Contents

Food and Nutrition Bulletin

Food and Nutrition Bulletin, vol. 19, no. 4

United Nations University Press
The United Nations University
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ISSN 0379-5721

Design and Production by Desktop Publishing & Design Co., Newton, MA USA
Printed by Rivkind Associates, Stoughton, MA USA

Erratum

In the Commentary by Guillermo Arroyave on L. L. Diosady et al., "Stability of iodine in iodized salt used for correction of iodine-deficiency disorders. II," in the *Food and Nutrition Bulletin*, Volume 19, Number 3, September 1998, pages 195–196, a serious error occurred that destroys some of the context of the article. In his penultimate paragraph, Dr. Arroyave wished to emphasize that in only five years the prevalence of endemic goitre among children in Guatemala dropped from 38% to 5%. As a result of an error in the editorial offices of the *Bulletin*, the printed version reads, "In 45 years"—rather a long time to wait for the results. It should read, "In five years, the prevalence of endemic goitre among children in Guatemala dropped from 38% to 5%." Please make the correction either mentally or on your copy.

Commentary

The blind men and the elephant

The phenomenon of different blind men describing an elephant in totally different ways depending on the part of his anatomy they touch is a parable with many applications. In the 1970s, a physician working in a country with marasmus due to severe undernutrition but with no kwashiorkor assumed that those in many African and Latin American countries who rarely saw marasmus were missing its importance. The physician believed that protein deficiency was not a serious problem if infants and young children received sufficient calories. Yet at the time clinical kwashiorkor *was* occurring in many countries due to a dietary deficiency of protein relative to calories. It was usually superimposed on chronic undernutrition and precipitated by episodes of infection. Most of it was appropriately identified as marasmic-kwashiorkor [1]. A few cases of apparently obese infants with the so-called sugar-baby type of kwashiorkor were described from Jamaica. Kwashiorkor has now disappeared from most of the countries in which it was formerly prevalent, but the perception that it was not a serious public health problem in many developing countries during the l960s was erroneous. Its prevalence is documented in dozens of articles and several books of the era.

Similarly, in the early 1950s, soon after Ancel Keys first published his six-country comparison relating fat consumption to coronary heart disease, I returned to the United States from Guatemala to attend a national medical meeting and heard a presentation categorically denying such a relationship on the basis of a study in a small population of U.S. males whose percentage of dietary calories from fat ranged from about 30% to 45%. In the poor populations with which I was working in Central America, the range was more nearly from 10% to 25%, and deaths from coronary heart disease were not observed. Later the Interamerican Atherosclerosis Project, with serial autopsies of all deaths from 1962 to 1965 in 13 public hospitals in Latin America as well as New Orleans, confirmed the virtual absence of significant aortic and coronary heart disease in Latin American public hospital deaths and a high prevalence in New Orleans [2]. There was a strong association between dietary fat intake and the atherosclerotic index [3].

Similarly, the role of salt in hypertension could not be firmly established by studies in single populations. Analyses of cross-sectional surveys of various populations have generally shown a positive correlation between the intake of sodium and the level of systolic and diastolic blood pressure [4]. These have been confirmed by the Intersalt Study in 52 centres in 32 countries [5]. About 30% of the population is sensitive to salt intakes that are lower than in most industrialized-country diets [6]. In populations consuming less than 4.5 g of salt daily, an age-related rise in blood pressure is slight or absent, and the frequency of hypertension is uniformly low. As sustained intakes of salt rise progressively above 6 g daily, blood pressure rises with age and hypertension is increasingly frequent, but this is difficult to establish within the range of the salt intake of any single population.

The three preceding examples concern major disease issues, but the same risk of misleading extrapolation from studies in a single country applies to any level of observation. The paper in this issue, "The Helen Keller International food-frequency method underestimates vitamin A intake where sustained breastfeeding is common," reports that even evaluation of a method in three different countries was apparently not sufficient to ensure its applicability to all countries [7]. The authors show that this is the case for the Helen Keller International food-frequency methodology to assess the community risk of vitamin A deficiency. The authors make sensible suggestions for modifying the way in which this simple and innovative method can be adapted for use in a broader range of countries and populations.

Nevin S. Scrimshaw

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Editorial

Effectiveness of salt iodization for the prevention of iodine-deficiency disorders

Two papers in this issue, "Virtual elimination of iodine-deficiency disorders achieved in nine counties of Jiangsu Province, China"[1] and "Knowledge, attitudes, and practices of people in Ulaanbaatar, Mongolia, with regard to iodine-deficiency disorders and iodized salt"[2], report contemporary success in the introduction of a programme of iodized salt in a developing country. The latter of these depended on an education campaign and achieved a substantial consumption of this salt, despite its slightly higher price. The study demonstrated that where policy makers decide that a campaign for the iodization of salt in endemic areas must be based on achieving sufficient voluntary consumption, it can be effective. Unfortunately, it was accompanied by an increase in total salt consumption by 58% of the families, because they thought more salt would be good for them. Although most individuals are not affected by salt intake at moderate levels, some have a rise in blood pressure [3]. The higher the sodium intake, the higher is the prevalence of essential hypertension in a population, with an associated increase in morbidity and mortality from cardiovascular diseases.

It is only fair to point out, therefore, that where acceptable, there is a cheaper and better alternative. This is legislation requiring the iodization of all salt for human consumption in a country or region. It can be highly effective if compliance with the legislation is ensured by careful laboratory monitoring and enforcement For example, after legislation requiring the iodization of all salt for human consumption was implemented and monitored in Guatemala, the nationwide prevalence of endemic goitre fell from 38% in 1962 to 14% in 1965 [4], and two years later it was 5%. No investment in a nationwide education campaign was required, and there was no effect on salt consumption.

Countries that have followed the legislative approach of making salt iodization obligatory have been successful wherever they have implemented it. Those countries that have relied on the promotion of voluntary consumption of iodized salt have spent much more money and rarely achieved comparable results. Nevertheless, this paper is of value for those countries where, for policy or political reasons, a public information campaign is required to promote either voluntary use of iodized salt or the acceptability of legislation for compulsory iodization. However, the other paper demonstrates once again that if iodization of all or most salt for human consumption is achieved, goitre promptly disappears as a public health problem [1]. This is the basis for the increasingly successful global programme for the elimination of iodine-deficiency disorders of UNICEF/World Health Organization/International Council for the Control of Iodine-Deficiency Disorders[5]. The feasibility and effectiveness of iodization of even crude moist salt was conclusively demonstrated by the Institution of Nutrition of Central America and Panama (INCAP) in the early 1960s, as indicated above. In the intervening years, new data have established the lasting effect of iodine deficiency in pregnancy on the cognitive performance of offspring [6]. It is a tragic irony that almost 40 years later the *Bulletin* finds it useful to publish a paper that confirms the effectiveness of the iodization of salt for a new generation.

Nevin S. Scrimshaw

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Effects of iron supplementation on iron nutrition status and cognitive functions in children

Kornelia Buzina-Suboticanec, Ratko Buzina, Ana Stavljenic, Meri Tadinac-Babic, and Vesna Juhovic-Markus

Editorial introduction

Moderate to severe anaemia in infancy has been shown to have a lasting impact on cognitive performance [1, 2], but if the anaemia in infancy has been mild, the effects are reversible. Iron deficiency at any age has been shown to have adverse effects on cognitive performance [3], with the response to iron supplementation depending on the circumstances. Studies of adolescent girls in Pennsylvania in the United States found an adverse effect of iron-deficiency anaemia [4, 5]. The present study is significant because it demonstrates that even in a relatively well-nourished population, at least with normal weight-for-age, iron deficiency still has a highly significant effect on cognitive performance that can be corrected by iron supplementation. Although not discussed in this paper, iron deficiency also has an adverse effect on immune competence and resistance to infection and on physical work capacity [6]. The important message is that iron deficiency should be prevented wherever it occurs, whether in developing or industrialized-country populations.

Nevin S. Scrimshaw

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Abstract

This study examined the effect of iron supplementation on cognitive function by a double-blind intervention trial in nine-year-old mildly anaemic schoolchildren. Their nutritional status was assessed by anthropometric measurements and the following biochemical values: haemoglobin, haematocrit, red blood cell count (RBC), mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV), mean corpuscular haemoglobin concentration (MCHC), serum iron, total iron-binding capacity (TIBC), and transferrin saturation. In addition, biochemical values of vitamin A, vitamin C, thiamine, riboflavin, pyridoxine, and zinc were measured. The cognitive assessment was performed using an abbreviated Wechsler Intelligence Scale for Children-Revised (WISC-R) containing six subtests: arithmetic, similarities, digit span, picture completion, block design, and digit symbol (coding), in order to obtain information on both verbal and non-verbal aspects of intelligence. There were highly sig-

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nificant correlations of the WISC-R scores with initial height-for-age, haemoglobin, haematocrit, and transferrin saturation, and a correlation with MCHC. After completion of the baseline examination, one group of children was given a supplement containing 100 mg of iron for 10 weeks while the other group received a placebo. Iron supplementation had a positive effect on the biochemical measures of iron status, with haemoglobin, haematocrit, transferrin saturation, RBC, MCH, and MCHC all showing statistically significant increases ($p < .05$*). Iron supplementation also resulted in a statistically significant improvement in total WISC-R score (*$p < .01$*). This effect was primarily the result of improved performance on nonverbal subtests, of which improvements in block design and coding were statistically significant (*$p < .01$*). The small increase in the sum of scaled scores from the verbal subtest was not significant (*$p > .05$*), but within the verbal subtest there was a significant improvement on the similarities part of the test (*$p < .05$*). The effects of iron supplementation were more pronounced in children with initially lower haemoglobin values. It is concluded that iron supplementation in nine-year-old schoolchildren with haemoglobin levels between 110 and 119 g/L will result in an improvement of cognitive functions, even though they are not otherwise malnourished.*

Introduction

Iron deficiency is the most common nutritional deficiency in both developing and industrialized countries [1]. The consequences of iron deficiency include impaired immunity, increased morbidity from infectious disease, and decreased physical capacity. In infants and children, studies have demonstrated impaired motor development and coordination, impaired language and scholastic achievement, psychological and behavioural effects, and decreased work capacity [2-6].

The possible effects of iron deficiency on behavioural development were reviewed by Pollitt and Leibel [7], as well as by an International Conference on Iron Deficiency and Behavioral Development [8]. It was concluded that iron deficiency in infants and children is associated with lower scores on tests of development and with impaired learning and school achievement. These findings were of public health concern because of the potential effect of iron deficiency on education and consequently on social and economic development.

Over the past decade and a half, the relationship between iron deficiency and cognitive performance has received increasing attention and confirmation. Studies have indicated that iron therapy may favourably affect developmental test scores in some, but not all, anaemic children [9]. The first controlled demonstration of an adverse effect of subclinical iron deficiency on learning and behaviour in young children was by Pollitt et al. in Cambridge, Massachusetts, USA [10, 11]. On a battery of cognitive and behavioural tests, moderately iron-deficient three- to six-year-old children had lower test scores than those with normal iron status. These values returned to normal after 12 weeks of supplementary oral iron. However, when Pollitt repeated these studies on pre-school children with iron-deficiency anaemia in Guatemala, these effects were not reversed by iron supplementation [10, 12].

In this paper we report results from a double-blind intervention trial in which the impact of iron supplementation on the cognitive function of nine-year-old children was assessed. In addition to haematological measurements, nutritional status was assessed by anthropometric and biochemical values in order to identify nutritional variables possibly associated with iron nutrition status and intellectual functions.

Methods

Sample selection

Since relatively few cases of iron-deficiency anaemia are reported in Croatian schoolchildren in the official national health statistics, a pilot study to screen blood haemoglobin levels was carried out in cooperation with the school health services in a rural area of central Croatia. Children from an elementary school near Zagreb with a relatively high prevalence of mild anaemia were selected. In order to minimize the effect of age on iron nutrition status as well as on cognitive functions, only children attending the third grade of elementary education and between 8.7 and 9.6 years of age were selected.

The children remained under the regular supervision of the local school health services. There were no endemic infectious diseases in the area, and intestinal parasites were not a problem. Following oral and written explanation of the purpose and procedures of the study, parents gave written consent for their children to participate.

Study design

All children received initial anthropometric, biochemical, and psychological examinations to collect baseline pretreatment data. Children from one class (supplemented group) were then given tablets for 10 weeks containing 100 mg of iron in the form of ferri-glycine sulfate (Orferon Retard-Pliva, Zagreb), while children from the other class (control group) received placebo tablets identical in appearance. The tablets were distributed daily, except Sunday, in a double-blind manner under the supervision of the teachers. The school health nurse visited classes and teachers twice a week in order to confirm compliance with the distribution.

It was logistically unacceptable to assign the children within each class randomly to different treatment conditions. However, because a child's placement in a class is random, the two groups of children were comparable. This is supported by the lack of any significant difference between classrooms on the many baseline measures collected during this study.

All examinations were repeated after 10 weeks of supplementation. Thirty-one (18 boys and 13 girls) of the 34 children assigned to the supplemented group and 29 (17 boys and 12 girls) of the 32 children assigned to the control group completed all biochemical and cognitive examinations and were included in the analysis of treatment effects.

Assessment of nutritional status

Anthropometric examinations included measurements of body weight, body height, and bicipital, tricipital, subscapular, and midaxillary skinfolds. On the basis of weight and height measurements, the relative body weight (weight as percentage of standard weight-for-height) as a criterion of current nutrition status and the relative body height (percentage of standard height-for-age) as a criterion of growth performance were calculated. Relative body weight and relative body height were calculated using National Center for Health Statistics data as the reference standard [13]. The percentage of body fat was calculated from skinfold measurements according to the equation of Durnin and Rahaman [14].

Venous blood (20 ml) was drawn from each subject using disposable plastic needles and syringes. Approximately 3 ml of the whole blood was placed into an EDTA-containing tube for blood cell counts and other haematological examinations. An equal amount of the whole blood was mixed with acid citrate dextrose stabilizer containing 7.3 g/L citric acid, 22.0 g/L sodium anhydride, and 24.5 g/L D-glucose monohydrate for the enzymatic determination of thiamine, riboflavin, and pyridoxine in the red blood cells. The remaining blood was allowed to clot, and 0.5 ml of serum was separated and mixed with 4.5 ml of 5% metaphosphoric acid. This sample and the rest of the serum were frozen at -30°C for further analyses. All blood samples were drawn between 8 and 10 a.m. Iron status was assessed by measuring haemoglobin, haematocrit, and red blood cell count (RBC) and by calculating mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV), and mean corpuscular haemoglobin concentration (MCHC) using standard automated blood-cell counter procedures and the ABX-ARGOS counter (Roche). Serum iron and total iron-binding capacity (TIBC) were measured by the ferrozine method [15] and Spectrum autoanalyser (Abbot, Irving, Tex, USA), and transferrin saturation was calculated as the ratio of serum iron to TIBC × 100.

In addition, the following biochemical values were measured: vitamins A and E in serum by high-performance liquid chromatography [16] and vitamin C in serum by a modification of the fluorometric method of Brubacher and Vuilleumier [17]. Erythrocyte thiamine was determined on the basis of transketolase enzyme reactivation (ETK), erythrocyte riboflavin on the basis of the glutathione reductase reactivation test (EGR), and erythrocyte pyridoxine on the basis of glutamic oxalacetic transaminase (EGOT) reactivation [18, 19]. Zinc in serum was measured by atomic absorption spectrophotometry [20].

Assessment of cognitive function

Cognitive function was assessed between 8 a.m. and noon Monday through Saturday, with children from each class examined on alternate days. The testing was done in a separate, quiet room in the school library with which the children were familiar. The environment was comfortable and free of distraction.

The abbreviated Wechsler Intelligence Scale for Children-Revised (WISC-R) containing six subtests—arithmetic, similarities, digit span, picture completion, block design, and digit symbol (coding)—was used to obtain information on both verbal and non-verbal aspects of intelligence in individual subjects.

In the coding test, children have to substitute symbols for numbers as quickly as possible. The score represents the total number of correct symbols written during a fixed time. The coding test primarily assesses visual-motor coordination, visual encoding, and short-term memory, concentration, and sustained attention.

The arithmetic test involves primary mental arithmetic problems, each having a time limit. The scores represent the total number of correct answers. The arithmetic test primarily assesses numerical reasoning, concentration, verbal comprehension and integration, and knowledge of basic numerical operations. Other factors influencing performance are short-term memory, attention, and interest in and comfort with mathematics.

The similarities test is composed of 13 questions inquiring how the concepts are related to each other. It is considered to reflect logical abstract (categorical) thinking and verbal concept formation. Other factors influencing performance are long-term memory, concentration, and cultural experience.

The digit-span test involves the immediate recall of increasingly longer strings of digits that are read to the children. One set has to be recalled forward as they are given and a second set has to be recalled backwards. The forward and backward items were analysed separately, and the children's scores represent the total number of correct responses. This test measures attention, short-term auditory memory, and auditory sequencing.

In picture completion, the subject is asked to find the missing parts in a picture. The test is said to reflect

visual alertness as well as visual recognition and identification (long-term visual memory).

In block design, the subject is required to copy a sample design using cubes painted in different colours and patches. This test breaks down the analysis of the whole into its component parts—nonverbal concept formation and spatial visualization.

Data analysis

The paired *t* test was used for pre- and post-treatment comparisons. Pearson's *r* correlation coefficients were determined from scattergrams, and regression analysis was used to evaluate the relationship between measures of cognitive function and anthropometric and biochemical measurements of nutritional status. All statistical analyses were done using the statistical software package SPSS for Windows 6.0 (SPSS, Chicago, Ill, USA).

Results

The results of anthropometric assessment of nutritional status (table 1) show that when relative body weight was used as an indicator of energy balance, most children had adequate dietary energy intake. Only one child had a weight below 80% of the reference standard, indicating undernutrition, whereas 7.6% of the children had weights greater than 125% of the reference standard. The percentage of body fat calculated from skinfold measurements showed that 7.4% of the boys and 10.1% of the girls were slightly obese.

Data on relative body height show that 98% of the children had attained satisfactory height-for-age, indicating that stunting, which usually reflects moderate to severe malnutrition during early childhood and is associated with poorer mental performance, was not a problem in the population studied.

Children with lower haemoglobin values (below 120 g/L) were slightly shorter than children with haemoglobin levels above 120 g/L, but these differences were not statistically significant. On the basis of the relative body weight and the percentage of body fat, two indices of soft-tissue development, the non-anaemic children appeared to have a better nutritional status than the mildly anaemic ones. However, only the difference in boys reached the level of statistical significance ($p < .05$).

The results of biochemical examinations (table 2) show that, despite the adequate energy intake and satisfactory mean values for biochemical indices of nutritional status, approximately 40% of the children had iron deficiency, a rather high prevalence. However, as judged by serum values, other micronutrient deficiencies were also present, including riboflavin (31%), pyridoxine (18%), and vitamin C (9%) deficiencies.

Correlation coefficients between baseline anthropometric and biochemical measurements of nutritional status and summary scores from the WISC-R administered prior to intervention are given in table 3. The only statistically significant association between anthropometric or biochemical measurements of nutritional status and total WISC-R score was with transferrin saturation ($p < .01$). However, the sum of scaled scores from verbal tests of the WISC-R was significantly correlated with haemoglobin ($p < .01$), haematocrit ($p < .01$), transferrin saturation ($p < .01$), MCHC ($p < .05$), and relative body height ($p < .01$). It was also positively correlated with red cell thiamine content ($p < .05$). None of the nutritional status indicators were significantly associated with the sum of scaled scores from the nonverbal tests of the WISC-R.

TABLE 1. Baseline anthropometric measures (mean ± SD) of nutritional status according to sex and haemoglobin concentration

	Total sample		Hb < 120 g/L		Hb ≥ 120 g/L	
Measurement	Boys ($n = 38$)	Girls ($n = 28$)	Boys ($n = 15$)	Girls ($n = 13$)	Boys ($n = 23$)	Girls ($n = 15$)
Age (yr)	9.3 ± 0.4	9.1 ± 0.2	9.2 ± 0.4	9.1 ± 0.2	9.3 ± 0.3	9.1 ± 0.3
Weight (kg)	30.3 ± 6.3	30.6 ± 5.5	27.6 ± 4.4	30.2 ± 7.3	32.1 ± 6.8	31.3 ± 3.6
Weight-for-height (% of standard)[a]	101.6 ± 12.9	104.1 ± 14.3	95.6 ± 8.7[b]	100.6 ± 12.4	105.5 ± 13.9[b]	107.1 ± 15.5
Height (cm)	135.0 ± 4.9	134.9 ± 4.5	133.4 ± 4.5	134.7 ± 5.2	136.1 ± 4.9	135.2 ± 3.8
Height-for-age (% of standard)[c]	101.1 ± 3.9	101.6 ± 3.2	100.1 ± 4.5	101.4 ± 4.1	101.8 ± 3.5	101.8 ± 2.2
Body fat (%)	16.5 ± 4.2	24.2 ± 4.7	15.2 ± 2.7	22.7 ± 4.9	17.3 ± 3.8	25.6 ± 4.4

a. Relative body weight in text.
b. Groups differ significantly ($p < .05$).
c. Relative body height in text.

TABLE 2. Baseline biochemical measures of nutritional status

Measure	Baseline value (mean ± SD)	Criterion of deficiency	% Deficient	
			Boys	Girls
Haemoglobin (g/L)	120.4 ± 5.2	<120[a]	39.5	46.4
Haematocrit (%)	38.8 ± 1.5	<34[a]	0.0	0.0
Serum iron (mol/L)	17.4 ± 7.2	<10.8[a]	10.5	25.0
Transferrin saturation (%)	24.8 ± 7.5	<15.0[a]	7.9	3.6
MCV (μ^3)	83.8 ± 2.4	<76.0[a]	0.0	0.0
MCH (pg)	26.3 ± 1.2	<26.0[a]	57.9	39.3
MCHC (%)	310.1 ± 13.8	<320.0[a]	75.6	75.0
Vitamin A (g/L)	284.7 ± 42.2	<100.0[b]	0.0	0.0
Vitamin C (mg/L)	5.5 ± 2.4	<2.0[b]	10.5	7.1
Vitamin E (mg/L)	7.4 ± 1.6	<5.0[b]	2.6	3.6
Thiamine (α-ETK)[c]	10 ± 0.05	>1.25[b]	0.0	0.0
Riboflavin (α-EGR)[c]	1.29 ± 0.10	>1.30[b]	26.3	39.3
Pyridoxine (α-EGOT)[c]	1.89 ± 0.12	>2.0[b]	13.2	25.0
Zinc (mol/L)	13.9 ± 1.2	<10.7[d]	2.6	0.0

a. Source: ref. 21.
b. Source: ref. 22.
c. Reaction coefficients.
d. Source: ref. 23.

TABLE 3. Correlations (Pearson *r*) between anthropometric and biochemical indicators of nutritional status and WISC-R scores

Indicator	WISC-R score		
	Verbal	Non-verbal	Total
Weight-for-height (% of standard)	0.0801	-0.1652	-0.0758
Height-for-age (% of standard)	0.3844***	0.1521	0.1051
Body fat (%)	0.0658	-0.0379	0.0093
Haemoglobin	0.3950***	0.0055	0.2265
Haematocrit	0.2943**	0.0462	0.1319
Serum iron	0.1343	0.1429	0.1802
Transferrin saturation	0.3574**	0.1851	0.3367**
MCV	0.0928	0.0024	0.054
MCH	0.1843	0.0431	0.0722
MCHC	0.2435*	0.0388	0.1655
RBC	0.202	0.0354	0.0878
Vitamin A	0.1225	0.1049	0.0078
Vitamin C	0.1812	0.0892	0.0367
Vitamin E	0.1829	0.2425*	0.0746
Thiamine	0.2466*	0.0069	0.1338
Riboflavin	0.0307	0.0861	0.0458
Pyridoxine	0.1106	0.0426	0.0934
Zinc	0.0813	0.1238	0.1364

*$p < .05$; **$p < .01$; ***$p < .001$.

Iron supplementation had the expected positive effect on the indicators of iron status, with haemoglobin, haematocrit, transferrin saturation, RBC, MCH, and MCHC showing statistically significant improvement (table 4). However, 10 weeks of iron supplementation did not significantly affect either serum iron concentrations or MCV. In the placebo group, there were no significant increases in the measures of iron status.

In both the iron-supplemented and the placebo groups, there was a statistically significant increase in serum concentrations of vitamin C ($p < .001$) and vitamin E ($p < .05$). The increase in the activity of the ETK and EGR tests, indicating a reduced dietary intake of thiamine and riboflavin in both groups, was not significant in either group. In both groups there was also a slight, but statistically significant, reduction in serum zinc values ($p < .05$).

Iron supplementation had a positive and statistically significant effect on several scaled scores from the WISC-R (table 5). Iron supplementation improved performance on all three nonverbal tests, of which improvements in block design and coding were statistically significant and the sum of the scaled scores from nonverbal subtests was statistically significant ($p < .01$). The slight increase in the sum of scaled scores from the verbal subtest was not statistically significant ($p > .05$). The only significant effect of iron supplementation on verbal scores was on the similarities subtest ($p < .05$).

The effects of iron supplementation were more pronounced in children with initial haemoglobin values below 120 g/L than in children with values of 120 g/L or more (table 6). The mean haemoglobin value of the former group of children increased from 115.2 to 120.8 g/L with supplementation ($p < .001$), whereas the mean haemoglobin value of the latter group only increased from 125.4 to 127.8 g/L ($p > .05$). However, despite the positive effect of iron supplementation on mean biochemical indicators of iron nutrition status, 6 out of 18 subjects (33.3%) with initial haemoglobin values below this limit continued to have values below 120 g/L after 10 weeks of iron supplementation.

TABLE 4. Effects of iron supplementation on biochemical measures of nutritional status (mean ± SD) in comparison with the group receiving the placebo

Measure	Iron supplementation ($n = 31$)			Placebo ($n = 29$)		
	Pre	Post	p	Pre	Post	p
Haemoglobin (g/L)	119 ± 6	123 ± 6	.05	121 ± 4	121 ± 6	NS
Haematocrit (%)	38.3 ± 1.7	39.3 ± 1.7	.05	38.3 ± 1.2	37.8 ± 1.6	NS
Serum iron (mol/L)	17.3 ± 5.6	17.4 ± 9.5	NS	17.2 ± 4.4	16.4 ± 4.0	NS
Transferrin saturation (%)	25.9 ± 8.5	30.2 ± 8.3	.05	24.2 ± 6.8	25.5 ± 7.0	NS
MCV (μ^3)	83.7 ± 2.6	84.1 ± 2.6	NS	84.2 ± 2.0	84.1 ± 2.4	NS
MCH (pg)	25.5 ± 0.9	27.2 ± 1.1	.001	26.8 ± 1.1	27.0 ± 1.4	NS
MCHC (%)	303 ± 8	323 ± 8	.001	316 ± 10	320 ± 9	NS
RBC ($\times 10^6$)	4.5 ± 0.2	4.7 ± 0.2	.05	4.6 ± 0.2	4.5 ± 0.2	.05
Vitamin A (g/L)	274 ± 53	296 ± 50	NS	296 ± 28	302 ± 25	NS
Vitamin C (mg/L)	5.1 ± 2.5	11.1 ± 3.7	.001	5.8 ± 2.5	11.1 ± 2.0	.001
Vitamin E (mg/L)	6.9 ± 1.4	8.0 ± 1.2	.01	7.9 ± 1.7	9.0 ± 1.1	.05
Thiamine (α-ETK)	1.11 ± 0.05	1.13 ± 0.05	NS	1.08 ± 0.05	1.12 ± 0.08	NS
Riboflavin (α-EGR)	1.28 ± 0.13	1.35 ± 0.13	NS	1.30 ± 0.08	1.34 ± 0.07	NS
Pyridoxine (α-EGOT)	1.90 ± 0.12	1.92 ± 0.11	NS	1.88 ± 0.12	1.87 ± 0.08	NS
Zinc (mol/L)	13.8 ± 1.3	11.7 ± 1.2	.01	14.0 ± 1.2	13.3 ± 1.6	.05

TABLE 5. Effects of iron supplementation on Wechsler Intelligence Scale for Children-Revised (WISC-R) scaled scores (mean ± SD)

Scale	Iron supplementation ($n = 31$)			Placebo ($n = 29$)		
	Pre	Post	p	Pre	Post	p
Verbal	30.5 ± 3.8	32.2 ± 4.4	NS	30.4 ± 4.2	30.9 ± 4.3	NS
Arithmetic	10.8 ± 2.7	10.6 ± 2.0	NS	10.0 ± 2.1	10.8 ± 2.1	NS
Similarities	10.5 ± 2.2	12.0 ± 2.6	.05	11.9 ± 1.4	11.3 ± 1.9	NS
Digit span	9.2 ± 2.2	9.8 ± 1.7	NS	8.6 ± 2.2	8.9 ± 2.1	NS
Non-verbal	28.4 ± 6.9	33.5 ± 7.4	.01	29.3 ± 3.7	30.5 ± 3.4	NS
Picture completion	8.8 ± 2.8	9.9 ± 3.1	NS	8.9 ± 1.8	9.6 ± 1.8	NS
Block design	9.1 ± 3.4	11.2 ± 2.8	.01	10.2 ± 2.2	10.4 ± 1.7	NS
Coding	10.5 ± 2.6	12.4 ± 3.7	.01	10.2 ± 1.4	10.5 ± 1.7	NS
Total	58.8 ± 8.9	65.8 ± 9.1	.01	59.7 ± 5.7	61.3 ± 6.1	NS

TABLE 6. Effects of iron supplementation on iron nutrition status and WISC-R scores (mean ± SD) according to haemoglobin status at the beginning of the study

Measure	Hb < 120 g/L ($n = 18$)				Hb ≥ 120 g/L ($n = 13$)			
	Pre	Post	Δ	p	Pre	Post	Δ	p
Haemoglobin (g/L)	115.2 ± 2.5	120.8 ± 4.9	5.6	.001	125.4 ± 4.5	127.8 ± 4.2	2.4	NS
Haematocrit (%)	37.1 ± 1.4	38.1 ± 0.8	0.1	NS	39.3 ± 1.5	40.8 ± 1.3	1.5	.05
Serum iron (μmol/L)	17.2 ± 11.4	18.3 ± 5.9	1.1	NS	17.7 ± 6.2	16.4 ± 5.0	1.3	NS
Transferrin saturation (%)	23.9 ± 9.1	31.6 ± 8.0	7.7	.05	28.5 ± 7.0	28.3 ± 8.7	0.2	NS
RBC ($\times 10^6$)	4.5 ± 0.2	4.6 ± 0.2	0.1	NS	4.6 ± 0.2	4.7 ± 0.3	0.1	NS
MCV (μ^3)	82.8 ± 2.0	83.6 ± 2.3	0.8	NS	84.9 ± 3.1	84.8 ± 2.8	0.1	NS
MCH (pg)	25.1 ± 0.8	27.0 ± 1.2	1.9	.001	26.1 ± 0.8	27.6 ± 0.9	1.5	.001
MCHC (%)	301 ± 8	321 ± 7	20.0	.001	307 ± 6.4	325 ± 9.1	18	.001
WISC-R verbal	29.6 ± 4.1	31.1 ± 4.4	1.5	NS	31.7 ± 3.2	34.3 ± 3.3	2.6	NS
WISC-R non-verbal	28.6 ± 6.6	34.7 ± 7.5	6.1	.05	28.9 ± 7.5	31.8 ± 7.3	2.9	NS
WISC-R total	58.2 ± 8.8	65.7 ± 9.3	7.5	.05	59.8 ± 9.4	66.2 ± 8.5	6.4	NS

In the group with initial haemoglobin values below 120 g/L, iron supplementation also had more significant effects on the summary scores from the WISC-R. The total and non-verbal summary scores in this group showed significant effects, whereas none of the summary scores showed significant effects in the group with higher baseline haemoglobin values. The six children who still had haemoglobin values below 120 g/L after supplementation nevertheless increased their mean WISC-R scores from 63.8 ± 8.0 at the beginning of the study to 68.8 ± 10.0 at the end of the study. This increase, although not statistically significant because of the small number of subjects, was even more pronounced in children who also showed increased transferrin saturation with iron supplementation.

Discussion

Iron supplementation during a period of 10 weeks had a positive and statistically significant effect on the mean values of haemoglobin, haematocrit, red cell count, MCH, MCHC, and transferrin saturation. Iron supplementation did not significantly affect serum iron level and MCV. In the placebo group, the average blood haemoglobin values did not change during the period of the study; those of children with initial haemoglobin values below 120 g/L increased slightly but non-significantly ($p > .05$).

The fact that test scores also correlate with anthropometry and socio-economic status raises the question of the extent to which coexistent nutritional deficiencies contributed to the differences. During the period of the study, some of the other biochemical indicators of nutritional status changed as well. There was a highly significant increase in the vitamin C values in both groups. This increase could be explained by a seasonal increase in the dietary intake of ascorbic acid, which usually takes place at the end of the spring season. At this time, sources of ascorbic acid become available again after a shortage during the late winter and early spring. This phenomenon was repeatedly observed in our earlier studies with schoolchildren that were initiated in early spring and terminated before summer vacations in the middle of June [24]. The higher ascorbic acid content in the diet [25] might have improved iron absorption sufficiently to account for the increase in haemoglobin levels in children from the placebo group who had initially low haemoglobin values.

Serum vitamin E increased significantly in both the iron-supplemented and the placebo groups. The increase in vitamin E biochemical status was probably the result of the seasonal increase in the consumption of green leafy vegetables, which contain appreciable amounts of this nutrient [26].

In order to assess the possible influence of vitamin C and vitamin E on the WISC-R scores, we carried out an analysis of variance between the increase (Δ) in WISC-R scores in the supplemented and placebo groups, using the increase (Δ) in vitamins C and E as covariates. The increase in the biochemical values of these two vitamins did not have any significant effect on the WISC-R scores. Thus this study does not provide evidence for a significant effect of nutrients other than iron.

It is noteworthy that the serum zinc content was reduced at the end of the study in both groups, but more significantly in the iron-supplemented group. Although higher intakes of dietary iron have been reported to have a negative effect on the absorption of zinc [27-29], the significant decrease in serum zinc levels in the placebo group indicates that iron supplementation was not the only factor in serum zinc reduction in the iron-supplemented group.

The positive effect of iron supplementation on WISC-R scores was primarily on the non-verbal component of the test. Out of the three subtests of the non-verbal component, the differences between changes in block design and coding ($\Delta T_2 - T_1$) were statistically significant in comparison with changes in the placebo group ($p < .05$). The difference in picture completion scores did not reach statistical significance. In regard to the verbal component, however, only the increase in scores in the similarities subtest in the iron-supplemented group was statistically significantly different from the changes in the placebo group ($\Delta T_2 - T_1 = 2.34$; $t = 3.529$; $p < .001$).

In the placebo group, despite the absence of any significant increases in the mean values of iron nutrition status indicators, and a decrease in RBC, there was a non-significant increase in the total WISC-R scores at the end of the study. This increase in the test scores in the second testing in the non-supplemented group could be attributed to greater familiarity and consequently to a more comfortable feeling of the examinees under test situations, as described earlier [8].

In earlier studies, the effects of double-blinded oral supplementation with iron or a placebo were examined in rural Indonesian schoolchildren classified as anaemic or non-anaemic [30]. The haematological status returned to normal after supplementation with 10 mg of ferrous sulfate per kilogram body weight per day for three months, and the anaemic group markedly improved their learning and achievement scores with iron supplementation. No change was observed in non-anaemic children or in anaemic children given placebo. Three other studies in Indonesia had similar results [12, 31, 32].

Improvement in cognitive test performance in preschool children and schoolchildren after haematological response to iron supplementation was also reported from Egypt [12]. However, the effect of supplementation was not significant when the entire supplemented group was compared with the group receiving the placebo. Studies in 8- to 15-year-old schoolboys in India

compared the effect of 30- and 40-mg doses of elemental iron and a placebo on a number of tests of cognitive function, using the Indian adaptation of the WISC [33]. Both doses improved recent memory, attention, auditory memory, auditory sequencing, visual-motor coordination, and visual perception. Furthermore, they found that the prophylactic dose of 60 mg of elemental iron per day improved attention, memory, and concentration. The conclusion from these studies was that iron supplementation would improve scholastic performance. The same conclusion was reached by Soemantri in Indonesia and by Pollitt and co-workers in Indonesia and Egypt.

In a double-blinded study of children 9 to 11 years of age in Bangkok, a significant positive association was found between iron status and performance on the Raven Progressive Matrices used to measure IQ, on the Thai language test, and on a mathematics test [34]. Even children who were iron depleted without anaemia had significantly lower scores on the Thai language test than did iron-repleted children. However, no improvement was observed after the administration of 100 mg of iron per day as ferrous sulfate. These results differ from those obtained by the same author in Indonesia and Egypt. The explanation proposed is that reversibility depends on whether damage occurs during a critical period of brain growth during infancy. Iron-deficiency anaemia in schoolchildren and adults may or may not be a continuation of the same deficiency in infancy. Where it is not, the effects on cognitive function are reversible, as in the present study as well as in four separate studies in India [33] and on adolescent girls in the United States [35].

It is evident that key iron-containing compounds in the brain respond to iron deficiency at any age, even when the deficiency is not sufficiently severe to affect haematopoiesis. However, the mechanism by which iron-deficiency anaemia in infancy has a lasting effect, even when the individual is no longer iron deficient, is unknown. Work from Israel with iron-deficient rats suggests that iron deficiency at a critical developmental state reduces the number of central dopamine neurotransmitters [36, 37]. It is postulated that interference with iron metabolism at an early age in humans could cause similar irreversible damage to brain function. It has also been proposed that the underlying problem is a reduction in non-haem iron in the brain or other systemic changes in the organism associated with the reduction of the transport of oxygen [38]. It is of interest that in our study the six children with initially low haemoglobin values increased their WISC-R scores after supplementation, without an increase in haemoglobin values.

It is concluded that mild iron deficiency in otherwise adequately nourished nine-year-old schoolchildren with haemoglobin levels between 110 and 119 g/L may affect behaviour and cognitive functions, and that iron supplementation resulted in an improvement of haematological status and cognitive functions. The overall results of this and the other studies cited indicate that iron deficiency can be educationally disadvantageous at any age, independently of ethnicity and of physical and social environment.

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Anaemia in Central Asia: Demographic and Health Survey experience

Almaz Sharmanov

Abstract

Nationally representative anaemia levels among women and children were recently determined in conjunction with the Demographic and Health Surveys in Kazakstan (1995), Uzbekistan (1996), and the Kyrgyz Republic (1997). Anaemia was assessed by measuring the haemoglobin level in capillary blood of women aged 15 to 49 and their children under the age of 3 using the photometric Hemocue technique. The numbers of women tested were 3,658, 4,333, and 3,760 in Kazakstan, Uzbekistan, and the Kyrgyz Republic, respectively. All three Central Asian republics had a high prevalence of anaemia. The highest overall rates were in the regions of Kazakstan and Uzbekistan near the Aral Sea, which are characterized by severe agrochemical pollution and other environmental and socio-economic problems. Approximately half (49%) of the women in Kazakstan, 60% of the women in Uzbekistan, and 40% of the women in the Kyrgyz Republic suffered from some degree of anaemia. Mild anaemia (haemoglobin level, 10.0–11.9 g/dl; 10.0–10.9 g/dl for pregnant women) was diagnosed in 37%, 45%, and 28% of the women in Kazakstan, Uzbekistan, and the Kyrgyz Republic, respectively. Eleven percent of the women in Kazakstan, 14% in Uzbekistan, and 9% in the Kyrgyz Republic had moderate anaemia (haemoglobin level 7.0–9.9 g/dl). Severe anaemia (haemoglobin level less than 7.0 g/dl) was found among 1% of the women in all three Central Asian republics.

In Kazakstan, 69% of the children under the age of three suffered from some degree of anaemia. About the same number of children had mild (30%) and moderate (34%) anaemia. A smaller, but substantial, proportion of children (5%) were severely anaemic. In Uzbekistan and the Kyrgyz Republic, 61% and 50% of children, respectively, suffered from anaemia. The percentages of children with mild, moderate, and severe anaemia were 34%, 26%, and 1%, respectively, for Uzbekistan, and 24%, 24%, and 1%, respectively, for the Kyrgyz Republic.

There is sufficient evidence to suggest that negative iron balance is probably a major cause of anaemia among both women and children in Central Asia. Our findings provide important information for the development of health intervention programmes to prevent iron-deficiency anaemia among women of certain ethnic, educational, and residential groups in this region. Based on the results of the Demographic and Health Survey as well as other geographically focused studies, the UNICEF Area Office for the Central Asian Republics and Kazakstan proposed an integrated strategy of education, supplementation, fortification, and research to address the problem and called for donors' support. It is expected that this approach can considerably improve maternal and child health in Central Asia.

Introduction

Anaemia is a condition characterized by a reduction in red blood cell volume and a decrease in the concentration of haemoglobin in the blood. Commonly, anaemia is the final outcome of nutritional deficiencies of iron, folate, vitamin B_{12}, and other nutrients. Although many other causes of anaemia have been identified, such as haemorrhage, infection, genetic disorders, and chronic disease, nutritional deficiency due primarily to a lack of bioavailable dietary iron accounts for the majority of cases [1–4].

Anaemia is known to have detrimental health implications, particularly for mothers and young children. Unfavourable pregnancy outcomes are more common in anaemic than in non-anaemic mothers [2, 5]. Women with severe anaemia can have difficulty meeting oxygen transport requirements near and at delivery, especially if significant haemorrhage occurs. This may be an underlying cause of maternal death and of prenatal and perinatal infant loss [6–8]. Iron-deficiency anaemia among children has been associated with impairment of cognitive performance, motor development,

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coordination, language development, and scholastic achievement [5, 9]. Anaemia increases morbidity from infectious diseases, because several immune mechanisms are affected [10].

Anaemia due to iron deficiency is recognized as a major public health problem throughout the world. According to the epidemiological data collected from multiple countries by the World Health Organization, some 35% of women and 43% of young children have anaemia [5, 11]. In developing countries, about half of the women and young children are anaemic [5, 12, 13]. In the United States and Europe, the prevalence of anaemia is 7% to 12% among women and children [14, 15]. The highest overall rates of anaemia have been reported in southern Asia and certain regions of Africa.

For decades anaemia has been one of the leading public health problems in Central Asia. According to the 1988 nutrition survey conducted by the Nutrition Institute in four regions of Kazakstan, 60% of non-pregnant and non-lactating women and 60% to 80% of pregnant women had anaemia on the basis of haemoglobin and haematocrit measurements [16]. The 1993 study by the Crosslink group in the Muynak District of adjoining Uzbekistan found anaemia levels of over 60% for women of reproductive age and approximately 80% for children under the age of three [17]. Because of correspondingly low serum levels of iron and ferritin, iron deficiency was recognized as a major cause of anaemia among women and young children in that area. In a study of women and children in Kazalinsk District of the Kzyl-Orda Region of Kazakstan in July 1994, the prevalence of anaemia was estimated as 46% among women aged 15 to 45 years and 64% among children aged 6 to 60 months [18].

With the socio-economic changes that have taken place in the former Soviet Union in the last few years, the probability that the prevalence of anaemia may have increased in Central Asia is of great public health concern. Testing women and children for iron-deficiency anaemia was one of the major efforts of the Demographic and Health Surveys conducted in Kazakstan in 1995, Uzbekistan in 1996, and the Kyrgyz Republic in 1997. These were the first anaemia studies done in Central Asian republics on nationally representative samples. This paper summarizes the results of anaemia testing and examines the systematic differences in haemoglobin concentrations between certain population groups in these three countries.

Methods

Kazakstan survey sample design

The Kazakstan survey was conducted between 15 May and 30 August 1995 by the Institute of Nutrition of the Kazakstan National Academy of Sciences. A detailed description of the survey design has been published elsewhere [19]. The survey employed a nationally representative and multistage probability sample of women between the ages of 15 and 49. The primary information for the sampling was obtained from the 1989 census, data from the National Statistical Office, and the Ministry of Health of Kazakstan. The country was divided into five survey regions. With the exception of the capital city, Almaty, which constituted a survey region by itself, the other four survey regions were groups of contiguous oblasts located in south, west, central, and northeast Kazakstan.

A total of 4,480 households were selected from 176 sampling areas, which yielded 3,899 women who were eligible for anaemia testing (all women 15 to 49 years of age who were either usual residents or visitors and who had spent the previous night in the household). Anaemia testing was done on 3,658 of these women and 739 of their children born since January 1992.

Uzbekistan survey sample design

The Uzbekistan survey was conducted between 24 June and 12 October 1996 by the Institute of Obstetrics and Gynaecology, Ministry of Health of Uzbekistan. A detailed description of the survey design has been published elsewhere [20]. The survey employed a nationally representative and multistage probability sample of women between the ages of 15 and 49. The primary information for the sampling was obtained from the National Statistical Office and the Ministry of Health of Uzbekistan. The country was divided into five survey regions. With the exception of the capital city, Tashkent, which constituted a survey region by itself, the other four survey regions were groups of contiguous oblasts located in the Aral Sea area and in the central, eastern, and Ferghana Valley regions.

A total of 3,945 households were selected from 164 sampling areas, which yielded 4,544 women who were eligible for anaemia testing; 4,333 of these women and 1,106 of their children born since January 1993 were tested.

Kyrgyz survey sample design

The Kyrgyz survey was conducted between 8 August and 8 November 1997 by the Research Institute of Obstetrics and Paediatrics of the Ministry of Health of the Kyrgyz Republic. A detailed description of the survey design has been published [21]. The primary information for the sampling was obtained from the National Statistical Office and the Ministry of Health of the Kyrgyz Republic. The Kyrgyz survey employed a representative probability sample of women aged 15 to 49. Selected survey estimates were to be produced for four survey regions. The capital city of Bishkek and Narynskaya Oblast, which is located in the mountainous eastern part of the Kyrgyz Republic, constituted

two survey regions by themselves (Bishkek City and East). The remaining two survey regions consisted of groups of contiguous oblasts located in the north and south of the Kyrgyz Republic.

A total of 3,821 households were selected from 168 sampling areas, which yielded 3,954 women who were eligible for anaemia testing. Testing was done on 3,760 of these women and 980 of their children born since January 1994.

The Kazakstan, Uzbekistan, and Kyrgyz surveys were funded by the United States Agency for International Development (USAID), and technical assistance was provided by Macro International (Calverton, Md, USA) through its contract with USAID.

Informed consent

Prior to participating in the study, women in the Kazakstan, Uzbekistan, and Kyrgyz surveys were asked to sign a consent form giving permission for the collection of a blood droplet from themselves and their children under the age of three years. In addition, if a woman was diagnosed as having severe anaemia (haemoglobin level less than 7 g/dl), she was asked to sign another consent form giving permission to the study team to inform the local health care facility about her condition.

Blood collection and Hemocue analyses

For haemoglobin measurement, capillary blood was taken from the finger using Tenderlett lancets (sterile disposable instruments that allow a relatively painless skin puncture). Haemoglobin was measured with the Hemocue system, which detects the level of haemoglobin within a minute. This system consists of a battery-operated portable photometer and a disposable cuvette, which serves as both the blood-collection device and the site where the reaction occurs. The procedure was performed by specially trained medical personnel and was confirmed to be accurate, precise, and suitable for the various field conditions.

Diagnostic criteria

Levels of anaemia were classified as severe, moderate, or mild based on the haemoglobin concentration in the blood and according to criteria developed by the World Health Organization [12]. Haemoglobin concentrations less than 7.0 g/dl were considered severe anaemia; concentrations of 7.0 to 9.9 g/dl were considered moderate anemia; concentrations of 10.0 to 11.9 g/dl (10.0–10.9 g/dl for pregnant women and children under the age of three years) were considered mild anaemia.

Haemoglobin high-altitude adjustments

The haemoglobin concentration in the blood is negatively regulated by the level of saturation of arterial blood with oxygen. The decline in the partial pressure of oxygen with altitude is accompanied by a decline in the saturation of arterial blood with oxygen and an increased concentration of haemoglobin in the blood. On the basis of these relationships, Hurtado et al. developed adjustments of haemoglobin levels according to altitude for the Centers for Disease Control Pediatric Nutrition Surveillance System [22].

For the population of the Kyrgyz Republic, which lives at altitudes that range from 488 m (1,600 feet) in the Ferghana Valley to more than 3,000 m (10,000 feet) in some areas of Narynskaya Oblast, altitude is an important factor that could affect the level of haemoglobin in the blood and therefore should be considered in calculating anaemia rates. For this reason, in the Kyrgyz survey the rates of anaemia were calculated using high-altitude adjustment equations. According to these equations:

$$\text{Adjusted level of altitude} = \text{observed level} - \text{adjustment coefficient}$$

The adjustment coefficient is calculated as

$$\text{Adjustment coefficient} = (-0.032 \times \text{altitude}) + (0.022 \times \text{altitude}^2)$$

Altitude is measured as

$$(\text{Altitude in metres}/1{,}000) \times 3.3$$

Ferritin assessment

To evaluate body iron stores, the level of serum ferritin was tested in a small subsample of women from Almaty City with haemoglobin values less than 10 g/dl. The blood for ferritin testing was taken by venipuncture. The serum ferritin was determined in duplicate with a commercially available enzyme immunoassay (ELISA) kit (Ramco Laboratories, Houston, Texas, USA) using a Titertek Multiscan R plus (EFLAB, Labsystems, Helsinki, Finland).

Statistical procedures

Data were entered and edited on microcomputers using the software package Integrated System for Survey Analysis (ISSA). Tabulations also used the ISSA package. To correct for differences in selection probabilities between the different survey regions, sampling weights have been applied to the data.

Results

Table 1 shows the results of testing of women for anaemia in Kazakstan. Almost half (49%) of those tested were anaemic. More than 11% of them had moderate or severe anaemia, with haemoglobin levels less than

TABLE 1. Anaemia among women in Kazakstan: Percentage of women classified as having iron-deficiency anaemia according to background characteristics, Kazakstan Demographic and Health Survey, 1995

Background characteristic	Percentage of women with:			Women measured	
	Severe anaemia[a]	Moderate anaemia[b]	Mild anaemia[c]	Weighted	Unweighted
Age (yr)					
15–19	0.4	6.4	38.8	657	650
20–24	0.6	11.4	39.0	557	566
25–29	0.9	10.5	35.8	514	518
30–34	2.1	11.8	39.4	539	536
35–39	1.5	12.2	37.4	552	546
40–44	0.8	10.1	34.0	521	486
45–49	2.0	13.8	33.0	344	356
Residence					
Urban	0.7	9.0	36.5	2,058	1,958
Rural	1.7	12.6	37.8	1,626	1,700
Region					
Almaty City	1.1	9.4	27.7	249	564
South	0.8	10.6	38.9	1,177	901
West	2.5	16.4	40.0	459	801
Central	0.7	8.0	35.1	354	718
North-east	1.1	9.5	36.8	1,445	674
Education					
Primary/secondary	1.3	11.6	37.8	1,352	1,364
Special education	1.0	10.7	37.9	1,681	1,584
Higher	1.1	8.2	33.5	651	710
Ethnicity					
Kazak	1.9	14.3	40.7	1,654	1,885
Russian	0.7	7.2	33.8	1,283	1,141
Other	0.3	8.2	34.7	747	632
Total	1.1	10.6	37.1	3,684	3,658

a. Haemoglobin level < 7 g/dl.
b. Haemoglobin level 7–9.9 g/dl.
c. Haemoglobin level 10–11.9 g/dl (10–10.9 g/dl for pregnant women).

10 g/dl. The highest prevalence of anaemia was in the western region of Kazakstan, where 19% were diagnosed with moderate or severe anaemia. The rates of moderate and severe anaemia were higher among ethnic Kazaks than ethnic Russians and among rural women than urban. Women with higher education were less likely to be anaemic than those with primary or secondary education. There were no significant differences in rates of anaemia among different age groups, except for a low frequency of moderate anaemia among women 15 to 19 years old.

As seen in table 2, 60% of the women tested in Uzbekistan had some degree of anaemia, mostly mild (45%) or moderate (14%). One percent had severe anaemia. Differences in anaemia status of women according to age, residence, ethnicity, and education were minor. However, regional differences were more marked. High rates of moderate and severe anaemia were found in the Aral Sea region and in Ferghana Valley (23% and 25%, respectively), whereas Tashkent City had the lowest rate of moderate anaemia (7%) and no cases of severe anaemia.

Table 3 presents anaemia rates for women in the Kyrgyz Republic, 38% of whom had some degree of anaemia. Nine percent of these women had moderate anaemia and 2% had severe anaemia. There was a high rate of moderate and severe anaemia in the south (12%). The rates of moderate and severe anaemia were higher among rural women than urban women, and higher among ethnic Kyrgyz and Uzbek women than among ethnic Russians or women of other ethnic groups.

Figure 1 shows the prevalence of moderate and severe anaemia among pregnant, breastfeeding, and nonpregnant, non-breastfeeding women. In all three countries, moderate and severe anaemia was almost two to three times more prevalent among pregnant women than among nonpregnant women (breastfeeding or non-breastfeeding).

TABLE 2. Anaemia among women in Uzbekistan: Percentage of women classified as having anaemia according to background characteristics, Uzbekistan Demographic and Health Survey, 1996

Background characteristic	Percentage of women with:			Women measured	
	Severe anaemia[a]	Moderate anaemia[b]	Mild anaemia[c]	Weighted	Unweighted
Age (yr)					
15–19	0.6	10.4	45.3	964	916
20–24	0.9	16.6	45.0	792	791
25–29	0.6	16.4	45.5	697	679
30–34	1.2	16.3	45.8	615	603
35–39	1.6	14.6	47.0	551	557
40–44	0.8	11.5	45.4	414	423
45–49	1.1	13.3	41.5	300	305
Residence					
Urban	0.9	12.8	45.5	1,625	2,181
Rural	0.9	15.1	45.2	2,709	2,093
Region					
Aral Sea region	2.1	21.3	48.1	461	961
Central	0.3	10.0	33.7	1,049	922
East	0.4	8.5	44.7	1,243	751
Ferghana Valley	1.8	23.1	53.4	1,224	909
Tashkent City	0.0	6.7	50.2	357	731
Education					
Primary/secondary	1.0	13.8	45.8	2,787	2,478
Special education	0.8	16.6	44.7	1,095	1,247
Higher	0.5	10.8	43.7	451	549
Ethnicity					
Uzbek	0.9	14.6	45.9	3,594	3,259
Other	0.8	12.1	42.3	739	1,015
Total	0.9	14.2	45.3	4,333	4,274

a. Haemoglobin level < 7 g/dl.
b. Haemoglobin level 7–9.9 g/dl.
c. Haemoglobin level 10–11.9 g/dl (10–10.9 g/dl for pregnant women).

Figure 2 shows haemoglobin concentrations in non-pregnant and non-lactating women. The entire haemoglobin distribution for women in each of the three Central Asian countries is shifted downward (to the left) as compared with the distribution for healthy non-anaemic women in the United States according to the sample of the US National Health and Nutrition Examination Survey (NHANES-II). The NHANES-II distribution can be used as a reference, since individuals with abnormal mean cell volume and transferrin saturation were excluded from the distribution [11].

Table 4 presents anaemia rates for children under the age of three years in Kazakstan. There is a high national rate of anaemia (69%) among children. One-third of all children were diagnosed with moderate anaemia and 5% with severe anaemia. As in women, the highest prevalence of anaemia in children occurred in the western region, where almost half were moderately anaemic and 8% were severely anaemic. The most pronounced differentials are observed in the rates of severe anaemia. Nine percent of ethnic Kazak children were severely anaemic, in contrast to no ethnic Russian children and only 1% of children in other ethnic groups. Similarly, the rates of severe anaemia among children of mothers with a primary or secondary education and among children in the southern, western, and central regions were two to five times higher than the rates for other groups of children. Children living in rural areas had severe or moderate anaemia more frequently than urban children.

Table 5 presents anaemia rates for children under three years of age in Uzbekistan. Sixty-one percent had some degree of anaemia, 26% had moderate anaemia, and 1% were severely anaemic. The differences in overall rates of anaemia according to the sex of the child, residence, and education of the mother were relatively minor. However, as is the case with women, the regional differences were substantial. More than half of the children (53%) living in the Aral Sea region had moderate or severe anaemia. The preva-

TABLE 3. Anaemia among women in the Kyrgyz Republic: Percentage of women classified as having anaemia according to background characteristics, Kyrgyz Demographic and Health Survey, 1997

Background characteristic	Percentage of women with:			Women measured	
	Severe anaemia[a]	Moderate anaemia[b]	Mild anaemia[c]	Weighted	Unweighted
Age (yr)					
15–19	0.7	5.9	25.2	720	718
20–24	0.8	8.9	24.3	642	631
25–29	1.3	7.4	28.4	525	543
30–34	2.7	11.2	30.3	618	605
35–39	1.0	10.3	30.3	566	549
40–44	2.8	10.2	26.1	396	402
45–49	1.5	10.5	31.1	300	312
Residence					
Urban	0.8	6.5	24.8	1,250	1,430
Rural	1.8	10.2	29.1	2,517	2,330
Region					
Bishkek City	0.6	5.0	23.5	500	862
North	1.4	8.5	26.6	1,157	997
East	0.5	7.0	22.6	211	756
South	1.9	10.5	30.0	1,898	1,145
Education					
Primary/secondary	1.1	10.1	27.6	2,018	1,892
Special education	2.3	8.4	28.9	1,128	1,156
Higher	1.3	6.5	25.5	621	712
Ethnicity					
Kyrgyz	1.9	9.6	27.6	2,347	2,518
Russian	0.3	3.9	20.7	391	470
Uzbek	1.1	10.8	34.2	680	432
Other	0.7	7.1	23.3	349	340
Total	1.5	9.0	27.7	3,767	3,760

a. Haemoglobin level < 7 g/dl.
b. Haemoglobin level 7–9.9 g/dl.
c. Haemoglobin level 10–11.9 g/dl (10–10.9 g/dl for pregnant women).

lence of moderate and severe anaemia was also high in the east and in Ferghana Valley (26% and 28%, respectively).

Table 6 presents anaemia rates for children under three years of age in the Kyrgyz Republic. Fifty percent had some degree of anaemia, 24% had moderate anaemia, and 1% were severely anaemic. Differences in overall rates of anaemia according to sex of the child, ethnicity, residence, and education of the mother were relatively minor. However, as was the case with women, the regional differences were substantial; 32% of the children in the north and 24% percent of those in the south and east had moderate or severe anaemia. In Bishkek City the prevalence of moderate anaemia among children was relatively low (13%).

Certain relationships were observed between the prevalence of anaemia among mothers and their children. Figure 3 shows cumulative data from Kazakstan, Uzbekistan, and the Kyrgyz Republic on the prevalence of moderate or severe anaemia among children according to the anaemia status of their mothers. Among children of mothers with severe anaemia, 68% were severely or moderately anaemic. The percentage of chil-

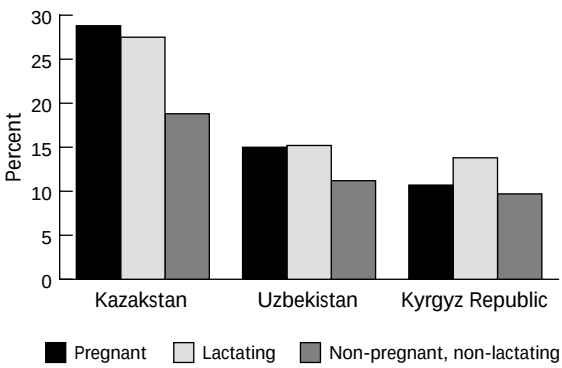

FIG. 1. Prevalence of moderate and severe anaemia among women according to pregnancy status and breastfeeding status

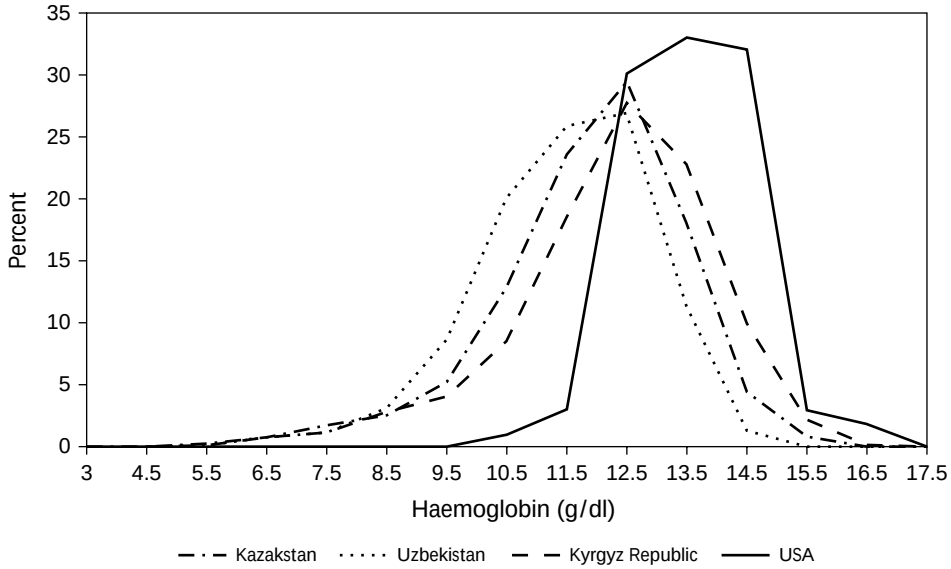

FIG. 2. Percent distribution of non-pregnant and non-lactating women age 15–19 years according to blood haemoglobin levels

TABLE 4. Anaemia among children in Kazakstan: Percentage of children under three years classified as having anaemia according to background characteristics, Kazakstan Health and Demographic Survey, 1995

Background characteristic	Percentage of children with:			Children measured	
	Severe anaemia[a]	Moderate anaemia[b]	Mild anaemia[c]	Weighted	Unweighted
Residence					
Urban	4.5	26.9	32.3	293	275
Rural	6.1	38.2	28.6	422	464
Region					
Almaty City	1.5	20.0	26.2	29	65
South	7.4	32.8	32.7	319	253
West	7.7	47.3	26.0	93	173
Central	5.1	40.0	21.7	73	153
North-east	2.0	27.9	31.7	200	95
Education of mother					
Primary/secondary	6.7	35.3	25.7	261	270
Special education	5.3	32.9	33.8	340	346
Higher	3.0	31.7	29.5	113	123
Ethnicity					
Kazak	8.9	40.6	28.2	420	487
Russian	0.0	27.5	31.0	159	137
Other	1.3	19.0	35.1	135	115
Total	5.5	33.6	30.1	714	739

a. Haemoglobin level < 7 g/dl.
b. Haemoglobin level 7–9.9 g/dl.
c. Haemoglobin level 10–11.9 g/dl (10–10.9 g/dl for pregnant women).

dren with moderate or severe anaemia born to mothers with moderate anaemia was 46%, whereas for those children born to mothers with mild anaemia, it was 30%. Only 24% percent of children born to non-anaemic mothers suffered from moderate or severe anaemia. This is less than one-third of the rate among children born to mothers who were severely anaemic at the time of the surveys.

TABLE 5. Anaemia among children in Uzbekistan: Percentage of children under three years classified as having anaemia according to background characteristics, Uzbekistan Demographic and Health Survey, 1996

Background characteristic	Percentage of children with:			Children measured	
	Severe anaemia[a]	Moderate anaemia[b]	Mild anaemia[c]	Weighted	Unweighted
Sex					
Male	1.8	27.5	31.8	557	512
Female	0.6	23.7	36.2	549	506
Residence					
Urban	0.9	23.8	32.8	310	400
Rural	1.4	26.3	34.4	795	618
Region					
Aral Sea region	5.2	48.2	27.5	122	251
Central	0.5	17.6	29.6	294	249
East	0.5	25.8	26.9	335	197
Ferghana Valley	1.4	26.9	50.2	307	223
Tashkent City	0.0	7.1	22.4	48	98
Education of mother					
Primary/secondary	1.1	26.8	35.1	709	584
Special education	1.9	23.6	31.4	293	322
Higher	0.4	23.1	33.4	104	112
Ethnicity					
Uzbek	1.0	25.0	34.6	980	840
Other	3.2	30.2	29.3	126	178
Total	1.2	25.6	34.0	1,106	1,018

a. Haemoglobin level < 7 g/dl.
b. Haemoglobin level 7–9.9 g/dl.
c. Haemoglobin level 10–11.9 g/dl (10–10.9 g/dl for pregnant women).

Discussion

Nationally representative anaemia levels among women and children were recently determined in conjunction with the three demographic and health surveys in Kazakstan (1995 Kazakstan survey) [19], Uzbekistan (1996 Uzbekistan survey) [20], and the Kyrgyz Republic (1997 Kyrgyz survey) [21]. Anaemia was assessed by measurement of the haemoglobin level in capillary blood of women aged 15 to 49 years and their children under the age of 3 years using the photometric Hemocue technique. The studies showed that approximately half (49%) of the women in Kazakstan, 60% of the women in Uzbekistan, and 40% of the women in the Kyrgyz Republic had some degree of anaemia. The percentages of children diagnosed as having anaemia in Kazakstan, Uzbekistan, and the Kyrgyz Republic were 69%, 61%, and 50%, respectively. There were some socio-economic, residential, demographic, and ethnic differentials in the prevalence of anaemia in each of these countries.

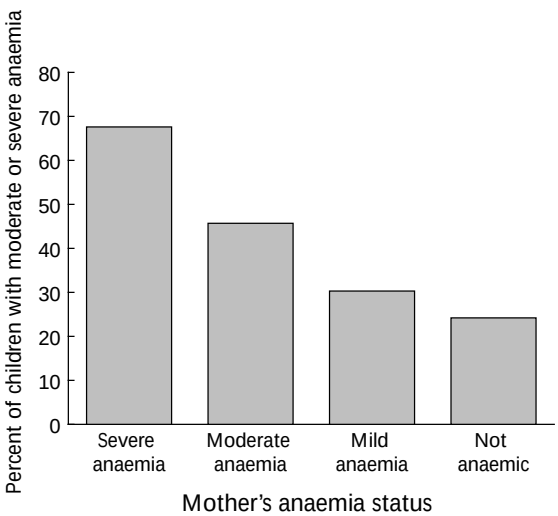

FIG. 3. Percentage of children with moderate or severe anaemia according to anaemia status of their mothers (cumulative data from Kazakstan, Uzbekistan, and the Kyrgyz Republic)

The highest overall rates of anaemia were found in the Aral Sea region of Uzbekistan, which includes the autonomous Republic of Karakalpakstan and Khorezm Oblast: 72% of women and 61% of children were anaemic. This region of Uzbekistan is considered part of the area of the Aral Sea environmental crisis, which is characterized by severe agrochemical pollution, lack of water and food, and a number of other socio-eco-

TABLE 6. Anaemia among children in the Kyrgyz Republic: Percentage of children under three years classified as having anaemia according to background characteristics, Kyrgyz Republic Demographic and Health Survey, 1997

Background characteristic	Percentage of children with:			Children measured	
	Severe anaemia[a]	Moderate anaemia[b]	Mild anaemia[c]	Weighted	Unweighted
Sex					
Male	2.1	28.1	22.9	511	500
Female	0.7	20.5	25.4	510	480
Residence					
Urban	2.2	15.9	20.4	227	244
Rural	1.2	26.7	25.2	793	736
Region					
Bishkek City	0.8	12.7	17.8	69	118
North	2.1	30.0	19.9	284	249
East	3.6	20.0	24.9	69	245
South	0.9	23.4	26.7	599	368
Education of mother					
Primary/secondary	1.2	25.5	24.5	535	499
Special education	1.8	24.0	24.4	359	344
Higher	1.1	19.8	21.8	126	137
Ethnicity					
Kyrgyz	1.4	25.5	26.0	664	709
Russian	0.0	22.5	10.8	45	55
Uzbek	0.9	20.3	24.4	240	151
Other	3.5	27.4	13.8	71	65
Total	1.4	24.3	24.1	1,021	980

a. Haemoglobin level < 7 g/dl.
b. Haemoglobin level 7–9.9 g/dl.
c. Haemoglobin level 10–11.9 g/dl (10–10.9 g/dl for pregnant women).

nomic problems. The rates of anaemia in the western region of Kazakstan, which is also close to the Aral Sea, were 59% among women and 81% among children.

Approximately half of the children in the Aral Sea region of Uzbekistan and the western region of Kazakstan had moderate anaemia. A significant proportion of these children (more than 5%) were severely anaemic. Patients with severe anaemia require medical assistance in clinical settings, whereas moderate anaemia can be treated by public health approaches such as iron-fortification or iron-supplementation programmes.

The high rates of anaemia found by the Demographic and Health Survey study in the Aral Sea areas of Uzbekistan and Kazakstan are in accordance with data from two other recent studies: the 1993 Crosslink study in Muynak District of Uzbekistan [17] and the study done by the London Institute of Tropical Diseases in Kzyl-Orda Oblast of Kazakstan [18]. Both studies showed similarly high rates of anaemia among women and children living in the area of environmental crisis around the Aral Sea.

Although many causes of anaemia have been identified, such as haemoglobinopathies, parasitic infestation, chronic bleeding, and deficiencies of folic acid and vitamin C, there is sufficient evidence to suggest that the majority of cases of anaemia in Kazakstan are due to negative iron balance. A special study conducted in a subsample of 44 women living in Almaty City with haemoglobin levels below 10 g/dl (data not shown) showed that 41 of these women also had low blood levels of ferritin (<12 ng/dl).

Anaemia represents only the severe end of iron deficiency, and the real magnitude of iron deficiency in a population is greater than that reflected by haemoglobin measurement alone. Iron deficiency is caused primarily by the low consumption of foods containing bioavailable iron and promoters of iron absorption, such as animal protein and ascorbic acid. In a series of dietary assessment studies done by the Kazakstan Nutrition Institute during the last decade, an overall decrease in consumption of animal protein, essential vitamins, and microelements by various population groups in Kazakstan has been documented [23]. Deficiencies of iron and other nutrients are especially critical during pregnancy and growth in early childhood.

When iron deficiency is the main cause of anaemia, population groups with a high iron requirement are disproportionately affected and more frequently develop anaemia. Negative iron balance due to an im-

balance of iron requirements versus iron intake often occurs during pregnancy and growth. For this reason, when iron deficiency is highly prevalent in a population, pregnant women, who provide the foetus with a considerable amount of iron, are at greater risk of developing anaemia than non-pregnant women. In Central Asia the prevalence of anaemia among pregnant women is two to three times greater than among non-pregnant and non-lactating women. Our data also showed that the percent distribution of non-pregnant and non-lactating women according to the level of haemoglobin shifted towards the lower concentration of haemoglobin in the blood as compared with the corresponding reference sample population of healthy US women.

Negative iron balance is probably also a major cause of anaemia among young children in Central Asia. The highest rate of anaemia among children in Kazakstan is found among those 12 to 24 months of age, which can be explained by a rapid rate of growth during this period and the relatively low iron content of the diet. This is in accordance with several physiological studies showing that the iron stores are more likely to become depleted between six months and two to three years of age [2, 24–26]. In addition, the relatively low consumption of meat products, a major source of bioavailable iron, plus the Central Asian custom of giving children tea, which inhibits iron absorption, could also lead to the depletion of iron stores and the development of anaemia. For example, according to a supplemental foods assessment done in the Kazakstan, Uzbekistan, and Kyrgyz surveys, tea was given in the 24 hours before the interview to 21%, 49%, and 34% of infants 0 to 3 months of age in Kazakstan, Uzbekistan, and the Kyrgyz Republic, respectively [19–21].

Some demographic predisposing factors increase the likelihood of anaemia in children: being 12 to 23 months of age, a high birth order, and a birth interval of 24 to 47 months (data not presented). Our results also show that having an anaemic mother increases the risk of moderate and severe anaemia among children.

It is unlikely that haemoglobinopathies contribute substantially to the high prevalence of anaemia in these regions. In the study by the Crosslink group, only 0.14% of people in the Muynak District of Karakalpakstan had haemoglobinopathy (thalassaemia was not determined) [17]. Considering common genetic features of people of Kazak and Karakalpak origin, the prevalence of haemoglobinopathies among the Kazaks is also probably low. However, without focused studies of the prevalence of haemoglobinopathies and thalassaemias, it is difficult to exclude their role as aetiologic factors of anaemia in such regions as the Ferghana Valley and Samarkand Oblast of Uzbekistan, as well as the southern region of the Kyrgyz Republic, which is characterized by high ethnic admixture and a historically intensive migration process and therefore a high chance of blood disorders among the population.

The Kazakstan, Uzbekistan, and Kyrgyz surveys, as well as other geographically focused studies, provide an important information base for the development of health intervention programmes to prevent many severe complications of pregnancy and delivery related to iron-deficiency anaemia among women of certain ethnic, educational, and residential groups in these countries. These data are important as a background for public health policy decisions with regard to the iron fortification of food.

Since anaemia represents only the severe end of the iron-deficiency spectrum, it is assumed that the total proportion of iron-deficient persons in the population is greater than that reflected by the prevalence of anaemia detected by haemoglobin measurement alone. It can be assumed that in Central Asia, where the prevalence of anaemia according to haemoglobin measurement is higher than 40% among both women and their children, the real magnitude of iron deficiency is greater, and therefore universal iron fortification or supplementation may be justified. Another solution would be to provide certain population groups, such as pregnant women and young children, with selective supplementation of iron.

Based on the results of Demographic and Health Survey anaemia studies in Kazakstan and Uzbekistan, the UNICEF Area Office for the Central Asian Republics and Kazakstan (UNICEF CARK) proposed an integrated strategy of education, supplementation, fortification, and research to address the problem and called for donors' support. The proposed strategy considered an intervention approach and includes the following elements:

» National and area-wide education and training efforts aimed at affordable and acceptable change in the environments of economic transition;
» Fortification of cereal flour with iron;
» A major expansion for a period of two years of iron supplementation (weekly) to encompass women of reproductive age, pregnant women, and children 6 to 24 months of age;
» Retention of current treatment practices for all persons found to be suffering from severe anaemia;
» A research agenda of key studies and monitoring activities by the Ministries of Health and other institutions, beginning with a study of the effectiveness of weekly supplementation in all groups and action research on channels, messages, and other factors that will be developed as part of the programme.

Acknowledgements

I thank Dr. Jeremiah M. Sullivan for his help in analysis of the anaemia data, Mr. Trevor Croft for assistance with the tabulations, Ms. Thanh Lê for the Kazakstan survey sampling design, and all Kazakstan, Uzbekistan, and Kyrgyz survey field staff for the anaemia testing.

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The Iraqi National Nutrition Survey: Correlation between various anthropometric measurements as indicators of severity of malnutrition

Haifa Tawfeek, Shalan A. Al-Mashikhi, and Amer Salom

Abstract

This study is part of a national nutrition survey conducted in Iraq during 1992 and 1993. Anthropometric measurements were obtained in 3,616 children under five years of age. Of those children, 24% were diagnosed as moderately undernourished and 6% as severely undernourished by mid-upper-arm circumference measurements. According to weight-for-height, only 11% were diagnosed as moderately undernourished and 3% as severely undernourished. The discrepancy between the results of these two measurements can be minimized by establishing a new cut-off level for mid-upper-arm circumference for defining malnutrition in our population.

Introduction

Under the long economic blockade of Iraq, poor nutrition and undernutrition have become most common and severe among infants and young children [1–3]. Many anthropometric measurements are used to evaluate the nutritional status of a population [4, 5]. The most commonly used measurements to assess the severity of undernutrition are weight-for-age, height-for-age, and weight-for-height [6, 7].

Mid-upper-arm circumference (MUAC) has been shown to be correlated closely with clinical and other anthropometric indicators of nutritional status [8, 9].

Materials and methods

This study was part of a countrywide nutrition survey conducted during 1992 and 1993. It focused on comparison of various anthropometric measurements as indicators of severity of undernutrition. Details of the research design have been described elsewhere [10]. The subjects were children under five years of age attending the maternal and child health centres for preventive care or for routine immunization. The centres are part of the governmental health-care system where, among other services, immunization and some medicines are provided free. Each centre was visited on a different day, and all children attending on that day were included in the study. The survey involved 3,616 children (1,883 boys and 1,733 girls) of varying socioeconomic status.

In 1991 Iraq had a total population of over 18 million people, 8.5 million of whom were under five years of age. Approximately 70% of the people live in cities and the other 30% in rural areas [11]. Eleven of the 18 Iraqi governorates were chosen for the study: Baghdad, Mousel, Basrah, Dialah, Al-Anbar, Wasit, Babil, Kerbala, Al-Quidisia, Theqar, and Al-Aumara. The other seven were excluded because of transportation difficulties and low population density.

Information on the infants was obtained by detailed interviews with the mothers. Age was determined to the nearest month from the birth certificate. Supine length was measured on a special board to the nearest millimetre for children up to 24 months of age. For those 24 months or more of age, standing height (without shoes) was measured to the nearest millimetre on a portable measuring board or using a tape secured to a wall or flat surface. Weight (in light clothing) was measured to the nearest 100 g, using a baby balance scale for infants and a Salter hanging scale for older children. MUAC was measured with insertion-style arm tapes at the midpoint of the child's left upper arm [12] according to the recommendations of the Committee on Nutrition Advisory to the Centers for Disease Control [13].

The scales were calibrated daily, and the standardization was rechecked at the completion of the fieldwork. The interviews with the mothers and the anthropometric measurements were carried out by a physician and a nutritionist under the supervision of the authors

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to assure consistency in the data. The anthropometric indices used to identify malnutrition were weight-for-age, weight-for-height, and height-for-age Z scores. Each anthropometric index was categorized as mild (–1 to –2 SD), moderate (–2 to –3 SD), or severe (< –3 SD) [14]. The cut-off points used to identify undernourished children were < 13.5 and < 12.5 cm for moderate and severe malnutrition, respectively [9].

The significance of the comparison was assessed by Student's *t* test, and associations between measurements were evaluated by correlation analyses.

Results

The correlation coefficients between different anthropometric measurements are shown in table 1. There was a highly significant correlation of about +0.88 between weight and height ($p < .001$). Weight and MUAC were positively correlated ($r = .61$; $p < .05$).

Table 2 shows the discrepancies between assessments based on weight-for-height and those based on MUAC for moderate and severe malnutrition. Only 11% of the pre-school children were below 2 SD of standard weight-for-height, but 24% had MUAC less than 13.5 cm. Of the children with MUAC less than 12.5 cm (6%), only 3% were below 3 SD of weight-for-height.

Figure 1 shows the prevalence of malnutrition in the children based on two different indicators. MUAC identified a higher percentage of moderately or severely undernourished children among one- to three-year-olds than among three- to five-year-olds.

Discussion

Weight-for-height and MUAC are two commonly used methods for assessing undernutrition in children under five years of age. Shakir has reported that 90% of the children in Baghdad whose arm circumference was less than 75% of the standard also had body weights less than 60% of the Harvard standard [7].

We, however, found a disagreement between estimates of undernutrition based on weight-for-height and those based on MUAC. A limit of 13.5 cm was suggested by Shakir and Morley [9] for identifying children with mild to severe malnutrition. In our population, the 13.5-cm cut-off point was too low to detect mild undernutrition as judged by weight-for-height.

The discrepancies between < 2 SD weight-for-height and < 13.5 cm MUAC values were evident because fewer children had weights less than 2 SD of their height, i.e., estimates of undernutrition based on MUAC measurements were greater than those based on weight-for-height. The same problem was faced by Ritmeijer in Myanmar. Reducing the MUAC cut-off to 13.0 cm improved the positive predictive value for weight-for-height < 75%, but it still remained poor [15]. The results of a study in Indonesia suggest that a single cut-off point of MUAC 13.5 cm cannot be used for screening all children under five years of age for moderate malnutrition, but the cut-off point should be elevated with increasing age of the children [16]. Our important differences were more evident in the age-specific groups. The disagreement was higher in one- to three-year-old children than in three- to five-year-olds. A recent World Health Organization Expert Committee concluded that

TABLE 1. Correlation between different anthropometric measurements for Iraqi pre-school children

Indicator	Wt/age	Ht/age	Wt/ht	Ht	Wt	MUAC
Wt/age	1					
Ht/age	0.72	1				
Wt/ht	0.79	0.81	1			
Ht	0.73	0.82	0.81*	1		
Wt	0.8	0.73	0.78	0.88**	1	
MUAC	0.58	0.42	0.60*	0.41	0.61	1

*$p < .05$; **$p < .001$.

TABLE 2. Comparison of weight-for-height and mid-upper-arm circumference as indicators of malnutrition

Indicator	Moderate malnutrition	Severe malnutrition
Wt/ht	< 2 SD N = 390 Cut-off 11%	< 3 SD N = 90 Cut-off 3%*
MUAC	< 13.5 cm N = 858 Cut-off 24%	< 12.5 cm N = 232 Cut-off 6%**

*$p < .05$; **$p < .001$.

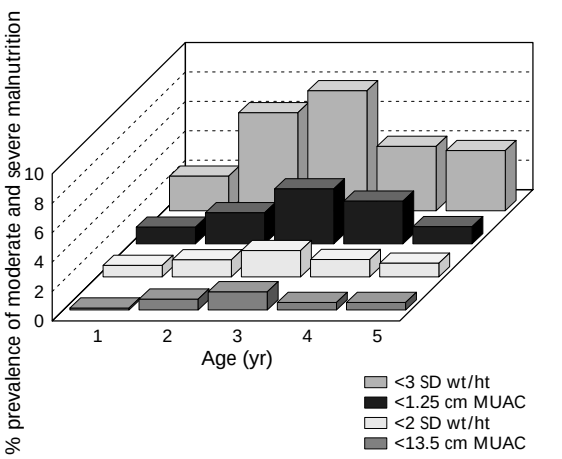

FIG. 1. Age-specific prevalence of moderate and severe malnutrition in Iraqi children based on two different nutritional status indicators

the pattern of mid-upper-arm growth is not age independent [17] and that the proper interpretation of MUAC requires the use of MUAC-for-age references for children aged 6 to 60 months [18]. Our data confirm that MUAC is not an effective indicator for wasting in our population unless new cut-offs are applied.

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Concurrent prevalence of chronic energy deficiency and obesity among women in Purworejo, Central Java, Indonesia

Detty Siti Nurdiati, Mohammad Hakimi, Abdul Wahab, and Anna Winkvist

Abstract

There are few studies on the nutritional status of non-pregnant women. A population-based, cross-sectional study of nutritional status in 5,817 non-pregnant women 15 to 49 years of age was conducted in Purworejo District, Indonesia, in 1996. Weight, height, mid-upper-arm circumference (MUAC), and triceps skinfold thickness were measured, and information on socio-economic, demographic, and reproductive factors was collected. Seventeen percent of the women had chronic energy deficiency and 11% were obese. Mean weight, MUAC, and triceps skinfold thickness corresponded to the 25th percentile of standards and mean height to the 5th percentile. Obesity was more common among older women and chronic energy deficiency among both the oldest and the youngest women. Women working in agriculture, not using contraceptives, and not owning a television, radio, or refrigerator were more likely to have chronic energy deficiency. In summary, both chronic energy deficiency and obesity existed in Purworejo, and risk factors were identified. Interventions are needed to improve the nutritional status of girls and women before and after pregnancy.

Introduction

The Safe Motherhood Initiative is a global effort to reduce maternal mortality and morbidity, particularly in the developing world. In 1994 it was noted that Indonesia had the highest maternal mortality among the ASEAN countries: 390 per 100,000 live births, with an inter-provincial variation of 130 to 750 [1]. In rural Java, maternal mortality ranged from 360 to 570. Recognizing the need for urgent measures, the Indonesian government set the target of reducing maternal mortality from 390 per 100,000 to 225 per 100,000 in its Sixth Five-Year Development Plan for 1994–1999 ("Repelita VI"). Factors shown to contribute to the high rate of maternal mortality were limited accessibility, efficiency, and coverage of health care during pregnancy and childbirth; poor nutritional status of the women; poor availability and use of family-planning services, especially among high-risk mothers; women's heavy workload; and traditional beliefs relating to women's status and fertility [2]. Thus, efforts to reduce maternal mortality ultimately need to address all of these factors.

Maternal nutritional status is important for a host of reasons—for the woman herself, for her capacity to reproduce, and for the development of her children, with implications for the health and reproductive capacity of the next generation's mothers. However, for decades, issues in women's nutrition have centred on nutrition during pregnancy and lactation. Much of the concern has thus been for the newborn's health and well-being [3–11]. The nutritional issues of women themselves have rarely been investigated. In earlier nutritional research, only a few publications made women's own health the main objective, and not many nutritional data are available from non-pregnant women. As a result, insufficient attention has been paid to the extent, causes, and consequences of malnutrition among women. The result has been inadequate resources, both public and private, allotted to the improvement of women's nutrition for their own sake [12].

Only recently has attention been paid to the link between women's own nutritional and health status and their multiple roles in family and society. Several reviews have emphasized the vulnerability of women throughout their life cycle [12–14]. The biologic and socio-economic differences between women and men sometimes place women at higher risk for malnutri-

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tion and mortality. In some countries, girls are treated differently in terms of access to health care, food, and education. Also, girls are at risk for early pregnancy, which may affect their own prepubertal growth. Women of reproductive age are subject to numerous stresses affecting their health and well-being. Finally, elderly women in many societies are deprived [15].

The objectives of this research were to estimate the nutritional status as reflected by anthropometry and to explore the associations between demographic and socio-economic factors and nutritional status among non-pregnant women of reproductive age in Central Java, Indonesia.

Subjects and methods

The research was conducted in Purworejo District, Central Java, which consists of 16 sub-districts and 494 villages with a total population of 729,825. The total area of Purworejo is 1,035 km^2, including both lowlands and mountains. The infant mortality rate has declined over the past five years, and the current estimate is 52 per 1,000 live births. The total fertility rate is 3.13 per woman.

The study took advantage of a large surveillance programme that was initiated in Purworejo District in June 1994 by the Community Health and Nutrition Research Laboratory, Gadjah Mada University, Yogyakarta. A 10% sample of the total population was monitored here, i.e., approximately 14,500 households. A two-stage cluster sampling method with probability proportional to the estimated size of the cluster was used to select households representative of the district. The sampling frame for the first stage consisted of a 20% sample of the Central Bureau of Statistics enumeration areas used in the 1990 census. The frame for the second stage was the household listings of each enumeration area prepared for the 1993 Agricultural Census, from which an equal sample of households was systematically sampled [16].

Through this surveillance system, we had access to an updated list of women of reproductive age (15–49 years) consisting of 13,094 women. For cultural reasons, only married women defined as at risk of becoming pregnant (i.e., not currently pregnant or sterilized) were invited to participate. Women from this sample who later become pregnant were enrolled in a pregnancy study for which the measurements described in this article represent the baseline measures. Pregnancy was identified by the woman's own report (last menstrual period). In case the pregnancy was not later diagnosed by the midwives (by fundal palpation), the fieldworkers carried out a β-human chorionic gonadotropin test for pregnancy. Only 15 women originally defined as non-pregnant at the time of measurement were later found to have been pregnant; these were removed from the analyses. Individual written informed consent was obtained. Ethical approval was provided by the research ethics committees of the Medical Faculty of Gadjah Mada University and Umeå University.

Measurements

The cross-sectional study of nutritional status among non-pregnant women took place between January and March 1996. Eligible women were invited to undergo anthropometric measurements at the health post in each village. Training and standardization in anthropometric measurements, consisting of weight, height, mid-upper-arm circumference (MUAC), and triceps skinfold thickness, were carried out in December 1995. Weights were measured within 0.1 kg with calibrated electronic scales (Seca Model 835, CMS, London) with clothes as light as possible. A portable stadiometer kit (CMS) was used to measure body height with an accuracy of 0.1 cm. MUAC was measured on the left arm to the nearest centimetre with the insertion-type arm circumference tapes obtained from UNICEF. The Harpenden skinfold caliper (CMS) was used for the skinfold thickness measurements, with an accuracy of 0.1 mm. As reference, the female Canadian standard for weight and height [17] and the US National Health and Nutrition Examination Survey (NHANES) standard for MUAC and triceps skinfold thickness [18] were used.

Women were classified as chronically energy deficient or obese as described by James et al. [19] and the World Health Organization [20]. Chronic energy deficiency grades I, II, and III correspond to body mass index (BMI) 17.0–18.4, 16.0–16.9, and <16.0, respectively. Women with BMI 18.5–24.9 were classified as normal. Finally, obesity grades I, II, and III correspond to BMI 25.0–29.9, 30.0–39.9, and ≥ 40, respectively.

Socio-economic and demographic information for the women were retrieved from the surveillance data collected between August and October 1995. These were categorized in close agreement with the Indonesian Demographic and Health Survey categorization scheme [1]. A system of quality control of the information collected was instituted in order to ensure good validity of data.

Data analyses

Women were excluded from the analyses if their anthropometric data were incomplete or seemed to be affected by measurement errors. In those cases where only one of the indicators of nutritional status was below the 5th or above the 95th percentile, while others were closer to the median, this was classified as measurement or recording error and the subject was excluded.

Data analyses were performed with the Statistical Package for Social Science (SPSS version 7.1, 1997). The chi-square and *t* tests were used to compare the nutritional status and background factors of the selected

TABLE 1. Mid-upper-arm circumference (MUAC) and background variables for the different subsamples of women

Background variable	At risk of pregnancy (n = 8,154)			Not at risk of pregnancy (n = 4,940)	Total (n = 13,094)
	Attended measurement sessions (n = 5,880)		Did not attend measurement sessions (n = 2,274)		
	Data complete (n = 5,817)	Data incomplete (n = 63)			
MUAC (cm)—mean ± SD[a]	25.8 ± 2.9	27.4 ± 4.9	25.3 ± 3.0	23.7 ± 2.5	24.8 ± 2.8
Age (yr)—mean ± SD	34.9 ± 7.3	36.4 ± 6.3	35.3 ± 7.9	22.6 ± 7.9	30.4 ± 9.74
Marital status (%)					
Unmarried	0[b]	0	0.1	65.5	24.7
Married	94.3	95.2	91.1	32.7	70.5
Divorced	1.5	1.6	2.8	0.6	1.4
Widowed	3.3	1.6	4.6	0.7	2.6
Separated	0.9	1.6	1.5	0.4	0.8
Parity (%)					
0	3.2[b]	3.2	6.9	73.4	30.3
1–2	40.1	33.3	39.6	16.9	31.2
3–4	37.2	39.7	34.3	7.1	25.3
≥5	19.4	23.8	19.3	2.7	13.1
Contraceptive use (%)					
Yes	57.0[b]	61.9	48.2	4.7	35.7
No	36.7	31.7	40.3	70.5	50.1
No data	6.4	6.3	11.4	24.8	14.2
Residence (%)					
Rural	91.9[b]	88.9	79.9	81.6	85.9
Urban	8.1	11.1	20.1	18.4	14.1
Years of education (%)					
0	7.2[b]	7.9	7.8	4.2	6.2
1–6	69.9	65.1	57.4	32.8	53.7
7–9	13.1	17.5	14.0	27.4	18.7
≥10	9.7	9.5	20.8	35.6	21.4
Occupation (%)					
Unemployed or housewife	24.8[b]	30.2	26.8	67.2	41.2
Agricultural	55.3	49.2	40.2	17.7	38.5
Non-agricultural	19.9	20.6	33.0	15.1	20.4

a. Sample sizes: n = 5,817, 59, 2,104, 3,793, and 11,633, respectively.
b. Significant difference among subsamples (attended vs. did not attend); $p < .001$, chi-squared test.

sample with those for all women in the surveillance area. Univariate logistic regressions were used to examine the relationships between nutritional status and other individual characteristics. Variables significant in the univariate logistic regressions were included in multivariate logistic regressions, where possible associated factors were evaluated simultaneously. The logistic regression analyses were constructed with chronic energy deficiency and obesity as dichotomous variables (all chronic energy deficiency categories vs. normal, extreme chronic energy deficiency vs. normal, all obesity categories vs. normal, and extreme obesity vs. normal). Interactions among independent variables likely to show joint effects were evaluated by the construction of a new variable that expressed the combined effect of both. Only significant variables were kept in the final multivariate models (confidence interval not including 1).

Results

Representativeness of the study sample

All 8,154 married women defined as at risk of becoming pregnant were invited to the measurement sessions (fig. 1). Among 4,940 women defined as not at risk of becoming pregnant, 554 women had already become

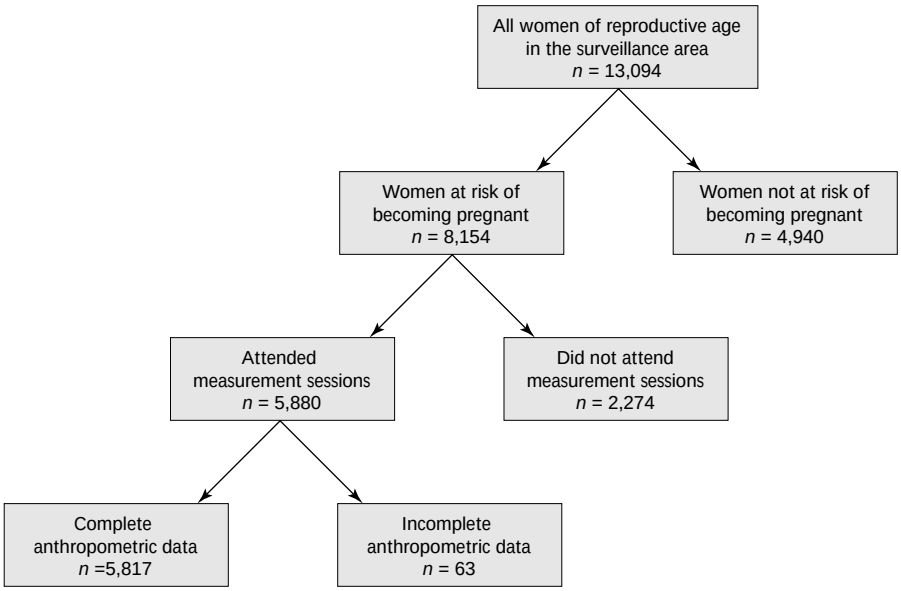

FIG. 1. Sample selection for nutritional analyses

pregnant. Of those invited to participate, 2,274 (28%) did not participate, 282 because they were not at home and the remainder for unknown reasons. Thus, 72% of the women at risk of becoming pregnant attended the measurement sessions. Measurements on 63 women were incomplete or affected by measurement errors. Hence, 5,817 (71%) of the eligible women were included in these analyses, of whom 567 (10%) were breastfeeding.

Because of the selection process, women not at risk of becoming pregnant were different in several ways from women at risk of becoming pregnant. Women in the former group were younger, were more likely to be unmarried, had fewer children, and were more educated, albeit still unemployed. To evaluate possible selection bias, nutritional status and background characteristics were compared for those who attended and those who did not attend the measurement sessions. Among those attending, the group with incomplete data was small (63 women) and was therefore combined with the group with complete data for statistical testing. MUAC had been measured on all 13,094 women between August and October 1995 and therefore could be used for comparative purposes.

The mean MUAC was not significantly different between those who did and did not attend the measurement sessions (t test, $p = .14$). However, there were significant differences between these two groups in most background factors ($p < .001$). The women attending were somewhat less educated and more likely to use contraceptives, live in rural areas, and work in agriculture. However, the difference between the two groups in mean age was barely significant ($p = .05$).

Nutritional status among women in the study sample

The mean anthropometric values for the 5,817 women in the sample were 47.8 ± 7.9 kg weight, 149.1 ± 5.1 cm height, 25.8 ± 2.9 cm MUAC, 15.0 ± 6.3 mm triceps skinfold thickness, and 21.2 ± 3.1 BMI.

A comparison of the nutritional status of the women with reference data indicated that overall, 37% were below the 5th percentile for weight and 49% were below the 5th percentile for height. In total, 22% were below the 5th percentile for MUAC and 30% were below the 5th percentile for triceps skinfold thickness. The proportion of women falling below the 5th percentiles was significantly different among the different age strata ($p < .001$). The proportion was lowest for women in the middle of the age range for all four indicators (fig. 2).

The total prevalence of chronic energy deficiency among the women was 17% and the total prevalence of obesity was 11%. Further, chronic energy deficiency grades III, II, I, normal, obese I, and obese II were found among 1.2%, 3.0%, 12.8%, 71.7%, 10.0%, and 1.4% of the women, respectively. Obesity was most common among older women, and chronic energy deficiency was most common among the youngest and the oldest (fig. 3).

Relationship between nutritional status and background factors

Chronic energy deficiency

In univariate logistic regression analyses with normal versus chronic energy deficiency grades I, II, and III as binary dependent variables, chronic energy deficiency

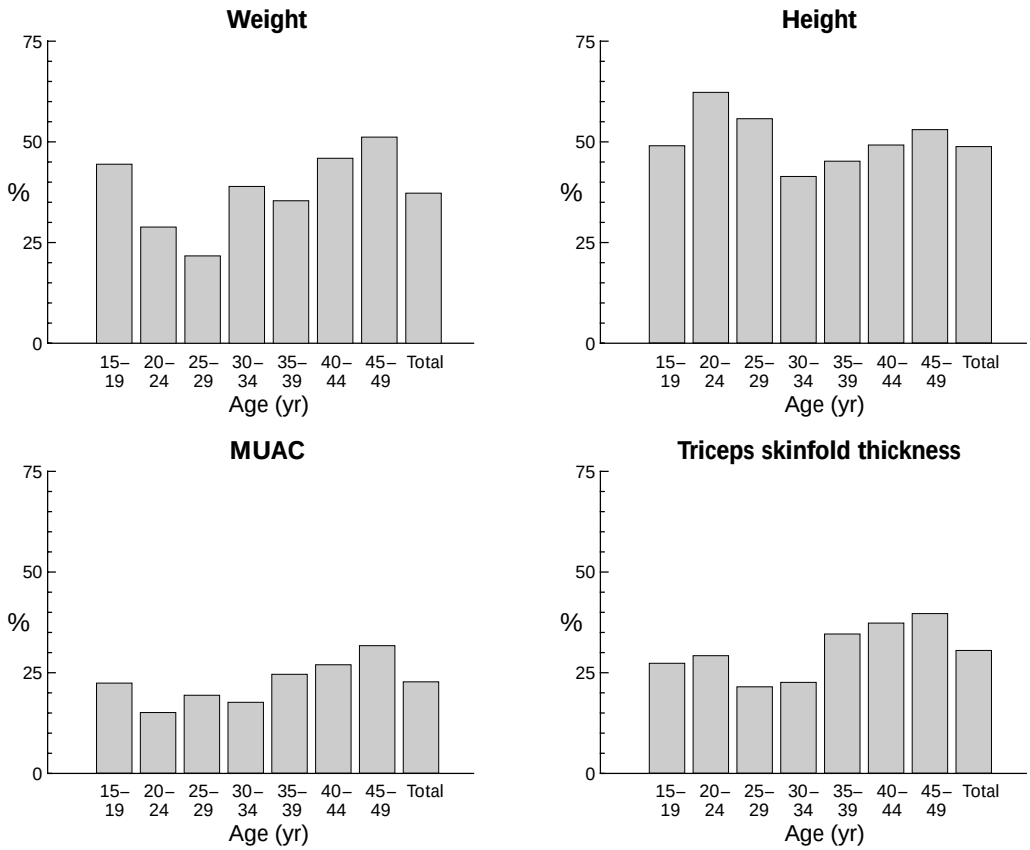

FIG. 2. Percentage of women under the fifth percentiles of weight, height, MUAC, and triceps skinfold measurements according to age group

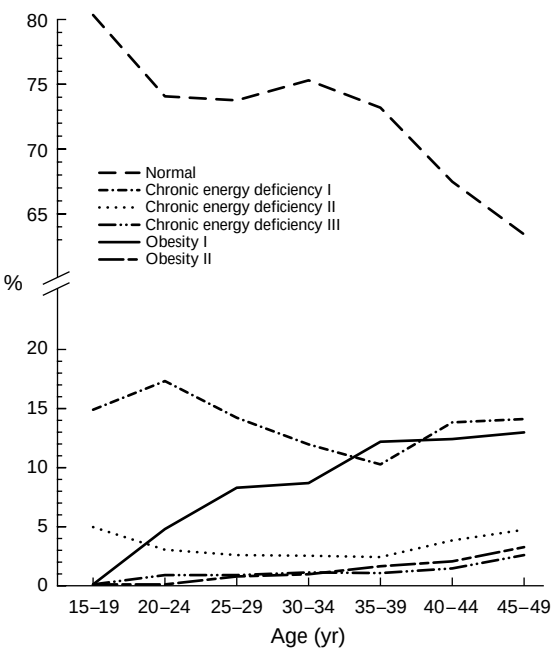

FIG. 3. Distribution of chronic energy deficiency and obesity according to age group

was less common among women in the middle range of age (table 2). Chronic energy deficiency was more prevalent among women who worked in agriculture or at home. Women who did not provide any data on the use of contraceptives were more likely to have chronic energy deficiency. Women who did not own a radio, television set, or refrigerator were also more likely to have chronic energy deficiency. However, chronic energy deficiency was less likely among women who did not own a bicycle and among women who had good water supplies.

The association between occupation and chronic energy deficiency remained significant after adjustment for other factors, and so did the association between chronic energy deficiency and the use of contraceptive methods. Women who worked in agriculture or at home had a 28% to 38% higher risk of chronic energy deficiency than non-agricultural workers. Women who did not answer questions about the use of contraceptive methods had almost twice the risk of chronic energy deficiency as women who used contraceptives. Not owning a television set or a radio was associated with chronic energy deficiency.

When normal and extreme chronic energy deficiency

TABLE 2. Relationship between background variables and chronic energy deficiency: Odds ratios (OR) and 95% confidence intervals (CI) are given for the risk of having chronic energy deficiency I, II, and III versus being normal according to logistic regression analysis ($n = 5{,}817$)

Background variable	n	Univariate analysis		Multivariate analysis[a]	
		OR	95% CI	OR	95% CI
Age (yr)					
45–49	567	1.00		1.00	
40–44	895	0.84	0.66–1.08	1.00	0.77–1.31
35–39	1,174	0.55	0.44–0.72	0.67	0.52–0.88
30–34	1,177	0.62	0.49–0.80	0.78	0.60–1.02
25–29	828	0.72	0.56–0.93	0.89	0.67–1.18
15–24	486	0.85	0.64–1.13	1.05	0.77–1.43
Contraceptive use					
Yes	2,871	1.00		1.00	
No	1,921	1.35	1.16–1.56	1.30	1.12–1.51
No data	335	2.25	1.75–2.89	1.94	1.46–2.57
Occupation					
Non-agricultural	934	1.00		1.00	
Unemployed or housewife	1,233	1.44	1.15–1.80	1.37	1.08–1.73
Agricultural	2,960	1.40	1.14–1.71	1.25	1.01–1.54
Water supply					
Private or public tap	141	1.00			
Private or public pump or well	3,467	1.72	1.04–2.85		
Spring, river, rain, or other	1,519	1.44	0.86–2.40		
Radio ownership					
Yes	4,341	1.00		1.00	
No	786	1.28	1.06–1.54	1.23	1.02–1.49
Television ownership					
Yes	1,664	1.00		1.00	
No	3,463	1.35	1.16–1.58	1.33	1.12–1.57
Refrigerator ownership					
Yes	81	1.00			
No	5,046	2.17	1.04–4.51		
Bicycle ownership					
Yes	3,831	1.00		1.00	
No	1,296	0.77	0.65–0.91	0.66	0.56–0.79

a. All six variables are included, likelihood ratio statistic on 4902.497, df = 12, $p < .001$.

(grade III) were compared in univariate analyses, not using contraceptives and not owning a television remained significant risk factors (table 3). Chronic energy deficiency grade III was less common among women who lived in hilly and highland areas. Finally, chronic energy deficiency III was more common among women who lived in houses with wooden floors. In multivariate analyses, all these variables remained significant.

None of the combined variables (interactions) were significantly associated with the risk of chronic energy deficiency grades I, II, and III or only chronic energy deficiency grade III.

Obesity

Obesity grades I and II was least common among young women according to both univariate and multivariate analyses (table 4). Women with high parity, those who used contraceptives, and those who were more educated were more likely to be obese, as were women who lived in urban and lowland areas. However, women who worked in agriculture were the least likely to be obese. Obesity was more common among women who had better sanitation, as indicated by good water sources, tile floors, and latrine facilities in their homes, and who owned a television set, bicycle, or motorcycle. However, the associations between obesity and parity, education, urban or rural residence, altitude, type of floor, type of latrine, and refrigerator ownership became nonsignificant in multivariate analyses.

Older age, high parity, non-agricultural work, and having electricity, a television set, a refrigerator, and a motorcycle were also significant risk factors for extreme

TABLE 3. Relationship between background variables and chronic energy deficiency: Odds ratios (OR) and 95% confidence intervals (CI) are given for the risk of having chronic energy deficiency III versus being normal according to logistic regression analysis ($n = 5,817$)

Background variable	n	Univariate analysis		Multivariate analysis[a]	
		OR	95% CI	OR	95% CI
Age (yr)					
45–49	433	1.00			
40–44	715	0.53	0.26–1.10		
35–39	1,007	0.38	0.18–0.78		
30–34	990	0.38	0.49–0.79		
25–29	677	0.32	0.13–0.75		
15–24	383	0.28	0.09–0.84		
Contraceptive use					
Yes	2,420	1.00		1.00	
No	1,552	2.21	1.32–3.71	2.33	1.37–3.97
No data	243	4.12	1.95–8.68	4.40	2.06–9.40
Education (yr)					
≥ 7	320	1.00			
1–6	2,981	1.54	0.78–3.05		
None	914	2.90	1.19–7.03		
Altitude					
Lowland	892	1.00		1.00	
Coastal	1,958	0.65	0.39–1.11	0.57	0.33–0.99
Hills or highland	1,365	0.29	0.14–0.60	0.27	0.13–0.57
Type of floor					
Ceramic or tile	2,230	1.00		1.00	
Wood	17	7.49	1.66–33.87	6.24	1.33–29.39
Soil	1,968	0.81	0.50–1.32	0.68	0.39–1.19
Television ownership					
Yes	1,411	1.00		1.00	
No	2,804	1.83	1.03–3.25	2.21	1.19–4.12

a. All four variables are included, likelihood ratio statistic on 661.889, df = 7, $p < .001$.

obesity (grade II)(table 5). Women who lived in hilly or highland areas and those whose homes had bare earth floors, poor water supplies, and no latrine facilities were less likely to be classified as having obesity grade II. Multivariate analyses that included age, occupation, altitude, type of floor, and motorcycle ownership as independent variables indicated that all five were significantly associated with the risk of obesity grade II.

None of the combined variables (interactions) were significantly associated with the risk of being classified into obesity grades I and II or grade II alone.

Discussion

The coverage of women at risk of becoming pregnant was 72%. Because some of the background factors differed between those attending and those not attending the measurement sessions, extrapolation of our results should be done with some caution. Relatively fewer highly educated women in the city were represented. For cultural reasons, only married women were available to the study. However, most women in Purworejo are Moslem, and practically all women who become pregnant are married. Nevertheless, information on unmarried women would have been desirable. Most importantly, the mean MUAC did not differ between those attending and those not attending the measurement sessions, indicating that we did not have a selection bias as to anthropometry on our study. Thus, overall the study was performed on a large, population-based sample where representativeness was evaluated and deemed appropriate.

The mean weight of the women in Purworejo was 47.8 ± 7.9 kg. This was higher than the mean weight obtained in previous studies in Indonesia in East Java (data collected in 1982–1985 and 1987–1989) and West Java (data collected in 1991–1992), which were 42 and 46 kg, respectively [21, 22]. This could be due to improved economic conditions in Purworejo District. On the other hand, the mean height of the Purworejo women was slightly lower: 149.1 ± 5.1 cm, as compared

TABLE 4. Relationship between background variables and obesity: Odds ratios (OR) and 95% confidence intervals (CI) are given for the risk of having obesity I and II versus being normal according to logistic regression analysis ($n = 5{,}817$)

		Univariate analysis		Multivariate analysis[a]	
Background variable	*n*	OR	95% CI	OR	95% CI
Age (yr)					
45–49	533	1.00		1.00	
40–44	848	0.84	0.64–1.11	0.74	0.55–1.00
35–39	1,174	0.74	0.57–0.96	0.60	0.45–0.80
30–34	1,100	0.50	0.38–0.67	0.40	0.29–0.55
25–29	750	0.48	0.35–0.66	0.42	0.30–0.59
15–24	400	0.22	0.14–0.36	0.22	0.13–0.36
Parity					
0–2	2,077	1.00			
3–4	1,792	1.14	0.94–1.37		
≥ 5	936	1.43	1.16–1.78		
Contraceptive use					
Yes	2,822	1.00		1.00	
No	1,718	0.75	0.63–0.89	0.82	0.68–0.99
No data	936	0.80	0.54–1.16	0.63	0.41–0.96
Education (yr)					
≥ 7	332	1.00			
1–6	3,359	0.63	0.53–0.75		
None	1,114	0.30	0.19–0.48		
Occupation					
Non-agricultural	1,010	1.00		1.00	
Unemployed or housewife	1,187	0.77	0.62–0.95	0.90	0.72–1.13
Agricultural	2,608	0.37	0.30–0.45	0.52	0.41–0.65
Residence					
Urban	412	1.00			
Rural	4,393	0.35	0.28–0.44		
Altitude					
Lowland	1,064	1.00			
Coastal	2,254	0.75	0.62–0.91		
Hills or highland	1,487	0.43	0.34–0.55		
Water supply					
Private or public tap	191	1.00		1.00	
Private or public pump or well	3,265	0.32	0.24–0.44	0.43	0.31–0.60
Spring, river, rain, or other	1,349	0.14	0.09–0.19	0.28	0.19–0.42
Type of floor					
Ceramic or tile	2,671	1.00			
Wood	18	0.91	0.26–3.17		
Soil	2,116	0.41	0.12–0.50		
Type of latrine					
Private septic tank	1,350	1.00			
Private, no septic tank	426	0.69	0.52–0.93		
Shared or public toilet	282	0.49	0.33–0.73		
River, pond, or yard	2,747	0.44	0.37–0.53		
Electricity					
Yes	3,066	1.00			
No	1739	0.46	0.38–0.55		
Television ownership					
Yes	1,751	1.00		1.00	
No	3,054	0.43	0.37–0.51	0.80	0.65–0.97

continued on next page

TABLE 4. Relationship between background variables and obesity: Odds ratios (OR) and 95% confidence intervals (CI) are given for the risk of having obesity I and II versus being normal according to logistic regression analysis ($n = 5{,}817$)

Background variable	n	Univariate analysis		Multivariate analysis[a]	
		OR	95% CI	OR	95% CI
Refrigerator ownership					
Yes	115	1.00			
No	4,690	0.26	0.18–0.39		
Bicycle ownership					
Yes	3,629	1.00		1.00	
No	1,176	0.45	0.36–0.57	0.70	0.53–0.91
Motorcycle ownership					
Yes	654	1.00		1.00	
No	4,151	0.38	0.31–0.46	0.67	0.54–0.85

a. All seven variables are included, likelihood ratio statistic on 3534.321, df = 14, $p < .001$.

with 150 cm in East Java [21] and 152 cm in West Java [22]. Several major achievements in Indonesian national development took place during the 1980s and 1990s: economic growth, self-sufficiency in food, a sharp decline in infant mortality, a reduction in population growth, and a significant reduction in the number of the poor. The breakdown by province of these achievements, particularly economic growth, also showed a similar pattern to the national figure [23]. These developments might have positively influenced the current nutritional status of the women, whereas their relatively short stature may reflect poorer conditions in their childhood. Environmental and socio-economic factors influence childhood growth in height and weight more than genetic factors [24]. Comparison of our sample with other Indonesian or foreign studies should be made with caution, because we have selected only women at risk of becoming pregnant, whereas other studies may include pregnant as well as non-pregnant women.

The mean BMI was 21.2 ± 3.1. However, the interpretation of BMI should be based on practical BMI cut-offs [25], since the prevalence of thinness and overweight varies widely from country to country. Still, the mean BMI of the Indonesian women was higher than the average BMI of women of reproductive age in Ethiopia (18.5 ± 1.8) and India (18.0 ± 2.1), and slightly lower than that for Zimbabwian (22.0 ± 3.3) and Thai (21.4 ± 2.5) women [26, 27]. When the data from Purworejo women were compared with standards for chronic energy deficiency, most women were classified as normal (71.7%). However, when the sample was compared with the Canadian standards for weight of women 15 to 49 years old [17], the mean weight was below the 25th percentile. Further, when the sample was compared with the Canadian standards for height, the mean height was below the 5th percentile. Thus, the relatively normal BMI of these women may be a reflection of a large height deficit masking any weight deficit, again, as the result of poorer conditions earlier in life.

For adult women over 15 years old, the MUAC cut-off commonly used for indicating risk is 22.5 cm. The mean MUAC for the study sample was 25.8 ± 2.9 cm, which was higher than this cut-off point, although still only in the 25th percentile of the NHANES standards. The mean triceps skinfold thickness was 15.0 ± 6.3 mm, which lies in the 25th percentile of the NHANES standards [18].

We have shown that 17% of the Purworejo women had chronic energy deficiency, with 1.2%, 3.0%, and 12.8% having chronic energy deficiency grades I, II, and III, respectively. Thus, the prevalence of chronic energy deficiency was lower than that in East Java (41%) and also lower than that in other developing countries such as India (61%) and Ethiopia (57%). Still, it is higher than that in Zimbabwe (11%) and Thailand (11.6%) [21, 26, 27]. The percentage of obesity among Purworejo women was 11.4%, much higher than the less than 1% obesity among Indian and Ethiopian women but lower than the 13.6% obesity among Thai women. Obesity among women is associated with increased risk of non-insulin-dependent diabetes mellitus, coronary heart disease, stroke, hypertension, gall bladder disease, menstrual irregularities, and cancers of the breast, cervix, endometrium, ovary, and gall bladder [28]. Obesity affects many women in Western countries; 35% of adult women in the United States are obese. It is more common among women of lower socio-economic status in Western countries, whereas in developing countries the opposite is true. As there is an increasing trend in cardiovascular disease in Indonesia [29], further increase of obesity among women should be prevented.

Both chronic energy deficiency and obesity were more prevalent among older women, and chronic energy deficiency was also common among the youngest women. Even though the distribution of chronic en-

TABLE 5. Relationship between background variables and obesity: Odds ratios (OR) and 95% confidence intervals (CI) are given for the risk of having obesity II versus being normal according to logistic regression analysis (n = 5,817)

Background variable	n	Univariate analysis		Multivariate analysis[a]	
		OR	95% CI	OR	95% CI
Age (yr)					
45–49	447	1.00		1.00	
40–44	721	0.58	0.31–1.08	0.51	0.27–0.98
35–39	1,013	0.41	0.22–0.76	0.35	0.18–0.67
30–34	989	0.25	0.12–0.51	0.20	0.09–0.41
25–29	675	0.18	0.07–0.45	0.15	0.06–0.38
15–24	380	0.05	0.01–0.40	0.05	0.01–0.37
Parity					
0–2	1,848	1.00			
3–4	1,573	1.22	0.72–2.08		
≥ 5	804	2.17	1.25–3.77		
Occupation					
Non-agricultural	824	1.00		1.00	
Unemployed or housewife	1,015	0.89	0.54–1.48	1.13	0.67–1.91
Agricultural	2,386	0.19	0.10–0.35	0.26	0.14–0.50
Residence					
Urban	314	1.00			
Rural	3,911	0.25	0.14–0.42		
Altitude					
Lowland	899	1.00		1.00	
Coastal	1,960	0.52	0.32–0.85	0.56	0.34–0.93
Hills or highland	1,366	0.27	0.14–0.51	0.49	0.24–1.00
Water supply					
Private or public tap	127	1.00			
Private or public pump or well	2,835	0.74	0.27–2.07		
Spring, river, rain, or other	1,263	0.20	0.06–0.66		
Type of floor					
Ceramic or tile	2,256	1.00		1.00	
Wood	16	2.25	0.29–17.27	4.27	0.52–34.87
Soil	1,953	0.23	0.12–0.41	0.45	0.23–0.87
Type of latrine					
Private septic tank	1,104	1.00			
Private, no septic tank	372	1.02	0.51–2.05		
Shared or public toilet	253	0.40	0.12–1.32		
River, pond, or yard	2,496	0.45	0.27–0.73		
Electricity					
Yes	2,621	1.00			
No	1,604	0.26	0.14–0.49		
Television ownership					
Yes	1,448	1.00			
No	2,777	0.26	0.16–0.42		
Refrigerator ownership					
Yes	77	1.00			
No	4,148	0.34	0.12–0.94		
Motorcycle ownership					
Yes	512	1.00		1.00	
No	3,713	0.24	0.15–0.39	0.53	0.32 –0.89

a. All five variables are included, likelihood ratio statistic on 673.945, df = 13, $p < .001$.

ergy deficiency was significantly different among age groups, this association disappeared in the multivariate analyses, probably because some of the covariates also were related to age. However, obesity was clearly linked to older age. It has also been shown that BMI correlates well with age [30–33]. In many non-Western countries, low BMI is found especially among older people. In contrast, in Western populations low BMI is found predominantly among younger people. Thus, Purworejo districts contain subpopulations similar to both non-Western and Western countries.

Many studies have found associations between nutritional status and reproductive and socio-economic status [27, 31, 33–37]. The Purworejo women who worked in agriculture had the highest risk of chronic energy deficiency compared with non-agricultural workers (when possible confounding factors were adjusted for), and they were less likely to be obese. Being a housewife or being unemployed increased the risk of chronic energy deficiency by 28% to 38%. These findings were similar to those in Cuba [38], where the highest proportions of underweight and chronic energy deficiency were found among agricultural workers and housewives. This phenomenon may be explained by findings in Ethiopia, where the physical activity levels for agricultural, domestic, and other productive work in relation to maintenance energy cost in women were 2.8, 2.0, and 1.3, respectively, based on actual measurements [39]. Unfortunately, many types of heavy physical activity are such that individuals of low BMI are clearly at a disadvantage, and those types of activity could be important in some types of agricultural work [40].

As expected, women with better economic status, as indicated by the availability of a radio, television, refrigerator, drinking water, and tile floors, had better nutritional status. These findings were similar to those of Achadi and co-workers in West Java, where women owning a motorcycle and a radio had better nutritional status [22]. However, in our study higher proportions of both chronic energy deficiency and obesity were found among women who owned a bicycle. Thus, appropriate socio-economic indicators for these two study sites may differ. In West Java a motorcycle and radio may indicate relative wealth, whereas in Purworejo a radio, television, and refrigerator may instead indicate a similar level of wealth. Ownership of a bicycle increased with age, and so did the prevalence of both chronic energy deficiency and obesity; this may explain a spurious relationship.

We found that women who used contraception had the best nutritional status. Women not using any contraception had a 31% increased risk, and women without any information on contraceptive methods had more than a 95% higher risk of chronic energy deficiency. Conversely, these women were less likely to be obese. Women without information on contraceptive methods were older, had more children, had less education, and worked in agriculture. Thus, this variable could also act as a proxy for these other background factors.

Only in univariate analyses did parity show a significant association with obesity (but not with chronic energy deficiency); women with parity greater than four had a higher risk of being obese. In multivariate analyses, parity showed no significant association with obesity. However, the East Java study also found the prevalence of chronic energy deficiency to be unrelated to parity [41]. It could be that the degree of undernutrition influences reproductive performance and fecundity, rather than reproduction leading to maternal depletion. However, evaluation of women's nutritional status across age and parity is probably not the correct way to investigate maternal depletion [42, 43].

Conclusions

In Purworejo, Central Java, Indonesia, 17% percent of non-pregnant women of reproductive age had chronic energy deficiency, 71.7% were normal, and 11.4% were obese. The height deficit was more severe than the weight deficit, indicating past malnutrition combined with an improved situation in today's society. The major causes of malnutrition—limited resources and poor socio-economic status of the population—will need to be addressed through programmes that increase the purchasing power of the poor throughout the year. There is a need to improve the nutritional status of both girls and women before and after pregnancy. Intervention during pregnancy, a period with high nutritional demands, may be too late. Efforts to enhance work opportunity, expand access to primary and secondary education, improve dietary intake, and facilitate the use of health and nutrition services are needed to improve women's nutritional status.

Acknowledgements

We thank all those involved with the conduct of the study. It was supported by grants from Sida/SAREC (Swedish International Development Authority/Swedish Agency for Research Cooperation in the Developing Countries), Sweden (SWE-94-149), and the World Bank through the Community Health and Nutrition Development Project of the Ministry of Health, Indonesia (IBRD Loan No. 3550-IND).

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Energy and protein intake and nutritional status of primary schoolchildren 5 to 10 years of age in schools with and without feeding programmes in Nyambene District, Kenya

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Abstract

The dietary intake and nutritional status of 162 children in a school with a lunch programme (the feeding-programme group) and 163 children in a school without a lunch programme (the no-feeding-programme group) in Nyambene District, Kenya, were compared. The relationship between such child growth determinants as income sources, per capita weekly food expenditure and consumption frequency, per capita energy and protein intake, and the nutritional status of the children was also compared between the two groups. Daily caloric consumption in the group with a feeding programme was significantly higher than in the group without a feeding programme: 1,590 kcal, or 86% of the recommended daily allowance (RDA), versus 1,457 kcal, or 76% of the RDA ($p < .05$). The protein intake was mainly of plant origin. Although not significantly different between the two groups, it was higher for children without a feeding programme (62 g; 238% of the RDA) than for those with a feeding programme (56 g; 216% of the RDA). The prevalence of wasting among children with a feeding programme (9%) was significantly higher than among those without a feeding programme (2%) ($p < .05$). The level of stunting was about the same in both groups: 24% in the group with a feeding programme and 25% in the group without a feeding programme. There was no significant difference in the prevalence of underweight between the two groups. Overall, the nutritional status of girls was better than that of boys, although the difference was not statistically significant. It is evident that children participating in the feeding programme did not have a nutritional advantage over non-participants. Thus, there is need to evaluate school feeding programmes in Kenya to identify and address the weaknesses that curtail their impact.

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Introduction

Protein-energy malnutrition, mainly due to inadequate dietary intake, is the major form of malnutrition among school-age children in Kenya [1]. The negative impact of malnutrition on learning here as well as in other countries has been well documented [2-5]. A survey by the Central Bureau of Statistics showed that malnutrition is widespread among schoolchildren in Kenya and is consistently higher among boys than among girls in Kwale and Kitui districts [6]. In another study in Kenya, the nutritional status of schoolchildren was shown to deteriorate with age [7]. Similar observations were reported for Tanzania [8].

In addition to improved academic achievement, improved nutrition as a result of school feeding programmes has been shown to improve school enrolment and attendance [9-11]. School feeding programmes have been initiated in a number of countries [12]. Most of these programmes have three main objectives: to improve school attendance, school performance, and the nutritional status of the children. However, past experience has shown that many nutrition interventions, including school feeding programmes, are usually not based on information from research findings. Further, in many cases the implementation process has met with a number of problems. Consequently, the results, in terms of cost, effectiveness, and magnitude of impact, have been disappointing [13]. In an evaluation of a school feeding programme in India, its irregularity was found to be responsible for poor school enrolment and attendance [14]. Observations in Kenya have shown that school feeding programmes do not necessarily improve enrolment levels nor do they improve the educational performance or the nutritional status of the children. In some cases, however, the programmes may improve school performance, nutritional status, or both. A National School Feeding Council of Kenya school feed-

ing programme was shown to improve the nutritional status of participating children [15].

A Government of Kenya/World Food Programme school feeding programme was introduced in 1981 and is still in operation. The objectives of this programme were essentially similar to those given above. It covers arid and semi-arid areas as well as divisions of the less arid and low-potential areas in which food production is low. These areas, which have food deficits, are poor and have school enrolment levels that are below the national average of 87%. During the first school term of 1995, the programme covered 19 districts in the Rift Valley, Coast, Northeastern, and Eastern Provinces, with a total enrolment of 360,000 children.

As a result of a shortage of funds at both the Ministry of Education and District headquarters, there has been no monitoring and evaluation of the programme's performance. The Ministry of Education has been unable to meet the agreed 50% of the internal transport, handling, and storage costs [16]. The nutritional impact of the school feeding programme has not been evaluated [17]. The objective of this study was to assess the effect of a school lunch feeding programme on the nutritional status of the children and school attendance levels in Nyambene District. Household factors likely to influence child nutritional status were controlled for in the analysis. The hypothesis was that children in a school participating in the feeding programme would, by the end of the school term, have better nutritional status and school attendance records than those in a school without a feeding programme. The relationship between some of the child growth determinants and nutritional status was also examined and compared with that of children in the school without a feeding programme.

Methods

Study site, population, and subjects

The study subjects were children aged 5 to 10 years in a randomly selected school (Lukununu primary school) in Antuambui, Laare division of Nyambene District, eastern Kenya, participating in a World Food Programme school lunch feeding programme (feeding-programme group) and children in a school (Mwerongundu primary school), purposely selected from a number of schools without a feeding programme (no-feeding-programme group) in the same area.

Nyambene District is 400 km from Nairobi and has an area of 12,000 km^2. Low and unreliable rainfall together with low altitude and high temperatures classify this area as semi-arid. This is a constraint to the production of staples (maize and beans), which has made the district dependent on food from other districts [18]. Antuambui and Laare have areas of 181 and 1,112 km^2, respectively. Antuambui has a population of 18,864, a population density of 104 per square kilometre, and 3,452 households [19]. The paradoxical wealth of Nyambene is derived from the sale of *Catha edulis*, i.e., khat or miraa (as it is known locally), a slightly intoxicating herb.

Statistics from 1992 indicate that miraa is the most important cash crop in this district. It covers 5,200 hectares around Maua Hills, which include the divisions of Tigania, Ntonyiri, Laare, and Antubetwe. In Laare, miraa covers approximately 1,000 hectares [18]. Most of the miraa is sold in urban areas in Kenya, while some is exported to Middle East countries. An average household earns about KSh 12,000 (US$200) per month from the crop, as compared with an estimated gross national product of US$295 per capita per annum based on 1998 figures. Miraa is traditionally a business for men, most of whom make merry with the proceeds from it in towns and shopping centres. Thus, despite the high earnings from miraa, the money does not contribute to food security and is of limited benefit to women and children. Casual jobs related to the crop are readily available.

Field study instruments

A structured questionnaire was developed to elicit information on demographic and socio-economic characteristics of the households. The questionnaire also sought information on foods or meals consumed by the household and by the index child during the previous 24 hours, the amounts of ingredients used for preparing the foods or meals, food expenditures, and the sources and frequency of intake of various foods: cereals (maize, millet, and sorghum), legumes (kidney beans, peas, horse beans, and green gram), vegetables (cabbage, kale, green English peas, green pigeon peas, green beans, spinach, and carrots), livestock products (meat, eggs, and milk), fruits (orange, avocado, tomato, and passion fruit), root and tuber crops (Irish potato, sweet potato, and arrowroot), and plantains.

Weights were measured with a 100-kg capacity bathroom Salter scale with increments of 100 g. A vertical measuring rod with a length of 175 cm and a precision of 0.1 cm was used for measuring height. School records for the 65-day term were used to obtain information on the level of attendance.

Sample size and sample determination

The sample size (169 children from each school) was determined according to Fisher et al. [19] using a prevalence of stunting among older children (5–10 years) of 30% reported by the Central Bureau of Statistics for the area [20] and an assumption that the difference in malnutrition between the two groups would be significant at the .05 level.

Conduct of the study

Sample selection

Nyambene District was selected randomly from among 19 districts with World Food Programme school feeding programmes. Central Laare was then randomly selected from the three World Feeding Programme-designated feeding zones in the district, Igembe South, Igembe North, and Central Laare. Finally, Lukununu primary school was randomly selected from the three primary schools in Central Laare with a feeding programme.

A primary school without a feeding programme (Mwerongundu primary school) near the Lukununu primary school was selected to ensure that its characteristics were similar to those of the school with a feeding programme.

Registration of all children between 5 and 10 years of age in the schools was then obtained. In each school, 169 children were randomly selected for the study, ensuring that, in the case of the school with a feeding programme, these had participated in the feeding programme for at least a year. Sixty-two (38%) of the children in each school were also randomly selected for the 24-hour dietary recall study.

Training of interviewers and pilot study

Two enumerators from the study area who spoke the local language were trained in interviewing techniques to collect biodata on the children, anthropometric measurements, and dietary intake data. The enumerators were used to pretest the questionnaire, which was adjusted accordingly before the definitive study began.

Definitive study

The definitive study was conducted during the school term from January to March 1995. The field assistants were closely supervised by the researchers, and the questionnaires were examined every day to check on the validity and reliability of the information collected.

Administration of the questionnaire

The selected children gave directions to their homes so that the enumerators could administer the questionnaire to their mothers and, where applicable, record the 24-hour dietary recall information. Since the enumerators were from the area, they easily found the homes. Household measures and food models, as described by Cameron and Van Staveren [21], were used to assess the amounts of food prepared or consumed.

Intake at lunchtime in school was observed for children in the feeding programme (Lukununu primary school). All the ingredients used for the meal and their weights were recorded. The amounts consumed by individual children were determined using the "observed weighed technique" as described by Cameron and Van Staveren [21]. This technique involved weighing the food before serving and weighing the food remaining on the plate afterwards. The amount of food consumed by each child was expressed as a proportion of the total amount of food that had been prepared for all the children, to calculate the amounts of the ingredients in the food for each child.

The information on the amount of food consumed at lunch by the children in the school without a feeding programme (Mwerongondu primary school) was collected from their mothers. Intakes from breakfast and supper meals for both groups of children were assessed at their homes.

Anthropometric measurements

Weights and heights were measured as described by the United Nations National Household Survey Capability Programme Manual [22] and recorded to the nearest 100 g and 0.1 cm.

School attendance

Each child's attendance was determined by reviewing the school records at the end of term.

Data entry and analysis

Preliminary data cleaning was done in the field with the assistance of the enumerators. At the end of each day, the researchers checked all the questionnaires to ensure that all the data had been collected; if any were missing, the households were revisited. The questionnaires were then sent to the Applied Nutrition Programme of the University of Nairobi where the data were entered and analysed with the Statistical Package for the Social Sciences (SPSS).

Estimation of caloric and protein intake

The Eastern, Central, and Southern Africa (ECSA) Technical Center for Agriculture and Rural Cooperation (CTA) food-composition tables for Eastern and Central Africa [23] were used to calculate the total daily intake of calories and proteins by household and by child, using data from the 24-hour dietary recall and, for children attending the school with a feeding programme, the ingredients of the school lunch. The Kenya food-composition tables compiled by Sehmi were used for any food items not found in these tables [24]. The combined caloric and protein contributions of breakfast and supper (two meals consumed at home by all children) were also computed according to the same food-composition tables. The adequacy of protein and caloric intake was expressed as the proportion of the recommended daily allowance (RDA) according to the Food and Agriculture Organization/World Health Organization/United Nations University [25]. Household per capita energy and protein intake was then computed.

Assessment of nutritional status

The Centers for Disease Control ANTHRO computer

programme was used to compute Z score deviations of the weights or heights from the weights and heights of the National Centre for Health Statistics (NCHS) reference children of the same height (or age). The indices obtained were weight-for-age, height-for-age, and weight-for-height, as indicators of underweight, stunting, and wasting, respectively. The children were considered to be malnourished when the respective Z scores were below -2 SD from the median for NCHS reference children.

Results

General characteristics of study households and parental characteristics

The general characteristics of the study population are shown in table 1. The study groups were similar in household size and dependency ratio, and the sex ratio in both areas was 1:1.

The fathers and mothers of the children with a feeding programme were significantly older (44.3 ± 9.4 and 35.3 ± 7.2 years, respectively) than the parents of the children without a feeding programme (41.6 ± 8.1 and 32.7 ± 6.4 years; $p<.01$ and $p < .005$, respectively). In both groups, the level of education of the parents, as measured by the number of years of schooling, was generally low, and the fathers had more years of schooling than the mothers. The fathers and mothers of the children without a feeding programme had significantly more years of schooling (4.0 ± 4.5 and 2.3 ± 3.4 years, respectively) than the parents of the children in the feeding-programme group (2.7 ± 3.5 and 1.7 ± 2.8 years; $p < .005$ and $p < .05$, respectively).

TABLE 1. Demographic characteristics of the study households (mean ± SD)

Characteristic	School feeding programme		t
	Yes (n=162)	No (n=163)	
Household size	8.2 ± 2.6	8.3 ± 2.5	–0.3
Dependency ratio	1.2:1.0 ± 0.7	1.0:1.0 ± 0.6	1.6
Father's age (yr)	44.3 ± 9.4[a]	41.6 ± 8.1	2.7
Mother's age (yr)	35.5 ± 7.2[a]	32.7 ± 6.4	3.4
Father's education (yr)	2.7 ± 3.5	4.0 ± 4.5[a]	–3.1
Mother's education (yr)	1.7 ± 2.8	2.3 ± 3.4[a]	–1.8

a. $p < .05$, t test.

Characteristics of the study subjects

The distribution of the children by sex and age is shown in table 2. The mean age of the children was about the same for both groups (8.2 ± 1.2 years for children with a feeding programme and 8.3 ± 1.2 years for children without a feeding programme). Absenteeism of children in the school with a feeding programme (8.6 ± 7.5 days per 65-day school term) was significantly higher than that of children in the school without a feeding programme (3.1 ± 3.9 days; $p < .001$).

Household income sources and food expenditure

Table 3 shows the distribution of households by sources of income, ranked in order of importance and also by per capita household food expenditure. The main source of income was miraa, which was reported by the same proportion of households in both groups (60% and 61% in the programme and non-programme groups, respectively). There was also no significant difference in the proportion of households who derived part of their income from business (23% and 22% of households whose children attended schools with and without feeding programmes, respectively). The sale of food crops was reported by a small proportion of households (4% of feeding-programme households and 6% of no-feeding-

TABLE 2. Distribution of the children in the schools with and without feeding programmes according to age group, mean age, and school absenteeism rate

Age group (yr)	Feeding programme			No feeding programme		
	Boys	Girls	%	Boys	Girls	%
5–6	17	19	22	14	15	18
7–8	31	43	46	32	42	45
9–10	22	30	32	28	32	37
Total	70	92	100	74	89	100
Age (yr)—mean ± SD	8.2 ± 1.2			8.3 ± 1.2		
Absenteeism (days/term) —mean ± SD	8.6 ± 7.5[a]			3.1 ± 3.9		

a. Difference significant at $p < .001$.

TABLE 3. Distribution of households according to source of income and food expenditure

Variable	School feeding programme		Total
	Yes	No	
Source of income—no.(%)			
Miraa	97 (60)	99 (61)	196 (60)
Business	38 (23)	35 (22)	73 (23)
Casual employment	11 (7)	8 (5)	19 (6)
Sale of food crops	7 (4)	9 (6)	16 (5)
Permanent employment	4 (3)	11 (7)	15 (5)
Sale of animals and animal products	5 (3)	1 (1)	6 (2)
Weekly household food expenditure (KSh)—mean ± SD[a]	45.6 ± 37.2	52.2 ± 42.2	t = -1.5

a. KSh44.2 = US$1.00, January 31, 1995.

programme households) and was not significantly different between the two groups. Employment was an important source of income for only a small number of households in both groups (9% of the feeding-programme households and 10% of the no-feeding-programme households). Sale of animals and their products was the least important source and involved very few households: 3% and 1% for the programme and no-programme households, respectively.

Food expenditure was low: KSh 45.6 ± 37.2 in households whose children participated in the school feeding programme and KSh 52.2 ± 42.2 in households whose children did not participate. Food expenditure did not differ significantly between the two groups.

Caloric and protein intake by households and children

In feeding-programme households, the per capita daily caloric and protein intakes were 3,010 kcal and 139.5 g. The values in no-feeding-programme households were slightly higher, 3,320 kcal and 148.5 g, but there was no significant difference between the two groups.

The school feeding programme was designed to provide the children with 150 g of maize, 40 g of beans, and 15 g of vegetable oil, which would provide 793 kcal (43% of the RDA) and 24 g of protein (92% of the RDA). Because of a shortage of ingredients, the school lunch programme operated for only 38 of the 65 days of the school term. The children therefore obtained only 59% of the energy and nutrients they would have if the programme had operated throughout the term.

The lunchtime caloric intake of the children with a feeding programme (860 kcal) was significantly higher than that of the children without a feeding programme (666 kcal) (table 4) ($p < .05$), but the protein intake from home lunch of the children without a feeding programme (31 g) was significantly higher than the lunchtime protein intake of those with a feeding programme (24 g) ($p < .01$). The total caloric and protein intakes were not significantly different.

A paired t test on the caloric intake for the feeding-programme children showed a significantly higher intake at lunch (860 ± 1.0 kcal) than at supper (556 ± 326.1 kcal) ($p < .001$). No significant difference was found in protein intake for the two meals. A paired t test for lunch and supper at home for the no-feeding-programme children, on the other hand, did not show any significant difference for either caloric or protein intakes. The mean total protein consumption by children without a feeding programme (238 ± 129% of the RDA) was slightly but not significantly higher than that of the group with a feeding programme (216 ± 109% of the RDA).

Children in both groups consumed fewer calories and more protein than the RDA. Breakfast contributed

TABLE 4. Twenty-four-hour intake of energy (kcal) and protein (g) and adequacy of intake by children[a]

Meal	School feeding programme		t
	Yes (n=162)	No (n=163)	
Breakfast			
Energy	173A (9.3)	187A (9.7)	-0.5
Protein	5.2a (20.4)	5.8a (22.5)	−0.8
Lunch			
Energy	860C (46.3)	666B (34.6)	4.5[b]
Protein	24.0b (94.3)	30.8c (118.7	−2.6[b]
Supper			
Energy	556B (30.1)	605B (31.7)	−1.8
Protein	26.4b (101.6)	25.2b (97.1)	0.3
Total			
Energy	1,590 (85.7)	1,457 (76.0)	1.7[b]
Protein	55.6 (216.3)	61.8 (238.4)	−1.2

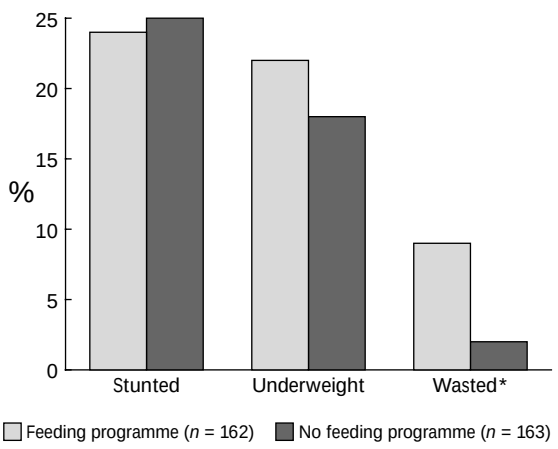
a. Figures in parentheses are proportions of WHO/FAO/UNU 1985 [24] recommended daily allowances. Figures for different meals followed by the same upper-case letters in the columns show that there is no significant difference for calories at $p < .05$; figures followed by the same lower-case letters show no significant difference for proteins at the same p value.

b. $p < .05$ for figures in the same row, t test.

less than 10% of the RDA for calories. The caloric adequacy for the children with a feeding programme (86 ± 21% of the RDA) was significantly higher ($p < .05$) than that for the children without a feeding programme (76 ± 27% of the RDA; $p < .05$) (table 4). This was because the lunch meal contributed significantly more calories for the group with a feeding programme (46 ± 3% of the RDA) than that for the group without a feeding programme (35 ± 17% of the RDA; $p < .001$). The contribution of breakfast and supper (two meals that children in both groups took at home) to the RDA for energy and protein did not show any significant difference between the two groups (table 4).

Nutritional status of the children

The proportions of stunting (height-for-age), underweight (weight-for-age), and wasting or acute malnutrition (weight-for-height) are shown in fig. 1. The prevalence of chronic malnutrition indicated by stunting among children in the feeding programme (24%) was not significantly different from that of the children without a feeding programme (25%). This was also the case for the proportion of underweight children with a feeding programme (22%) compared with children without a feeding programme (18%). Nevertheless, significantly more children in the feeding programme (9%) showed signs of acute malnutrition (i.e., wasting) than did those not in the programme (2%; $p < .05$). In both groups, there was a negative and significant relationship between age and nutritional status as shown by the level of wasting (weight-for-height) ($p < .05$ for those with a feeding programme and $p < .005$ for those without a feeding programme). There was also a negative and significant relationship between age and underweight (weight-for-age) in both groups of children ($p < .05$ for children with a feeding programme and $p < .005$ for children without a feeding programme). For children without a feeding programme, there was a significant and positive relationship between age and stunting (height-for-age)($p < .001$).



* $p < 0.05$, chi-square test, for the comparison between schools.

FIG. 1. Prevalence of malnutrition among children attending schools with and without feeding programmes

Discussion

General characteristics of the study population

The percentage of economically inactive persons in the study area has not changed much since the 1989 survey of the Central Bureau of Statistics. Fifty-three percent were economically inactive during the study, as compared with 56% in 1989 [20]. These results indicate a high dependency ratio of dependents to wage earners: 1.2 to 1 in feeding-programme households and 1.0 to 1.0 in households not in the programme). This is characteristic of many communities in developing countries.

The significantly higher mean age of the parents in the programme group than in the no-programme group influenced the educational status of the study population. The findings on parental level of education are similar to those from other parts of Kenya [20], which show that younger persons are, on the average, more educated than older ones. This explains the higher average level of schooling of the younger parents of children in the feeding programme.

The higher literacy rate of adult males compared with females was expected [20]. However, the overall educational status of the community (based on the number of years spent in school) was very low, due to a high school dropout rate that has been attributed to the growing of miraa [20]. This would explain the low ranking of permanent employment (second to last) as a source of family income in both groups of households.

Food sources and dietary intakes

The similarity between the two groups in household caloric and protein intake and in the contribution of different meals to their total nutrient intake is not unexpected, since the community agricultural activities, family characteristics, sources of income, and expenditures on food are similar, and they share the same sociocultural characteristics. The dependence on purchased food rather than on home-produced food is mainly due to the growing of miraa, which is difficult to intercrop, as well as to the shortage of rain and water in the region. This has made the area heavily dependent on market food supplies from outside the district [18]. It is possible that the slightly higher household per capita caloric and protein intake placed the no-feeding-programme children at an advantage as compared with the programme group, whose school lunch programme was irregular.

The calories (less than 10% of the RDA) derived from

breakfast, equivalent to four slices of bread for both groups, are too few to enable the children to perform adequately until lunch. This suggests that the children were hungry for a great part of the morning. The proportionately high contribution of lunch and supper to daily nutrient intake implies that more emphasis was placed on these two meals than on breakfast.

Lunch was a more important source of calories than supper for the children in the school feeding programme. The low caloric intake observed in both groups is of concern. Even with the introduction of the lunch programme, the caloric intake did not improve much, as indicated by the study data: 86% of the RDA for the feeding-programme group and 76% for the no-feeding-programme group. Others have observed that schoolchildren in Kirinyaga and Embu Districts in Kenya, similar ecological zones, have lower intakes of calories [2] and protein [15] than the RDA.

Although the total protein intake was apparently adequate in both the programme and the no-programme groups, the proteins were mainly of plant origin with low nutritional value. Food and Agriculture Organization data show that the *in vivo* biological value (BV) of eight proteins of plant origin (cereals and legumes) is 61.2 ± 2.65 as compared with 81.6 ± 7.05 for five animal proteins [26].

The low intake of animal protein (less than 10% for both groups) is typical for schoolchildren in Embu, Kenya [15], where children obtain more than 90% of their protein from plant sources. Although in theory, combinations of proteins from different plants in the right proportions can give amino acid profiles comparable to those of animal proteins [27], this is not the case when a high proportion of the protein comes from cereal. The community should be encouraged to use the income from miraa to keep small animals, in order to improve the amino acid balance. In addition, increased consumption of legumes should be promoted. In advising the community, it should be pointed out that the diet should be adequate in energy, since energy spares protein [28].

Nutritional status of the study children

The level of stunting of the children in both groups implies a similar past nutritional experience. The stunting levels observed were slightly higher than the 22% reported by the Central Bureau of Statistics [29] in 1989 for children under five years. Similar results were obtained in Samburu District [30], where stunting increased with age. Other studies have reported practically the same levels in similar ecological zones in Kenya for schoolchildren. A Central Bureau of Statistics survey [6] showed that 24% of the schoolchildren in Kitui District and 26% in Kwale District were stunted.

The failure of the school feeding programme to achieve its objective of improving nutritional status is, however, evident from the observation that wasting levels were significantly higher among children with a school feeding programme than among children without a programme. In fact, the level of wasting in the school with a feeding programme (9%) was more than three times the national level for children under five years of age as reported by the Central Bureau of Statistics [29]. A possible explanation for this could be the irregularity of the school lunch programme, coupled with lower dietary intake at home for children with a school feeding programme.

If the children had obtained all of the nutrients that were intended to be supplied by the lunch, their nutritional status would have been better. Clearly, the existence of the feeding programme as implemented did not confer better protection on the participating children, as shown by the prevalence of wasting. The observations, however, do not justify phasing out the school feeding programme, but rather improving its nutrient quality and regularity of supply. In Kirinyaga District [15] the nutritional status of children participating in a school feeding programme under the National School Feeding Council of Kenya improved when these problems were addressed.

The observation that the nutritional status of girls was generally better than that of boys is consistent with results of studies on schoolchildren in other parts of Kenya, including Samburu [30], Kitui, and Kwale [6]. Similar findings were reported in Tanzania [8]. This may be due to the fact that customarily among the Meru people, girls are socially more actively involved in food preparation and would, therefore, have greater access to food.

The higher proportion of children in the school feeding programme who had a present and past history of malnutrition is not surprising, considering that the prevalence of wasting among children in the feeding programme was significantly higher than among children not in the programme. Moreover, the children in the programme were slightly more underweight than those not in the programme.

The negative relationship between age and wasting in the two groups is consistent with the higher proportional nutrient demand for growth and development in younger children. The positive increase in stunting with age was also found in another study on schoolchildren in Samburu District, Kenya [30].

Conclusions and recommendations

The school feeding programme did not improve children's school attendance or nutritional status. The hypothesis that children in the programme school would have better nutritional status and school attendance was not confirmed. The actual implementation of the lunch programme fell far short of its goal. This is a

disappointing outcome. There are two obvious recommendations. One is to determine how the supplementary feeding programme can be improved. The other is to determine whether a better-implemented programme would have given a better result.

Acknowledgements

This study was undertaken with assistance from the Agency for Technical Cooperation of the Federal Republic of Germany (GTZ) and the University of Nairobi.

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The Helen Keller International food-frequency method underestimates vitamin A intake where sustained breastfeeding is common

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Abstract

A recent innovation in assessing community vitamin A status is the Helen Keller International food-frequency method, which is based on weekly intakes of key foods among pre-school children. Since it excludes breastmilk, we investigated whether the amount of breastmilk received by 40 children aged one to three years in a rural area of Bangladesh contributed significantly to their vitamin A intake. Vitamin A intake was indirectly calculated from the consumption of breastmilk, which was quantified over a 9-hour period by a test-weighing technique. The estimated mean 24-hour milk intake was 548 g for the 97% who were breastfed at 12 to 23 months and 312 g for the 73% who were breastfed at 24 to 36 months. This represents an average daily intake of 41% and 23% of the safe recommended daily intake (400 RE) for vitamin A, respectively. The Helen Keller International food-frequency method should be revalidated for settings where breastfeeding is sustained beyond infancy.

Introduction

Vitamin A deficiency is a major health problem in the less-developed countries. It is estimated that 250 million children are at risk [1]. Correcting mild to moderate vitamin A deficiency at the community level is thought to lead to at least a 23% reduction in mortality rates among young children [2]. At the International Conference on Nutrition jointly convened by the Food and Agriculture Organization and the World Health Organization in 1992, it was declared that efforts should be made to eliminate vitamin A deficiency before the end of this decade [3].

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The planning and implementation of programmes to reduce vitamin A deficiency require simple and reliable methods of assessing the risk of vitamin A deficiency at the community level. However, conventional quantitative methods of assessing the prevalence of vitamin A deficiency in the community, including xerophthalmia prevalence surveys, dietary assessment, and biochemical analyses of serum indicators, pose important financial, logistical, and technical constraints. This has constrained how much attention governments and non-governmental organizations can give to vitamin A deficiency.

Perhaps the simplest and most innovative method to assess community risk of vitamin A deficiency now coming into frequent use is the Helen Keller International food-frequency method [4]. This method is based on diets of children one to six years of age. A score is assigned to each child based on the number of animal versus plant sources rich in vitamin A that were consumed during the past week, ignoring amounts. Nearly all the foods taken into consideration contain at least 100 retinol equivalents (RE) per 100 g. The Helen Keller International food-frequency method is intended for use in assessing whether or not vitamin A deficiency is a public health problem in a population. However, it may also prove useful in monitoring large-scale shifts in consumption of these foods, for example, in response to campaigns promoting dietary improvement. Also, in areas where both short-term and long-term strategies to ameliorate vitamin A deficiency are running concurrently, diet-based monitoring indicators are needed to tell decision makers when untargeted distribution of vitamin A capsules can be phased out as diets improve [5, 6].

The Helen Keller International food-frequency method approach has certain advantages. General eating habits are easier to remember and, therefore, are more reliably reported than specific quantities of foods. A seven-day food-frequency method also captures eating patterns over a whole week, increasing the likelihood that holidays and market days will be included. It has been shown that estimating the exact nutrient

intake in individuals is not always necessary to predict the prevalence of nutritional deficiency in a community [7, 8]. Food-frequency methods have also been shown to have predictive power in relating the intake of food to risk of disease [9].

The Helen Keller International food-frequency method excludes breastmilk, on the grounds that it is only a minor source of vitamin A after the first year of lactation, i.e., the one- to six-year-old target group. The vitamin A content of breastmilk of deprived mothers in Bangladesh at 12 months and more post-partum has been estimated to be 30 RE per 100 g of milk consumed [10, 11]. At this level, breastfed children are less likely to develop xerophthalmia than non-breastfed children [12, 13], even at older ages [14, 15].

The Helen Keller International food-frequency method has been validated against serum retinol in three countries: the Philippines, Guatemala, and Tanzania [16]. However, the majority of vitamin A deficiency is located in South Asia, where such studies have not yet been conducted. At the same time, the tradition of sustaining breastfeeding beyond the first year is stronger in this region than anywhere else in the world. In Bangladesh, for example, the 1996–1997 Demographic and Health Survey found that the mean duration of any breastfeeding was 28 months, based on current status data for children less than three years of age [17], and the median was 36 months. This is comparable to the mean of 27 months reported in 1975–1976 [18], suggesting that no decline in duration has occurred since then.

This study examined whether rural Bangladeshi children, at least at the lower end of the one- to six-year age group, might receive enough breastmilk to contribute significantly to their total vitamin A intake, or whether breastmilk intake can indeed be ignored in applying the Helen Keller International food-frequency method.

Materials and methods

Study area and study population

The study was conducted in five villages in rural Thakurgaon District, Bangladesh, in November and December 1996. Breastmilk intakes were measured in 40 children selected by quota sampling. Women volunteers working in the Worldview International Foundation Comprehensive Nutrition and Blindness Prevention Program were instructed to recruit a predetermined number of breastfed children one to three years old within their programme areas. This gave a sample with a mean age of 18 ± 8.4 months, with equal numbers of one- to two-year-olds and two- to three-year-olds and equal numbers of boys and girls.

Breastmilk intake

The consumption of breastmilk over a 9-hour period was quantified by a test-weighing technique. Children were weighed immediately before and after all feedings from 9 a.m. to 6 p.m. on a UNICEF beam balance accurate to 5 g. The change in body weight during the feeding was assumed to be equal to the weight of the milk consumed. From these data, the 12-hour intake was derived as 1.33 of the 9-hour intake, and the 24-hour consumption was extrapolated using the correction factor 12-hour consumption/0.53 previously determined for Bangladeshi women [19]. The scales were calibrated on a daily basis. Four women volunteers were selected to perform the test weighing in the homes of the breastfeeding women. They were trained in weighing and record-keeping techniques. The day before the last weighing, the mothers were asked to keep track of the frequency of breastfeeding for the period from 6 p.m. the day before test weighing until 9 a.m. the day of test weighing, allowing a 24-hour suckling frequency to be estimated.

Results

Breastmilk intake

As shown in table 1, the mean 9-hour intake of breastmilk for the whole sample was 171 ± 126 g (range, 20–470). The mean intake of breastmilk for girls (166 g) was not significantly different from that for boys (176 g; $p = .8$). The intake of breastmilk in the 12- to 23-month age group was 218 ± 129 g, significantly higher than the 124 ± 106 g value for the older group ($p = .015$). Using the correction factors, the estimated mean 24-hour intake would be 548 g for the 12- to 23-month-old group and 312 g for the 24- to 36-month-old group.

Frequency of breastfeeding

The mean suckling frequency was 6.3 ± 2.3 per 9 hours. The mean was 6.0 for girls and 6.5 for boys ($p = .45$) (table 2). In the 12- to 23-month-old group, the mean frequency was 6.8 ± 2.2, and in the older age group,

TABLE 1. Measured nine-hour breastmilk intake (g) according to age group (mean ± SD)

Age (mo)	Boys	Girls	All
12–23	216 ± 132	221 ± 134	218 ± 129[a]
24–36	136 ± 123	111 ± 91	124 ± 106
Total	176 ± 131	166 ± 125	171 ± 126

a. $p = .015$ (*t* test).

TABLE 2. Suckling frequency according to age group (mean ± SD)

Age (mo)	9-h measurement	Mothers' 15-h record	Total
12-23	6.8 ± 2.2	4.9 ± 1.6[a]	11.6 ± 3.1
24-36	5.8 ± 2.3	3.8 ± 1.6	9.6 ± 3.6
Total	6.3 ± 2.3	4.3 ± 1.6	10.6 ± 3.5

a. $p = .04$ (*t* test).

5.8 ± 2.3 ($p = .19$). For the period between 6 p.m. and 9 a.m., the mothers' estimations of suckling frequency yielded a mean of 4.3 ± 1.6 (range, 1–8). The overall estimated total was 10.6 ± 3.5.

Vitamin A intake from breastmilk

By multiplying the values for breastmilk intake shown in table 1 by the estimated retinol concentration of 30 RE/100 g, the total intake of retinol from breastmilk is calculated as 164.4 RE in the younger and 93.6 RE in the older age group. This corresponds to 41% and 23% of the safe recommended daily intake (RDI) of 400 RE for children at those ages, or 82% and 46%, respectively, of the basal RDI of 200 RE [20].

Conclusions and discussion

There is no doubt that breastmilk is important in the nutrition of young children in Bangladesh. In Gaibandah and other districts located in the same region as Thakurgaon, 97% of children 12 to 23 months of age, 73% of those 24 to 35 months of age, 32% of those 36 to 47 months of age, and 10% of those 48 to 59 months of age were still being breastfed [21].

The mean intake of breastmilk was about 550 g in the 12- to 23-month age group and 300 g in the 24- to 36-month age group. For the 12- to 17-, 18- to 23-, and >24-month age groups, Brown et al. [19] estimated 24-hour breastmilk intakes to be 563, 501, and 368 g, respectively. Our estimate for the younger age group was similar to theirs, and for the older age group ours was slightly lower. These levels are in turn similar to, although slightly higher than, Jelliffe and Jelliffe's [22] estimates for poorly nourished populations of 300 to 500 ml/day at 12 to 23 months and 270 to 350 ml/day for children over 24 months. Although breastmilk production is only slightly affected by malnutrition, women in Bangladesh are among the most malnourished in the world (56% of women of child-bearing age have a body mass index less than 18.5) [23], and thus these results are likely to be conservative, applying to most places where breastfeeding is common among older children.

The mean observed suckling frequency in the study was 6.3 times per 9-hour period for 12- to 36-month-old children. The recalled suckling frequency was only 4.3 for a 15-hour evening period, very likely an underestimate. Women in the study area sleep beside their babies and may not remember or be fully aware of all nighttime feedings.

Our observed values were compatible with the findings of two previous studies using observational techniques. Huffman et al. [24] observed five to six suckling episodes per 8-hour observation period for 18- to 36-month olds, as compared with our 6.3 episodes for a slightly younger group 12 to 36 months of age. Our value of 6.8 episodes per 9 hours for 12- to 23-month-olds was slightly higher than the finding by Guldan et al. [25] of four to six suckling episodes per 9-hour period among 16- to 24-month olds. The fact that suckling frequency declines with age would explain much of this small difference.

The daily vitamin A intake from breastmilk in the younger and older age groups was found to be about 160 and 90 RE/100 g, respectively, corresponding to approximately 80% and 40% of the basal requirement of 200 RE, which is equivalent to about 25% of the basal requirement for the entire age group one to six years of age covered by the Helen Keller International food-frequency method. Taking into account the actual percentage of children being breastfed, according to regional rates cited above, it would then correspond to approximately 10% of the basal requirement for the entire one- to six-year-old age group.

In this study, dietary intake was not assessed quantitatively, and thus the contribution of breastmilk to the children's total vitamin A intake could not be calculated. Brown et al. [10] estimated it to be more than 70% in children 18 to 30 months of age. Zeitlin et al. [26] estimated that when breastmilk was included, overall dietary intakes for children 25 to 27 months of age came close to the RDI of 300 RE. They concluded that the only other significant source of vitamin A for children was seasonally available mangoes.

The bioavailability of β-carotene from various dietary sources is currently being debated. In 1967 WHO/FAO estimated the retinol conversion factor for β-carotene to be 6:1, but this is now being questioned. Recent studies in Indonesia and Viet Nam suggest that it should be 12:1 for yellow and orange fruits and 27:1 for vegetables [27]. If confirmed, this would increase the relative importance of breastmilk in the nutrition of young children, particularly in low-income areas.

In conclusion, this study showed, in agreement with earlier findings, that breastmilk is an important source of vitamin A in rural Bangladesh, even in the second and third year of life. Thus, we recommend that it be taken into account in rapid dietary assessments in settings where breastfeeding is commonly continued for longer than one year. One way of doing so would be

to include breastmilk in the category of "animal food." Another might be to assume that children one to two years old in Bangladesh are largely protected from clinical vitamin A deficiency by breastfeeding and to use the food-frequency method on the two- to six-year age group, since breastmilk will have less overall importance as a source of vitamin A and can be ignored more safely. One question in either case is whether the scales used in the Helen Keller International food-frequency method will need to be revalidated once again against serum retinol values to determine the sensitivity and specificity of the new approach.

Acknowledgements

We express our sincere appreciation to the Swedish International Development Cooperation Agency (Sida) for financing this research and to the Worldview International Foundation for providing needed assistance.

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Virtual elimination of iodine-deficiency disorders achieved in nine counties of Jiangsu Province, China

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Abstract

To assess the iodine-deficiency disorder status in nine counties of Jiangsu Province, China, where salt iodization was initiated in 1985, a special verification survey was conducted in 1997 by a provincial multisectoral team. Results obtained by regular monitoring of counties indicated that the goitre rate in schoolchildren had progressively decreased from 41.9% in 1983 to 3.9% in 1997, while the median urinary iodine concentrations of the population had remained above 100 μg/L since 1985. More than 90% of the edible salt supplied to households had been iodized at ≥ 20 mg I/kg during the previous five years. The data obtained by provincial verification confirmed the county findings of ≥ 90% adequate iodized salt in households, < 5% goitre rate in schoolchildren, and adequate urinary iodine excretions. The provincial team also considered the established mechanisms for salt iodization and supply and iodine information management potentially sustainable. The high variability of the iodine content of household salt indicates that improved quality assurance of iodized salt at production and continued monitoring of population iodine indicators are needed.

Introduction

Iodine deficiency is the leading cause of preventable intellectual deficit worldwide, with 1.6 billion people globally at risk [1]. The prevention of iodine-deficiency disorders received a major impetus at the 1990 United Nations Global Summit for Children from the call by world leaders for its virtual elimination by the year 2000 [2]. Following recommended policy [3], salt iodization has been started in many countries, and almost all have passed legislation to assure its implementation. UNICEF estimated that by 1997 nearly 60% of all the edible salt produced in the world was iodized [4].

In Jiangsu, a province in China with 70 million inhabitants, endemic goitre and mental retardation have long been recognized as a public health problem. Provincial surveys of iodine-deficiency indicators during the early 1980s showed an average prevalence of goitre of 25.5% among 7- to 14-year-old schoolchildren, a mean urinary iodine concentration in the population of 76 μg/L, and an average drinking water iodine content of 6.6 μg/L [5]. Nine of the 75 counties of the province, Gaoqun, Jiangning, Jiangpu, Jintan, Jurong, Lishui, Liyang, Luhe, and Xuyi, were most severely affected, with an overall total goitre prevalence of 41.9% in schoolchildren in 1983. In 1985, before its introduction throughout the province, salt iodization was initiated in these counties, and by 1997 the policy had been in place for more than 10 years.

Since 1993, when the Chinese government proclaimed the national goal of elimination of iodine-deficiency disorders by the year 2000, a substantial amount of human and financial resources has been mobilized throughout the country. Universal salt iodization, requiring 50 mg I/kg salt at production, was started in Jiangsu Province in 1995. The supply and quality of iodized salt have been improved continually by the salt industry, and provincial data indicate that 90% or more of the population have had access to iodized salt since 1996 [6].

To follow the progress being made towards elimination of iodine-deficiency disorders in all the counties of Jiangsu Province, a surveillance system was devised based on provincial investigation of iodine-deficiency disorder indicators every two years and continuous monitoring of the iodine content in salt. According to national guidelines, all counties collect 25 salt samples for titration monthly from salt factories and households,

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and quarterly from retail outlets. Each month the iodine content of salt samples obtained at the factory, retail, and household levels is checked using rapid test kits.

In 1997 government officials and management personnel from the provincial health and salt sectors formed a special evaluation team to assess the salt and iodine status of the population in the nine counties of Jiangsu Province most at risk. The overall aim was to determine whether there was sufficient evidence that virtual elimination of iodine-deficiency disorders had been achieved in these nine counties, based on criteria recommended by the World Health Organization/UNICEF/International Council for the Control of Iodine-Deficiency Disorders [7].

Methods

Review of existing data

The provincial team inspected the monitoring records from each county and reviewed the data on total goitre rates and urinary iodine concentrations among schoolchildren and salt iodine contents at salt factories, retailers, and households for the previous five years.

Self-evaluation by county

County officials divided each township into five areas that served as primary sampling units. The population of each primary sampling unit was listed alphabetically, and 30 clusters were selected proportionately to population size [7]. One elementary school was randomly selected per cluster, and in each school, 40 pupils aged 8 to 10 years were selected at random from the attendance roster for palpation of thyroid size, 25 pupils for collection of salt samples brought from home, and 12 pupils for casual collection of urine samples.

Verification by the provincial team

Each county was divided into five areas of approximately equal size, and two elementary schools were randomly selected in each area. In each school, 40 pupils aged 8 to 10 years were selected at random from the attendance roster for palpation of thyroid size and ultrasonography, and 12 pupils for casual collection of urine samples. In each area, 25 pupils were selected to bring a salt sample from home for iodine titration.

Thyroid size determination

County health professionals palpated the thyroid gland and classified the grade of goitre according to the WHO/UNICEF/ICCIDD description [7]. For verification, an experienced physician obtained an ultrasonogram of the thyroid gland with a portable ultrasound unit equipped with a 7.5-MHz linear array transducer (AKHO, Canada). The depth (d), width (w), and length (l) of each lobe in millimetres were obtained from longitudinal and transverse scans, and the volume of the lobe was calculated by the formula [8]:

$$V\ (\text{ml}) = 0.479 \times d \times w \times l \times 1/1{,}000$$

The thyroid volume was the sum of the volumes of both lobes without including the volume of the isthmus. Thyroid size was classified according to age standards [10].

Laboratory methods

Urinary iodine was analysed by the acid-digestion method [9]. The iodine content in salt samples was obtained by titration [10]. The urine and salt samples from the county self-evaluation surveys were analysed in county laboratories, which are accredited by the provincial laboratory. All iodine analyses for the verification survey were done by the provincial laboratory, which is under regular quality surveillance by the Chinese Academy of Preventive Medicine in Beijing and the National Institute of Iodine-Deficiency Disorders in Harbin. Urinary iodine analysis of 18 blinded control samples at three levels by the provincial laboratory did not demonstrate bias compared with the results from the reference laboratories. The precision of these determinations was 2.4%.

Data analysis

All field survey and laboratory data were analysed with Epi Info 6.04. The total goitre rate according to palpation was calculated as the proportion of pupils with grade 1 or 2 goitre. The total goitre rate according to ultrasonography was calculated as the proportion of pupils with thyroid volume above the age-specific reference [11]. Because of their skewed distributions, the median was used to measure the central tendency of urinary iodine concentrations.

A county was declared to be free of iodine-deficiency disorders if ≥90% of households had access to adequately iodized salt during the last five years; the median urinary iodine concentration of the population was above 100 μg/L; and a sustainable mechanism for monitoring salt iodine content and iodine-deficiency disorders had been established. For the purpose of this survey, salt samples from households with an iodine content above 20 mg/kg were classified as adequate.

Results

County monitoring records

Figure 1 shows the percentage of household salt samples containing adequate iodine from 1993 to 1997, obtained

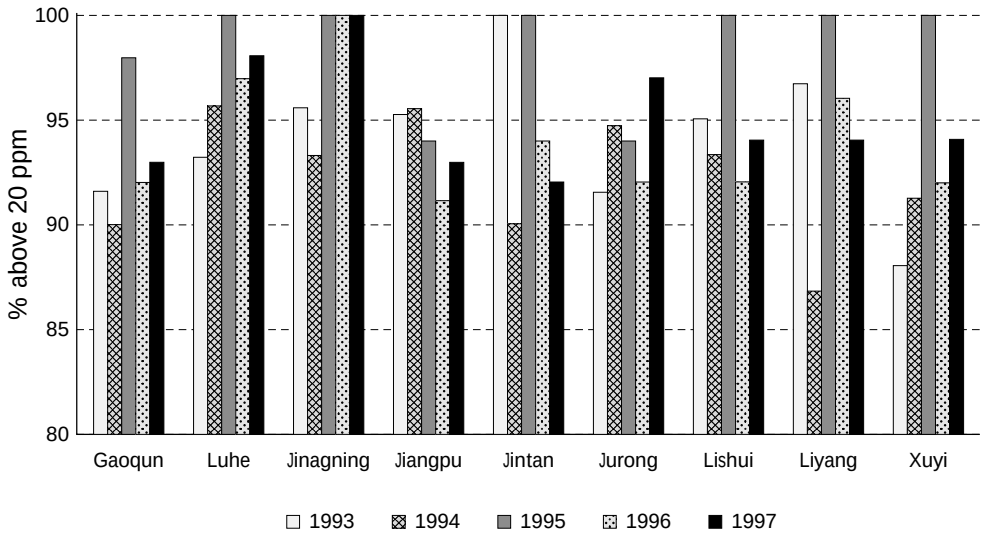

FIG. 1. Adequacy of iodized salt in households in nine counties during 1993–97

from review of county monitoring records. In 2 of 45 possible occurrences (once each in 1993 and 1994), the adequacy was below 90%. Overall, however, in each county ≥90% of the household salt samples had adequate iodine according to titration during the five-year period.

The results obtained by provincial review of the county's urinary iodine and total goitre monitoring since 1983 are shown in table 1. The median urinary iodine concentrations exceeded 100 μg/L in all counties from 1985 onwards, and the total goitre rate declined to below 20% in 1988–1989, below 10% in 1995, and below 5% in 1997 (fig. 2).

County self-evaluation

The self-evaluation results obtained by the counties are presented in table 2. The total goitre rate according to palpation ranged from 2.4% in Luhe to 5.1% in Xuyi, and the median urinary iodine concentrations were above 250 μg/L in all counties. The frequency distribution of iodine contents in 6,897 household salt samples analysed by titration is presented in figure 3. Almost 60% of salt iodine concentrations were between 20 and 40 mg/kg, and the large majority were between 20 and 70 mg/kg.

Provincial verification

Table 3 shows the results obtained by the provincial verification team. The total goitre rate according to ultrasonography ranged from 3.0% in Gaoqun to 6.3% in Xuyi, with an average of 3.6%. The urinary iodine concentration of 246 μg/L found in Jurong was the lowest median value, whereas in the other counties the uri-

TABLE 1. Median urinary iodine excretion (UI)(mg/L) and total goitre rate (TGR)(%) during 1983–1997 in nine counties of Jiangsu Province

	1983[a]		1985[a]		1988–89[a]		1992[b]		1995[b]		1997[b]	
County	UI	TGR	UI	TGR	UI	TGR	UI	TGR	UI	TGR	UI	TGR
Gaoqun	65	37.1	102	35.7	168	18.5	251	13.6	463	8.2	670	2.6
Jiangning	79	45.3	126	42.2	245	19.7	324	15.4	268	9.7	322	2.8
Jiangpu	69	39.8	106	39.5	236	18.6	220	14.5	196	8.6	358	4.7
Jintan	80	40.4	143	39.9	255	17.6	216	13.3	327	7.5	339	4.5
Jurong	69	42.4	104	41.5	174	19.2	169	15.3	362	9.4	257	3.8
Lishui	68	38.2	96	37.5	196	18.5	263	14.2	330	8.6	318	4.9
Liyang	64	45.8	155	44.5	357	19.8	452	15.6	362	9.3	346	4.8
Luhe	69	41.4	99	39.7	216	17.6	224	14.4	241	9.4	363	2.4
Xuyi	65	43.9	89	44.3	152	20.3	152	18.7	415	10.3	420	5.1

a. UI measured in healthy adults, TGR in children aged 7–14.
b. UI measured in schoolchildren, TGR in children aged 8–10.

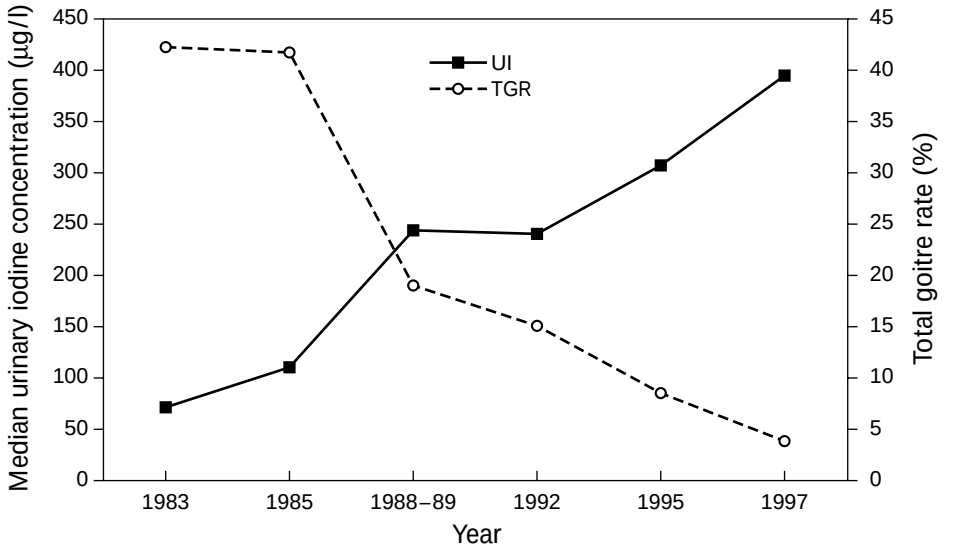

FIG. 2. Median urinary iodine concentration (UI) and total goitre rate (TGR) in nine counties during 1983–1997

nary iodine was above 250 μg/L. The proportion of adequate salt iodine levels was above 90% in all counties.

Discussion

In Jiangsu Province, as in other areas of China and the world, iodization of food-grade salt is the main measure to prevent the public health consequences of iodine deficiency. As evident from the prevalence of goitre in more than 25% of the schoolchildren during surveys in the early 1980s, the population did not obtain sufficient iodine from foods grown indigenously. The low iodine content in drinking water indicated that the iodine deficit was of environmental origin. It also appeared that the nine counties presently under review were the most severely affected. If elimination of iodine-deficiency disorders by salt iodization could be accomplished in these counties, its achievement in other parts of the province, where iodine deficiency was milder, was considered to be less problematic.

The combined population of the nine counties is 5 million, and the geography is hilly and mountainous. Since 1985 the salt-iodization efforts by counties have formed part of an overall strategy to ameliorate iodine deficiency in the population, and prior to 1997 oral iodized oil was distributed annually by health workers to high-risk groups of schoolchildren and women of child-bearing age. Public health surveillance of salt iodine levels and population indicators of iodine-deficiency disorders was also part of the programme from its inception.

The results from the province- and county-based surveillance system indicated that the nine counties have made progress continuously during the past 12 years in supplying iodized salt and reducing iodine-deficiency disorders. The median urinary iodine concentration of the population has remained above 100 μg/L in each

TABLE 2. Salt iodine and population indicators of iodine-deficiency disorders in nine counties of Jiangsu Province, 1997: Results of counties' self-evaluation

	TGR (%)		UI (mg/L)			Salt iodine adequacy	
County	*n*	Palpation	*n*	Median	Range	*n*	% adequacy
Gaoqun	1,200	2.6	360	670	100–2,500	750	94
Jiangning	1,200	2.8	360	322	25–3,881	897	94
Jiangpu	1,200	4.7	360	358	103–712	750	93
Jintan	1,200	4.5	360	339	60–1,540	750	94
Jurong	1,200	3.8	360	257	65–3,083	750	99
Lishui	1,200	4.9	360	318	130–701	750	100
Liyang	1,200	4.8	361	346	34–2,729	750	100
Luhe	1,200	2.4	360	363	81–801	750	100
Xuyi	1,200	5.1	360	420	24–992	750	93

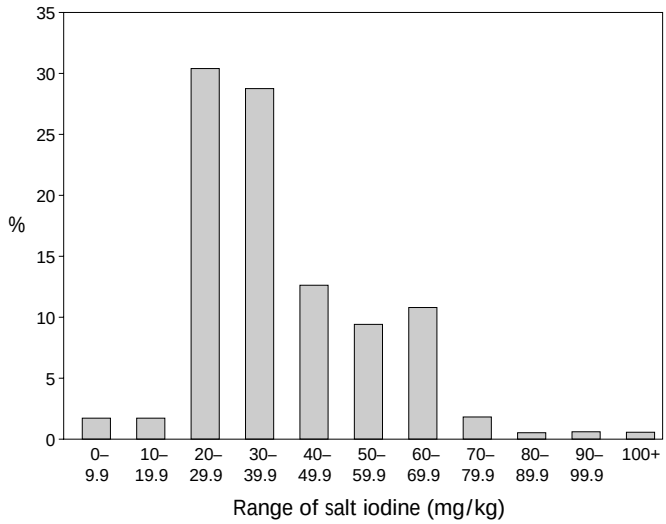

FIG. 3. Salt iodine contents in 6,897 households in nine counties in 1997

county since 1985, and the total goitre rate decreased steadily from above 40% in 1983 to below 5% in 1997. Although the use of iodized oil may have contributed to the urinary iodine improvement, the extent of its contribution is unknown. From the observations it is clear, however, that the use of iodized oil should be discontinued.

An effort was made in 1997 by county and provincial authorities to verify the results obtained from surveillance, including the collection of evidence about whether iodine-deficiency disorders had been eliminated in these counties. The design included the collection of salt iodine and population indicators of iodine-deficiency disorders by county officials, complemented by special independent verification of the data by a multisectoral provincial team. Overall, the results obtained by the counties and the provincial team satisfy the criteria recommended by an international expert group [7]. At least 90% of the household salt brought from home for testing at school by a random selection of schoolchildren had ≥20 ppm iodine, and the total goitre rate in schoolchildren according to palpation was 3.9% for all counties combined. The total goitre rate according to ultrasound was 3.6% on average for all counties. The true prevalence is probably less, however, because the early study [11] is now known to have overestimated goitre status [12]. It is concluded, therefore, that iodine-deficiency disorders in the nine counties of Jiangsu have been eliminated as a public health problem. This means that the consequences of iodine deficiency, such as new cases of endemic cretinism and mental retardation due to iodine deficiency in utero, are extremely rare or nonexistent.

The provincial team concluded from their review of salt production and supply and iodine information-management systems that the mechanism of salt iodization, distribution, and monitoring established in the nine counties was potentially sustainable. At the same time, it must be understood that the iodine deficit of the environment will not be improved by intro-

TABLE 3. Salt iodine and population indicators of iodine-deficiency disorders in nine counties of Jiangsu Province, 1997: Results of provincial verification

	TGR (%)			UI (mg/L)			Salt iodine adequacy	
County	*n*	Palpation	Ultrasound	*n*	Median	Range	*n*	% adequacy
Gaoqun	400	3.0	3.0	120	630	100–1,030	124	96
Jiangning	400	3.3	4.5	124	436	25–3,881	322	91
Jiangpu	400	2.8	3.3	120	358	101–708	125	98
Jintan	400	3.3	3.5	120	739	39–1,244	129	100
Jurong	400	3.0	3.5	118	246	60–809	125	100
Lishui	400	3.3	5.0	120	309	128–578	125	100
Liyang	400	3.5	4.0	120	290	23–3,879	125	96
Luhe	400	3.0	4.5	121	525	86–1,028	127	94
Xuyi	400	5.0	6.3	120	427	40–976	122	99

ducing iodine into the food supply. It should be kept in mind that in some countries, after iodine deficiency had been controlled, iodine-deficiency disorders re-emerged when governmental, industrial, and popular support for the programme decreased [13]. It was recommended, therefore, that the efforts to maintain regular monitoring of iodized salt and surveillance of the prevalence of iodine-deficiency disorders should be continued.

Salt iodization is a successful measure to eliminate iodine-deficiency disorders, and since its introduction in 1985, iodized salt has been the main food source of iodine in these nine counties. As shown in figure 3, the salt iodine content observed in households in 1997 was very variable, and 40% of the samples had iodine contents outside the expected range of 20 to 40 mg/kg. This indicates the need to improve quality assurance at the production sites. Also, although the median urinary iodine concentration in the population of the counties was ≥250 μg/L, urinary iodine concentrations above 800 μg/L or below 100 μg/L were observed in individuals in casual samples. Thus, a certain proportion of the population may have had a very high or a very low iodine intake, due to variability in salt intake or iodine content. Hyperthyroidism from high salt iodine intake has been reported in a number of countries [14], while on the other hand, low iodine intake may continue to impair children's normal brain development. It is necessary to strengthen quality assurance of salt production and reassess the assumption of iodine loss during supply to ensure that the urinary iodine concentrations of the population fall between 100 and 200 μg/L, as recommended by WHO [15].

The elimination of iodine-deficiency disorders from nine counties in Jiangsu Province is a small initial success in accomplishing the national mission launched in 1993 to eliminate iodine-deficiency disorders in China. The approach and methodology applied in this survey may serve as an example for other parts of China as to how the status of iodine-deficiency disorders in a population could be assessed and conclusions drawn to preserve the success of iodine-deficiency disorders elimination, once achieved.

Acknowledgements

The evaluation mission was supported by the Office for Endemic Disease Control, Jiangsu Provincial Government. We thank the governments and salt producers in the nine counties. We are grateful to Dr. P. H. Wang, Mr. X. X. Yang, Mr. Z. G. Chen, Mr. D. M. Zhang, Dr. T. Y. He, Mr. T. Z. Zhang, and others for their involvement in data and sample collection, and laboratory analysis. We also thank the children and their families for their participation in the surveys.

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Knowledge, attitudes, and practices of people in Ulaanbaatar, Mongolia, with regard to iodine-deficiency disorders and iodized salt

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Abstract

In 1995 Mongolia introduced a national programme of salt iodization to eliminate iodine-deficiency disorders. To investigate the extent of acceptability and utilization of iodized salt, a study of people's knowledge, attitudes, and practice (KAP) was carried out in the capital city, Ulaanbaatar, in 1996 and 1997. A total of 838 people (housewives, parents of schoolchildren, post-partum women, and pregnant women) were interviewed about their KAP regarding iodine-deficiency disorders and iodized salt. In addition, the amount of salt consumption at the household level was examined. Over 95% of the study population knew about iodine-deficiency disorders and iodized salt, and most of them received the information from television and radio. About 90% of them had already used iodized salt. The price of iodized salt is a little higher than that of common salt, but it is still affordable for most people. This study demonstrates the possibility of the expansion of the programme nationwide.

Introduction

Iodine-deficiency disorders have been recognized as a public health problem in 118 countries worldwide, and there are approximately 1.5 billion people at risk [1, 2]. Iodine deficiency particularly affects pregnant women, foetuses, neonates, and children and causes mental and physical disorders [1–4]. Iodine deficiency is a preventable health problem, and its impact on socio-economic development has also been recognized globally during the last decade.

As an intervention, salt iodization is the most effective public health approach for the elimination of iodine-deficiency disorders without side effects [5–9]. In fact, a dramatic decrease in the prevalence of goitre from the use of iodized salt was reported in Pakistan, Finland, and Austria [10–12]. The effectiveness of salt iodization was also confirmed biochemically by the examination of urinary iodine excretion in Finland [11].

Mongolia, a landlocked country in the northern part of Central Asia, has severe endemic iodine-deficiency disorders. A nationwide survey of goitre prevalence conducted from 1992 to 1994 indicated a high goitre rate of approximately 30% in both mothers and children [13–15]. In 1992 the Mongolian government pledged the elimination of iodine-deficiency disorders by the year 2000. A limited salt-iodization programme was initiated in 1995. By 1996 domestically produced iodized salt made up approximately 42% of the total salt consumption in Mongolia [15]. In a report issued by UNICEF in 1994, daily salt consumption was estimated to be 5 g per capita [16].

Although salt iodization is progressing well, it is important to know how much iodized salt is consumed by Mongolians and to assess their knowledge about iodized salt consumption and iodine-deficiency disorders. Therefore, a study estimating salt consumption and evaluating people's knowledge, attitudes, and practices (KAP) was conducted in 1996 and 1997.

Methods

The study was conducted in two phases during November 1996 and April 1997. During the first period, KAP and salt intake were examined in three groups: parents of schoolchildren, post-partum women, and households. During the second period, the same study was conducted with pregnant women.

Study participants

Parent group

The parents of 300 randomly selected children (189 mothers and 95 fathers) from 30 randomly selected schools in Ulaanbaatar were requested to answer a self-administered questionnaire regarding their KAP on iodine-deficiency disorders and iodized salt, and the

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price and kind of salt that they used. Samples of salt used in the home were collected and analysed for iodine by the titrimetric method. The mean age of the mothers was 38 ± 5.4 years (range, 28–58), and the mean age of the fathers was 41.0 ± 6.8 years (range, 28–67). There were no significant differences between the responses of the mothers and the fathers.

Post-partum group

One hundred forty-three women admitted to four public maternity hospitals, which handle almost all deliveries in Ulaanbaatar, were interviewed by trained staff on the third day after delivery using the same questionnaire that was used with the parent group. The mean age of the women was 25.0 ± 5.2 years (range, 15–40). Two women refused to participate in the study.

Pregnant group

The second phase of the KAP and salt intake measurement study was carried out with 144 pregnant women who attended three Public Health Units in Ulaanbaatar. Their mean age was 26 ± 5.6 years (range, 17–41). Thirteen (9%), 54 (37%), and 80 (54%) were in their first, second, and third trimesters, respectively. They responded to the same questionnaire used during the first phase of the study but were also asked some additional questions regarding the possession of a television set and radio in their homes. No women refused to participate. From this group, 64 women were randomly selected to participate in a salt-consumption study.

Household group

To measure salt consumption, 264 households were randomly selected from six central districts in the city. One woman of reproductive age, with children, from each household was selected to participate in the study. The mean age of the women was 33.1 ± 5.4 years (range, 20–54). Only six households refused to participate.

Estimation of salt intake

The household participants and the 64 randomly chosen pregnant women agreed to use iodized salt, provided by the study investigators, for two weeks. The weight of salt remaining after two weeks was used to determine consumption. The female head of the household provided data on sex, age, number of meals consumed, and the estimated food intake at home for each family member. To estimate the relative amounts of food intake within the family, a score of 1.0 was assigned to the person who ate the most. Each family member was then given a score relative to 1.0 based roughly on his or her food intake; e.g., the housewife score was 0.8. Family members were categorized into four age groups: 1 to 4, 5 to 9, 10 to 14, and 15+ years. It was assumed that salt intake correlated with food intake and that people ate equal portions at each meal. The women recorded the meal frequency of each member and house guests during the study period. The salt intake was calculated from these data. This study did not take into account salt consumed outside the home or contained in processed foods.

Market study

The study staff visited 57 randomly selected retailers in the six central districts of Ulaanbaatar. They obtained information about the kind of salt sold, its price, and the prices of several foods. The retailers surveyed were chosen to represent the different types of sellers throughout the city.

Statistical analysis

Student's *t* test was used to test the difference between two means, and the chi-square test was used to test the difference between population proportions.

Results

Knowledge

The parent group and the post-partum group were asked if they had heard of iodine-deficiency disorders and iodized salt, and the consequences of iodine-deficiency disorders. All participants had completed elementary school and most had completed high school.

Of 284 parents, 273 (96%) were aware of iodine-deficiency disorders and 260 (92%) knew about iodized salt, whereas of 143 post-partum women, 139 (97%) knew about iodine-deficiency disorders and 140 (98%) knew about iodized salt. When they were questioned about their knowledge of the consequences of iodine-deficiency disorders, more participants knew about goitre than any other consequence (96% of the parents and 99% of the post-partum women). Mental retardation was the least well known consequence, although more than 80% of both groups responded that it was one of the consequences of iodine-deficiency disorders. Growth failure was recognized by 96% of the post-partum women and 89% of the parents as a consequence of iodine-deficiency disorders; however, the difference was not significant. The sources of the information about iodine-deficiency disorders and iodized salt available to these populations were examined. More than 90% of the respondents obtained information about iodine-deficiency disorders from television, followed by radio, articles in the newspaper and other written material, and medical personnel (table 1). Similarly, more than 80% of both groups received information about iodized salt from television, followed by radio and newspapers (table 2). In the group of pregnant women, 97% owned a television set and 87%

TABLE 1. Sources of information about iodine-deficiency disorders among parents and post-partum women (percentages, multiple responses)

Source	Parents	Post-partum women
Television	91	97
Radio	52	73
Newspapers	52	43
Written materials	23	43
Medical personnel	26	22
Family members	15	6
Teachers	13	1
Friends	11	3
Others	2	0

TABLE 2. Sources of information about iodized salt among parents and post-partum women (percentages, multiple responses)

Source	Parents	Post-partum women
Television	81	94
Radio	46	72
Newspapers	45	41
Written materials	22	43
Medical personnel	35	14
Family members	14	3
Teachers	10	2
Friends	1	0
Others	1	2

owned a radio. The mass media campaign was conducted with the collaboration of the UNICEF Mongolia office and the Mongolian government. Throughout 1996, nine 20-minute radio programmes on iodine-deficiency disorders and iodized salt were broadcast every week, for a total of 150 hours, and two 30-minute television programmes were each broadcast twice. In addition, when the people were asked when they watched television at home, many of them responded that they kept television on continuously during broadcasting hours (7 a.m. to 8 a.m. and 6 p.m. to midnight). Moreover, many offices (governmental and private) keep radios turned on all day.

Attitudes

Four questions on iodine-deficiency disorders and iodized salt were asked only of pregnant women: "Are iodine-deficiency disorders a health problem?" "Does iodized salt prevent iodine-deficiency disorders?" "Is iodized salt good for your baby?" "Is iodized salt good for you?" Over 95% of the women answered in the affirmative to each of these questions.

A question about the taste of salt was asked of the household and the pregnant groups. More than 40% responded that iodized salt tasted different from common salt (table 3). Of the 66 pregnant women who answered yes, 57 (86%) said that iodized salt was less salty and 6 said it was bitter. A sub-study, testing for difference of "saltiness" between the two salts, was carried out among pregnant women, using a double-masking procedure. Sixteen (36%) of 44 respondents answered correctly, 22 (50%) answered incorrectly, and six could not distinguish between the salts.

The household and pregnant groups were asked if they used more or less salt when they used iodized salt. More than 57% of the participants said that they used more (table 3). Of the 99 pregnant women who said they used more salt when they used iodized salt, 82 (82%) said they thought they needed more salt to pre-

TABLE 3. Attitudes towards the taste and use of salt in households and among pregnant women—no.(%)

Question	Households (n=234)		Pregnant women (n=144)	
	Yes	No	Yes	No
1. Is the taste of iodized salt different from that of common salt (less salty, bitter, other)?	100 (43)	134 (57)	66 (46)	78 (54)
2. I use a larger amount of salt when I use iodized salt than when I use common salt	133 (57)	101 (43)	99 (69)	45 (31)
3. I use a larger amount of salt when I use iodized salt because it is less salty[a]	–	–	17 (17)	–
4. I use a larger amount of salt when I use iodized salt because I should consume more to prevent iodine-deficiency disorders[a]	–	–	82 (83)	–

a. Questions 3 and 4 were only asked of pregnant women who answered yes to question 2.

vent iodine-deficiency disorders, and 17 (17%) said it was because iodized salt tasted less salty.

The three groups were asked about purchasing iodized salt. Eighty-four percent of the parent group, 94% of the post-partum group, and 99% of the pregnant group said they were willing to purchase iodized salt. The post-partum and pregnant groups were significantly more likely than the parent group to be willing iodized salt ($p < .01$).

Practices

All four groups were asked if they used iodized salt, and more than 83% of the respondents answered affirmatively (table 4). In the household and pregnant groups, a further question was asked about whether they used iodized salt exclusively or used both iodized salt and common salt. Sixty-nine percent of the household group and 60% of the pregnant group said they used iodized salt exclusively.

The parent and the post-partum groups were asked about household salt consumption for a month. Most people said they purchased 2 to 3 kg per month per household. Furthermore, of 288 salt samples collected from the parent group, 210 (73%) contained more than the recommended level for households of 20 ppm iodine.

Measurement of salt consumption

Daily salt consumption at home was estimated in the household and the pregnant groups. In the household study, the mean individual daily salt consumption was 12.4 g for adult males and 8.3 g for adult females (table 5). The mean salt consumptions of the adult male and of the adult female in families with pregnant women were 14.3 g and 10.1 g, respectively (table 5). The mean salt intakes for both males and females in the families of the pregnant group were significantly higher than those of the household group (male, $p < .05$; female, $p < .01$).

Iodized salt sales and price in the market

Of 57 retailers, 40 (70%) sold only iodized salt, 6 (11%) sold only common salt, and 11 (19%) sold both kinds of salt. The price of iodized salt ranged from US$0.32 to $0.50 per kilogram. Similarly, prices of common salt ranged from US$0.13 to $0.35 per kilogram. The cost difference between the two kinds of salts (US$0.15) was equal to the price of an egg, a half-loaf of bread, or a glass of milk.

Discussion

From a public health perspective, it is encouraging that almost 90% of the study population already used iodized salt within one year of the introduction of the salt-iodization programme. It is also important to note that more than 90% of the people knew about the relationship between iodine-deficiency disorders and iodized salt. The study population recognized iodine-deficiency disorders as an important health problem, and they accepted iodized salt as a good tool to prevent iodine-deficiency disorders. Although it is possible that the participants tried to give the answers to the interviewers they thought might be most favourable, there is no evidence that they had been exposed to surveys of this type, and they seemed to appreciate being asked to participate.

Although 83% of the parent group said they had ever used iodized salt, only 73% of salt samples taken from their homes were iodized. This is probably because there are three types of iodized salt users: exclusive users, occasional users, and users of both iodized and non-iodized salt. Although it has not been clearly examined how much occasional use of iodized salt or simultaneous use of it with common salt prevents iodine-deficiency disorders, it is important to increase the number of people who use only iodized salt.

TABLE 4. Participants using iodized salt, according to study group—no. (%)

Group	Using	Not using
Parents	238 (84)	46 (16)
Post-partum	132 (92)	11 (8)
Household	182 (69)	30 (11)
Only iodized salt		
Iodized salt and common salt	51 (19)	
Total	234 (89)	
Pregnant	88 (60)	3 (2)
Only iodized salt		
Iodized salt and common salt	56 (38)	
Total	144 (98)	

TABLE 5. Salt consumption (g) among household members and pregnant women according to age and sex—mean ± SD

Category	Households (n=264)	Pregnant women (n=64)
Adult males	12.4 ± 5.4**	14.3 ± 6.1**
Adult females	8.3 ± 3.7*	10.1 ± 3.9*
Children 10–14 yr	8.4 ± 4.0	10.5 ± 5.1
Children 5–9 yr	6.0 ± 2.9	7.0 ± 3.1
Children 1–4 yr	4.3 ± 2.7	4.1 ± 2.6

* $p < .05$.
** $p < .01$.

In Ulaanbaatar television was found to be the most popular and effective source of information, and almost all households of the pregnant women surveyed owned a television. Radio was identified as the second most effective mass media source for public health education. More people in rural areas of Mongolia have access to radio than to television. In a report from Peru, the investigators found that interpersonal communication was the most effective means to disseminate health information in rural areas [17]. Although this has not been studied in Mongolia, we suggest that television and radio programmes, with the addition of trained health educators, should be the focus of a nationwide programme to promote the elimination of iodine-deficiency disorders through increased consumption of iodized salt.

In general, iodized salt costs more than common salt because of its additional processing cost. In Ulaanbaatar, however, people had no difficulty purchasing iodized salt. In fact, the difference in monthly expenditure for iodized salt and common salt for a household was approximately US$0.30, equivalent to the cost of a loaf of bread or two eggs. The current cost of iodized salt may not be acceptable in some rural areas. Rock salt is commonly used in rural areas, and it is much cheaper than in Ulaanbaatar (about US$0.04–0.13 per kilogram). In general, purchasing power is lower in rural areas. Therefore, some intervention strategies may need to be considered. One strategy might be to add iodine to salt in the home or in a community centre or to provide the iodine capsule to individuals.

Although information on iodine-deficiency disorders and iodized salt was well disseminated to people in Ulaanbaatar, caution should be taken about the content and correctness of the information. For instance, about half of the pregnant and household groups said the taste of iodized salt was not the same as that of common salt; however, in a double-blind study they could not distinguish this difference. Nearly 60% of the household and pregnant groups incorrectly believed that they should use more salt when they used iodized salt. Increased salt intake may cause some physical problems, especially in pregnant women and people with cardiovascular diseases. Health information messages should incorporate these findings.

Salt iodization was recommended by the World Health Organization/UNICEF/International Council for the Control of Iodine-Deficiency Disorders as the means of eliminating iodine-deficiency disorders [1]. The reasons that many countries are not able to achieve 90% usage include political factors and logistical problems in production and distribution [18–20]. Moreover, a country with numerous small-scale salt producers and scattered local markets may take many years to achieve universal salt iodization.

In contrast, Mongolia seems to likely to achieve a sufficient level of salt iodization within a few years. There are several reasons for this. All nine domestic salt factories were able to produce iodized salt from 1996. The government allowed the importation only of iodized salt from May 1997. People in Ulaanbaatar became highly aware of iodine-deficiency disorders through an extensive media campaign. Finally, Mongolia has a high rate of literacy (83%) [21] and level of education, which allowed the public to understand and act upon information regarding iodine-deficiency disorders and iodized salt. These encouraging results will provide a strong incentive for a national expansion of the iodine-deficiency disorders programme throughout the country. The success of a national programme will be enhanced by the recent interest of some international donor agencies in collaborating with this programme, such as the Japan International Cooperation Agency. Therefore, we believe that iodine-deficiency disorders will be controlled by the year 2000 in Mongolia.

Acknowledgements

We thank Dr. M. Irie, representative of the Japanese Branch of the International Council for the Control of Iodine-Deficiency Disorders, the UNICEF Mongolia Office, and the Japan International Cooperation Agency for their technical and financial support to this study. A special acknowledgement goes to Dr. K. Enkhjargal, Director of the Public Health Department, Mongolian Ministry of Health and Social Welfare, for her technical and administrative contribution to this study.

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Indigenous knowledge of wild food hunting and gathering in north-east Thailand

Prapimporn Somnasang, Geraldine Moreno, and Kusuma Chusil

Abstract

Rural people in north-east Thailand depend on locally gathered or hunted wild food, such as fish, crabs, snails, shrimps, birds, red ants' eggs, frogs, toads, rabbits, rats, insects, and many kinds of plants. Twenty rural villages in north-east Thailand were surveyed, and one village was studied in depth. The objective was to identify knowledge about hunting and gathering of wild food and gender-based differentiation associated with this knowledge. The study showed that the knowledge related to hunting and gathering wild food was different for women and men. Men had more knowledge of fishing and hunting; women had more knowledge of gathering plants and insects and of scooping for shrimp. These findings should be used in developing appropriate programmes to help the local people.

Introduction

Many societies throughout the world rely heavily on wild plants and animals [1] that provide a rich source of nutrients [2]. Wild plants also supply material for housing, shelter, and crafts; plants and animals provide items for religious observances; and both are important sources of income that can be vital for women, children, and the poor.

Moreno-Black and Price [3] have shown that wild food plays an important economic role among the rural poor in north-east Thailand (Isan). The north-east is the poorest part of the country and includes about one-third of its area and population. Poor rural agricultural families depend on wild plants and animals, which they also sell in local markets [3–7]. Indigenous knowledge of wild food and techniques for obtaining it is crucial for their survival [8–10].

The collection and use of wild food is differentiated according to economic level, social class, and gender. The poor rely on wild food because they cannot afford to buy food, and women and men frequently obtain different kinds of foods. Knowledge of what kinds of wild food to obtain and of where, when, and how to obtain them generally differs between men and women. However, we need to be careful not to allow preconception to influence our expectation as to who is knowledgeable in different societies. For example, Browner [11] found that, contrary to expectations, many men in a Mexican village were more knowledgeable than women about medicinal plants used for women's reproduction and about women's reproductive health problems. We should take gender-based distribution of power into account in analyses of intracultural variation.

The objective of this study was to identify knowledge about hunting and gathering of wild food and gender-based differentiation associated with this knowledge in north-east Thailand.

Methods

The study was done in two phases. First, a survey of 20 rural villages in Surin, Roiet, and Mahasarakam Provinces was conducted between January and March 1995. This survey provided general information about how the people hunted or gathered indigenous food and how they obtained their knowledge of such food. This information was used to determine what specific wild-food gathering and hunting activities to study in depth in one typical village in the second phase of the study. The in-depth study of Ban Fang village in Khon Kaen Province was conducted between January and September 1995.

The survey of the 20 villages was conducted by the rapid rural appraisal (RRA) method [12–14]. Researchers in nutrition, social science, and agriculture were

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involved in this multidisciplinary study. The headman in each village was interviewed to determine the social status of the people in the village, and the team of researchers interviewed both men and women in three to six households that were categorized as poor, middle-class, or rich. This permitted a triangulation of differences with economic status.

The guideline open-ended questions for the RRA were as follows:

» Do you consume wild food (products of wild plants and animals)?
» What wild plants and animals do you and your family consume in each season?
» How do you gather or hunt those foods? What methods, tools, or special equipment are used?
» Do men, women, children, or old people gather or hunt those foods?
» Who makes the tools? How do you know about the tools?
» From whom or where did you learn about this?
» Who gathers or hunts with you?
» When do you gather or hunt those foods (any time of the day, daytime, nighttime)?
» Where do you gather or hunt those foods?

While the survey of the 20 villages was being conducted, the in-depth study of the village of Ban Fang was also started. The village was chosen because, according to the district information, it represented a typical village that still depended on wild food. It was within an hour of Khon Kaen by car.

The qualitative methods included guided but open-ended interviewing, participant observation, and focus groups. After a period of extensive participant observation, six focus-group sessions were held in the village. These groups contained from four to eight persons, and group composition was determined by gender criteria (table 1). Groups 1 to 4 were asked to talk about the role of women and men in the family, decisions made concerning what to eat, who obtained food for the family, and who cooked food. Groups 5 and 6 were asked to talk about their indigenous knowledge about hunting and gathering wild food, from whom they learned it, and how they did it.

The participant observation included activities with men and women, such as hunting and gathering fish, crabs, snails, shrimp, birds, red ants' eggs, frogs, toads, rabbits, and rats. All the methods, tools, and equipment were recorded and photographed.

Study site

The 20 villages were surveyed by the RRA method at the same time as a health assessment team from the Khong Chee Moon Project was evaluating the impact of proposed irrigation canals on this area of the northeast. Men and women in three to six households in each village were interviewed.

TABLE 1. Composition of focus groups

Group	No. of people	Sex	Mean age (yr)	Age range (yr)
1	8	F	40	27–54
2	5	M	54	42–68
3	6	F	43	30–50
4	4	M	49	37–56
5	5	F	39	26–52
6	5	M	42	25–50
Total	3	19 F 14 M	30 F 33 M	25–68

The village studied in depth is in a remote area near both mountains and forest about 48 km from Khon Kaen. Villagers still depend largely on wild food and other items in the forest and aquatic animals in a natural reservoir. There were 112 houses in the village with a total population of 583 people (309 males and 274 females). The most important agricultural crop was rice. Only one crop of rice could be grown per year because of the lack of water. If the rainfall was not good, rice production suffered. Other crops grown in the village were cucumbers, corn, betel nut leaves, asparagus, and other green vegetables. The average yearly household cash income was US$1,581.

Gender-based patterns of knowledge

Data from the 20 villages showed that most people still consumed both wild and cultivated food daily. Wild foods were available in paddy fields, ponds, reservoirs, forests, and mountainous areas. The availability of wild food depended on the season. During rainy years, wild food was usually abundant. If the agricultural yield was poor, people depended more on wild foods rather than buying food. Most people, both rich and poor, preferred wild food to cultivated food. Therefore, wild foods were not only for the poor. People who did not hunt or gather wild foods purchased them from those who did. Some villagers also sold wild foods in a market in the town. Examples of wild food eaten daily are wild plants with *jeaw* or *pon* (spicy dips), fish (usually boiled with vegetables, curried, or roasted), frog spicy soup or dip, mushroom soup, and roasted insects.

In the 20 villages studied, women did most of the gathering of plants, including mushrooms and bamboo shoots. They also scooped for shrimp, fish, and small insects; gathered snails and crabs; dug for insects; and gathered red ants' eggs. Normally men did most of the deep-water fishing and most hunting of birds, rats, rabbits, frogs, toads, and geckos.

Women in the focus groups claimed that they obtained more wild food for family use than men did. For example, they stated:

» Women gather wild food and animals more than men.
» Women bring food to the family more than men.
» Men do not gather food because they have other work to do, such as working in paddies, growing plants, preparing plots, cutting wood, constructing houses, or working in cities.
» We gather plants in the paddies, uplands, swamps, and forests almost every day. We also scoop for fish and small shrimp and gather snails and crabs.
» Men catch fish in deep water and use guns to hunt for birds and wild animals.
» Women do not hunt birds and animals because we do not know how to use a gun and we cannot go into the deep forest (48-year-old woman).

Women took children with them to gather wild food when there was no one to look after them at home. In this way, children learned how to recognize different kinds of plants and animals and where, when, and how to find them. Boys often accompanied their fathers when they went fishing and hunting, so they learned these skills. Thus, indigenous knowledge of how to hunt and gather wild food is passed down from one generation to another.

» When I was young my mother took me to gather wild plants and animals with her. She taught me how to recognize and gather them, and when to find them in each season. I remembered helping her gather *dork grajaew* and mushrooms in the forest. It's fun. We would dig for crabs in the paddy in the hot season. We went to gather red ants' eggs together. I also helped her scoop for shrimp and water insects (*maeng langum*). I watched my mom make nets for scooping and my grandfather make and mend fishing nets. He also made *khong* from bamboo to put fish in (50-year-old woman).
» My father taught me how to use a net to fish, a gun to shoot birds, rubber bands and a stick to hit birds, and many kinds of bamboo traps to catch rats and ground lizards (56-year-old man).

The traditional division of labour contributes to the differences in knowledge between men and women. Women are knowledgeable about wild plants, including tubers, mushrooms, bamboo shoots, and fruits. They know how to find them, when and how to gather them, how to cook them, and how to preserve them. Edible plants in the forests and upland include *meg, teaw, gradone, kramanoi, bond, dork grajew, erok*, bamboo shoots (*nor mei*), and mushrooms. Women usually gather plant food, but the men will help gather plant food items that are too high for women to reach. However, women try to do most of the gathering by using a long stick, sometimes with a knife attached. Women gather fruits and other plant parts by hand, using spades or knives to cut tough plants if necessary. The women like to go in groups with relatives and friends to gather mushrooms and bamboo shoots. This is considered fun, it provides delicious meals, and the surplus can be sold in the market. Men sometimes join women in the forest to help in the gathering, act as companions, and carry heavy food back. Plants in paddies and other aquatic areas, such as *nork, ehin, van,* morning glory, and *pak bung,* are picked by women if the water is not too deep. Women also transplant some plants to their home or paddy gardens so they can have them to eat all year. Thus, some of the plants become cultivated and eventually domesticated.

Women are experts in scooping for small fish, shrimp, insects, and water animals in swamps or shallow water, using a home-made round net. The insects they catch include *maeng neal, maneng langum, maeng grachon,* and *maengda.* They take their children with them, since they have to take care of them. Women and children gather crabs and snails more frequently than men. They scoop the animals from the swamp or pick them out of the water or mud. In the dry season, they dig the animals from the paddy or from buffalo dung with a spade, using a bamboo container (*khong*), basket, or bucket to carry their catch back home. Sometimes men also collect crabs and snails if they happen to find them on the way home.

Red ants' eggs are considered delicious. They are eaten only at the end of the cool season and the beginning or middle of the hot season. Women are the primary gatherers, but men also participate if they go in a group to gather them to sell. Some villagers earn quite a lot of money by selling red ants' eggs.

Men, on the other hand, are expert in fishing and hunting for wild animals such as ground lizards, birds, rats, rabbits, snakes, wild chickens, wild pigs, geckos, frogs, and toads. Men usually are responsible for providing fish for the family. They use many kinds of tools to catch fish, depending on the level of water and the season. They know how to use different kinds of fishing nets, such as *haa, auan, yor,* and *dang.* They also use homemade fishing rods. Sometimes they catch fish with a *pu* blowpipe, which consists of a long bamboo stick with an arrow made of a thin sharp stick wrapped with cotton. They use many kinds of bamboo traps to catch fish and other aquatic animals such as shrimp.

Only men and boys hunt and trap birds. The method depends on the kind of bird. For example, *grata* birds are caught by using a decoy bird in a cage; the bird's singing attracts other birds, which are caught in a net around the decoy. Another method uses a large net held between two long poles in a sugarcane plantation. When a flock of birds comes to rest on the sugarcane, five to seven men chase them in the direction of the net, where they are caught. This is a popular way to catch *omsael* birds in the cool season. The men divide the birds to eat or to sell. They also hunt birds with the *pu* blowpipe.

The rat that is most popular for food is the white rat (*noo khao*), which lives in paddies. The villagers do not eat house rats because they are considered dirty. Men and boys hunt white rats with slingshots. They

also use a net (*sing*) to catch rabbits as well as rats. The *sing* is placed on the ground with bait on it; when the rat or rabbit comes to eat the bait, it is caught in the net.

Frogs and toads can be gathered only from the rainy season until the beginning of winter. Immediately after a rain, men and older boys go in groups of at least two to a paddy or swamp to catch frogs. The best time to catch them is at night, using lights. Men also hunt frogs and toads during the day using the *pu.* Frogs, toads, and tadpoles are considered delicious protein foods that can also be sold for a good price in the market.

Insects, red ants' eggs, and bamboo shoots are gathered by both men and women. Many insects are available in different seasons, and they are also a good source of protein. Women and children scoop or dig insects (*maeng kutgee*) from the ground in the dry season. At night men and boys use long neon lights to attract insects, which then fall into a bucket of water.

Discussion and conclusions

Rural people in north-east Thailand pass knowledge of how to hunt and gather wild plants and animals from generation to generation. They learn how to survive in the driest part of the country on wild foods and supplement the main staple of rice, which they consume in large quantities at each meal. Wild plants are an important source of vitamins and minerals (table 2). Fish, small shrimp, snails, frogs, birds, and insects are all good sources of protein and energy (table 3; see table 4 for local, English, and scientific names of food plants and animals). The availability of these wild foods varies with the season, and they usually are important components of the diet when they are available.

Villagers have experienced a decrease in the availability of wild foods as a result of the massive deforestation that has been going on for years in Thailand. Some species of plants and animals have disappeared completely. Ecological changes have affected the remaining species also. Even though women have transplanted some species close to their homes, many do not survive outside their natural setting. In some areas insects and plants are no longer safe to eat because of chemicals that have been introduced into the environment.

Indigenous knowledge of how to gather wild food is most critical to the poor. The knowledge is passed down in the family. Children learn the varieties of plants and animals when they go hunting and gathering for food with their parents or relatives.

Rocheleau et al. [8] pointed out that local knowledge of native plants is very important. We also emphasize that rural people have an impressive knowl-

TABLE 2. Nutritional value of wild plants per 100 g

Plant[a]	Moisture (g)	Protein (g)	Fat (g)	Carbohydrate (g)	Fibre (g)	Ash (g)	Energy (kcal)	Ca (mg)	P (mg)	Fe (mg)	Na (mg)	K (mg)	Vitamin B_1 (mg)	Vitamin B_2 (mg)	Niacin (mg)	Vitamin C (mg)
Pak kadon	73.5	2.9	0.5	17.8	3.9	1.4	87.3	57.5	48	2.5	77.9	267	0.12	0.15	NA[b]	7.75
Pak khom	88.3	3.9	0.6	2.9	1.0	3.2	32.8	318	69	NA	49.2	475	0.03	0.26	1.01	22.9
Lin pak kee lek	70.6	5.8	0.7	18.1	3.6	1.9	103.4	125.8	160.7	3.7	28	516.5	0.55	0.42	2.94	21.7
Teaw	76.3	2.7	1.1	18.0	2.3	1.3	90.6	47.8	53.3	2.5	35.6	365	0.12	0.33	1.21	14.5
Pak bung	93.1	1.6	0.5	2.3	1	1.3	20.4	43.1	49.3	2.2	89.9	268	NA	NA	NA	NA
Waan	91.6	2.0	0.1	3.2	1.7	1.4	21.3	33.3	53.8	NA	79.0	369	NA	0.2	1.36	0.5

Source: ref.. 15.
a. Available local, English, and scientific names can be found in table 4.
b. Not yet analysed.

TABLE 3. Nutritional value of fish and other animals per 100 g

Animal[a]	Energy (kcal)	Moisture (g)	Protein (g)	Fat (g)	Carbohydrate (g)	Ash (g)	Ca (mg)	P (mg)	Fe (mg)
Dried zew (fish)	404.7	4.9	58.9	18.7	0.3	17.3	4,257	2,634	9.66
Dried khow (fish)	397.0	4.8	62.7	16.2	0.1	16.2	4,721	2,523	7.36
Fermented fish	88.0	52.0	13.0	4.0	0	31.0	1,857	1,276	5.1
Frog	351.7	5.4	75.1	5.7	0	13.8	3,564	2,045	10.8
Cricket	125.1	71.2	15.4	6.3	1.7	2.7	75.7	254	41.7
Red ant eggs	82.8	81.9	7.0	3.2	6.5	0.6	8.4	113	4.1

Source: refs. 15 and 16.
a. Available local, English, and scientific names can be found in table 4.

TABLE 4. Examples of wild foods eaten in north-east Thailand

Local name	English name	Scientific name
Plants		
Wean		*Marsilea crenata*
Pak khom (khen khom)	Chinese spinach	*Amoranthus gangeticus* Linn
Lin pak kee lek		*Cassia siamea* Britt
Kanjong		*Limnocharis flava*
Nork		*Centella asiatica*
Yopae		*Hydrocharis morsus-ranae*
Ehin		*Monochoria vaginalis*
Kayang		*Limnophila aromatica* Merr
Pinoy		*Tenagocharis latifolia*
Kipum		*Wolffia globosa*
Sommong		*Garcinia cowa*
Ob-ab		*Embelia subcoriacea* Mez
Erok		*Amorphophallus brevispathus* Gagnep
Kruamanoi		*Cyclea peltata*
Dork grajeaw (flower)		*Curcuma parviflora*
Teaw		*Cratoxylon formosum* Dyer
Linpi		*Emilia sonchifolia*
Linfa (pod)		*Oroxylum indicum*
Mark kheng		*Solanum trilobatum*
Markmao		*Antidesma acidum*
Kloy (tuber)		*Dioscorea hispida* Dennst
Monliam (tuber)		*Dioscorea alanta* Linn
Kha-pa	Wild galangal	*Languas* sp
Normai huak	Bamboo shoots	*Thyrsostachys siamensis*
Hed phungtam (mushroom)		*Careya sphaerica*
Whai	Rattan	*Calamus* spp
Bakbok (fruit)		*Iruingia malayana*
Kantong		*Sauropus androgynus*
Paew		*Polygonum odoratum*
Waan		*Melientha suavis* Pierre
Tamnin	Ivy gourd	*Coccinia grandis*
Paksienedit	Bratard mustard	*Cleome gynandra* Linn
Yaanang		*Tiliacora triandra* Diels
Bak-kheng		*Solanum torvum* Sv
Bak-wa		*Lepisanthes rubignosa* Leenh
Khawtonmak		*Paederia linearis* Hook
Pak bung	Morning glory	*Ipomoia aquatica* Forsk
Pak-sai	Bitter cucumber	*Momordica charantia* Linn
Pak-pan	Chinese chive	*Allium tuberosum* Roxb
Bak-khaeg		*Solanum torvum* Sv
Bak-tan	Common jujube	*Zizyphus rotundifolia* Lamk
Dokpaksarp		*Adenia viridiflora*
Pak-kradon		*Careya spaerica* Roxb
Hed-kra-darng		*Lentinus praeriqidus* Berk
Ma-muangpa	Wild mango	*Chibula retz*
Rarg-bua	Lotus root	*Nelumbo nucifera* Linn
Nhaam		*Lasia spinosa*
Mak-ngaew		*Lipisanthes rubiqnosa* Leenh
Kradon		*Careya herbacea* Roxb
Tuew		*Cratoxylon formosum* Dyer
Jik		*Barrintonia racemosa*
Bak-wah		*Lepisanthes rubignosa* Leenh
Sarb		*Adenia viridiflora* Craib
Som		*Rumax crispus* Linn
Bak-ngaew		*Nephelium hypoleucum* Kurz
Bak-waa		*Lepisathes rubignosa* Leenh
Mum koa gum	Yam	*Dioscorea* spp
Ma-duea	Fig	*Ficus* sp
Kii lec waan		*Cassia surattensis* Burmf
Ma-muangnoi	Mango	*Mangifera* spp
Dokbuahdang	Lotus	*Nympheae lotus* Linn
Dok-kajiew		*Curcuma aeruginosa* Roxb
Maipaipa	Bamboo	*Babusa* spp
Mun muasua	Lesser yam	*Dioscorea esculenta* Burk
Mun kaogum	Yam	*Dioscorea* sp
Bon	Caladium	*Caladium gigantea* Hookf
Fresh-water fish		
Pla khona		*Cirrhinus jullieni*
Zew	Rasbora	
Khow	Julien's mud carp	*Cirrhinus jullieni*
Frog	Tiger frog	*Rana tigrinia*

continued on next page

TABLE 4. Examples of wild foods eaten in north-east Thailand *(continued)*

Local name	English name	Scientific name
Insects		
Maeng kinoon		*Microtricia* sp
Maeng kizorn (krachorn)		*Gryllotalpa africana*
Tuckatan	Locust	*Locusta* sp
Maeng kutgee	Dung beetle	*Heliocopris bucephalus*
Jing reed (jilaw)	House cricket	*Acheta tetacea*
Jipome	Short-tailed cricket	*Bachytropes portentosus*

edge about how to hunt and gather wild food. Chambers and Leach [10] discussed how the forest is a vital source of security for the poor and how much they depend on it. We found that the Isan villagers relied on wild food both as a rich and varied source of nutrition and as a supplement to their income from sales in town markets.

Unfortunately, the natural resource habitats—forests, mountains, paddies, and ponds—are under constant and increasing assault from many agents, both mechanical and chemical. These need to be considered in rural development projects in Thailand, as has been done in Africa and in some other countries. The kinds of wild foods that should be encouraged are wild plants eaten as vegetables and all fish and other aquatic animals, because they are important sources of nutrients in the daily diet. Thailand should promote reforestation and enforce the existing ban on deforestation. It must also preserve its natural water resources so there will be more aquatic species, including wild fish and plants.

We found that young villagers had less knowledge of hunting and gathering methods and could not identify the items as well or as accurately as the older villagers. The young people had other interests and pursuits, including working for wages outside the village. Therefore, their time in the village was limited and they had less chance to learn from the elders. They might also lose their interest in the traditional gathering of subsistence wild food from the environment. This loss of knowledge in one generation is significant, since it means that they will depend more on market food in the future. Moreno-Black and Price [3] pointed out that women earned cash from selling wild food in the markets, which they used to purchase cultivated and processed foods as well as other wild foods.

We also found major gender differences in knowledge of wild food and methods of procurement. Women will be vital in identifying threatened wild species and conservation efforts, because they realize that forests and other natural resources are critical to their survival and the survival of future generations. However, we also found that men can recognize wild plants and often know how to prepare them, even though they usually do not gather them. They may bring plants that they happen to find on their way home, but they do not consider it their responsibility and consider plant gathering to be a woman's task.

Acknowledgements

This work was supported by the Margaret McNamara Memorial Fund from the World Bank in 1994.

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Production and nutritional quality of traditional Nigerian masa from mixtures of rice, pearl millet, cowpea, and groundnut

Iro Nkama and Nagappa G. Malleshi

Abstract

Masa (waina) *is a Nigerian yeast-fermented puff batter of millet or rice cooked in a pan with individual cuplike depressions. It resembles the Indian* idli *in shape and* dosa *in taste. Since masa is a single cereal food, its protein is of relatively poor nutritional quality. Studies were conducted to assess the feasibility of supplementing millet or rice with grain legumes for masa preparation. Based on a least-cost computer programme, masa formulations containing millet or rice blended with cowpea or groundnut were prepared and their chemical and nutritional qualities were evaluated. Phosphorus and calcium concentrations were low, and magnesium and sodium concentrations were high. Significant improvements in lysine (9%–75%), threonine (16%–25%), and isoleucine (10%–28%) were observed for some masa samples. The biological value (81%–93%), apparent digestibility (82%–88%), and net protein utilization (74%–79%) of all masa samples showed improved nutritional qualities. Supplemented masa was nutritionally better than masa made from millet or rice alone.*

Introduction

Masa (*waina*) is a fermented puff batter of rice, millet, maize, or sorghum cooked in a pan with individual cuplike depressions. It resembles the Indian *idli* in shape and *dosa* in taste. It is different from the maize masa used in tortillas in Mexico and Central America. Masa is consumed in various forms by all age groups in the northern states of Nigeria and many other Sahelian African countries (Mali, Burkina Faso, Niger, Chad, and Ghana). It is the principal ingredient of a variety of cereal-based foods and is a good source of income for the women who prepare the traditional product for sale.

Protein-energy malnutrition has been identified as one of the most important problems in Africa [1]. Attempts have been made to devise strategies for combating this nutritional problem. Nutritious foods of high protein and energy value based on cereal-legume combinations have been suggested. In African countries, traditional foods, such as masa, play a critical role in the nutrition of the population [1–9]. Like other single-cereal-based foods, masa protein is deficient in the essential amino acid lysine. Grain legumes and oil seeds are higher in protein density and lysine. Therefore, a combination of cereals and grain legumes in traditional preparations of masa will have improved nutritive value. Moreover, it is a way of increasing grain legume consumption in Africa, as is done in India for dosa and idli [9].

The objective of this study was to evaluate the chemical and nutritional qualities of cereal-based masa.

Materials and methods

Materials

Milled raw rice (*Oryza sativa* L.), pearl millet (*Pennisetum americanum*), cowpea (*Vigna unguiculata* L.), groundnut (*Arachis hypogea* L.), and other ingredients—vegetable oil, sugar, salt, skim milk powder, starch, tamarind fruit pulp (*Tamarindus indica* L.), and active dried bakers yeast (*Saccharomyces cerevisiae*)—were purchased in bulk from a local market in Mysore, Karnataka, India. *Kanwa* or *trona* (sodium sesquicarbonate) was purchased from a local market in Maiduguri, Borno State, Nigeria, and shipped by air to the Central Food Technological Research Institute in sealed polythene bags. Foreign matter was removed from the grain samples, which were then stored in a cold room at 8 ± 2°C. The salt mixture for animal feeding experiments was purchased from SISCO Research Laboratory, PVT, Bombay, India.

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Preparation of samples

Raw rice flour and grits

Raw milled rice was cleaned to remove foreign matter, then ground in a plate mill to produce fine flour (rice flour sieved through a BS. No. 28 600-mm mesh sieve) and grits (coarse flour sieved through a BS No. 4 1.4-mm mesh sieve) (BS 410 Laboratory Test Sieves, Endicott Ltd., London).

Millet flour and grits

The millet sample was first cleaned and adjusted to 4% moisture. A sample was dehulled using a laboratory scale McGill No. 3 dehuller (Houston, Texas, USA). The dehulled millet was ground and sieved to produce flour and grits as described for rice. However, preliminary results on the use of local Indian pearl millet for masa preparation showed that the product had an unacceptably bitter aftertaste. Therefore, dehulled pearl millet grain was acidified by treatment with tamarind fruit pulp to improve the colour and taste. Tamarind fruit pulp (150 g) was macerated in 10 L of water, and the resulting mixture was filtered with a fine sieve to remove seeds and fibrous materials. Dehulled millet (9 kg) was soaked in the tamarind extract (pH 2.77) for 48 hours. The sample was washed with water, dried in the sun for about eight hours, cooled, and then ground and sieved into fine flour and grits as described for rice.

Roasted cowpea flour

The cowpea sample was soaked in water for four hours at room temperature, dried in the sun for eight hours, then cooled and dehulled using a hand-operated dahl dehuller (CFTRI, Mysore, India). The hulls were removed by aspiration and the dehulled cowpea was roasted in a 5-kg capacity Indlab electric roaster (Indlab Furnaces, Mysore, India) at about 120°C for 30 minutes. The roasted cowpeas were pulverized into fine flour using a plate mill with a BS No. 28 mesh sieve.

Roasted groundnut

The groundnut sample was cleaned and roasted for 75 minutes in the same roaster that was used for cowpea. It was then skinned by rubbing between the palms of the hands, and the skins were removed by aspiration. Roasted groundnut was pulverized into flour as described above for cowpea flour.

Trona (kanwa water)

Preliminary results showed that 5% kanwa concentration was optimum for masa preparation. A 5% kanwa water solution was prepared by dissolving 20 g of the salt in 400 ml of water. The resultant mixture was filtered through Whatman No. 4 filter paper to remove suspended material. A 20-ml aliquot of this solution was used for 250 g masa batter in all preparations. This quantity of kanwa water was always adjusted based on the quantity of the batter to be cooked.

Formulation of masa flour blends

The criteria used for selecting the cereal-legume combination were based on Food and Agriculture Organization/World Health Organization/UNU [10] specifications of the daily protein and energy requirements for people of different ages, sexes, and levels of physical exertion. According to these standards, one-fifth of the total requirement was considered to be obtained at breakfast, since masa is a common breakfast food [9]. Linear programming was used to work out nutritionally optimum least-cost combinations from the following list of raw materials, with certain imposed constraints apart from satisfying the nutritional requirements: rice, millet, cowpea, groundnut, groundnut cake, soya bean, soya flour, and oil. The combinations selected are listed in table 1. Because oil is used in the final stages of cooking masa, it was eliminated during the computation of proportions of other raw materials. Nutritionally optimum formulations were determined for the five classes based on age.

TABLE 1. Masa formulations and a typical recipe (for 1,000 g)[a]

Formulation	Rice		Millet		Cowpea flour	Groundnut flour
	Grits	Flour	Grits	Flour		
Rice (100%)	332	668	–	–	–	–
Millet (100%)	–	–	332	668	–	–
Rice-cowpea (80:20)	332	468	–	–	200	–
Rice-cowpea-groundnut (80:8:12)	332	468	–	–	80	120
Millet-cowpea (83:17)	–	–	332	538	130	–
Rice-millet-cowpea (36:58:6)	166	260	166	337	71	–

a. Typical recipe for masa preparation: grits, 332 g; flour, 668 g; yeast, 3 g; sugar, 20 g; salt, 20 g; kanwa, 80 ml; water, 2,800 ml.

Laboratory preparation of masa

Masa was prepared as described in figure 1. The proportions of ingredients (grits, flour, yeast, water, sugar, salt, and kanwa water) for the different formulations are given in table 1, along with a typical recipe. All masa samples used for animal-feeding experiments were prepared as detailed in the recipe. Fermentation was carried out for about 10 hours. All samples were allowed to ferment at room temperature (30 ± 2°C). For animal-feeding experiments and chemical analysis, representative samples of masa formulations were cut into small pieces and freeze-dried before being pulverized into flour.

Chemical analysis

Moisture, crude protein, crude fat, and ash contents of samples were determined according to AACC methods 44-15A, 46-11A, 30-25, and 08-01, respectively [11]. Carbohydrate content was calculated by difference. Lead, copper, zinc, cadmium, chromium, iron, magnesium, manganese, and sodium contents of samples and kanwa were determined by atomic absorption (Perkin Elmer 460) using an air acetylene flame [12]. Phosphorus content was determined colourimetrically, and calcium content was determined by a titrimetric method [13].

Amino acid determination

For amino acid analysis, 200 to 250 mg of masa samples were hydrolysed with 5 ml of 6 N HCl (redistilled) at 110°C for 24 hours. The hydrolysate was filtered (Whatman No. 2) into a 50-ml flask and lyophilized in a freeze dryer. The dried sample was subsequently dissolved in 3 ml of water and again lyophilized. This was repeated three times to remove traces of HCl. The final dried sample was dissolved in about 2.0 ml of water.

An aliquot based on the total amino acids of the sample was taken (5 µl of 2.5 mmol), determined as alanine, and dried in a vacuum. The sample was redried using 25 µl of ethanol:triethylamine:water (2:2:1) and 20 ml of derivatizing solution, ethanol:triethylamine: water:phenylisothiocyanate (7:1:1:1). The sample was incubated at room temperature for 25 minutes, and then excess reagent was removed by drying under vacuum. It was then analysed by reverse-phase high-performance liquid chromatography (RP-HPLC) in an amino acid column (Water Associate System, Column Pico Tag) with sodium acetate buffer and acetonitrile. Amino acids were detected at 254 nm by analysis with a Shimadzu CR4A Chromatopac. The standard used was Pierce H. amino acid hydrolysate.

Amino acids were calculated from the peak areas as follows: Amino acids (pmol) = (Area of unknown amino acid/Area of standard amino acid) × 312.5 (or 156.2 for cysteine).

Animal-feeding experiments

The apparent net protein utilization (NPU), biological value (BV), and apparent digestibility of rice and millet masa and formulated cereal-legume masa blends at 10% protein level with mineral and vitamin fortification (table 2) were determined according to the methods of Pellett and Young [16].

For nitrogen-balance studies, five groups of eight male albino (Wistar strain) rats weighing about 57 g were housed in individual metabolic cages fitted with steel funnels and perforated discs to facilitate separate collection of faeces and urine. Water and food moistened

TABLE 2. Composition of experimental diets of cooked masa (g/100 g)

Dietary group[a]	Test material (%)	Vitaminized oil[b] (%)	Vitaminized starch[c] (%)	Salt mixture[d] (%)	Corn starch (%)	Oil (%)	Total (%)
Rice masa	96.0	1.0	1.0	2.0	–	–	100
Millet masa	96.0	1.0	1.0	2.0	–	–	100
Rice-cowpea masa	96.0	1.0	1.0	2.0	–	–	100
Rice-cowpea-groundnut masa	88.0	1.0	1.0	2.0	8.0	–	100
Millet-cowpea masa	91.0	1.0	1.0	2.0	5.0	–	100
Rice-millet-cowpea masa	96.0	1.0	1.0	2.0	–	–	100
Skim milk powder (reference)	28.4	1.0	1.0	2.0	58.6	9.0	100

a. Oil was not added to cooked masa diets because their oil contents ranged from 8% to 12%.

b. Ingredients of vitaminized oil (per kilogram): retinol, 300 mg; α-tocopherol, 10 g; vitamin D_2, 2 mg. Source: ref. 14.

c. Ingredients of vitaminized starch (per kilogram): vitamin K, 500 mg; riboflavin, 100 mg; pyridoxine, 400 mg; calcium pantothenate, 4.0 g; niacin, 4.0 g; choline (bitartrate), 200 g; inositol, 25 g; *para*-amino benzoic acid, 10 mg; vitamin B_{12}, 2 mg; biotin, 20 mg; folic acid, 200 mg. Source: ref. 14.

d. Ingredients of salt mixture (grams): $CaCO_3$, 543.00; $MgCO_3$, 25.00; $MgSO_4$, 16.00; NaCl, 69.00; KCl, 112.00; KH_2PO_4, 212.00; $FePO_4 \cdot 4H_2O$, 20.50; KI, 0.08; $MnSO_4$, 0.35; NaF, 1.00; $Al_2(SO_4)_3K_2SO_4$, 0.17; $CuSO_4$, 0.90. Source: ref. 15.

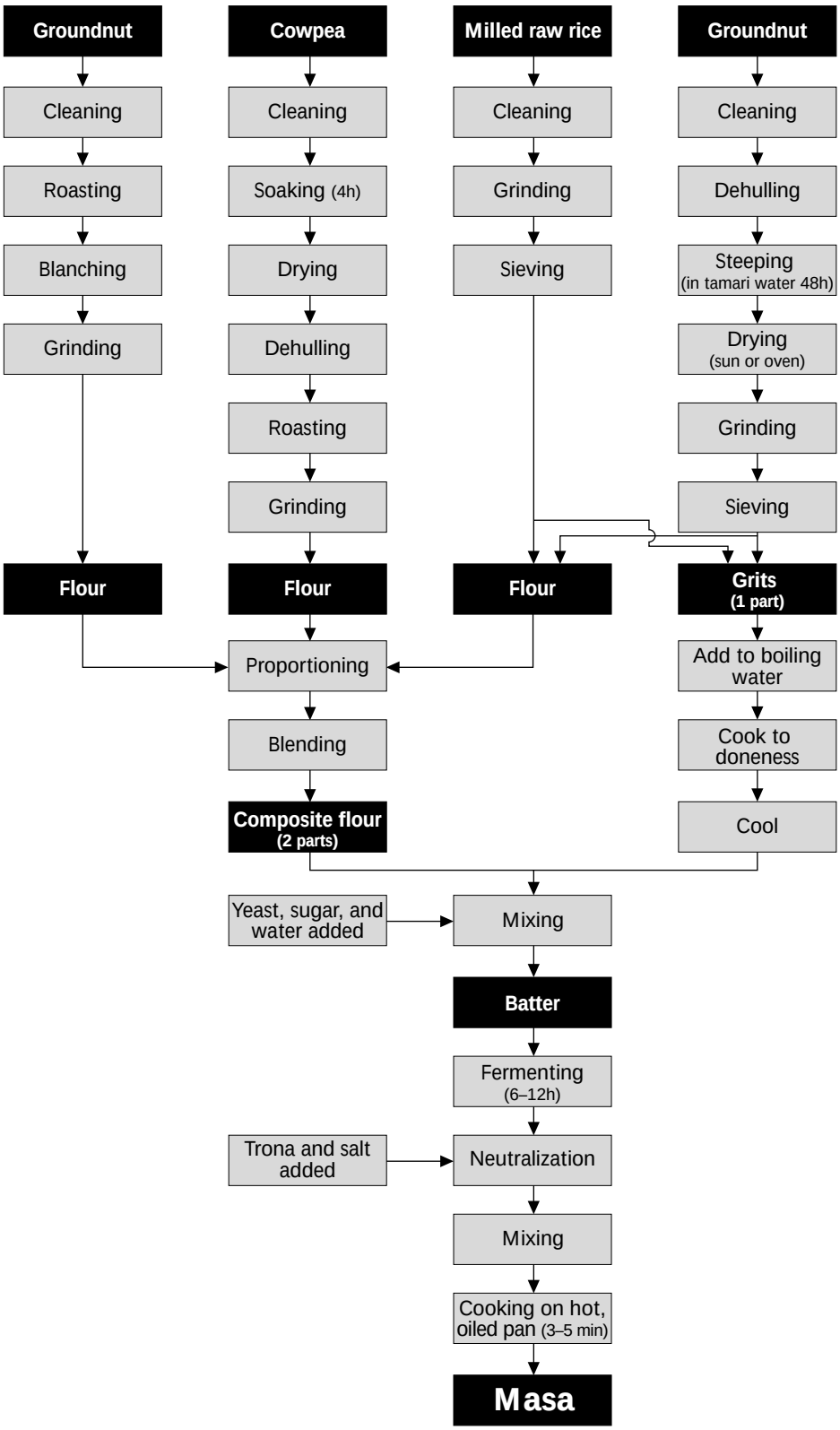

FIG. 1. Laboratory preparation of cereal-legume masa

with hot water were given ad libitum. Carmine (0.2%) was used as a faecal marker [17] at the beginning and end of the six-day experimental period. Thymol crystals and toluene (5 ml) were added to the urine bottles as preservatives. The faeces were freeze-dried and the urine was pooled together, the volumes of the faeces and urine were recorded, and both faeces and urine were analysed for nitrogen content [11]. The apparent biological value and apparent protein digestibility were assessed by the method of Pellett and Young [16] using the following formulas:

$$\text{Apparent BV} = [(\text{N intake} - \text{FN} - \text{UN})/\text{N intake}] \times 100$$

$$\text{Apparent digestibility} = [(\text{N intake} - \text{FN})/\text{N intake}] \times 100$$

$$\text{Apparent NPU} = [(\text{N intake} - \text{FN} - \text{UN})/\text{N intake}] \text{ or } (\text{BV} \times \text{TD})/100$$

Where

FN = faecal nitrogen and UN = urinary nitrogen.

These equations were used because correction was not made for obligatory losses; therefore, the calculation gave the apparent BV, digestibility, and NPU [16–18].

Results and discussion

Chemical composition

The proximate compositions of formulated unprocessed masa flour blends and the cooked masa samples are given in table 3.The protein content ranged from 7% to 12%, crude fat content from 0.8% to 12.7%, and ash content from 0.6% to 2.9%. The protein content of fermented and cooked masa was slightly lower than that of unprocessed masa in some samples. The fat and ash contents of cooked masa were higher than those of the unprocessed blends in all samples. The increase in fat was due to the vegetable oil used during cooking, some of which was absorbed by the batter. The increase in ash content could be due to the salt and trona water used in the preparation of masa. Oil absorption by masa resulted in an increase in the total energy as compared with the unprocessed blends. Masa is a food used for breakfast, and the FAO/WHO/UNU [10] recommendation is that at least one-fifth of the total daily requirement should be provided by breakfast. The energy content of formulated masa samples was within the recommended values [19].

The moisture content of cooked masa samples ranged from 56% to 62%. These values are comparable to the moisture content of traditionally baked masa, which was about 56% [9]. The titratable acidity and pH of masa (dry weight basis after freeze drying) ranged from 0.5% to 2.3% and from 3.4% to 3.8%, respectively, comparable to values for traditional masa.

The mineral compositions of formulated masa, rice masa, and millet masa are given in table 4. The calcium content of all samples was low when compared with ISI standards [14]. Cereal and grain legumes are not good sources of calcium. The phosphorus content was also low. Rice-cowpea masa and rice-cowpea-groundnut masa had the highest amount of phosphorus. Magnesium and sodium contents of formulated masa were high.

The addition of trona (an impure evaporate mineral sodium sesquicarbonate salt found as a saline lake deposit) and sodium chloride was responsible for the increase in magnesium and sodium. The levels of zinc, copper, and chromium were within the safe limits [20]. The total ash content of trona was 73%, and the levels of sodium, magnesium, iron, phosphorus, and lead were high (table 4). Trona also contained about 27% organic matter. The use of trona in traditional food preparation may be introducing these minerals into the diet of the people. The nutritional and toxicological aspects of trona have not been reported. However, the use of trona is believed to assist leavening or swelling (sponginess) of masa. It is also believed to reduce flatulence and the cooking time of cowpea and soya flour [9, 21].

TABLE 3. Proximate composition of cooked masa and masa flour[a]

Constituent	Masa from						
	Rice	Millet	Rice-cowpea	Rice-cowpea-groundnut	Millet-cowpea	Rice-millet-cowpea	ISI standards
Moisture (g)	2.1 (11.0)	1.6 (7.6)	2.0 (9.9)	1.8 (8.4)	1.7 (6.9)	2.0 (8.7)	Max 10.0
Protein (g)	7.0 (7.1)	9.6 (10.2)	10.8 (10.8)	11.4 (12.1)	11.1 (11.8)	10.0 (10.2)	Min 14.0
Crude fat (g)	8.5 (0.8)	9.7 (4.1)	10.4 (0.9)	12.7 (7.5)	10.1 (3.8)	9.4 (2.5)	Max 7.5
Total ash (g)	2.2 (0.6)	2.0 (1.3)	2.9 (0.7)	2.7 (1.1)	2.9 (1.1)	2.8 (0.8)	Max 5.0
Carbohydrate (g) by difference	80.3 (80.6)	77.1 (76.9)	74.1 (77.7)	71.5 (70.9)	74.4 (76.5)	75.9 (78.0)	Min 45.0
Energy (kcal)	426 (358)	434 (385)	433 (362)	446 (400)	434 (387)	428 (375)	

a. Values are means of duplicate determinations. Values in parentheses are proximate composition of masa flour formulations.

TABLE 4. Mineral composition of formulated masa blends and trona (kanwa)

Constituent	Masa from						
	Rice	Millet	Rice-cowpea	Rice-cowpea-groundnut	Millet-cowpea	Rice-millet-cowpea	Trona (kanwa)
Calcium (mg)	32.0	29.0	27.4	28.9	30.4	24.3	258.5
Phosphorus (mg)	125.0	103.0	167.6	159.1	129.1	125.6	773.3
Iron (ppm)	36.0	80.4	44.9	36.0	79.9	54.5	1,397.6
Lead (ppm)	1.0	1.0	0.5	1.0	1.5	1.8	9.8
Copper (ppm)	3.0	4.0	2.5	2.0	3.0	2.0	19.7
Zinc (ppm)	18.0	46.9	19.5	20.0	39.4	33.5	ND[a]
Cadmium (ppm)	ND	ND	ND	ND	ND	ND	ND
Chromium (ppm)	0.8	0.8	ND	ND	ND	ND	39.4
Manganese (ppm)	9.0	3.0	10.0	11.5	5.0	6.5	39.4
Magnesium (ppm)	1,299	699	1,996	2,997	898	899.5	5,905.5
Sodium (ppm)	1,499	1,596	1,397	1,499	1,596	1,599	15,748.0

a. ND, Not determined.

Effect of supplementation and processing on the amino acid composition of masa

Lysine increased as a result of the supplementation, especially in the millet-cowpea and rice-millet-cowpea masa (table 5). In millet-cowpea masa (83:13), the lysine content increased by about 75%. The increase in the lysine content of rice-cowpea (80:20) masa compared with rice masa was about 9%, while for rice-cowpea-groundnut (80:8:12) masa it was 12%. The other essential amino acids that increased as a result of supplementation were histidine, threonine, valine, and isoleucine. Threonine increased by 16% in rice-cowpea-groundnut masa and by 25% in millet-cowpea masa. Other workers have reported similar increases in amino acids for cereal-legume-based foods [22].

There was a considerable increase in weight gain, food intake, and protein intake of rats fed the fortified diet compared with those fed the unfortified diet. It appeared that sourness alone was not the only factor that resulted in low food intake. Minerals and vitamins appear to play a significant role in the ability of the rats to utilize the food consumed.

It could be observed that, although grain legumes may significantly improve the protein quality of cereal-based diets, the incorporation of minerals and vitamins is essential for the growth and well-being of those rats that consume them.

The apparent BV, apparent digestibility, and appar-

TABLE 5. Amino acid composition (mole%) of masa containing cowpea, groundnut, rice, and millet

Amino acid	Rice	Millet	Rice-cowpea	Rice-cowpea-groundnut	Millet-cowpea	Rice-millet-cowpea
Aspartate	6.9	4.5	7.1	7.6	6.1	5.4
Glutamate	16.0	17.3	15.3	16.5	17.6	14.8
Serine	6.9	5.6	6.1	6.6	5.8	6.0
Glycine	8.0	3.9	6.9	8.1	4.8	6.0
Histidine	2.9	0.6	1.9	1.0	1.5	1.7
Arginine	7.2	2.3	5.9	6.2	2.7	3.8
Threonine	3.8	2.8	3.1	4.4	3.5	3.4
Alanine	13.3	26.6	17.3	14.1	17.6	17.4
Proline	6.3	7.6	6.0	5.5	7.1	6.4
Tyrosine	2.0	1.1	1.6	1.8	1.5	1.8
Valine	6.8	5.9	6.2	6.6	6.9	7.6
Methionine	2.2	1.4	1.3	1.2	1.4	1.7
Cysteine	ND[a]	ND	ND	ND	ND	ND
Isoleucine	3.9	3.9	4.4	4.3	4.7	5.0
Leucine	9.5	12.2	9.9	8.6	11.8	11.5
Phenylalanine	4.1	3.3	4.0	4.1	4.4	4.6
Lysine	3.3	1.6	3.6	3.7	2.8	3.4

a. ND, Not determined.

TABLE 6. Apparent biological value (BV), apparent digestibility, and net protein utilization (NPU) of formulated masa[a]

Diet	N intake mg/day/rat	N excreted mg/day/rat		(%)	N retention BV	Apparent digesti-bility	NPU
		Faecal	Urinary				
Rice masa	87.1	15.6	6.6	75	91a	82a	75ab
Millet masa	96.4	11.3	8.5	80	90a	88c	79bc
Rice-cowpea masa	114.0	20.0	9.6	74	90a	82a	74a
Rice-cowpea-groundnut masa	125.3	22.3	7.5	76	93a	82a	76abc
Millet-cowpea masa	122.1	16.3	9.2	79	81a	86bc	79abc
Rice-millet-cowpea masa	113.8	18.5	8.7	76	91a	84ab	76abc
Skim milk powder	135.9	21.7	4.2	81	96b	84ab	81c
SEM					± 1.07	± 1.22	± 1.51

a. Means in the same column followed by different letters differ significantly ($p < .05$) according to Duncan's new multiple range test.

ent net utilization for the diets (table 6) ranged from 81% to 96%, 82% to 86%, and 74% to 81%, respectively. There was no significant difference in the BV of all the diets ($p > .05$) except for the reference diets. This could be due to the fairly similar amino acid levels (table 5) in the food proteins. Millet masa and millet-cowpea masa had the highest apparent digestibility, even though the rats did not grow well on these diets. The reason could be that what little quantity of food the rats ate was utilized to maintain body weight. Also the NPU of millet masa and millet-cowpea masa was higher than that for the other diets, except for the reference protein.

In conclusion, the nutritional quality of masa, an important breakfast item prepared mainly from rice and millet, can be improved by supplementation of rice or millet flour with cowpea and/or groundnut flour up to 20%. Sensory evaluation studies (results not shown) on masa quality revealed that cereal-legume-based masa was comparable to single-cereal-based masa. The introduction of such a nutritionally improved product in Nigeria and other Sahelian African countries should play an important role in improving the diet. Addition of vitamins and minerals can result in a more nutritionally complete food.

It is recommended that further studies on enriched masa should be based on formulating shelf-stable masa flour. This will help facilitate the acceptability of masa in other parts of Nigeria where it has not found wide acceptance. The microbiology of masa fermentation also needs to be investigated for its effect on quality.

Acknowledgements

We thank the following staff of CFTRI: Mr. S. Vibhakar and Dr. Nag for assisting in the mineral analysis of foods, Dr. L. Gowda for amino acid analysis, and Mr. B. S. Ramesh for statistical analysis of the data. The United Nations University awarded a fellowship to Dr. I. Nkama to carry out the study.

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Use of a participatory learning process to develop a curriculum for postgraduate nutrition training

Rainer Gross, Ha Hui Khoi, and Beatrice Senemaud

Abstract

A participatory learning process (PLP) was used in Viet Nam to formulate a curriculum for a master of science (M.Sc.) degree in community nutrition. Students and professionals from different disciplines participated in a two-day workshop to develop a curriculum. The knowledge, skills, and attitudes required of a community nutritionist were identified and a curriculum was formulated. The experience showed that broad participation is necessary, the metaplan technique is useful, time is essential, and facilitation is needed. The PLP was used to collect a maximum number of experiences, document the outcomes, develop a consensus, and create a sense of ownership within the principal actors in the process.

Introduction

Traditionally, a curriculum that emerges from an internal academic process within a university needs approval at a higher administrative level. This carries the risk that the interests of all affected parties, including the students, may not be sufficiently considered. A participatory learning process (PLP) can help to obtain and understand the opinions of different parties and to arrive at a consensus. The following is an example of the use of a PLP in developing a curriculum for a master of science (M.Sc.) degree in community nutrition. This subject offers a useful example, since a nutrition curriculum involves a variety of interacting disciplines.

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Academic nutrition training in Viet Nam

Despite the difficult nutritional situation in Viet Nam, which needs the technical assistance of nutritionists and other professionals trained in nutrition, no professional or academic degree programme in applied human nutrition was available in Viet Nam until recently. The implementation of the National Plan of Action in Nutrition (NPAN), which was prepared after the International Conference on Nutrition in 1992 and adopted by the Prime Minister in 1995, will require trained nutrition professionals at the postgraduate level. In October 1994, the National Institute of Nutrition (NIN) of the Ministry of Health and the College of Medicine in Hanoi, Socialist Republic of Viet Nam, started a master of science programme in community nutrition based on a curriculum they jointly developed. It was based mainly on existing expertise and was clinically oriented. The Southeast Asian Minister of Education Organization (SEAMEO) agreed to give support to the course in the context of their collaborative network. In January 1995, the Food and Agriculture Organization (FAO), with funds from the French government, began to assist the master of science programme and suggested a more multisectoral approach to community nutrition improvement [1]. In order to include new concepts into the two-year master of science programme, it was necessary to develop priorities for subject matters to be included in the curriculum.

It was believed that a participatory curriculum-development process based on the agreement of all participating institutions could help achieve a high-quality, sustainable academic training programme. The process involved three steps. First, it was agreed that the identification of priorities should be oriented mainly towards the *tasks of community nutritionists* and not mainly towards the expertise and resources of the academic training institutions. Second, these tasks were identified, and the *knowledge, skills, and attitudes* were described that were seen as necessary to complete these tasks. Third, the appropriate *curriculum* was determined.

An analysis identified how much of the revised curriculum could be taught using the human resources available locally at the two responsible institutions and what additional external resources would be needed.

Metaplan technique as an instrument for a PLP

Participatory action, visualization, and documentation are the main approaches of the metaplan technique that was used in the group work.

According to the *application rules:*

» All opinions are equally valid.
» The structure of the brainstorming process is based on a logical procedure.
» The facilitator helps with the structural development of the group work but gives no input on the contents of the discussion;
» Offered materials (cards, pens, etc.) are used according to the application rules.

Cards played a crucial role as the *visualization* instrument (metaplan technique). They were used as follows:

» Each participant wrote an idea related to the topic on a card.
» Only one idea was included on each card.
» The ideas were written as succinctly as possible.
» The facilitator collected the written cards from each participant.
» Then the facilitator read each card aloud to make sure that the idea was understood by all participants.
» If the wording was unclear, it was revised.
» After having been read and clarified, the cards were pinned to the board.

Expected tasks of a community nutritionist

Nutrition is an interdisciplinary science, and this must be reflected in the professional backgrounds of the students, the training content of the programme, the lecturers, and the career plans of the master's degree holders. To take into consideration all interests and expectations, a two-day participatory workshop was held with 48 people from various sectors to establish the basis for an appropriate curriculum for the academic training of community nutritionists. Ideas were collected from this wide range of individuals involved in the field of nutrition, and the scope of the master of science programme was defined. High-level decision makers and representatives of several national (e.g., State Planning Committee, Ministry of Education, Ministry of Health, Ministry of Agriculture, College of Medicine, College of Agriculture), and international (e.g., Food and Agriculture Organization, GTZ, Oxfam, UNICEF, World Health Organization) institutions in Hanoi working in the field of nutrition participated.

On the first morning, the objective of the workshop and the description of the three steps were explained to the participants. This information served to alert the participants to the scope of the work of a community nutritionist. The basic information on the nutritional situation in Viet Nam and a description of the existing curriculum were provided by the director of NIN. The participants were then asked to identify tasks that a community nutritionist should carry out while working at the different levels of the government (village, district, provincial, and national). The participants wrote their ideas on cards, using a separate card for each task. The cards were collected and hung on a board. Table 1 gives an overview of the contributions of the participants related to the tasks of a community nutritionist. The tasks were clustered into related activities. The most often stated tasks of a nutritionist were related to communication (eight cards), followed by nutritional assessment (seven cards), management (six cards), intervention (four cards), and research (one card).

Knowledge, skills, and attitudes

The results of the morning plenary session served as a basis for the afternoon work in two parallel groups to identify the knowledge, skills, and attitudes that students should gain during their academic training. Again, ideas were written on cards and displayed on a board. Both groups presented their results at the beginning of the next day and merged them into a single joint project. As shown in table 2, management (17 cards under skills and knowledge) and assessment (14 cards under skills and knowledge) appeared as the most important tasks and subjects. In contrast to preconceived ideas, clinical medicine was not emphasized. In particular, assessment (11 cards identified skills versus 3 knowledge), management (11 cards skills, 6 knowledge), and communication (5 cards skills, 2 knowledge) were seen as subjects in which the skills are most needed, whereas subjects such as basic nutrition (8 cards) and food safety (8 cards) were only mentioned in connection with an increase of knowledge. The importance of developing skills in an academic programme does not receive sufficient recognition internationally or in Viet Nam.

It is widely acknowledged that it is generally easier in an academic training programme to improve knowledge and skills than to instill in the students the necessary attitude for their future work. Attitudes necessary for better job performance were identified by a working group as shown in table 2. These accepted teaching goals will require new teaching methods and teaching structures. In the context of Viet Nam, with its strong community orientation and the set of goals regarding the NPAN, it was agreed that special attention would also be given to adopting required attitudes.

TABLE 1. Overview of tasks of a community nutritionist according to 48 workshop participants

Communicate
» Train
  – Conduct training for hospital staff (especially MCH staff)
  – Train field workers in nutrition
» Inform
  – Provide information, education, and training to the community
  – Disseminate nutritional knowledge to the public
» Interact
  – Communicate easily with the community
  – Communicate with the community and institutions
  – Communicate with foreign institutions
  – Work in a multidisciplinary approach

Diagnose and analyse
» Assess and understand the nutritional situation of the community
» Assess nutritional status and nutrient deficiencies at the community level
» Understand the common nutritional diseases in Viet Nam
» Assess the nutrient requirement to improve health status
» Assess the local nutritional situation
» Assess dietary intake
» Consider food behaviour and practices of farmers

Manage
» Manage nutrition programmes
» Implement nutrition programmes efficiently
» Organize adequate nutrition for the community
» Manage the treatment of food-borne diseases
» Coordinate activities of different sectors
» Implement nutrition programmes at the community level

Intervene
» Develop guidelines on feeding and food preparation for hospital departments of obstetrics and gynaecology and of paediatrics
» Contribute to the formulation of a policy and strategy for agricultural development
» Implement nutrition education
» Develop a strategy for food safety and hygiene programmes for the community

Conduct research
» Combine nutritional research with community nutrition intervention

TABLE 2. Assessment of the importance of different types of knowledge, skills, and attitudes that are needed to carry out the tasks of a nutritionist, according to the number of cards mentioning each type

Type of knowledge, skill, or attitude	No. of cards
Knowledge	
Basic nutrition	8
Food safety	8
Nutritional planning and management	6
Nutritional anthropology	5
Agriculture and nutrition	5
Nutritional epidemiology	4
Food science	3
Food and nutrient intervention	3
Health and nutrition	3
Assessment of nutritional situation	3
Nutrition and communication	2
Economy	2
Foreign languages	2
Computer usage	1
Statistics	1
Skills	
Assessing	11
Managing	11
Communicating	5
Identifying appropriate interventions	2
Research	2
Implementing interventions	1
Training the trainers	1
Attitudes	
Willingness to permanently learn	3
Eagerness to work in nutrition profession	2
Respect for traditional knowledge	1
Giving good example	1
Seeking practical and feasible solutions	1
Helping the community	1
Liking for scientific work	1
Eagerness to work in nutrition passionately	1
Carefulness in work	1
Liking to work with people	1

Curriculum

Using the results of the participatory workshop and considering the official regulations for an academic postgraduate programme in Viet Nam, a small group of experts formulated the objectives (table 3) and an outline of a curriculum (table 4) for the master of science programme in community nutrition. The structure has similarities to the master of science programme offered by the SEAMEO-TROPMED Community Nutrition Program at the University of Indonesia in Jakarta [2]. The objectives and the outline were presented again in a plenary session and after a final discussion approved by the participants.

The first year started with the four core certificates (S1–S4) required by the Ministry of Education. The three basic nutrition courses (B1–B3) cover nutrition at the molecular (biochemistry), organ (physiology), individual (pathology of malnutrition), and population (epidemiology) levels. The applied certificates (B4–B5) should start with assessment, followed by plan-

TABLE 3. General and specific objectives of the master of science programme in community nutrition

General objective
The master of science course in community nutrition provides professionals of different backgrounds with knowledge, skills, and attitudes needed to promote the improvement of nutrition of the rural and urban people of Viet Nam

Specific objectives
At the end of the training course, the participants will be able to:
» understand links between nutrition, food, health, and development, including population and environment issues;
» collect information about, identify, and analyse the nature, magnitude, severity, and causes of the nutrition problems of different population groups from the community to the national level;
» plan, implement, monitor, and evaluate nutrition programmes and projects at different levels following a multisectoral approach;
» carry out food and nutrition interventions;
» train and teach nutrition from the field level to the academic level;
» plan and implement applied research and disseminate the results to the public and the scientific community.

TABLE 4. List of certificates offered in the master of science programme in community nutrition

Course[a]		Training time
First academic year		
S1	English	120 h
S2	History of philosophy	96 h
S3	Statistics and computer usage	60 h
S4	Teaching and research methods	80 h
B1	Biochemistry and physiology	2 wk
B2	Pathology of nutrition	2 wk
B3	Nutritional epidemiology	3 wk
B4	Nutritional assessment and analysis	2 wk
B5	Nutritional planning and management	2 wk
B6	Nutrition and the agricultural system	2 wk
B7	Nutrition and the health system	2 wk
B8	Economy and development	2 wk
B9	Food and nutrition interventions	2 wk
B10	Food safety	2 wk
B10	Communications	4 wk
F1	Field practice	3 mo
Second academic year		
F2	Research proposal	2 mo
F2	Field study (thesis)	7 mo

a. Course numbers beginning with S indicate subjects that are offered 2–4 h weekly over the whole year. Numbers beginning with B indicate subjects that are offered in blocks as short courses. Numbers beginning with F indicate subjects that are related to field work (field practice, research proposal, thesis).

ning and management. The next three courses (B6–B8) deal with interventions that contribute to the improvement of nutritional status: nutrition and the agricultural system, nutrition and the health system, and economy and development.

A number of professionals, such as agronomists, public health specialists, and economists, are involved in teaching activities. This is particularly important, since the community nutritionists should know all of the important interventions available, the conditions under which they can be successfully implemented, and to whom to address their efforts. The last three applied courses (B9–B11) cover interventions implemented by nutritionists related to nutrients and food, nutrition education, and communication.

Special attention is required in training for gaining knowledge and skills. In particular, small classroom exercises should deepen freshly gained knowledge. The first year ends with field practice in which the participants merge their gained knowledge and skills in a comprehensive task under practical conditions. The second year of the programme is reserved for the development of a research proposal and the implementation of the thesis work. During this time, several oral and written reports present the conceptual framework, methodology, operational planning, and data analysis. The student should interact with the faculty and other professionals when completing the report.

Conclusions

Broad participation is necessary

A curriculum should be developed not only by academic staff but with additional expertise from different relevant segments of the society, such as educational planners, employers, students, and alumni. The inclusion of participants from different national and international organizations in the PLP ensured that the curriculum design would recognize their institutional needs, thus stimulating the brainstorming process and avoiding, or at least reducing significantly, the commonly experienced domination of particular academic interests and powers. The curriculum still lacks sufficient recognition of physiological, behavioural, and social aspects. However, considering that the starting point of the first curriculum was principally clinically oriented, a major achievement has been reached by accepting the multidisciplinarity of nutrition.

The metaplan technique is useful

The metaplan technique visualizes and documents communication within groups. This technique was used

as a communication tool in the participatory learning process. The use of cards to collect and visualize ideas leads to wide and active participation during the brainstorming process, since the cards are written anonymously and they allow input from participants who lack self-confidence or fear hierarchy or seniority.

Counting redundant cards helps to increase objectivity in the decision-making process. Visualization by cards leads to openness, which helps to understand the rationale of the decision process, document the outcome of the process, and avoid subjective and irrational decisions.

Time is essential

High-ranking decision makers always lack time. However, it is important to integrate them into the process in order to ensure that the outcome of the learning process is put into action. High-ranking representatives will participate in a workshop for a maximum of half a day. It is particularly important to have them in the process at the beginning of the workshop for crucial input of information to set the framework. Otherwise, there is the risk that the results will be developed under assumptions that are unrealistic and unacceptable to the decision makers.

Facilitation is needed

The participatory workshop is a process and an instrument. However, each instrument works only as well as its user. Working with high-ranking decision makers and academic staff members requires facilitators who have had much professional and group work experience.

Provision for prompt implementation

The best participatory learning process will lose its credibility with the participants, as well as with non-participants, if the decisions are not rapidly and visibly put into action. Therefore, leadership is needed within the institution that is responsible for the academic programme during the follow-up process to implement the results of the workshop.

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Books received

Feeding a world population of more than eight billion: A challenge to science. Edited by J. C. Waterlow, D. G. Armstrong, Leslie Fowden, and Ralph Riley. Oxford University Press. New York, 1998. (ISBN 0-19-511312-8) 280 pages, hardcover.

This volume is based on a two-day international symposium held in the United Kingdom in December 1996. The availability of food, as a consequence of advances in agricultural and food sciences, continues to exceed the demands created by unprecedented population growth. However, the world population is predicted to nearly double between 1990 and 2050, and the question is whether the increases in food production can continue to meet the need. This book does not provide a definitive answer to this question, but it does provide fascinating perspectives on the issues involved, including basic land and water resources and constraints, the potential for and limits to the contributions of agricultural and biotechnology research including limits to photosynthesis, disease, and drought resistance, as well as animal sources of food and the food chain for human use. Equally important is the potential for poverty alleviation and improved food security. The book ends with: "Poverty is the lock, productivity is the key and food security is the prize." It is a valuable source of information for those interested in interactions among food supply, population, agriculture, the environment, and public policy.

Nutrition and women's cancers. Barbara C. Pence and Dale M. Dunn. CRC Press, Boca Raton, Fla., USA, 1998. (ISBN 0-8493-8562-8) 179 pages, hardcover. US$79.95.

This book attempts to integrate current knowledge of nutrition and the prevention of cancers that occur predominantly in women. It includes not only breast, cervical, endometrial, and ovarian cancers, but also lung and colon cancers, which are seen in a high incidence in women as well as men. Each chapter deals with the general pathology of the disease, genetics, general epidemiological factors, and the important dietary factors that have been identified. Each chapter has a summary and recommendations. National policy issues and current large clinical trials are also covered. The need to integrate knowledge of nutrition and cancer is stressed throughout. The style is readable and the references are extensive. Its strength and its limitation is that it focuses only on the major cancers of women, but these are also the ones on which there is the most nutrition knowledge.

Rapid assessment procedures (RAP): Ethnographic methods to investigate women's health. Joel Gittelsohn, Pertti J. Pelto, Margaret E. Bentley, Karabi Ghattacharyya, and Joan Jensen. International Nutrition Foundation, Boston, Mass., USA, 1998. (ISBN 1-892468-01-8) 196 pages, paperback. US$15.00 plus $3.00 shipping and handling. (Developing country individuals and institutions: US$10.00 plus $5.00 shipping and handling.)

This manual contains guidelines and procedures for carrying out an ethnographic study of women's health. It provides tools for the generation and analysis of data to facilitate programme development, implementation, evaluation, and improvement by governmental and nongovernmental institutions concerned with women's health. The main body of the manual focuses on a series of data-collection exercises that will permit an organization to develop a sizeable body of data on local perceptions and practices regarding women's health in the study area. It differs from other ethnographic manuals in its focus on the health problems of women rather than a specific disease or cluster of diseases, it provides detailed suggestions for the appropriate training of data collectors, and it provides for the optional use of specialized computer software packages.

Readings on pro-poor planning through social mobilization in South Asia. Vol 1. The strategic option for poverty eradication. Edited by Penna Wignaraja and Susil

Sirivardana. Vikas Publishing House Pvt., Ltd., New Delhi, India. 1998. (ISBN 81-259-0500-6) 377 pages, paperback. SL Rs. 950/=. Available at SAPNA Regional Center, 75 Kynsey Rd., Colombo 8, Sri Lanka. Fax: 94-1-688676.

This book is an innovative state of the art on poverty eradication with social mobilization as the core methodology. Such a primer does not exist today for South Asian readers. The book is a valuable addition to training resources.

WHO global database on child growth and malnutrition. Compiled by M. de Onis and M. Blössner. World Health Organization, Geneva, 1997. 710 pages, paperback. Sw.fr. 50-/US $45.00. In developing countries Sw.fr. 35-.

This book presents and interprets the vast amount of data contained in the World Health Organization Global Database on Child Growth and Malnutrition. The data, which indicate the growth and nutritional status of children under the age of five, have been collected by WHO since 1986 as part of its efforts to monitor and identify those groups in need of priority interventions.

Information is derived from population-based nutritional surveys of representative samples collected and assessed according to standardized procedures. The database currently reflects more than 1,700 nutritional studies, and covers 84% of the world's total population of children under five years of age and 95% of this age group living in the developing world.

The book has two parts. Part one explains the importance of global nutritional surveillance and describes the origins and development of the database. Against this background, subsequent chapters summarize global, regional, and national situations and trends for key indicators of child growth and nutritional status. Numerous tables and selected maps are used to indicate the country-specific prevalence and geographical distribution of underweight, stunting, wasting, and overweight for boys, girls, and the two sexes combined in developing and developed countries; to classify countries according to very high, high, medium, and low prevalence for each indicator; and to estimate global and regional trends over time. While noting important achievements in overcoming malnutrition among those under five years of age, the analysis concludes that global progress is entirely inadequate to reach the goal, set for the year 2000, of a 50% reduction in 1990 prevalence levels of moderate and severe malnutrition. Part one ends with chapters describing the methods used in data collection and their standardized presentation, and offering guidance in the interpretation of the statistical tables.

Part two contains over 600 pages of data tables and references. Data on the nutritional status of children under five years old in 173 countries are presented, disaggregated by rural and urban areas, by regions, and by sex and age group. Survey data indicate the percentage of children wasted, stunted, and under- and overweight. Each country data table is followed by the list of data sources and additional references to the country's child growth patterns.

News and notes

Humanity CD-ROM Project

The Humanity CD-ROM project has created a multidisciplinary CD-ROM library containing 3,000 of the most useful books for developmental and humanitarian uses. It is cooperating with about 70 organizations, including the United Nations University. The goal of the not-for-profit Humanity CD-ROM project is to provide persons in the South owning a PC/CD set access to a complete basic library of about 3,000 essential books. This low-cost CD-ROM set will contain most disciplinary solutions, know-how, and ideas people will need to help themselves or others. The initial language will be English, but other languages will soon follow. Single CD-ROMs are available at the surprisingly low price of US$25.00. For use in developing countries, funding agencies, non-governmental organizations, and United Nations agencies can purchase 40 CD-ROMs for free distribution for US$5.00 each, plus delivery costs. More information can be obtained from the Humanity CD-ROM Project, Global Help Project vzw, Oosterveldlaan 196-, B-2610 Antwerp, Belgium. Tel: 32 3 448-05-04; Fax: 32 3 449-75-74; e-mail: mloots@innet.be; or the Internet: http://www.oneworld.org/globalprojects/humcdrom.

Childhood obesity: Partnerships for research and prevention

The International Life Sciences Institute (ILSI), in cooperation with Emory University, the Centers for Disease Control and Prevention, and the American Cancer Society, is sponsoring a conference on "Childhood obesity: Partnerships for research and prevention." The conference, the fifth in the biennial Conference Series on Nutrition and Health Promotion, will be held at the Emory Center in Atlanta, Georgia, USA, 3–5 May 1999. The two-and-a-half-day conference will bring together researchers, programme administrators, and practitioners to examine ongoing research and interventions for the prevention of childhood obesity. Experts from the health care system, schools, community organizations, and other sectors will work together to set an agenda for research and to identify ways to implement the research outcomes. The mechanisms to increase awareness of the growing problem of childhood obesity and possible intervention strategies among health professionals, managed care administrators, educators, community leaders, and health communicators will also be considered. The conference will combine plenary presentations with working group discussions centred around the three settings in which intervention efforts are feasible: the health care system, schools, and the community. This interdisciplinary meeting will be of interest to researchers in paediatric obesity, including behavioural, nutrition, and exercise scientists, along with federal, state, and community officials and policy makers responsible for nutrition, physical activity, and related programmes. For information contact ILSI Meetings—Childhood Obesity Conference, International Life Sciences Institute, 1126 Sixteenth Street, N.W., Washington, DC 20036-4810, USA. Tel: (202) 659-0074; fax: (202) 659-3859; e-mail: meetings@ilsi.org.

Note for contributors

The editors of the *Food and Nutrition Bulletin* welcome contributions of relevance to its concerns (see the statement of editorial policy on the inside of the front cover). Submission of an article does not guarantee publication—which depends on the judgement of the editors and reviewers as to its relevance and quality. All potentially acceptable manuscripts are peer-reviewed. Contributors should examine recent issues of the *Bulletin* for content and style.

Language. Contributions may be in English, French, or Spanish. If French or Spanish is used, the author should submit an abstract in English if possible.

Format. Manuscripts should be typed or printed on a word processor, double-spaced, and with ample margins. Only an original typed copy or a photocopy of equivalent quality should be submitted; photocopies on thin or shiny paper are not acceptable.

When the manuscript has been prepared on a word processor, a diskette, either 3½- or 5¼-inch, should be included with the manuscript, with an indication of the disk format and the word-processing program used.

Length. Ordinarily contributions should not exceed 4,000 words.

Abstract. An abstract of not more that 150 words should be included with the manuscript, stating the purposes of the study or investigation, basic procedures (study subjects or experimental animals and observational and analytical methods), main findings (give specific data and their statistical significance if possible), and the principal conclusions. Emphasize new and important aspects of the study or observations. Do *not* include any information that is not given in the body of the article. Do not cite references or use abbreviations or acronyms in the abstract.

Tables and Figures. Tables and figures should be on separate pages. Tables should be typed or printed out double-spaced. Submit only original figures, original line drawings in India ink, or glossy photographs. Labels on the figures should be typed or professionally lettered or printed, not handwritten.

Photographs. Ideally photographic materials should be submitted in the form of black and white negatives or black and white glossy prints. Photographs will not be returned unless a specific request is made.

Units of measurement. Preferably all measurements should be expressed in metric units. If other units are used, their metric equivalents should be indicated.

Abbreviations. Please explain any abbreviations used unless they are immediately obvious.

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Number references consecutively in the order in which they are first mentioned in the text. Identify references in the text and in tables and figure legends by arabic numerals enclosed in square brackets. References cited only in tables or figure legends should be numbered in accordance with the first mention of the relevant table or figure in the text. Be sure references are complete.

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1. Alvarez ML, Mikasic D, Ottenberger A, Salazar ME. Caracteristicas de familias urbanas con lactante desnutrido: un análisis critico. Arch Latinoam Nutr 1979;29:220–30.

—*corporate author:*

2. Committee on Enzymes of the Scandinavian Society for Clinical Chemistry and Clinical Physiology. Recommended method for the determination of gammaglutamyltransferase in blood. Scand J Clin Lab Invest 1976;36:119–25.

Book or other monograph reference

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3. Brozek J. Malnutrition and human behavior: experimental, clinical and community studies. New York: Van Nostrand Reinhold, 1985.

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—*chapter in book:*

6. Barnett HG. Compatibility and compartmentalization in cultural change. In: Desai AR, ed. Essays on modernization of underdeveloped societies. Bombay: Thacker, 1971:20–35.

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La rédaction du *Food and Nutrition Bulletin* recherche des articles traitant de sujets correspondant à ses thèmes (voir au vérso de la couverture la politique éditoriale de cette revue). La remise d'un manuscrit ne signifie pas sa publication, qui dépend de l'opinion de la rédaction et des réviseurs sur son intérêt et sa qualité. Tous les manuscrits susceptibles d'être acceptés sent révisés par des pairs. Les auteurs sent invités à se pencher sur les récents numéros du *Bulletin* pour prendre connaissance de son contenu et de son style.

Langues. Les manuscrits peuvent être rédigés en anglais, en français ou en espagnol, et dans ces deux derniers cas, l'auteur ajoutera, si possible, un résumé en anglais.

Format. Les manuscrits doivent être dactylographiés ou imprimés sur une machine de traitement de texte, en double interligne, avec une marge suffisante. Ne doit être présenté qu'un exemplaire original dactylographié ou une photocopie de qualité équivalente.

Lorsque le manuscrit a été préparé sur une machine de traitement de texte, une disquette de 3,50 ou de 5,25 pouces devrait dans toute la mesure possible y être jointe en précisant son format et le programme utilisé.

Longueur. Les manuscrits ne doivent pas, normalement, dépasser 4000 mots.

Résumé: Un résumé de 150 mots maximum doit accompagner le manuscrit. Il devra donner les buts de l'étude ou des recherches, les procédures de base (sujets de l'étude ou animaux expérimentaux et méthodes d'observation et d'analyse), les principaux résultats (fournir des données spécifiques et indiquer dans la mesure du possible leur importance statistique) ainsi que les principales conclusions. Veuillez mettre en relief les aspects nouveaux et importants de l'étude ou des observations. Prière de *ne pas* inclure des informations qui ne figurent pas dans le corps de l'article. Dans le résumé, ne citez aucun ouvrage de référence et n'utilisez ni abréviations ni sigles.

Tableaux et figures. Ils doivent être reportés sur des feuillets séparés. Les tableaux doivent être dactylographiés ou imprimés en double interligne. Veuillez soumettre uniquement des figures originales, des dessins à l'encre de Chine ou des photographies tirées sur papier glacé. Les labels qui apparaissent sur les figures doivent être dactylographiés ou gravé ou imprimés de manière professionnelle et non pas écrits à la main.

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Références. Les références doivent apparaître à la fin de l'article, en double interligne également. Les documents non publiés ne doivent pas figurer dans les références pas davantage que les documents présentés à des fins de publication mais qui n'ont pas encore été acceptés.

Veuillez numéroter les références dans l'ordre où elles sent mentionnées dans le texte. Identifiez au moyen d'un chiffre arabe placé entre crochets les références dans le texte, les tableaux et les légendes des figures. Les références citées uniquement dans les tableaux ou les légendes des figures doivent être numérotées en fonction de la première fois où il est fait mention du tableau ou de la figure appropriée dans le texte. Assurez-vous que les références sont complètes.

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—*article de journal type* (énumérer tous les auteurs):

1. Alvarez ML, Mikasic D, Ottenberger A, Salazar ME. Caracteristicas de familias urbanas con lactante desnutrido: un análisis critico. Arch Latinoam Nutr 1979;29:220–30.

—*auteur d'une société:*

2. Committee on Enzymes of the Scandinavian Society for Clinical Chemistry and Clinical Physiology. Recommended method for the determination of gammaglutamyltransferase in blood. Scand J Clin Lab Invest 1976;36:119–25. Livre ou autre monographie

—*auteur(s) à titre personnel:*

3. Brozek J. Malnutrition and human behavior: experimental, clinical and community studies. New York: Van Nostrand Reinhold, 1985.

—*auteur d'une société:*

4. American Medical Association, Department of Drugs. AMA drug evaluations. 3e éd. Littleton, Mass. (E.-U.): Publishing Sciences Group, 1977.

—*éditeur, compilateur, président en tant qu'auteur:*

5. Medioni J, Boesinger E, éds. Mécanismes éthologiques de l'évolution. Paris: Masson, 1977.

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Los editores del *Food and Nutrition Bulletin* agradecen el envío de contribuciones pertinentes al tema de la revista (vea la política editorial de esta revista en el interior de la tapa anterior). La presentación de un artículo no es garantía de su publicación, la cual dependerá del criterio de los editores y evaluadores en lo que respecta a su pertinencia y calidad. Los manuscritos con posibilidades de ser aceptados serán sometidos a evaluación por pares. Se ruega a quienes deseen colaborar que consulten números recientes de *Food and Nutrition Bulletin* para cerciorarse de su contenido y estilo.

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Cuando el manuscrito ha sido preparado usando tratamiento de textos, deberá enviarse junto al manuscrito un disco floppy, bien en 3½ pulgadas, bien en 5¼ pulgadas, indicando el formato del disco y el programa de tratamiento de textos que ha utilizado.

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Resúmenes. Se adjuntará al manuscrito un resumen que no exceda de 150 palabras, y que indicará el objetivo del estudio o investigacion, métodos básicos (individuos, animales seleccionados en experimentos y métodos de observación y análisis), descubrimientos principales (si fuera posible aportando datos específicos y su significado estadístico), y las conclusiones principales. Se enfatizarán los aspectos nuevos e importantes del estudio u observaciones. Rogamos *no* incluya informaciones que no se hayan dado en el cuerpo del artículo. En el resumen no se citarán referencias ni se usarán abreviaturas ni siglas.

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1. Alvarez ML, Mikasic D, Ottenberger A, Salazar ME. Caracteristicas de familias urbanas con lactante desnutrido: un análisis critico. Arch Latinoam Nutr 1979;29:220–30.

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2. Committee on Enzymes of the Scandinavian Society for Clinical Chemistry and Clinical Physiology. Recommended method for the determination of gammaglutamyltransferase in blood. Scand J Clin Lab Invest 1976;36:119–25.

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5. Medioni J, Boesinger E, editores, Mécanismes éthologiques de l'évolution. París: Masson, 1977.

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