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Is there an association between the nutritional status of the mother and that of her 2-year-old to 5-year-old child?

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Abstract

The aim of this study was to determine whether there is an association between the nutritional status of the mother and that of her 2-year-old to 5-year-old child in a rural village in South Africa where there is a high prevalence of childhood malnutrition (in particular, deficiencies of vitamin A and iron) and of maternal obesity.

A blood sample and anthropometric measurements were obtained for 118 child–mother pairs. There was a positive mother–child correlation for serum ferritin ($R = 0.2304$, $P < 0.05$) and haemoglobin ($R = 0.2664$, $P < 0.01$) concentrations, respectively. The child of an anaemic mother had a relative risk of 1.632 of also being anaemic. There was no mother–child association for either serum retinol concentration or anthropometric measurements. Serum retinol concentrations showed a positive correlation with both serum ferritin (mothers only; $R = 0.2161$, $P < 0.01$) and haemoglobin ($R = 0.2807$, $P < 0.01$ for mothers; and $R = 0.2710$, $P < 0.01$ for children) concentrations.

The mother–child association for iron status is probably because of an inadequate dietary intake and low bioavailability of dietary iron, which are major causes of iron deficiency. The lack of mother–child association for serum retinol concentration could probably be ascribed to the fact that children are more susceptible to vitamin A deficiency than adults because of childhood diseases.

Keywords: *Malnutrition, children, mothers, South Africa*

Background

Child malnutrition is associated with maternal characteristics (Begin et al. 1999) and an association between maternal and child nutritional status has been observed. It has been shown that underweight mothers are more likely to have underweight (Islam et al. 1994) and stunted (Engstrom & Anjos 1999) children; infants born to anaemic mothers are at risk of anaemia (De Pee et al. 2002); and the micronutrient status of lactating mothers and that of their infants are closely related (Dijkhuizen et al. 2001). Furthermore, maternal nutritional status can affect her caring capacity (Rahmanifar et al. 1993), which in turn could affect child malnutrition (UNICEF 1990).

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Most of the studies that have looked at the association between maternal and child malnutrition, especially those focusing on micronutrient status, were carried out on mother–infant pairs. During infancy the association between maternal and child malnutrition is affected by the biological consequences of maternal malnutrition during pregnancy and lactation, which become less important as the child grows older. The aim of this study was to determine whether there is an association between the nutritional status of the mother and that of her 2-year-old to 5-year-old child in a rural village in South Africa where there is a high prevalence of micronutrient deficiencies and of maternal obesity.

Methods

Study population

The study population resided in Ndunakazi, a mountainous rural village in the KwaZulu-Natal province, South Africa. A cross-sectional survey was performed to determine the nutritional status of 2-year-old to 5-year-old children and their mothers/caregivers. This was part of the baseline survey of an intervention study that was approved by the Ethics Committee of the South African Medical Research Council. Informed consent was obtained from the mother. In this paper, data collected for the baseline survey are used to determine whether there is an association between the nutritional status of the child and that of the mother (caregivers excluded).

At the time of the survey more than 80% of the households had access to a pit toilet and tap water, respectively. Although more than 70% of the households had access to electricity, the main source of energy for food preparation was wood, with nearly 80% of the households using an open fire inside the dwelling. Education levels of the caregivers were low, with 60% of the caregivers having had 7 years or less formal education. Dietary intake consisted mostly of *phutu* (a stiff porridge made with maize meal), bread, rice and beans (legumes). *Phutu* and rice were eaten either on their own or in combination with other foods such as beans, cabbage and *imifino* (a collection of various dark-green leaves, either growing wild or leaves from vegetables such as pumpkin and beetroot, and eaten as a vegetable). Bread spread with mainly hard margarine was eaten with tea. The variation of the diet was limited and the type of food items consumed by the children and the caregivers was similar, with only the portion sizes differing and slightly more children eating fruit. The diet was insufficient for most of the essential micronutrients (Faber et al. 2001).

Measurements

Blood sampling and analysis. Blood (5 ml) was obtained by venepuncture. A full blood count was performed within 8 h by means of an automated cell counter (Coulter STKS, FL, USA) on an aliquot of whole blood. A second sample of clotted blood was centrifuged to obtain serum that was stored at –80°C until analysed. Serum ferritin was determined by an immunoradiometric assay (Ferritin Mab Solid Phase Component System; Becton Dickinson and Company, USA) using an Auto Gamma 500C counting system from United Technologies Packard, USA. Serum retinol was determined by a slightly modified version of the reversed-phase high-performance liquid chromatography method described by Catignani and Bieri (1983).

Anthropometry. Weight and height measurements for both mother and child were taken without shoes and in light clothing. Weight was measured to the nearest 0.05 kg using a calibrated load cell operated digital scale (UC-300 Precision Health Scale, A & D Co. Ltd, Tokyo, Japan). Height was measured to the nearest 0.1 cm with a wooden height board fitted with a measuring tape and a movable headpiece. The child's date of birth was obtained from either growth-monitoring records or the child's clinic card. For children, z-scores for height-for-age (HAZ), weight-for-age (WAZ), and weight-for-height (WHZ) were calculated using the Epi Info 2000 software package. The prevalence of stunting, underweight and wasting was defined as the proportion of individuals who had a HAZ, WAZ and WHZ score below -2 standard deviations of the median of the reference population, respectively. The body mass index (BMI) was calculated for mothers as the weight (kg) divided by the square of the height (m^2).

Statistical analysis

The data were analysed using the SAS statistical package—version 8 (SAS Institute Inc., Cary, NC, USA). The data were checked to see whether the child's age and sex, and the mother's age and BMI were possible confounders when looking at the biochemical parameters. No such indications were found when parameter estimates were compared or when looking at the relevant plots. Associations between the nutritional status parameters of the children and the mothers were determined by calculating Spearman correlation coefficients. Linear regressions were performed to determine the effect of the mother's nutritional status parameters on that of the child. The relative risk that a malnourished mother would have a malnourished child was calculated for various biochemical and anthropometric indicators.

Results

Anthropometric measurements and blood samples were obtained for 118 child–mother pairs. The sample consisted of 53 (45%) boys and 65 (55%) girls. The children had a mean age of 3.6 ± 1.3 years, and the mean age of the mothers was 29.7 ± 7.6 years.

Nutritional status of the children and their mothers

The mean and standard deviation for the nutritional status parameters for children and mothers are presented in Table I and the prevalence of malnutrition is presented

Table I. Anthropometric indices and biochemical parameters for the children and their mothers.

	Children	Mothers
Age (years)	3.6 (1.3)	29.7 (7.6)
Weight-for-age z-score	−0.54 (0.96)	–
Height-for-age z-score	−1.38 (0.93)	–
Weight-for-height z-score	0.40 (0.96)	–
Body mass index	–	28.3 (5.6)
Serum retinol (μg/dl)	21.4 (6.2)	35.6 (10.2)
Serum ferritin (μg/l)	15.2 (14.8)	26.2 (26.6)
Haemoglobin (g/dl)	11.1 (1.3)	12.2 (1.2)

Values presented as the mean and standard deviation ($n = 118$).

in Table II. The mothers had a mean BMI of 28.3, which falls in the overweight category. For children, the mean scores for HAZ and, to a lesser extent, WAZ were negative values, indicating that these indices of malnutrition were shifted towards low, or undernourished, levels.

The Spearman correlation coefficients between the nutritional status parameters are presented in Table III. There was no significant correlation between the three anthropometric indices of the children and the BMI of their mothers. There was no significant correlation between the serum retinol concentration of the mother and that of her child. Although the correlation coefficients were low, there was a positive correlation between the mother and her child for serum ferritin and haemoglobin concentrations, respectively. Serum retinol concentrations showed a positive correlation with both serum ferritin (mothers only) and haemoglobin (children and mothers) concentrations.

Linear regressions statistics showed that for all three parameters (haemoglobin, serum retinol and ferritin) the mother's parameter had no significant predictive effect on that of the child. The mother's BMI was also not a significant indicator of the child's anthropometric status.

The relative risk that the child of a mother who has a nutrient deficiency will have the same nutrient deficiency is shown in Table IV. There was no significant relative risk that the child of a vitamin A-deficient mother would also be deficient for vitamin A. The prevalence of anaemia in children was higher among anaemic mothers than non-anaemic mothers (48% versus 29%), and the child of an anaemic mother had a relative risk of 1.632 of also being anaemic.

The relative risk that the child of an overweight/obese mother (BMI $>$25 kg/m^2) would be malnourished was calculated for the individual parameters as well as combinations thereof (Table V). A child of an overweight/obese mother did not have a bigger risk of being malnourished as compared with children from normal weight mothers.

Table II. Prevalence of malnutrition for the children and their mothers.

	Children	Mothers
Stunted	23	
Underweight	8	1
Wasted	1	
Overweight	3	26
Obese		40
Vitamin A deficient	52	29
Iron deficient	47	30
Anaemic	37	42

Values presented as percentages ($n = 118$). Stunted was defined as a height-for-age z-score < -2 standard deviations (SD). Underweight was defined as a weight-for-age z-score < -2 SD for the child, and a BMI $<$18.5 kg/m^2 for the mother. Wasted was defined as a weight-for-height z-score < -2 SD. Overweight was defined as a weight-for-height z-score $>$2 SD for the child, and 25 $\leq$BMI $<$30 kg/m^2 for the mother. Obesity was defined as BMI $>$30 kg/m^2. Vitamin A deficiency was defined as serum retinol $<$20 μg/dl for the child, and $<$30 μg/dl for the mother. Iron deficiency was defined as serum ferritin $<$10 μg/l for the child, and $<$12 μg/l for the mother. Anaemia was defined as haemoglobin $<$11 g/dl for the child, and $<$12 g/dl for the mother.

Table III. Spearman correlation coefficients for parameters of the children and their mothers, respectively.

	Child						Mother			
	Serum retinol	Serum ferritin	Haemoglobin	Height-for-age	Weight-for-age	Weight-for-height	Serum retinol	Serum ferritin	Haemoglobin	BMI
Child										
Serum retinol	–	0.0024	0.2710**	0.1368	0.1813*	0.1432	0.1109	−0.1544	0.0739	0.1427
Serum ferritin	–	–	0.2159*	−0.007	−0.1469	−0.1443	0.1683	0.2304*	−0.0336	0.0103
Haemoglobin	–	–	–	0.164	0.094	0.0289	0.1926*	−0.1105	0.2664**	0.1027
Height-for-age	–	–	–	–	0.6222***	0.0962	0.0585	0.0629	0.1946	0.0322
Weight-for-age	–	–	–	–	–	0.8068***	0.0596	0.0727	0.162	0.1142
Weight-for-height	–	–	–	–	–	–	0.0582	0.0164	0.0501	0.1801
Mother										
Serum retinol	–	–	–	–	–	–	–	0.2161**	0.2807**	0.2274*
Serum ferritin	–	–	–	–	–	–	–	–	0.2996***	0.0272
Haemoglobin	–	–	–	–	–	–	–	–	–	0.1637
BMI	–	–	–	–	–	–	–	–	–	–

$n = 118$. Statistical significance: * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

Table IV. Relative risk that the child of a mother who has a nutrient deficiency will have the same nutrient deficiency.

	Relative risk[a]	95% confidence interval	Significance
Vitamin A deficiency	1.1176	0.7741–1.6137	Not significant
Iron deficiency	1.3016	0.8856–1.9130	Not significant
Anaemia	1.632	1.0223–2.6054	Significant

$n = 118$. Vitamin A deficiency was defined as serum retinol <20 μg/dl for the child, and <30 μg/dl for the mother. Iron deficiency was defined as serum ferritin <10 μg/l for the child, and <12 μg/l for the mother. Anaemia was defined as haemoglobin <11 g/dl for the child, and <12 g/dl for the mother. [a]Child versus mother.

Discussion

Studies have shown a relationship between the micronutrient status of the mother and that of her infant (Dijkhuizen et al. 2001; De Pee et al. 2002). We could not demonstrate a similar relationship for 2-year-old to 5-year-old children, except for iron.

The association between the iron status of the mother and that of her child, although weak, can probably be ascribed to an inadequate dietary intake and low bioavailability of dietary iron, which are major causes of iron deficiency and anaemia. A dietary survey showed that, for both mother and child, iron intake was low, protein was mostly of non-heme sources (which is less bioavailable than heme iron), and legumes and tea were consumed regularly (Faber et al. 2001). Phytate in legumes and tannins in tea are inhibitors for iron absorption from non-heme sources.

The lack of association between maternal and child serum retinol concentrations can probably be ascribed to the fact that young children are more susceptible to vitamin A deficiency than adults because of childhood diseases such as diarrhoeal infections (Bloem et al. 1990a; Salazar-Lindo et al. 1993), measles (Coutsoudis et al. 1991) and respiratory infections (Bloem et al. 1990a), which can contribute to vitamin A deficiency through reduced absorption, increased utilization, increased excretion, and reduced food intake because of poor appetite.

The association observed between serum retinol concentrations and indicators of iron status for both mothers and children is in line with several other cross-sectional

Table V. Relative risk that the child of an overweight or obese mother will be malnourished for individual nutrition indices and combinations thereof.

	Relative risk	95% confidence interval	Significance
Vitamin A deficiency	0.8473	0.5968–1.2029	Not significant
Iron deficiency	1.5018	0.9368–2.4078	Not significant
Anaemia	0.8145	0.5079–1.3060	Not significant
Stunted	1.0256	0.5075–2.0727	Not significant
One deficiency	0.9955	0.8475–1.1693	Not significant
Two deficiencies	0.9436	0.6969–1.2777	Not significant
Three deficiencies	1.0256	0.4502–2.3365	Not significant
All four deficiencies	0.975	0.3953–2.4049	Not significant

$n = 118$. Maternal overweight/obesity was defined as BMI >25 kg/m^2. Vitamin A deficiency was defined as serum retinol <20 μg/dl for the child, and <30 μg/dl for the mother. Iron deficiency was defined as serum ferritin <10 μg/l for the child, and <12 μg/l for the mother. Anaemia was defined as haemoglobin <11 g/dl for the child, and <12 g/dl for the mother. Stunted was defined as a height-for-age z-score <−2 SD.

surveys (Wolde-Gebriel et al. 1993; Suharno et al. 1992; Bloem et al. 1989). This interaction is an important consideration in nutrition interventions as it has been shown that supplementation with vitamin A leads to a concomitant improvement in iron status (Mejia & Chew 1988; Bloem et al. 1990b; Suharno et al. 1993) and the presence of marginal vitamin A deficiency in a population may limit the effectiveness of iron intervention programmes (Van Stuijvenberg et al. 1997).

A study in Bangladesh showed that mothers who were underweight were 2.5 times more likely to have underweight children (Islam et al. 1994). Severe malnutrition in terms of being underweight was not prevalent in our study population. A previous survey in this population showed that children were stunted and presented with micronutrient deficiencies, with most of the mothers being either overweight or obese (Oelofse et al. 1999). This specific pattern of malnutrition may explain the lack of association between the anthropometric indices of malnutrition of the mother and that of her 2-year-old to 5-year-old child.

In conclusion, this study showed an association (although weak) between the iron status of the mother and that of her 2-year-old to 5-year-old child, probably because of an inadequate dietary intake and low bioavailability of dietary iron. Serum retinol concentration showed no mother–child association, probably because children are more susceptible to vitamin A deficiency than adults because of childhood diseases.

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