Effect of a fortified maize-meal porridge on anemia, micronutrient status, and motor development of infants\textsuperscript{1–3}

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ABSTRACT

Background: Maize-meal porridge is used for infant feeding in many African countries, including South Africa. A low-cost, finely milled, maize-meal porridge was fortified with β-carotene, iron, and zinc (100% of recommended dietary allowance), as well as ascorbic acid, copper, selenium, riboflavin, vitamin B-6, vitamin B-12, and vitamin E.

Objective: We assessed whether the fortified porridge could reduce anemia and improve the micronutrient status and motor development of infants.

Design: Infants aged 6–12 mo (n = 361) were randomly assigned to receive either the fortified or unfortified porridge for 6 mo. Primary outcomes were hemoglobin and serum retinol, zinc, and ferritin concentrations and motor development. Growth was assessed as a secondary outcome. Primary and secondary outcomes were assessed at baseline and 6 mo.

Results: Two hundred ninety-two infants completed the study. The fortified-porridge group had an intervention effect of 9.4 μmol/L (95% CI: 3.6, 15.1 μmol/L) for serum ferritin and 9 g/L (95% CI: 6, 12 g/L) for hemoglobin concentrations. The proportion of infants with anemia decreased from 45% to 17% in the fortified-porridge group, whereas it remained >40% in the control group. The fortified-porridge group achieved on average 15.5 of the 25 motor development score items, whereas the control group achieved 14.4 items (P = 0.007). Serum retinol concentration showed an inconsistent effect, and no intervention effect was observed for serum zinc concentrations.

Conclusions: This low-cost fortified porridge can potentially have a significant effect in reducing anemia and improving iron status and motor development of infants in poor settings. The formulation needs some adjustment in terms of zinc fortification. Am J Clin Nutr 2005;82:1032–9.

KEY WORDS Fortified porridge, infants, micronutrients, anemia, motor development

INTRODUCTION

The critical period for developing childhood malnutrition coincides with the introduction of complementary foods, which are nutritionally inadequate in many developing countries (1). Iron, zinc, and vitamin A are viewed as problem nutrients because of their low density in plant-based complementary foods (2). In South Africa, a national survey showed that, of children aged 6–71 mo, 33% were vitamin A deficient (serum retinol concentration < 0.7 μmol/L) and 21% were anemic (hemoglobin concentration < 110 g/L). Children aged 6–23 mo were affected the most: 48% of the children aged 6–11 mo were anemic (3). No national prevalence data for zinc deficiency are available, but 46.8% of infants aged 6–12 mo who participated in a supplementation study of multiple micronutrients had baseline serum zinc concentrations < 10.7 μmol/L (4).

Several strategies can be used to improve the micronutrient status of infants. The administration of high-dose vitamin A capsules can reduce vitamin A deficiency (5), but the sustainability of national programs for vitamin A supplementation has been questioned (6). Whereas the use of iron-fortified formula milk prevents iron deficiency anemia (7), bacterial contamination of bottle feeds is a concern (8). Iron drops and fortified sprinkles are effective in addressing anemia (9), but distribution may be a problem.

Fortification of plant-based complementary foods can be an effective strategy for addressing childhood malnutrition in developing countries (10), provided that it is affordable for most of the population. The use of fortified foods does not guarantee good nutritional status of infants, especially if inadequate amounts are consumed. For example, a cross-sectional survey in an urban area in South Africa where >80% of the infants usually consumed fortified infant cereals showed that many of these infants were anemic (83%) or deficient in vitamin A (23%) or zinc (32%). Dietary data showed that the fortified products were used in such a diluted form that they could not meet the infants’ nutrient requirements (11). The intake of inadequate quantities of infant cereals was also shown for infants in rural South Africa, and it was argued that the high cost of these products prohibited an adequate intake (12).

Maize porridge, which is a bulky food low in nutrient density, is used as complementary food in many African countries (10, 13, 14), including South Africa (15). A newly developed porridge made with finely milled maize meal that cooks in 3 min

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(compared with 20–30 min for standard maize meal) was fortified to supply 100% of the recommended dietary allowance (RDA) (16) for zinc, iron, and vitamin A for infants aged 6–12 mo (Tiger Food Brands Ltd, n’Dabeni, South Africa). At the time of the study, a prototype of the product was commercially available in 1 of the 9 provinces at a retail price 25–50% of that of other baby cereals, depending on the formulation of the baby cereal. We assessed the effect of this fortified porridge in reducing anemia and in improving iron, zinc, and vitamin A status and motor development of the infant.

SUBJECTS AND METHODS

Product

The finely milled maize meal was fortified to supply 3 mg β-carotene, 11 mg iron (ferrous fumarate), and 3 mg zinc (zinc sulfate) per 40 g dry product. This supplied 100% of the RDA for iron, zinc, and vitamin A (using a 6:1 conversion factor for β-carotene to retinol) for 6–12-mo-old infants (16). Ascorbic acid (sodium ascorbate) was added (36 mg/40 g dry product) to enhance iron absorption. The maize meal was further fortified with certain nutrients that are limited in the diet of South African children, so that it supplied 110 μg copper, 10 μg selenium, 0.4 mg riboflavin, 0.15 mg vitamin B-6, 0.25 μg vitamin B-12, and 2.5 mg vitamin E per 40 g dry product. The vitamin and mineral premix was supplied by Roche Products (Isando, South Africa). The dry product contained 617 kJ energy/40 g. The cooked product was analyzed for nutrient content by the South African Bureau of Standards to ensure that the specified amounts of micro-nutrient fortification were achieved after preparation. The mothers helped to identify a suitable portion size, which was set at 20 g dry product, mixed with 125 mL milk or water. The portion size was set at the intake of 6-mo-old infants to ensure that all participating infants could manage the recommended amount. The dry product was packed in individual 25-g color-coded sachets; the additional 5 g/sachet allowed for spillage and the mother’s tasting. An intake of 2 sachets/d was recommended, consumed as either 1 or 2 meals. A supply for 1 wk (14 sachets) was packed in color-coded zipper bags. The porridge was supplied for 6 consecutive months, free of charge. To avoid diversion of the product to other children in the household, all children aged ≤5 y in the household received 1.5 kg dry product (according to the treatment group of the participating infant) per month.

Study location, population, and structure

The study area was in The Valley of a Thousand Hills in KwaZulu-Natal province, South Africa. This is a rural area of low socioeconomic status. The population density is low because the families are scattered over a large mountainous area. The complementary diet of infants in this area supplies an adequate diet of infants in this area supplies an adequate diet for recording the amount of porridge issued and the date of the next appointment; a 10-L color-coded bucket (to collect and store the porridge); a porridge bowl with a tight-fitting lid; and a teaspoon. On the day of implementation, the nature and purpose of the study were reinforced, and the preparation of the porridge was demonstrated.

Subjects

Infants were recruited through the community-based health program. All eligible infants who were aged 6–12 mo at baseline were asked to participate, by invitation to their mothers. Infants were excluded from the study if their parent or legal guardian did not sign the consent form, their birth weight was <2500 g, a baseline blood sample was not obtained, or the hemoglobin concentration was <80 g/L. Infants with the latter exclusion criterion were referred to the clinic for appropriate treatment.

Sample size calculations were based on group differences of 0.1 μmol/L for serum retinol and 4 μg/L for serum ferritin. With a 5% significance level and a power of 80%, we needed 126 infants in each group. This sample size would allow us to detect group differences of 10 g/L for hemoglobin, 4 μmol/L for zinc, a 50% reduction in the prevalence of anemia (40–20%), and a 1-point group difference for the motor development score. The required sample size of 126 infants for each treatment group was adjusted to allow for an expected dropout rate of 30%, which was observed in a previous study in the same area. Therefore, 180 infants per treatment group were recruited. To enable us to recruit enough children to meet the sample size requirement, the study was done in 2 consecutive phases. During the first 6-mo phase, from February to August 2002, 144 infants completed the study (fortified-porridge group: n = 71; control group: n = 73). During the second 6-mo phase, September 2002 to March 2003, 145 infants completed the study (fortified-porridge group: n = 73; control group: n = 72).

Written informed consent was obtained from the mother or the guardian of each participating infant, after a detailed explanation of the purpose of the study was provided. The Ethics Committee of the South African Medical Research Council approved the study, and permission was obtained from local community leaders.

Design and intervention

The study was a randomized controlled trial with an intervention period of 6 mo. Infants were randomly assigned to either the fortified-porridge group or the control group. The allocation schedule was generated in blocks of 8 by the drawing of a sticker from a container that contained 4 yellow and 4 green stickers. Infants were randomly assigned in the order that they completed the baseline survey. Infants in the control group received the same porridge as did those in the fortified-porridge group, but without the added micronutrients. Color-coding was used to distinguish between the 2 treatment groups. The project leader was aware of which porridge each of the groups was receiving, because the fortified porridge had a slight yellow color due to the β-carotene used as fortificant. The mothers and community health workers were not aware of which porridge was fortified.

All baseline and postintervention measurements were done in a blinded manner.

Each infant was issued a color-coded identification card that contained the infant’s name and project code and included space for recording the amount of porridge issued and the date of the next appointment; a 10-L color-coded bucket (to collect and store the porridge); a porridge bowl with a tight-fitting lid; and a teaspoon. On the day of implementation, the nature and purpose of the study were reinforced, and the preparation of the porridge was demonstrated.
The community health workers visited each infant weekly to evaluate compliance. The amount of porridge that was left at each infant’s home was observed and recorded. At each visit, the community health worker reinforced the importance of daily consumption and correct preparation. Problems (if any) and possible solutions were discussed. The community health workers handled questions when possible; the nutrition monitors helped with problem cases.

The mothers collected a supply of porridge monthly from the health post according to a fixed schedule. For these meetings, the mothers were requested to bring the child with the identification card to the health post. During these meetings, porridge was issued, the child’s growth was recorded, a short questionnaire on compliance was completed, and the importance of daily consumption and correct preparation was reinforced. The acceptability of the porridge and whether the mothers were giving the porridge as required were explored during focus group discussions during the fourth month of the intervention. Seven focus group discussions were conducted across the 2 phases of the study; 3 during phase 1 and 4 during phase 2 (8–10 mothers per focus group). Additional data on the acceptability of the porridge were collected at 6 mo by questionnaire.

Measurements

The 6-mo intervention period was preceded by a baseline survey and followed by a postintervention survey. The sociodemographic data was collected during the baseline assessment only; during the baseline and postintervention assessments, a questionnaire was administered to collect nutritional and health data; anthropometric measurements were taken; and a blood sample was collected for each infant.

Motor development of the infants was assessed by the mothers’ reporting of gross motor milestones, a method known to be accurate and sensitive for identifying developmental delays (18, 19). Mothers were asked whether their infant could do each of 25 tasks related to motor development; 1 point was scored for each item that the mother reported the infant could do. When the scales were being constructed, the tasks listed underwent a series of piloting procedures before being finalized. The method whereby development of motor skills of infants aged 6–12 mo is assessed by parental interview before and after treatment has been used in an infant supplementation study of multiple micronutrients that was being constructed, the tasks listed underwent a series of piloting procedures before being finalized. 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replication phase, and treatment group × replication phase interaction as main factors. Baseline characteristics did not show any treatment group × replication phase interaction and are, therefore, given for the 2 treatment groups with the replication phases combined. The chi-square test was used to compare categorical variables between groups at baseline. Individual-level differences between preintervention and postintervention values (calculated as postintervention value − baseline value) were calculated and compared between groups by using ANOVA with treatment group, replication phase, and treatment group × replication phase interaction as main factors. Variables that showed a significant treatment group × replication phase interaction \((P < 0.05)\) are reported for the 2 replication phases separately, whereas variables that showed no treatment group × replication phase interaction \((P \geq 0.05)\) are reported for the 2 replication phases combined. The intervention effects and 95% CIs were calculated from the pre- to postintervention differences. Data were tested for equality of variances, and the appropriate value for significance \((P\text{ value})\) was applied. The \(t\) test for paired data was used to compare preintervention and postintervention values within each group. The intervention effect on the proportion of infants with concentrations of hemoglobin and serum micronutrients below a certain cutoff was ascertained by logistic regression analysis with 2-way interaction \((\text{time} \times \text{treatment group})\). When the interaction was significant, the change in proportion within treatment groups was determined by using MacNemar’s test. Serum ferritin concentrations were skewed, and therefore they were log transformed before statistical analyses were performed. The level of significance for all tests was \(P < 0.05\).

 Analyses were performed with the use of SPSS for WINDOWS software (version 10; SPSS Inc, Chicago, IL).

 The acute phase response was defined as serum CRP concentrations >10 mg/L \((25)\). Data analysis was repeated on a subset of data that excluded infants with CRP > 10 mg/L at baseline or postintervention assessment. Because the estimated intervention effects for concentrations of hemoglobin and of serum ferritin, retinol, and zinc in the above-mentioned subanalysis did not differ significantly from the estimates of the complete data set, only the latter are reported.

**RESULTS**

In total, 361 infants were enrolled in the study, of whom 292 completed the study. Reasons for dropping out of the study are listed in Figure 1. Children who dropped out of the study were older \((9.4 \pm 2.0\) compared with \(8.8 \pm 1.9\) mo; \(P = 0.034\)), had lower length-for-age \(z\) scores \((-1.2 \pm 1.2\) compared with \(-0.84 \pm 1.0; P = 0.003\)), weight-for-age \(z\) scores \((-0.17 \pm 1.25\) compared with \(0.35 \pm 1.3; P = 0.003\)), serum retinol concentrations \((0.85 \pm 0.23\) compared with \(0.98 \pm 0.28 \mu\text{mol/L}; P = 0.0001)\), and hemoglobin concentrations \((105 \pm 13\) compared with \(111 \pm 11\) g/L; \(P = 0.001)\), and had higher serum zinc concentrations \((10.9 \pm 2.5\) compared with \(10.2 \pm 2.1 \mu\text{mol/L}; P = 0.011)\) at baseline than did children who completed the study. A blood sample could not be obtained for 3 children during the postintervention survey, and they are excluded from the data set. The final data set consisted of 289 children (fortified-porridge group: \(n = 144\); control group: \(n = 145\)). Adequate blood samples to measure all the primary outcomes could not be obtained for all of the children (Figure 1).

Baseline characteristics for infants who completed the study are given in Table 1. No differences were observed between the 2 treatment groups in these baseline characteristics or in the other characteristics presented in Table 2 and Table 3, except for serum retinol concentrations, which were higher in the control group than in the fortified-porridge group during phase 2 \((P = 0.02)\). When infants with baseline CRP concentrations >10 mg/L were excluded, serum retinol concentrations no longer differed between the 2 groups during phase 2. At baseline, 83% of the infants were breastfeeding (fortified-porridge group: 87%; control group: 80%), and all were eating solid foods. At the postintervention assessment, >70% of the infants, who were now aged 12–18 mo, were breastfeeding. In a recent study in rural KwaZulu-Natal, the prevalence of breastfeeding was 83% for infants aged 6 to <12 mo and 64% for children aged 12 to <18 mo \((26)\). It is, therefore, clear that the porridge did not replace breastfeeding in our study.

Concentrations of serum ferritin and hemoglobin showed an intervention effect, and concentrations of serum retinol showed an intervention effect during phase 1 but not phase 2, but concentrations of serum zinc showed no intervention effect (Table 2). Logistic regression analysis showed an intervention effect for the proportion of infants with hemoglobin concentrations <110 g/L \((P < 0.001)\). The proportion of infants with hemoglobin concentrations <110 g/L decreased from 45% at baseline to 17% at the postintervention assessment in the fortified-porridge group \((P < 0.001)\), whereas it remained >40% in the control group \((P = 0.735)\).

The motor development scores at baseline and at the postintervention assessment are given in Table 3. The postintervention estimated mean motor development score of the fortified-porridge group was approximately 1 point above that of the control group \((P = 0.007)\).

The weight and length at baseline and postintervention assessments, as well as the \(z\) scores, are shown in Table 4. The length-for-age and weight-for-age \(z\) scores decreased during the 6-mo

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**FIGURE 1.** Study profile. CRP, C-reactive protein.
TABLE 1

<table>
<thead>
<tr>
<th>Sociodemographic indicators and baseline characteristics of the infants who completed the study†</th>
</tr>
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<tbody>
<tr>
<td><strong>Fortified-porridge group</strong></td>
</tr>
<tr>
<td>(n = 144)</td>
</tr>
<tr>
<td><strong>Boys:girls (n)</strong></td>
</tr>
<tr>
<td><strong>Access to tap water (%)</strong></td>
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<tr>
<td><strong>Toilet facilities (%)</strong></td>
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<tr>
<td><strong>Electricity in the house (%)</strong></td>
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<tr>
<td><strong>Household food security (%)</strong></td>
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<tr>
<td>- Always enough food to eat</td>
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<tr>
<td>- Sometimes not enough food to eat</td>
</tr>
<tr>
<td>- Often not enough food to eat</td>
</tr>
<tr>
<td><strong>Age (mo)</strong></td>
</tr>
<tr>
<td><strong>Breastfeeding (%)</strong></td>
</tr>
<tr>
<td><strong>Stunted (%)</strong></td>
</tr>
<tr>
<td><strong>Underweight (%)</strong></td>
</tr>
<tr>
<td><strong>Wasted (%)</strong></td>
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<tr>
<td><strong>Serum retinol &lt; 0.7 µmol/L (%)</strong></td>
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<tr>
<td><strong>Serum zinc &lt; 9.9 µmol/L (%)</strong></td>
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<tr>
<td><strong>Serum ferritin &lt; 10 µg/L (%)</strong></td>
</tr>
<tr>
<td><strong>Hemoglobin &lt; 110 g/L (%)</strong></td>
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<tr>
<td><strong>Elevated acute phase protein CRP &gt; 10 mg/L (%)</strong></td>
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</tbody>
</table>

† No significant difference was observed between the 2 groups (ANOVA for continuous variables, chi-square test for categorical variables).

From the focus group discussions, it was clear that compliance in terms of consumption and method of preparation was high. The frequency of consumption of the porridge, reported monthly and during the postintervention survey, showed that between 95% and 99% of the infants across the 2 treatment groups ate the recommended amount of porridge every day. Retrospective data collected at the postintervention assessment showed that approximately 90% of the mothers across the 2 groups mixed the porridge with water. Most mothers asserted they followed the instructions of 125 mL liquid/sachet of dry product. When asked whether they thought that the child benefited from participating in the study, 93% in the fortified-porridge group and 91% in the control group responded positively; the others were uncertain. In both groups, nutritional and health benefits were given as reason for the positive response.

**DISCUSSION**

This randomized controlled trial showed that the prevalence of anemia decreased and iron status and motor development improved after infants aged 6–12 mo consumed 40 g of a low-cost fortified maize–meal porridge daily for 6 mo. No consistent effect on serum zinc concentrations was observed. The fortified porridge failed to improve serum zinc concentrations.

After the age of 6 mo, an infant must receive nearly all of his or her iron requirements via complementary foods because of the low iron concentration in breast milk. The required amount of iron intake is difficult to obtain, and the median iron intake of infants aged 6–12 mo in this community was shown to be 3 mg (17), whereas the RDA is 11 mg (16). The fortified porridge supplied 11 mg iron/d, which is in line with a recent recommendation for fortified complementary foods (27). Although the use of ferrous fumarate in complementary foods has been questioned (28), our study showed an improvement in concentrations of hemoglobin and serum ferritin in infants after they consumed a porridge that was fortified with ferrous fumarate. According to Hurrell (29), studies in Bangladesh suggested that young children may absorb ferrous fumarate only 25% as well as they absorb ferrous sulfate. A disadvantage of the more soluble compounds such as ferrous sulfate is that they are associated with organoleptic changes of the fortified product. Ferrous fumarate may cause unwanted color and flavor reactions but to a lesser extent than does ferrous sulfate (29).

Porridge made with maize meal is an integral part of the diet of many infants in South Africa (15), as was the case in our study, in which all but 2 of the infants had consumed porridge made with maize meal on the day before the baseline interview (M Faber, unpublished data, 2002). A disadvantage of using maize meal as a carrier for fortification is that its high phytate content inhibits the absorption of both iron (30) and zinc (31). Ascorbic acid was added to the finely milled maize meal to overcome the inhibitory effect of phytate on iron absorption (32). The high phytate content of maize meal probably contributed to the absence of any effect on the concentration of serum zinc. The amount of zinc fortification was too low; a recent recommendation for fortified complementary foods to be used in a cereal–based diet was set at 4–5 mg zinc/d (27). The iron-to-zinc ratio in our study was 11:3. A high iron:zinc was shown to inhibit zinc absorption when given as supplements but apparently not when given with food (33).

The poor sensitivity and specificity of serum zinc concentrations to changes in dietary zinc also could have contributed toward the lack of effect on serum zinc concentrations (34). There is a diurnal variation, in which serum zinc concentrations are lower during the afternoon than in the morning (21). In our study, not all blood samples were taken before 1200, and, unfortunately, the time of blood sampling was not recorded for the individual children. It could be, therefore, that the baseline and
contributed toward the large within-subject variation in serum retinol concentrations. Vitamin A supplementation increased serum retinol concentrations, and supplementing the mother with capsules of high-dose vitamin A increased the vitamin A content of the breast milk (35). We tried to obtain information on vitamin A supplementation from the children’s clinic cards, but these data were unreliable. The mothers also could not provide this information because vitamin A supplements had been administered without informing the mothers what it was that they and their infants were receiving. The lack of reliable information on vitamin A supplementation prevented the drawing of any conclusions about the different responses in the 2 replication phases. Although suboptimal storage and undesirable cooking processes could have affected the β-carotene content of the product, that is unlikely because correct storage, giving the required amounts,
and preparing the porridge as required were reinforced during each encounter with the mothers during the weekly home visits and monthly sessions at the health posts. Because β-carotene was used as fortificant, the fortified porridge had a slightly yellow color, and the mothers reported a distinct taste and smell. Nonetheless, the product was highly acceptable within the study population. The consistent encouragement and motivation throughout the duration of the study could have contributed toward the mothers’ acceptance of the fortified porridge. Acceptability to the consumer in terms of color, taste, and smell must be determined more extensively before marketing the product nationally with β-carotene as a fortificant.

The reduction in anemia during the 6-mo intervention period is a favorable outcome, because children with low hemoglobin concentrations during infancy are at risk of being adversely affected in terms of developmental outcomes (36). At the postintervention assessment, children in the fortified-porridge group had on average a 1-point higher motor development score than did children in the control group. The advantage of using the parent rating method is that it is quick to administer and allows the parents to participate in a way that is meaningful to them. To forestall any tendency by mothers to overrate or underrate their child’s ability, care was taken to secure parental cooperation in providing accurate responses, and the child was asked to demonstrate the ability to perform some of the items. It is unlikely that the mothers’ responses were influenced by the slight color difference between the fortified and unfortified product, because most of the mothers in both groups were of the opinion that their children benefited from the study through the health and nutritional benefits of the porridge.

Just >10% of the infants were stunted and 3–5% were underweight at baseline. The decrease in mean length-for-age and weight-for-age z scores that was observed across the 2 groups during the 6-mo intervention period is commonly seen in this age group (37). Prenatal factors, maternal stature (38), poor socioeconomic conditions (39), frequent infections (40), and micronutrient deficiencies, such as those of zinc, iron, and possibly vitamin A (41), can contribute to poor growth. The study was not powered to measure an intervention effect on growth. For nonstunted children, a between-group difference of 1 cm for linear growth could be expected on the basis of a zinc supplementation trial reported by Umeta et al (42). We would have needed a sample size of ≥252 children per group. Even if the sample size were adequate, we most probably would not have seen any effect on growth because we failed to show a positive biochemical response to zinc fortification.

In conclusion, our study showed that a low-cost fortified maize-meal porridge can potentially have a significant effect on reducing iron deficiency and improving motor development of infants in a low socioeconomic setting. No conclusions can be drawn about the effect of the fortified porridge on vitamin A status because of the implementation of a supplementation program with high-dose vitamin A in the area just before the onset of the current study. The formulation needs some adjustment in terms of zinc fortification.

We thank the staffs of Tiger Brands and The Valley Trust; the nutrition monitors; community health workers and their facilitators; the phlebotomist; the team from the Human Sciences Research Council, who conducted the focus group discussions and completed the child development questionnaire; staff members from the Medical Research Council, who assisted during the fieldwork and provided technical support; and the mothers and children who participated in the study.

MF was the project leader, contributed toward the study design, organized and managed the data collection, conducted the statistical analysis, interpreted the results, and drafted the manuscript. JDK obtained, analyzed, and interpreted the data on the motor development of the infants and on the acceptability of the porridge as determined by focus group discussions. CIL guided the study design, the statistical analysis, and the interpretation of

### Table 4

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Postintervention</th>
<th>Change</th>
<th>Intervention effect (t test)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length (cm)</strong>&lt;sup&gt;7&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fortified-porridge group</td>
<td>69.1 ± 3.4&lt;sup&gt;5&lt;/sup&gt;</td>
<td>76.1 ± 3.3</td>
<td>7.0 (6.7, 7.3)</td>
<td>0.1 (–0.2; 0.2)</td>
<td>0.400</td>
</tr>
<tr>
<td>Control group</td>
<td>68.5 ± 3.8</td>
<td>75.7 ± 3.8</td>
<td>7.1 (6.9, 7.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Weight (cm)</strong>&lt;sup&gt;8&lt;/sup&gt;</td>
<td>9.0 ± 1.3</td>
<td>10.7 ± 1.4</td>
<td>1.6 (1.4, 1.7)</td>
<td>0 (–0.2; 0.2)</td>
<td>0.902</td>
</tr>
<tr>
<td>Control group</td>
<td>9.1 ± 1.4</td>
<td>10.7 ± 1.6</td>
<td>1.6 (1.4, 1.7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Length-for-age z score</strong>&lt;sup&gt;9&lt;/sup&gt;</td>
<td>–0.79 ± 0.97</td>
<td>–0.94 ± 1.05</td>
<td>–0.15 (–0.25, –0.04)</td>
<td>–0.01 (–0.14; 0.13)</td>
<td>0.962</td>
</tr>
<tr>
<td>Control group</td>
<td>–0.92 ± 1.09</td>
<td>–1.06 ± 1.15</td>
<td>–0.14 (–0.24, –0.05)</td>
<td></td>
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</tr>
<tr>
<td><strong>Weight-for-age z score</strong>&lt;sup&gt;10&lt;/sup&gt;</td>
<td>0.28 ± 0.125</td>
<td>0.05 ± 0.125</td>
<td>–0.23 (–0.36, –0.11)</td>
<td>0.04 (–0.15; 0.22)</td>
<td>0.725</td>
</tr>
<tr>
<td>Control group</td>
<td>0.37 ± 0.14</td>
<td>0.09 ± 0.137</td>
<td>–0.27 (–0.40, –0.13)</td>
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<td></td>
</tr>
<tr>
<td><strong>Weight-for-length z score</strong>&lt;sup&gt;11&lt;/sup&gt;</td>
<td>1.12 ± 0.16</td>
<td>0.82 ± 0.15</td>
<td>–0.30 (–0.46, –0.13)</td>
<td>0.05 (–0.19; 0.29)</td>
<td>0.661</td>
</tr>
<tr>
<td>Control group</td>
<td>1.34 ± 1.29</td>
<td>0.99 ± 1.23</td>
<td>–0.35 (–0.53, –0.17)</td>
<td></td>
<td></td>
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</tbody>
</table>

<sup>1</sup> Within-group change from baseline to postintervention assessment; <sup>2</sup> Between-group difference in mean change from baseline to postintervention assessment; <sup>3</sup> Between-group difference in change from baseline to postintervention assessment by t test.

<sup>4</sup> Both groups increased over time, with no significant difference between groups (time effect, ANOVA); <sup>5</sup> P < 0.0001, <sup>6</sup> P < 0.05, <sup>7</sup> P < 0.001.

<sup>5</sup> ± SD (all such values).
results. AJSB conceptualized the study and participated in the study design and interpretation of the results. All authors revised the manuscript and approved the final version. None of the authors had any personal or financial conflict of interest.

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