

How to Avoid the Loss of Potential in Over 200 Million Young Children in the Developing World

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Abstract

Over 200 million children under age 5 in developing countries are not achieving their full potential; therefore they are less prepared for and less able to profit from school. Societal costs include a 20% loss of adult wages per child. Major risks for poor child development include stunting, iodine and iron deficiency, and lack of cognitive stimulation. Risks needing further investigation include maternal depression, infectious diseases such as malaria, and environmental toxins. Evaluations of intervention at scale demonstrate that loss of potential can be reduced. The most effective interventions provide direct services, work with younger rather than older children, focus on the more disadvantaged, and are of longer intensity and duration. Despite these findings, actions have been slow.

Young children living in poverty in developing countries are exposed to a variety of biomedical risks, such as malnutrition and exposure to infectious diseases and environmental contaminants that threaten their survival. Not surprisingly policy makers and government and nongovernmental organizations are concerned with strategies to promote child survival. However, there is far less emphasis, either at a policy or an intervention level, with cognitive and social development of the millions of surviving children living in poverty in developing countries. Although policy makers and government ministries recognize that poverty is related to poor health and increased child mortality, there is little recognition of the negative impact that social and biological conditions related to living in poverty have on children's cognitive or social-emotional development. These risks, when suffered early, are particularly harmful to children's long-term success. They affect the architecture and function of the developing brain that is so critical to learning, health, and behavior (Bradley & Corwyn, 2002; Brooks-Gunn & Duncan, 1997; Rutter, O'Connor, & ERA Study Team, 2004).

This lack of emphasis on children's early development is particularly worrying, given that one of the major United Nations 2000 Millennium Development Goals is to ensure that all children complete primary schooling, and that another objective is to reduce extreme poverty and hunger (United Nations, 2002); both goals require children to develop their full potential.

Paper 1: Developmental Potential in the First 5 Years for Children in Developing Countries (Grantham-McGregor et al., 2007)

The first paper uses international data on poverty and chronic malnutrition to estimate the number of children around the world who do not reach their developmental potential and are at risk for educational failure.

These data are proxies of poor child development because in developing countries, poverty and associated problems of poor health and undernutrition undermine children's development early in life when brain growth is rapid (Black, Jones, Nelson, & Greenough, 1998; Committee on Integrating the Science of Child Development, 2000; Webb, Monk, & Nelson, 2001). As a result, millions of young children in poverty in developing countries are likely to be exposed to multiple biological and psychosocial risks that can detrimentally affect their cognitive, motor, and social-emotional development.

The early years affect school progress and eventual productivity. The paper presents evidence in developing countries showing that children's cognitive and social-emotional development prior to school enrollment influences their subsequent progress in school (Currie & Thomas, 1999; Feinstein, 2003; Pianta & McCoy, 1997). Fewer years of schooling and less learning per year in school have long-term economic consequences for adult income and economic productivity. The review of educational progress in developing countries indicates that over 20% of children enrolled in school fail to complete primary school (EFA Global Monitoring Report Team, 2004) and many children have lower achievement levels than children from developed countries at the same grade level (Gonzalez et al., 2004).

Ideally, a global indicator of child development would be used to derive an estimate of the numbers of young children in developing countries who are at risk for

deficits in early development through the first five years of life and for subsequent school failure. However, since there is no such indicator, the paper utilized existing country-level databases to assess the extent of early childhood chronic growth retardation (stunting, defined as length-for-age less than -2SD) and living in absolute poverty (income of less than U.S. \$1 per day). Both poverty and stunting are strongly associated with poor development, with low scores on cognitive tests prior to school entry and poor achievement while the child is in school (Bradley & Corwyn, 2002; Schady, & Paxson, 2005).

The paper therefore used the prevalence of early childhood stunting and living in absolute poverty as indicators of the numbers of children from low-income countries who are at risk for delayed development and for not achieving their developmental potential. To avoid double counting children who were both stunted and living in poverty, the authors estimated the prevalence of stunting among children in poverty and calculated the numbers of stunted children plus the number of nonstunted children living in poverty. The analysis indicated that there are 559 million children under the age of 5 years in developing countries, including 156 million who are stunted and 63 million who are not stunted but are living in poverty, for a total of over 219 million children under five years of age who are not fulfilling their developmental potential. Most of these children live in South Asia and sub-Saharan Africa. Regression analyses revealed that both poverty and stunting predict the proportion of children who do not reach the final grade in primary school (Grantham-McGregor et al., 2007).

Almost half of the total number of children in the world who are not developing their potential (89 million) live in South Asia, and ten countries account for 145 million (66%) of the 219 million disadvantaged young children in the developing world (India, Nigeria, China, Bangladesh, Ethiopia, Indonesia, Pakistan, Democratic Republic of Congo, Uganda, and Tanzania). In 11 countries (Angola, Zambia, Malawi, Tanzania, Uganda, Ethiopia, Niger, Mali, Nigeria, Burkina Faso, Nepal), over 60% of children are not reaching their potential. These disadvantaged children are likely to do poorly in school and subsequently have low incomes, high fertility, and provide poor care for their children, thus contributing to the intergenerational transmission of poverty (Grantham-McGregor et al., 2007). The loss in productivity is estimated to be more than 20% of yearly adult income for the 219 million disadvantaged children when they become adults (Grantham-McGregor et al., 2007). To grasp the significance of the magnitude of these figures, it helps to realize that only 11% of the world's young children live in the developed countries, and less than 4% live in the United States and Canada.

Paper 2: Child Development; Risk Factors for Adverse Outcomes in Developing Countries (Walker et al., 2007)

The second paper identifies biological and psychosocial risks for children's development that are well documented, can be modified, and are of high prevalence in the developing world. These are outlined in Figure 1. These risk factors affect children's school readiness on school entry, which is predictive of later school progress (Grantham-McGregor et al., 2007). School readiness is affected by cognitive ability, social-emotional competence, and sensorimotor development (Blair, 2002). It is important to recognize that school readiness is not solely a function of knowing academic skills like

letter recognition, but also involves many social skills such as understanding how to work in a group (Rouse, Brooks-Gunn, & McLanahan, 2005).

Poverty, and the sociocultural conditions that accompany poverty, often coexist with the biological and psychosocial risks that affect development through changes in brain structure and function. Children growing up in poverty are frequently exposed to multiple and cumulative risks. Research clearly indicates that the greater the number of risks, the more a child's development is compromised (Wachs, 2000). For example, in Guatemala there was a linear decrease in adolescents' school achievement and cognition associated with greater numbers of risk factors that children experienced in the first three years of their lives (Gorman & Pollitt, 1996).

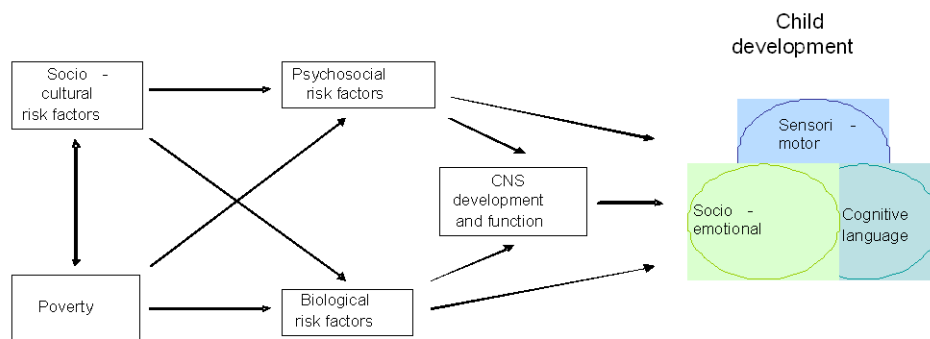


Figure 1. Pathways from poverty to poor child development. Sociocultural risk factors include gender inequity, low maternal education and reduced access to services. Biological risks include prenatal and postnatal growth, nutrient deficiencies, infectious diseases and environmental toxins. Psychosocial risks include parenting factors, maternal depression and exposure to violence. Although not shown in this figure the consequences of impairments in child development are likely to be intergenerational. Poorly developing children are likely to remain in poverty as adults, thus continuing the pathways shown for their offspring. From “Child development: Risk factors for adverse outcomes in developing countries,” by S.P. Walker, T.D. Wachs, J.M. Gardner, B. Lozoff, G.A. Wasserman, E. Pollitt et al., 2007, *The Lancet*, 369, pp. 145–157. Copyright 2007 by Elsevier. Reprinted with permission.

Walker et al. (2007) identified four key risk factors that are causally and consistently linked to development, affect large numbers of infants and young children in developing countries and can be modified: malnutrition that is chronic and severe enough to cause stunting, inadequate cognitive stimulation or learning opportunities, iodine deficiency, and iron deficiency anemia. These risks, their prevalence in developing countries, and our current level of knowledge about each one are shown in Table 1.

Table 1
Risk Factors for Poor Development

Risk	Prevalence	Effects on children	Strength of evidence
Stunting	25–30%	6–13 DQ points, (0.4–0.8 <i>SD</i>), social and emotional effects	Strong
Iodine deficiency	35%	9–13 IQ points (1 <i>SD</i>)	Strong
Iron deficiency anemia	20–30%	1.73 IQ/10 g/L Hgb; Some supplementation trials show benefits to motor, social-emotional and cognitive development of 0.3–0.4 <i>SD</i>	Strong
Lack of child stimulation and learning opportunities	60–90% of parents do not stimulate	Provision of stimulation/ learning opportunities has benefits of 0.5–1.0 <i>SD</i> in IQ	Strong
Maternal depression	17%, rates may be higher	0.5–1.0 <i>SD</i> in cognitive development scores	Correlations clear; need for treatment approaches
Exposure to violence	Major armed conflict in 27–38% countries from 1990 to 2003, affects 20 million children	Behavior problems, PTSD	Urgent need for research particularly on interventions
Intrauterine growth retardation	11%	0.25–0.5 <i>SD</i> compared to non-LBW	Associated with developmental deficits to age 3 years; need for longitudinal studies
Malaria	40% of pop in 90 countries—300–600 mill	Significant cognitive impairments associated with severe malaria or cerebral malaria, or number of episodes of malaria	Negative associations clear; needs further study
Lead levels	40%	2–5 IQ points	Correlational studies in developed and developing countries
Lack of Breastfeeding	40–50%	Small effects on cognition (2–5 IQ pts), may affect bonding	Consistent but small to moderate effects; hard to design good studies
Parental loss	Over 43 m orphans in sub-Saharan Africa, 16% below age 6 (7 million) in 2003	Descriptive studies show higher rates of mortality, some behavior problems, sense of vulnerability, depression, improves over time	Need for interventions and intervention research
Lack of Maternal	Unknown	Associated with less secure	Need for more

Risk	Prevalence	Effects on children	Strength of evidence
responsivity		attachment, lower cognitive ability and more behavior problems	intervention studies
Zinc deficiency	33%	Cognitive development and activity	Mixed results
Intestinal Helminths	33%	Cognitive development	Inconsistent results
HIV Infection	2%	Can be severe; developmental delays, language delays	Evidence for risk is strong
Diarrhea	Common	Some associations with cognitive development found	Suggestive; needs further study
Arsenic	High in areas such as Bangladesh	Lowered IQ	Correlational data; only investigated in older children
Manganese, pesticides	Depends on area	Lowered IQ	Some data but need for more

Note: References to substantiate information in this table are found in Walker et al., 2007.

Stunting or low height for age, often beginning with low birthweight, has been associated with cognitive as well as social and emotional effects, including apathy, less positive affect, less play, and more insecure attachment compared to well-nourished children (e.g., Berkman, Lescano, Gilman, Lopez, & Black, 2002; Chang, Walker, Grantham-McGregor, & Powell, 2002; Daniels & Adair, 2004; Gardner, Grantham-McGregor, Himes & Chang, 1999; Martorell, Rivera, Kaplowitz, & Pollitt, 1992; Mendez & Adair, 1999). Where reported, gains during intervention range from 6–13 developmental quotient (DQ) points compared with controls (Grantham-McGregor, Powell, Walker & Himes, 1991; Waber et al., 1981). The data in Figure 2 from an 18-year study in Jamaica illustrates this effect on IQ (Walker, Chang, Powell & Grantham-McGregor, 2005). A long-term follow-up in Guatemala showed effects through adolescence and up to age 30 years of early supplementation (Li, DiGirolamo, Barnhart, Stein, & Martorell, 2004; Pollitt, Gorman, Engle, Martorell, & Rivera, 1993). Stunting affects approximately 25–30% of young children in the developing world.

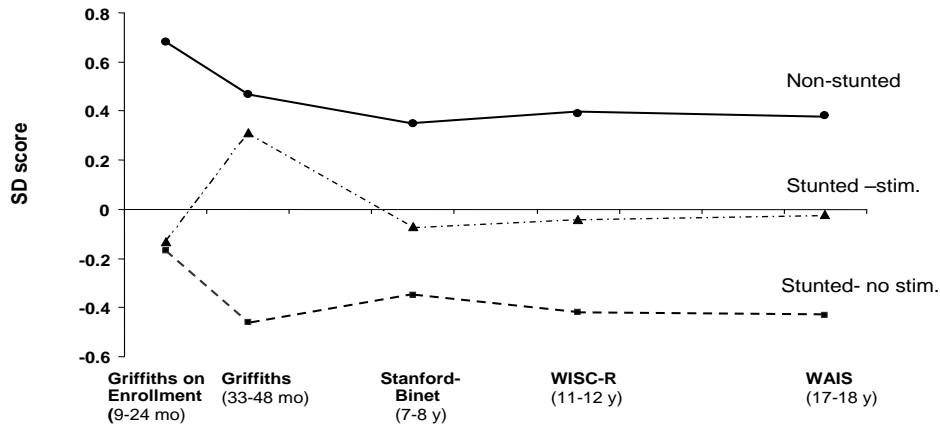


Figure 2. DQ/IQ scores of stunted and nonstunted Jamaican children from age 9–24 months through 17–18 years, showing long-term deficits associated with stunting and the sustained benefits to stunted children who received a home-visiting program providing early childhood stimulation. From “Effects of early childhood psychosocial stimulation and nutritional supplementation on cognition and education in growth-stunted Jamaican children: Prospective cohort study,” by S.P. Walker, S.M. Chang, C.A. Powell, and S.M. Grantham-McGregor, 2005, *The Lancet*, 366, pp. 1804–1807. Copyright 2005 by Elsevier. Reprinted with permission.

Iodine deficiency can cause irreversible mental retardation, making it the most common preventable cause of mental retardation (de Benoist, Andersson, Egli, Takkouche, & Allen, 2004; Grantham-McGregor, Fernald, & Sethuraman, 1999). Severe iodine deficiency causes cretinism, but even modest levels of iodine deficiency have been shown to have an effect on cognitive functioning (Choudhury & Gorman, 2003; Pharoah & Connolly, 1995). Two meta-analyses of studies in 1994 and 2005 reported that iodine deficient children had deficits in IQ of up to 13 IQ points (almost 1 standard deviation) and with supplementation, improvements of 9 IQ points (Bleichrodt, Garcia, Rubio, Morreale de Escobar, & Escobar del Rey, 1987; Qian, Wang, & Watkins, 2005). One longitudinal study showed that the greatest impact on child IQ occurred if supplementation began in the first and second trimester of pregnancy (Cao et al., 1994; O'Donnell et al., 2002). Worldwide, 35% of people have insufficient iodine intake (de Benoist et al., 2004).

Anemia affects between 45 and 65% of children under age 4 years, of which half is iron deficiency anemia (Stoltzfus, Mullany, & Black, 2005). There is conclusive evidence that infants with iron deficiency anemia are developmentally at risk in the short run, and consistent evidence that they continue to be at risk in the long run despite iron therapy (Walker et al., 2007). Children with iron deficiency have been shown to have

poorer mental and motor functioning (1.73 IQ points for each 10 g/L decrease in hemoglobin levels) (Stoltzfus et al., 2005), social problems, anxiety or depression and inattention through adolescence (Lozoff, Jimenez, & Walter, 2006; Lozoff, Jimenez, Hagen, Mollen, & Wolf, 2000). Supplementation with iron during in the preschool years has shown that it can have an impact in the short term, but there are as yet no long-term follow-ups of supplementation trials (Walker et al., 2007).

All but one of 16 studies in developing countries showed that improving children's cognitive stimulation or child-learning opportunities resulted in improvements in children's cognitive development of between half and one standard deviation (Walker et al., 2007). The evidence strongly supports the importance of early cognitive stimulation for young children's cognitive abilities. Follow-up studies in Turkey (Kagitcibasi, Sunar, & Bekman., 2001), South Africa (Magwaza & Edwards, 1991) and Jamaica (Walker et al., 2005) show lasting benefits for cognition with some maintained for up to age 17 years (Figure 2). Four of five studies also reported benefits for social-emotional development in areas such as social behavior, self-confidence and positive affect. One mechanism that explains this growth may be increases in maternal sensitivity and responsivity. Results from two small studies indicate that when caregivers are aware of their children's abilities, they are more responsive and their children do better in the short run (Cooper et al., 2002; Wendland-Carro, Piccinini, & Millar, 1999).

Based on available evidence there is an urgent need for further investigation of other potentially important risk factors such as inadequate breastfeeding, the prevalence of diarrhea, zinc deficiency, maternal responsivity and depression, exposure to violence, malaria, and parental loss. Table 1 summarizes 18 known and potential biological and psychosocial risk factors that affect substantial numbers of children in developing countries and have epidemiological, if not causal, evidence linking them to impairments in young children's cognitive or social-emotional development. For each risk factor, the effects on children are shown, along with the strength of our knowledge about their potential effect on children's development.

Taken together, these 18 potential risk factors often co-occur or cumulate. Exposure to multiple risks has a much larger impact than exposure to single risks (Wachs, 2000). These cumulative risks contribute to a developmental trajectory that includes poor health, immature behavior, lack of readiness for school, poor academic performance, limited preparation for economic opportunities, and perpetuation of the intergenerational cycle of poverty. Because many young children in developing countries experience multiple risks, integrated interventions that address several of these identified risk factors are the most effective. Such interventions are discussed below.

Paper 3: Strategies to Avoid the Loss of Developmental Potential in More Than 200 Million Children in the Developing World (Engle et al., 2007)

Based on the conclusions from the previous papers in the series, this paper evaluates programs that promote child development and either prevent or ameliorate the effects of stunting, iodine deficiency, iron deficiency anemia, and inadequate stimulation on child development.

The evidence from industrialized countries clearly shows that there are short- and long-term effects of quality programs to improve disadvantaged young children's

cognitive and social-emotional functioning that last over time, and the cost-effectiveness of these programs has been demonstrated (Currie, 2001; Currie & Thomas, 2001; Karoly, Kilburn, & Cannon, 2005; Karoly et al., 1998; McCormick et al., .2006; Mustard & McCain, 1999). However, the applicability of these findings to a developing country context has been questioned. For this reason, this paper reviewed evaluations of programs that had achieved some degree of scale to improve children's cognitive and social-emotional development exclusively in developing countries. They came from a variety of regions: Latin America, South Asia, Africa, East Asia, and Turkey.

There has been increasing interest in early child development (ECD) from both the health and educational sectors within developing countries. For example, by 2005, the World Bank had financed loans to 52 developing countries for ECD programs, for a total of 1.6 billion dollars. In addition, at least 34 developing countries had policies on early child development, and UNICEF was supporting parenting programs in 60 countries. However, there have been relatively few systematic evaluations of ECD programs.

Through an extensive search, we identified 20 ECD programs that have been implemented in developing countries that had an adequate comparison group, measured children's outcomes, and occurred prior to age 6 years. The programs fall into three groups; (a) center-based early learning; (b) parenting or parent-child interventions; (c) community-based interventions. All include health and nutrition interventions. As noted in the earlier papers, there is strong evidence for an additive or synergistic effect of stimulation and improved nutrition on a child's development. This is illustrated by studies showing the combined effect of initial malnutrition and improved environment on the outcomes of children adopted into middle-class homes (Figure 3).

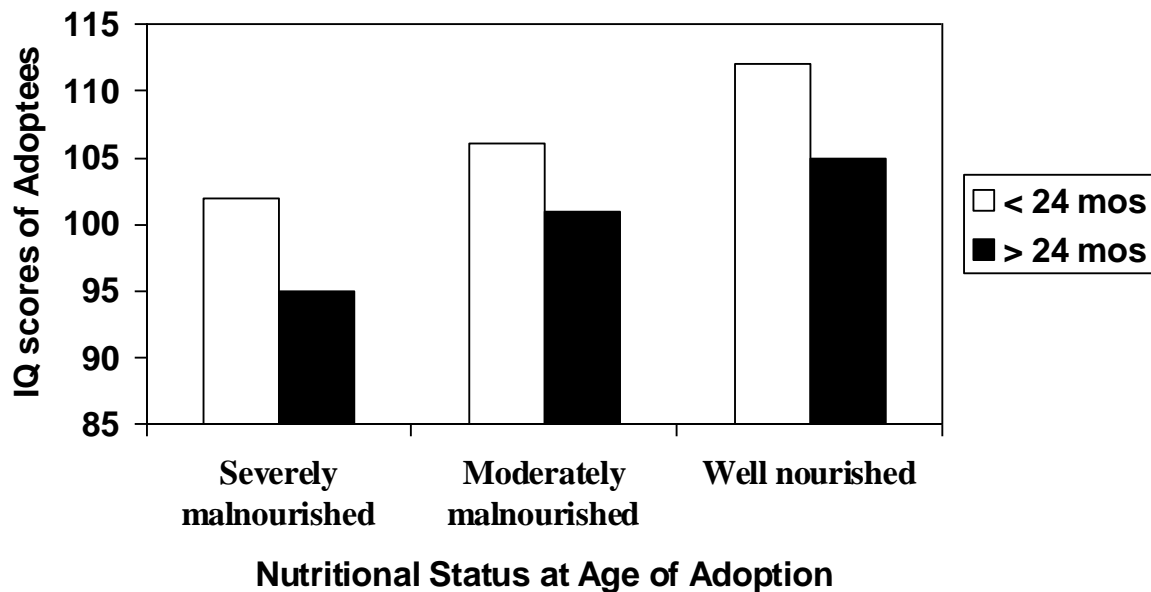


Figure 3. IQ scores among female Korean orphans at age 10 who varied by history of malnutrition and by age of adoption into middle-class homes (indicating length of time in a more stimulating environment).

All of the eight evaluations of center-based programs find a significant effect on children's cognitive development, either through preschools or treatment centers for

malnourished children. These programs also demonstrate noncognitive gains such as social skills, self-confidence, willingness to talk to adults, and motivation. Evaluations that follow children into school report improvements in the number of children entering school, age of entry, retention, and performance (Aboud, 2006; Berlinski, Galiani, & Gertler, 2006; Jaramillo & Tietjen, 2001; McKay, Sinisterra, McKay, Gomez, & Lloreda, 1978; Pollitt & Escamilla, 1996; Save the Children, 2003; Save the Children Myanmar Field Office, 2004; Watanabe, Flores, Fujiwara, & Tran, 2005).

Four of the six parenting interventions using home visits found positive effects on child development (Powell, 2004; Powell, Baker-Henningham, Walker, Gernay, & Grantham-McGregor, 2004; Morenza, Arrazola, Seleme, & Martinez, 2005; Super, Herrera, & Mora, 1990; Waber et al., 1981). The remaining two parenting programs used group sessions with mothers. In one, mothers practiced skills to play with their children and there were short and long-term effects on child development (Kagitcibasi et al., 2001). In the other, sessions included information but no activities (Aboud, 2007). Mothers' knowledge increased, but there was no impact on child development. Effective parenting programs need to be designed to help parents improve their skills with children. One approach is to emphasize skill-based activities involving children.

Four of the five community-based programs illustrate the beneficial effects of integrating ECD programs into existing community-based systems (India: Rao, 2005; Vazir & Kashinath, 1999; Peru: Cueto & Diaz, 1999; Philippines: Ghuman, Behrman, Gultiano, & King, 2006; Bangladesh: Hamadani, Huda, Khatun, & Grantham-McGregor, 2005). The remaining program shows how reduced gains occur when child development interventions are not delivered with a sufficient level of intensity (Uganda: Britto et al., 2007).

The size of the effect ranged from a third to almost two standard deviations (effect sizes). Given these effect sizes, if there were coverage of 90% of disadvantaged children with an early child development program, the result would be a net increase of a year of school per child. Preschool enrollment would contribute to increases of about 5–10% in lifetime labor income.

From these studies, Engle et al. (2007) concluded that effective ECD programs (a) target disadvantaged children, (b) provide services for children aged 3 years and under, (c) continue throughout early childhood, (d) are of high quality, and are defined by structure (e.g., child-staff ratio, staff training) and processes (e.g., responsive interactions, variety of activities), (e) provide direct services to children and parents, and (f) are integrated into existing health, nutrition, or educational systems.

Despite convincing evidence, program coverage is low. Barriers to implementation include lack of awareness of the loss of children's developmental potential and its cost to society, lack of globally accepted indicators for child development to monitor progress or to ensure accountability, the difficulty in making long-term investments and in working with the multiple stakeholders for young children, and the lack of a single strategy or "package" of interventions for ECD. Efforts are underway to address some of these concerns, such as the lack of a global indicator, and systems for calculating costs are improving. But more work is urgently needed to determine what kinds of interventions are most effective and in which contexts.

Policy recommendations include the need to make child development promotion a goal in developing countries, to expand high quality, cost-effective ECD programs, and

to include indicators to track progress in child cognitive and social-emotional development. To achieve the Millennium Development Goals of reducing poverty and ensuring primary school completion for girls and boys, governments and civil society should consider expanding high quality, cost-effective early child development programs.

Conclusions and Implications

Four main conclusions come from these three papers. First, over 200 million children under the age of five years worldwide are not developing to their potential due to poverty, poor health and nutrition, and lack of stimulation.¹ Second, the immediate risk factors, which are very well documented, include stunting, iron deficiency, iodine deficiency and lack of a stimulating and nurturing environment. The developmental consequences of other risks such as maternal depression, exposure to violence, and environmental toxin exposure and infectious diseases are increasingly being documented. Third, interventions exist at scale that can reduce the loss of human potential during early childhood, particularly for the most disadvantaged, and include parenting, home visits, health-related services, and comprehensive programs combining learning opportunities, nurturing environments, nutrition and health and environmental improvements. And finally, although effective interventions are available, coverage is still far too low, political will is still lacking, and opportunities are being lost.

Sir Richard Jolly, development economist, Honorary Professor at the Institute of Development Studies, UK, and senior UN and UNICEF official for over 20 years, including during the UNICEF Child Survival Revolution, compared the significance of these findings to the development of immunization and oral rehydration therapy, which reduced child deaths dramatically in the 1980s and 1990s. These papers, “if taken seriously, could have an impact hardly less dramatic. The problem is not the lack of knowledge about what to do but the lack of professional and political commitment to mobilise action on the scale required—and for poorer communities in countries throughout the world” (Jolly, 2007, p. 8). Just 4 years ago, the world was again galvanized into action with the recognition that 10 million children a year were dying, largely from preventable causes (Jones et al., 2003). Surely this loss deserves as much attention, and the consequences are as great.

The papers in this special issue of *Child Health and Education* will illustrate with new data and case studies the evidence that early child development interventions can be effective at scale, and that without intervention, the risks to early child development are too important to ignore.

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¹ The 2003 *Lancet* Series on Child Survival found that 10 million children per year are dying, 6 million of whom are dying from largely preventable causes (Jones et al., 2003).

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