

# Complementary feeding: a critical window of opportunity from six months onwards

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## Abstract

This paper aims to propose evidence-based, paediatric food-based dietary guidelines on the complementary feeding period, from six to 24 months, of South Africa. A growing body of evidence supports the World Health Organization recommendation that, following six months of exclusive breastfeeding, appropriate and adequate complementary foods should be introduced, with continued breastfeeding for up to two years of age and beyond. A literature search was done by searching electronic databases (PubMed, the Cochrane Library and Sabinet) and hand searching key reference lists from January 2004 to April 2012, including studies published prior to 2004. Relevant international and national documents from normative bodies, global health and infant feeding authorities, professional and scientific societies and government were identified. It has been established that, in South Africa, high levels of stunting, growing concerns about overweight and obesity and the poor intake of certain micronutrients in the critical six- to 24-month period are, in part, a consequence of poor breastfeeding and complementary feeding practices, as well as the poor quality of the complementary diet. The introduction of semi-solid foods before four months of age is a common practice. The typical maize-based feeding pattern is low in food sourced from animals, vegetables and fruit and omega-3 fatty acids. Efforts by mothers to improve the quality of their children's diets by adding energy-rich food to maize meal improves energy intake, but not micronutrient intake. Low nutrient-dense liquid, such as tea and coffee, energy-dense sugar-sweetened drinks, an excessive intake of fruit juice and high-fat and salty snacks exacerbate poor nutrient intake and displace nutrient-dense food in the diet. Healthcare workers should provide consistent, evidence-based messages and guidelines to caregivers of future generations. Interventions must be implemented and strengthened at a programme level. These could include nutrition education to improve caregiver practices, the use of high-quality, locally available foods, the use of enriched complementary foods, and exceptional support of food-insecure populations.

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## Introduction

In 2007, a technical support paper entitled "Optimising the introduction of complementary foods in the infant's diet: a unique challenge in developing countries", on the South African paediatric food-based dietary guideline (FBDG) pertaining to complementary feeding, was published as the evidence base for an adequate diet for the optimal growth and development of children in South Africa.<sup>1</sup> According to the State of the World's Children 2010 report,<sup>2</sup> this challenge is still evident. The report indicated that only 58% of breastfed children aged six to nine months in developing countries were given complementary foods in a given 24-hour period. When stunting figures are reviewed to inform this picture, it becomes evident that a large proportion of young children are not receiving an adequate diet on a frequent basis.<sup>3</sup>

A growing body of evidence has emerged since 2007 that supports the World Health Organization (WHO) recommendation that, following six months of exclusive breastfeeding, appropriate and adequate

complementary foods should be introduced, with continued breastfeeding for up to two years of age and beyond.<sup>4</sup> However, inconsistent messages and selective communication have caused confusion among healthcare workers and the general public.<sup>5</sup> In this context, it is very important to differentiate between public health messages and those that target individuals members of the public. Public health messages are intended for the general public, and can be communicated as "blanket" evidence-based messages based on proven public health problems in a population. Messages to individual members of the public should be interpreted as a one-on-one consultation, based on scientific reasoning and motivation for deviation from the public health message.<sup>6</sup> A good example of the lack of differentiation between public health and individual messages can be found in the opinion held by some authorities on the appropriate age at which to introduce complementary feeding in infants.<sup>7</sup> They state that "exclusive breastfeeding provides adequate nutrition up to six months of age for the majority of infants (*public health nutrition message*), while

some infants may need complementary foods before six months", (*individual message*), (but not before four months). However, the two messages are combined when advising that the introduction of solid foods between "four and six months of age is safe, and does not pose a risk of adverse health effects".<sup>7</sup> The contradiction in these messages is clear, and may confuse the audience for whom they are intended.

South Africa has adopted the WHO breastfeeding and complementary feeding recommendation.<sup>8</sup> It is of crucial importance that there is consistent communication of this message to mothers and caregivers. In the National its Roadmap for Nutrition in South Africa 2012-2016, the National Department of Health cited the following as one of five overall goals: "To promote the optimal growth of children and to prevent overweight and obesity later in life, by focusing on optimal infant and young child feeding". Improved complementary feeding, with continued breastfeeding and targeted supplementary feeding where needed, is one of several key nutrition interventions. The document highlights the need to develop specific counselling messages on feeding and dietary practices.<sup>8</sup> In the paper in this series by Du Plessis and Pereira, entitled "Commitment and capacity for the support of breastfeeding in South Africa", the food-labelling legislation and new regulations on infant foods are highlighted as further strategies to be used to protect infant and young child feeding in South Africa.<sup>9</sup>

This paper, following a review of the latest evidence and current global recommendations on complementary feeding, aims to propose paediatric FBDGs for South Africa that pertain to the complementary feeding period. Optimal complementary feeding from six months of age, together with continued breastfeeding up to two years and beyond, will contribute to optimal infant and young child feeding during this critical and formative period.

## Definitions

The following definitions, as defined in the Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act No 54 of 1972) regulations relating to the fortification of foodstuffs, dated October 2002, apply throughout this paper:

- "Enrichment" means the addition of one or more nutrients to a food, whether or not it is normally contained in the food, with the sole purpose of adding nutritional value to the food.
- "Fortification" means the addition of one or more nutrients to a food, whether or not it is normally contained in the food, for the purpose of preventing or correcting a demonstrated deficiency in one or more nutrients in the population or specific population groups by the relevant authority.

## Method

### Data sources and search strategy

Studies were identified by searching electronic databases and hand searching key reference lists. The search strategy was developed and conducted by the authors. The following databases were used for the electronic search: PubMed, the Cochrane Library and Sabinet. Searches were carried out to include publications from January 2004 to April 2012. Relevant studies identified by hand searching that were published prior to 2004 were included. Search terms included a combination of keywords and associated terms that were relevant to the various subsections of this paper. For example, studies performed in South Africa on complementary feeding were identified using the keywords "South Africa" and "infant/child" and "nutrition", whereas for technical issues, the phrase "complementary feeding" was used together with other relevant words and associated terms. After abstracts or full articles were drawn from the literature search, they were excluded if they focused on children older than three years of age only. Relevant international and national documents (e.g. strategy, policy and survey documents), guidelines, reports, statements, opinions and position statements from normative bodies, leading global health), food and infant feeding authorities, professional and scientific societies and national government [e.g. WHO, the Pan American Health Organization (PAHO), the United Nations Children's Fund (UNICEF) and the South African Department of Health], were identified by the authors using electronic searches via the Google platform. The final search was conducted on 22 April 2012.

### Complementary feeding practices in South Africa in relation to malnutrition

A nationwide survey conducted in 1994 found a medium prevalence of stunting (20%) and a low level of underweight (8.3%) and wasting (3.6%) in infants aged 6-11 months.<sup>10</sup> The prevalence of stunting increased with age, with 12- to 23-month-old children showing a high prevalence (30.2%). Rural children were nutritionally at a greater disadvantage than urban children, as evidenced by a higher prevalence of underweight, stunting and wasting in the former.<sup>10</sup> Just under a decade later, a similar progression of growth faltering during the first two years of life was evidenced in a provincial study conducted in the rural areas of the Eastern Cape and KwaZulu-Natal, where a medium prevalence of stunting in infants aged six to 12 months (20.5%) increased to a high prevalence (30.9%) in the second year of life.<sup>11</sup> A higher combined overweight and obesity prevalence of 20.3% was found in infants aged six to 12 months, compared to 15% in children aged 12-24 months. There was a low prevalence of underweight and wasting in all age groups.<sup>11</sup> It appears that little progress has been made in improving the nutritional status

of children since South Africa became a democracy in 1994.<sup>12,13</sup> There are still high levels of poverty and stunting, as well as growing concerns about increased rates of overweight and obesity that are prevalent in the critical window period of six to 24 months of life.

A secondary analysis of the 1999 National Food Consumption Survey (NFCS), using the 2006 WHO reference standards, showed a medium prevalence of stunting (20.1%) in a broader age category of 12-60 months of age.<sup>14</sup> The analysis classified 30% of the children as combined overweight and obese, leading the authors to conclude that overweight and obesity are major nutritional problems facing South African children in this age group. Stunting closely followed overweight and obesity.<sup>14</sup> A study by Kimani-Murage et al<sup>15</sup> found that the co-existence of stunting and combined overweight and obesity in the same child was common in children younger than five years of age. This presents evidence of a worrying double burden of malnutrition in a South African community undergoing a nutrition transition. As stunting is indicative of chronic malnutrition,<sup>10</sup> it is reasonable to construe that the high prevalence of stunting in the second year of life is, in part, due to poor complementary feeding practices.<sup>16,17</sup>

The early introduction of semi-solid foods is common practice in South Africa and is a major challenge for healthcare workers. It has been reported that over 56% of infants in peri-urban Western Cape,<sup>18</sup> 61% in rural KwaZulu-Natal<sup>19</sup> and 73% in rural Limpopo<sup>20</sup> received foods before four months of age. The average age of the introduction of solid foods is reported to be two to three months of age,<sup>19-21</sup> although studies show that solids can be introduced as early as the first week.<sup>16,18,22</sup> Soft maize meal porridge is the first solid food that is introduced in rural areas,<sup>18,20</sup> and processed infant cereals in urban areas.<sup>18,23</sup>

The main constraint to the timely introduction of solid foods (from six months of age) is the mother's lack of knowledge. Mothers perceive the inadequate production of breastmilk, and the belief that breastmilk alone is not enough to satisfy the infant, as the primary reasons for the early introduction of solid foods.<sup>18,21,22,24</sup> Additional cited reasons included the baby being hungry, crying or not sleeping, the mother not coping well with breastfeeding, and incorrect advice from relatives, friends or nurses.<sup>20,21,24</sup>

Some cultural practices are barriers to the timely introduction of solids. The practice of introducing *tshiunza* (a traditional dish prepared from maize and roots, and fermented to make a soft sour porridge) immediately after birth was noted by Mushapi et al<sup>20</sup> in a study conducted in the Limpopo province. More than one third (36%) of mothers indicated that they gave their infants foods for cultural or medical reasons, specifically naming *tshiunza*. This practice was encouraged by grandparents and was based upon the belief that the infants were not receiving

enough breast milk and that *tshiunza* gave babies energy and helped them to pass stools and grow well.<sup>20</sup>

Soft maize meal porridge, a bulky food of low-nutrient density, is the food most often used by South African mothers to introduce solids to their infants.<sup>16,19,20,25</sup> Maize meal is typically diluted with water to obtain a thin consistency, which lowers the nutrient density even further, and is high in phytates, which inhibit iron and zinc absorption.<sup>26</sup> A study in KwaZulu-Natal<sup>26</sup> reported that most mothers (96%) who fed their infants porridge added between one and four energy-rich food items (margarine, peanut butter, sugar, formula milk, fresh or powdered milk and eggs) to the porridge. Less than 20% of the infants consumed animal products or vitamin A-rich fruit and vegetables, and only 26% consumed dairy products in a 24-hour recall period. Although energy and protein intake was adequate, the nutrient composition of this typical rural South African complementary diet was found to be insufficient, especially with regard to iron, zinc and calcium. Infants who consumed commercial infant products (e.g. enriched infant cereals, ready-to-eat bottled baby foods and formula milk powder) were found to have significantly higher intakes of micronutrients than infants who did not.<sup>26</sup>

Considering the poor nutrient density of the South African complementary diet, it is unsurprising that two nationwide surveys, conducted in 1994 and 1999, found that South African children's diets were deficient in iron, selenium, calcium and zinc, as well as most vitamins, especially vitamins A, C, D, E and B<sub>2</sub>.<sup>10,27</sup> The most recent national survey, conducted in 2005, highlighted a deterioration in the vitamin A and iron status of children aged one to five years, and a high prevalence of poor zinc status in children aged one to nine years.<sup>28</sup> Deficient nutrient intake was further identified in a study in rural KwaZulu-Natal, where high prevalences of anaemia (49%), vitamin A deficiency (20%), zinc deficiency (32%) and iron deficiency anaemia (35%) were reported in infants aged 6-12 months.<sup>19</sup> The high prevalence of overweight and obesity that has been observed in young South African children,<sup>14</sup> and which often co-exists with stunting in the same child,<sup>15</sup> is an additional challenge to healthcare workers who need to consider the quality of the South African complementary diet.

High levels of malnutrition persist in South Africa.<sup>10,13,14</sup> Major constraints faced by mothers and caregivers include poverty<sup>10,13</sup> and a dependence on plant-based staples.<sup>16,19,20,25,26</sup> Inexpensive oils, margarine and sugar became widely available as a result of the nutrition transition, and are among the most common energy-rich food items that are added to maize meal.<sup>26</sup> Insufficient knowledge on infant feeding,<sup>18,21,22,24</sup> inconsistent messages<sup>20,21,24</sup> and cultural practices<sup>20</sup> are barriers to optimal complementary feeding practices, and need to be addressed through nutrition programme interventions.<sup>24-26</sup>

## The age at which to introduce complementary foods

The WHO states that complementary foods should be introduced at six months of age (180 days), while continuing to breastfeed.<sup>4</sup> This recommendation followed a report by a WHO expert consultation on the optimal duration of exclusive breastfeeding,<sup>4</sup> which took into consideration the results of a systematic review<sup>29</sup> (updated in 2009). The conclusion was that exclusive breastfeeding for six months confers several benefits on the infant and the mother.

Fewtrell et al<sup>30</sup> questioned the appropriateness of exclusive breastfeeding for six months in UK babies. The basis of their argument was that delaying the introduction of solid food until the age of six months might increase the risk of iron-deficiency anaemia, coeliac disease and food allergies, and that introducing new tastes might increase acceptance of green leafy vegetables and encourage healthy eating habits later in life. They further argued that guidelines should be established based on a "current practice" perspective, rather than on the current evidence-based angle. This article elicited extensive media coverage, followed by a vast number of comprehensive responses by concerned researchers.<sup>5</sup> UNICEF (UK) refuted each of the statements and concluded that "any new research should be considered as part of the whole body of evidence, and any recommendations made should be based on full evidence, rather than on single papers".<sup>31</sup> Health professionals should continue to support mothers using accurate information based upon WHO guidance, to help them to recognise their infant's signs of readiness to try new foods, while continuing to breastfeed.<sup>31</sup> Unfortunately, the relevant article was published in a reputable journal, and remains a resource that is consulted and cited, with the potential to cause confusion among healthcare professionals.

In a systematic review that investigated the determinants of the early introduction (i.e. before four to six months of age) of solid foods and the use of unmodified cow's milk in infants, Wijndaele et al<sup>32</sup> found strong evidence for the following six determinants in developed countries:

1. Young maternal age.
2. Low maternal education.

3. Low socio-economic status.
4. Absence or short duration of breastfeeding.
5. Maternal smoking.
6. Lack of information or advice from healthcare providers.

Low maternal education and low socio-economic status were strong determinants of the early introduction, i.e. before 12 months, of unmodified cow's milk. In the short term, ensuring that the advice given by healthcare providers is improved appears to be the most manageable area with regard to intervention. These factors, including cultural practices, might be applicable to a developing country as well, but this would have to be verified. Healthcare workers should take these factors into account when developing programmes that focus on the mothers and caregivers of infants.

## The nutritional requirements of six- to 36-month-old infants and young children

Breastmilk continues to provide up to half of a child's nutritional needs during the second half of the first year, and up to one third during the second year of life, while continuing to impact positively on disease morbidity and mortality.<sup>33</sup> The total energy requirement derived from complementary foods given to healthy, breastfed infants with an "average" breastmilk intake in developing countries is approximately 200 kcal (840 kJ)/day at six to eight months of age, 300 kcal (1 260 kJ)/per day at nine to 11 months of age, and 550 kcal (2 300 kJ)/day at 12-23 months of age (Table I).<sup>33</sup>

Depending on the amount of breastmilk consumed, the required amount of complementary foods has to be adapted accordingly. The principle of responsive feeding<sup>34</sup> should guide the amount of food that is offered, while the energy density and frequency of feeding should be adequate to meet the child's needs. Since each child's needs differ, each child consumes different quantities of breastmilk and complementary foods, and each child grows differently, the amount of complementary foods should not be overly prescriptive.<sup>4</sup> However, the frequency and quality of complementary foods should be stressed, since some infants tend to want to consume more milk and eat less food, especially during periods of illness.<sup>4</sup>

**Table I:** Total energy requirements derived from complementary foods given to healthy, breastfed infants with an "average" breast milk intake in developing countries<sup>33</sup>

| Age (In months) | Energy requirements (kJ/day) | Average breast milk energy intake in developing countries (kJ/day) | Average breast milk energy intake in industrialised countries (kJ/day) | Energy needs from complementary foods in developing countries (kJ/day) | Energy needs from complementary foods in industrialised countries (kJ/day) |
|-----------------|------------------------------|--|--|--|--|
| 6-8             | 2 583                        | 1 735  | 2 041  | 840  | 546  |
| 9-11            | 2 881                        | 1 592  | 1 575  | 1 260  | 1 302  |
| 12-23           | 3 755                        | 1 453  | 1 315  | 2 310  | 2 436  |

High nutrient needs, due to the rapid growth and development of the infant in the first two years of life, coupled with the relatively small amounts of consumed complementary foods in this period, means that the nutrient density of complementary foods must be very high.<sup>4</sup> Complementary diets in developing countries often do not contain adequate amounts of key nutrients, such as zinc and iron,<sup>35</sup> because of a lack of diversity in the diet and dependence on plant-based staples, such as maize.<sup>25</sup> The recommended foods for complementary feeding should address the key nutrient gaps that are most prevalent in a particular setting.<sup>3</sup>

### Suitable complementary foods

PAHO and WHO<sup>4</sup> provide the following guidelines with regard to complementary foods that can provide adequate nutrients to meet the growing breastfed child's nutritional needs:

- Provide a variety of foods to ensure that nutrient needs are met.
- Meat, poultry, fish and eggs should be eaten daily, or as often as possible. At this age, vegetarian diets cannot meet nutrient needs, unless nutrient supplements or fortified products are used.
- Vitamin A-rich vegetables and fruit should be eaten daily.
- Provide diets with an adequate fat content.
- Use fortified complementary foods or vitamin-mineral supplements for the infant, as needed.

Complementary feeding guidelines are also available for the non-breastfed child<sup>36</sup> but, in line with the Tshwane Declaration which encourages all mothers to breastfeed,<sup>9,37</sup> this paper will focus on public health messages that are suitable for breastfed children. It is intended that these scientifically based guidelines will be used to develop population-specific FBDGs for complementary foods, based on local feeding practices and conditions and the composition of locally available foods.<sup>4</sup> If these foods cannot provide sufficient micronutrients, supplementation with multiple micronutrients may be necessary, in addition to optimisation of the use of local foods.<sup>3</sup> If locally available foods cannot provide the required levels of both macro- and micronutrients in food-insecure populations, enriched complementary foods, products for home enrichment (micronutrient powders), and lipid-based nutrient supplements (LNS) may be necessary to fill nutrient gaps.<sup>3,38</sup>

The eating of foods from animal sources is associated with improved nutrient intake and diet quality, which results in better growth outcomes. Thus, it is recommended that meat, poultry, fish and eggs should be eaten daily, or as often as possible.<sup>4,39</sup> Unfortunately, these foods are often expensive, and so their inclusion in the diet in the required amounts may be a challenge, especially for

lower-income groups. Examples of relatively inexpensive food from animal sources, containing adequate amounts of protein, iron, zinc and vitamin A, include chicken, beef or sheep liver, and eggs. The regular intake of liver was associated with a favourable vitamin A status in children in the Northern Cape province.<sup>40</sup>

Religious practices and cultural taboos may also be a constraint to the intake of food derived from animal sources.<sup>41</sup> A study conducted in the Moretele district in North-West province identified that cultural factors and taboos have a powerful influence on feeding practices and eating patterns, mainly because of inadequate nutrition knowledge. The authors recommended that in order to improve feeding practices, nutrition education programmes should focus on changing the current knowledge, attitudes and practices.<sup>25</sup> A study in rural KwaZulu-Natal showed that food from animal sources was not consumed frequently by six to 12-month-old infants.<sup>19</sup> The infants had a significantly higher prevalence of iron deficiency anaemia (35%) than the national figure of 9.3% for infants aged six to 11 month-olds.<sup>42</sup> Animal food products are high in many micronutrients, and many minerals and vitamins are better absorbed from milk, meat and eggs than from plant-derived foods. Most food from animal sources is more energy dense than plant-based food, because of the higher fat content and better source of fat-soluble vitamins and essential fatty acids (EFAs).<sup>39</sup> Animal food products are the only foods that contains enough iron, zinc, calcium and riboflavin to supply daily requirements for complementary feeding, while being low in antinutrients.<sup>39</sup>

Infants have a great need for iron, because of rapid growth and depleted iron stores. Therefore, complementary foods should supply nearly all of the infant's iron requirements beyond the age of six months. The addition of 25 g of meat to a home-prepared vegetable meal for infants aged seven to eight months was shown to increase the absorption of non-haem iron, and also prevented a decline in haemoglobin concentration in the infants.<sup>43</sup> In a study by Krebs et al,<sup>44</sup> exclusively breastfed infants were randomised to receive either puréed beef or iron-enriched infant cereal as the first complementary food. The mean daily zinc intake from complementary foods for the infants in the meat group was 1.9 mg, compared to 0.6 mg in the cereal group, which is approximately 25% of the estimated average requirement. An increase in the head circumference of infants aged seven to 12 months was marginally greater in the meat group. Zinc and protein intake was a predictive of head growth.<sup>44</sup>

As breastmilk is generally a more abundant source of fat than most complementary foods, total fat intake often decreases as the contribution of breastmilk to total dietary energy declines. The general fat intake recommendation to supply sufficient EFAs, while at the same time decreasing

the likelihood of childhood obesity, is that fats should provide 30-45% of total energy. The amount of fat to be provided by the complementary diet is dependent on the intake of breast milk.<sup>33</sup> It is important to also consider the potential effect of added fat on the overall nutrient density of the diet in vulnerable populations.<sup>45</sup> Fat is an important part of the diet in infants and young children, because it provides EFAs, facilitates the absorption of fat-soluble vitamins, and enhances dietary energy density and sensory qualities.<sup>4</sup> Omega-3 and omega-6 fatty acids, particularly docosahexaenoic acid (DHA), are known to play an important role in the growth and development of infants and young children. The associated intake in pregnancy and early life affects growth and cognitive performance later in childhood.<sup>46</sup>

Research data, including limited information from South Africa,<sup>46,47</sup> show that most complementary foods are low in omega-3 fatty acids. The low intake of food from animal sources results in a greater risk of inadequate EFA intake in the complementary feeding period in populations in developing countries. In addition, some micronutrients have an effect on the conversion of  $\alpha$ -linolenic acid and linoleic acid to eicosapentaenoic acid, DHA and arachidonic acid, which may further decrease the EFA content in the diet in micronutrient-deficient populations.<sup>48</sup> Therefore, infants and young children are at risk. It is crucial to ensure adequate intakes of fat, EFAs, and especially DHA, early in life. Cost-effective dietary sources of EFA should be included either as food (e.g. fatty fish) or enrichment in the complementary feeding diet, together with continued breastfeeding of up to two years and beyond to ensure adequate EFA and DHA intake in these populations.<sup>49</sup>

Milk products are good sources of animal protein, fat and calcium, but not iron. Small amounts of dried milk powder mixed with other foods, e.g. in cooked maize meal, or small volumes of pasteurised milk, may be added to complementary foods during the first year of life, but should not displace breast milk in the infant's diet.<sup>4,50</sup> The promotion of liquid milk products in settings with poor sanitation is risky as they become easily contaminated, especially when placed in a bottle for feeding.<sup>4</sup> There are also concerns about faecal blood loss and lower iron status when fresh, unheated cow's milk is consumed by infants younger than 12 months of age.<sup>4</sup> Therefore, caregivers should be advised that if cow's, or goat's, milk, is an available home-produced food, it should be heat-treated before being offered to young children in small amounts, bearing in mind the recommendation of continued breastfeeding.

The complementary diet should be rich in vegetables and fruit. In addition to their high nutrient density, vegetables are also low in energy density (kJ/g), and when consumed in sufficient quantities as part of the diet, may also serve

to prevent the development of overweight and obesity in children, and chronic diseases in later life.<sup>51</sup> Although it is important to include a wide range of vegetables and fruit, dark-green leafy vegetables and orange-coloured vegetables and fruit are important sources of vitamin A, and should be consumed daily.<sup>4</sup> The challenge to overcome is that vegetables are often disliked by children.<sup>51</sup> Affordability and, to a lesser extent, availability, are cited as major constraints to the consumption of vegetables and fruit in South Africa.<sup>52</sup> Infants who are offered a wide variety of vegetables in the complementary feeding period may be more accepting of vegetables and fruit,<sup>53</sup> and are more likely to accept novel foods indicated and to increase their food repertoire. Studies have also indicated that seeking a variety of foods at age two to three years was a predictor of the same behaviour until early in adult life, highlighting the importance of establishing a varied food intake in infancy.<sup>51</sup>

Good-quality industrially processed complementary food, especially in the context of increased urbanisation, higher levels of female employment and the use of purchased foodstuffs, may be a particularly important option for sections of the population who have the means to buy these foods and the knowledge and facilities needed to prepare and provide them safely.<sup>54,55</sup> Six- to 12-month-old infants in rural KwaZulu-Natal, who consumed enriched infant products, were shown to have a significantly higher intake of most micronutrients.<sup>26</sup> Low-cost fortified maize meal porridge was potentially shown to have a significant effect on reducing anaemia and improving the iron status of infants in poor settings.<sup>23</sup> Considering all of the applicable strategies used to improve the nutritional quality of a maize-based complementary diet, the enrichment of complementary foods, enrichment products used at home (micronutrient powders), LNS or supplementation may be the most effective way of achieving an adequate iron intake.<sup>26,38</sup> Although the fortification of maize has been mandatory in South Africa since 2003, it is not expected to impact significantly on infant nutrition, because of the small amounts of food that infants consume.<sup>26</sup>

### Foods that are not recommended in the complementary feeding period

Infants do not need additional water when complementary feeding is being introduced. Generally, infants and children who breastfeed consume enough fluid.<sup>4</sup> Non-breastfed infants and young children need at least 400-600 ml/day of extra fluid, in addition to the 200-700 ml/day of water that is estimated to come from milk and other foods in a temperate climate, and 800-1 200 ml/day in a hot climate. Plain, clean (boiled, if necessary) water should be offered from a cup several times a day to ensure that the infant's thirst is satisfied.<sup>36</sup> Tea and coffee are not recommended as drinks for infants, because of their low nutrient content and the inhibitory

effects of polyphenols on iron bioavailability.<sup>56</sup> Faber and Benade<sup>19</sup> reported that the consumption of tea by infants aged six to 12 months in South Africa was identified as a risk factor for anaemia. Anaemic infants were more likely to show growth faltering.<sup>19</sup> Non-enriched cold drinks provide 7-10 g of sugar and 110-170 kJ per 100 ml, but no micronutrients.<sup>57</sup> A South African study showed that 12% of infants aged six to 12 months consumed carbonated drinks at least four days per week, and an additional 26% at least once a week.<sup>19</sup> The results of a systematic review<sup>58</sup> showed that the consumption of sugar-sweetened beverages in the first five years of life was associated with later overweight and obesity.

The intake of fruit juice (including unsweetened juice) in infants aged six to 12 months should be limited to approximately 10 ml/kg of body weight, or 120-180 ml daily.<sup>59</sup> Excessive amounts of juice displace other nutrient-dense foods in the infant's diet,<sup>59</sup> and is associated with increased caries from the age of four years.<sup>60</sup> Fructose (from juice with a high fructose-to-glucose ratio) and sorbitol (in apple and pear juice), are incompletely absorbed in the small bowel. Unabsorbed sugars ferment in the intestines and cause diarrhoea. Other juices, such as grape and orange juice, have an equimolar fructose-to-glucose ratio and contain almost no sorbitol, which results in more complete carbohydrate absorption. However, infants aged five to nine months who received 10 ml/kg pear or grape juice daily showed no signs of adverse effects resulting from sugar malabsorption.<sup>61</sup> The relationship between fruit juice intake and paediatric obesity is controversial,<sup>62,63</sup> but there is general consensus that breastmilk should remain the primary source of nutrition throughout the first year of life, and that fruit juice should not displace breastmilk in the infant's diet.<sup>64</sup>

The consumption of honey has been associated with infant botulism. The general recommendation is that, if a mother wants to use honey, it should not be given before 12 months of age.<sup>65</sup>

Fibre-rich, plant-based foods are high in phytates which decrease iron and zinc bioavailability, and thus may contribute to iron and zinc deficiencies. This could potentially cause anaemia, impaired growth and an increased risk of diarrhoea in infants with a high intake of these foods. Swedish infants receiving porridge with regular phytate content had a 77% higher risk of diarrhoea, compared with infants receiving phytate-reduced porridge during the 12- to 17-month period.<sup>66</sup> A study in the Philippines, where complementary foods are predominantly plant-based, showed that the phytate content and phytate-to-zinc molar ratio, were higher in maize-based, rather than rice-based, complementary foods. The phytate content of complementary foods was reduced by soaking. Enrichment with protein derived from animal foods and soaking are strategies which successfully

enhance the bioavailability of iron, zinc and calcium to varying degrees in maize-based complementary foods.<sup>67</sup>

The addition of extra table salt to complementary foods is discouraged,<sup>1</sup> but complete elimination of salt from complementary foods is also contraindicated. Iodised salt is an important source of iodine, which is necessary for the growth and mental development of infants. A study in Switzerland showed that infants who did not receive iodine-enriched complementary foods were at risk of inadequate iodine intakes.<sup>67</sup> Savoury snacks, for example fried dry maize or potato chips, provide approximately 200 kJ, 0.5 g protein, 3.5 g fat, 5.5 g carbohydrates and 100 mg sodium per 10 g snack, but contain very small amounts of micronutrients.<sup>56</sup> A study in rural KwaZulu-Natal reported that more than 40% of infants aged six to 12 months consumed savoury snacks at least four days per week.<sup>19</sup> The high fat and sodium content of these snacks is concerning, because of the potential harmful effect of excessive sodium intake on the developing kidneys and blood pressure in later life.<sup>68</sup> Other complementary food sources that contribute to excessive sodium intake in infants include gravy and bread with salty spreads.<sup>69</sup> A study in Mexico indicated that infants aged five to 24 months who received high-fat snacks and sweetened cold drinks one or more times per week were more likely to be overweight or obese than those who didn't (odds ratio 1.82, 95% confidence interval 1.24-2.65).<sup>70</sup>

According to the authors of a study in rural KwaZulu-Natal, mothers added several food items, especially energy-rich foods, such as margarine, to the maize porridge, instead of micronutrient-rich foods. The addition of micronutrient-rich foods would have been more appropriate, as 23% of the infants were overweight for length (z-score, > 2 standard deviations), and the complementary diet was inadequate in most micronutrients.<sup>71</sup>

Trans-fatty acids should be avoided in complementary foods, and saturated fats limited. In general, the working group of the Codex Committee on Food Labelling supports the establishment of a "free" claim for trans-fatty acids, and not pursuing consideration of claims of "low in trans-fatty acids", because global strategy pertains to virtual elimination of trans-fatty acids from food.<sup>72</sup> Children of low socio-economic status should be given food products that meet long-term safety standards and are not just the cheapest source of available energy.<sup>73</sup>

### Quantities and frequency of complementary foods

Infants aged six to 12 months should be given small, frequent nutrient-dense meals because of their limited gastric capacity and high nutrient requirements.<sup>4</sup> Complementary feeding should start with small amounts of food, and quantities can be increased as the infant grows older.<sup>4</sup> Each child's needs vary according to the

amount of breastmilk consumed and his or her growth rate, but if energy density of 4-6 kJ/g from complementary food is assumed, 140-90 g of complementary food should be offered at six to eight months, 200-280 g at nine to 11 months, and 380-500 g at 12- 23 months, of age.<sup>4</sup> A thin maize porridge meal, the most frequently used complementary food in South Africa,<sup>16,19,74</sup> of 35 g per feed provides < 30 kJ (< 1 kJ/g) and negligible protein per feed. The nutritional value of maize meal porridge consumed by some infants is improved by the addition of milk, providing additional energy and protein,<sup>74</sup> but most caregivers add margarine or sugar to increase the energy content, but not the micronutrient content, of the food. These studies indicate that the most frequently fed complementary foods had a lower energy density than the assumed energy density of 4-6 kJ/g, and were also of low micronutrient density.<sup>16,19,74</sup> Quantities >140-190 g (half to one cup) would then be necessary to provide 840 kJ daily from complementary foods at six to eight months of age, or more frequent meals would need to be offered.

The guiding principle for the frequency of feeding complementary foods is to increase the number of times that the child is fed complementary foods as he or she gets older. Complementary food meals should be provided two to three times per day from six to eight months, and three to four times per day from nine to 24 months of age. (The figures are based on an average healthy breastfed infant.) For children older than eight months, one meal may be a snack, defined as usually self-fed, convenient and easy-to-prepare foods eaten between meals. Mothers or caregivers should feed the infant slowly and encourage him or her to eat, without forcing him or her, while being sensitive to hunger and satiety cues.<sup>4</sup>

### Food consistency

PAHO and WHO<sup>4</sup> provide the following guideline on the consistency of complementary foods: "Gradually increase food consistency and variety as the infant gets older, adapting to the infant's requirements and abilities". The minimum age at which infants are physically capable of ingesting different types of foods is dependent upon their stage of neuromuscular development. Initially, infants are only able to suckle. This is followed by "munching" and then chewing.<sup>75</sup> Providing foods of an inappropriate consistency can result in the infant being unable to eat the food, or requiring an excessive amount of time to do so, and thus compromising intake.<sup>75</sup> For this reason, infants should be introduced to puréed, semi-solid and mashed foods from six months of age and to "finger foods" (foods that infants can eat on their own) at eight months. By 12 months, most children are able to eat the same types of foods as the rest of the family.<sup>4</sup> However, it is important to bear in mind that despite being physically capable of eating family foods from one year, young children still

require nutrient-dense foods. Care should be taken to avoid foods that may cause choking such as nuts, raw carrots and grapes.<sup>35</sup> The progression of food consistency from six months is important, as there is evidence to suggest that infants who are only introduced to lumpy solids (foods that require chewing) after nine months of age are more likely to have long-term feeding problems and reduced consumption of important food groups, such as vegetables and fruit.<sup>76</sup>

The practice of premastication by South African caregivers of lower socio-economic status for the purpose of homogenising food when feeding older infants<sup>77</sup> should be cautioned, since it could be a potential route of HIV transmission to children.<sup>78</sup>

### The safe preparation and storage of complementary foods

It is critical to pay attention to hygienic practices during the preparation of complementary foods and feeding, especially to prevent gastrointestinal illness.<sup>4</sup> The peak incidence of diarrhoeal disease is in the six-12-month-age period, when complementary food intake increases. The greater risk of microbial contamination is often due to lack of safe water and facilities for the safe preparation and storage of food.<sup>36</sup> This is covered in more detail in the paper entitled "Food safety and hygiene".<sup>79</sup> Research also shows that some traditional methods for preparing foods, in developing countries, such as fermentation, peeling, dehulling, dry roasting and toasting, may also have food safety benefits, as they reduce the risk of microbial contamination, while also having the added benefit of potentially improving the nutrient content.<sup>4,80</sup>

### Allergies and sensitivities to foods

The incidence of genuine food allergy, as opposed to food intolerance, is rare.<sup>81</sup> There has been speculation, and some observational data have also reported, that the early introduction of certain foods may be beneficial when there is a family history of true allergy. Randomised control trials are now being undertaken to test this theory. Should this prove to be the case, which is by no means certain, then high-risk families would need to be advised on a case-by-case basis. This would not affect public policy, as the majority of children are not affected by allergies.<sup>5</sup> Once again, the difference between public health and one-on-one messages is stressed.

Most estimates for the prevalence of cow's milk protein allergy vary from 2-3%. Breastfed infants have a decreased risk of developing cow's milk protein allergy. If confirmed, an elimination diet is indicated for the mother. If a food challenge is positive in formula-fed infants, an extensively hydrolysed formula and cow's milk-free diet is recommended.<sup>82</sup>

The European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) Committee on Nutrition compiled commentary on complementary feeding in 2008. It focused on healthy infants in Europe. The following conclusions were formulated: "There is no convincing scientific evidence that avoidance or the delayed introduction of potentially allergenic foods, such as fish and eggs (yolk and white), reduces allergies, either in infants considered to be at increased risk of the development of allergy, or in those not considered to be at increased risk. It is prudent to avoid both the early (< 4 months) and late (> 7 months) introduction of gluten, and to introduce gluten gradually while the infant is still being breastfed, in as much as this may reduce the risk of celiac disease, type 1 diabetes mellitus and wheat allergy".<sup>50</sup>

Although food allergies are not considered to be a public health problem in South Africa, they are highlighted here because the ESPGHAN Committee on Nutrition recommendation is often referenced by international speakers at conferences and symposia in South Africa. In the context of early sensitisation to allergenic foods, there has been lobbying for a return to the recommendation of introducing complementary food between four and six months. When the benefits of exclusive breastfeeding for six months are taken into consideration,<sup>29</sup> the guideline of commencing complementary foods at six months and "not later than seven months" can be used as a practical recommendation in the South African context. The value of exclusive breastfeeding, and the continuation of breastfeeding while potentially allergenic foods are being introduced to prevent food allergies,<sup>49</sup> should be promoted.

### Communication approaches for the effective promotion of appropriate feeding practices

The need for effective communication approaches that target caregivers cannot be overemphasised. For example, in a study in KwaZulu-Natal, caregivers listed community health workers as their main source of nutritional information.<sup>70</sup> The majority (76%) of mothers in a study in Limpopo said they had not been taught which foods were good for their babies, and 13.5% were informed in this regard by health workers or nurses and 7% by mothers or mothers-in-law. Three per cent were influenced by radio, television or magazines.<sup>20</sup>

Studies in rural areas in South Africa have shown that nutrition education programmes undertaken by trained local women improved infant feeding practices and maternal knowledge of vitamin A.<sup>83</sup> The UNICEF 2011 programming report recommended the need to strengthen the quality of counselling given to mothers and caregivers, and the importance of appropriate behavioural change communication to other family and community decision-makers, in order to improve infant and young child feeding practices.<sup>3</sup>

The report also recommended:

- The development of communication strategies which are based on situational assessments.
- Formative research to identify locally appropriate feeding recommendations and solutions to overcoming barriers.
- The development and pretesting of a limited set of key messages that promote action which can practically be carried out.
- Dissemination of the messages through multiple channels and contacts, including individual counselling and behavioural change communication.<sup>3</sup>

In the South African setting, the need to build the capacity of community structures, such as community health workers, lay counsellors, community caregivers and ward committees, is crucial to ensure adequate targeting of households and caregivers with appropriate messages on infant and young child feeding.<sup>9,37</sup>

### Conclusion and recommendations

South Africa has adopted the WHO recommendation that, following six months of exclusive breastfeeding, appropriate and adequate complementary foods should be introduced, with continued breastfeeding for up to two years of age and beyond.<sup>8</sup> Conclusive evidence has shown that there is no benefit in giving infants aged four to six months any solid foods, and that the optimal duration of exclusive breastfeeding is six months.<sup>29,84</sup>

High levels of stunting and growing concerns about overweight, obesity and the poor intake of a number of micronutrients in the critical window period of six to 24 months of life are a consequence, in part, of poor breastfeeding and complementary feeding practices, and the poor quality of complementary diets in South Africa. The introduction of solid foods before four months of age is common practice, and the typical maize-based diet is low in food sourced from animals, vegetables, fruit and sources of omega-3 fatty acids. Efforts by mothers to improve the quality of complementary foods by adding energy-rich foods to maize meal improve energy intake, but not nutrient intake. The practice of feeding infants and young children low nutrient-density liquid, such as tea and coffee, as well as energy-dense sugar-sweetened drinks, exacerbates poor nutrient intake and may displace other nutrient-dense foods in the diet. These practices contribute to paediatric micronutrient deficiencies and the growing problem of overweight and obesity.

The following best practice and evidence-based interventions at programmatic level should be implemented and strengthened without delay: the delivery of consistent and evidence-based nutrition education and counselling messages on complementary feeding to improve care-

giver practices; use of high-quality locally available foods to improve complementary feeding; the use of enriched complementary foods, home fortification with LNS or micronutrient powders; and the provision of exceptional support to food-insecure populations.<sup>3,38,85</sup>

The Road to Health Booklet (RtHB) for children aged 0-60 months was implemented by the Department of Health in 2011 to enable healthcare workers to assess children's growth and development more comprehensively.<sup>86</sup> By comparison with the previous Road to Health Card (RtHC), the new RtHB incorporates the 2006 WHO growth standards, based on a more representative reference population of children who are given the most appropriate infant feeding and optimal paediatric health care and who are raised in health-promoting environments.<sup>87</sup> The new RtHB includes a larger section on age-appropriate health promotion messages,<sup>88</sup> and not only on oral rehydration, as in the previous RtHC. All healthcare workers should be encouraged to communicate these messages to the caregivers of future generations. These messages should be regularly reviewed and updated to ensure that they are consistent with the latest evidence and aligned with the country's paediatric FBDGs.

The indicators that are used to assess complementary feeding practices have only recently been finalised (Table II).<sup>89</sup> It is of paramount importance that South Africa considers gathering data that can be used to calculate these indicators, as well as data that assess breastfeeding practices in national and district health information systems, community-based surveys and the South African National Health and Nutrition Examination Survey (NHANES).<sup>9</sup> Experience from other developing countries, with specific reference to South Asia, has shown that results obtained from such assessments and analyses greatly

**Table II:** Indicators to measure complementary feeding practices<sup>89</sup>

1. The introduction of solid, semi-solid or soft foods: The proportion of infants aged six to eight months who receive solid, semi-solid or soft foods.
2. Minimum dietary diversity: The proportion of children aged six to 23 months who receive foods from four or more of the seven food groups [grains, roots and tubers; legumes and nuts; dairy products (milk, yoghurt and cheese); flesh foods (meat, fish, poultry and liver or organ meats); eggs; vitamin A-rich vegetables and fruit and other vegetables and fruit].
3. Minimum meal frequency: The proportion of breastfed and non-breastfed children aged six to 23 months who receive solid, semi-solid or soft foods (this also includes milk feeds for non-breastfed children) for the minimum number of times or more (two times for breastfed infants aged six to eight months; three times for breastfed children aged nine to 23 months; and four times for non-breastfed children aged six to 23 months).
4. The minimum acceptable diet: The proportion of children aged six to 23 months who consume a diet that is minimally acceptable. This composite indicator is calculated from indicators 2 and 3 above.

assist in identifying determinants of poor complementary feeding practices and enable the contextualisation of data.<sup>90</sup> This has implications for policies, programmes and research on infant and young child feeding.

The paediatric FBDGs for complementary feeding should be aligned with interventions at programmatic level, and should aim to address poor complementary feeding practices, optimise the use of locally available and appropriate foods, and encourage the use of enriched complementary foods, multiple micronutrients and/or LNS, when appropriate, to fill nutrient gaps.

Thus, the following messages are proposed and should be field tested for South Africa:

- From six months of age, start giving your baby small amounts of complementary foods, while continuing to breastfeed for up to two years and beyond.
- Gradually increase the amount of food, number of feeds and food variety as your child gets older.
- From six months of age, give your baby meat, chicken, fish, liver and eggs every day, or as often as possible.
- Start spoon feeding thick foods, and gradually increase to the consistency of family food.
- Give your child dark-green leafy vegetables and orange-coloured vegetables or fruit every day.
- Avoid giving tea, coffee, sugary drinks, and snacks that are high in sugar, fat or salt.

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