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Copenhagen Consensus 2008 Perspective Paper

Malnutrition & Hunger

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1. Introduction

Horton, Alderman and Rivera (in press) address the challenge of hunger and malnutrition, as done earlier by Behrman, Alderman and Hoddinott (2004) for the 2004 Copenhagen consensus. Horton, Alderman and Rivera (in press) state their work "builds on and updates" the earlier work. There are differences in approach between these two analyses. Four opportunities are proposed by Behrman, Alderman and Rivera: 1) reducing the prevalence of birthweight, 2) infant and child nutrition and exclusive breastfeeding promotion, 3) reducing the prevalence of iron deficiency anemia and vitamin A, iodine and zinc deficiencies and, 4) investment in technology in developing country agriculture. Horton, Aldeman and Rivera (in press) list four opportunities (or solutions as they call them): 1) micronutrient interventions, 2) antihelminthics, 3) breast feeding promotion – baby-friendly hospitals, and 4) nutrition education at the community level. While Behrman, Alderman and Hoddinott (2004) describe the first three opportunities that address nutrition directly in terms of the intended goals (e.g., reducing the prevalence of birthweight), Horton, Alderman and Rivera (in press) describe theirs in terms of the types of interventions to be implemented (e.g., micronutrient interventions), which makes them seem less compelling. Focusing on the interventions rather than the problems may narrow the mix of cost effective interventions that can address the problem and may expand the populations of interest beyond women and children under 2 years, the high priority groups for nutrition interventions (e.g., to school age children). Finally, Horton, Alderman and Rivera (in press) do not include investment in agriculture as one of their opportunities.

In early 2008, Lancet will publish a series of 5 papers dedicated to maternal and child undernutrition and survival. This body of work represents the collective effort of many of the leaders of the nutrition scientific community. The first three papers are particularly relevant to Horton, Alderman and Rivera (in press). Black et al (in press) consider the extent of the problem of maternal and child undernutrition and estimate the lost disability adjusted life years (DALYs) contributed by these problems, Victora et al (in press) consider the long term consequences of maternal and child undernutrition for human capital and adult health and Bhutta et al (in press) consider the evidence about impact of the arsenal of interventions to improve maternal and child nutrition and end up with specific recommendations about which are "proven" interventions to recommend and which are not.

In this note, attention is drawn to advances in research that are relevant to the challenge of eliminating hunger and malnutrition and which complement the presentation by Horton, Alderman and Rivera (in press). In addition to what new research reveals about the efficacy and effectiveness of some nutrition interventions, we identify areas where the conclusions by Horton, Alderman and Rivera (in press) may not be supported by the evidence or where they differ from those of the Lancet series on maternal and child undernutrition.

2. Limitations of Underweight as an indicator of nutritional status

Underweight (< -2 SD below the reference mean) is the most widely used indicator of nutritional status in children less than 5 years of age and is the indicator emphasized in the paper by Horton, Alderman and Rivera (in press). Underweight is also the indicator selected to assess progress in meeting the first millennium development goal (MDG1) of eradicating extreme poverty and hunger. One of two targets of MDG1 to be achieved between 1990 and 2015 is to halve the proportion of people who suffer from hunger and the indicator used by WHO and UNICEF to monitor progress is the underweight rate in children less than 5 years (http://www.mdgmonitor.org/goal1.cfm. When time trends in underweight rates are examined, including projections to 2015, Eastern Asia (mainly driven by China), and Southeastern Asia along with Latin America and the Caribbean are regions of the developing world that are projected to meet MDG1 (de Onis et al, 2004) as noted by Horton, Alderman and Rivera (in press).

Underweight is probably a very useful global indicator in populations where both stunting and wasting are common. However, childhood obesity is now increasingly common in many parts of the world, and in Latin America and the Caribbean in particular (Wang and Lobstein, 2006; de Onis et al, 2000; Martorell et al, 2000). Childhood obesity can mask the problem of stunting and provide a false impression of progress in reducing hunger. National rates from Bolivia from the 2003 Demographic Health Survey (http://www.measuredhs.com) are presented in **Figure 1** for stunting, underweight, wasting and obesity for children less than 5 years of age. Two reference populations are used, the 1978 WHO/NCHS reference (Dibley et el, 1987) and the newly released 2006 WHO standards (de Onis et al, 2006). Regardless of the reference used, it is clear that the principal problem with impaired child growth in Bolivia is stunting; indeed about 30% of children were stunted in 2003. Wasting, on the other hand was as rare as in the reference population (by definition, less 2.3% of the reference population is below -2 SDs). Underweight was much less common than stunting, as it is in countries in the region, and one reason this is the case is that childhood obesity, even in Bolivia, one of the poorest countries of the Western hemisphere, was more common than underweight in 2003. Use of the WHO 2006 standard, which is based on healthy children from around the world who were fed according to WHO's infant feeding recommendation and who grew up in environments that did not constrain growth (de Onis et al, 2006), yields higher rates of stunting and obesity and a slightly lower rate of underweight than obtained with the older reference.

The Lancet series on maternal and child undernutrition has selected stunting as the indicator of choice to represent child undernutrition, complemented by indicators derived from comparisons of weight relative to height: wasting and obesity (Black et al, in press). Stunting was the best predictor of long term consequences on human capital (Victora et al, in press).

The Copenhagen Consensus process should prefer stunting rather than underweight as the indicator of choice to track world progress over time as well as for use in evaluating the cost effectiveness of interventions. Indeed, there is the danger that in some settings, nutrition interventions may increase obesity (Uauy and Kain, 2002; Gibson, 2004; Gibson, 2006); were underweight the indicator of choice in these settings, the reduction in underweight would be seen as an achievement. The Copenhagen consensus process should also use statistics about the extent of child undernutrition that are based on the new WHO standards.

3. The window of vulnerability/opportunity: pregnancy and the first two years of life

The paper by Horton, Alderman and Rivera (in press) makes the point that emphasis should be placed, although not exclusively, on the first 5 years of life because of the serious consequences of malnutrition in children of this age. In fact, the consensus of the nutrition community is that one should focus even further on the vulnerable periods of intrauterine life and the first two years of life. One of the central messages of the recent advocacy publication “Repositioning Nutrition as central to development: a strategy for large scale action” is precisely the need to target this “window” in programs aimed at preventing undernutrition and its consequences (The World Bank, 2006). Behrman, Alderman and Hoddinott (2004) explicitly focus on women and young children and do not include in their analysis of costs and benefits interventions aimed at school children.

Figure 2 uses data from Peru to show that stunting is a phenomenon that develops in utero (i.e., growth retardation is observed at birth) and continues throughout the second year of life. By 2 years of age, z-scores are flat, implying that growth rates are similar to those in the reference population. While the pattern may vary somewhat, similar observations apply to all developing countries where stunting is observed (Shrimpton et al, 2001). Also, anemia, a marker of mineral deficiencies, is more common and its consequences more severe in children under two years of age (Lozzoff, Jimenez and Smith, 2006).

We need to re-define the indicators of successful program delivery, impact and costs in light of the need to focus on children under two. A good example are growth promotion programs; weighing children and promoting growth through counseling about health and nutrition in children older than two years of age is not the best use of resources; yet, many such programs aimed at children under 5 reach more of the over twos than the under twos, who may be more likely to benefit (see discussion later about growth monitoring). It is likely that the effectiveness of programs measured through responses in either growth or micronutrient indicators of deficiency may actually be increased by reaching the more vulnerable and thus more responsive younger group.

4. New Knowledge of the Consequences of Child Undernutrition

The authors make reference to new information since the 2004 Copenhagen Consensus volume about the consequences of child undernutrition, in particular evidence linking early childhood nutrition with human capital and economic productivity. Results from the 2002-04 follow-up study of the individuals who participated in the 1969-77 INCAP longitudinal study, which included a community randomized, nutrition supplementation intervention aimed at women and children less than 7 years of age, are now published (Hoddinott et al, in press). In the initial study, two villages were randomly assigned a nutritious supplement (atole) and two villages a less nutritious one (fresco). Economic data were obtained from 1424 former participants in the supplementation trial (aged 25–42 years) and used to estimate annual incomes, hours worked, and average hourly wages from all economic activities. Exposure to atole before, but not after, age 3 years was associated with higher hourly wages, but only for men. For exposure to atole from 0–2 years, the increase was US$ 0.67 per hour (95% CI: 0.16, –1.17), which meant a 46% increase in average wages. There was a nonsignificant tendency for hours worked to be reduced and for annual incomes to be greater for those exposed to atole from 0–2 years.

The Great Leap Forward policies of Chairman Mao precipitated one of the worst famines in history, resulting in 15-30 million deaths. The long term effects of the 1959-61 famine on the health and economic status of the survivors has been quantified (Chen and Zhou, 2007). Exposure to the famine in early life (in people born between 1959 and 62) was associated with a reduction in adult height of 3 cm and with lower incomes and wealth.

Information from 5 long-standing cohorts from Brazil, Guatemala, India, The Philippines, and South Africa show that poor fetal growth and stunting at two years of age is associated with shorter adult height, lower attained schooling, reduced adult income and decreased offspring birthweight (Victora et al, in press). Also, children who are undernourished in the first two years of life and who put on weight rapidly later in childhood and in adolescence are at higher risk of chronic diseases related to nutrition (Victora et al, in press).

The results from Guatemala about the effects of improved nutrition prior to 2 years of age, of exposure to famine in the first two years of life and of the consequences of poor fetal growth stunting at two years of age is the strongest evidence available indicating that investments in early childhood nutrition lead to improved adult health and greater economic wellbeing.

5. Interventions that impact on maternal and birth nutrition outcomes

Improving maternal nutrition during pregnancy will lead to improved birth outcomes, an important step in improving child health and nutrition. However, the problem of intrauterine growth failure is often viewed as intractable. The draft by Horton, Alderman and Rivera (in press) did not comment on measures to improve birthweight and instead referred readers to previous work by Behrman, Alderman and Hoddinott (2004). Bhutta et al (in press) review the pertinent literature to date and provide summary estimates of impact for several interventions during pregnancy or delivery that are known to improve maternal and birth outcomes and that are recommended for implementation in all developing countries; these interventions and the intended outcome (in parenthesis) include iron-folate supplementation (reduced risk of anemia) , maternal iodine status through salt iodization (improved child survival and lower risk of cretinism), maternal calcium supplementation (reduced risk of pre-eclampsia), interventions to reduce smoking and indoor air pollution (outcomes not stated; these might include the prevention of respiratory infections, particularly in children and possibly, the improvement of birth weight) and delayed cord clamping (improved neonatal iron status). This same review also recommended several interventions during pregnancy for implementation in specific contexts and these include: balanced energy protein supplementation during pregnancy (36 % reduction in small for gestational age newborns), maternal iodine supplements (better survival of children and lower risk of cretinism), maternal deworming in pregnancy (reduced risk of anemia), intermittent preventive treatment for malaria (reduced risk of anemia, 46% reduction in LBW) and insecticide treated bed nets (23% reduction in risk of low birth weight). All other interventions, including maternal multiple micronutrient interventions, nutrition education and advise during pregnancy were not recommended because of insufficient evidence or no evidence of impact.

6. Effect of iron and multiple micronutrients on birth outcomes

Maternal anemia during pregnancy is associated with reduced birthweight (Rasmussen, 2000) but evidence from randomized controlled trials of supplementation effects is limited, likely because the standard of care in many countries is to provide iron/folate supplements to women during pregnancy, making the inclusion of a placebo group often objectionable on ethical grounds. There are two studies from the United States that were carried out in iron replete, non-anemic women who were randomized early in pregnancy to receive iron until about 28 weeks, when all women regardless of initial assignment began to receive iron (Cogswell et al, 2003; Siega-Riz et al, 2006). These studies found an average effect of iron supplementation to about 28 weeks of 157 g (Table 1). This is presumably an underestimate of the impact of iron because all women began to receive iron at about 28 weeks. Also, several studies from developing countries are available that allow comparison between iron and placebo groups (Ziaei et al, 2007; Christian et al, 2003; Preziosi et al, 1997) or between iron *and* folic acid vs. placebo (Agarwal et al, 1991; Christian et al, 2003). Overall, the average effect was 110 g and 76 g respectively in weighted and unweighted averages, equivalent to effect sizes of 0.24 and 0.17 respectively (Table 1). The difference between weighted and unweighted averages reflects the influence of larger studies, such as the one from Nepal.

The potential impact of iron supplementation during pregnancy should be explored further in developing countries; a possible design that would meet ethical requirements would be one that contrasts the provision of iron and folic acid tablets, the standard of care, under regular program conditions and under enhanced conditions, with improved delivery and encouragement to consume the supplements. Folic acid has not been consistently shown to influence birth weight, so any differences would be attributed to iron. This design would underestimate the impact of iron because under regular program conditions, some women would ingest the supplements.

Several studies have been carried out to investigate whether multiple micronutrient supplementation during pregnancy leads to improved birthweight compared to supplementation with iron/folate (Table 2). These studies suggest that there is small effect attributed to multiple micronutrients of the order of 63 and 59 g of birth weight in weighted and unweighted analyses respectively, equivalent to effect sizes of 0.14 and 0.12 respectively. It is not clear whether the effect of multiple micronutrients relative to placebo would be the addition of the effect of iron relative to no iron *plus* the effect of multiple micronutrients relative to iron. This could be tested by adding a multiple micronutrient supplementation group under enhanced conditions to the design discussed immediately above.

All of the above suggests that successful implementation of iron folate supplementation during pregnancy will not only improve iron status but also have a small effect on birth weight. Multiple micronutrient programs may yield slightly greater effects on birthweight compared to iron.

7. Flour fortification

Fortification of staples, such as wheat flour, is a promising intervention. If bioavailable fortificants are used and if the fortified product is consumed in adequate amounts by the target group, then the potential impact can be significant. Fortification has the potential to impact on women prior to pregnancy whereas supplementation programs often begin several months into pregnancy for many women. Women who habitually consume fortified products may have improved folate intakes around the periconceptual period and this will reduce the risk of neural tube defects. It is also advantageous to improve iron status prior to pregnancy. Children under two years will benefit less from fortification because they consume only small amounts of the staple and other measures may be required for them such as supplementation, home fortification (sprinkles) or fortified complementary foods.

Although a great deal of attention is being paid to fortification, particularly flour fortification, few sound evaluations of impact are available outside of the case of Chile where flour fortification has been shown to impact on folate status and reduce neural tube defects (Castilla et al, 2003; Hertrampf et al , 2003). Imhoff-kunsch et al (2007) examined the potential contribution of flour fortification with iron and folic acic to the intakes of women of reproductive age in Guatemala, using national data on household purchases of wheat flour and products made from it. Assuming 5% availability for iron, wheat flour fortification met 6% of the estimated average requirement for iron and 33% of that of folic acid. For women living under extreme poverty (mostly rural, indigenous households) the corresponding figures for iron and folic acid were 1 and 5% respectively whereas for women in non poor households (mostly urban, non-indigenous), the corresponding figures were 12 and 71 %. Thus, in Guatemala, where the traditional staple is corn but where bread is now consumed, particularly in urban areas, flour fortification has low potential for improving iron status but significant potential for improving folate status. However, rates of neural tube defects are high in the indigenous regions of Guatemala precisely where little fortified wheat flour is consumed. This analysis illustrates the need for careful evaluation of potential and actual impact, which will obviously vary across countries by level of consumption of the fortified staple. The wheat belt around North Africa and the Middle East would be an example of an area where wheat flour fortification can achieve a lot.

8. Neonatal interventions

Bhutta et al (in press) recommend breastfeeding promotion (provided individually or in groups to increase rates of exclusive breastfeeding in all countries and neonatal vitamin A supplementation in Asian populations (where it has been shown to improve survival). Neonatal vitamin K dosing and Baby friendly Hospital initiatives were not recommended because of insufficient evidence and mass media strategies for breastfeeding promotion because of evidence of little or no impact. Horton, Alderman and Rivera (in press), on the other hand, highlight baby Friendly Hospital initiatives as a particularly cost effective intervention.

9. Interventions that impact on nutrition outcomes in infants and children

Bhutta et al (in press) have also identified interventions aimed at improving nutrition outcomes and survival in infants and children that are recommended for implementation in all developing countries, that are to be recommended in specific contexts and that are not recommended because of insufficient or no evidence of impact. Intervention that are recommended universally include, zinc fortification and supplementation (improved survival, prevention of diarrhea and pneumonia, reduced stunting), zinc supplementation in the management of diarrhea (reduced duration and severity of diarrhea), vitamin A fortification and supplementation (improved vitamin A status, improved survival), universal salt iodization (improved development), hand washing and hygiene interventions (prevention of diarrhea), cooking in iron pots (improved iron status) and treatment of severe malnutrition (improved survival, reduced wasting). Intervention for specific contexts include conditional cash transfer programs (with nutrition education), behavioral change interventions to improve complementary feeding (reduced stunting), deworming (improved iron status), iron supplementation or fortification programs (improved iron status), and insecticide treated bed nets (reduced risk of malaria, improved iron status, improved survival).

The implementation of WHO guidelines for the treatment of severely malnourished children has been shown to be efficacious in reducing case fatality rates when compared to conventional treatment (Bhutta et al, in press). However, the treatment of severe malnutrion in a clinical setting is resource intensive and requires skilled personnel; usually, the mother stays with the child and away from home, with disruptive consequences for the household and other children. Collins et al (2006) argue that child-survival initiatives have ignored the problem of severe acute malnutrition which is estimated to kill 1.7 million children a year. According to Collins at al (2006), where acute malnutrition is common, such as in conflict situations and in famine stricken areas, the number of cases exceeds available inpatient capacity, case-fatality rates are 20-30% and coverage is commonly under 10%. Moving the recuperation of those severely malnourished children without complications to the community and enabling the mother herself to treat the child is a promising alternative that appears to reduce case-fatality rates and increase coverage rates. This is possible through the use of new, ready-to-use, therapeutic foods that contain milk powder, sugar, vegetable oil, peanut butter, vitamins and minerals; these energy dense products need no water or cooking and are resistant to bacterial contamination. They have the potential to increase access to services, reduce costs, permit early initiation of treatment and enhance compliance and thus increase coverage and recovery rates. Collins et al (2006) believe that this approach promises to be a successful and cost-effective treatment strategy. Bhutta et al (in press) could not find any randomized controlled trials evaluating the impact on mortality reduction of community programs using ready-to-use therapeutic foods and hence did not recommend this specific intervention.

Interventions not recommended for implementation anywhere include growth monitoring and promotion and feeding of older pre-school children (Bhutta et al, in press). The recommendation about growth monitoring and promotion is likely to be controversial. Growth monitoring (i.e., the act of weighing and plotting weights) is not an intervention but a tool and in many programs this is all that is done. Growth promotion implies using the information to counsel mothers about best practices in feeding and caring for children. At issue is whether the growth monitoring part is needed; can the promotion part be done effectively without the monitoring part? Can growth monitoring be an effective platform for anchoring other child health and nutrition interventions? These questions cannot be answered with certainty and good evaluations of growth monitoring and promotion programs are needed. The lack of information, particularly from randomized controlled trials led Bhutta at al (in press) not to recommend growth monitoring programs. Not recommending the feeding of older children is clearly supported by the evidence; growth failure, as noted earlier, is confined to children less than two years. What about feeding children less than 2 years of age? It is not clear whether interventions that provide complementary foods are recommended by Bhutta et al (in press) for some settings or not at all. While interventions that provide complementary foods (with or without education) are not explicitly listed in their summary table (i.e., Table 1), the text does include summary estimates from 7 studies of the impact on height for age Z scores that are the highest for any intervention: 0.41 Z. The corresponding estimate based on three studies of nutrition education without complementary foods, a cheaper option, was smaller, 0.25Z, but still substantial.

10. Micronutrients and stunting

Micronutrient programs have important effects on several outcomes such as survival (vitamin A, zinc), infection prevention (zinc) and cognitive development (iron, iodine); these effects provide ample rationale for programs that seek to correct micronutrient deficiencies. However, do micronutrient programs reduce stunting? Bhutta et al (in press) as well as Behrman, Alderman and Hoddinott (2004) and Horton, Alderman and Rivera (in press) report that zinc interventions improve growth. In recent work (Ramakrishnan, Nguyen and Martorell, in preparation), we have been able to confirm the findings of Ramakrishnan et al (2004) and find no effects on growth in height of interventions that provide iron or vitamin A. However, contrary to current consensus, we do not find that zinc interventions improve growth in height. Bhutta et al (in press) did not undertake a review of new literature but accepted results from a meta-analysis published by Brown et al in 2002 that found an average effect size for change in height of 0.35 (95% C.I. 0.19-0.51). Our 2007 review was restricted to children under 5 years and included all previous studies included by Brown et al (2002) for this age group as well as the numerous studies published since then. Based on 40 studies involving 8,642 children we found that the overall weighted mean effect was 0.07 (95%CI: -0.03, 0.17, p=0.18). We do not find a significant effect of zinc interventions on growth simply because most of the more recent studies report null findings. On the other hand, we find that providing multiple micronutrients has a weighted mean effect of 0.09 (95%CI: 0.006, 0.17; p=0.04); this effect, while statistically significant is small. Thus, micronutrient interventions have important effects that improve health and survival but do not prevent stunting.

11. Concluding remarks

The timing of the current consensus report is unfortunate in that Horton, Alderman and Rivera (in press) were not able to take advantage of the information available in the Lancet series on maternal and child undernutrition. It is difficult to predict to what extent the series will be accepted as the consensus of the scientific community about effective interventions to address the problems of hunger and malnutrition but the expectation is that series will be seminal and influential. Not everything in this wide ranging analysis will be accepted; for example, results from our recent meta-analysis indicate that zinc interventions are unlikely to prevent stunting as claimed in the series.

Bhutta et al (in press) ran models to determine the potential impact of implementing “proven” interventions in the 36 countries with 90% of the burden of undernutrition and report that stunting at 3 years of age could be reduced by 30%, mortality between birth and 3 years by 25% and DALYs associated with stunting, severe wasting, intrauterine growth retardation and micronutrient deficiencies by 24%. These reductions are substantial but would address only part of the problem. Other causes, such as poverty, education and infection control also need to be addressed. We must also continue to conduct research to identify new and better approaches to addressing the challenge of hunger and malnutrition.

What the Lancet series lacks is explicit consideration of costs. What is needed is to take the work of the Lancet series and estimate the cost of intervention packages for different regions of the world (packages will differ across regions because some interventions are useful only for certain situations). Measures of impact are available from the Lancet series to estimate cost effectiveness and similarly, measures of DALYs lost are available to estimate cost benefit ratios using the arbitrary values of $1000/DALY and $5000/DALY used in the Copenhagen Consensus methodology (Horton, Alderman and Rivera, in press). The resulting product of adding costs to the work presented in the Lancet series would have wide appeal and legitimacy.

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Table 1. Effects of iron supplementation during pregnancy on birth weight

Study		Birth weight differences (g)	Country	Effect size[1]	95% CI		P
Ziaei et al (2007)		10	Iran	0.02	-0.12	0.17	0.75
Siega et al (2006)		108	USA	0.19	0.00	0.38	0.04
Cogswell et al (2003)		206	USA	0.36	0.09	0.64	0.01
Christian et al (2003)		67	Nepal	0.15	0.04	0.27	0.01
Preziosi et al (1997)		30	Niger	0.07	-0.21	0.35	0.63
Agarwal et al (1991)[2]		290	India	0.77	0.51	1.02	0.00
Christian et al (2003)[2]		60	Nepal	0.14	0.03	0.24	0.01
Overall [1]	**Unweighted**	**110**		**0.24**	**0.06**	**0.43**	**0.0111**
	Weighted	**76**		**0.17**	**0.01**	**0.33**	**0.0355**

[1] Effect sizes were calculated for individual studies by dividing the difference between the mean change in treatment and control groups by the pooled standard deviation.

The overall mean effect size and 95% confidence were estimated using a random effects model.

The overall mean effect size is reported for unweighted and weighted (weighted by the inverse of the intra-study variance) analyses.

[2] These two comparisons contrasted iron and folic acid supplementation to placebo. All other comparisons were contrasts between iron alone and placebo.

Table 2. Effects of multiple micronutrient supplementation vs. non supplementation

Study		Birth weight differences (g)	Country	Effect size[1]	95% CI		P
Gupta et al (2007)		156	India	0.39	0.06	0.72	0.02
Fawzi et al (2007)		67	Tanzania	0.13	0.08	0.17	0.00
Osrin et al (2005)		77	Nepal	0.18	0.05	0.30	0.00
Kaestel et al (2005) (IRDA)[2]		53	Guinea-Bissau	0.10	-0.04	0.25	0.16
Kaestel et al (2005) (IRDA)[2]		95	Guinea-Bissau	0.20	0.05	0.34	0.01
Fris et al (2004)		49	Zimbabwe	0.08	-0.04	0.19	0.21
Christian et al (2003)		4	Nepal	0.01	-0.10	0.12	0.87
Ramakrishnan et al (2003)		4	Mexico	0.01	-0.15	0.17	0.90
Overall [1]	**Unweighted**	**63**		**0.14**	**0.05**	**0.43**	**0.0019**
	Weighted	**59**		**0.12**	**0.05**	**0.33**	**0.0003**

[1] Effect sizes were calculated for individual studies by dividing the difference between the mean change in treatment and control groups by the pooled standard deviation.

The overall mean effect size and 95% confidence were estimated using a random effects model. The overall mean effect size is reported for unweighted and weighted (weighted by the inverse of the intra-study variance) analyses.

[2] The study by Kaestel et al (2005) allows contrasts between multiple micronutrient supplementation at either 1 or 2 RDAs vs. iron.

Figure 1. Mean Z-scores for height-for-age relative to the new WHO standards in national data for Peru in 2000

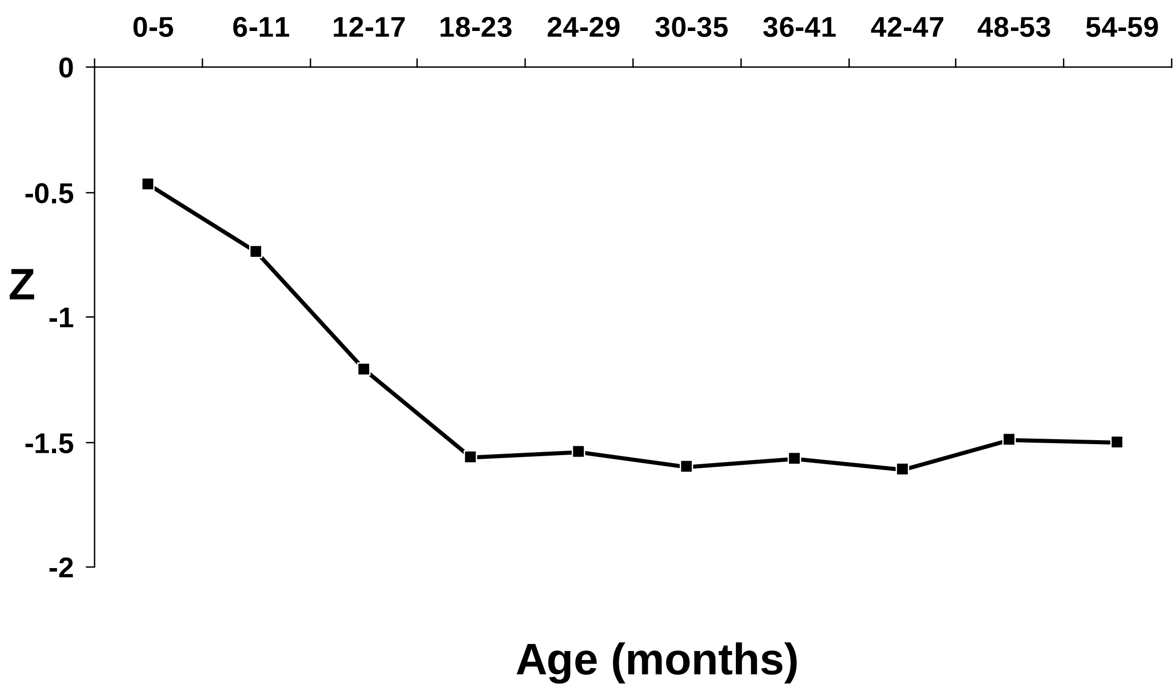

Figure 2. Prevalence of stunting, underweight, wasting and obesity (% below -2Z for all indicators except obesity, which is % above 2Z) in children < 5y using NCHS/WHO 1978 and WHO 2006 curves for Bolivia (DHS, 2003)