

perspective paper

HUNGER AND MALNUTRITION

BEATRICE L. ROGERS



COPENHAGEN
CONSENSUS 2012

solving the world's challenges



Copenhagen Consensus 2012 Perspective Paper

Beatrice Lorge Rogers¹

Tufts University

May 3, 2012

1. Introduction

This paper represents a response to the Challenge Paper prepared by Hoddinott, Rosegrant, and Torero on recommendations to address hunger and malnutrition. The suggestions made in the Challenge Paper are comprehensive in crossing multiple sectors: agricultural research, marketing, and direct health/nutrition interventions. The present paper strongly supports the proposed interventions, and particularly the approach of treating hunger and malnutrition as problems requiring a multisectoral response. The causal pathways leading to malnutrition lie in many sectors – health, agriculture, water and sanitation, food systems, economic development – and sustainable improvements in nutrition and food security may often require interventions in all of them.

Implementing multisectoral interventions poses a challenge to the estimation of benefit-cost ratios. Quantifying the costs of nutritional insult – whether stunting and wasting, specific micronutrient deficiencies, or nutrition-related chronic disease – is perhaps more straightforward than identifying and attributing the costs of a particular component in a package of interventions to an impact which is the result of the interaction of several actions working together. This is especially relevant in cases where multiple interventions are required for any one of them to achieve its potential impact, as is the case, for example, with improving food consumption and reducing exposure to infection as means to address child growth retardation. In cases where sequencing of interventions is critical, the same approach may be effective or ineffective depending on whether critical preconditions for success have been put in place, so attributing a given impact to the later intervention alone may be misleading. It is noted below that improved agricultural productivity and smallholder income may be a prerequisite for increasing the quality and quantity of food consumed in the household, but explicit interventions focused on behavior change are necessary in order to realize the potential nutritional effects of these improvements in resources. This argues for a flexible approach to benefit-cost estimation, with a focus on addressing the most urgent and costly problems and, through implementing and evaluating the best available interventions, building the evidence base for selecting the most effective and cost-effective multisectoral approaches.

The intervention package proposed in the Challenge Paper is well justified. Nonetheless, there are additional elements that could well be included. The Challenge Paper explicitly rejects consideration of what is commonly (and misleadingly) called “overnutrition” – that is, the rising problem in the developing world of nutrition-related chronic diseases linked to overweight, obesity, and physical inactivity. These chronic diseases are increasing in prevalence among poor populations in low-income and low-middle-income countries, and their high cost in terms of lost productivity and increased demand for health care poses a threat to economic progress. Further, there are strong reasons to link approaches to addressing undernutrition with those to address chronic disease: the demonstrated relationship between early nutritional deprivation and later susceptibility to obesity and chronic disease, and the fact that increasing access to health care and capacity in the health care system will benefit both sets of health issues.

¹ Thanks for helpful comments from Will Masters, Brooke Colaiezzi, and Amelia Fischer.

The following pages elaborate on these points, with the goal of complementing the suggestions incorporated in the Challenge Paper and contributing an additional perspective to the process of identifying priority actions to promote economic development and the improved well being of poor and vulnerable populations.

2. Combining and Sequencing Interventions

The Challenge Paper makes an important contribution in proposing a combination of interventions to improve health reduce undernutrition. It seems intuitively obvious that addressing the multiple constraints to nutrition and food security will be more successful than dealing with single approaches or single nutrients. Benefit-cost estimates are difficult enough for single interventions, but such estimation for combined interventions is much more so. If a combined intervention is effective, and in the absence of full-factorial experimental designs to test all possible combinations, attribution of a benefit to one or another component is not difficult, but impossible. (IFPRI's evaluations of conditional cash transfers (CCTs) in Nicaragua did in fact implement a full factorial design, testing combinations of "supply side" – improving the quality of service – and "demand side" – providing a cash transfer – for the relative contribution of each to the overall goals of the program (Maluccio and Flores 2005). Such studies are very useful, but also costly and therefore rare.) This is in no way an argument for implementing only isolated, unitary nutrition interventions; bundling interventions for maximum impact is quite valuable – essential, in fact – but the benefit-cost analyses will generally have to be for the combined intervention rather than each individual element. Webb and Block (2010) rightly argue for the development of new measures to account for the interactive and cumulative effect of multiple policies, to go beyond techniques that link single policies to unitary outcomes.

There are two ways to think about combining interventions. One is to consider that each intervention by itself may be necessary, but not sufficient to achieve the nutrition, health, or economic benefit anticipated. A good example of this might be the provision of supplementary food to children to promote linear growth and prevent stunting in the absence of complementary interventions to improve household hygiene practices and environmental sanitation, including access to adequate and safe water. In a food-scarce environment, either one alone may be insufficient to prevent, much less reverse, stunting.

The evidence to support the provision of food supplements to pregnant and lactating women and children up to age two in order to prevent growth retardation is strong, but the evidence for the potential for catch-up growth after that age is mixed. Martorell and colleagues (1990, 1994) argue that there is very limited potential for catch-up growth after age two, but Golden (1994) holds that the reason catch-up growth is not observed is that the conditions that led to early childhood stunting are rarely changed. It has been suggested (Solomons et al, 1993; Kau et al, 2011; McKay et al, 2010) that a major cause of impaired linear growth in children is the presence of low level infection: environmental stress on the immune system produces pro-inflammatory cytokines that impair the metabolic pathways that promote bone growth; in the absence of significant improvement in sanitation, food supplements will not be able to achieve adequate growth, much less catch up growth. Whether or not this mechanism fully explains childhood stunting, it is well recognized that frequent diarrheal and other infections are an independent risk factor for child undernutrition (Brown 2003); to reach his/her growth potential, a child needs both adequate food *and* protection from infectious disease. In this case, therefore, two interventions – one addressing inadequate diet and another addressing water, sanitation and hygiene – need to be implemented together for either one to have a substantial impact on child

stunting. This means benefit-cost estimation for one intervention may be misleading, making it seem less effective than its potential would be if other constraints on adequate growth were addressed.

A second aspect of the proposal to implement combined interventions has to do with the appropriate sequencing of interventions. An example here is the development of improved seeds (higher yielding, drought and salt tolerant, adapted to the local conditions of smallholders in target regions) and the promotion of demand for fertilizer through a reduction in price. Demand for fertilizer among smallholder farmers may indeed be constrained by price and access (including access to credit), but in the short run, is conditioned more on farmers' perception of the marginal benefit of using such inputs (Byerlee and Hesse 1986; Lindert 2000). The adoption of new seeds that are responsive to fertilizer should eventually result in demand for fertilizer, especially if farmers are at the same time linked to markets, so their increased production can be translated into increased income, providing the resources to purchase inputs; but response to a lower fertilizer price may be disappointing if adoption of improved seed varieties does not precede it.

Similarly, the ability of the proposed interventions – improved seeds (appropriate to the crops and context of smallholder farmers), cheaper fertilizer, better market information – to improve household income, and thereby at least potentially the nutritional status of children, depends on having a functioning market at the regional and national level. Continued use of improved seeds and purchased agricultural inputs depends on commercialization of these crops, so that sales can fund future purchases of inputs. To benefit sustainably from the proposed package of market interventions, farmers must be able to gain access to a functioning market. This is not only a matter of sequencing interventions; it is equally a matter of institutional and economic context. Factors such as market infrastructure, marketing and trade regimes, and small farmer integration into regional, national or international markets (individually or as part of a farmer organization) will affect the success of interventions aimed at smallholders.

The proposed package of interventions for reducing stunting and micronutrient deficiencies includes elements known to be both effective in addressing undernutrition and cost effective in terms of expected impact on economic growth (Bhutta et al 2008). Direct provision of food supplements to pregnant/lactating women and children 6-23 months has been demonstrated to be effective in reducing rates of stunting, especially if given preventively (that is, provided to at-risk populations, not conditional on being stunted or wasted before receiving the supplement) (Ruel et al 2008). Nonetheless, in contexts where absolute food scarcity is not a constraint, behavior change strategies that promote the appropriate use of locally available (purchased or home produced) foods for complementary feeding of weanlings may be a cost effective option. This is a case where, again, sequencing may be critical: increased agricultural productivity, more food available in the household, and increased income to permit food purchases are likely to be essential precursors to the promotion of the use of local food as a substitute for the direct provision of supplementary food to prevent stunting and wasting. (Clearly, this argument does not apply to therapeutic food in emergencies or for the treatment of acute malnutrition, where immediate provision of nutrient-dense food is critical to assuring rapid recovery and avoiding the high risk of mortality.)

Finally, the benefit cost estimates incorporated into the IMPACT model analysis need to take account of the non-linear relationship between cost and benefit. As a higher percentage of the target group is reached, it becomes more costly to reach the remaining ten or twenty percent. This non-linearity has been explicitly recognized in the benefit cost estimates associated with the 'Scaling up Nutrition' initiative to bring nutrition interventions to low income populations (Horton et al, 2010). Ecker et al

(2012) note that malnutrition is less responsive to economic growth as its prevalence declines. The reasons are twofold: presumably it is the remote, hard to reach populations that will be the last to benefit from any intervention, and the most costly to reach due to their remoteness; but it is also likely that the causal pathways underlying nutritional outcomes may be different, perhaps more intractable, but in any case possibly requiring different approaches to benefit that small remaining percentage.

3. Strengthening Agriculture – Nutrition Linkages

Hoddinott (2012), in his introduction to the recent Delhi conference on Agriculture – Nutrition Linkages, lays out a rich and comprehensive set of pathways by which improved agricultural productivity might affect the nutritional status of farm household members, especially children. These pathways are entirely plausible, and some have been documented in particular settings. But while agricultural development may play a key role in improving child nutrition status through increasing rural household income and crop productivity, increased food production does not necessarily nor automatically lead to improved nutrition outcomes. Furthermore, these pathways and linkages are culturally and geographically diverse. The impact of similar agricultural programs on nutritional outcomes may vary by context. The relationship between production, income, and nutrition is neither direct nor simple, and depends on social and economic factors specific to the geographic context (Marsh 1998; von Braun 2002).

A review of the links between agricultural interventions and nutrition outcomes (Berti et al 2003) found mixed evidence of direct benefits on children's or adults' anthropometric status, although most had significant impacts on household food production. Home gardens were more consistently associated with nutritional improvement, presumably because these interventions were typically implemented in the context of explicitly nutrition-focused programs that included other components such as behavior change communication. The review found that when agricultural interventions were combined with nutrition education, dietary improvement was more likely, but also found that changing household diets did not always correlate closely with anthropometric status. They conclude that health and nutritional status are not consistently responsive to agricultural interventions without complementary efforts focused explicitly on nutritional outcomes.

A simulation of agricultural investment strategies in Tanzania (Klauw and Thurlow 2012) similarly concluded that agricultural growth had inconsistent impacts on poverty, calorie insufficiency, and undernutrition; the effects were dependent on growth in the agricultural sectors where smallholders are concentrated: production of staple crops such as maize, root crops, oil seeds, and pulses, since these are produced by low income farmers and their increased production (in the simulation) lowered prices for these foods, which are disproportionately consumed by the poor. This suggests that yield improvements in the right crops have the potential to affect food consumption of the poor, but there is still an intrahousehold process by which household food consumption translates into nutritional status of its members.

These observations underline the importance of ensuring that the proposed agricultural strategies end up reaching the smallholder farmers who are the presumed beneficiaries, and to integrate improvements in agricultural production and marketing with explicit nutrition programs that translate production and income gains into nutritional benefit.

4. Addressing the Rising Problem of Overweight/Obesity and Chronic Disease

Childhood undernutrition is without a doubt the most pressing nutrition priority for global development. According to UNICEF's most recent statistics (UNICEF 2012), 66 countries in the world have a prevalence of childhood stunting of 25% or more, and 31 countries have prevalence over 40%. There are 27 countries with a ten percent or higher prevalence of wasting among children under five years of age. The average prevalence of childhood stunting is 39% in Sub-Saharan Africa, and reaches 47% in South Asia (34% for Asia as a whole); comparable figures for wasting are 9% for Sub-Saharan Africa and 19% for South Asia. The problems of micronutrient deficiency highlighted in earlier Consensus documents are far from eliminated. These statistics are unarguable and compel continued attention to these issues.

Nonetheless, the time has passed when it is reasonable to ignore the rising prevalence of overweight and obesity and associated chronic disease in the developing world. Rates of overweight and obesity in low-income countries have reached levels comparable to those of high-income countries (Beaglehole et al 2007), and the incidence of non-communicable chronic diseases, including coronary heart disease and stroke, diabetes, chronic pulmonary disease, and cancer, is rising rapidly (Beaglehole et al 2007). Deaths and DALYs from NCCDs in low income countries are projected to exceed, by a wide margin, deaths from undernutrition and infectious disease by 2015, and increase sharply by 2030 (WHO 2008). Developing countries including India, Indonesia, Pakistan, as well as China and Brazil are among the top ten countries for prevalence of diabetes (IDB 2009). Previous Copenhagen Consensus papers have focused on the nutritional status of children at risk of undernutrition. Global efforts on "Scaling Up Nutrition" similarly focus primarily on the needs of young children at risk, based on recognition of the critical importance of the "first 1,000 days" in determining the health of a child into adulthood (Shekar et al, Horton et al 2010). Chronic disease, of course, primarily affects adults, although adults younger than age sixty in low-income countries are far more likely to suffer morbidity and mortality from chronic disease than those in developed countries (Nugent 2008).

Given the current significance and rapidly rising burden of chronic disease in low and middle income countries, addressing them should be a priority for investment in economic development for several reasons. First, the economic cost of these diseases is substantial. Costs to the existing health care system are significant, but in low-income countries, where much of the population does not have access to high quality health care, the major cost is from lost economic contributions due to disability and premature death (Abegunde et al 2007). Further, it is no longer the case (if it ever was) that chronic disease can be considered a 'disease of affluence'. It is true that wasting and stunting fall and obesity rises with GDP growth and the population shift out of agriculture – an increase of 4.4% for every 10% increase in GDP (Webb and Block 2009). But overweight, obesity, and chronic disease are rising rapidly in the poorest countries (FAO/WHO 2002; Finucane et al. 2011; Popkin 2009). The "double burden" of undernutrition and infectious disease, along with overweight/obesity and chronic disease, is posing serious challenges to the health care system and to prospects for continued economic development in many low and middle income countries, including India and China as well as those in sub-Saharan Africa – regions that are the target of the interventions proposed in the Challenge Paper (as well as Scaling Up Nutrition efforts).

Second, the evidence is strong that the risk of chronic disease in adulthood is related to health and nutritional status in early childhood (Barker et al 1993; Joseph and Kramer 1996; Prentice and Moore 2005; Hales et al. 1991; Calkins and Devaskar 2011) – in the 'first 1,000 days' – which suggests that the benefits of improving nutrition in early childhood include a reduction in chronic disease in later life. The arguments for investing in childhood undernutrition and for investing in the prevention and control of chronic disease converge in this case.

A third argument for investing in the prevention and control of chronic diseases is that even beyond the protective effect of early child nutrition, there is likely significant overlap, and large potential synergy, between interventions aimed at children and those aimed at adults at risk. Among the priority interventions recommended in the *Lancet* series on Chronic Disease (Beaglehole et al 2007) and by the WHO Task force on Chronic Disease (WEF/WHO 2011), strengthening the primary health care system and increasing access to it in order to permit behavior change communication, screening, and the distribution of medications to those at highest risk (or already suffering from chronic disease) again converges with the priorities for reaching undernourished children and their mothers with growth monitoring, primary care, and the provision of micronutrient and food supplements. It is very much in the spirit of the Challenge Paper to emphasize potential synergies in the proposed interventions between agricultural and targeted nutrition interventions; addressing chronic disease adds another layer of potential benefit to these health interventions.

Finally, there have been few documented successes in reversing the trend toward higher prevalence of overweight, obesity through changes in diet and physical activity. WHO (2009) identifies characteristics of successful efforts to promote physical activity; these are largely modifications in the built environment and local services (sidewalks, amenities in walking distance, recreational facilities). But overweight and obesity continue to rise in the developing world (Popkin 2009), and there is little evidence of the potential to reverse the trend. Chronic disease prevalence continues to rise as well, although the rate of increase in adult BMI appears to slow at higher incomes (Nugent 2008). Interventions that focus on prevention may possibly have a higher likelihood of success than interventions to reverse the process once it is far advanced.

4.1 Chronic Disease as a Health and Development Priority

The “double burden” of malnutrition – that is, the coexistence in a single country of high rates of child undernutrition and infectious disease along with high and rising rates of overweight, obesity, and chronic disease, has been documented in developing countries in all regions of the world (FAO 2006). According to WHO (2009), chronic disease risk factors (high blood pressure, high blood glucose, physical inactivity, tobacco and indoor smoke exposure, and high cholesterol) account for almost 28% of attributable mortality in low income countries, compared to 7.8% of deaths due to child undernutrition and another 3.4% due to poor breastfeeding practices. (Infectious disease does not make it into the top ten risk factors, though unsafe water, sanitation and hygiene add 6.1% to attributable mortality.) The Institute of Medicine finds cardiovascular disease accounts for 30% of all mortality in low and middle income countries (Fuster and Kelley 2011). High cholesterol and blood glucose, high blood pressure and physical inactivity together account for 19.6% of deaths in low income countries. In middle income countries, over 45% of deaths are due to these four factors plus poor diet (low fruit/vegetable intake). The picture is reversed for DALYs, with child underweight and micronutrient deficiencies accounting for more attributable DALYs than chronic disease risk factors: 18.1% compared with 8.1% for chronic disease risk factors (counting only those in the top ten risk factors). Nonetheless, chronic diseases are associated with significantly lower life expectancy (WHO 2009) and a long period of disability before death.

More than 84% of diseases associated with chronic disease risk factors occur in low and middle income countries (WEF/HSPH 2011; WHO 2009). Only in South Asia and Sub-Saharan Africa, the two regions with the highest prevalence of child undernutrition, are risk factors for chronic disease present in less than 50% of the adult population (Nugent 2008), but rates there are rising, and the rate of increase in factors such as overweight and physical inactivity appears to become greater as prevalence rises

(Martorell et al 2000). CVD is now the second leading cause of adult death in Sub Saharan Africa (FAO 2006); rates of diabetes in that region doubled between 1994 and 2010 (FAO 2006). Rates in Latin America are similarly projected to rise (Kain et al 2003).

The economic cost of chronic disease in low income countries is high and rising. Nugent (2008) reports WHO estimates that the annual cost of chronic disease in 23 developing countries will reach \$84 billion in the ten years to 2015 (Abegunde *et al* 2007). Other estimates put the economic cost for low income countries at \$310 million, and for lower middle income countries at \$1.85 trillion over the period 2011-25 (Abegunde and Starciolo 2006). The cost in terms of lost GDP in low and middle income countries has been estimated as high as 4% (WEF/WHO 2011). It has been estimated that each 10% rise in chronic disease mortality slows economic growth by .5% in low and middle income countries (Stuckler et al 2010). Thus chronic disease poses a serious threat to the pace of economic development (WHO 2004). WHO has identified non communicable chronic diseases as a significant barrier to achievement of the MDGs as well (WHO 2008), since chronic disease results in disability and death that can precipitate a fall into poverty due to both medical costs and lost earnings (as demonstrated by Mahal et al for India).

Chronic disease is now recognized as an important health issue in low and middle income countries. The UN World Health Assembly, convened in 2004, adopted a Global Strategy on Diet, Physical Activity and Health, and in 2005 the WHO developed the Framework Convention on Tobacco Control (Beaglehole et al 2007; Uauy and Kain 2002). An influential series published in *Lancet* in 2007 (*Lancet* vol 370, 2007) drew attention to the problem of chronic disease in the developing world, and provided estimates of the economic and health burden, with recommendations and cost estimates for intervention to address the risk factors. A subsequent series published in 2010 (vol 376) provided more detailed assessments of the health and economic costs, and the effectiveness and cost of possible interventions. The recent UN High Level Meeting on Non-Communicable Diseases, convened in September 2011, represented a convergence of opinion on the importance of these diseases, and provided an opportunity to promote coordinated national and global action to address them.

Clearly, it is time to consider chronic disease, along with undernutrition, as a challenge to economic progress that should not be ignored.

4.2 Links of Chronic Disease with Poverty and Undernutrition

The rise of chronic disease in the developing world is linked to lifestyle changes that are occurring rapidly in low income countries: increased access to supermarkets (Reardon et al 2003; Witherspoon and Reardon 2003) and other sources of refined foods high in fat/salt/sugar (Popkin and Neilsen 2003, Popkin 2006); availability of mechanized transportation, and mechanization of labor (Webb and Block 2010). Many researchers cite urbanization as a factor in the disease process [WEF/WHO], but there is evidence that the same process is operating in both rural and urban areas (Popkin and Gordon-Larsen 2004; Mendez 2005) suggesting the possibility of similar interventions in both areas, though the challenge of delivering services in rural areas is likely to be higher.

Low income populations exposed to nutritional deprivation *in utero* or in the first two years of life are at higher risk of chronic disease if, in later life, they have access to a more abundant, calorie dense diet [Barker et al 1993; Joseph and Kramer 1996; Prentice and Moore 2005], consistent with the hypothesis advanced by Barker and colleagues in 1986 (Barker et al 1986; Barker and Osmond 1986; Barker et al. 1989; see also Eriksson et al. 1999). There is evidence that in children born with IUGR, rapid growth up to the age of two results in accumulation of lean body mass and has positive health benefits, while rapid

growth in stunted children after the age of two risks accretion of adiposity with consequent health risks including hormone-related cancers (breast, prostate) as well as cardio-vascular disease (Victora et al 2008; Sachdev et al 2005; Newsome et al 2003; Victora et al 2007; Wells et al 2005). Investing in prevention of chronic disease starts with addressing undernutrition in children, and a corollary is that obesity prevention is an especially high priority for those undernourished in early life.

Beyond childhood, chronic disease risk factors are no longer characteristic of those with higher income. The poorest populations in the poorest nations have high rates of obesity, and the burden of obesity is shifting to the poor in these countries (Popkin 2009). In 36 low income countries, overweight exceeds underweight in both rural and urban areas (Mendez et al 2005). Monteiro *et al* (2004 a, b) have estimated that overweight and obesity become problems of lower income populations within a given country at a per capita GDP around \$2,500, a relatively high level when compared with the incomes of the countries with the highest burden of childhood undernutrition (*Lancet* 2008 countries). But overweight and obesity represent only one of many risk factors for chronic disease; the prevalence of NCCDs is greater than that of overweight/obesity, and is more skewed toward the poorer populations even in low income countries (Popkin 2009); the poor are at less likely to receive treatment for NCCDs due to lack of access and affordability of preventive health care (Nugent 2008). Furthermore, resource-constrained governments are more apt to fund basic health services, as outlined in the United Nations Millennium Development Goals (MDGs), rather than the prevention and treatment of NCCDs (WEF 2010), although as noted above, extending the reach and capacity of basic health services contributes to addressing chronic disease as well as infectious disease and maternal and child health.

4.3 Chronic Disease Priorities for Intervention, their Cost and Effectiveness

The UN convened a High Level Meeting on Non-Communicable Diseases in September 2011 to focus attention on the importance of implementing cost-effective, achievable interventions to prevent and treat NCCDs in low and middle income countries. The meeting built on the work of the World Economic Forum and Harvard School of Public Health to identify priority actions for reducing the impact of chronic disease (WEF/HSPH 2010). The actions, defined as “Best Buys”, were recommended based on three factors: (a) feasibility; (b) reasonable cost; (c) demonstrated effectiveness. The aggregated cost of these interventions was estimated in this study at about \$500 billion a year, or 4% of the combined annual output of the low and middle income countries considered in the analysis.

Not all the interventions recommended at the WHO High Level Meeting relate to nutrition. Their recommendations for top five priorities for addressing chronic disease are: reducing the use of tobacco to a target level of 4%; reducing consumption of salt; improving dietary quality (increased fruit and vegetable consumption, reduced consumption of sugar, saturated and trans fats) and increasing physical activity; reducing abuse of alcohol; and finally, targeted counseling and medical intervention for individuals at high risk or already suffering from chronic disease (CVD, cancer, diabetes, chronic respiratory disease).

The first four are addressed at the population level, through a combination of taxes, regulation, and communication strategies. The last one is targeted to individuals and makes use of the primary health care system to screen, counsel, and prescribe medications for high risk patients. The WEF/HSPH study estimated costs and benefits for this set of interventions in the 42 low and middle income countries that represent 90% of the chronic disease burden. As would be expected, population-based strategies are far less costly than those targeted to individuals. The total package of “best buy” interventions is estimated to cost \$11.4 billion per year, of which only \$2 billion is for the population based

Perspective Paper May 3, 2012
Bea Rogers

interventions, and about \$2 billion represent private costs (cost to patients of participating in screening and treatment). However, as Nugent (2008) points out, the evidence base for the effectiveness of population based measures is weak, and even more so in low and middle income countries.

The preventive strategies proposed by WHO include taxing and regulating access to tobacco and alcohol; workplace interventions to reduce smoking; health information campaigns; and restrictions on advertising these products. Dietary interventions include working with the food industry to reduce salt and replace saturated and trans fats with healthier fats, as well as advertising and mass media campaigns to promote healthier diets and physical activity. The targeted strategies delivered through the health care system include screening for CVD and diabetes risk, and provision of a multidrug regimen targeting blood pressure and cholesterol and including aspirin, as well as immunizing for hepatitis B. These cost estimates have a time horizon of 15 years, from 2011 – 2025, and are based on a target of 80% population coverage.

The authors recognize that time is required to develop sufficient reach and capacity in the primary health care system, but may be optimistic in assuming only a one year lag compared with the implementation of population based interventions. Direct treatment need not depend only on doctors, but could be incorporated into the work of community based health workers, allowing for greater coverage at lower cost (Abegunde *et al* 2007), but still would require training and capacity building as well as expanded outreach.

This package of interventions is viewed as having a highly favorable benefit-cost ratio. For example, the WEF/HSPH report estimates that achieving a 10% reduction in CVD would reduce economic losses by \$25 billion annually, about three times the estimated cost of the interventions. However the basis for the 10% figure for expected impact is not given.

Cecchini *et al* (2010), in a simulation analysis of six countries, find that price interventions (taxation) produce the most rapid gains. The most cost-effective measures in their analysis include taxes, regulation (restricting access to tobacco and alcohol), and workplace interventions. They note that obesity, diet quality, and physical activity are targeted by similar interventions, and suggest that all the proposed interventions have synergies in addressing multiple chronic diseases, improving the benefit cost picture.

Beaglehole *et al* (2007) estimated the annual cost of interventions proposed by the Chronic Disease Action Group to cost \$5.8 billion a year in the 23 highest burden countries (2005 dollars), again with a highly favorable benefit cost ratio. Similar to the WEF/HSPH study, they find population based interventions to be less costly: \$1.1 billion/year for the 23 countries, compared with \$4.7 billion for individual medical attention. Their estimate is that an achievable reduction in salt consumption of 15% would avert 13.8 million deaths between 2006 and 2015 at a cost of \$1 billion/year; individual screening and multidrug treatment could avert 17.9 million deaths over the same period at a cost of \$4.7 billion.

Meanwhile, the Institute of Medicine report on cardiovascular health emphasizes that chronic disease requires a multisectoral, coordinated approach that involves agricultural policy, urban planning and transportation policy to promote physical activity, taxes and regulations to affect the food supply as well as access to tobacco and alcohol, as well as mass media campaigns and capacity building within the public health system (Fuster and Kelly 2011). Such coordinated and potentially synergistic approaches are exceedingly difficult to cost, but most of the literature recognizes the need to move beyond unitary to multisectoral approaches.

Many of these estimates are based on simulation models that have significant error associated with them. Good empirical information on costs and effectiveness of interventions is lacking, and (as mentioned earlier), benefit-cost estimates are typically unable to account for potential synergies (for example, other benefits from improving access to the primary health system; multiple benefits from single public health campaigns) or diseconomies. Nonetheless there is little question that investment in the prevention and treatment of chronic disease in low and middle income countries, including those suffering from the “double burden” of undernutrition and chronic disease, can have significant payoffs for health and well-being as well as for poverty reduction and economic development through more years of healthy life.

The policies proposed by the UN Task Force incorporate exercise and dietary modification, on the assumption that both of these approaches would address the calorie imbalance between intake and expenditure that is at the root of obesity. Some analysts lay the blame for the obesity epidemic in the developed world on the productivity of agriculture and the ready availability of abundant and cheap food (Schoonover and Muller 2006; Bleich et al 2007), but in countries facing the double burden, it is a policy challenge to devise policies that address undernutrition while not exacerbating the problems of excess. Price policies need to be carefully framed, and feeding programs carefully designed to promote healthy consumption and discourage unhealthy consumption without jeopardizing their ability to address nutritional insufficiency.

4.4 Future Research Needs

The benefit-cost estimates incorporated into these figures are based on assumptions about the presumed potential effect of regulations, labeling, mass media campaigns, and workplace interventions on outcomes such as salt consumption, tobacco and alcohol use, diet and physical activity, but empirical support for the effectiveness of specific interventions in developing country contexts is sparse at best. Many of the action plans described above rightly call for more rigorous assessment and recommend allocating substantial resources to developing the evidence base for designing effective and cost-effective programs, and to incorporate assessment of coordinated multiple interventions. There can be no question that chronic disease is emerging as a major threat to health and well being, and to poverty reduction and economic growth, but estimating the cost associated with this burden is more straightforward than assessing the potential impacts and benefit to cost ratio of specific programs.

Given the need for individual medical intervention, research into better and lower-cost methods of screening would be a useful target for future research as well.

Nonetheless, action should not be conditioned on such studies; rather, action on this front will provide the basis for future evaluation and the design of more effective and cost effective means to reduce the spread of chronic disease risk.

5. Summary and Conclusions

This paper has suggested some additional considerations to complement the proposals in the Hunger and Malnutrition Challenge Paper. The points are summarized below.

- The effectiveness of multiple interventions depends on their appropriate combination and sequencing; the effectiveness of some of the suggested interventions, policies and programs

depends on others already being in place. In addition to the sectors mentioned, water and sanitation may be a critical input into the prevention of child growth retardation.

- Assessing the benefit-cost ratios of combined, multisectoral interventions is far more challenging than calculating such ratios for one single intervention at a time; estimates of the cost-effectiveness of the contribution of individual components of an integrated package of different interventions may not be realistic to achieve in many cases.
- This in no way argues against implementing combined and multi-sectoral interventions; indeed, such packages of interventions have a higher likelihood of sustainable success than isolated interventions. Implementing multisectoral activities with the explicit goal of evaluation can contribute to the empirical basis for choosing interventions.
- It is critical to recognize that improvements in agricultural productivity, even if targeted appropriately to poor smallholder farmers, will not automatically translate into improvement in diet, and thus nutritional status of vulnerable household members. Explicit nutrition-focused efforts are needed to ensure that the potential nutritional impact of these improvements is realized.
- The rapidly rising prevalence of risk factors for non-communicable chronic disease (including overweight/obesity and physical inactivity) in low and low-middle income countries, and of the NCCDs themselves, constitute a serious threat to the health and well-being of poor populations in poor countries, and a challenge to their economic progress. These conditions are costly in terms of lost income due to DALYs and premature death as well as health care, and efforts to prevent them are likely to be cost effective.
- The dietary and epidemiologic transitions exacerbate the threat of childhood undernutrition because of the relationship between early-life undernutrition and increased risk of overweight/obesity and chronic disease later in life.
- Investment in improved access to health care and in interventions to prevent and treat both undernutrition in early life and chronic disease risks in older children and adults represents a convergence of goals.
- Research is needed on effective interventions to prevent and reverse the rise of NCCDs and their risk factors, and on methods of assessing their benefit-cost ratios, but action should not be delayed on this account; rather, action to address these problems can provide the basis for expanding the evidence base for future actions.

Perspective Paper May 3, 2012
Bea Rogers

REFERENCES

- Abegunde DO, Shengelia B, Luyten A, et al. Can non-physician health-care workers assess and manage cardiovascular risk in primary care? *Bull World Health Organ* 2007; 85: 432–40.
- Abegunde DO, Mathers CD, Adam T, Ortegón M, Strong K. The burden and costs of chronic diseases in low-income and middle-income countries. *Lancet* 2007; 370: 1929-1938.
- Abegunde, .D, Stanciole, A. “An estimation of the economic impact of chronic noncommunicable diseases in selected countries”. WHO Working Paper Department of Chronic Diseases and Health Promotion (CHP), 2006.
- Alwan, A; D.R.MacLean; L.M.Riley et al. Monitoring and Surveillance of Chronic Non-communicable Diseases: Progress and Capacity in High Burden Countries. *Lancet* 2010.
- Asaria P, Chisholm D, Mathers C, Ezzati M, Beaglehole R. Chronic disease prevention: health effects and financial costs of strategies to reduce salt intake and control tobacco use. *Lancet* 2007; 370: 2044-2053.
- Barker DJ, Osmond C. Infant mortality, childhood nutrition, and ischaemic heart disease in England and Wales. *Lancet* 1986; 1: 1077–81.
- Barker DJ, Gluckman PD, Godfrey KM, Harding JE, Owens JA, Robinson JS. Fetal nutrition and cardiovascular disease in adult life. *Lancet* 1993; 341: 938–41.
- Beaglehole, R.; S. Ebrahim; S. Reddy et al. Prevention of Chronic Disease: A Call to Action. *Lancet* 370:2152-7, 2007
- Bhutta ZA, Ahmed T, Black RE, et al, for the Maternal and Child Undernutrition Study Group. What works? Interventions for maternal and child undernutrition and survival. *Lancet* 2008;
- Bleich S, Cutler D, Murray C, Adams A (2007) Why Is the Developed World Obese? National Bureau of Economic Research Working Paper No. 12954 (National Bureau of Economic Research, Cambridge, MA).
- Brown, K. “Diarrhea and Malnutrition” *Journal of Nutrition*. 133(1):328S-332S, 2003 Jan.
- Byerlee, Derek; Edith Hesse de Polanco, Farmers' Stepwise Adoption of Technological Packages: Evidence from the Mexican Altiplano *American Journal of Agricultural Economics* , Vol. 68, No. 3 (Aug., 1986), pp. 519-527
- Calkins K, Devaskar SU. “Fetal origins of adult disease.” *Curr Probl Pediatr Adolesc Health Care*. 2011 Jul;41(6):158-76.
- Cecchini, M; F. Sassi; J.A.Lauer et al. Talking of Unhealthy Diets, Physical Inactivity, and Obesity: ;Health Effects and Cost Effectiveness. *Lancet* 2010
- Chow, CK. K.Lock; K. Teo; S.V.Subramanian; M.McKee;S.Yusuf. Environmental and Societal Influences Acting on Cardiovascular Risk Factors and Disease at a Population Level: A Review. *Int. J. Epidemiol* 2009 38:1580-94.

Perspective Paper May 3, 2012
Bea Rogers

Du S, Mroz TA, Zhai F, Popkin BM (2004) Rapid income growth adversely affects diet quality in China—particularly for the poor! *Soc Sci Med* 59:1505–1515.

Ecker, O.I, C. Breisinger; K.Pauw “Reshaping Agriculture” Chapter 6 in *Reshaping Agriculture for Nutrition and Health*, S. Fan and R Pandya-Lorch, eds. Washington DC: IFPRI 2012

FAO (Food and Agricultural Organization), 2006. *The Double Burden of Malnutrition: Case studies from six developing countries*. Rome, 2006.

Fuster ; Kelly. Summary of IOM Report “Promoting Cardiovascular Health in the Developing World. *Global Heart* 2011 6:4

Gaziano TA, Galea G, Reddy KS. Scaling up interventions for chronic disease prevention: the evidence. *Lancet* 2007; 370: 1939-1946

Gluckman P, Hanson M. *Mismatch. Why our world no longer fits our bodies*. Oxford: Oxford University Press, 2006.

Golden, M.H.N. “Is complete catch-up possible for stunted malnourished children?” *European Journal of Clinical Nutrition* (1994) 48,(Suppl. 1), S45-S57.

Hales CN, Barker DJP, Clark PMS, Cox LJ, Fall C, Osmond C, Winter PD “Fetal and infant growth and impaired glucose tolerance at age 64 years”, *British Medical Journal* 1991;3003:1019-22

Horton, Susan; Meera Shekar;Christine McDonald;Ajay MahalJana Krystene Brooks, *Scaling Up Nutrition What Will It Cost?* Washington DC: World Bank 2010.

IDB (International Diabetes Federation) *The Diabetes Atlas* (International Diabetes Federation, Brussels), 4th Ed. (2009).

Jamison, DT; JG Breman; AR Measham et al. *Disease Control Priorities in Developing Countries* 2nd ed. Washington DC: Oxford University Press and World Bank 2006.

Joseph KS, Kramer MS. Review of the evidence on fetal and early childhood antecedents of adult chronic disease. *Epidemiol Rev* 1996; 18: 158–74.

Kain, J., Vio, F., Albala, C. *Obesity trends and determinant factors in Latin America*. *Cad. Saúde Pública*. 2003; 19(Sup.1):S77-S86

Kau, Andrew L., P. Ahern, N.W. Griffin, A.L. Goodman, J.I. Gordon. Human nutrition, the gut microbiome, and the immune system. *Nature* 474, 327-336, June 2011.

Lim SS, Gaziano TA, Gakidou E, et al. Prevention of cardiovascular disease in high-risk individuals in low-income and middle-income countries: health effects and costs. *Lancet* 2007; 370: 2054-2062.

Perspective Paper May 3, 2012
Bea Rogers

Lindert, Peter *Shifting Ground: The Changing Agricultural Soils of China and Indonesia*. Cambridge: MIT Press 2000.

Lock K, Pomerleau J, Causer L, Altmann DR, McKee M. The Global Burden of Disease due to low fruit and vegetable consumption: implications for the global strategy on diet. *Bull WHO* 2005; 83: 100-108.

Lopez, A.D., C.D. Mathers, M. Ezzati, *et al.* 2006. *Global Burden of Disease and Risk Factors*. World Bank. Washington, DC

Mahal, A; A.Karan; M.Engelau. *Economic Implications of Non-Communicable Diseases for India*. World Bank, 2010.

Maluccio, John and Rafael Flores, *Impact Evaluation of a Conditional Cash Transfer Program: the Nicaraguan Red de Protección Social*. IFPRI Research Report 141, 2005.

Martorell R, *et al.* 2000, Obesity in women from developing countries. *European Journal of Clinical Nutrition* 54: 247–252

Martorell R, Rivera J, Kaplowitz H (1990): Consequences of stunting in early childhood for adult body size in rural Guatemala. *Ann Nestle* 48, No. 2, 85-92.

Martorell R., L. Kettel Khan, and D.G. Schroeder. "Reversibility of stunting: epidemiological findings in children from developing countries". *European Journal of Clinical Nutrition* (1994) 48,(Suppl. 1), S45-S57.

Martorell R. *The policy and program implications of research on the long-term consequences of early childhood nutrition: lessons from the INCAP follow-up study*. Washington DC: Pan American Health Organization, 2005.

Matsudo SM, Matsudo VR, Araujo TL, Andrade DR, Andrade EL, de Oliveira LC, Braggion GF. *The Agita São Paulo Program as a model for using physical activity to promote health*. *Rev Panam Salud Publica*. 2003 Oct; 14(4):265-72.

McKay, Sue. E. Gaudier, D. I. Campbell, A.M. Prentice, R. Albers. Environmental enteropathy: new targets for nutritional interventions. *International Health* 2010(3): 172-180.

Mendez MA, Monteiro CA, Popkin BM (2005) Overweight exceeds underweight among women in most developing countries. *Am J Clin Nutr* 81:714–721.

Monteiro, C.A., E.C. Moura, W.L. Conde & B.M. Popkin. 2004. Socioeconomic status and obesity in adult populations of developing countries: a review. *Bull. World Health Organ*. 82: 940–946.

Monteiro, C.A. *et al.* 2004. Obesity and inequities in health in the developing world. *Int. J. Obes*. 28: 1181–1186.

Newsome CA, Shiell AW, Fall CH, Phillips DI, Shier R, Law CM. Is birth weight related to later glucose and insulin metabolism?—A systematic review. *Diabet Med* 2003; 20: 339–48.

Perspective Paper May 3, 2012
Bea Rogers

Norgan, NG. Long-term physiological and economic consequences of growth retardation in children and adolescents *Proceedings of the Nutrition Society*. 2000 May; 59(2):245-56.

Nugent, R. Chronic diseases in developing countries: Health and economic burdens, *Annals of the New York Academy of Sciences*, 1136: 70-79 (2008).

Pauw, K; J. Thurlow. The Role of Agricultural Growth in Reducing Poverty and Hunger, in *Reshaping Agriculture for Nutrition and Health*, S. Fan and R Pandya-Lorch, eds. Washington DC: IFPRI 2012.

Popkin B *The World Is Fat: The Fads, Trends, Policies, and Products That Are Fattening the Human Race* (Penguin Books, London (2009)).

Popkin, B. *Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases*. *American Journal of Clinical Nutrition*. 2006 August; 82(2):289-298.

Popkin BM, Gordon-Larsen P (2004) The nutrition transition: Worldwide obesity dynamics and their determinants. *Int J Obes Relat Metab Disord* 28(Suppl 3):S2–S9.

Prentice AM, Moore SE. Early programming of adult diseases in resource poor countries. *Arch Dis Child* 2005; 90: 429–32.

Prentice AM. The emerging epidemic of obesity in developing countries. *Int J Epidemiol* 2006; 35: 93-99.

Reardon, T., P.C. Timmer & J.A. Berdegue. 2003. Supermarket expansion in Latin America and Asia: implications for food marketing systems. *New Directions in Global Food Markets/AIB-794*. Economic Research Service/USDA.

Ruel MT, Menon P, Habicht JP, Loechl C, Bergeron G, Pelto G, Arimond M, Maluccio J, Michaud L, Hankebo B. Age-based preventive targeting of food assistance and behaviour change and communication for reduction of childhood undernutrition in Haiti: a cluster randomised trial. *Lancet*. 2008 Feb 16;371(9612):588-95.

Sachdev HS, Fall CH, Osmond C, et al. Anthropometric indicators of body composition in young adults: relation to size at birth and serial measurements of body mass index in childhood in the New Delhi birth cohort. *Am J Clin Nutr* 2005; 82: 456–66.

Sassi F, Cecchini M, Lauer J, Chisholm D. Improving lifestyles, tackling obesity: the health and economic impact of prevention strategies. OECD Health working paper 48. Paris: OECD, 2009.
http://www.who.int/choice/publications/d_OECD_prevention_report.pdf

Schoonover H, Muller M (2006) *Food without Thought: How U.S. Farm Policy Contributes to Obesity* (The Institute for Agriculture and Trade Policy, Minneapolis).

Shekar et al, *Scaling Up Nutrition: A Framework for Action*. Washington DC: World Bank (reprinted April 2011)

Solomons NW, Mazariegos M, Brown KH, Klasing K. The underprivileged, developing country child: environmental contamination and growth failure revisited. *Nutr Rev*. 1993;51:327-332.

Perspective Paper May 3, 2012
Bea Rogers

Stucker, P. S. Basu; M.McKee, Drivers of Inequalities in MDG Progress: A Statistical Analysis. *PLoS Med* 2010; [7](#)e100241.

Uauy R, Kain J. The epidemiological transition: need to incorporate obesity prevention into nutrition programmes. *Public Health Nutr* 2002; 5: 223–29.

UNICEF 2012 ChildInfo: Monitoring the Situation of Children and Women.
http://www.childinfo.org/undernutrition_nutritional_status.php Accessed May 3 2012.

Victora, Cesar, Linda Adair, Caroline Fall, Pedro C Hallal, Reynaldo Martorell, Linda Richter, Harshpal Singh Sachdev Maternal and child undernutrition: consequences for adult health and human capital *Lancet* 2008

Victora CG, Sibbritt D, Horta BL, Lima Rda C, Cole TJ, Wells J. Weight gain in childhood and body composition at 18 years of age in Brazilian males. *Acta Paediatrica* 2007; 96: 296–300

Waage et al., The MDGs: A cross-sectoral analysis and principles for goal setting after 2015. *Lancet* 376:9745, 991-1023, 2010.

Webb, Patrick; Steve Block Support for agriculture during economic transformation: Impacts on poverty and undernutrition (2010) PNAS www.pnas.org/cgi/doi/10.1073/pnas.0913334108

Wells JC, Hallal PC, Wright A, Singhal A, Victora CG. Fetal, infant and childhood growth: relationships with body composition in Brazilian boys aged 9 years. *Int J Obes (Lond)* 2005; 29: 1192–98.

Witherspoon, D.D. & T. Reardon. 2003. The rise of supermarkets in Africa: implications for agrifood systems and the rural poor. *Dev. Policy Rev.* 21(3): 333–355.

WEF/HSPH: World Economic Forum (WEF) and Harvard School of Public Health (HSPH) The Global Economic Burden of Non-communicable Diseases (2011). Available through:
<http://www.weforum.org/EconomicsOfNCD>

WHO: World Health Organization (2009) Global Health Risks: Mortality and Burden of Disease Attributable to Selected Major Risks (World Health Organization, Geneva).

WHO: World Health Organization Commission on Social Determinants of Health. Geneva: WHO 2008

WHO: World Health Organization *Scaling up action against noncommunicable diseases: How much will it cost?* –(2011). Available through: <http://www.who.int/nmh/publications>

WHO. World Health Organization. *2008–2013 Action Plan for the Global Strategy for the Prevention and Control of Non-communicable Diseases*. Geneva: World Health Organization, 2008.

WHO. World Health Organization. Global strategy on diet, physical activity and health. Geneva: World Health Organization, 2004.
http://www.who.int/dietphysicalactivity/strategy/eb11344/strategy_english_web.pdf

Perspective Paper May 3, 2012
Bea Rogers

WHO. World Health Organization, World Health Statistics 2008, Geneva:2008.

WHO (World Health Organization), 2009. *Interventions on Diet and Physical Activity: What Work. Geneva, 2009.*

WHO. Global strategy on diet, physical activity and health. Geneva: World Health Organization, 2004.

WHO/FAO. Report of the Joint WHO/FAO Expert Consultation on Diet, Nutrition and the Prevention of Chronic Diseases. Geneva: World Health Organization, 2002.

Younger M, Morrow-Almeida H, Vindigni S, Dannenberg A. The built environment, climate change, and health: opportunities and co-benefits. *Am J Prev Med* 2008; 35: 517-526.