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Zimbabwe Demographic and Health Surveys

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Stanley Gwavuya
Conrad Murendo
Naomi Wekwete
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Nyasha Madzingira

August 2014 • No. 10

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Stanley Gwavuya[1]

Conrad Murendo[2]

Naomi Wekwete[3]

Felicia Takavarasha[4]

Nyasha Madzingira[5]

ICF International

Rockville, Maryland, USA

August 2014

[1] United Nations Children's Fund, Zimbabwe; [2] Global Food Research Training Group, Department of Agricultural Economics and Rural Development, Georg-August University of Göttingen; [3] Centre for Population Studies, University of Zimbabwe; [4] United Nations Children's Fund, Zimbabwe; [5] Consultant, Harare, Zimbabwe

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ACKNOWLEDGMENTS

The authors gratefully acknowledge the technical support provided by the DHS Program and in particular the analytical support provided by Trevor Croft and Sarah E.K. Bradley during an Extended Analysis Workshop in Zimbabwe in June 2013. The authors also thank Tesfayi Gebreselassie and Simbarashe Rusakaniko for thorough content review during the paper writing process. Additional thanks go to Cameron Taylor for logistical support.

Editor: Bryant Robey

Document production: Yuan Cheng

Corresponding author*:* Stanley Gwavuya, United Nations Children's Fund, Harare, Zimbabwe; E-mail: sgwavuya@gmail.com

The *DHS Working Papers* series is a prepublication series of papers reporting on work in progress. The *Zimbabwe Working Papers* are based on further analysis of data collected in the Zimbabwe Demographic and Health Surveys. The development of these working papers was funded by the United States Agency for International Development (USAID) through the MEASURE DHS-III project at ICF International, Rockville, Maryland, USA. The views expressed are those of the authors and do not necessarily reflect the views of USAID or the governments of the United States or Zimbabwe.

Recommended citation:

Gwavuya, Stanley, Conrad Murendo, Naomi Wekwete, Felicia Takavarasha, and Nyasha Madzingira. 2014. *Maternal Iron and Vitamin A Supplementation and the Nutritional Status of Children in the 2010-2011 Zimbabwe Demographic and Health Survey*. DHS Working Papers No. 109 (Zimbabwe Working Papers No. 10). Rockville, Maryland, USA: ICF International

ABSTRACT

Background: Child stunting is a public health problem in developing countries. Studies have shown that maternal nutrition is an important determinant of fetal and postnatal growth. However, the diets of women in developing countries are often deficient in energy, protein and vital micronutrients. Improving the health and nutrition of mothers and mothers-to-be is important in addressing many underlying causes of child malnutrition. Hence strategies to improve children's nutritional status and growth should include interventions to improve nutrition of pregnant and lactating women. The World Health Organization (WHO) advises that, to improve children's growth, pregnant women in developing countries should take iron supplements, and lactating mothers should take Vitamin A supplements. Despite the implementation of these interventions, there is little information on how antenatal and postnatal maternal micronutrient supplements influence child growth in developing countries.

Objective: Evaluate the role of maternal Vitamin A and iron supplements on children's nutritional status and growth. We compare the differences in stunting between children whose mothers received one or both of these two micronutrient supplements during pregnancy and after delivery and children whose mothers did not receive either of the micronutrients.

Methods: We use cross-sectional survey data from the Zimbabwe Demographic and Health Survey of 2010-11 (ZDHS 2010-11). A stratified, two-stage cluster design was used for the survey. For our analysis we use data from 2,007 children under age 3 whose anthropometric measurements were recorded during the survey. Logistic regression analysis was used to identify determinants of child nutritional status, defined as height-for-age (stunting).

Results: Forty percent of the mothers received postpartum Vitamin A supplements, while 53% received iron supplements during pregnancy. Results show that maternal iron supplements reduced child stunting (aOR = 0.73; 95% CI = (0.58, 0.91); p = 0.006). However, Vitamin A supplementation did not have an effect on child stunting (aOR = 1.09; 95% CI = (0.86, 1.37); p = 0 .474).

Conclusion: The results of this study indicate that maternal iron supplementation during pregnancy reduces early childhood malnutrition, especially stunting. Postpartum Vitamin A supplementation, however, does not appear to have an effect on the nutritional status of children.

The effects of Vitamin A supplements on child nutrition may be indirect, and may not necessarily be on child growth but rather on other children's health and developmental issues.

Key Words: Children, stunting, Vitamin A, iron, lactating, pregnancy, Zimbabwe

INTRODUCTION

Severe malnutrition in children under age 5 remains relatively rare (2%) across Zimbabwe (ZIMSTAT and ICFI 2012). The country has achieved remarkable progress in reducing the prevalence of severe malnutrition for children under age 5. Despite such progress, severe malnutrition among children age 6-23 months is nearly twice as prevalent compared with children age 18-59 months (UNICEF 2010). Only 8% of children age 6-23 months in Zimbabwe receive the minimum acceptable complementary foods in terms of quality and diversity (UNICEF 2010).

Globally, malnutrition is one of the major causes of infant mortality and poor child growth. Various studies show that maternal nutrition is an important determinant of fetal growth and of postnatal growth (Huy et al. 2009; Gewa et al. 2012; Gewa et al. 2013; Khan et al. 2011). In many developing countries diets are low in animal products and are mostly cereal-based, which is associated with a high risk for micronutrient deficiencies (Ramakrishnan et al. 2012; Wieringa et al. 2003). The diets of most women in developing countries have pronounced micronutrient, energy and protein deficiencies because of poor access to resources (Appoh and Krekling 2005; Ramakrishnan et al. 2012; Wieringa et al. 2003).

During pregnancy, most women need iron supplements to prevent iron deficiency. Iron deficiency may affect growth and development of the child during pregnancy and in the long term (Stoltzfus 2011). Improving the health and nutrition of mothers and mothers-to-be is important in addressing many underlying causes of child malnutrition. Hence strategies to improve children’s nutritional status and growth should include interventions to improve nutrition of pregnant and lactating women. According to the World Health Organization (WHO), pregnant women in developing countries are advised to take iron supplements, and lactating mothers are advised to take Vitamin A supplements to improve their children’s growth (WHO 2012; WHO and UNICEF 1997). Providing Vitamin A supplements to lactating mothers is done so as to improve Vitamin A content in breastmilk, an important source of nutrition for young children.

Very few studies have looked at the postnatal growth of children of mothers whose diets were supplemented with food or micronutrients during and after pregnancy. In Zimbabwe most of these studies have focused on the role of maternal Vitamin A supplementation on child survival and mortality (Humphrey et al. 2006; Malaba et al. 2005), anemia on infants (Miller et al. 2006) and prevention of breastfeeding-associated HIV transmission (Piwoz et al. 2005). In addition, the effectiveness of iron supplementation for pregnant women has been evaluated mostly in terms of improvement in haemoglobin concentration (Zhang et al. 2013), rather than improvements in infant health. The role of maternal Vitamin A and iron supplementation on child nutrition, especially stunting, has not been systematically analysed in Zimbabwe.

Using data from the Zimbabwe Demographic and Health Survey of 2010-11 (ZDHS 2010-11), we contribute to the literature by assessing the differences in child malnutrition between children whose mothers received postnatal Vitamin A and antenatal iron supplements and children whose mothers received neither of these two supplements. The contribution of our study is twofold: First, we assess the individual and combined roles of Vitamin A and iron supplementation on child nutrition. Second, we describe the specific effect of these interventions in Zimbabwe.

In the literature, factors such as micronutrient deficiencies, poor protein intake, intrauterine malnutrition, maternal stature and infections are cited as the most common direct causes of child stunting (Mamabolo et al. 2005). Multiple micronutrient deficiencies during pregnancy may contribute to poor fetal growth and stunting. Vitamin A and iron are some of the important micronutrients required for maternal and child nutrition (Pee and Bloem 2009). Studies assessing the role of micronutrient supplementation on child growth have yielded mixed results. The importance of Vitamin A has been demonstrated in Zambia, where the introduction of Vitamin A resulted in Vitamin A deficiency being halved, which led to a reduction of anemia in children under age 5 from 65% to 53% between 1997 and 2003 (MOST et al. 2003). Maternal iron deficiency, anemia or undernutrition is critical to the nutritional status of children under age 5, as it increases the probability of low-birth weight, which in turn increases the probability of neonatal deaths due to infections and asphyxia (WHO 2013).

Studies have suggested that antenatal micronutrient supplementation potentially results in modest but increased growth up to age 2 (Vaidya et al. 2008; Huy et al. 2009). Huy et al. (2009) in a nonrandomized trial found that multiple micronutrient supplementation (with Vitamin A, B, C, D, E, iron, zinc, selenium and iodine) reduced child stunting in Vietnam. Vaidya et al. (2008) found that in Nepal children whose mothers had taken multiple micronutrient supplements similar to those in Huy et al. (2009) during pregnancy were heavier than the control group. Children in the micronutrient group were also less likely to be stunted, wasted or underweight, although these findings were not significant.

On the contrary, another strand of literature finds no evidence on the influence of food and micronutrient supplementation on child growth (Khan et al. 2011; Lind et al. 2004). In Indonesia, Lind et al. (2004) concluded that single supplementation with either iron or zinc improved growth, yet combined supplementation with iron and zinc had no effect on child growth or development. Such results could be due to interactions among micronutrients producing adverse effects. Khan et al. (2011) found that micronutrient supplementation increased the risk of stunting for children age 0-54 months in Bangladesh. The reasons are unclear and the authors argue that this result could be due to low doses of micronutrients being insufficient to induce fetal growth. However, the study also found that early food supplementation during pregnancy reduced the occurrence of stunting at age 0-54 months for boys, but not for girls.

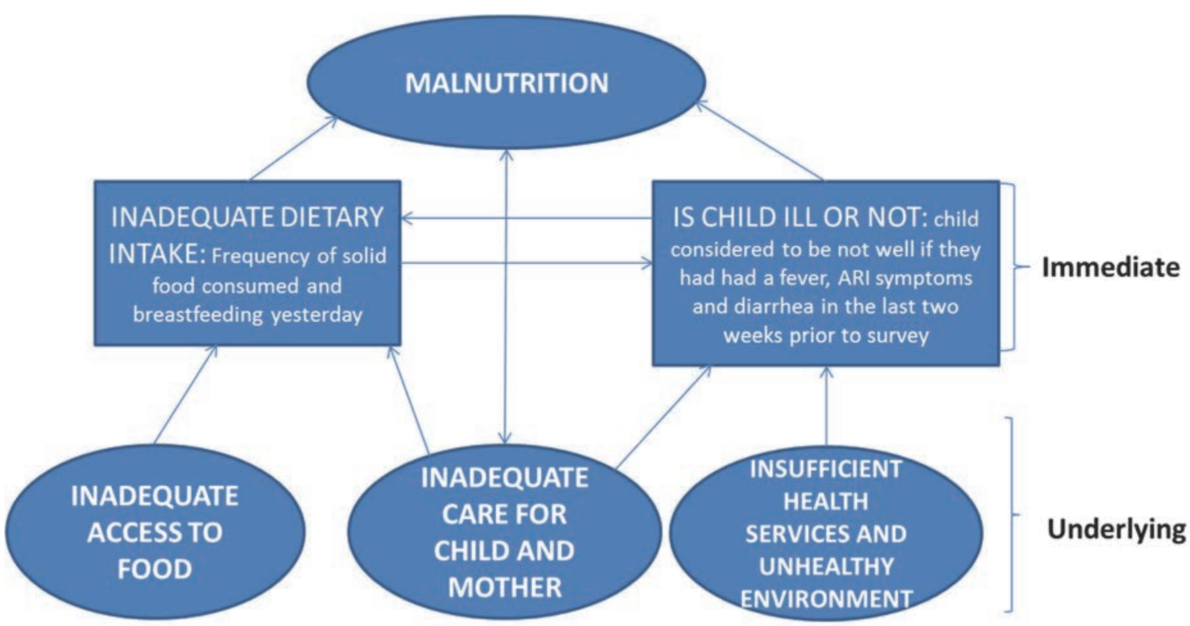
METHODOLOGY

For our analysis we used the most recent survey data available, the ZDHS 2010-11. The ZDHS 2010-11 sample was selected using a stratified, two-stage cluster design to provide nationally representative data for a wide range of monitoring and impact evaluation indicators in the areas of population, health and nutrition. We used data for 2,007 children under age 3 whose anthropometric measurements were recorded during the survey. Approval to use the data was obtained from ICF International as part of the Zimbabwe extended DHS analysis exercise. A full description of the survey is available (ZIMSTAT and ICFI 2012).

Conceptual Framework

To explore the causes of child malnutrition, we adapted the conceptual framework developed by Smith and Haddad (1999) (see Figure 1). This framework is used by the United Nations Children's Fund (UNICEF) for identifying the causes of child malnutrition. In this study we restricted the analysis to the immediate and underlying causes of malnutrition only.

Figure 1. Conceptual framework on causes of child malnutrition adapted from Smith, Haddad 1999



Data Analysis

We ran logistic regression models for our analysis. We were interested to know how our key independent variables behave in the presence of other factors. Therefore, in a multivariate analysis we controlled for the effect of other variables available in the ZDHS 2010-11. The conceptual framework for this study guided the selection of independent variables.

Dependent Variable

The common indicators of children's nutritional status are height-for-age index (stunting), weight-for-height (wasted), and weight-for-age (underweight) (WHO 2006). Results from the ZDHS 2010-11 show that 32% of children under age 5 are stunted, while 3% and 10% respectively are considered wasted and underweight (ZIMSTAT and ICFI 2012). In the data, stunting is the only anthropometric measure with a sufficient sample size to explore deeply. Because of this, we use stunting, an indicator of linear growth retardation and cumulative growth deficits, as our dependent variable. Following the conventional cut-off points (WHO 2006), children whose height-for-age Z-scores are below minus-two standard deviations (-2 SD) from the median of the reference population are defined as stunted.

Independent Variables

We ask, are there differences in malnutrition between children whose mothers received micronutrient supplements during pregnancy and after delivery and children whose mothers did not? Specifically, are there differences in malnutrition between children whose mothers received Vitamin A and iron supplements during pregnancy and after delivery and those whose mothers did not? We constructed two binary variables from the ZDHS 2010-11 data on mother's Vitamin A and iron intake respectively. Respondents who said "don't know" in the survey were considered to have received neither Vitamin A nor iron supplements, while those with missing values were excluded from the analysis. This treatment is consistent with DHS treatment of the variable during analysis. We use these variables as our key variable in analysis, while controlling for the effects of other variables on children's malnutrition, as follows:

Immediate Causes of Child Malnutrition

Child's health status: A proxy indicator of child health was derived from questions in the ZDHS 2010-11 asking if the child has had a fever, ARI symptoms and/or diarrhea in the last two weeks preceding the survey.

Child dietary intake: Children's dietary intake was constructed from two questions in the ZDHS 2010-11. The first question looked at breastfeeding status for all children born in the three years preceding the survey. The second question dealt with the frequency of solid meals for children under age 2.

The minimum feeding requirement for children under age 6 months is exclusive breastfeeding. For children age 6-8 months, breast milk and at least two or three meals per day is recommended, and at least four meals per day if not breastfeeding. For children age 9 -23 months, breastfeeding and at least three or four meals per day is recommended, and at least four meals per day if not breastfeeding, according to WHO guidelines on infant and young child feeding (IYCF) (PAHO/WHO 2003; WHO 2008; WHO 2010).

Underlying Causes of Child Malnutrition

Only covariates applicable to every subject in our sample were used. These include:

(a) *Characteristics of the household:* Wealth quintile, access to safe water, access to improved sanitation facility, residence (rural or urban), province.

(b) *Characteristics of the mother:* Mother's age, nutritional status, control of household economic resources, education level, religion, employment status, access to information, parity, marital status, previous experience of terminated pregnancy.

RESULTS

Sample Description

Table 1 shows the background characteristics of 2,007 children under age 3. Over half (59%) of the children in the sample were reported as not feeling well in the two weeks preceding the survey, while 54% were considered not fed a minimum required number of the meals.

Concerning mothers' characteristics, 53% of the mothers of children in our sample reported having received iron supplementation during pregnancy and 40% reported receiving Vitamin A supplementation postpartum. Also, 9% of mothers in the sample were stunted, while a similar number had experienced a terminated pregnancy. About a quarter (23%) of the mothers reported having control over household economic resources. The mothers with children in the sample had given birth to four children, on average.

Household characteristics show that about three-quarters (74%) of children in the sample reside in rural areas. Only about 28% and 42% of children, respectively, reside in households that have access to safe drinking water, and to safe sanitation.

Table 1. Feeding practice of children under age 2 living with their mothers and mothers' demographic and socio-economic characteristics

Variable	%	N*
CHILD'S CHARACTERISTICS		
Child health status		
Child well in the last two weeks	40.7	817
Child not feeling well in the last two weeks	59.3	1,189
Child's feeding		
Child not fed minimum required meals	53.7	1,078
Child fed minimum required meals	46.3	929
MOTHER'S CHARACTERISTICS		
Age		
15-19	12.4	249
20-24	31.5	632
25-29	27.8	557
30-34	16.2	325
35+	12.1	243
Religion		
Roman Catholic	6.6	132
Protestant	13.3	267
Pentecostal	18.5	371
Apostolic Sect	45.8	919
Other Christian	7.1	143
Other/None	8.7	175
Marital status		
Married/cohabiting	88.1	1,768
Divorced/separated/widowed	7.5	151
Single-never in union	4.3	87
Highest education level attained		
No education/primary	32.9	656
Secondary and higher	67.1	1,350
Employment status		
Unemployed	62.6	1,256
Professional/sales/clerical	15.5	311
Agriculture	11.3	227
Domestic/manual	10.0	200
Don't know	0.6	12
Received iron supplements during pregnancy		
Yes	52.8	1,060
No	47.2	946
Received Vitamin A supplements in the first two months after delivery		
Yes	40.4	811
No	59.6	1,196
Mothers nutrition status		
Not stunted	91.4	1,834
Stunted	8.6	173

(Continued...)

Table 1. – *Continued*

Variable	%	N*
Ever had terminated pregnancy		
Yes	9.0	180
No	91.0	1,826
Access to information		
Yes	66.1	1,326
No	33.9	681
Woman has control over economic resources within household		
Yes	23.2	465
No	76.8	1,542
Parity		
Mean number of children	2.6	sd=1.66
HOUSEHOLD CHARACTERISTICS		
Province		
Manicaland	15.3	307
Mashonaland Central	11.3	226
Mashonaland East	11.1	222
Mashonaland West	12.4	248
Matabeleland North	4.8	97
Matabeleland South	5.2	104
Midlands	13.1	264
Masvingo	11.4	229
Harare	11.3	227
Bulawayo	4.1	82
Wealth quintile		
Lowest	23.5	471
Second	22.1	444
Middle	20.1	404
Fourth	20.4	409
Highest	13.9	278
Residence		
Urban	25.5	512
Rural	74.5	1,495
Source of drinking water		
Unsafe water source	72.5	1,454
Safe drinking water	27.5	553
Sanitation		
Unsafe sanitation	58.5	1,173
Safe sanitation	41.5	833
Total	100.0	2,007

* Weighted N as such may not add up to 2007 for each variable due to rounding

Multivariate Regression Analysis

We used multivariate regression to investigate the effect of Vitamin A and iron supplementation on child stunting while controlling for other factors. Results in Table 2 show that iron supplementation sustains its association with child nutrition even in the presence of other factors. On average, children whose mothers received iron supplementation during pregnancy are 27% less likely to be suffering from stunting. However, Vitamin A supplementation remains insignificant in its effect on stunting in children. Due to concerns of effect modification, a separate model was run to check on the effect of Vitamin A supplementation in the absence of iron supplementation, but results remained insignificant for Vitamin A supplementation.

A look at the effect of immediate causes on stunting shows important results. Children fed in line with recommended IYCF practice are about 28% less likely to be stunted compared with children not fed in line with the IYCF guidelines (AOR = .723; 95% CI = (.574, .991)). Children whose mothers suffer from stunting are 2.7 times more likely to be suffering from stunting compared with children whose mothers are not stunted (AOR = .723; 95% CI = (.574, .991)). Children whose mothers are divorced, separated or widowed are also 1.5 times more likely to be stunted. In terms of province, our results show that children in Bulawayo are 2.2 times more likely to be stunted compared with children in Manicaland. Similarly, children in Mashonaland East are 1.7 times more likely to be stunted compared with children in Manicaland Province ($p < 0.05$). The other household characteristics studied, as well as most of the provinces, are not significant in determining stunting in children.

Table 2. Adjusted odds ratios from multivariate logistic regression of child stunting on child's, mother's and household characteristics

Variable	Odds Ratio	95% Confidence Interval		*p*-value
CHILD'S CHARACTERISTICS				
Child not feeling well	0.855	0.685	1.066	0.162
Child fed minimum required meals	0.723**	0.574	0.911	0.006
MOTHER'S CHARACTERISTICS				
Received Vitamin A supplements	1.088	0.864	1.369	0.474
Received iron supplements	0.730**	0.584	0.911	0.006
Stunted	2.728**	1.913	3.890	0.000
Secondary education	1.018	0.770	1.346	0.902
Previous terminated pregnancy	1.003	0.662	1.521	0.988
Employment status (Ref.= Unemployed)				
Professional/sales/clerical	1.087	0.675	1.749	0.730
Agriculture	1.334	0.836	2.129	0.226
Domestic/manual	1.292	0.816	2.046	0.274
Don't know	3.368	0.769	14.758	0.107
Marital status (Ref. = Married)				
Divorced/separated/widowed	1.547*	1.064	2.250	0.023
Single-never in union	1.377	0.774	2.448	0.275
Parity	0.999	0.900	1.110	0.987
Woman has no control over economic resources within household	0.725	0.468	1.123	0.149
Religion (Ref. = Roman Catholic)				
Protestant	1.363	0.742	2.503	0.317
Pentecostal	1.382	0.747	2.557	0.302
Apostolic Sect	1.123	0.638	1.976	0.687
Other Christian	1.756	0.887	3.478	0.106
Other/None	0.973	0.492	1.926	0.938
Age in years (Ref. = 15-19)				
20-24	0.928	0.612	1.405	0.722
25-29	1.046	0.674	1.622	0.842
30-34	1.117	0.657	1.899	0.681
35+	1.332	0.737	2.407	0.342

(Continued...)

Table 2. – *Continued*

Variable	**Odds Ratio**	**95% Confidence Interval**		***p*-value**
HOUSEHOLD CHARACTERISTICS				
Province (Ref. = Manicaland)				
Mashonaland Central	1.151	0.760	1.745	0.506
Mashonaland East	1.685*	1.087	2.613	0.020
Mashonaland West	1.202	0.749	1.928	0.446
Matabeleland North	1.118	0.649	1.925	0.687
Matabeleland South	1.092	0.622	1.915	0.759
Midlands	0.942	0.618	1.436	0.781
Masvingo	0.729	0.411	1.292	0.278
Harare	1.439	0.776	2.669	0.247
Bulawayo	2.227*	1.214	4.086	0.010
Household wealth quintile (Ref. = Lowest 20%)				
Second	0.822	0.586	1.154	0.256
Middle	1.018	0.698	1.484	0.927
Fourth	0.831	0.517	1.333	0.441
Highest	0.631	0.337	1.181	0.149
Rural residence	1.532	0.906	2.588	0.111
Access to media	1.209	0.904	1.618	0.201
Access to safe water	1.030	0.792	1.340	0.825
Access to safe sanitation	1.033	0.760	1.405	0.834

Notes: For categorical variables, reference group (Ref.) is shown in parenthesis

Significance level: * p < .05, ** p < .01

DISCUSSION

This paper examined the association between maternal Vitamin A and iron supplementation and child stunting. Our results suggest that maternal iron supplementation reduces child stunting, while Vitamin A supplementation does not have an effect on reducing stunting in children. These are interesting results with important policy implications.

Our results on the positive influence of maternal iron supplementation resonate with various studies (Huy et al. 2009; Lind et al. 2004), while contradicting some other studies (Khan et al. 2011). Huy et al. (2009) found that multiple micronutrient supplementations, including iron and vitamins, reduced child stunting in Vietnam.

For Vitamin A supplementation, our finding of no effect on child growth contradicts findings by Huy et al. (2009) and other studies as reviewed by Rivera and colleagues (Rivera et al. 2003). Vitamin A supplements had a positive growth effect only in children with severe infections (Villamor et al. 2002) who had Vitamin A deficiency (Hadi et al. 2000; Donnen et al. 1998), or who were not being breastfed (Hadi et al. 2000). In another study, Oliveira-Menegozzo et al. (2010) reviewed several clinical trials that examined the effect of maternal postpartum Vitamin A supplementation on child's and mother's health outcomes and found a general lack of effect both on maternal and infant health, with the exception of some improved infant morbidity in one small study, and the improvement in maternal Vitamin A status.

Lind et al. (2004) found mixed evidence of the influence of micronutrient supplementation in Indonesia. The researchers concluded that single supplementation with either iron or zinc improved child growth, but combinations of these had no effect on growth. Contradicting our findings, Khan et al. (2011) found that in Bangladesh micronutrient supplementation (15 different vitamins and minerals including Vitamin A and iron) had no effect on child nutrition, while food supplementation had an effect. Our study did not control for dietary intake due to data concerns; hence the effect could not be seen as mothers were possibly on high vitamin A dietary intake. Khan and colleagues found surprising results that micronutrient supplementation increased the risk of stunting at 0-54 months for children in Bangladesh. The reasons for such evidence were unclear and the authors argue that this could be due to low doses of micronutrients being insufficient to induce fetal growth and possibly interactions among micronutrients producing adverse effects. In a related study, Christian (2003) found that in Nepal antenatal folic acid-iron supplements modestly reduced the risk of low birth weight.

In the study by Khan et al. (2011), the food supplements were supplied through government-supported national programs and were available through community nutrition centres. The supplements contained energy-protein foods (e.g. rice, pulse powder, molasses). The finding from this study that food supplements had an effect on child nutrition has important policy implications. Together with findings from our study, we argue that there is need for promotion of micronutrient and food-based interventions. In contrast to micronutrient supplementation programs, food-based interventions are more sustainable and offer a long-term solution for the problem of micronutrient deficiency. Most food-based programs attempt to increase the consumption of low-cost micronutrient-rich fruits and vegetables, since foods containing preformed Vitamin A and others are generally more expensive.

Our results also show that children whose mothers are stunted are more likely to be stunted. This finding is in line with Gewa et al. (2012), who found a positive association between maternal anthropometric status and child nutritional status in Kenya. This result is important in that it calls for interventions that improve both maternal and child nutrition.

Our study relied on cross-sectional data and did not capture the basic causes of malnutrition. Therefore, we could not analyze different pathways through which micronutrients influence child growth. We encourage further research using randomized control trials to better understand this topic.

CONCLUSION

The findings from this study add to the scarce literature on micronutrient supplementation in developing countries. Our results give further support to the evidence that maternal iron supplementation is crucial in the fight against child malnutrition. For Vitamin A, we found no evidence of an effect on child nutrition. The effects of Vitamin A supplements on child nutrition may be indirect, and may not necessarily be on child growth but rather on other children's health and developmental issues. The positive association found between maternal anthropometric status and child nutritional status highlights the need to jointly improve maternal and child nutrition in developing countries. Improvement in nutrition will help reduce stunting in children.

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