF-TAG) [Internet]. Geneva: Home Fortification Technical Advisory Group, Vienna: United Nations Industrial Development Organization; 2014 (<http://www.hftag.org/assets/downloads/hftag/HF-TAG%20Quality%20Manual%20on%20Micronutrient%20Powders%20%97%20A%20Guiding%20Document.pdf>, accessed 1 December 2016).
89. WHO, ExpandNet. Nine steps for developing a scaling-up strategy. Geneva: World Health Organization; 2010 ([http://apps.who.int/iris/bitstream/10665/44432/1/9789241500319\\_eng.pdf](http://apps.who.int/iris/bitstream/10665/44432/1/9789241500319_eng.pdf), accessed 1 December 2016).
90. WHO/CDC logic model for micronutrient interventions in public health. Geneva: World Health Organization; 2011 ([http://www.who.int/vmnis/toolkit/logic\\_model/en/](http://www.who.int/vmnis/toolkit/logic_model/en/), accessed 11 December 2016).
91. World Health Organization. eCatalogue of indicators for micronutrient programmes (<https://extranet.who.int/indcat/>, accessed 1 December 2016).

92. World Health Organization. Vitamin and Mineral Nutrition Information System (VMNIS). About VMNIS (<http://www.who.int/vmnis/en/>, accessed 1 December 2016).
93. World Health Organization. Global database on the Implementation of Nutrition Action (GINA) (<https://extranet.who.int/nutrition/gina/>, accessed 1 December 2016).
94. Blas E, Sivasankara Kurup A, editors. Equity, social determinants and public health programmes. Geneva: World Health Organization; 2010 ([http://apps.who.int/iris/bitstream/10665/44289/1/9789241563970\\_eng.pdf](http://apps.who.int/iris/bitstream/10665/44289/1/9789241563970_eng.pdf), accessed 1 December 2016).
95. WHO handbook for guideline development, 2nd ed. Geneva: World Health Organization; 2014 ([http://www.who.int/kms/handbook\\_2nd\\_ed.pdf?ua=1](http://www.who.int/kms/handbook_2nd_ed.pdf?ua=1), accessed 1 December 2016).
96. World Health Organization expert advisory panels and committees. Geneva: World Health Organization; 2010 ([http://www.who.int/rpc/expert\\_panels/Factsheet\\_EAP2010.pdf](http://www.who.int/rpc/expert_panels/Factsheet_EAP2010.pdf), accessed 1 December 2016).
97. Brouwers MC, Kho ME, Browman GP, Burgers JS, Cluzeau F, Feder G et al. AGREE II: advancing guideline development, reporting and evaluation in health care. CMAJ. 2010;182(18):E839–42. doi:10.1503/cmaj.090449.
98. Basic documents, 48th ed. Geneva: World Health Organization; 2014 (<http://apps.who.int/gb/bd/PDF/bd48/basic-documents-48th-edition-en.pdf?page=1>, accessed 1 December 2016).
99. Declaration of interests for WHO experts. Geneva: World Health Organization; 2010 ([http://www.who.int/occupational\\_health/declaration\\_of\\_interest.pdf](http://www.who.int/occupational_health/declaration_of_interest.pdf), accessed 1 December 2016).

## ANNEX 1.

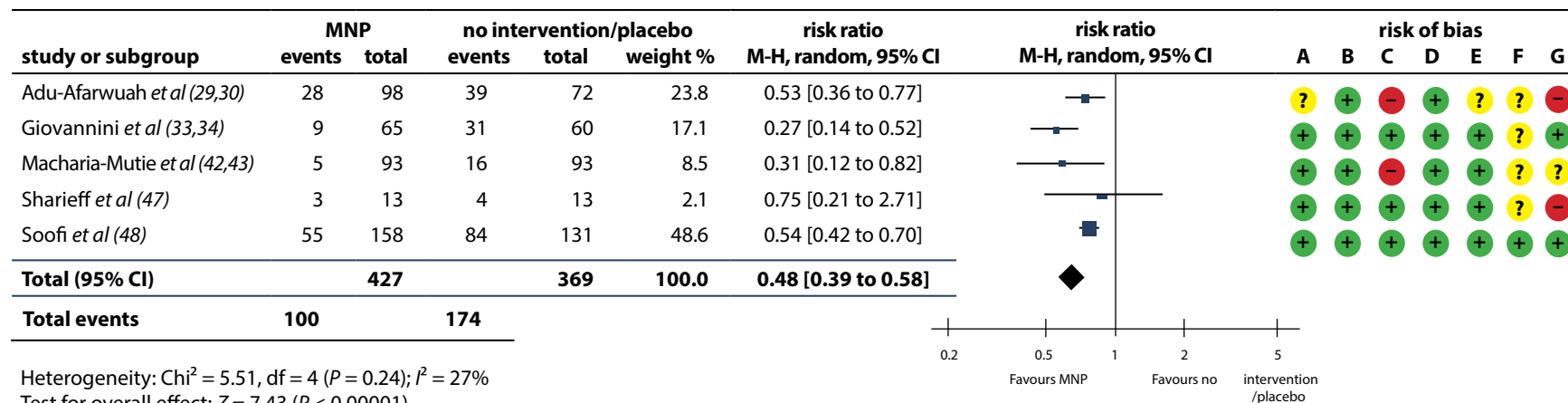
## FOREST PLOTS ON EFFECT ESTIMATES AND CONFIDENCE INTERVALS FOR SOME CRITICAL OUTCOMES, FOR BOTH INDIVIDUAL STUDIES AND META-ANALYSES

## A. Effects of the provision of multiple micronutrient powders on anaemia (defined as haemoglobin values lower than 110 g/L) in comparison to no intervention or placebo in infants and young children aged 6–23 months



(C) for cluster-randomized trials; CI: confidence interval; df: degrees of freedom; M-H: Mantel–Haenszel; MNP: multiple micronutrient powders for point-of-use fortification.

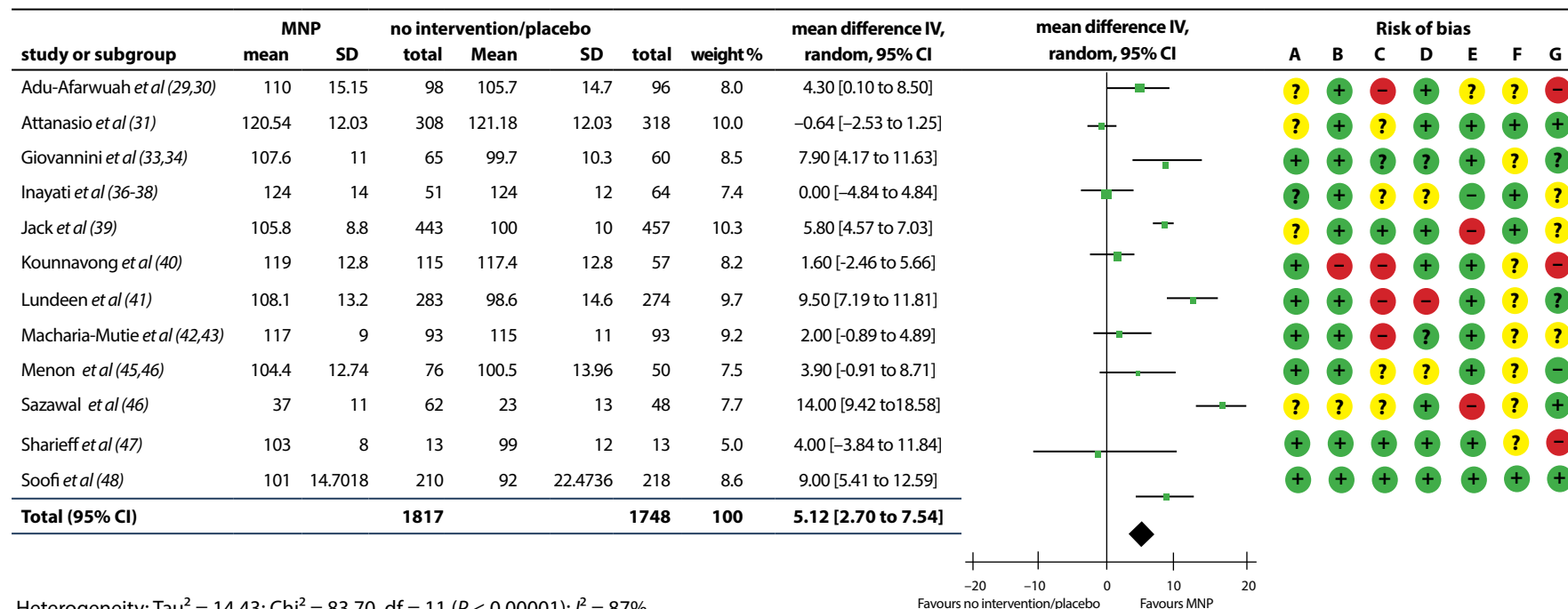
**B. Effects of the provision of multiple micronutrient powders on iron deficiency (as defined by trialists) in comparison to no intervention or placebo in infants and young children aged 6–23 months**



Risk of bias legend  
 (A) Random sequence generation (selection bias)  
 (B) Allocation concealment (selection bias)  
 (C) Blinding of participants and personnel (performance bias)  
 (D) Blinding of outcome assessment (detection bias)  
 (E) Incomplete outcome data (attrition bias)  
 (F) Selective reporting (reporting bias)  
 (G) Other bias

**CI:** confidence interval; **df:** degrees of freedom; **M-H:** Mantel–Haenszel; **MNP:** multiple micronutrient powders for point-of-use fortification.

### C. Effects of the provision of multiple micronutrient powders on haemoglobin concentration (g/L) in comparison to no intervention or placebo in infants and young children aged 6–23 months



Heterogeneity:  $\text{Tau}^2 = 14.43$ ;  $\text{Chi}^2 = 83.70$ ,  $\text{df} = 11$  ( $P < 0.00001$ );  $I^2 = 87\%$

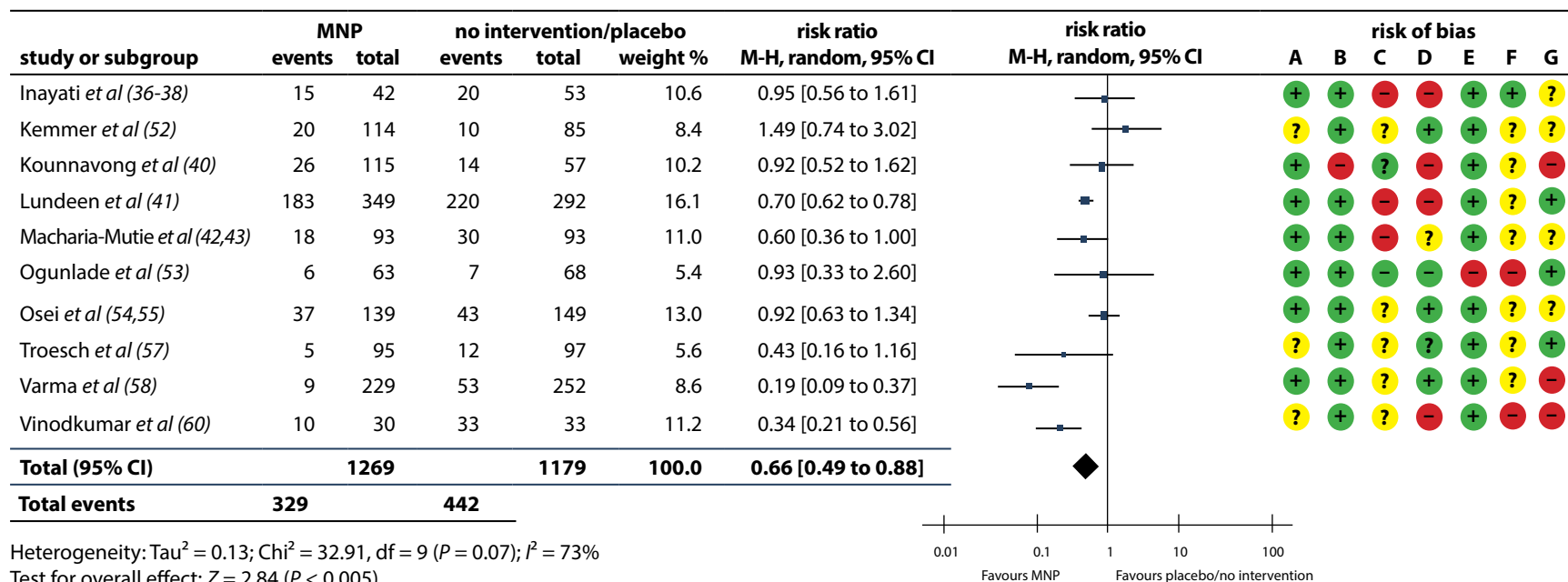
Test for overall effect:  $Z = 4.14$  ( $P < 0.0001$ )

#### Risk of bias legend

- (A) Random sequence generation (selection bias)
- (B) Allocation concealment (selection bias)
- (C) Blinding of participants and personnel (performance bias)
- (D) Blinding of outcome assessment (detection bias)
- (E) Incomplete outcome data (attrition bias)
- (F) Selective reporting (reporting bias)
- (G) Other bias

(C) for cluster-randomized trials; **CI**: confidence interval; **df**: degrees of freedom; **M-H**: Mantel–Haenszel; **MNP**: multiple micronutrient powders for point-of-use fortification.

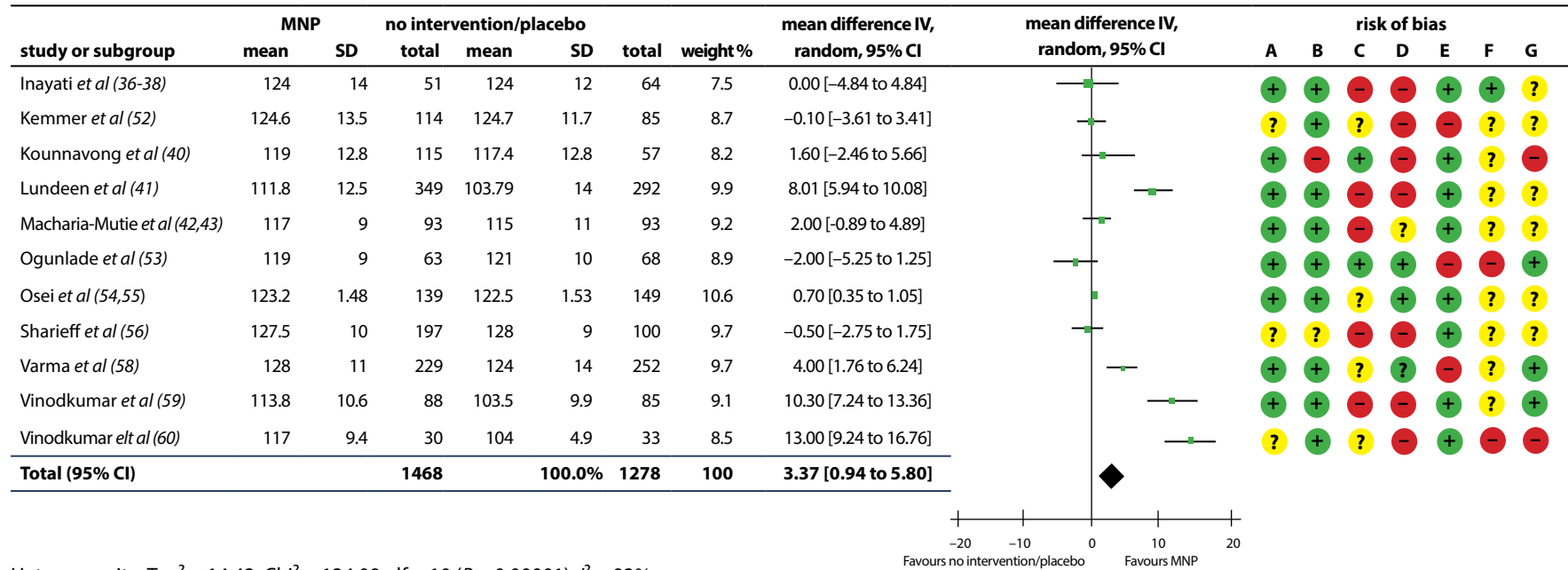
**D. Effects of point-of-use fortification of foods with micronutrient powders containing iron on anaemia (defined as haemoglobin lower than 110 g/L for children aged 24–59 months and lower than 115 g/L for children aged 5–11.9 years, adjusted by altitude where appropriate) in comparison to no intervention or placebo in children of preschool and school age**



(C) for cluster-randomized trials; **CI**: confidence interval; **df**: degrees of freedom; **M-H**: Mantel–Haenszel; **MNP**: multiple micronutrient powders for point-of-use fortification.



### E. Effects of point-of-use fortification of foods with micronutrient powders containing iron on haemoglobin (g/L) in comparison to no intervention or placebo in children of preschool and school age



Heterogeneity:  $\text{Tau}^2 = 14.42$ ;  $\text{Chi}^2 = 134.09$ ,  $\text{df} = 10$  ( $P < 0.00001$ );  $I^2 = 93\%$

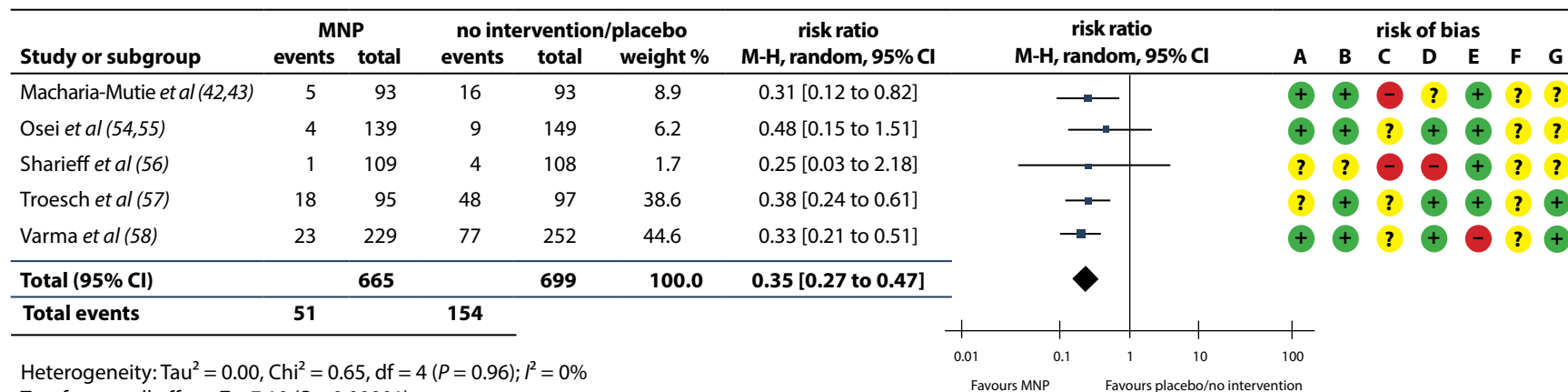
Test for overall effect:  $Z = 2.72$  ( $P < 0.006$ )

#### Risk of bias legend

- (A) Random sequence generation (selection bias)
- (B) Allocation concealment (selection bias)
- (C) Blinding of participants and personnel (performance bias)
- (D) Blinding of outcome assessment (detection bias)
- (E) Incomplete outcome data (attrition bias)
- (F) Selective reporting (reporting bias)
- (G) Other bias

(C) for cluster-randomized trials; **CI**: confidence interval; **df**: degrees of freedom; **M-H**: Mantel–Haenszel; **MNP**: multiple micronutrient powders for point-of-use fortification.

**F. Effects of point-of-use fortification of foods with micronutrient powders containing iron on iron deficiency (as defined by trialists) in comparison to no intervention or placebo in children of preschool and school age.**



- Risk of bias legend
- (A) Random sequence generation (selection bias)
  - (B) Allocation concealment (selection bias)
  - (C) Blinding of participants and personnel (performance bias)
  - (D) Blinding of outcome assessment (detection bias)
  - (E) Incomplete outcome data (attrition bias)
  - (F) Selective reporting (reporting bias)
  - (G) Other bias

(C) for cluster-randomized trials; CI: confidence interval; df: degrees of freedom; M-H: Mantel–Haenszel; MNP: multiple micronutrient powders for point-of-use fortification.

## ANNEX 2.

### GRADE SUMMARY OF FINDINGS TABLES

#### A. Micronutrient powders for point-of-use fortification of foods versus placebo/no intervention in infants and young children aged 6–23 months

##### Micronutrient powders for point-of-use fortification of foods versus placebo/no intervention in infants and young children aged 6–23 months

**Patient or population:** infants and young children aged 6–23 months

**Settings:** community settings

**Intervention:** point-of-use fortification with multiple micronutrient powders

**Comparison:** placebo/no intervention

Outcomes	Relative effect (95% CI)	Number of participants (studies)	Quality of the evidence (GRADE) comments
Anaemia (haemoglobin values lower than 110 g/L)	RR 0.74 (0.66 to 0.83)	2802 (10 RCTs)	⊕⊕⊕⊕ HIGH
Iron deficiency (as defined by trialists)	RR 0.48 (0.39 to 0.58)	796 (5 RCTs)	⊕⊕⊕⊖ MODERATE <sup>1</sup>
Haemoglobin (g/L)	MD 5.12 (2.70 to 7.54)	3565 (12 RCTs)	⊕⊕⊖⊖ LOW <sup>2,3</sup>
Iron status (ferritin concentrations in µg/L)	MD 16.47 (3.03 to 29.91)	694 (3 RCTs)	⊕⊖⊖⊖ VERY LOW <sup>1,4</sup>
Weight-for-age (in z-scores)	MD 0.04 (0.13 to 0.21)	606 (4 RCTs)	⊕⊕⊖⊖ LOW <sup>4,5</sup>
All-cause mortality	Not estimable	0 (0)	None of the trials reported on this outcome

CI: confidence interval; RCT: randomized controlled trial; RR: risk ratio; OR: odds ratio.

\* **The risk in the intervention group** (and its 95% CI) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

GRADE Working Group grades of evidence:

**High quality:** we are very confident that the true effect lies close to that of the estimate of the effect.

**Moderate quality:** we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.

**Low quality:** our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.

**Very-low quality:** we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

<sup>1</sup> One study (29) has serious risk of bias and contributed 23.8% weighting for meta-analysis.

<sup>2</sup> Four studies (around 40% weighting) were unclear on randomization, and two studies had high risk of attrition bias.

<sup>3</sup> Heterogeneity was high (I<sup>2</sup> greater than 75%).

<sup>4</sup> Two studies were unclear on randomization and had high risk of attrition bias.

<sup>5</sup> Sample size was under optimal information size and there was a wide 95% CI.

## B. Micronutrient powders for point-of-use fortification of foods versus iron supplements in infants and young children aged 6–23 months

### Micronutrient powders for point-of-use fortification of foods versus iron supplements in infants and young children aged 6–23 months

**Patient or population:** infants and young children aged 6–23 months

**Settings:** community settings

**Intervention:** point-of-use fortification with multiple micronutrient powders

**Comparison:** placebo/no intervention

Outcomes	Relative effect (95% CI)	Number of participants (studies)	Quality of the evidence (GRADE) comments
Anaemia (haemoglobin values lower than 110 g/L)	RR 0.89 (0.58 to 1.39)	145 (1 RCT)	⊕⊕⊖⊖ LOW
Iron deficiency (as defined by trialists)	Not estimable	0	None of the trials reported on this outcome
Haemoglobin (g/L)	MD 2.81 (10.84 to 5.22)	278 (2 RCTs)	⊕⊖⊖⊖ VERY LOW <sup>1,2</sup>
Iron status (ferritin concentrations in µg/L)	Not estimable	0 (0)	None of the trials reported on this outcome
Weight-for-age (in z-scores)	Not estimable	0 (0)	None of the trials reported on this outcome
All-cause mortality	Not estimable	0 (0)	None of the trials reported on this outcome

CI: confidence interval; RCT: randomized controlled trial; RR: risk ratio; OR: odds ratio.

\* **The risk in the intervention group** (and its 95% CI) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

GRADE Working Group grades of evidence:

**High quality:** we are very confident that the true effect lies close to that of the estimate of the effect.

**Moderate quality:** we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.

**Low quality:** our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.

**Very-low quality:** we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

<sup>1</sup> Considerable statistical heterogeneity and inconsistency in the results between trials.

<sup>2</sup> Small sample size with wide 95%CI.

### C. Iron-containing micronutrient powders for point-of-use fortification of foods versus placebo/no intervention in children aged 2–12 years

#### Iron-containing micronutrient powders for point-of-use fortification of foods versus placebo/no intervention in children aged 2–12 years

**Patient or population:** infants and young children aged 6–23 months

**Settings:** community settings

**Intervention:** point-of-use fortification with multiple micronutrient powders

**Comparison:** placebo/no intervention

Outcomes	Relative effect (95% CI)	Number of participants (studies)	Quality of the evidence (GRADE) comments
Anaemia (haemoglobin lower than 110 g/L for children aged 24–59 months and lower than 115 g/L for children aged 5–11.9 years)	RR 0.66 (0.49 to 0.88)	2448 (10 studies)	⊕⊕⊕⊖ MODERATE <sup>1</sup>
Haemoglobin (g/L)	MD 3.37 (0.94 to 5.80)	2746 (11 studies)	⊕⊕⊖⊖ LOW <sup>2</sup>
Iron deficiency (as defined by using ferritin concentrations of less than 15 µg/L)	RR 0.35 (0.27 to 0.47)	1364 (5 studies)	⊕⊕⊕⊖ MODERATE <sup>3</sup>
Iron status (ferritin concentrations in µg/L)	SMD 0.42 (–4.36 to 5.19)	1066 (3 studies)	⊕⊖⊖⊖ VERY LOW <sup>4</sup>
All-cause mortality (number of deaths during the trial)	MD 0 (–0.03 to 0.03)	115 (1 study)	⊕⊕⊖⊖ LOW <sup>5</sup>
Diarrhoea (three liquid stools or more per day)	RR 0.97 (0.53 to 1.78)	366 (2 studies)	⊕⊕⊕⊖ MODERATE <sup>6</sup>

CI: confidence interval; MD: mean difference; RR: risk ratio; SMD: standardized mean difference.

GRADE Working Group grades of evidence:

**High quality:** we are very confident that the true effect lies close to that of the estimate of the effect.

**Moderate quality:** we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.

**Low quality:** our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.

**Very-low quality:** we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

<sup>1</sup> Most of the studies had no blinding. High heterogeneity (72%) with most of the studies showing a positive effect of multiple micronutrient powders. No serious imprecision.

<sup>2</sup> Most of the studies had no blinding. High heterogeneity (93%) with most of the studies showing a positive effect of multiple micronutrient powders. Serious imprecision.

<sup>3</sup> Most of the studies had no blinding. Nil heterogeneity with most of the studies showing a positive effect of multiple micronutrient powders. No serious imprecision.

<sup>4</sup> All the studies had no or unclear blinding. 100% heterogeneity with most inconsistency in the direction of the effect. Serious imprecision.

<sup>5</sup> Only one low-risk trial reported on this outcome.

<sup>6</sup> Two low-risk trials reported on this outcome. Nil heterogeneity with both studies showing no difference between the intervention and the comparison group. Serious imprecision.

## ANNEX 3.

### SYSTEMATIC REVIEW TEAMS

#### Systematic review 1

##### **Home fortification of foods with multiple micronutrient powders for health and nutrition in children under two years of age**

*Luz Maria De-Regil,<sup>1</sup> Parminder S Suchdev,<sup>2</sup> Maria Elena del Socorro Jefferds,<sup>3</sup> Ota Erika<sup>4</sup>*

- <sup>1</sup> Research and Evaluation, Micronutrient Initiative, Ottawa, Canada
- <sup>2</sup> Pediatrics and Global Health; Nutrition Branch, Emory University; Centers for Disease Control & Prevention (CDC), Atlanta, GA, United States of America
- <sup>3</sup> Nutrition Branch, Division of Nutrition, Physical Activity, and Obesity, Centers for Disease Control and Prevention, Atlanta, Georgia, United States of America
- <sup>4</sup> Global Health Nursing, St. Luke's International University, Graduate School of Nursing Sciences, Tokyo, Japan

*Note:* we report in this document a summary of the results from a recent update of a systematic review (October 2016) first published in the Cochrane Database of Systematic Reviews in 2011 (25). The systematic review has been finalized and is undergoing editorial process with the Cochrane Developmental, Psychosocial and Learning Problems Group. Cochrane reviews are regularly updated as new evidence emerges and in response to feedback, and the Cochrane Database of Systematic Reviews should be consulted for the most recent version of the full review. A pre-publication summary can be obtained by contacting the Department of Nutrition for Health and Development, World Health Organization, Geneva, Switzerland ([nutrition@who.int](mailto:nutrition@who.int)).

#### Systematic review 2

##### **Point-of-use fortification of foods with micronutrient powders containing iron in children of preschool and school age**

*Luz Maria De-Regil,<sup>1</sup> Maria Elena del Socorro Jefferds,<sup>2</sup> Juan Pablo Peña-Rosas<sup>3</sup>*

- <sup>1</sup> Research and Evaluation, Micronutrient Initiative, Ottawa, Canada
- <sup>2</sup> Nutrition Branch, Division of Nutrition, Physical Activity, and Obesity, Centers for Disease Control and Prevention, Atlanta, Georgia, United States of America
- <sup>3</sup> Evidence and Programme Guidance, Department of Nutrition for Health and Development, World Health Organization, Geneva, Switzerland

*Note:* we report in this document a summary of the results from a recent update of a systematic review (October 2016) first published as a protocol in the Cochrane Database of Systematic Reviews in 2012 (26). The systematic review has been finalized and is undergoing editorial process with the Cochrane Developmental, Psychosocial and Learning Problems Group. Cochrane reviews are regularly updated as new evidence emerges and in response to feedback, and the Cochrane Database of Systematic Reviews should be consulted for the most recent version of the full review. A pre-publication summary can be obtained by contacting the Department of Nutrition for Health and Development, World Health Organization, Geneva, Switzerland ([nutrition@who.int](mailto:nutrition@who.int)).

## ANNEX 4.

### QUESTIONS IN POPULATION, INTERVENTION, CONTROL, OUTCOMES (PICO) FORMAT

#### Effects and safety of multiple micronutrient powders for infants and young children aged 6–23 months and children aged 2–12 years

- a. Can multiple micronutrient powders be used in infants and young children aged 6–23 months and children aged 2–12 years to improve health outcomes?
- b. If so, at what dose, frequency and duration?

<b>POPULATIONS:</b>	<p><b>Infants and young children aged 6–23 months and children aged 2–12 years</b></p> <p>Subpopulation:</p> <p><i>Critical</i></p> <ul style="list-style-type: none"> <li>• By malaria transmission (four categories: no transmission or elimination achieved, susceptibility to epidemic malaria, year-round transmission with marked seasonal fluctuations, year-round transmission; with consideration of <i>Plasmodium falciparum</i> and/or <i>Plasmodium vivax</i>)</li> <li>• By use of concurrent antimalarial measures</li> <li>• By prevalence of anaemia in infants and young children aged 6–23 months: countries with a public health problem (5–19.9%, mild; 20–39.9%, moderate; ≥40% or more, severe) versus no public health problem (less than 5%)</li> <li>• By individual anaemia status: anaemic children versus non-anaemic children (defined as haemoglobin less than 110 g/L)</li> <li>• By iron status: iron-deficient versus non-iron deficient children (as defined by ferritin, transferrin receptor, and/or zinc protoporphyrin/haem ratio cut-off values)</li> </ul>
<b>INTERVENTION:</b>	<p><b>Multiple micronutrient formulations containing iron, zinc and vitamin A, with or without other micronutrients</b></p> <p>Subgroup analyses:</p> <p><i>Critical</i></p> <ul style="list-style-type: none"> <li>• By content of product: <ul style="list-style-type: none"> <li>• Iron: less than 12.5 mg versus 12.5 mg or more</li> <li>• Zinc: less than 5.0 mg versus 5.0 mg or more</li> </ul> </li> <li>• By number of micronutrients: 5 or fewer versus 6 or more</li> <li>• By frequency: daily versus weekly versus flexible</li> <li>• By duration of intervention: less than 6 months versus 6 months or more</li> <li>• By level of exposure to the intervention: high versus low</li> </ul>
<b>CONTROL:</b>	<ul style="list-style-type: none"> <li>• No provision of multiple micronutrient powders, or placebo</li> <li>• Provision of iron supplements</li> </ul>
<b>OUTCOMES:</b>	<p><i>Critical</i></p> <ul style="list-style-type: none"> <li>• Anaemia</li> <li>• Iron status (as defined by trialists)</li> <li>• Haemoglobin values</li> </ul> <p><i>For malaria-endemic areas only</i></p> <ul style="list-style-type: none"> <li>• Malaria incidence and severity (parasitaemia with or without symptoms)</li> </ul>
<b>SETTINGS:</b>	All countries



## ANNEX 5.

### SUMMARY OF THE CONSIDERATIONS OF THE MEMBERS OF THE GUIDELINE DEVELOPMENT GROUP FOR DETERMINING THE STRENGTH OF THE RECOMMENDATIONS FOR USE OF MULTIPLE MICRONUTRIENT POWDERS FOR POINT-OF-USE FORTIFICATION OF FOODS CONSUMED BY INFANTS AND YOUNG CHILDREN AGED 6–23 MONTHS AND CHILDREN AGED 2–12 YEARS

<b>QUALITY OF EVIDENCE:</b>	The overall quality of the evidence was considered moderate. Moderate quality of evidence for anaemia, low quality of evidence for haemoglobin and very low quality of evidence for iron status (ferritin concentrations).
<b>VALUES AND PREFERENCES:</b>	Health-care providers generally accept providing this intervention to infants and children. The intervention is generally acceptable to families with young children.
<b>TRADE-OFF BETWEEN BENEFITS AND HARMS:</b>	Most of the members of the guideline development group (67%) perceived that benefits (i.e. reduced anaemia, iron deficiency) clearly outweigh the harms (i.e. increased diarrhoea episodes). One third of the members of the guideline development group (33%) perceived that benefits and harms are balanced.
<b>COSTS AND FEASIBILITY:</b>	<p>With respect to resources, three quarters of members of the guideline development group (75%) perceived that net benefits were worth the costs. One quarter of the members of the guideline development group (25%) were uncertain about this factor.</p> <p>A large majority of the members of the guideline development group (63%) understood that this intervention was conditionally feasible to each specific setting and the prevalence of anaemia in that specific setting. A little over one third of the members of the guideline development group (37%) considered that this intervention is globally feasible.</p> <p>The guideline development group as a whole agreed on highlighting that this is not the only policy option for increasing iron intakes in the populations of interest. Therefore, decision-makers need to decide which intervention is best suited for their context, needs and resources.</p>

## ANNEX 6.

### WHO STEERING COMMITTEE FOR NUTRITION GUIDELINES DEVELOPMENT

#### **Emergency Risk Management and Humanitarian Response**

Dr Richard Brennan  
Director  
World Health Organization  
Avenue Appia 20, 1211 Geneva  
Switzerland

#### **Food Safety, Zoonoses and Foodborne Diseases**

Dr Kazuaki Miyagishima  
Director  
World Health Organization  
Avenue Appia 20, 1211 Geneva  
Switzerland

#### **Global TB Programme**

Dr Knut Lonnroth  
Medical Officer  
World Health Organization  
Avenue Appia 20, 1211 Geneva  
Switzerland

#### **Health System Policies and Workforce**

Dr Ties Boerma  
Director, Health Statistics and Information Systems  
World Health Organization  
Avenue Appia 20, 1211 Geneva  
Switzerland

#### **HIV/AIDS**

Dr Gottfried Otto Hirsenschall  
Director  
World Health Organization  
Avenue Appia 20, 1211 Geneva  
Switzerland

#### **International Agency for Research on Cancer**

Dr Isabelle Romieu  
Section and Group Head  
Nutritional Epidemiology Group  
International Agency for Research on Cancer  
150, cours Albert Thomas  
69372 Lyon Cedex 08  
France

Dr Nadia Slimani  
Group Head  
Dietary Exposure Assessment Group  
International Agency for Research on Cancer  
150, cours Albert Thomas  
69372 Lyon Cedex 08  
France

#### **Immunization, Vaccines and Biologicals**

Dr Jean-Marie Okwo-Bele  
Director  
World Health Organization  
Avenue Appia 20, 1211 Geneva 27  
Switzerland

#### **Knowledge Management and Sharing**

Dr Najeeb Mohamed Al Shorbaji  
World Health Organization  
Avenue Appia 20, 1211 Geneva  
Switzerland

Maternal, Newborn, Child and Adolescent Health  
Dr Elizabeth Mason  
World Health Organization  
Avenue Appia 20, 1211 Geneva  
Switzerland

#### **Nutrition for Health and Development**

Dr Francesco Branca  
Director  
World Health Organization  
Avenue Appia, 20, 1211 Geneva  
Switzerland

**Prevention of Noncommunicable Diseases**

Dr Douglas Bettcher  
Director  
World Health Organization  
Avenue Appia 20, 1211 Geneva  
Switzerland

**Public Health, Environmental and Social Determinants of Health**

Dr Maria Purificacion Neira  
Director  
World Health Organization  
Avenue Appia 20, 1211 Geneva  
Switzerland

**Reproductive Health and Research**

Dr Marleen Temmerman  
Director  
World Health Organization  
Avenue Appia 20, 1211 Geneva  
Switzerland

**The Special Programme for Research and Training in Tropical Diseases**

Professor John Charles Reeder  
Director  
World Health Organization  
Avenue Appia 20, 1211 Geneva  
Switzerland

## ANNEX 7.

### WHO GUIDELINE DEVELOPMENT GROUP – NUTRITION ACTIONS 2013–2014

(Note: the areas of expertise of each guideline group member are given in *italics*)

**Ms Deena Alasfoor**

Ministry of Health  
Muscat, Oman  
*Health programme management, food legislations, surveillance in primary health care*

**Dr Kalid Asrat Tasew**

Consultant Pediatrician  
St Paul Hospital Millennium Medical College  
Addis Ababa 17974  
Ethiopia  
*Paediatrics, primary health care*

**Dr Mary Chea**

National Nutrition Programme  
National Maternal and Child Health Centre  
Phnom Penh, Cambodia  
*Programme implementation, midwifery*

**Dr Luz Maria De-Regil**

Director, Research and Evaluation and Chief Technical Adviser  
Micronutrient Initiative  
180 Elgin Street, Suite 1000  
Ottawa, Canada  
*Epidemiology, systematic reviews, programme implementation*  
*Methodologist*

**Dr Heba El Laithy**

Statistical Department  
Faculty of Economics  
Cairo University  
Cairo, Egypt  
*Statistics, economics*

**Dr Davina Gherzi**

Executive Knowledge and Development Cluster  
National Health and Medical Research Council  
Canberra, Australia  
*Policy-making, systematic reviews, evidence*

**Dr Rukhsana Haider**

Training and Assistance for Health and Nutrition (TAHN) Foundation  
House 12 (1st Floor) Rd 13, Block-E, Banani  
Dhaka-1213  
Bangladesh  
*Breastfeeding, capacity-building on counselling and nutrition*

**Dr Maria Elena del Socorro Jefferds**

Nutrition Branch  
Division of Nutrition, Physical Activity and Obesity  
US Centers for Disease Control and Prevention (CDC)  
Atlanta, United States of America  
*Behaviour science, programme evaluation*

**Dr Patrick Wilfried Kolsteren**

Department of Public Health  
Institute of Tropical Medicine  
Nationalestraat 155, 2000 Antwerp  
Belgium  
*Public health, food safety, laboratory methods*

**Dr Guansheng Ma**

National Institute for Nutrition and Food Safety  
Chinese Center for Disease Control and Prevention  
Beijing, China  
*Food safety, public health, programme management*

**Dr Lynnette Neufeld**

Monitoring, Learning and Research  
Global Alliance for Improved Nutrition (GAIN)  
Geneva, Switzerland  
*Micronutrients, programmes, epidemiology*

**Professor Orish Ebere Orisakwe**

Toxicology Unit, Faculty of Pharmacy  
University of Port Harcourt  
Rivers State  
Nigeria  
*Pharmacology, food safety, toxicology*

**Dr Mical Paul**

Infectious Diseases Unit  
Rabin Medical Center, Belinson Hospital  
Sackler Faculty of Medicine Tel Aviv University  
Petah-Tikva, Israel  
*Infectious diseases, HIV*

**Professor Dalip Ragoobirsingh**

Medical Biochemistry and Diabetology  
Diabetes Education Programme  
University of the West Indies  
Faculty of Medical Sciences Teaching & Research  
Mona, Kingston 7  
Jamaica  
*Diabetes*

**Professor HPS Sachdev**

Sitaram Bhartia Institute of Science and Research  
New Delhi, India  
*Paediatrics, systematic reviews*

**Ms Rusidah Selamat**

Nutrition Division  
Department of Public Health  
Ministry of Health Malaysia  
Putrajaya, Malaysia  
*Public health nutrition*

**Dr Rebecca Joyce Stoltzfus**

Division of Nutritional Sciences  
Cornell University  
Ithaca, United States of America  
*International nutrition and public health, iron and vitamin A nutrition, programme research*

**Dr Igor Veljkovic**

United Nations Children's Fund (UNICEF) Skopje  
Skopje, Former Yugoslav Republic of Macedonia  
*Programme implementation*

**Dr Maged Younes**

Committee on World Food Security (CFS)  
Food and Agriculture Organization (FAO)  
Rome, Italy  
*Food safety, public health, programme management*

## ANNEX 8.

### WHO SECRETARIAT

#### *WHO headquarters*

**Dr Maria de las Nieves García-Casal**

Consultant  
Evidence and Programme Guidance  
Department of Nutrition for Health and Development

**Mr Leendert Maarten Nederveen**

Technical Officer  
Surveillance and Population-based Prevention  
Department of Prevention of Noncommunicable Diseases

**Dr Juan Pablo Peña-Rosas**

Coordinator  
Evidence and Programme Guidance Unit  
Department of Nutrition for Health and Development

**Dr Lisa Rogers**

Technical Officer  
Evidence and Programme Guidance  
Department of Nutrition for Health and Development

**Mr Gerardo Zamora**

Technical Officer, Implementation Research and Equity  
Evidence and Programme Guidance  
Department of Nutrition for Health and Development

#### *WHO regional offices*

**Dr Kunal Bagchi**

Regional Adviser  
Nutrition and Food Safety  
WHO Regional Office for South-East Asia  
New Delhi, India

**Dr Chessa Lutter**

Regional Adviser  
Child and Adolescent Health  
WHO Regional Office for the Americas/Pan American Health Organization  
United States of America

**Dr Ruben Grajeda Toledo**

Adviser, Nutrition and Social Determinants  
Regional Office for the Americas of the World Health Organization  
Pan American Health Organization  
United States of America

## ANNEX 9.

### EXTERNAL RESOURCE EXPERTS

**Dr Robert J Berry**

Prevention Research Branch  
National Center on Birth Defects and Developmental  
Disabilities  
Centers for Disease Control and Prevention  
United States of America

**Ms Nita Dalmiya**

United Nations Children's Fund  
3 UN Plaza, New York, NY 10017  
United States of America

**Dr Julia Finkelstein**

Division of Nutritional Sciences, Cornell University  
Ithaca, New York  
United States of America

**Dr Elvira González de Mejía**

Department of Food Science and Human Nutrition  
University of Illinois  
United States of America

**Dr Jeff Gwartz**

Food Fortification Initiative  
United States of America

**Dr Chowdhury Jalal**

Operations and Evaluation Research  
Micronutrient Initiative  
Canada

**Mr Phillip J Makhumula-Nkhoma**

Independent consultant  
Tuckahoe, New York 10707  
United States of America

**Dr Luis A Mejía**

Department of Food Science and Human Nutrition  
University of Illinois  
United States of America

**Dr Helena Pachon**

Food Fortification Initiative  
Emory University  
United States of America

**Mr Peter Ranum**

Independent consultant  
United States of America

**Mr Georg Steiger**

DSM Nutritional Products  
Switzerland

**Dr Parmi S Suchdev**

Emory University, Division of Hospitalist Medicine,  
Egleston  
Joint appointment, Rollins School of Public Health  
United States of America



## ANNEX 10.

### PEER-REVIEWERS

**Mr Mirak Raj Angdembe**

FHI360  
Kathmandu, Nepal

**Professor Marly Augusto Cardoso**

Department of Nutrition  
School of Public Health  
University of Sao Paulo  
Sao Paulo, Brazil

**Ms Nuzhat Choudhury**

Nutrition and Clinical Services Division  
International Centre for Diarrhoeal Disease Research,  
Bangladesh (icddr,b)  
Dhaka, Bangladesh

**Dr Francisco Guillén-Grima**

Department of Health Sciences  
Public University of Navarra  
Pamplona, Spain

**Dr Ana-Lucía Mayen-Chacón**

Nutrition and Social Determinants of Health  
Guatemala City, Guatemala

**Mr Alejandro Vargas**

Action Against Hunger  
Lima, Peru

**Dr Pattanee Winichagoon**

Institute of Nutrition, Mahidol University  
Salaya, Nakhon Pathom  
Thailand

**Dr Stanley Zlotkin**

Centre for Global Child Health  
The Hospital for Sick Children  
Professor, Departments of Paediatrics, Nutritional  
Sciences and Public Health  
University of Toronto  
Canada

*Note:* The names and affiliations of peer-reviewers are provided here as an acknowledgement and by no means indicate their endorsement of the recommendations in this guideline. The acknowledgement of the peer-reviewers does not necessarily represent the views, decisions or policies of the institutions with which they are affiliated.



**For more information, please contact:**

**Department of Nutrition for Health and Development**

World Health Organization  
Avenue Appia 20,  
CH-1211 Geneva 27,  
Switzerland

Fax: +41 22 791 4156

E-mail: [nutrition@who.int](mailto:nutrition@who.int)

[www.who.int/nutrition](http://www.who.int/nutrition)



WHO Guideline:

**USE OF MULTIPLE MICRONUTRIENT POWDERS**  
**FOR POINT-OF-USE FORTIFICATION OF FOODS CONSUMED BY**  
INFANTS AND YOUNG CHILDREN AGED 6–23 MONTHS AND CHILDREN AGED 2–12 YEARS

ISBN 978-92-4-154994-3

