THE MICRONUTRIENT IMPACT OF MULTISECTORAL PROGRAMS FOCUSING ON NUTRITION:

EXAMPLES FROM CONDITIONAL CASH TRANSFER, MICROCREDIT WITH EDUCATION, AND AGRICULTURAL PROGRAMS

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Abstract

Millions of people in low and middle income countries suffer from micronutrient (MN) deficiencies as a consequence of monotonous diets based on plant-based staple foods. MN deficiencies affect the survival, health, development, and well-being of individuals, especially those with high requirements such as children and women of reproductive age.

The most commonly used strategies to combat MN deficiencies are MN supplementation and fortification, breastfeeding promotion, behavior change and communication strategies to improve complementary feeding practices, and health interventions aimed at reducing infectious diseases. Common to all of these strategies is the fact that they address the immediate causes of MN malnutrition. The sustainability of these direct MN interventions, however, is questionable if they do not simultaneously address key underlying determinants of malnutrition. Malnutrition is rooted in poverty, food insecurity, gender inequity, and lack of access to health and other services. The failure to address these underlying causes of malnutrition – or the global context in which malnutrition occurs – is likely to weaken the long-term impacts of interventions limited to addressing the immediate determinants of nutrition.

This paper reviews the evidence regarding the MN impact of multisectoral programs that combine targeted nutrition interventions (i.e, addressing the immediate causes), with poverty-alleviation, food security enhancement, and/or income-generating approaches (the underlying causes). The three types of programs reviewed are conditional cash transfers (CCT), microcredit with education (MCE), and agricultural interventions. The review uses a program theory framework to synthesize evidence of impact as well as evidence regarding potential pathways of impact of these programs. Our main focus is the MN status of children.

Impact on child micronutrient (MN) status and anthropometry

Overall, we find limited evidence of an impact of CCT programs on children's MN status. Three of the five programs reviewed assessed impact on hemoglobin, and only one of them (Mexico) documented modest improvements in mean hemoglobin and in the reduction of anemia. The program was also the only one that included the distribution of a fortified food to participating mothers and children; the Nicaragua program provided iron supplements and the Honduras program did not have any specific iron intervention. Positive

impacts on child anthropometry, height in particular, were much more consistent across studies and were of meaningful size. Given the low prevalence of energy deficiency in the Latin American countries included in the CCT review, we hypothesize that at least some of the positive effects of these programs on linear growth could be due to (unmeasured) improvements in growth-enhancing MNs such as zinc.

Our review of MCE programs highlights the dearth of information on the impact of these programs on nutrition: none of the programs assessed impact on micronutrient status, and the few programs that measured child anthropometry showed little evidence of impact. Overall, insufficient information and the lack of rigor in the evaluation designs prevent any firm conclusion on the impact of MCE programs on child micronutrient status or anthropometry.

Agricultural interventions showed a more consistent picture of impact on MN status, vitamin A in particular, as it was the usual nutrient targeted. The addition of animal production to home gardening programs to address the problem of low bioavailability of MN in plant foods did not strengthen the evidence of an impact on either vitamin A or iron status. Few agriculture interventions assessed impact on child anthropometry, and of those, approximately half documented an impact on at least one indicator.

Impact on immediate determinants (food and health)

Food and nutrient intake. The impact of CCTs on child food and nutrient intake was measured in only two studies: the Mexico program, which showed positive impacts of the fortified food on iron, zinc, and vitamin A intake; and the Colombia program, which showed an increase in the consumption of animal products and vegetables, probably as a result of increased income from the cash transfer. The review of MCE programs shows scattered evidence of the impact of the education intervention on child feeding practices and dietary intake. Several of the horticulture and animal production interventions also documented improvements in child dietary intakes, either MN intakes or consumption of the micronutrient-rich foods targeted by the program.

Child health. Improvements in child health – usually measured by recall of morbidity symptoms – was found to improve in all but one CCT program. Health was not evaluated in the MCE programs. Findings from the few agriculture studies that evaluated child health suggest a small protective effect. It must be noted, however, that only the CCT programs are

specifically designed to improve health through the health conditionality. Nonetheless, all programs have the potential to improve health if the nutrition/health education intervention is successful in eliciting greater use of health services. A potential, yet poorly documented and understood threat to health is the risk of zoonotic infections in agricultural programs promoting animal husbandry.

Impact on underlying determinants

Access to food. Our review of impact pathways confirms that the large majority of programs reviewed – CCT, MCE, and agriculture interventions – did achieve their fundamental objective of improving household income, food availability, and access. Many of the programs also documented that not only did they increase household energy availability (i.e., increasing the quantity of food), but they also improved access to high-quality, micronutrient-rich foods such as animal source foods, dairy products, and fruits and vegetables.

Women's empowerment and maternal and childcare practices. In addition to increasing household resource availability, many of the programs documented having achieved another one of their key objectives, i.e., empowering women and increasing their access to – and control over – resources. Empowering women is one of the key mechanisms to ensure that gains in household resources translate into greater benefits for children. The impact of education and behavior change communication on women's knowledge and improved feeding and health-seeking practices, however, was assessed only in the MCE studies, where it was found to be positive. The agricultural literature also shows that globally, programs that include an education/behavior change communications component are more effective at improving nutrition than those that focus narrowly on production.

Water, sanitation, and health services. Only CCT programs assessed impact on utilization of health-care services, as regular health visits is the key conditionality for households to receive program benefits. The review shows a significant impact of CCTs on the use of preventive health services (e.g., growth monitoring, well-baby clinic attendance), but evidence regarding impact on immunization rates or curative health-care utilization is mixed. Lack of supplies of vaccines in certain areas may be responsible for the mixed findings regarding immunization, but information on the availability of the health and nutrition

inputs at health centers, or the quality of their delivery, is unavailable from the published evaluation reports.

Conclusions

Our overall assessment of the literature on CCT, MCE, and agricultural programs is that they have an enormous potential to contribute to reducing childhood micronutrient deficiency and undernutrition, but that this potential is yet to be unleashed. Currently, the main constraints limiting the effectiveness of these programs include problems of design (especially of their nutrition package), the lack of conceptualization and documentation of the programs' potential pathways of impact, the lack of measurement and understanding of facilitating factors and constraints to implementation, and their often weak evaluation designs. CCTs are an exception with regards to evaluation designs, as several of these programs have been evaluated using state-of-the-art randomized evaluation designs and rigorous analytical methods.

Given the enormous potential of the reviewed programs to address both the immediate and the underlying determinants of child undernutrition, it is fundamental that we generate the evidence base that will allow for the design and implementation of more effective programs. A first step in doing so is to adopt a program theory framework to identify, evaluate, and document the multiple impact pathways by which these programs can improve MN nutrition. Only then will these programs achieve their full potential at improving nutrition and generate the needed information for scalability and replicability in other contexts.

1. Introduction

Many people worldwide, particularly in low and middle income countries, suffer from micronutrient (MN) deficiencies as a consequence of monotonous diets based on staple foods such as rice or maize. The most important MN deficiencies in the developing world are vitamin A deficiency, iron deficiency, and iodine deficiency disorders. The deficiencies of other nutrients, such as zinc, calcium, riboflavin, vitamin B6 and B12, and folate, constitute important problems as well (1, 2). Children and women of reproductive age are especially vulnerable. This is because they have particularly high MN requirements (3, 4), and are often exposed to unfavorable intrahousehold food allocation patterns that reduce their access to micronutrient-rich, expensive foods of animal origin, for instance, and high-quality diets (5). The quantity, frequency, and quality of complementary foods are also often inadequate and breastfeeding practices suboptimal (6).

MN deficiencies affect the survival, health, development, and well-being of those afflicted. Vitamin A deficiency can lead to child growth faltering and impaired motor and cognitive development, vision, and immune system. It has been estimated to account for approximately 20-24% of child mortality from measles, diarrhea, and malaria, and for about 20% of all-cause maternal mortality (7). Extreme deficiency leads to blindness and death (8). Vitamin A deficiency has further been associated with maternal mortality (9). Iron deficiency is one of the most prevalent nutrient deficiencies and is estimated to affect 4 to 5 billion people. In young children, iron deficiency may impair growth, cognitive development, and immune function. In school-aged children, it can affect school performance, and in adults it may lower work capacity. A 1 g/dl change in hemoglobin is expected to result in a change of 1.73 (95% CI 1.04 – 2.41) in intellectual quotient (IQ) points (10). Iron deficiency anemia is responsible for tens of thousands of maternal deaths each year (3, 11). Severe zinc deficiency is rare, but even mild zinc deficiency may have far reaching consequences. Zinc deficiency may result in pregnancy complications, low birth weight, impaired immune function, maternal and infant mortality and morbidity, and growth faltering in infancy and childhood (12). Moreover, zinc is known to play a central role in the immune system and, subsequently, zinc-deficient individuals are more susceptible to a variety of infectious diseases (13). Zinc deficiency causes an estimated 176,000 diarrhea deaths, 406,000 pneumonia deaths, and 207,000 malaria deaths worldwide (14). The loss of human intellectual, physical, and social potential caused by iodine deficiency has been enormous. Iodine deficiency is particularly

damaging during pregnancy, as it retards fetal development, resulting in a range of intellectual, motor, and hearing deficits in the offspring (15-17).

Different approaches are used to combat MN deficiencies. The most common strategies are MN supplementation and fortification. MN fortification includes the addition of MNs to food, which can be done centrally, locally, or at home (e.g., microencapsulated MN ("Sprinkles") added to food at the time of use), and biofortification (the agricultural process of breeding food crops that are rich in bioavailable MNs). Breastfeeding promotion, behavior change and communication strategies to improve complementary feeding practices, and health interventions aimed at reducing infectious diseases are additional strategies to reduce MN deficiencies among infants and young children.

Common to all of these strategies is the fact that they address the immediate causes of MN malnutrition, i.e., inadequate food and nutrient intake, and poor health (18). As such, these direct nutrition interventions have the potential to improve MNs in the short term, especially if they are well targeted and achieve high coverage. The sustainability of these direct MN interventions, however, is questionable if they are implemented without simultaneously addressing the key underlying determinants of malnutrition. Malnutrition is rooted in poverty, food insecurity, gender inequity, and lack of access to health and other services. The failure to address the underlying causes of malnutrition – or the global context in which malnutrition occurs – is likely to undermine the long-term impacts and sustainability of interventions focusing only on the immediate determinants of MN malnutrition.

This paper reviews the evidence regarding the MN impact of multisectoral programs that combine targeted nutrition interventions with poverty-alleviation, food security enhancement, and/or income-generating approaches. We specifically focus on conditional cash transfer and microcredit with education programs. The review also incorporates a summary of recently completed reviews of the impact of agricultural programs on nutrition. Our main focus is the MN status of children. We synthesize the available evidence of impact, as well as the evidence regarding potential pathways of impact, using a program theory framework. We conclude with a discussion of what is needed – in terms of design, implementation, and evaluation research – to capitalize on these multisectoral programs and achieve larger, faster, and more sustainable improvements in child growth and MN nutrition.

2. Review of Multisectoral Programs Addressing both Immediate and Underlying Determinants of Nutrition: Evidence of their Impact on Nutrition, with a Focus on Child Micronutrient Nutrition

The UNICEF conceptual model, which has been widely used since it was first developed in the early 1990s, distinguishes the immediate, underlying, and basic determinants of child undernutrition and their interdependence (18). Figure 1 illustrates where, in the impact pathway, targeted nutrition interventions such as breastfeeding and complementary feeding promotion, vitamin A supplementation, zinc supplementation, promotion of optimal hygiene practices act. All of these interventions focus on the immediate causes of undernutrition, i.e., suboptimal food and nutrient intake and suboptimal health. These types of interventions are referred to as "short routes" to reducing undernutrition as they are more likely to achieve impact on nutrition in the relatively short term by targeting the immediate determinants of nutrition (19). The "long routes" to improving nutrition (bottom part of the framework) address the underlying determinants of nutrition such as improved food security, adequate maternal and childcare-giving resources and practices, and improved availability and access to adequate health-care services and a healthy environment.

By assessing the MN impact of multisectoral programs such as conditional cash transfer, microcredit with education, and agricultural programs, the present review focuses on both the "short" and the "long" routes. Both the short routes and the long routes need to be addressed simultaneously to create an enabling environment for sustained improvements. The "short routes" will ensure quick nutritional benefits; the "long routes" will ensure that benefits are maintained over time and will allow individuals, communities, and countries to move out of poverty, food insecurity, gender discrimination, poor health, and undernutrition in a sustainable way.

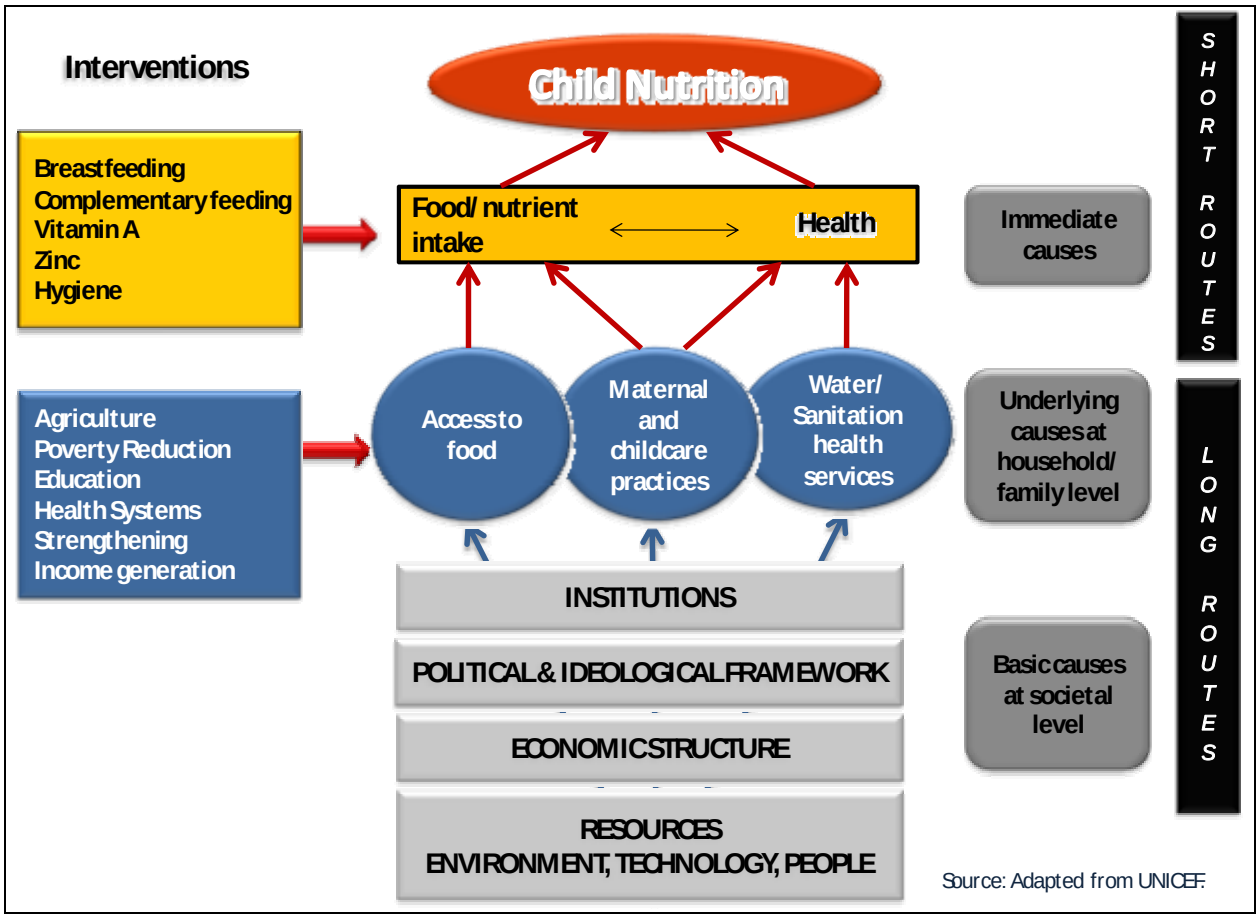

Figure 1. Short and long routes to improving child nutrition (20).

2.1 Evidence from Conditional Cash Transfer (CCT) Programs[1]

2.1.1 Introduction

In 1997, the Mexican government designed and launched the *Programa Nacional de Educacion, Salud y Alimentacion* (*PROGRESA*) (Program for Education, Health, and Nutrition, now called *Oportunidades*), the first conditional cash transfer (CCT) program.

PROGRESA initially covered 300,000 rural households in 6,344 localities in 12 states, with a budget of US$60 million. The program was expanded to urban areas in 2002 and has now enrolled its target population size: 5 million households (25% of the Mexican population) in all regions of the country. The program has successfully survived two changes of government. In 2007, the program had an annual budget of US$37 billion (19).

[1] For further details refer to: Leroy, Jef L., Ruel, Marie & Verhofstadt, Ellen (2009). The impact of conditional cash transfer programmes on child nutrition: a review of evidence using a programme theory framework. Journal of Development Effectiveness, 1 (2), 103-129. Retrieved August 06, 2009, from http://www.informaworld.com/10.1080/19439340902924043

The Mexican example was soon followed by a number of countries both in the region and beyond. Currently at least 33 countries have CCT programs and a number of other countries are studying their feasibility or planning to implement them (20).

Conditional cash transfer programs typically provide monetary transfers to households conditional upon their complying with a number of program requirements. Beneficiaries are usually required to attend preventive health/nutrition-care activities (including nutrition and health education workshops, growth monitoring activities, immunization, and preventive health-care checkups) and to enroll and maintain school-age children in school. Some programs also provide a MN-fortified food or a MN supplement. Overall, these programs aim at reducing poverty in the short term while providing incentives to poor households to invest in long-term human capital development, thereby breaking the intergenerational transmission of poverty. Cash payments promote greater food security and consumption, and the conditions foster greater utilization of health-care and education services, which, in turn, helps build stronger, healthier, and more economically productive current and future generations.

2.1.2 Methods

We searched EconLit and *Index Medicus* using "conditional cash transfer" as the search term. We also reviewed existing reviews of CCT programs focused on different outcomes, such as their impact on poverty, food security, education, health service utilization, and health and nutrition outcomes (20-24). The reviews were identified through discussions with colleagues and supplemented with the original research articles where necessary.

2.1.3 Results

Brief description of the evaluated programs

Five CCT programs have been evaluated for their impact on nutrition-related outcomes (Table 1). All programs provide a basic cash transfer, although the contribution to household income varies widely. At least three of the programs target the cash incentive to women in the household, with the rationale that women are more likely than men to invest in the health, nutrition, and education of their children (25). All programs either encourage or are conditioned upon the use of preventive health-care services. The health supply was

strengthened in some programs. A MN-fortified food and a MN supplement were provided in Mexico and Nicaragua, respectively. Health and nutrition education is present in all but one of the programs (Honduras). Except for Brazil, all programs provide scholarships.[2] In an effort to promote greater female education, the scholarships in the Mexico program are slightly higher for girls than for boys in secondary school.

With the exception of Brazil, all of the evaluation studies used controlled before-and-after designs (Table 1). A cluster randomized design was used in rural Mexico, Nicaragua, and Honduras. The evaluation studies in urban areas in Mexico and Colombia used a cluster-matched design. Cross-sectional data were used in Brazil. Beneficiaries were matched to eligible individuals who were quasi-randomly excluded from the program (23, 26, 27). The programs are discussed in greater detail below.

Table 1: Evaluation designs of the reviewed CCT programs

Program (country)[a]	Evaluation design
Oportunidades (rural Mexico)(30)	Cluster randomized controlled trial Longitudinal (household panel)
Oportunidades (urban Mexico)(28)	Quasi experimental (cluster matched) Longitudinal (household panel)
Red de Protección Social (Nicaragua)(31)	Cluster randomized controlled trial Longitudinal (household panel)
Familias en Acción (Colombia)(32)	Quasi experimental (cluster matched) Longitudinal (household panel)
Programa de Asignación Familial (Honduras)(33)	Cluster randomized controlled trial Longitudinal (household panel)
Bolsa Alimentação (Brazil)(29)	Household matched Cross-sectional

[a] Key references are given here. For additional references, see text.

Beneficiary families of the **Mexican** *Oportunidades* program receive monthly cash transfers provided they comply with several requirements. These include immunization of children, attending nutrition growth monitoring clinics for children 0-60 months of age, prenatal and postpartum care visits, and preventive health checkups for all family members. Household members 15 years and older need to attend monthly meetings at which health, hygiene, and nutrition issues are discussed (28, 29). To receive the scholarship, school-aged children must be enrolled and attend at least 80% of the lessons. The scholarship increases

[2] Brazil's new program, *Bolsa Familia,* which merged the previous *Bolsa Alimentaçaõ and Bolsa Escola,* now includes both health and education benefits.

in higher grades and is slightly higher for girls than for boys in secondary school. The cash transfers received constitute an estimated 25% of mean household income in rural areas and 15% to 20% in urban areas. The fortified food products are provided to all children between 6-23 months of age, to children between 2 and 5 years of age with low weight and to pregnant and lactating women. The fortified food is to be prepared as a porridge and to be consumed daily. If used as recommended, the fortified porridge provides the daily recommended dietary allowance of zinc, iron, and a number of essential vitamins, and approximately 20% of energy needs for children less than 2 years of age (28, 30, 31).

The **Nicaraguan** *Red de Protección Social* (*RPS*) pilot program used a design similar to the *Oportunidades* program. Poor households in low-income areas received a cash transfer conditional on attending health education workshops and bringing their children younger than 5 years of age for preventive health checkups, which included deworming treatment, distribution of vitamin and iron supplements, and immunization. The program was designed so that beneficiary children would receive vitamin A and iron supplements following the Ministry of Health protocol. Strengthening the health supply was planned. The scholarship was received contingent on enrollment and regular attendance at primary school. The cash transfer was equivalent to 18% of average household expenditure (32).

The program *Familias en Acción* in **Colombia** provided mothers in low-income households in poor municipalities with monetary transfers if their children 0 to 6 years attended preventive health checkups. No fortified food or MN supplements were provided. Scholarships were given to children 6 to 17 years of age provided they enrolled and attended school regularly. The transfers received constituted 24% of household expenditure. Attending health education sessions was encouraged (33).

The *Programa de Asignación Familial* (*PRAF*) in **Honduras** was targeted to areas with high levels of child stunting. All households with pregnant women, children under the age of 3, or children 6 to 12 years who had not completed fourth grade were eligible. The study localities were assigned one of four groups: cash to households (demand focus), resources to local health teams with a community-based nutrition intervention (supply focus), a combination of both (demand and supply focus), or the control group. The basic transfer was received contingent on attending monthly preventive health checkups for children and prenatal care for women.

Children 6 to 12 years were eligible to receive the scholarship on the condition that they enrolled and regularly attended school. Averaging at 4% of household expenditure, the transfer received was small compared to other programs included in this review (Table 2). No fortified food or MN supplements were provided (34).

The **Brazilian** *Bolsa Alimentação* was targeted to families with pregnant and lactating women and/or children younger than 7 years of age. The monthly cash transfers were conditional on regular attendance at antenatal care and growth monitoring, and adherence to vaccination schedules. Women further had to attend health and nutrition education seminars. The average transfer was equivalent to 8% of household expenditure. No fortified food or MN supplements were provided (23, 27, 35).

Evidence of impact

Direct impact on micronutrient status - Only three of the CCT programs (Mexico, Nicaragua, and Honduras) studied the impact on micronutrient status (Table 3). The Mexico program provided a fortified food to all children under two years of age and to children 2 to 4 with weight-for-age Z-score below -1 SD. The Nicaragua program distributed iron supplements to children 0 to 5 years of age. At the time of the evaluation, the Honduras program did not provide any micronutrient supplements or fortified products, but impact on hemoglobin was measured nonetheless.

Table 2: Program components of the reviewed CCT programs

	Basic cash transfer		Nutrition supplement		Health			Scholarships	
Program[a] (country)	**Targeted to women**	**Estimated percent of total expenditures**	**Children**	**Women**	**Supply-side intervention**	**Health and nutrition education**	**Preventive health checkups and growth monitoring**	**For whom**	**Girls > boys?**
Oportunidades (Mexico)(26, 36)	Yes	25% (rural) 10-15% (urban)	6-24 mo, 24-48 mo (low weight) (fortified food)	Pregnant and lactating (fortified food)	No	Household members > 15 y	0-5 y > 17 y Pre- and postnatal	Primary (starting 3rd grade) and secondary	Yes (secondary)
Red de Protección Social (Nicaragua)(32)	Yes	18%	0-5 y (Fe supplement)	-	Yes	Mothers	0-5 y	7-13 y (not completed 4th grade)	No
Familias en Acción (Colombia)(37)	Yes	24%[b]	-	-	No	Mothers	0-7 y	Primary and secondary	No
Programa de Asignación Familial (Honduras)(38)	?	4%	-	-	Yes (2 of 4 arms of study)	?	0-3 y Prenatal	6 – 12 y	No
Bolsa Alimentação (Brazil)(39)	?	8%	-	-	?	Mothers	? – ? y Prenatal	-	-

[a] Key references are given here. For additional references, see text.

[b] Estimated from Attanasio and Mesnard 2006 (37).

?: These aspects of the program were unclear, based on documentation available.

Table 3: Nutrition outcomes evaluated in the reviewed CCT programs

Program[a] **(country)**	**MN status**	**Child growth**	**Child diet/ food intake**
Oportunidades (Mexico)(26, 36)	Yes	Yes	Yes
Red de Protección Social (Nicaragua)(32)	Yes	Yes	-
Familias en Acción (Colombia)(37)	-	Yes	Yes
Programa de Asignación Familial (Honduras)(38)	Yes	Yes	-
Bolsa Alimentação (Brazil)(39)	-	Yes	?

[a] Key references are given here. For additional references, see text.
?: Unclear based on documentation available.

The *Oportunidades* program had a modest effect on child anemia in rural areas of Mexico. Rivera et al. studied anemia in children younger than 12 months at baseline. Blood samples were collected at the 1- and 2-year follow-up, but not at baseline. One year into the intervention, children in the intervention group were found to have significantly higher hemoglobin than in the control group (11.12 vs. 10.75 g/dl; $P = 0.01$). This difference disappeared when the control children were enrolled in the intervention after 1.5 years. The anemia rates were significantly lower among children in the intervention (44%) compared to the control group (44%, $P = 0.03$), but still close to half of the children who had been exposed to the intervention for one year were anemic (36). Gertler compared intervention and control children who were 12 to 48 mo of age after one year of program exposure. The program was found to reduce the probability of anemia by 25.5%: 41.1% and 48.3% of children were anemic in the intervention and control group, respectively (29).

The impact on MN status in Mexico's urban areas was evaluated in two repeated cross-sections (one of which was at baseline) of children 2 to 4 years of age. No differences between groups were found at baseline. In the follow-up survey, the hemoglobin levels in beneficiary children 2 to 3 years of age were 0.3g/dl higher ($P < 0.05$) than in the control children. This difference was not associated with a difference in the prevalence of anemia. No effect was found in the older children. Iron, zinc, and vitamin A status were evaluated in a small subsample of children. No differences were found between beneficiary and non-beneficiary children in the serum concentration of ferritin or soluble transferrin receptor (sTfR), or in the serum zinc or serum retinol concentration. Differences did emerge,

however, when comparing beneficiary children who had consumed the fortified porridge with those who had not: log(sTfR) was lower (0.12 log(mg/l), $P = 0.08$) and serum retinol concentration significantly higher (1.7 μg/l, $P = 0.02$) in children consuming the fortified porridge (40).

No impact of the iron supplement on anemia was found in the evaluation of the *RPS* in Nicaragua. In both the intervention and control groups around 32% of children between 6 to 59 months of age were anemic at baseline, and this prevalence did not change with the program (32). In Honduras, anemia prevalence among 12-23 month old children ranged from 22 to 40%, and the program had no impact on mean hemoglobin or anemia (38). The lack of impact of the *PRAF* program on micronutrient status is not entirely surprising as there was no specific targeted micronutrient intervention component. The amount of the cash transfer, averaging at 4% of household expenditure, was most likely too low to have an impact on improved household food availability and subsequently child dietary quality.

These findings point to a very limited impact of CCT programs on child micronutrient status. The Mexico program, which provided a micronutrient fortified food, had a small impact on anemia, which appeared to be mostly due to consumption of the fortified food. Low rates of utilization and the use of reduced iron, which is not absorbed well, resulted in the modest overall impact. Only half of the children 6 to 23 months consumed the supplement at least once a week in urban areas, and of those, only two-thirds consumed it regularly (4-6 times a week). Among fortified food consumers, mean intake was less than half of the recommended dose. Consequently the mean daily intake of the food was much lower than recommended. In rural areas, only 57% of the treatment group ingested the fortified food four or more times a week. In both urban and rural areas, studies have shown problems, including sharing with other family members and not properly preparing the food, as well as not receiving the supplements (36, 41, 42). Based on the findings of the evaluation, a series of studies were conducted to evaluate the efficacy and acceptability of the food with different types of iron (43). Iron gluconate was chosen and is currently being used to fortify the porridge.

In Nicaragua, iron supplements distributed through the health system had no impact on mean hemoglobin levels or anemia prevalence. The irregular and incomplete delivery of the supplements to children has been argued to be one of the main reasons for the lack of impact of the program on hemoglobin and anemia (32). The Honduras program, on the

other hand, did not provide any specific micronutrient product or education intervention, and the cash transfers were very small. Not surprisingly, the program failed to improve anemia prevalence.

Impact on other child nutrition outcomes – The impact of the CCT programs on child anthropometry is summarized in Table 4. For the programs using a before-and-after design (all programs but Brazil), we provide the time children were exposed to the program, the child age and anthropometry at baseline, and the estimated impact. The impact for these programs was estimated using a double difference approach: double differences are calculated by comparing the changes over time in the intervention and control groups. The Brazil evaluation used a cross-sectional design. The values shown for the *Bolsa Alimentação* are the average time beneficiary children had been receiving the benefits, the values in the control group, and the estimated impact.

A substantial positive impact on linear growth was found in Mexico, Nicaragua, and Colombia. No impact was found in Honduras and Brazil (Table 4) (23, 26, 38, 44, 45). As mentioned above, the lack of an effect in Honduras was most likely due to the small size of the transfer, equivalent to 4% of household expenditure. The program also suffered from problems implementing the health supply component (38). A small negative effect was found on child weight in Brazil. This might have been due to the erroneous perception that program benefits would be discontinued if the child started to grow well (27). This hypothesis, however, was not verified in further analyses of the data (personal communication with Eduardo Nilson).

Table 4: Impact of CCT programs on child anthropometry

Program (country)[a]	Exposure (mo)	Age[b] (mo)	Height or height-for-age[c]		Weight or weight-for-length/height[d]	
			Baseline[e]	Impact[f]	Baseline[e]	Impact[f]
Oportunidades (rural Mexico)(36)[g]	18	0-6	B:-0.45 C: -0.25 SD B: 58.0 C: 58.9 cm	**+1.1 cm[h] (*)**	B: 0.46 C: 0.45 SD	-
		6-12	B: -1.04 C: -1.03 SD B: 68.3 C: 68.4 cm	? (NS)	B: -0.01 C: 0.07 SD	-
Oportunidades (urban Mexico)(26)	24	0-6	B:-1.29 C:-1.40 SD B: 70.9 C: 70.2 cm	**+0.41 SD (*)** **+1.53 cm (*)**	B: 0.30 C: 0.33 SD B: 8.62 C: 8.46 kg	**+ 0.46 SD (*)** **+0.76 kg (*)**
		6-12		+0.23 SD (NS) +0.73 cm (NS)		-0.17 SD (NS) +0.026 kg (NS)
		12-24		+0.02 SD (NS) -0.07 cm (NS)		+0.10 SD (NS) +0.090 kg (NS)
Red de Protección Social (Nicaragua)(32)	24	0-60	B: -1.73 C: -1.77 SD B: 39.8 C: 39.5 %	+0.13 SD (NS) **- 5.5% (*)**	B: 0.8 C: 0.4 %	-0.3 PP (NS)
Familias en Acción (Colombia)(37)	12	0-24	22.1 %	**+0.16 SD (*)** **- 6.9 PP (*)**	2.5 %	-
		24-28	23.1 %	+0.01 (NS) +0.4 PP (NS)	0.7 %	-
		>48	23.0 %	+0.01 (NS) - 2 PP (NS)	1.8 %	-
Programa de Asignación Familial (Honduras)(38)	24	0-60	Demand group: -2.05SD, 52.0% Demand & Supply: -2.11 SD, 54.3 % Supply group: -1.88 SD, 46.6 % Control group: -2.16 SD, 55.4 %	Demand vs. control: -0.02SD (NS), -0.3PP (NS) Demand & Supply vs. control: +0.02SD (NS), -0.8PP (NS) Supply vs control: S: -0.03SD (NS), +0.5PP (NS)	Demand group: -0.08 SD, 1.5 % Demand & Supply: -0.12 SD, 1.3 % Supply group: -0.02 SD, 1.1 % Control group: -0.07 SD, 1.4 %	Demand vs. Control: 0.0 SD (NS), +0.7PP (NS) Demand&Supply vs. Control: 0.0SD (NS), +0.3PP (NS) Supply vs. Control: -0.05 SD (NS), +0.1 PP (NS)
Bolsa Alimentação (Brazil)(39)	5.9	0-24	-0.78 SD	-0.85 SD (NS)	-	**- 0.183 kg (*) (all)**
		24-48	-0.63 SD	-0.95 SD (NS)	-	**- 0.274 kg (*) (0-12 mo)**
		>48	-0.93 SD	-0.90 SD (NS)	-	

[a] Key references are given here. For additional references, see text.
[b] A panel was used in Mexico (age refers to the age at baseline); repeated cross-sections for children in Nicaragua, Colombia, and Honduras (age refers to the age in both cross-sections); cross-sectional data were used in Brazil (age refers to age in the beneficiary and non-beneficiary group).
[c] SD refers to Z-scores, cm to absolute height, % to prevalence of stunting, and PP to percentage points; NS indicates $P > 0.05$.
[d] SD refers to Z-scores, kg to absolute weight % to prevalence of wasting, and PP to percentage points; NS indicates $P > 0.5$.
[e] Entries refer to values at baseline among beneficiary (B) and control (C) households, respectively; Colombia: values are for children in the treatment areas, no values were reported for controls; Honduras: D = demand intervention, S = supply intervention, D&S = demand and supply intervention, C = control; Brazil: values for the control group.
[f] Impact estimates are double difference estimates for Mexico (urban and rural), Nicaragua, Colombia, and Honduras. Double differences are calculated by differencing the changes over time in the intervention and control groups. The estimates for Brazil are the difference between intervention and control at end line.
[g] Impact estimations are based on Rivera et al. 2004 (36). "*" = statistically significant impact; "NS" = non-statistically significant.
[h] Effect in children living in the poorest households. Not statistically significant in children living in less poor households.

Only two programs, *Oportunidades* and *Familias en Acción*, have evaluated the impact on child dietary intake. In Mexico's rural areas, the diet of children in the control group was compared to all beneficiary children and to two subgroups of beneficiary children: those consuming the fortified food and those not consuming it. Beneficiary children 12 to 60 months of age consumed more iron, zinc, and vitamin A than non-beneficiary children. The largest effects were found in children 12 to 24 months. An increase in energy consumption was found in the same age group. Fortified food consumers (12 to 60 months) had greater intakes of iron (7.7 mg/day), zinc (7.6 mg/day), and vitamin A (398.5 μgRE/day) (all $P < 0.05$) than the control group. The diet of beneficiary children not consuming the fortified food was not different from that of non-beneficiary children. The only exception was the consumption of zinc: beneficiary children12 to 24 months of age consumed more zinc (+ 0.3 mg ($P = 0.04$)) than control children. The impact of the program on dietary intake was thus mostly due to the consumption of the fortified food rather than to changes in the child's regular diet (46).

In urban areas in Mexico, beneficiary children (6-38 mo) consumed more iron (0.5 mg/day) than non-beneficiary children. Surprisingly, energy and protein intake were significantly lower in beneficiary children than in control children. When the beneficiary group was divided in fortified food consumers and nonconsumers, significant positive impacts were found on the intake of iron (2.7 and 5.6 mg/day in breastfed and non-breastfed children, respectively), zinc (2.9 and 5.1 mg/day in breastfed and non-breastfed children, respectively), and folic acid (20.3 and 20.2 mg/day in breastfed and non-breastfed children, respectively) for the consumers compared to the nonconsumers. Zinc consumption was significantly lower in beneficiary children not consuming the supplement than in non-beneficiary children. There was no impact on vitamin A consumption. The analyses of child dietary diversity provided no convincing evidence of program impact (40).

The number of days in the last week children 24 to 60 months of age consumed certain foods was evaluated in Colombia. The results show that the frequency of animal source food and vegetable consumption increased considerably. Chicken consumption, for instance, increased by 0.25 to 0.38 days per week and vegetable consumption by 0.91 to 1.23 days per week. No significant impact was found on the frequency of fruit consumption (33).

Evidence on pathways of impact

CCT programs may affect nutrition through a number of different mechanisms (Figure 2). The cash transfer may alleviate poverty in beneficiary households. The additional resources, in turn, may allow households to purchase more and better (i.e., more nutrient dense) foods and increase household food security and diet quality (*the income, household food security, and household diet quality pathway*). The program targeting strategy, which involves giving the cash transfers to women, may increase women's control over resources and their decision-making power relative to child nutrition and health (*the women's income and control over resources pathway*). The nutrition and health education component, also targeted to women, might change households' preferences for nutrient-rich foods, may change the intrahousehold allocation of foods in favor of children, and may lead to improved child feeding and caregiving practices; health education may also improve household practices related to water and sanitation and improve child health (*the women's knowledge and awareness pathway*). For programs that include a MN-fortified food or MN supplements, these products can directly improve the micronutrient status and overall nutritional status of the child (or contribute to the nutritional status of all/other household members if the products are shared within the household) (*the child MN-fortified food and supplement pathway*). The program condition requiring that mothers, children, and other family members follow a schedule of regular primary health-care visits may increase overall use and coverage of health services and reduce child illnesses, especially infectious diseases. Improved health, in turn, is likely to have a direct impact on improving nutritional status (*the health services utilization and child health pathway*). The program condition to enroll and maintain school-age children in school can also have long-term, intergenerational effects on nutrition through the well-documented pathway linking female education and positive child nutrition, health, and survival outcomes (*the long-term girls' education pathway*). The program conditions, on the other hand, may have a negative effect on women's time, especially if women have to travel long distances to receive their payment, comply with the health visit schedule and/or attend the nutrition/health education sessions (*the women's time pathway*).

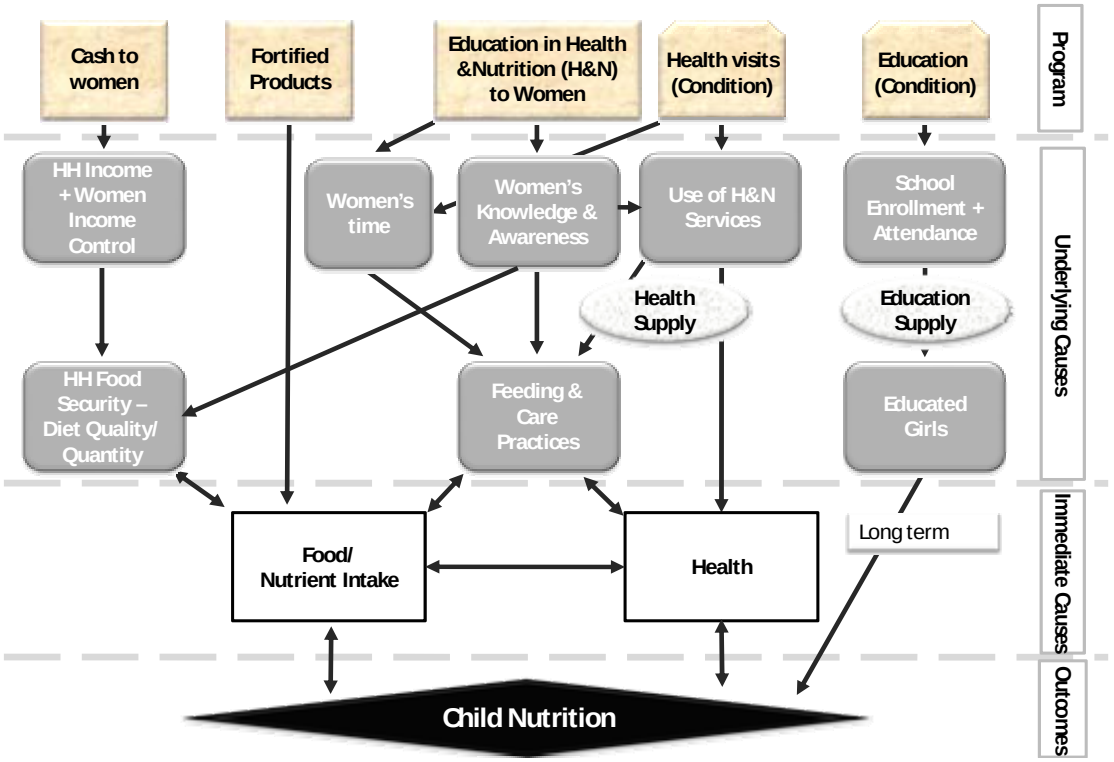

Figure 2: Mechanisms by which CCT programs might affect nutritional status

The actual pathways by which CCT programs improve nutritional status and the relative contribution of the different program components are largely unknown. The impact on a number of outcomes at different steps along these pathways (e.g., household income, food security, child health) has been studied. No study, however, has modeled the actual pathways and assessed their relative importance in improving child MN status and anthropometry. The evidence on the outcomes that may be part of these pathways is summarized in Tables 5a and 5b and discussed below.

Table 5a: Evidence on pathways through which CCT programs may improve MN status

Program (country) [a]	Poverty[b,c]			Household expenditure[b,d]		
	Headcount	**Gap**	**Severity**	**Total**	**Food**	**Quality of household diet**
Oportunidades (Rural Mexico)(36) NOTE: Baseline data 1998	Estimation: -11.7 PP (-17%) Simulation: -10%	Estimation: - 12.9 PP (-36%) Simulation: -30%	Estimation: -11.5 PP (-46%) Simulation: -45%	+14.53%	*kcal:* mid 99: +3.3%, end 99: +3.4%	*kcal*: AP:+10,+13% Grains:+3.1% F&V:+17,+16% Other: NS (mid, end 99)
Oportunidades (Urban Mexico)(26) NOTE: Baseline data 2002	-	-	-	2003: +12% 2004: +22%[6]	2003: +16~21% 2004: +23~26%	Protein[g]: +11~25% F&V: +8~18% Carb: NS
Red de Protección Social (Nicaragua) (32) NOTE: Baseline data 2000	Poverty: 2001: -10 PP 2002: -5.0 ~ -6.7PP Extreme poverty: 2001: -21 PP 2002: -15 PP	2001:-13.3 PP 2002: -9.8 PP	2001: -11.3 PP 2002: -8.7 PP	Household: 2001: ~ +20% 2002: ~ +14% Per capita: 2001: ~ +25% 2002: ~ +18%	Per capita: 2001: ~ +33% 2002: ~ +24%	Meat: +64% Fats: +54% F&V: +71% Sweets: +34% Carb., beans, milk: NS *DD*: +33%
Familias en Acción (Colombia)(37)	Poverty: NS Extreme poverty: R: - 5.9 PP U: -5.8 PP	-3.7 PP (R and U)	-	+15%	+15%	AP: +20% Cereals: +9~17% Fats: +15~24% F&V, tubers, legumes, sweets: NS
Programa de Asignación Familial (Honduras)(38)	NS	NS	-2.0 PP	NS	NS	NS
Bolsa Alimentação[e] (Brazil)(39)	-	-	-	-	+9%	*Kcal* from non-staples: +12% *DD*: +9%

[a] Key references are given here. For additional references, see text.
[b] Based on Adato and Bassett (2007) (21) and own calculations. See the Adato and Bassett paper for sources; U = urban, R = rural.
[c] PP = percentage points.
[d] Estimates are in monetary value, unless stated otherwise (*kcal* or *DD*); AP = animal protein, F&V = fruits and vegetables, Carb = carbohydrates (cereals, tubers, bread, …), DD = dietary diversity.
[e] Poverty and household expenditure estimates from a preliminary report. Final estimates may change.
[f] Algebraic calculation summing the estimated effect on food and nonfood expenditure. Impact on total expenditure was not estimated by Angelucci and Attanasio (47).
[g] Note that the estimates for total and food expenditure come from a published paper (47), the expenditure on separate food groups come from a report submitted to the program (48). Both sources provide different estimates on the total and food expenditure.

Table 5b: Evidence on pathways through which CCT programs may improve MN status (continued)

Program[a] (country)	Women			Children[b]		
	Income and control over resources	**Health and nutrition knowledge**	**Time availability**	**Health-care utilization**	**Health status**	**Diet and supplement intake[c]**
Oportunidades (Rural Mexico)(36) NOTE: Baseline data 1998	No change in decision making domains. May increase women's autonomy	+ general knowledge and practices (did not include child health or nutrition)	+ time burden, in general not perceived as problematic	Preventive: +5, 13, 7PP (<24mo) +5, 10, NS (<24-48 mo) after 8, 15 & 20 mo of exposure Immunization: NS[d] Curative: all: NS (<72mo) hospital:-0.007 visits/mo (<36 mo) private; -0.012 visits/mo (<36 mo)	Overall illness -23.3% Longer exposure associated with lower illness (<36 mo)	B vs. NB: Fe: +0.8mg, Zn:+0.7mg, vit A: 77.2µgRE BC vs. NB: Fe: +7.7mg, Zn: +7.6mg, vit A: +399µgRE BNC vs. NB: NS (12-59 mo)
Oportunidades (Urban Mexico)(26) NOTE: Baseline data 2002	-	*Idem* Lack of effect of education on appropriate use of fortified food	-	Preventive: 2003: 2004: +52.1PP Immunization: - Curative: 2003: 2004: NS (all <72mo)	Overall illness: -0.97d/mo	B vs. NB: Fe: +0.5mg BC vs. BNC: Fe: 2.7~5.6mg, Zn: 2.9~5.1mg, FA:20mg, Vit A: NS (6-38 mo) DD: NS
Red de Protección Social (Nicaragua)(32) NOTE: Baseline data 2000	-	-	-	Preventive: 2001: +19.5PP (<36mo) 2002: +11.0PP *(id.)* Immunization: NS (12-23 mo) Combined preventive + curative: 2001: +28.9PP (<36mo) 2002: +17.5PP (*id.*)	-	-
Familias en Acción (Colombia)(37)	-	-	-	Preventive: +22.8PP (<24 mo) +33.2PP (24-48 mo) NS (>48 mo) Immunization (DPT): +8.9PP (<24 mo) NS (>24 mo)	Urban: Diarrhea: -NS Urban: Resp. Dis: - NS Rural: Diarrhea: -11% Rural: Resp. Dis: NS (<48 mo)	AP: e.g., chicken +0.25~0.38d/week V: +0.91~1.23d/week F: NS (24-60 mo)

Program[a] (country)	Women			Children[b]		
	Income and control over resources	Health and nutrition knowledge	Time availability	Health-care utilization	Health status	Diet and supplement intake[c]
Programa de Asignación Familial (Honduras)(38)[e]	-	-	-	Preventive: +15.6~21.1PP (D), +14.6~17.6PP (D&S), NS (S) Immunization: DPT: +6.9PP(D), +9.1PP(D&S), NS(S) Measles: NS Combined preventive + curative +20.2PP(D), +14.9PP(D&S), NS (S) (all <36 mo)	Diarrhea: NS	-
Bolsa Alimentação (Brazil)(39)	-	-	-	-	-	-

[a] Key references are given here. For additional references, see text.
[b] B = beneficiary child, NB = non-beneficiary child, BC = beneficiary child consuming the fortified food, BNC = beneficiary child not consuming the food, PP = percentage point, U = urban, R = rural, NS = not statistically significant.
[c] Nutrient intakes expressed per day.
[d] See text for details.
[e] H = household cash intervention, S = health services intervention, HS = household and services intervention.

Income, household food security, and household diet quality pathway – The CCT programs have the dual objective of alleviating short-term poverty and hunger and easing constraints on household investment in human capital development (22).

Overall, these programs have had a large impact on short-term poverty alleviation, irrespective of the poverty measure used (headcount, gap, severity)(21, 32, 37, 38, 45, 48-51). All programs reviewed here, except Honduras, have also shown significant positive effects on total household expenditure (a proxy for income). The same is true for household food expenditure, which improved substantially among participating households in all programs, except in Honduras. The magnitude of impact on food expenditure was larger than the impact on total expenditure in Mexico and Nicaragua, but about the same in Colombia. In Nicaragua, the absolute change in food expenditure was roughly equal to the change in total expenditure. In all studies, the quality of the diet also improved, as shown in increased spending on animal source foods. The studies in Mexico, Nicaragua, and Brazil also found a positive impact on the consumption of fruits and vegetables. This effect was not seen in Colombia. Of concern is the significant increase in expenditure on fats in Nicaragua and Colombia, and on sweets in Nicaragua. The lack of impact in Honduras is likely to be due to the small size of the cash transfers, which had a value of only 4% of poor household's total expenditures.

Hoddinott and Wiesmann assessed the impact of the Honduras, Nicaragua, and rural Mexico programs on household caloric availability (a proxy for food security). For each country, they looked at impacts by income tertile, using baseline total food expenditure to stratify their samples. They show that the three programs significantly raised per capita caloric availability by a percentage ranging from 5.8% to 12.7% in the poorest tertiles. Apart from the middle tertile in rural Mexico, this magnitude of effect was not found for any other income tertile (52). Thus, in terms of household food security, poorest households benefited more from the program than households from higher income tertiles. It is not clear from the analyses, however, whether the larger proportional impact in the lowest tertile also corresponded to a larger absolute change in the poorest household.

The specific role of cash in improving child nutritional status was studied by Fernald et al. They estimate that a doubling of the cumulative transfers received by households over time was associated with a 0.2 SD increase in height-for-age Z-score ($p < 0{\cdot}0001$), a 10-percentage point drop in the prevalence of stunting ($p < 0{\cdot}0001$) and an 8-percentage point

drop in being overweight (p = 0·001). A limitation of the study is that it did not control for the endogeneity of the transfers received, i.e., they did not control for the fact that the decision to send children to school (and thus receive additional cash) was most likely related to parental attitudes that have positive effects on the measured outcomes (child nutritional status in this case) (19).

Women's income and control over resources pathway – The impact of the Mexico program on women's status, bargaining power, and intrahousehold relations was studied using both quantitative and qualitative methods. The results show that women benefited from the program in several ways that contribute to their empowerment – defined as increased self-confidence, awareness, and control over their movements and household resources. First, by putting additional resources in the hands of women and focusing on improving their health and nutrition, the program contributed to lifting some of the basic obstacles to their empowerment. The program also gave women more opportunities to leave the house; educated them on health and nutrition issues; provided new spaces in which to communicate with other women (through the health/nutrition training sessions), and educated girls to improve their position in the future (49, 51). Similar findings were documented from a qualitative study of the Nicaragua program (25). Both studies also found little evidence of increased tensions within the household as a result of women receiving the cash. Acceptance of this aspect of the program was assumed to be a result of communities associating the program with women's traditional roles of caring for the family and children, and of managing household food purchases and consumption (25).

Women's knowledge and awareness pathway – The impact of the health and nutrition education on general health knowledge and practices was evaluated only in Mexico, where a positive impact was found. The evaluation, however, did not include knowledge or practices related to child nutrition or health-care seeking for childhood illness (53). A qualitative study specifically aimed at assessing the barriers and facilitators for adequate use of the fortified food in rural areas showed that women knew that the vitamins in the fortified food had a beneficial impact on their children. An important barrier was the belief that foods for young children need to have a more liquid consistency than the prepared fortified food. This leads to the addition of too much water. The use of Spanish (in

indigenous areas) and the use of technical terms in the sessions where the preparation and use of the food is explained were identified as important barriers to knowledge acquisition (54). No other programs have evaluated their impact on maternal knowledge.

Child MN-fortified food or supplement pathway – As reviewed above, two programs (rural and urban *Oportunidades* and *Familias en Acción*) studied the consumption of the fortified food and/or child dietary intake. The *Oportunidades* results show that the positive impact on iron, zinc, and vitamin A intake in children was mostly due to the consumption of the nutrition supplement. This confirms that the supplement intervention was successful, but it also indicates that the documented impact of the program on household food consumption (i.e., more diverse and nutrient-dense foods) did not translate into improved diets for children. By contrast, the study in Colombia showed that the program increased the frequency of consumption of animal products and vegetables among children. No studies have been conducted on the impact of CCT programs on intrahousehold food allocation.

The *RPS* evaluation showed severe shortages of vitamin A and iron supplements, which were supposed to be part of the intervention package. Irregular or incomplete delivery of the supplements to children has been argued to be one of the main reasons for the lack of impact of the program on hemoglobin and anemia (32). Iron supplementation generally has no known effect on child growth (55) and the effect of vitamin A supplementation on growth is limited to cases of severe deficiency (56). We can thus assume that the positive impact on child growth was due to better diets, lower morbidity, or a combination of both. As mentioned before, the *RPS* study did not collect child dietary intake data to substantiate this hypothesis.

Notwithstanding the important role of the fortified food in improving child nutrition, evaluations of the program in Mexico have shown that children did not consume the supplement daily as recommended (see above). So, although the fortified product did improve the mean intake of iron, zinc, and vitamin A in children consuming the food, and had a marginal impact on anemia in some age groups, overall the effect was diluted by sharing and low rates of utilization.

On a final note, the anthropometric data suggest that at least part of the impact on linear growth in Mexico, Nicaragua, and Colombia may have been due to improved MN status. Data from all three countries suggest that there was little or no wasting (or low

weight-for-length/height) at baseline, and no change in this indicator among program participants. Thus, it is unlikely that linear growth retardation in these populations was due to energy deficits. A more plausible hypothesis, which has not been tested, however, is that linear growth was improved as a result of improved MN intake and status. Zinc could have been particularly important in that respect, given the well-documented association between zinc supplementation and linear growth (57). The reduced illness in Mexico and Colombia (see below) may also have contributed to better growth.

Health services utilization and child health pathway – The impact of CCT programs on the use of health-care services was evaluated in Mexico, Nicaragua, Honduras, and Colombia. All studies found significant and large positive effects on well-baby clinic visits. The programs in Colombia and Honduras had a positive impact on immunization rates but no effect was found in Mexico or Nicaragua. It is not clear to what extent curative health-care seeking is effected by the program. The detailed findings per country are discussed below.

In rural Mexico, growth monitoring visits for children under 24 months increased by about 5, 13, and 7 percentage points after 8, 15, and 20 months of program exposure, respectively. The impact in children 24 to 48 months of age was 5 and 10 percentage points after 8 and 15 months, respectively. No impact was found at 20 months of exposure in this age group. Immunization rates for tuberculosis (children under 12 months at baseline) and measles (children 12 to 23 months at baseline) increased 5.2 and 3.0 percentage points after 6 months of exposure, respectively. This result, however, was most likely due to a decline in coverage in the control areas. After 12 months, when immunization coverage in the control areas was back to normal, no significant program impact was found. The baseline immunization rates, however, were already high (58). No effect on overall curative health-care utilization was found in children younger than 60 months. Public hospital visits and private provider visits, however, fell by 0.007 and 0.012 visits per month, respectively, in children 0 to 36 months of age (59).

The urban program increased the proportion of children younger than 6 years taken to well-baby visits by 52 percentage points, equivalent to one additional visit in the last 6 months. Immunization was not evaluated. No effect was found on curative health-care utilization in either the private or public system (60).

The *RPS* had a positive effect on the number of children being taken for a well-baby checkup in the previous 6 months (19.5 and 11.0 percentage points after 1 and 2 years, respectively). The effect on the percentage taken to a health-care provider and weighed during the visit was even larger (28.9 and 17.5 percentage points after 1 and 2 years, respectively). The effects were largest for the extremely poor. No program impact on immunization coverage was observed. This result, however, may be due to the fact that vaccination delivery in program communities positively affected vaccine availability in the control communities too (32). The Colombian program had a significant effect on compliance with the growth and development program in children younger than 24 months (estimated at 22.8 percentage points, $P < 0.05$) and between 24 and 48 months (33.2 percentage points, $P < 0.05$). No effect was found in children over 48 months. Adequate DPT vaccination increased by 8.9 percentage points ($P < 0.1$) in the youngest children; no effect was found in the other age groups (61).

The *PRAF* increased the percentage of children under 3 years being weighed in the past 30 days by 15.6 to 21.1 percentage points (health card and mother's report, respectively) in the group receiving the demand-side intervention and by 14.6 to 17.6 percentage points (*idem*) in the group receiving the demand + supply-side intervention. No effect was found in the group receiving only the supply-side intervention. An increase of 6.9 percentage points was seen in DPT1 vaccination for children younger than 3 years; measles vaccination was not affected by the program. The percentage of children under 3 years who had been taken to a health center at least once in the last 30 days increased by 20.2 and 14.9 percentage points in the household and household and service intervention groups, respectively. It is not clear whether these were preventive or curative visits or a combination of both (39).

The impact of CCTs on actual child health outcomes was evaluated in Mexico, Honduras, and Colombia (23). *Oportunidades* in rural Mexico lowered child illness in the 4 weeks prior to the survey as reported by the mother by 23.3% in children aged less than 3 years at baseline. Longer program exposure was associated with larger reductions in the prevalence of illness symptoms reported: children who had been in the program for 2, 8, 14, and 20 months were 6% (NS), 25% ($P < 0.05$), 16% (*idem*) and 40% (*idem*) less likely to have been reported ill, respectively, compared to non-beneficiary children. The illness symptoms were not specified by the author (29). In urban areas the program lowered child illness by one day per month after two years of exposure (60). The Honduras program did not show

an impact on morbidity as measured by childhood diarrhea (38). The results, however, might have been affected by a seasonality problem (62). In Colombia, the program lowered the probability of reported diarrhea symptoms in children 12-48 months living in rural areas by 11 percentage points. No effect was found for children in urban areas or children older than 48 months. Respiratory illness was not affected by the program (33).

Women's time pathway – There is a dearth of information on the impact of CCT programs on women's time availability. A qualitative study in rural Mexico showed that traveling to receive the transfers and attending meetings place extra time burdens on women. Women also have to do the household work previously done by children who are now in school. Only a few women, however, perceived the time burden to be a problem (63). No other evaluations studied this outcome.

Long-term girls' education pathway – None of the CCT programs have been operating long enough to evaluate the impact of additional years of schooling on the health and nutrition of girls' offspring. There is, however, substantial evidence that higher maternal education is beneficial to children. A cross-country analysis of data from 63 developing countries estimates that improvements in female secondary school enrollment rates were responsible for 43% of the total 15.5% reduction in child underweight observed in these countries during the 1970-1995 period (64). Educated mothers may attach higher values to the welfare and health of children. They may be better informed about disease causation, prevention, and cure and, hence, may be more proactive in taking action to ensure adequate health, nutrition, and development of children. Educated people are more capable of "manipulating" the world. Not only do they know better where services can be found, they are also more successful in using those services (65-67). In Brazil, the positive effects of maternal education on child growth were shown to operate through increased access to information (68). Better-educated women are more likely to use available services that improve child health as shown in studies in Guatemala (69), the Philippines (70), and Bangladesh (71). By fostering female education, CCT programs have a great potential to improve the well-being of future mothers and their offspring.

2.1.4 Discussion

Few CCT programs have been assessed for their impact on MN nutrition, and those that have show little or no impact on MN status. The effect on linear growth, however, is substantial. Given the low level of energy deficiency in the studied population, it is plausible that part of the documented improvements in length or height are actually due to improved MN nutrition, but this hypotheses cannot be tested with the available data. The positive impact of these programs on child health may also contribute to improved MN status and growth.

Notwithstanding their limited documented impact, CCT programs provide an excellent entry point for improving maternal and child MN status for a number of reasons. First, they are targeted to – and effectively reaching – poor populations who suffer the highest burdens of MN deficiencies. Second, the coverage of CCT programs is usually high, and in some cases reaching national scale. Third, the programs provide inputs that address several of the underlying determinants of child undernutrition (e.g., cash targeted to women, increased household income, and food security) and have shown positive impacts on most of these outcomes. These programs also simultaneously provide direct nutrition interventions such as fortified foods or MN supplements, and nutrition/health education. Also, the condition that children comply with regular visits to health-care facilities may improve child health, which is another direct input into improved nutrition. The emphasis on women also provides a unique opportunity to improve child, as well as maternal, health, nutrition, and MN status through greater women's access to – and control over – resources and increased autonomy and decision-making power within the household. Finally, these programs have received widespread support from politicians as well as donors and have been perceived as a major breakthrough in poverty-alleviation programs. The full potential of CCTs to improve MN nutrition, however, is yet to be realized. Strengthening the different program components with specific nutrition and health objectives in mind could improve program effectiveness considerably.

It must be emphasized that our understanding of CCT programs, and especially of their impact on nutrition outcomes, is very limited. It is clear from the review (e.g., Tables 5a and 5b) that critical information is missing to identify how CCT programs might have an impact on MN status and anthropometry. None of the evaluated programs had gathered sufficient information to map and quantify all possible pathways. In some cases the available

evidence seems contradictory. Evidence from Mexico would suggest that a MN-fortified food (or other type of MN supplement) is essential if a CCT program is to have an impact on nutrition outcomes. The studies in Nicaragua and Colombia, however, tell a different story: in both countries the impact on child growth seems to have resulted from improved diets, and the iron supplement in Nicaragua had no impact on iron status.

Given the enormous potential of CCT programs to address both the immediate and the underlying determinants of child undernutrition, it is fundamental that we generate the evidence base that will allow the design and implementation of CCT programs that have a stronger and more effective package of nutrition inputs and can consequently make a greater contribution to reducing the high burden of childhood undernutrition in the developing world. A first step in doing so is to adopt a program theory framework to identify, evaluate, and document the multiple impact pathways by which these programs can improve MN nutrition. Only then will these programs achieve their full potential at improving nutrition and generate the needed information for scalability and replicability in other contexts.

2.2 Evidence from Microcredit-with-Education Programs

2.2.1 Introduction

Microcredit programs[3] provide small loans to poor people who are often excluded from formal financial systems in order to engage in economic activities that generate income (72). Many microcredit programs worldwide are modeled after the Grameen Bank in Bangladesh, which originated in 1976 from an action research project designed to study credit delivery systems targeting the rural poor. Given the project's success, it was extended, with the sponsorship of the national central bank and the support of the nationalized commercial banks (73, 74). The success of the Grameen Bank projects in turn resulted in the establishment of many replications worldwide (75, 76).

A key feature of many of the programs, so called group-based microcredit programs, is that the credit is provided without "traditional" collateral. Instead they make use of social relationships in solidarity groups as an alternative source of collateral, social collateral. As the requirement of physical or financial collateral would prevent most clients to participate, the social capital substitutes for what they lack in physical or financial resources (77). Under joint

[3] Microcredit programs can be seen as a part of the more general microfinance framework. While microcredit refers mostly to the provision of credit, microfinance refers to the overall provision of investing (savings), lending (credit services), and insurance (risk management) facilities.

liability, each member of the solidarity group is made responsible for the loan repayment of the other members. This means that if one member defaults, the other group members need to repay the loan from their own resources in order not to lose access to future loans (78).

In most cases, the credit is provided with a combination of other noncredit services. A common characteristic of most microcredit programs are regular meetings of solidarity groups. These meetings not only attempt regular repayment but also play a crucial role to strengthen the solidarity within the group and also provide a forum for the noncredit services like vocational training, organizational help, small business skills and management training, education in and resource provision for health care, sanitation, and family planning (72).

As of December 2006, 3,316 microcredit institutions reported reaching over 133 million, of whom 85.2% were women. The programs are particularly popular in Asia (79).

2.2.2 Methods

We searched Econlit, *Index Medicus*, JStor and Web of Science using "microcredit" and "nutrition" and "microfinance" and "nutrition" as search terms. We further searched the websites of the National Bureau of Economic Research (NBER) and Research Papers in Economics (RePEc) for relevant papers. Additional articles were added through discussions with colleagues and by checking the reference list of the identified articles.

2.2.3 Results

After screening the title and the abstracts of the identified studies, a total of seven articles were selected for review. Two articles were excluded for lack of clarity (80, 81). The five remaining studies evaluated microcredit programs in Bolivia, Ghana (one program in the north and one in the south), and Bangladesh (three programs evaluated in two published studies). All studies included a health/nutrition education intervention component and all assessed impact on at least one nutrition outcome (nutritional status or diet). We will refer to these programs as microcredit-with-education (MCE). The reviewed programs and their evaluation designs are described briefly below (Table 6).

Brief description of the programs reviewed and their evaluation design

Freedom from Hunger implemented the "Credit with Education" program in Bolivia and Ghana. This program combined small loans with education on health and nutrition,

including diarrhea management, breastfeeding, infant and child feeding, immunization, and family planning. Other topics included micro-enterprise and credit association management. Program participants formed self-managed village banks and guaranteed each other's loans. The program's underlying premise is that the education and credit components are mutually reinforcing by alleviating two important barriers to better health and nutrition, i.e., limited information and lack of resources (82).

Table 6: MCE programs reviewed

Country (area)	Program evaluated	Intervention				Evaluation[a]		
		Microcredit	Health and/or nutrition education	Focused on women	Other components	Design	Methods	Analysis
Bolivia (rural)	Freedom from Hunger Credit with Education program (82)	Yes	Health Nutrition	Yes	Education on family planning, small business skills	- Cluster randomized - Repeated cross-sections	Household surveys, anthropometry	- Comparisons of participants, eligible nonparticipants, and households living in control communities - Some analyses control for covariates
Ghana (coast) (rural)	Freedom from Hunger Credit with Education program (83)	Yes	Health Nutrition	Yes	Education on family planning, small business skills	- Cluster randomized (although with exceptions) - Repeated cross-sections	Household surveys, anthropometry	- Comparisons of participants, eligible nonparticipants, and households living in control communities - Some analyses control for covariates
Ghana (north) (rural)	Integrated community-based development program (84)	Yes	Sanitation Nutrition	Yes	Education on gender dynamics, financial topics Some communities received food-based interventions	Cross-sectional	Household surveys	- Intent to treat and treatment on the treated - Control for endogeneity of household expenditure, vitamin A knowledge and program participation - Control for covariates
Bangladesh (rural)	Grameen Bank, BRAC[a], BRDB's[b] RD-12 Program (85, 86)	Yes	Health	Yes[c]	Education on gender dynamics, literacy, small business skills, bank rules, investment strategies, civil responsibilities	Study Pitt et al. - Cross sectional - Quasi experimental - Stratified random sampling	Household surveys anthropometry	- Comparisons of participants, eligible nonparticipants, and households living in control communities - Endogeneity of program participation controlled for - Control for covariates
						Study Khandker - Panel data	Household surveys	- Comparisons of participants, eligible nonparticipants, and households living in control communities - Endogeneity of household and village program participation controlled for - Control for covariates

[a] Bangladesh Rural Advancement Committee.

[b] Bangladesh Rural Development Board.

[c] Initially, women and men were equally represented. However, when results indicated that income earned by women resulted in greater benefits for the family in general, and children in particular, lending was being shifted toward women (74).

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In Bolivia, the program started operating in 1990 and had enrolled 15,600 members in 774 credit associations by 1999. The baseline survey (July/August 1994 and November 1995) was conducted in households with a child 11 to 24 months of age in 69 rural communities. Communities were randomly assigned to the treatment and control group after the baseline. A follow-up survey (November 1997) was conducted in a sample of households with children 6 to 24 months of age living in the same villages. The nutrition outcomes measured included child growth, child and household diet, and maternal knowledge and practices. A total of 502 households (249 baseline and 253 follow-up) living in 38 communities were included in the analysis: a number of communities were too sparsely populated to start the program; others were excluded because of operational problems. The households were equally distributed between program participants, eligible nonparticipants living in treatment communities, and households living in control communities (82).

In Ghana, Credit with Education services were provided to women in the coastal zone starting in 1992. By 1998, five rural banks were implementing Credit with Education and approximately 6,000 members had enrolled. In August 1993, baseline data were collected from 19 communities in which women with a child 12 to 23 months of age were randomly selected. The communities were stratified into four groups, based on their size and on access to the main road. The original design in which communities in each stratum would be randomly assigned to the treatment or control was not strictly followed: three control communities received the intervention (matched controls were sought for these communities) and one stratum was dropped. In each of the strata, communities were randomly assigned to the treatment and the control group. The follow-up survey (August 1996) was conducted in households with children aged 12 to 36 months in 17 of the 19 communities. As in Bolivia, data were collected on child growth, child and household diet, and maternal knowledge and practices. A total of 589 mothers (299 baseline and 290 follow-up) were included in the analysis (83).

Jacobs and Simler (2007) evaluated the impact of three different interventions in Northern Ghana. All of the 50 rural intervention communities received behavior change and communication (BCC) through mother-to-mother support groups. The BCC focused on breast- and complementary feeding. Two subgroups of communities were randomly selected to receive additional interventions. A first subgroup received microcredit with an educational component, including sanitation and nutrition. A second subgroup received a food-based

intervention. This included a porridge enrichment strategy and the promotion and preservation of the production of vitamin A-rich foods (orange-fleshed sweet potato and dark green leafy vegetables). Both subgroups were not mutually exclusive, meaning that some communities received both microcredit and the food-based intervention. Some of the 15 control communities received the BCC intervention as well. The authors do not mention the number of communities per treatment. An estimated 33% of mothers living in BCC communities actually participated in the intervention. Participation for the microcredit and the food-based interventions were 23% and 32%, respectively. Using cross sectional data, the authors estimated intent to treat and treatment on the treated effects on the diets of children aged 36 months or younger. The analysis is based on data from a 2004 survey in 1,689 households. The analysis (partially) addressed potential problems of the endogeneity[4] of household expenditure, vitamin A knowledge, and program participation (84).

Pitt and colleagues (2003) estimated the impact of the three major MCE programs in rural Bangladesh implemented by the Grameen Bank, by BRAC, and BRDB's[5] Rural Development RD-12 program. Program participants were mostly women and were provided with credit combined with other, noncredit, services such as consciousness raising, skill development training, literacy, bank rules, investment strategies, health, schooling, civil responsibilities, and altering the attitudes of and toward woman. The evaluation was based on a 1991/1992 survey of 1,798 households in 87 villages in rural Bangladesh. First, eight subdistricts per program were randomly selected from the program subdistricts and five subdistricts were randomly selected from nonprogram subdistricts. Then, in each subdistrict, three villages were randomly selected. Only villages where the program had been in operation for at least 3 years were included in the program subdistricts. Participating and nonparticipating target households and nontarget households were identified and a stratified random sampling technique was used to select the participating and nonparticipating target households. Child anthropometric data were only collected in eligible households in 15 program villages. The outcomes measured included arm circumference, body mass index

[4] Endogeneity is the problem of an independent variable (expenditure) being correlated with the error term (14). This problem arises when an unmeasured variable is associated with both an independent variable (which is labeled "endogenous") and the dependent variable. Program participation, for instance, is most likely associated with unobserved attitudes or behaviors that may have affected the outcome of interest (consumption of vitamin A-rich foods). Not taking endogeneity into account leads to biased estimates.

[5] Bangladesh Rural Advancement Committee (BRAC) and Bangladesh Rural Development Board (BRDB).

(BMI), and height-for-age; the statistical model controlled for endogeneity of program participation (85).

The same programs were evaluated by Khandker, who used a household-level, fixed-effect method with panel data. The data from the 1991/1992 survey were used as baseline data and a follow-up survey was conducted in 1998/1999. Only households surveyed in both baseline and follow-up were included in the analyses. Of the households classified as nonparticipant target and nontarget, about 45% and 13% became program participants, respectively, between baseline and follow-up (86).

It is important to note that the reviewed studies had important limitations in the evaluation design and analysis, which makes interpretation of the results difficult. First, some studies are based on intervention/control comparisons after a period of intervention, even though before and after data were available in some studies. Using baseline data would help determine whether or not the intervention and control groups were comparable at baseline. As people who decided to adopt an intervention may be inherently different from people who choose not to do so, differences in outcomes at the end of the study may be affected by a "selection bias." Second, the potential consequences of the (often substantial) loss to follow-up of communities and households are not discussed. Third, many of the reviewed studies did not adequately control for potentially confounding factors, such as child age in analyses of the program's impact on child nutritional status.

Evidence of impact

Direct impact on micronutrient status – None of the studies directly evaluated the impact on micronutrient status (Table 7).

Impact on other nutrition outcomes – Three studies evaluated the impact on child anthropometry. In Bolivia, no overall impact of the intervention was found on the height-for-age (HAZ), weight-for-height (WHZ), and weight-for-age Z-scores (WAZ) of children 11 to 26 months of age. Similarly, no impact was found on maternal BMI. To assess the effect of the relative quality of the education received, participants were categorized into three groups – those who received "worst," "average," and "best" education – by using a quality score based on an assessment of the performance of the field(s) agents over the period of study. Members of some credit associations received little or no health education due to implementation problems such as a lack of supervision or training and due to a high

turnover rate among the field agents. Subgroup analyses revealed a significant decline in child WAZ in the group receiving the lowest quality education. No change in WAZ was seen in the group receiving average or good education (82).

In southern Ghana, the HAZ of children 12 to 24 months at baseline in intervention communities was significantly worse than in the control communities (-1.27 vs. -0.97, $P = 0.03$). Comparing child HAZ in future participants at baseline with child HAZ in actual participants at follow-up, improvements of 0.33 SD in HAZ were observed. By contrast, the HAZ of children in control communities declined by 0.20 SD during the same period (*P* for difference = 0.01). A similar pattern was found for child weight-for-age: mean WAZ improved by 0.2 SD in children from participating families, while mean HAZ decreased by 0.20 SD in children from control communities (*P* for difference = 0.04). It must be noted the effects could be biased by selection bias since households self-selected into being participants or nonparticipants. No effect of participation was found on maternal BMI (83).

Table 7: Impact of MCE programs on child anthropometry

Country	Exposure (months)	Age[a]	Height or height-for-age[b,d]		Weight or weight-for-length/height or weight-for-age[c,d]		Arm circumference
			Baseline	Impact	Baseline	Impact	
Bolivia (82)	24-36	11-26 mo	P & NP: -1.7SD C: -1.8	NS	WH: P & NP: -0.26SD C: -0.13SD WA: P & NP: -1.2SD C: -1.2SD	WH: NS WA: NS By quality of education (P only): Worst: WA: -0.5SD Average & best: WA: NS	-
Ghana (coast) (83)	36	11-24 mo	P: -1.23SD NP: -1.29SD C: -0.97SD	DD P-C: +0.53SD DD P-NP: NS	WA P:-1.2SD NP: -1.4SD C: -1.3SD	WA DD P-C: +0.5SD DD P-NP: NS	-
Ghana (north) (84)	-	-	-	-	-	-	-
Bangladesh (85, 86)	> 36	< 15 y	-	♀borrowing +10%: Girl: +0.36cm/y Boy: +0.50cm/y ♂borrowing: NS	-	-	♀borrowing +10%: Girl: 0.45cm Boy: 0.39cm ♂borrowing: NS

[a] (Repeated) cross-sections were used in Bolivia, Ghana, and Bangladesh (age refers to the actual age in each cross-section).
[b] SD refers to Z-scores, cm to absolute height, and % to change in prevalence of stunting; NS = not significant.
[c] SD refers to Z-scores, kg to absolute weight, and % to change in prevalence of wasting; NS = not significant.
[d] Abbreviations used: NS = not significant, DD = double difference, P = participants, NP = nonparticipants living in treatment communities, C = controls.

In Bangladesh, participation in a credit program was a significant ($P < 0.05$) determinant of the arm circumference and height-for-age, but not of the BMI of children age 15 years and younger. Only credit provided to women significantly improved the nutritional status of their children: a 10% increase in female credit increased the arm circumference of girls and boys by 0.45 and 0.39 cm, respectively, and their height by 0.36 and 0.50 cm per year (85). Credit provided to men had no impact on these outcomes.

The impact on child feeding practices was estimated in Bolivia and in southern and northern Ghana. In Bolivia, breastfeeding practices of the study child were compared to how the older sibling of the study child was fed. Improvements were seen in 21%, 12%, and 9% of the participant, nonparticipant and control groups, respectively. The largest effect was found in the group receiving the best education (38% vs. 8% in the best and poor education group, respectively). It is not clear to what extent this result might be driven by reporting bias. The proportion of participants giving their newborns colostrum increased significantly more in participants (from 69% to 94%) then in nonparticipants (65% to 69%) and control groups (66% to 77%) ($P < 0.05$). Relative to nonparticipants, participants in the program reported positive changes in breastfeeding and feeding practices, such as introducing complementary foods closer to the ideal age of about 6 months and not using feeding bottles. No differences were found in terms of feeding frequency. The only significant difference in dietary quality was found for meat and fish: mothers of participating children reported having given meat or fish to the child 3.2 times in the past 3 days vs. 2.6 times in the nonparticipant group (living in the intervention communities). Again, selection bias may have affected the results (82).

In southern Ghana, a breastfeeding score based on five ideal behaviors increased more over time in participants than in nonparticipants and controls. When comparing the study child with the older sibling, improvements in the breastfeeding score were seen in 63% of the participants, compared to 23% among nonparticipants and 20% among the control group ($P = 0.01$). Compared to the baseline, the proportion of newborns receiving colostrum increased significantly more in the participant group (60% to 98%) than in the nonparticipant (65% to 78%; $P = 0.003$) and the control groups (61% to 71%; $P < 0.001$). The mean age for introducing water was 4.2 months for participants, 2.1 months for nonparticipants, and 1.7 months for controls ($P < 0.001$). The program also led to a decrease in the bottle use: from 88% to 23% for participants as compared to a decrease from 88% to

52% and from 83% to 60% for nonparticipants ($P = 0.02$) and controls ($P < 0.01$), respectively. Participants increased the number of nutritional enrichments to complementary foods significantly more than did the controls ($P = 0.03$). Program promotion to add legumes had more success than the message to add fish powder. There was no significant change in the use of *Weanimix*, a premixed complementary food promoted by the Ministry of Health. Of the mothers who had tried *Weanimix*, a significantly larger proportion in the participant group had added fish powder (68%) as compared to the nonparticipant (40%) and control groups (41%). Feeding frequency increased significantly more over time in participants than in nonparticipants and controls ($P < 0.05$). At follow-up, participant children consumed meat/fish and eggs more frequently than children of controls ($P = 0.06$). No differences were found for green leafy vegetables. As in Bolivia, reporting and selection bias might be driving some of these results (83).

In northern Ghana, the intent to treat analyses showed that only one combination of intervention packages had significant impact on child diet. Children living in communities offered microcredit and the BCC consumed red palm oil and dark green leafy vegetables more frequently than children living in the other communities. Their consumption frequency of vitamin A-rich foods, and their total vitamin A intake was also higher. Surprisingly, living in a community that additionally received the food-based intervention did not have an effect. No effect was found on egg consumption. The treatment on the treated analysis showed that participating in any of the three interventions increased egg consumption in children. Participating in more than one intervention, however, had no effect on egg consumption. The consumption of red palm oil increased only among children of households participating in the BCC. No effects were found for dark green leafy vegetable consumption. Participation in the mother-to-mother support groups had a positive effect on the consumption frequency of vitamin A-rich foods and vitamin A intake. Participation in the MCE intervention increased vitamin A intake. None of the other interventions was associated with either frequency or total intake of vitamin A-rich foods. The results of this study are difficult to interpret. Even though program assignment was random, no evidence is provided that the treatment groups were comparable before program implementation. It is also not clear whether the study had sufficient power to detect impacts of all of the interventions and their combinations (84).

Evidence on pathways

MCE programs could affect nutritional status through different pathways (Figure 3). The credit may allow households to engage in economic activities that, in turn, may result in higher income. The additional income can be used to buy more and better (i.e., more nutrient-dense) foods (*the income, household food security, and household diet quality pathway*). Participating in economic activity may also increase women's income, especially since many of the programs are targeted toward women. Women's income has been shown to improve household nutrition and health (*the women's income and control over resources pathway*). On the other hand, working women may have less time available for childcare, which could negatively affect child nutrition and health (*the women's time pathway*). Reasonable workloads and adequate time availability are factors determining the ability of mothers or caregivers to provide adequate childcare (87, 88). Engle and Pedersen stress that very young children are at risk of poor nutrition if their mothers are engaged in time-intensive activities, if they have little control over resources and do not have access to high quality alternate childcare (89). The education component provided by some programs might change households' preferences for quality foods, may change the intrahousehold allocation of foods, and may lead to better feeding practices (*the women's knowledge and awareness pathway*). The availability of additional resources and the new knowledge from health education could lead to better health, which, in turn, can improve MN status (*the health services utilization and child health pathway*).

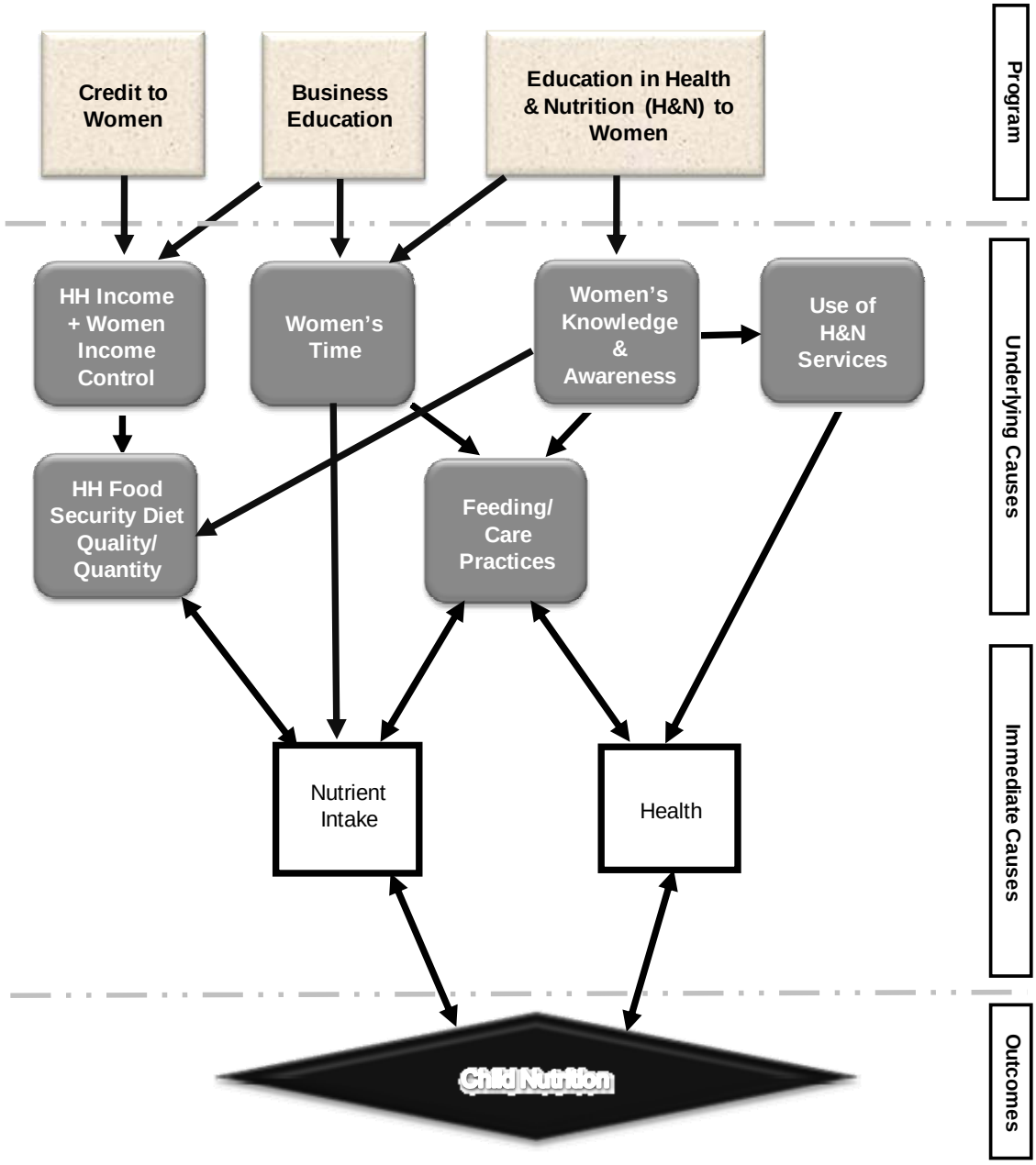


Figure 3: Mechanisms by which MCE programs might affect nutritional status

The studies reviewed provide very little information on the pathways by which MCE programs may improve MN nutrition (Tables 8a and 8b). It is important to note, however, that our review was limited to programs that included a health and nutrition education component. These studies constitute a very small subset of the literature on microcredit programs, which has focused mostly on alleviating credit constraints to help households, and

women in particular, move out of poverty. The impact on reducing poverty and on women's empowerment is not reviewed here. A number of quantitative and qualitative studies showed increases in income and assets and decreases in vulnerability of microcredit clients. It has also been documented that access to credit can improve women's empowerment. Gender-related issues are complex, however, so appropriate design is critical if programs are to empower women (90).

Table 8a: Evidence on pathways through which MCE programs may improve MN status

		Household expenditure[a]		
Country	**Poverty**	**Total**	**Food**	**Quality of household diet[b]**
Bolivia (82)	-	-	Food insecurity: NS	Meat/fish: P: +28% NP: +140% C: NS Maize/rice: NS Oil: NS Cooked food: NS Vegetables/fruit: NS Total food: NS
Ghana (coast) (83)	-	-	Food insecurity: DD P-NP: -23% DD P-C: -25%	Total food: DD P-NP: -$22 Vegetables: DD P-NP: -$0.69 Meat/fish: NS Cooked food: NS
Ghana (north) (84)	-	-	-	-
Bangladesh (85, 86)	-	Female borrowing: 100 taka of credit: +21.0 taka total annual expenditure Male borrowing: NS	Female borrowing: 100 taka of credit: +11.3 taka food expenditure Male borrowing: NS Spillover: +10% ♀borrowing: +0.094% total exp P +0.034% total exp NP ♂borrowing: NS	-

[a] Abbreviations used: NS = not significant, DD = double difference, P = participants, NP = nonparticipants living in treatment communities, C = controls, CC = continuing clients, DC = departing clients, $ = US dollar.
[b] Expenditure, unless indicated.

Table 8b: Evidence on pathways through which MCE programs may improve MN status (continued)

Program (country)	Women[a]			Children[a]		
	Health and nutrition knowledge	Income and control over resources	Time availability	Health-care utilization	Health status	Diet
Bolivia (82)	Diarrhea prevention: Cover food/avoid flies: P-NP= +18% P-C= +15% Keep food clean: P-NP= +12% P-C= +10% Wash hands: NS BF: NS	Income: 66% P report: + NF-income/m: NS Profit/m[1]: NS Control over spending: house repairs: DD P-NP: 28% DD P-C: 25% Other: NS	Help from husband: NS No (indirect) indication that quality of childcare decreased	-	Immunization: Inconsistent results Diarrhea treatment Give more liquids: DD P-NP: +32% Limiting food: NS	BF: P-C= +12%, P-NP= NS By quality of education: best: +42% Colostrum DD P-NP: +21%, DD P-C: +14% Appropriate exclusive BF DD P-NP: +23%, DD P-C: +32 % Bottle use: DD P-NP: -31%, DD P-C: NS Feeding freq: NS Meat/fish: DD P-NP: +0.4times/3d, DD P-C: NS Carrot/squash: DD P-C: +2.74 times/3d, DD P-NP: NS Eggs, green leafy veg, legumes: NS
Ghana (coast) (83)	Diarrhea prevention, Cover food/avoid flies: DD P-NP: +36% DD P-C: +43% Keep food clean: DD P-NP: +25% DD P-C: +33% Wash hands: NS BF: NS	Income: 90% P report: + NF-income/mo: DD P-C: +$17.88 DD P-NP +$17.85 Profit/mo: DD P-C: +$15.53 DD P-NP +$17.33 Control over spending: Schooling: P>NP, P-C: NS other: NS	Help from husband: Childcare: P>NP P-C: NS Income generation: P>NP P-C: NS No (indirect) indication that quality of childcare decreased	-	Immunization: NS Diarrhea treatment ORS: P-NP= 54% P-C= 65% Limiting food: NS	BF score: DD P-NP: +0.8, DD P-C: +1.4 Giving colostrum: DD P-NP: +25%, DD P-C: +28% Introduction liquids: DD P-NP: +59 d, DD P-C: +75 d Introduction foods: DD P-NP: +1.6mo, DD P-C: +1.6mo Bottle use: DD P-NP: -29%, DD P-C: -42% Feeding freq/24h: DD P-NP: +0.3, DD P-C: +0.4 # nutritional enrichments: DD P-NP: +0.3, DD P-C: +0.5 Use Weanimix: NS Meat/fish: DD P-C: +1.1times/3d, DD P-NP: NS Eggs: DD P-C: +0.6times/3d, DD P-NP: NS Green leafy vegetables: NS

Program (country)	Women[a]			Children[a]		
	Health and nutrition knowledge	Income and control over resources	Time availability	Health-care utilization	Health status	Diet
Ghana (north) (84)	Don't know vit A food: Intent to treat: BCC+MC: NS BCC +MC+FB:-20.9PP Treatment on treated: MC, MC+: NS	-	-	-	-	Intent to treat: BCC+ MC: # times red palm oil/w: 0: - 9.7PP, 1-2: +4.6PP, 3-4: +3.3PP, 5-7: +1.0PP, 8-14: +0.8PP # times green leafy veg./w: 0: - 8.8PP, 1-2: -3.9PP, 3-4: -4.8PP, 5-7: +6.7PP, 8-14: +7.2PP, 15-21: 1.0PP, 22+: +2.6PP # times eggs /w: NS ln(freq vit A rich foods):+0.59 ln(µgRAE):+0.761 BCC+MC+FB:NS Treatment on treated: MC: # times egg/w: 0: - 16.1PP, 1-2: +5.2PP, 3-4: +4.9PP, 5-7: +5.0PP, 8-14: +0.6PP # times red palm oil/w: NS # times green leafy veg./w: NS ln(freq vit A rich foods):NS ln(µgRAE): +1.415 BCC+MC: NS
Bangladesh (85, 86)	-	Female borrowing: 100 take of credit: +21 taka total annual expenditure of which 11.3 taka on food	-	-	-	-

[a] Abbreviations and symbol used: NS = not significant, DD = double difference, P = participants, NP = nonparticipants living in treatment communities, C = controls, BCC = behavior change communication, FB = food-based intervention, MC = MCE intervention, BF = breastfeeding, PP = percentage points, $ = US dollar.

Income, household food security, and household diet quality pathway – The studies in Bolivia, southern Ghana, and Bangladesh evaluated some of these outcomes. The results indicate that the MCE program may have a positive impact on household expenditures, food security, and diet quality.

In Bolivia, both participant and nonparticipant households (living in treatment communities) increased per capita expenditure on meat and fish by 28% and 140%, respectively. Total per capita food expenditure did not change significantly. Food insecurity, measured as the percentage of households that had experienced a period of eating less or less well, did not change (82). In southern Ghana, the increase in food expenditure appeared to be largest for nonparticipants as compared to participants and controls. This could indicate that they were more dependent on purchased food. Household food insecurity, as defined in Bolivia, decreased significantly more in participants as compared to nonparticipants and controls (82). A limitation of the studies in Bolivia and Ghana is that they did not take into account the value of goods consumed from own production to estimate total expenditure.

In Bangladesh, female borrowing had a significant positive effect on household total food and nonfood expenditure. Male borrowing, however, did not have an effect. An additional 100 taka of credit in 1998/99 increased the household's total annual expenditure by almost 21.0 taka, of which 11.3 taka was on food expenditure. The marginal returns for male borrowers were insignificant. The lack of an effect for male borrowers might be due to the fact that the program targeted women, resulting in fewer male members and a lower loan volume among men. Interestingly, there were significant spillover effects: credit to women had a positive effect on the food consumption of nonparticipants living in areas where credit was available. A 10% increase in women's current borrowing increased nonparticipant per capita total expenditure by 0.034% (86).

Women's income and control over resources pathway – The limited evidence indicates that the MCE programs may have the potential to increase women's income and control over resources. In Bolivia, 66% of the participants (all of which were women) felt that their income had increased since they joined the program. Women's reported monthly profit and income from nonfarm income-generating activities, however, did not increase. Participants gained decision-making power with respect to spending on house repairs, but not with respect to schooling, clothing, medicine, or agricultural inputs. No impact was found on getting help from husbands to look after children or with income-generating activities. From baseline to follow-up, participants

became more likely to discuss ways to avoid pregnancies (*P* for change over time in participants vs. controls $P < 0.1$) (82).

In southern Ghana, 90% of the participants (all women) felt that their income had increased. Women's reported monthly profit and income from nonfarm income-generating activities increased significantly more for participants than for nonparticipants and controls. Women's income shares in total household food expenditure increased in participant households (50% to 60%) but did not change in the control group (51% to 47%, $P = 0.09$). It is not clear, however, how these concepts were measured and estimated. These results indicate a possible substitution of intrahousehold responsibility for food purchases in participants. As participants began to earn more profit, it could be that husbands and other members of the households started to contribute less money for food purchases. This may actually undermine the program's impact on food expenditure. Program participation in Ghana was associated with higher levels of confidence with respect to child nutrition and illness prevention, with having a greater say in sending children to school, and with having husbands help with childcare. It is very likely, however, that these results are affected by self selection of participants. No baseline data were presented on these outcomes (83).

As the program in Bangladesh had both male and female clients, the differential impact could be evaluated. Only female borrowing had a significant positive effect on household total food and nonfood expenditure and on child anthropometry (85, 86). This finding is in line with previous studies that have shown that women tend to spend a large proportion of their income on food and health care for children and on household consumption goods (25).

Women's time pathway - None of the reviewed studies directly measured the impact of the programs on maternal time and workload. The positive impact on breast- and complementary feeding practices in Bolivia and coastal Ghana, however, suggests that the time spent on income-generating activities did not prevent women from engaging in these time-intensive caring practices (82, 83).

Women's knowledge and awareness pathway – Knowledge was studied in Bolivia and in the two studies in Ghana. The Freedom from Hunger studies also evaluated the impact on women's knowledge on a limited number of topics. In Bolivia, participants were more likely to know that keeping food clean and covered are important measures to prevent diarrhea. No impact was found,

however, in knowledge about other practices promoted by the program (e.g., hand washing and breastfeeding) (82). The same result was found in Ghana (83).

In northern Ghana, the intent to treat analyses showed that living in a community receiving BCC and microcredit did not improve maternal knowledge about vitamin A. Living in a community receiving the additional food-based intervention, however, did improve knowledge. The treatment of the treated showed no significant impact on knowledge for any of the program combinations that included microcredit (84).

Health services utilization and child health pathway – None of the reviewed studies evaluated the impact of participating in a MCE program on changes in health services used or in child health. The studies in Bolivia and southern Ghana investigated diarrhea treatment and immunization, two of the topics discussed during the education sessions. The reported immunization results for Bolivia seemed inconsistent (82). No impact on immunization was found in Ghana (83).

In Bolivia, the program had a significant ($P < 0.05$) impact on the number of women giving more liquids to a child with diarrhea (comparing participants with nonparticipants). There was no significant effect on the practice of limiting or withholding food from children having diarrhea (82). In Ghana, participants were more likely than nonparticipants and residents in control communities to give oral rehydration salts (ORS) or home liquids. As in Bolivia, there was no significant effect on the practice of limiting or withholding food from children having diarrhea (83).

Child diet pathway – As reviewed above, there is some indication that MCE programs improve child-feeding practices and the quality of the child diet. The results, however, may be affected by reporting or selection bias (Freedom from Hunger studies) or are difficult to interpret because of the lack of clarity in whether or not the groups were comparable at baseline (northern Ghana).

2.2.4 Discussion

Our review highlights the dearth of information on the impact of MCE programs on nutritional outcomes. No studies were found that had measured the impact of MCE programs on MN status. Child growth was found to improve in some, but not all programs. Overall, the review presents some scattered evidence that these programs can improve child nutritional status, child feeding, the quality of child dietary intake, and household food expenditure. As indicated before,

however, the lack of rigor in the evaluation designs and the lack of control for self-selection and/or reporting biases in the studies reviewed prevent any firm conclusion on the impact of MCE programs on nutrition outcomes.

An additional limitation of this body of literature is the lack of assessment and knowledge on the pathways through which microcredit programs may affect nutrition. The potentially negative effects of the programs on maternal workload, and consequently their ability to care for and feed their children optimally, need to be studied. Another concern related to the design of microcredit programs is whether they adequately assess whether the contextual and cultural environment in which women live allows them to engage in productive, income-generating work. Poor women often have to juggle with their dual role as caretakers and breadwinners, they may have limited skills to set up a viable business (e.g., low levels of education) and may face a lack of economic opportunities in their neighborhoods, and cultural factors may limit their mobility. An anthropological study conducted in Bolivia found that most women did not make enough money from their income-generating activities to make their payments and had to borrow money from family and friends to do so. Cutting back on the quantity or quality of the home diet was another strategy used to help repay the loans. Repayment rates in this program were reportedly high (91).

As for CCT programs, future evaluations need to adopt a program theory framework to identify, evaluate, and document the multiple impact pathways by which microcredit programs can improve MN nutrition.

2.3 Evidence from Programs Promoting Agricultural Production

2.3.1 Introduction

Programs promoting agriculture production are assumed to improve production and consumption of targeted foods and to improve nutrition outcomes through increased household food availability and consumption of micronutrient-rich foods, and possibly through income generation, improved knowledge, and women's empowerment. For this review we consider the impact of programs promoting production of fruits and vegetables (home gardening), and programs promoting animal production on children's MN intake and status, and on growth.

Home gardens are generally located close to the home and managed by household members using low-cost inputs. The primary goal of these gardens is to increase the production and year-round availability of a variety of fruits, vegetables, some secondary staple foods (e.g., sweet potatoes and legumes), and herbs for household consumption. In the early 1990s it was recognized that to

improve dietary intake, it was necessary to include nutrition education along with the promotion of home gardening; therefore the majority of the programs considered here included a nutrition education component. Additionally, many targeted women farmers. Programs to promote animal source food production have primarily focused on increasing fish, milk, or poultry production, and usually did not contain a nutrition education component. A few programs have included a combination of agriculture interventions (i.e., home gardening and animal production) along with additional program inputs (55, 92-94).

2.3.2 Methods

The impact of agriculture interventions have been comprehensively reviewed in four recent reviews, with the latest published in 2008 (55, 92-94). All of these reviews have included many of the same studies and have generally come to the same conclusions about the impact of agricultural interventions on production, consumption, income, and children's nutritional outcomes, therefore here we have summarized these recent reviews. The earliest review included here used a Sustainable Livelihoods Framework to evaluate the impact of investment in five types of capital within agriculture programs on nutrition outcomes (92). Leroy and Frongillo evaluated the impact of programs promoting animal production on production, consumption, income, and nutritional status (93). In 2007, the World Bank published a comprehensive review examining the links from agriculture interventions to nutrition outcomes, drawing mostly on studies included in previous reviews (94). In 2008, the impact of dietary diversification strategies on nutrition outcomes was reviewed in the *Lancet* Series on Maternal and Child Undernutrition and covered mostly the same studies included in the World Bank review (55). We have also included a recent analysis of Helen Keller International's (HKI) homestead food production (HFP) program in Cambodia, which has begun to examine some of the pathways of effects from program inputs to children's nutritional outcomes (95). Only programs that had a stated nutrition objective (household or individual consumption, MN status, or growth) are considered here (Tables 9-11).

Table 9: Intervention components and measured outcomes of home gardening programs[a]

	Intervention components						Measured outcomes			
	Targeted to women	Agriculture inputs	Animal inputs	Agriculture training	Nutrition and health education	Other	Child MN status	Child growth	Household diet	Child diet
Bangladesh [b,c,e] (96)	+	+		+	+		+			
Bangladesh [b,c] (97)	+	+		+	+			+	+	+
Bangladesh [c,d] (98)	+	+	+	+	+	+	+		+	
Guatemala [b,c,e] (99)		+			+	+	+		+	
India [c] (100)		+			+		+		+	
Indonesia [c] (101)	+				+	+	+		+	+
Kenya [b,c,e] (102)	+	+			+	+				+
Nepal [b,c] (103)		+				+				+
Nepal [e] (104)		+		+	+				+	
Niger [c] (105)	+				+	+			+	+
Peru [c] (106)	+				+	+	+		+	
Philippines [b,c,e] (107-109)		+		+			+	+		+
Philippines [b,c,e] (110)		+			+	+			+	
Senegal [b,c,e] (111)		+		+	+				+	
South Africa [e] (112)		+			+		+			+
Tanzania [b,c,e] (113)	+				+	+	+		+	
Tanzania [c] (114)	+				+	+			+	
Vietnam [b,c,e] (115)	+				+		+		+	

[a] Program inputs and selected measured outcomes. + denotes that the study included an input or outcome. Agriculture and animal inputs were considered to be seeds, saplings, or animals. Promotion of these activities was not considered an input under these headings.
[b] Included in (93).
[c] Included in (95).
[d] Included in (94).
[e] Included in (54).

Table 10: Intervention components and measured outcomes for programs promoting animal production[a]

	Intervention components						Measured outcomes			
	Targeted to women	Agriculture inputs	Animal inputs	Agriculture training	Nutrition education	Other	Child MN status	Child growth	Household diet	Child diet
Bangladesh [c,d] (98)	+		+		+				+	+
Bangladesh [c,d] (116)			+	+					+	
Bangladesh [c,d] (117)						+			+	
India [b,c,d,e] (118)			+						+	
India [b,c,d,e] (119)			+						+	
Ethiopia [b,c,d,e] (120, 121)			+			+			+	
Kenya [c,d] (122)	+	+				+			+	
Egypt [b,c,d,e] (123)		+	+				+		+	+
Bangladesh [c,d,e] (124)	+		+	+		+			+	
Bangladesh [c,d] (125)	+			+		+			+	

[a] Program inputs and selected measured outcomes. + denotes that the study included an input or outcome. Agriculture and animal inputs were considered to be seeds, saplings, or animals. Promotion of these activities was not considered an input under these headings.
[b] Included in (93).
[c] Included in (95).
[d] Included in (94).
[e] Included in (54).

Table 11: Program components and measured outcomes for programs including both promotion of home gardening and animal production[a]

	Intervention components						Measured outcomes			
	Targeted to women	Agriculture inputs	Animal inputs	Agriculture training	Nutrition education	Other	Child MN status	Child growth	Household diet	Child diet
Ethiopia [b,c,d,e] (126, 127)	+	+	+	+	+	+	+	+	+	+
Iran [e] (128)	+	+		+	+	+		+		
Lao PDR [e] (129)	+	+	+		+			+		
Vietnam [b,c,d,e] (130)	+	+		+	+			+	+	+
Thailand [b,c,d,e] (131)	+				+	+	+		+	
Bangladesh [c,e] (132, 133)	+	+	+		+				+	+
Cambodia [c,e] (134, 135)	+	+	+	+	+				+	+
Cambodia (95)	+	+	+	+	+		+	+	+	+
Nepal [c,e] (134, 136)	+	+	+	+	+				+	+

[a] Program inputs and selected measured outcomes. + denotes that the study included an input or outcome. Agriculture and animal inputs were considered to be seeds, saplings, or animals. Promotion of these activities was not considered an input under these headings.
[b] Included in (93).
[c] Included in (95).
[d] Included in (94).
[e] Included in (54).

2.3.3 Results

Brief description of the evaluated programs

Programs promoting home gardening . Programs focused on improving fruit and vegetable production are widely implemented by governmental and nongovernmental organizations throughout the world. Most programs promoting home gardening provide seeds, seedlings and/or saplings; some also include additional program components such as agriculture-related training and social marketing. With the exception of two programs, one implemented in the late 1970s in the Philippines (107-109) and one in the early 1990s in Nepal (103), all of the home gardening programs included here have also included a nutrition education component. A total of 18 programs focused primarily on promoting fruit and vegetable production are included in this review (96-106, 108 1980, 110, 111, 113-115, 137, 138).

Programs promoting animal production. Animal production programs have primarily focused on increasing production of fish, milk, or poultry products. The aquaculture programs, all implemented in Bangladesh (n = 3), aimed to increase fish production through polyculture fish production or by promoting production of certain species. Milk production has been promoted through the formation of dairy cooperatives in India and through improved dairy inputs, including crossbred cows and household fodder production in Ethiopia and Kenya (n = 4). Poultry production programs (n = 3) have been promoted in Egypt and Bangladesh. The program in Egypt was combined with the promotion of increased crop production and the two in Bangladesh were combined with financial assistance and technical training, and focused on women. Ten animal production programs were included in this review (98, 117-125).

Combined programs. Some programs have included a combination of agriculture interventions, nutrition education, and additional program inputs, such as growth monitoring, iron supplements, and loans (n = 9). Helen Keller International has supported programs combining home gardens, animal source food production, nutrition education, and agricultural training for the past 10 years in Bangladesh, Cambodia, and Nepal (n = 4). Like many home gardening programs, their programs began with the intention of increasing production and consumption of vitamin A-rich fruits and vegetables. In the late 1990s the importance of adding animal source foods that provide more bioavailable MNs than plant foods was recognized and HKI began to integrate small animal production activities into its

homestead food programs. All of the country programs promote poultry production through improved breeds and technologies and the program in Bangladesh also promotes improved milk and fish production (132-135). Aside from the four programs supported by HKI (two of which were different rounds of the same program in Cambodia), five other mixed programs are included in this review. Programs designed to reduce child malnutrition in Iran and Lao People's Democratic Republic (PDR) included nutrition and health education and promotion of home gardening and small-animal production, in addition to growth monitoring (128, 129). A program in Vietnam included nutrition education and the promotion of home gardens, as well as fish and livestock production (126, 130, 139). In Ethiopia, a program to promote goat production failed to achieve its intended impact on nutrition and therefore expanded to include nutrition education, training in gardening and food preparation, and school garden clubs (127). Lastly, in Thailand, a broad-based community-based project included promotion of small animal production, home gardens, nutrition education, and targeted interventions to schoolchildren, including improved school lunches and iron supplements (131).

Evaluation designs. Of the 37 studies included in this review, 1 used a before (recall)/after design, 8 used a pre-post design without a control group, 8 used a treatment/control design with a post comparison only, and 20 used a treatment/control pre-post design.

Evidence of impact

Tables 9-11 present an overview of the characteristics of the different programs reviewed, including the country where the study was conducted, the different intervention components included in the programs, and the main outcomes measured in the evaluation. More detail on the individual studies is provided in the previous reviews as well as in the original papers. Table 12 presents a summary of the impact of the reviewed interventions on child MN status and growth.

Impact on micronutrient status

Programs promoting home gardening. More than half of the studies included in this review included a measure of MN status (11/18). The majority (8/11) of these examined the impact of the program on vitamin A status either by serum retinol concentrations or clinical

signs of deficiency, such as night blindness or Bitot's Spots. Of the four programs that measured serum retinol, two reported positive relationships between the intervention and higher serum retinol concentrations (101, 138). A study in the Philippines reported no change (108). One in Tanzania actually reported a decrease in serum retinol concentrations among children in the treatment area; however, there was also a higher prevalence of helminth infections in the treatment area, which may have been due to environmental differences or increased exposure to helminthes among children in the intervention area (113). With the exception of the intervention in the Philippines (108), all of the programs that included a measure of clinical signs of vitamin A deficiency found positive relationships between the programs and reduction of clinical vitamin A deficiency signs (96, 99, 100, 115).

Table 12: Summary of the impacts of agricultural interventions on child nutrition outcomes[a]

	MN Status	Iodine	Vitamin A	Iron	Growth
Home gardening					
Measured	11/18	0	8/18	3/18	3/18
+	7/11	0	6/8	1/3	2/3
NS	3/11	0	1/8	2/3	1/3
-	1/11	0	1/8	0	0
Animal production					
Measured	1/10	0	0	1/10	0/10
+	1/1	0	0	1/1	0
NS	0	0	0	0	0
-	0	0	0	0	0
Combined programs					
Measured	3/9	1	2/9	2/9	5/9
+	2/3	1/1	2/2	1/2	2/5
NS	1/3	0	0	1/2	3/5
-	0	0	0	0	0/0

[a] The number of studies that included each outcome measure out of total studies in each category (measured) and of those that included the measure, the number of studies that reported a positive result (+), nonsignificant result (NS), or a negative result (-).

Three studies examined the impact of home gardening promotion on iron status (97, 98, 106). Two of these studies were conducted in Bangladesh: one study reported a 50% reduction in the prevalence of anemia among children in the intervention group compared to no change in the control group (97), while the other study reported no impact on changes in hemoglobin (98). The study in Peru did not find a significant effect of the program on changes in the prevalence of anemia among preschool children (106).

Programs promoting animal production. Only one program promoting animal production (in Egypt) included a measure of micronutrient status and found a decrease in

the prevalence of anemia among school-aged children during the intervention period and an increase in iron, protein, and animal source food intake in adopting households (123).

Combined programs. Three of the nine combined studies included measures of MN status. Two of the three studies found a positive effect of the intervention on improvements in at least one marker of MN status. Children in households that participated in a goat development project in Ethiopia had a lower prevalence of clinical vitamin A deficiency (night blindness and Bitot's spots) compared to children in control households (126). In Thailand, participation in a comprehensive program that included promotion of poultry and rabbit production, home gardening, improved school lunches, and iron supplements for 10-to-13-year-old schoolgirls was associated with significant improvements in serum retinol and serum ferritin, but not hemoglobin among the schoolgirls (131). Participation in this program was also associated with improved iodine status over the course of the intervention (131). The recent analysis of HKI's program in Cambodia found no differences between the intervention and control groups in mean hemoglobin concentration or prevalence of anemia in children < 5 years of age (95). All of the studies that measured MN-status outcomes included multiple interventions, so it is not possible to disentangle the contribution of specific program components in improving these outcomes.

Impact on other child nutrition outcomes

Programs promoting home gardening. Very few programs evaluated impact on growth (3/18). One of the programs found no significant differences in anthropometric measures between the intervention and control groups (138). The other two reported a positive relationship between the program and at least one anthropometric indicator. Improvements in stunting and wasting were reported in a program in Bangladesh (97). And in the Philippines, a program that did not include a nutrition education component reported improvements in WHZ and a decrease in the prevalence of severe wasting, although this same study reported no impact of the program on vitamin A status indicators (108).

Studies promoting animal production. None of the studies that focused on promotion of animal production alone included child anthropometric measures.

Combined programs. Five of the nine combined studies measured impact on child anthropometry and two of these reported a positive effect. An intervention in Vietnam reported that children in the intervention group had better anthropometric measures

compared to children in the control group; however, there was only one treatment village and one control village, so the differences in anthropometric measures could be due to factors other than the program, although children in the intervention village also had increased intakes of a variety of foods and macro and micronutrients that could contribute to improved anthropometric measures (130). A program in Iran found a reduction in the prevalence of underweight in two of three provinces and in stunting in all three provinces, although reductions in the prevalence of underweight and stunting also decreased in some of the control areas (128). The programs in Ethiopia and Lao PDR did not find a significant effect of the programs on anthropometric measures (126, 127, 129). The recent analysis of HKI's program in Cambodia also did not reveal any significant differences in anthropometric measures between children in the intervention households compared to control households at end line (95). Overall evidence of the impact of these programs on child anthropometric measures is not convincing.

Evidence on pathways of impact

Interventions promoting home gardening and animal production have the potential to improve child nutrition outcomes through a number of pathways (Figure 4). The primary aim of these programs is to increase production of targeted foods (usually micronutrient-rich foods) by providing agricultural or animal inputs and production-related training, with the goal of increasing household food security. Increased household production of micronutrient-rich foods can contribute to increased household food availability and consumption, as well as to increased income through the sale of surplus foods (*the production, household food security and household diet quality pathway*). Many programs also specifically target women and/or address gender equity issues that may, in turn, contribute to women's empowerment by increasing women's access to – and control over – income, and enhancing their role in decision-making related to household expenditures (*the women's income and control over resources pathway*).

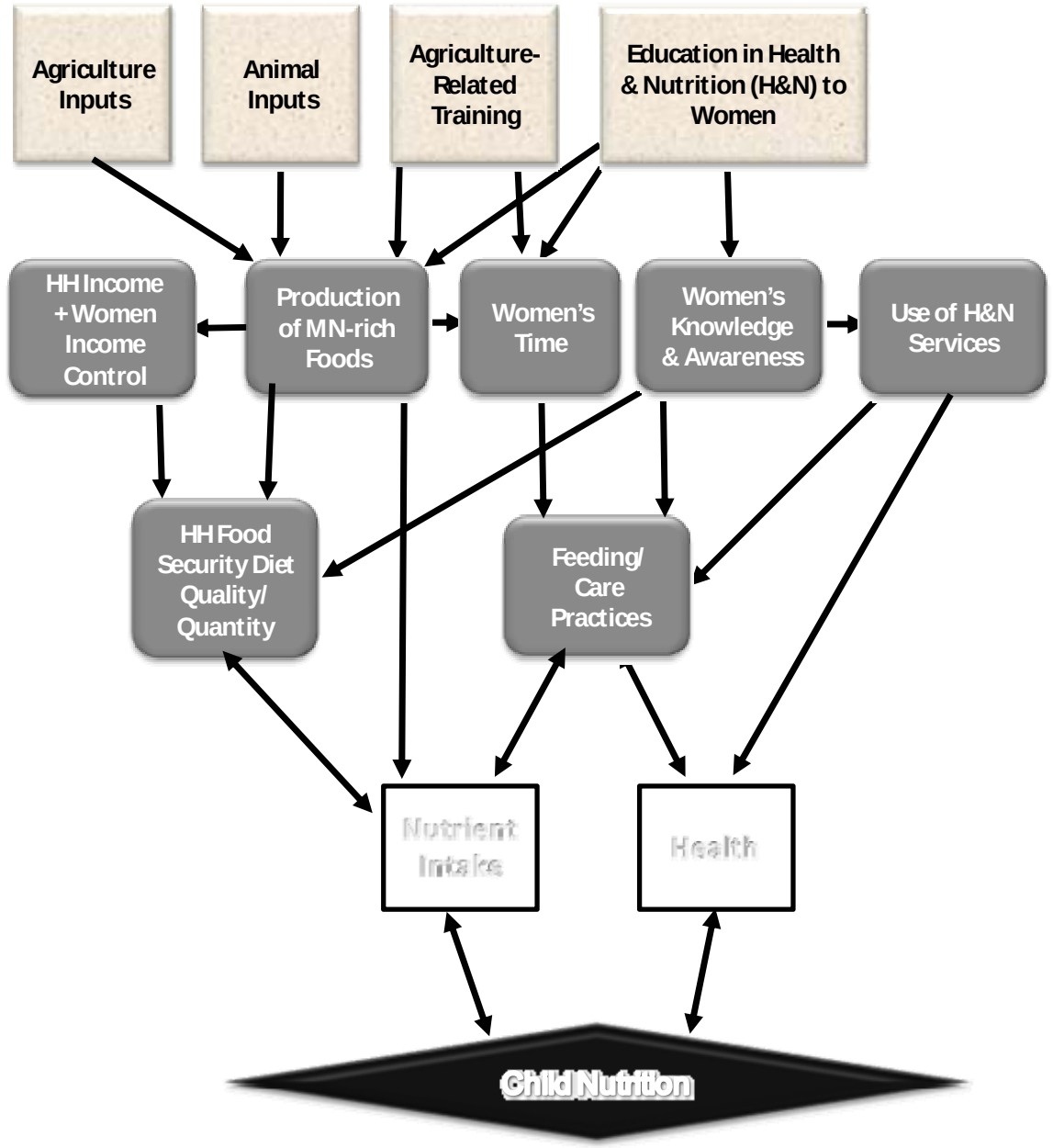


Figure 4: Potential pathways of impact of agriculture programs on child nutrition

In addition, many programs include a health and nutrition education component that varies greatly between programs but generally aims to improve childcare and feeding practices, general hygiene practices, and best methods for food preparation and preservation. This component has the potential to improve child health and nutrition outcomes by improving knowledge, attitudes, and practices in regards to diet quality, childcare and feeding practices, and utilization of health services (*the women's knowledge and awareness pathway*). If women are primarily responsible for the agriculture and animal production activities, they

may have less time to spend with their children, which may result in less than optimal care and feeding practices. However, the converse may also be true if women who participate in income-generating activities that take them away from their homes are able to stay closer to home without decreasing household income or food availability (*the women's time pathway*). Participation in programs promoting agricultural or animal production activities may positively impact child health through the women's knowledge and awareness pathway and related increased use of health and nutrition services, or negatively through increased exposure to infections such as helminthes or malaria (*health status pathway*). Lastly, these types of programs have the potential to impact child nutrition outcomes by increasing dietary intake of micronutrient-rich foods (*child diet pathway*). The pathways through which programs promoting home gardening and/or animal production have the potential to impact child nutrition outcomes are dependent on the program inputs as well as implementation and utilization of the various program components.

Production of micronutrient-rich foods pathway

Programs promoting home gardening. All of the studies promoting home gardening that included a measure of production reported improvements in at least one of these outcomes (10/18 programs). Four of these programs reported an increased percentage of households with gardens, although one found an increase in the percentage of households with gardens in the control area as well (96). The other six programs reported increases in the varieties and/or quantity of fruits and/or vegetables produced (55, 94).

Programs promoting animal production. With the exception of a fish production project in Bangladesh (116), all of the studies that included a measure of production were successful in increasing at least one of the targeted production outcomes (6/10).

Combined programs. Six of the nine combined programs included a measure of production, four of which were HKI's HFP programs. All six of the programs found improvements in at least one production-related outcome. However, some programs were successful in increasing production of some foods, but not others (126, 135). For example HKI's program in Nepal was successful in increasing vegetable and egg production but not chicken production (136).

Income from sale of products pathway

Programs promoting home gardening. Very few programs evaluated the impact of the program on income (3/18). Of the three studies that included an income–related measure, two reported positive effects. However, it is unclear how these reported improvements contributed to overall household income. A program in India reported that 40% of the households participating in the program sold 10 to 25% of the produce from their gardens (100) and HKI's program in Bangladesh reported increased income in participating households (132). A program in Tanzania to promote the adoption of solar driers did not find a significant increase in the percent of households selling dried vegetables or in income from the sale of dried vegetables (113).

Programs promoting animal production. Positive impacts of animal production programs on income generation were demonstrated in all programs that included this measure (7/10). Some of the increases in income were considered modest and others did not measure income in the context of overall household income, so it is not possible to assess the potential impact of any increase in income due to the program. In the four studies that looked at expenditure, the additional income was primarily used to purchase additional MN-rich foods as well as some nonfood items, such as school fees and books (93, 94).

Combined programs. Of the combined programs, only HKI's HFP programs included measures of income and expenditure in their evaluations (n = 4); however, these programs again only consider the income from HFP activities and do not evaluate the contribution of this income to overall household income. However, HKI's HFP programs have generally reported positive effects of participation in the program on increases in income from HFP activities and have reported that this income is primarily used to buy additional MN-rich foods (132-136). The recent analysis of HKI's HFP program in Cambodia found that at end line, households in the intervention group were more likely to earn some income from HFP activities; however, this was also true at baseline (95).

Household food consumption pathway

Programs promoting home gardening. Most of the studies (11/18) included one or more measures of household consumption of targeted foods, micro- or macro-nutrients or dietary diversity. Three of these studies reported increased consumption of vegetables, ten reported increased consumption of vitamin-A rich foods, most of which was from plant sources, and two reported increased consumption of iron-rich foods (55, 94). The study in

Vietnam reported increased consumption of energy, fat, and protein at the end of the intervention, compared to the baseline (115).

Programs promoting animal production. Household consumption improved in terms of quantity of specific foods consumed or in diet quality in the majority (7/9) of programs that included a measure of household consumption (9/10). The only programs that did not demonstrate a positive impact on consumption were two of the three aquaculture projects (98, 116): one had no effect (116) and, in the other, there was a shift in consumption patterns with households consuming less small fish and more larger fish, which may have negative implications for MN availability (98). The two dairy projects that measured consumption both reported improvements overall (118, 120, 121), although in one study the consumption of milk in the intervention group actually decreased (118). In addition, a program promoting semi-scavenging poultry production did not change consumption of chicken or eggs, but participation in the program was associated with increased fish consumption in women and girls (124).

Combined programs. The combined programs also reported at least some improvement in household consumption related to program participation in those that measured this outcome (7/9). The program in Ethiopia found that households that owned goats consumed all of the milk produced by the goats (126) and the study in Thailand found increases in vitamin A intake, although the findings for fat and iron intakes were inconsistent (131). The study in Vietnam reported increased household consumption of fruit, fat, and iron among households in the intervention group compared to the control group (130). HKI's programs in Bangladesh, Nepal, and Cambodia have all also documented improvements in household consumption of some targeted foods such as eggs and vitamin A-rich vegetables (134-136). The recent analysis of the data from HKI's HFP program in Cambodia also documented higher production among participating households and found that greater production was associated with greater household consumption and dietary diversity scores (95).

Women's income and control over resources pathway

Programs promoting home gardening. Although some home gardening programs targeted women farmers, only four examined impacts on women's income or control over resources. The program in Tanzania, which promoted the adoption of solar driers, found

that 8% of the women in the program area adopted solar driers, which could have increased women's income; however, there was no evidence of increased income from selling dried vegetables in this program (114). HKI's program in Bangladesh reported that participating women gained more control over income over the course of the program (97). The program in Kenya found that women had control over whether to cook or sell the sweet potatoes produced as a result of the program, but generally the men had control over household income and resources (102). The study in Senegal reported a positive impact of the intervention on women's income but also found that the income was generally not used to purchase food and found no significant differences in per capita intakes of energy, protein, vitamins, or minerals (111).

Programs promoting animal production. There is some evidence that participation in programs targeted to women that specifically address gender equity issues has resulted in increased women's income and control over resources. Of the three studies that measured women's income or influence in decision-making on the use of household income, two reported increases in income or women's influence in decision-making (122, 125). Only the dairy project in India did not find a significant impact on women's income; however, men's income did improve with participation in this project (119).

Combined programs. Of the combined programs, only HKI's HFP programs have included measures of women's control over resources. Their program in Bangladesh found that women's engagement in decision-making on household expenditures was greater among participating households than nonparticipating households at end line (133). And in Nepal, HKI found an increase in the percent of women responsible for keeping and spending the money earned from HFP activities (136).

Women's knowledge and awareness pathway

Programs promoting home gardening. A few studies have provided evidence that nutrition education is a necessary and possibly sufficient component to improve nutrition outcomes (3); however, in areas where food availability and access are restricted, this is unlikely to be true. In Kenya, children of participants in a sweet potato intervention had higher vitamin A food frequency scores if they participated in the nutrition education component in addition to the agricultural component (102). And a program implemented in Tanzania that promoted the adoption of solar driers reported higher vitamin A food

frequency scores in the treatment group and among adopters; this change was associated with an increase in animal source food intake and attributed to the nutrition education component of the program, since there was no significant increase in the percentage of women selling dried vegetables or income from dried vegetables (114).

Programs promoting animal production and combined programs. Only one program that promoted animal production included a nutrition education component, but it did not examine the impact of the program on changes in nutrition-related knowledge (98).

Combined programs. All of the combined programs included a nutrition education component; however, only two studies (in Ethiopia and Thailand) explicitly measured changes in nutrition-related knowledge, attitudes, and practices (KAP). Both studies found better KAP among participants compared to nonparticipants (126, 131).

Women's time availability

Programs promoting home gardening. Only two of the 18 studies examined the impact of the interventions on women's time. A study in Bangladesh that included either the promotion of vegetable production or fish production found that the demand on women's time to participate in the program was relatively small (98). The intervention in Tanzania promoting solar driers provided some qualitative information indicating that use of the solar driers seemed to save women time and in some cases also the time of children (114).

Programs promoting animal production. Although many of the interventions targeted women, the effects of these interventions on women's time demands were only reported in a few of the studies. Most notable was the difference in the effect of two of the dairy projects on women's time (119, 122). One found little impact on women's time but also no difference in women's income (119), whereas the other reported a significant impact on women's time but also a significant increase in women's income (122). The contribution of income or women's time to child nutrition outcomes was not directly measured in either of these studies. It could be that if there were any negative effects of increasing women's time demands for income-generating activities, they were offset by the increased income, and the income may even have been more beneficial than the time if adequate alternative childcare was available.

Combined programs. None of the combined programs examined the impact of the interventions on women's time demands.

Child health status pathway

Programs promoting home gardening. Only 3 of the 20 studies included measures of morbidity. Two examined the effects of the intervention on respiratory infections and diarrhea. Respiratory infections were less common in children participating in the intervention in both Bangladesh (140) and Vietnam (130). The incidence of diarrhea was also lower in the intervention group in Vietnam (130); however, the prevalence of diarrhea was not different between the treatment and control groups in Bangladesh (140). In Tanzania, an intervention promoting home production of vitamin A-rich foods found lower serum retinol concentrations among children in the intervention group compared to the control area. However, the prevalence of helminth infections was also higher in the intervention area. Since no baseline data were collected, it is not clear whether this was a consequence of the program (113).

Studies promoting animal production. None of the studies that focused on promoting animal production included morbidity-related measures.

A potential, yet poorly documented and understood, threat to health, however, is the risk of zoonotic infections in programs promoting animal husbandry. In malaria-endemic areas, for example, the introduction of livestock could range from a zooprophylactic to a potentiating effect on malaria transmission. The introduction of livestock may increase the mosquito population through higher success of blood-feeding (or the creation of habitats for mosquito larvae). Consequently, this may raise the transmission of vector-borne diseases to humans. On the other hand, cattle may lead to zooprophylaxis against a disease. Zooprohylaxis is defined as the use of animals that are not the reservoir hosts of a specific disease to divert blood-seeking mosquito vectors from the human host of the disease (141). The results of studies in this area are ambiguous. The potential negative impact likely varies, depending on disease virulence, number of animals at risk, dependency on animal production for livelihood, and method of control (142). Current research efforts are insufficient, with fewer than 300 U.S. researchers focusing on emerging diseases from animals (143). More research is needed to ensure that promotion of small-scale agriculture production to improve livelihoods and child nutrition does not end up doing more harm than good if zoonotic infections increase, leading to illness of children and adults, and consequent lost production and livelihood (93).

Combined programs. To our knowledge, of the combined programs, only the recent analysis of HKI's HFP program in Cambodia has examined the impact of the intervention on child morbidity outcomes. From this analysis there was some indication that the HFP program was positively associated with a lower prevalence of fever and diarrhea among children in participating households compared to control households, although only the difference in the prevalence of fever between the groups at end line was significant. It is possible that participation in the health and nutrition education component of this program raised women's awareness and incentives to use preventive health-care services motivating them to increase their use of health services for their children (95).

Child diet pathway

Programs promoting home gardening. The home gardening programs that measured children's dietary intake (10/18) primarily focused on the intake of vitamin A or vitamin A-rich foods. Nine out of the ten studies that measured child intake reported positive associations between the programs and children's diets. Studies in the Philippines (108) and South Africa (138) reported increased vitamin A intake and both studies in Tanzania (113, 114) as well as the studies in Niger (105), Indonesia (101), Kenya (102), and Bangladesh (96, 97) reported increased consumption of vitamin A-rich foods as measured by different indicators: intake of vitamin A-rich foods (in Niger and Indonesia), vitamin A food frequency scores (in Kenya and Tanzania), and vegetable intake (in Bangladesh). Only one study, which did not include a nutrition education component, reported inadequate intake of vitamin A both before and after the program (103). This study also reported a general deterioration of children's nutritional status after the program compared to before, which is probably due to factors unrelated to the program.

Studies promoting animal production. Only two studies promoting animal production examined children's dietary intake. In India, participants in a dairy intervention were divided into three groups based on production of milk with large producers producing > 5 L/d; children of these producers met the RDA for protein and had higher energy intakes than children in the other two groups (119). In Bangladesh, preschoolers tended to be favored in terms of intrahousehold distribution of food (98).

Combined programs. Six of the nine combined studies included an indicator of children's dietary intake and four of these were HKI's programs in Bangladesh, Nepal, and

Cambodia. All of the programs were associated with improvement in at least one dietary intake outcome, such as higher intakes of micro- or macro-nutrients, increased intakes of targeted food items, or increased dietary diversity. In general, the improvements seemed to be limited to specific micro- or macro-nutrients or foods targeted by the program (93, 94), although one program reported improvements in a wide range of food groups and nutrients (130).

2.3.4 Discussion

Less than half of the studies included in this review assessed impact on nutrition outcomes (MN status or anthropometry) and those that did show limited evidence to support significant positive impacts on nutrition outcomes with the possible exception of vitamin A status. The majority of the home gardening programs were designed with the specific goal of increasing production and consumption of vitamin-A rich foods, therefore it is not surprising that, overall, the interventions may have been most successful in improving this particular nutrition outcome.

Although there are a number of pathways through which programs promoting home gardening or animal production could improve child nutrition outcomes, the primary pathway is increased production for own consumption. In general, programs promoting agriculture production have been successful in achieving their major goal of increasing production of targeted foods. In addition, the majority of programs that have included measures of household consumption and/or child intake have documented improvements in these measures. However, these benefits on household food security and consumption have often failed to translate into improved child health and nutrition outcomes. To our knowledge, none of the previously published studies have attempted to carefully examine the relationships along the hypothesized pathways of effects, although some have suggested pathways by which the intervention may have improved dietary intake or nutritional status. The lack of consistent effects on nutrition outcomes may be due to program design constraints such as low quality of nutrition/health education, low program impact on some of the key pathways of impact (lack of empowerment of women), or to weaknesses in the evaluation designs. The quality of the evaluations of these types of programs has been highly variable. Many evaluations had important design limitations, including unclear methodology for group selection, lack of randomization, lack of control for confounders, and lack of

control for self-selection bias. In addition, some of the evaluations did not use clear statistical methods for the comparisons. Lastly, the differences in the types and quality of the inputs of these studies make it difficult to compare the impact of these interventions and to determine what, if any, program components or combination of components are most likely to improve nutrition outcomes (3, 95).

Examining outcomes along the hypothesized pathways of effects may improve our understanding of the potential of these types of programs to improve children's nutritional status, although it is likely that additional – or more focused - health and nutrition inputs will be necessary for these programs to reach their full potential. To our knowledge, the recent analysis of HKI's homestead food production program in Cambodia is the first agricultural intervention to begin to attempt to explicitly examine the relationships between the outcomes along the proposed primary pathway of impact (production for own consumption) by which this program is expected to improve health and nutrition outcomes. These analyses confirmed some, but not all, of the links along this pathway from production to household consumption to child diet intake to nutrition outcomes (Figure 4). It revealed significant positive relationships between better production outputs and greater household consumption of micronutrient-rich foods and household dietary diversity; and between greater household dietary diversity and individual dietary diversity among mothers and children. However, child and maternal dietary diversity scores were not significantly related to health or nutrition outcomes, implying that it is unlikely that this program has the potential to improve nutrition outcomes through this pathway, given the current program inputs, implementation, and utilization. This analysis supports the general conclusion that programs promoting home gardening and animal production are likely to increase production, may increase household consumption and individual intake, but may have little to no effect on children's nutritional outcomes unless their nutritional inputs are revisited and strengthened.

The recent reviews that have documented the nutritional benefits of home gardening and small animal husbandry have concluded that agricultural programs were more successful at improving nutrition when they included explicit nutrition objectives and when they were targeted to women, and incorporated interventions to promote human capital and nutrition education with strong behavior change communication (92, 94). It is further suggested that in order to improve nutrition, programs promoting home gardening and animal production

should incorporate both nutrition and agricultural considerations throughout the planning and implementation processes, taking local health and nutrition concerns and food availability and preferences into consideration (144). Given the complexity of the determinants of maternal and child undernutrition, one can expect that focusing primarily on improving income, household availability of micronutrient-rich foods (and possibly women's empowerment), albeit necessary and useful in addressing the underlying determinants of undernutrition, may not be sufficient to contribute significantly to improvement in children's micronutrient status or growth. Additional health and nutrition inputs are needed to simultaneously address the immediate and underlying causes of child undernutrition, usually referred to as food, health, and care (18).

2.4 In Summary: What Have We Learned?

2.4.1 Evidence of impacts on micronutrient and nutritional status

We reviewed the literature on CCT programs, MCE programs, and agricultural interventions to assess their impact on child micronutrient (MN) status and intake, and on anthropometric outcomes. Overall, we find limited evidence of an impact of CCT programs on children's MN status. The Mexico program – the only one that provided a fortified food product to participating children - documented modest improvements in mean hemoglobin and in the reduction of anemia. The other two programs that measured hemoglobin and anemia showed no impact on these outcomes. Poor compliance with iron supplement use seemed to be the limited factor in Nicaragua, whereas delivery problems were documented for Honduras. Positive impacts on child anthropometry, height in particular, were much more consistent across studies and were of meaningful size. Given the low prevalence of energy deficiency in the Latin American countries included in the CCT review, we hypothesize that at least some of the positive effects of these programs on linear growth could be due to (unmeasured) improvements in growth-enhancing MNs such as zinc.

Our review of MCE programs highlights the dearth of information on the impact of these programs on nutrition: none of the programs assessed impact on micronutrient status, and the few programs that measured child anthropometry showed little evidence of impact. Overall, insufficient information and the lack of rigor in the evaluation designs prevent any firm conclusion on the impact of MCE programs on child micronutrient status or anthropometry.

Agricultural interventions showed a more consistent picture of impact on MN status, vitamin A in particular, as it was the usual nutrient targeted. The addition of animal production to home gardening programs to address the problem of low bioavailability of MN in plant foods did not strengthen the evidence of an impact on either vitamin A or iron status. Few agriculture interventions assessed impact on child anthropometry, and of those, approximately half documented an impact on at least one indicator.

The next section summarizes what we have learned from the review regarding the impact pathways by which these programs may improve MN nutrition and child anthropometry.

2.4.2 Evidence on pathways of impact

Immediate determinants of nutrition (food and health)

The programs reviewed also included some direct nutrition interventions aimed at improving the immediate determinants of nutrition: food and nutrient intake, and child health. The CCT program in Mexico, for instance, provided a MN fortified food, and the Nicaragua CCT included an iron supplement. Most programs reviewed – in all three categories – included a nutrition education/behavior change component aimed at improving breastfeeding and complementary feeding practices, which typically addresses issues related to micronutrient intake.

Food and nutrient intake. The impact of CCTs on child food and nutrient intake was measured in only two studies: the Mexico program, which showed positive impacts of the fortified food on iron, zinc, and vitamin A intake; and the Colombia program, which showed an increase in the consumption of animal products and vegetables, probably as a result of increased income from the cash transfer. There is some indication from the review of MCE programs that they have had some impact on improving child-feeding practices through their education intervention. Several of the horticulture and animal production interventions also documented improvements in child dietary intakes, either MN intakes or consumption of the micronutrient-rich foods targeted by the program.

Child health. Improvements in child health – usually measured by recall of morbidity symptoms – was found to improve in all but one CCT program. Health was not evaluated in the MCE programs. Findings from the few agriculture studies that evaluated child health suggest a small protective effect. It must be noted, however, that only the CCT programs are

specifically designed to improve health through the health conditionality. Nonetheless, all programs have the potential to improve health if the nutrition/health education intervention is successful in eliciting greater use of health services. A potential, yet poorly documented and understood, threat to health is the risk of zoonotic infections in agricultural programs promoting animal husbandry.

Underlying determinants of nutrition

All three types of programs provide inputs that address the underlying determinants of child undernutrition (food, health, and care), as referred to in UNICEF's conceptual framework (Figure 1).

Access to food. Our review of impact pathways confirms that the large majority of programs reviewed – CCT, MCE, and agriculture interventions – did achieve their fundamental objective of improving household income, food availability, and access. Many of the programs also documented that not only did they increase household energy availability (i.e., increasing the quantity of food), but they also improved access to high-quality, micronutrient-rich foods such as animal source foods, dairy products, and fruit and vegetables.

Women's empowerment and maternal and childcare practices. In addition to increasing household resource availability, many of the programs documented having achieved another one of their key objectives, i.e., empowering women and increasing their access to – and control over – resources. Empowering women is one of the key mechanisms to ensure that gains in household resources translate into greater benefits for children. Research has shown that women spend a large proportion of their income on food and health care for children and on household consumption good, whereas men typically use a larger proportion of their income for personal expenditures (25)(93). Evidence from the studies reviewed confirm these findings: for instance, only credit to women had a significant impact on household total, food, and nonfood expenditures and on child anthropometry; comparing the impact of the horticulture and animal production studies, it appears that programs specifically directed to women had larger impacts on child outcomes.

Targeting programs to women, on the other hand, can entail certain risks, such as adding to their time burden and reducing time available for childcare and other household responsibilities. The additional income earned by women may also negatively affect the

dynamics of intrahousehold resource allocation if other household members respond by reducing their contribution to the family budget. Domestic violence resulting from changes in women's access to resources or increased mobility and autonomy are also a potentially negative consequence of programs targeted to women. More evidence on these potential threats is necessary in order to quantify their importance and tailor appropriate program responses.

Maternal and childcare practices are explicitly addressed in the programs reviewed through health and nutrition education sessions. There is a dearth of evidence on the quality of this education and on its effectiveness at increasing maternal knowledge and practices in the context of the programs included in this review. Even information on the main topics addressed in the education sessions, or the frequency and intensity of exposure of participating women, is lacking. It is likely that, similar to the education conducted in the context of other types of programs (e.g., Title II food aid programs), the quality and effectiveness of education varies widely between contexts, programs, and individual health workers. In our review, only the MCE studies provided some evidence of impact of the education on knowledge and improved feeding and health-seeking practices. The agricultural literature also shows that globally, programs that include an education/behavior change communications component are more effective at improving nutrition than those that focus narrowly on production. In general, however, more evidence is needed on the design, implementation, quality, and impact of the nutrition/health education intervention of the types of programs reviewed here on childcare and feeding practices and on the use of health services. Again, such information would help design stronger and more effective nutrition education and behavior change communication strategies and enhance their potential for impact.

Water, sanitation, and health services. Only CCT programs assessed impact on utilization of health-care services, as regular health visits are the one key conditionality for households to receive program benefits. The services provided at health clinics should include a combination of essential health and nutrition actions such as immunization, growth monitoring, vitamin A supplementation, iron supplementation, breastfeeding promotion, education on optimal complementary feeding practices, hygiene and sanitation, and prevention and control of childhood illnesses. A few of the programs also included a "supply-side component" aimed at improving the quantity and quality of these health

services. The review shows a significant impact of CCTs on the use of preventive health services (e.g., growth monitoring, well-baby clinic attendance), but evidence regarding impact on immunization rates or curative health-care utilization is mixed. Lack of supplies of vaccines in certain areas may be responsible for the mixed findings regarding immunization, but information on the availability of the health and nutrition inputs at health centers, or the quality of their delivery, is unavailable from the published evaluation reports.

Other relevant characteristics – All of the reviewed programs target poor households that also have the highest burden of MN deficiencies. Additionally, the coverage of CCT and MCE programs is often high, sometimes reaching national scale.

2.5 Where Do We Go from Here?

Our review summarizes current evidence on the MN and nutritional impact of three types of broad-based poverty alleviation strategies that simultaneously address both immediate and underlying determinants of child undernutrition. As such, these types of programs have great potential to improve nutrition because they operate through direct nutrition actions, while simultaneously lifting some of the economic-, behavioral-, and service-access-related barriers to improved nutrition. The review, however, highlights an enormous gap in knowledge about how these programs work, how their nutrition interventions are designed and implemented, and what are the mechanisms by which they can improve nutrition. We found scattered information documenting the impact of the programs on different intermediary or final nutrition outcomes, but no study has explicitly identified and tested these pathways in a systematic fashion.

Information on pathways of impact is needed for several reasons. First, we need to improve our understanding of what works and what does not work and derive best practices. We need to analyze and carefully document how the different inputs and program components interact and contribute to impact. We also need to understand the role of contextual factors and how they may reduce or enhance program effectiveness. All this information is essential if we want to design and implement more effective programs, which can be successfully scaled up and replicated in different contexts.

Some of the key gaps identified in our review, for instance, relate to why improving household resource availability leads to better household diets, but does not necessarily

translate into better child diets or MN status. As discussed in the CCT section, both the Mexico and the Colombia programs improved household diet but only the Colombia one led to better quality diet among children. Clearly, intrahousehold dynamics and resource allocation are likely to play an important role in explaining these contradictory results, but none of the evaluations collected the necessary information to carefully study these aspects.

Given the great potential of the reviewed programs and the fact that they are generally reaching poor and vulnerable households, it was rather sobering to see what little impact they have had on tackling MN malnutrition. Understanding where the bottlenecks are, in design, implementation or utilization, would lead to better programs and more cost-effective programs.

2.5.1 The need for evaluation guided by program theory

The lack of "pathway" thinking is associated with the general problem that programs have not used an explicit program theory framework to plan the intervention components. A program theory provides an explicit map of how the program inputs are meant to produce the desired outcomes. A key characteristic of a good program theory is that it identifies all of the intermediary factors through which the program may exert its impact and all of the factors that may modify or inhibit the desired effect. The steps to develop a program theory are discussed in detail in the paper by Houston and Pelletier and are not repeated here (145).

Once the program theory has been developed, it should be used to guide the impact evaluation. The theory shows which variables need to be measured and how the analyses should be conducted. A program theory for the programs reviewed here would have identified women's time and workload as critical factors, as well as zoonotic diseases in the case of animal rearing. Evidence on these factors, however, is largely absent from the evaluations of the types of programs reviewed.

3. Toward an Evaluation Framework

Two fundamental questions need to be answered by program evaluation: "Does it work" and "How does it work?" Answering the first question is important to identify whether the package as a whole results in the desired effect, whether the program should be implemented at scale, and whether it might be used in other settings. Even though the first question is a necessary step, it is not sufficient as it does not provide any information on the pathways by which the program exerts its impact. As discussed before, this information is crucial to improve program effectiveness (i.e., keep and strengthen components that work and drop components that do not or cannot work), and to identify what is needed to scale up and to adapt the program for implementation in other settings. Both questions should be part and parcel of each evaluation, but unfortunately they are not.

3.1 Does It Work?

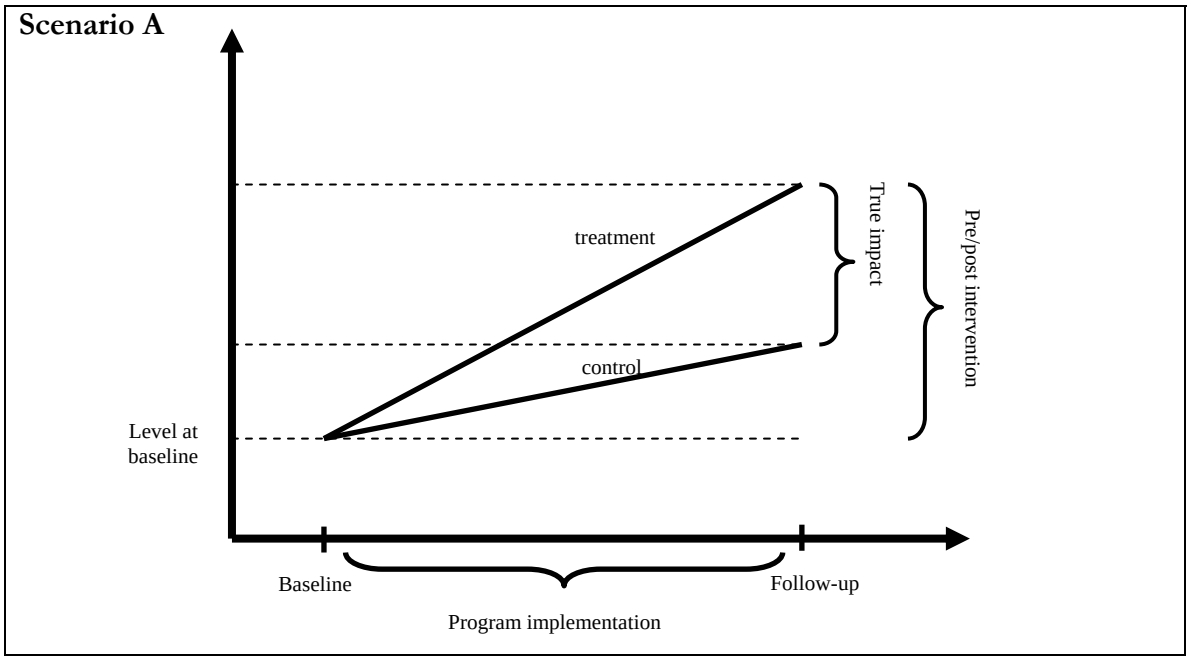
We consider a program we want to evaluate. The program is delivered to the treatment group; the control group does not receive the intervention. For an individual *i*, we can define two possible outcomes: *Yi*(*0*), the outcome of the individual when exposed to the program, and *Yi*(*1*), when not exposed. The impact of the program in individual *i* is thus *Yi*(*1*) - *Yi*(*0*). The key problem is that *Yi*(*1*) and *Yi*(*0*) are never both "observable," i.e., no individual can be in the intervention and control group at the same time. For an individual in the intervention group, *Yi*(*0*) is unknown; conversely, for an individual in the control group, we do not know what his outcome would have been had he been in the intervention group, (*Yi*(*1*)). The key challenge to impact evaluation is thus to find a valid "counterfactual," i.e., identify what would have happened in the absence of the program, ceteris paribus.

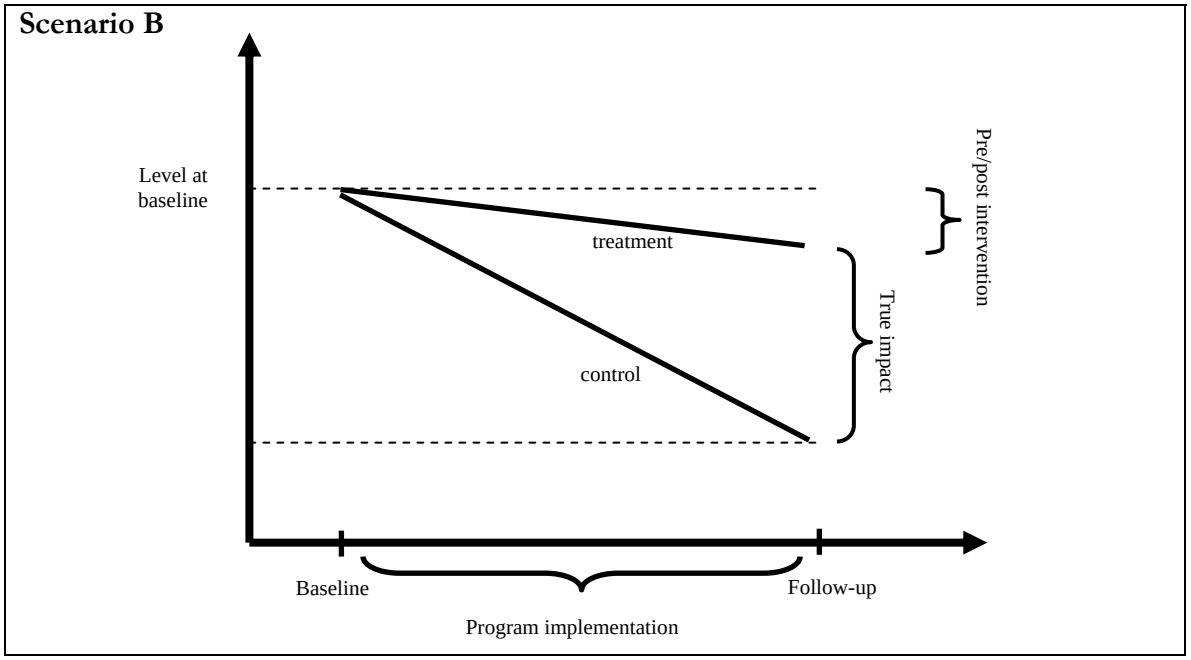
The straightforward answer to the challenge of finding a valid counterfactual is to use an experimental design. In this design, the eligible population is randomly assigned to the treatment and the control group. If the randomization is done well (and the group to be randomized is sufficiently large), one can (reasonably) assume that both groups will be comparable and that the only difference between both groups is the treatment. Any differences found in the outcomes of interest can then be assigned to the treatment.

Experimental designs, even though attractive from an analytic point of view, are often difficult to implement for practical or political reasons. As a consequence, many evaluations use quasi-experimental or nonexperimental designs. The challenge here is to

ensure that treatment and control units are comparable on all relevant characteristics. It must be noted that even within experimental studies, the extent to which people participate in the program in the treatment group may depend on factors that are not independent from the outcomes of interest. Assume, for instance, that the take-up of the program is proportionally largest in households with high levels of education. It is likely that children of these women, through the higher levels of education, have better health and nutrition status than children of other women. If not carefully considered, the program evaluation may overestimate the impact, assigning some of the effect of women's education to the program.

A strong evaluation design thus ensures comparability of the treatment and control groups before the program is started. A second important characteristic is that both groups are followed over time. Following the control over time provides information about factors unrelated to the program that nevertheless affect the outcome of interest. Scenarios A and B show the importance of having baseline and follow-up measurements for both groups. In Scenario A, the outcome in the control group improved over time. This might be because of favorable economic conditions or because a social welfare program was implemented by another agency. If it wasn't for the information collected in the control group, we would assign the entire difference between baseline and follow-up to the intervention. The graph shows that the difference attributable to the program is smaller. In Scenario B, the true impact would be underestimated if we did not have the information on the control group. In this scenario, an economic crisis hit the region. Without the program, the treatment group would have followed the downward path of the control group. The true impact is the difference between treatment and control in the follow-up and not the (much smaller) difference between baseline and follow-up in the treatment group.





3.2 How Does It Work?

The importance of understanding the pathways through which the program exerts its impact was discussed in section 2.4. Once the variables have been identified in the program theory framework, they need to be measured. The characteristics of strong evaluation discussed above – comparability at baseline and following both control and intervention through time – apply to both the intermediary and the outcome variables of interest.

One additional point we want to add here is the use of qualitative research methods. These methods can provide very useful insights in the pathways. A good example is a study in Mexico that investigated the barriers and facilitators to the appropriate use of the fortified food provided by the *Oportunidades* program (54).

4. Conclusions

Our review of CCT, MCE, and agricultural programs concludes that evidence of the impact of these programs on child micronutrient status is scant. This is at least partly due to the lack of assessment of the impact of these programs on micronutrient outcomes as very few of the programs actually measured micronutrient intake or status. This is particularly true for CCT and microcredit with education programs; although three of the five CCT programs reviewed measured micronutrient status, all three measured only one indicator, hemoglobin; and none of the MCE programs measured any micronutrient status indicator. In the case of the agricultural interventions, weaknesses in the evaluation designs often prevent drawing clear conclusions on their impact, although several of the evaluations suggest some impact of increased agricultural production on maternal and child intake of micronutrient-rich foods and in some cases on vitamin A status.

Our assessment also reveals that multisectoral programs such as those reviewed, which integrate a set of actions that address the determinants of child nutrition at several levels, have an enormous potential to contribute to reducing childhood MN deficiency and undernutrition This potential, however, is yet to be unleashed. Currently, the main constraints limiting the effectiveness of these programs include problems of design and integration of their different components (especially of their nutrition package); the lack of conceptualization, framework of analysis, and documentation of their pathways of impact; the lack of measurement and understanding of facilitating factors and constraints to implementation and success; and their often weak monitoring and evaluation designs (CCT programs being the exception with regards to evaluation designs).

Given the political popularity of multisectoral programs, especially the CCTs, the fact that for several low- and middle-income countries, they absorb the largest share of the budget allocated to poverty reduction, and the fact that they achieve large coverage of poor households where most of the undernutrition occurs, these programs have enormous potential to help accelerate progress in reducing child undernutrition. In order to reach their full potential, the programs will need to be revisited and will need to have clearer nutrition objectives, a better defined set of nutrition actions and a clear implementation and integration plan, a strong program theory framework, and an effective monitoring and evaluation system. Such leveraging of multisectoral programs could lead to faster, larger, and

more sustainable nutrition improvements, as a result of the more effective use of synergies between sectors in human development.

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