Technical note

Supplementary foods for the management of moderate acute malnutrition in infants and children 6–59 months of age

World Health Organization

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Contents

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Scope and purpose

Currently there are no evidence-informed recommendations for the composition of supplementary foods specially designed for the management of children with moderate acute malnutrition. This technical note summarizes the available evidence and presents some principles underlying the dietary management of children with moderate acute malnutrition with a proposed nutrient composition profile for supplementary foods relevant to situations in which their use may be warranted. The information presented does not cover the quantity of supplementary foods that should be given, the proportion of dietary intake that should be made up by supplementary foods, the duration of the intervention, the discharge criteria or the benchmarks for making these decisions.

This document is intended for senior technical and programme staff in organizations involved in operational research and in the design and implementation of food-based interventions to manage moderate acute malnutrition in children. It is not intended for field staff or community-based health workers involved in the management of malnutrition.

Background

It is estimated that in 2010, 55 million preschool-age children were wasted, of whom about 40 million were moderately acutely malnourished[1] (*2*). Childhood malnutrition is a major global health problem, contributing to increased morbidity and mortality, impaired intellectual development, suboptimal adult work capacity and even increased risk of disease in adulthood (*3*). Of the 7.6 million deaths annually among children under 5 years of age, approximately 20% can be attributed to child underweight (*4*).

Malnutrition in infants and young children typically develops during the period between the first 6 and 18 months of age (*5*), and is often associated with intake of low nutrient and energy density diets, consisting predominantly of starch-rich staples that are provided in addition to breast milk. Linear growth and brain development are especially rapid during the first 2 years of life and young children are particularly susceptible to growth failure and developmental delays if they are not breastfed and are fed complementary foods with low nutrient and energy density and poor bioavailability of vitamins and minerals (*6*). Furthermore, preparation of complementary foods in conditions of poor hygiene and sanitation can lead to dietary contamination and frequent infections, which further impairs children's nutritional status.

Children with moderate acute malnutrition have nutritional requirements that differ from non-malnourished and severely malnourished children, that is, they require increased intake of energy and essential nutrients over and above those required by non-malnourished children and, when necessary, treatment for any associated medical conditions.

The dietary management of moderate acute malnutrition should normally be based on the optimal use of locally available nutrient-dense foods to improve the nutritional status of children and prevent them from becoming severely acutely malnourished or failing to thrive (*7*). Intake of nutrients present in inadequate amounts in the habitual diet can be increased through a number of approaches, including dietary diversification and fortification of certain staple foods with vitamins and minerals.

In situations of food shortage, or where some nutrients are not sufficiently available through local foods, caregivers may not be able to provide infants and young children recovering from moderate acute malnutrition with a diet that meets their nutritional needs. This risk of nutrition insecurity may be aggravated in emergencies, droughts and/or displacement situations. In such conditions, specially formulated supplementary foods[2] are usually required to supplement the regular diet and contribute to an improved intake of the required nutrients (*8*). Supplementary foods with varying nutrient compositions have been used to facilitate the recovery of children with moderate acute malnutrition but their efficacy and effectiveness have been suboptimal.

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[1] Moderate acute malnutrition in children is defined as weight-for-height between –3 and –2 Z-scores of the median of the WHO child growth standards without oedema (*1*).

[2] Supplementary foods are specially formulated foods, in ready-to-eat or in milled form, which are modified in their energy density, protein, fat or micronutrient composition to help meet the nutritional requirements of specific populations. Supplementary foods are not intended to be the only source of nutrients and are different from complementary foods, in that the latter are intended for progressive adaptation of infants 6 months of age and older to the food of the family. They are also different from food supplements, which refer to vitamin and mineral supplements in unit dose forms such as capsules, tablets, powders or solutions, where national jurisdictions regulate these products as food.

Supplementary foods have been used to rehabilitate moderately malnourished persons or to prevent a deterioration of nutritional status of those most at risk by meeting their additional needs, focusing particularly on children 6–59 months of age, pregnant women and lactating mothers. Examples of supplementary foods include fortified blended foods, which can be used to prepare smooth, ready-to-eat porridges, and lipid-based nutrient supplements.

Nutrient intakes for optimal recovery of children with moderate acute malnutrition were reviewed in October 2008 at a joint consultation of the WHO, United Nations Children's Fund (UNICEF), World Food Programme (WFP) and the United Nations High Commissioner for Refugees (UNHCR) on the management of moderate malnutrition in children under 5 years of age (*9*). It was agreed that the desirable nutrient intakes in relation to energy were probably in the range between the recommended nutrient intakes for well-nourished children and the intakes recommended in the recovery phase for those with severe acute malnutrition (*10*).

Summary of evidence and current thinking

The proposed nutrient composition for supplementary foods (**Table 1**) is derived from a comprehensive review prepared for the WHO/UNICEF/WFP/UNHCR consultation on the management of moderate acute malnutrition in children under 5 years of age (*9*), in particular, the "proposed recommended nutrient densities for moderately malnourished children" (*10*) and "choice of foods and ingredients for moderately malnourished children 6 months to 5 years of age" (*11*). These reviews and the background paper on technical considerations served as the basis for the proposed ranges with minimum and maximum nutrient levels in the composition of supplementary foods for moderately malnourished children. Experimental data from human and animal studies were used to inform the estimates, taking into consideration the effect of different levels of nutrients and their bioavailability.

In deriving the proposed nutrient composition for supplementary foods for moderately malnourished children, it was assumed that the basic diet of these children commonly consists primarily of cereals and pulses, with variable amounts of breast milk. The composition of the foods was determined from several food composition databases. The amount of energy and the amount of each nutrient (per 1000 kcal) provided by the assumed basic diet of the children was estimated and subtracted from the amount that should be in 1000 kcal of the ideal complete diet. A nutrient composition highlighting the desired dietary intake was then developed. This intake may be achieved either through regular foods or through the provision of supplementary foods to bridge the shortfall, taking into account the amount of energy and the nutrient density required to achieve the recommended daily energy and nutrient intakes. The safety of the ingredients that can be used to formulate supplementary foods was also considered to avoid any potential toxic effects.

Recommended intakes of nutrients for normal healthy children and for children with severe acute malnutrition have been specified (*12*, *13*). Adequate intakes of nutrients for moderately malnourished children 6–59 months of age were determined by interpolation between these two values. Basic science has been used to estimate the nutritional cost of growth and deposition of new lean body tissue. An energy intake of 25 kcal/kg/day in addition to the requirements of non-malnourished children is likely to support a weight gain of 5 g/kg/day, based on average tissue composition. Although not yet proven, this additional amount of energy is unlikely to lead to overweight or obesity when provided during this period of life.

Remarks on the use of the proposed nutrient composition of supplementary foods for use in the management of moderate acute malnutrition in children (**Table 1**):

- In order to translate the above nutrient density recommendations into choice of ingredients and fortification levels for specific foods, both the native nutrient content of the ingredients as well as the fortification levels need to be considered.
- Sufficient excess of labile minerals and vitamins (overage) for the product needs to be added to remain within specifications under the anticipated storage conditions until its best-used-before date.
- The minimum level of iodine content takes into consideration the consumption of iodized salt.
- Vitamin C levels should take losses during cooking into account, which may be as high as 50%.

TABLE 1

Proposed nutrient composition of supplementary foods for use in the management of moderate acute malnutrition in children[a,b]

Nutrient per 1000 kcal	Unit	Minimum	Maximum
Protein[c]	g	20	43
Fat	g	25	65
Minerals			
Sodium (Na)	mg	—	500
Potassium (K)	mg	1500	2200
Magnesium (Mg)	mg	280	420
Phosphorus (P)[d]	mg	850	1400
Zinc (Zn)	mg	20	35
Calcium (Ca)	mg	1000	1400
Copper (Cu)	mg	1	3.5
Iron (Fe)[e]	mg	18	30
Iodine (I)	µg	150	350
Selenium (Se)[f]	µg	35	90
Manganese (Mn)	mg	1	2[g]
Vitamins, water soluble			
Thiamin (B_1)	mg	> 1	—
Riboflavin (B_2)	mg	> 4	—
Pyridoxine (B_6)	mg	> 2	—
Cobalamine (B_{12})	µg	> 5	—
Folate (dietary folate equivalent)	µg	> 400[h]	—
Niacin	mg	> 25	—
Ascorbate (vitamin C)	mg	> 150	—
Pantothenic acid	mg	> 5	—
Biotin	µg	> 20	—
Vitamins, fat soluble			
Retinol (vitamin A)	µg	2000	3000
Cholecalciferol (vitamin D)	µg	20	60
Vitamin E (DL-α tocopherol acetate)	mg	>30	—
Phytomenadione (vitamin K)	µg	>50	—
Fatty acids			
ω-6 fatty acid	% energy	>4.5	<10
ω-3 fatty acid	% energy	>0.5	<3
Trans-fatty acids	% total fat		3
Ratios of nutrients (based on weight)			
Ca/P ratio		1.0	1.5
Zn/Cu ratio		5	20
Zn/Fe ratio		0.8	3.5
Vitamin C/Fe		3	16

a The suggested concentrations are calculated as an example when supplementary foods provide 70% of energy. This does not constitute a recommendation that supplementary foods should provide 70% of the energy intake of moderately malnourished children. The formulation is such that it would be safe and effective if the quantity taken by moderately malnourished children represented 100% of the energy needs and that it would also provide benefit, although of a lesser order of magnitude, if taken in lower quantities. There is no evidence to determine maximum levels for some nutrients. In countries with established maximum levels for these nutrients in healthy children, it would appear convenient to use those amounts to inform product formulation.

b The energy density of supplementary foods when they are ready to be consumed should be not less than 0.8 kcal/g.

c Protein digestibility-corrected amino acid score >70%. Corresponds to cereal/legume mixtures, milk and animal proteins.

d Excluding most phosphorus from phytate because that is not bioavailable – assume 30% of phosphorus from plant sources to be available for absorption.

e Assumes 5% iron bioavailability.

f Ensure homogeneity in food because of the low toxicity limit for selenium.

g This proposed value applies to added manganese and not intrinsic manganese occurring naturally in foods.

h Equivalent to 240 µg (0.24 mg) folic acid.

- The inclusion of milk powder as an ingredient improves the amino acid profile (has a high Protein Digestibility Corrected Amino Acid Score) and it is a good contributor of bioavailable calcium and potassium. In addition, it has a specific stimulating effect on linear growth and insulin growth factor 1 (IGF-1) levels in the child and does not contain anti-nutrients.

Principles of nutritional management of children with moderate acute malnutrition

1. Every child needs to receive nutrition of a sufficient quality and quantity to enable normal growth and development as defined by the WHO growth and development standards (*1*).
2. Management of moderate acute malnutrition in children 6–59 months of age should include essential nutrition actions such as breastfeeding promotion and support, education and nutrition counselling for families, and other activities that identify and prevent the underlying causes of malnutrition, including nutrition insecurity. Interventions to improve food security include the provision of conditional or non-conditional cash transfers and support to agriculture, such as crop diversification.
3. Children 6–59 months of age with moderate acute malnutrition need to receive nutrient-dense foods to meet their extra needs for weight and height gain and functional recovery.
4. Nutrient-dense foods enable children to consume and maximize the absorption of nutrients in order to fulfil their requirements of energy and all essential nutrients. Animal-source foods are more likely to meet the amino acid and other nutrient needs of recovering children. Plant-source foods, in particular legumes or a combination of cereals and legumes, also have high-quality proteins, although they also contain some anti-nutrients such as phytates, tannins or inhibitors of digestive enzymes, which may limit the absorption of some micronutrients, particularly minerals.
5. The amounts of anti-nutrient compounds and naturally occurring toxins, cyanogens, alkaloids or other potentially poisonous or deleterious ingredients can be minimized by using appropriate food-processing methods, such as soaking, germination, malting and fermentation.
6. Supplementary foods, particularly when they represent the main source of energy, need to provide nutrients at levels that do not cause adverse effects in moderately malnourished children when consumed for several months.
7. Determination of the amount of supplementary food that needs to be given to a moderately malnourished child requires consideration of the availability and nutrient content of the child's habitual diet, including whether the child is being breastfed, the likelihood of sharing of the supplementary food within and beyond the household, and access to other foods.
8. The formulation of supplementary foods should be safe and effective, particularly where moderately malnourished children use this food as their only source of energy.
9. The mineral components should be authorized by a regulatory body. The *Codex Alimentarius* includes a list of approved additives and fortificants for foods for infants and young children (*14*). **Table 2** shows the list of compounds that have been used for such a preparation and are considered to have adequate bioavailability and stability in a flour-based matrix (e.g. maize or wheat) of a fortified blended food or a lipid-based matrix. In areas where coeliac disease is common, attention should be given to avoiding early introduction of wheat products. Additionally, because of the impaired digestive capacity of malnourished children, water-soluble salts should be used where possible.
10. Hygiene standards should comply with the *Codex Alimentarius* for infant and young children's food. These are being revised and will be discussed and agreed at the 34th Session of the Codex Committee on Nutrition and Foods for Specially Dietary Uses in July 2012 (*17*). It is advisable to give instructions for the safe and hygienic preparation of meals, e.g. those containing fortified blended food.

TABLE 2

Mineral and vitamin compounds currently used in supplementary foods available on the market for the dietary management of moderate acute malnutrition in children

Minerals		Lipid-based nutrient supplements	Fortified blended foods
Iron	Ferrous sulfate	x	–
	Ferrous fumarate[b]	x	x
	Coated ferrous fumarate	x	x
	Coated ferrous sulfate	x	x
	Ferrous gluconate	x	x
	NaFeEDTA[a]	x	x
Zinc	Zinc sulfate[b]	x	x
	Zinc oxide	(x)	(x)
Copper[c]	Copper sulfate[d]	x	—
	Encapsulated copper sulfate[e]	—	(x)
	Copper gluconate[e]	—	(x)
Iodine	Potassium iodide[f]	x	x
Potassium	Potassium chloride[g]	x	x
Magnesium	Magnesium sulfate	x	x
	Magnesium oxide[b]	—	x
	Magnesium citrate	x	x
	Magnesium gluconate	x	x
Calcium and phosphate[h]	Dicalcium phosphate	x	x
	Tricalcium phosphate	x	x
Selenium[i]	Sodium selenite	x	x
	Sodium selenate	x	x
Manganese	Manganese sulfate	x	x
	Manganese gluconate	x	x

a The intake of ethylenediaminetetraacetic acid (EDTA) (including other dietary sources) should not exceed 1.9 mg EDTA/kg of body weight/day (*15*, *16*).

b Bioavailability with low stomach acidity is questioned.

c Addition of copper is recommended, unless it negatively affects product stability, such as in blended flours. The total amount of zinc in the product should respect the limits of the Zn/Cu ratio and thus depends on whether copper is added to the product.

d Most soluble form.

e Stability of fortified blended foods when adding copper needs to be tested.

f A formulation is needed that avoids caking/lumping.

g The amount needs to be limited because of taste impact and formulation with anti-caking compound is needed.

h Best calcium/phosphate ratio.

i Ensure homogeneity in food because of the low toxicity limit for selenium.

Vitamins		Lipid-based nutrient supplements	Fortified blended foods
Vitamin A	Dry vitamin A acetate	x	—
	Dry vitamin A palmitate	x	—
	Dry vitamin A palmitate beadlet	—	x
	Dry vitamin A palmitate spray dried	—	x
Vitamin D	Dry vitamin D_3 spray dried	x	x
	Dry vitamin D_3 beadlet	—	x
Vitamin E	Dry vitamin E acetate 50%	x	x
Vitamin K	Dry vitamin K 5%	x	x
Vitamin B_1[j]	Thiamine hydrochloride	x	—
	Thiamine mononitrate	x	x
Vitamin B_2[k]	Riboflavin	x	—
	Riboflavin fine powder[l]	—	x
Vitamin B_6	Pyridoxine hydrochloride	x	x
Niacin	Niacin amide	x	x
Folic acid	Folic acid	x	x
Vitamin B_{12}	Vitamin B_{12} 0.1% spray dried or 1% spray dried	x	x
Vitamin C	Ascorbic acid[m]	—	x
	Ascorbic acid fine powder[n]	x	x
	Sodium ascorbate[o]	x	x
Pantothenic acid	Calcium D-panthothenate	x	x
Biotin	Biotin 1%	x	x

j Cannot be used in flour because of ability to absorb water.

k Shows as yellow spots, but not visible in lipid-based nutrient supplements

l Fine powder does not show as yellow spots.

m Sour taste, disappears after cooking.

n Less acid taste.

o Less acid taste, but more costly.

Remarks for mineral and vitamin compounds currently used in supplementary foods available on the market for the dietary management of moderate acute malnutrition in children (**Table 2**):

- Calcium and magnesium should not be given as chloride salts as these may induce acidosis in malnourished children.
- The above compounds take into consideration bioavailability, matrix characteristics and processing steps of lipid-based nutrient supplements and fortified blended foods available in the market.
- Salts requiring high stomach acidity to make them bioavailable should be avoided where possible.

Further research

WHO recognizes the need for more research on the composition, acceptability and use of supplementary foods for the management of moderate acute malnutrition to further validate the efficacy and effectiveness of the proposed composition. Growth and functional improvement of moderately malnourished children should be measured as outcomes. Results of ongoing and future research trials using the proposed composition of supplementary foods will be drawn on to build the evidence base for the World Health Organization (WHO) evidence-informed guidelines on the benefits and harms of the use of supplementary foods in the management of children with moderate acute malnutrition.

Pending further research, supplementary foods used in the management of moderate acute malnutrition should conform to the above principles and the proposed nutrient composition in **Table 1**.

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