Child Development 1

Inequality in early childhood: risk and protective factors for early child development

Susan P Walker, Theodore D Wachs, Sally Grantham-McGregor, Maureen M Black, Charles A Nelson, Sandra L Huffman, Helen Baker-Henningham, Susan M Chang, Jena D Hamadani, Betsy Lozoff, Julie M Meeks Gardner, Christine A Powell, Atif Rahman, Linda Richter

Inequality between and within populations has origins in adverse early experiences. Developmental neuroscience shows how early biological and psychosocial experiences affect brain development. We previously identified inadequate cognitive stimulation, stunting, iodine deficiency, and iron-deficiency anaemia as key risks that prevent millions of young children from attaining their developmental potential. Recent research emphasises the importance of these risks, strengthens the evidence for other risk factors including intrauterine growth restriction, malaria, lead exposure, HIV infection, maternal depression, institutionalisation, and exposure to societal violence, and identifies protective factors such as breastfeeding and maternal education. Evidence on risks resulting from prenatal maternal nutrition, maternal stress, and families affected with HIV is emerging. Interventions are urgently needed to reduce children's risk exposure and to promote development in affected children. Our goal is to provide information to help the setting of priorities for early child development programmes and policies to benefit the world's poorest children and reduce persistent inequalities.

Published Online
September 23, 2011
DOI:10.1016/S0140-6736(11)60555-2

See Online/Comment
DOI:10.1016/S0140-6736(11)61450-5

This is the first in a Series of two reports about child development

Tropical Medicine Research Institute, The University of the West Indies, Kingston, Jamaica (Prof S P Walker PhD, H Baker-Henningham PhD, S M Chang PhD, C A Powell PhD); **Department of Psychological Sciences, Purdue University, West Lafayette, IN, USA** (Prof T D Wachs PhD); **Institute of Child Health, London, UK** (Prof S Grantham-McGregor MD); **Department of Pediatrics, University of Maryland, College Park, MD, USA** (Prof M M Black PhD); **Children's Hospital Boston/Harvard Medical School, Boston, MA, USA** (Prof C A Nelson PhD); **Department of Nutrition, University of California, Davis, CA, USA** (S L Huffman ScD); **Child Development Unit, ICDDR,B, Dhaka, Bangladesh** (J D Hamadani PhD); **Center for Human Growth and Development, Department of Pediatrics, University of Michigan, Ann Arbor, MI, USA** (Prof B Lozoff MD); **Caribbean Child Development Centre, The University of the West Indies, Open Campus, Jamaica** (Prof J M Meeks Gardner PhD); **Institute of Psychology, Health, and Society, University of Liverpool, Liverpool, UK** (Prof A Rahman PhD); **and Human Sciences Research Council & University of the Witwatersrand, South Africa** (Prof L Richter PhD)

Introduction

In a 2007 Series in *The Lancet* we estimated that more than 200 million children younger than 5 years from low-income and middle-income countries were not attaining their developmental potential, primarily because of poverty, nutritional deficiencies, and inadequate learning opportunities.[1,2] Economic recession and climate change will probably increase the number of children affected.[3,4] Biological and psychosocial risk factors associated with poverty lead to inequalities in early child development, which undermine educational attainment and adult productivity, thereby perpetuating the poverty cycle.[5] In this Series, we review new evidence on the mechanisms and causes of developmental inequality and economic implications and strategies to promote early child development. In this report we summarise evidence from developmental neuroscience on how experiences in early life affect the structure and functioning of the brain, and subsequent child development. We review evidence on risks and protective factors for development, updating evidence on previously identified risks (panel 1),[1] and highlight risks not previously identified. Our focus is on modifiable risks that affect large numbers of children younger than 5 years in low-income and middle-income countries.

Key messages

- Exposure to biological and psychosocial risks affects the developing brain and compromises the development of children
- Inequalities in child development begin prenatally and in the first years of life
- With cumulative exposure to developmental risks, disparities widen and trajectories become more firmly established
- Reducing inequalities requires early integrated interventions that target the many risks to which children in a particular setting are exposed
- The most effective and cost-efficient time to prevent inequalities is early in life before trajectories have been firmly established
- Action or lack of action will have lifetime consequences for adult functioning, for the care of the next generation, and for the wellbeing of societies

Search strategy and selection criteria

We searched relevant databases (eg, PubMed, PsychInfo, Cochrane Review) with multiple search terms for articles published since 2005. The search terms we used were linked to each of the risk or protective factors: "child development", "child behaviour", "infant behaviour", "cognition", "social", "emotional", "intelligence", "language", and "motor development". We searched citation lists of articles retrieved and review articles published since the last Series for further references. We included earlier key publications in which the risk or protective factor was not reviewed in the previous Series. We include only risk and protective factors that can be modified by interventions or public policy and which affect large numbers of children younger than 5 years in low-income and middle-income countries. We consider exposures in utero to age 5 years and focus on research done in low-income and middle-income countries. Although many of the risk and protective factors we considered are also relevant to children's health outcomes, we focus on children's cognitive, motor, and social–emotional development.

Corresponence to:
Prof Susan P Walker, Tropical Medicine Research Institute, Epidemiology Research Unit, The University of the West Indies, Mona, Kingston, 7, Jamaica
susan.walker@uwimona.edu.jm

***Panel 1:* Previously identified priority risk factors**

- Key risks: inadequate cognitive stimulation, linear growth retardation (stunting), iodine deficiency, and iron-deficiency anaemia
- Other priority risks: intrauterine growth restriction, malaria, lead exposure, maternal depressive symptoms, and exposure to violence

Risk, stress, and brain development

The foundations of brain architecture are laid down early in life through dynamic interactions of genetic, biological, and psychosocial influences, and child behaviour. Biological and psychosocial influences affect the timing and pattern of genetic expression, which can alter brain structure and function,[6] and behaviour.[7] Through bidirectional effects, children's behaviour affects brain development directly and by modifying the effects of biological and psychosocial influences.[8]

Childhood risks associated with poverty, such as lack of stimulation or excessive stress, affect brain development, result in dysregulation of the hypothalamic–pituitary–adrenocortical system,[9] and change electrical activity of the brain related to efficiency of cognitive processing.[10] The influence of risks can begin prenatally because the fetal brain can be influenced by exogenous factors that produce maternal stress.[11] At present there is insufficient evidence from research in human beings to establish if the effects on hypothalamic–pituitary–adrenocortical regulation are reversible.[12]

Three translational processes influence how risk factors and stress affect brain and behavioural development: the extent and nature of deficits depend on timing, co-occurring and cumulative influences, and differential reactivity (figure 1 and table 1). Risks often co-occur and persist, leading to exposure to multiple and cumulative risks. For example, maternal depression increases risk of low birthweight (LBW; additional references in webappendix pp 1–5), stunting,[13] and insecure attachment.[14] Because of differential reactivity, the effect of risks on behaviour might vary by individual or environmental characteristics.

See Online for webappendix

Maternal nutrition

There is maternal undernutrition (body-mass index <18·5 kg/m²) in 10–19% of women in most low-income and middle-income countries, with higher prevalence in sub-Saharan Africa and south Asia. Maternal pre-pregnancy body-mass index and weight gain during pregnancy predict birthweight, and balanced energy–protein supplementation benefits birthweight and reduces births that are small for their gestational age. However, there is little information on associations between maternal nutritional status and child development. Pre-pregnancy weight and weight gain in Jamaican women that were mostly adequately nourished were not associated with child cognition at age 7 years.[15] In Bangladesh, infants of undernourished mothers had poorer problem-solving ability at 7 months,[16] and ability was better in infants of mothers given food supplements early rather than later in pregnancy. By age 18 months, no effects of maternal undernutrition or supplementation were identified.[17] Analyses of the Dutch (1944–45) and Chinese (1959–61) famines suggest that prenatal nutritional deficits might have long-term effects on adult mental health. There is a need for research on the effect of food supplementation before and during pregnancy on child development.

About 42% of pregnant women in low-income and middle-income countries are anaemic, and, of these, 60% are iron deficient; however, there is little information on perinatal iron deficiency and child development. Lower maternal haemoglobin and neonatal ferritin predicted lower intra-individual variability in temperament-like behaviours in Peruvian infants that suggested diminished responsiveness.[18] In South Africa, maternal iron-deficiency anaemia at 6–10 weeks post partum was associated with lower maternal sensitivity and child responsiveness.[19] Although both disorders improved after treatment with iron, infant development was delayed at age 9 months.[20]

Meta-analyses of 12 randomised controlled trials from low-income and middle-income countries show that supplementation with multiple micronutrients in pregnancy leads to increased birthweight. Trials of supplementation with multiple micronutrients during pregnancy in Bangladesh and in pregnant women in Tanzania infected with HIV suggest small benefits to infants' motor development,[16,21] and to mental development in China,[22] compared with iron and folic acid alone. In Peru, zinc supplementation during pregnancy had no effect on children's cognitive, social, or behavioural development at ages 4–5 years.[23] In Nepal, children whose mothers received iron and folate during pregnancy had better intelligence quotient (IQ), executive, and motor functioning than the placebo group at ages 7–9 years;[24] provision of multiple micronutrients or iron plus folate plus zinc had no benefits, possibly because of zinc inhibition of iron absorption.

Inadequate intakes of ω3 fatty acids (including α-linoleic acid, docosahexaenoic acid [DHA], eicosapentaenoic acid) have been reported in pregnant women in some low-income and middle-income countries. In high-income countries, trials of fish oil, DHA, or DHA and eicosapentaenoic acid showed that infants born to supplemented mothers had improvements in visual acuity,[25] attention,[26] and aspects of cognitive performance.[27] Supplementation with ω3 fatty acids and micronutrients benefited birthweight and length and reduced very early preterm births in Chile. In Mexico, supplementation with ω3 fatty acids benefited birthweight and head size in primigravid women only. Information is needed on possible benefits to infant development.

Infant and child nutrition

In low-income and middle-income countries, 16% of births are LBW with rates as great as 27% in south Asia, most of these births being intrauterine growth restriction (IUGR)-LBW. A Guatemalan study[28] showed associations between birth size adjusted for gestational age and development at 6 and 24 months, supporting earlier conclusions that IUGR is associated with early developmental risk.[1]

Evidence for longer-term effects of IUGR is less consistent. Significant effects of birthweight unadjusted for gestational age were identified on IQ at age 5 years[29] and on highest school grade achieved.[30] However, contributions of prematurity cannot be estimated. No significant differences were identified between term LBW and normal birthweight children in IQ or parent-reported behaviour at 6 years in Jamaica,[31] or at 8 years in Brazil,[32] and no difference in self-reported behaviour at 12 years in South Africa.[33] By contrast, a large study in Taiwan[34] reported significant small deficits in academic achievement of term LBW at 15 years. More evidence is needed on long-term effects of IUGR in low-income and middle-income countries on IQ, and specific cognitive and social skills.

About 39% of infants aged 0–6 months in low-income and middle-income countries are exclusively breastfed, with wide variations in duration of exclusive breastfeeding between countries. In a large cluster-randomised trial in Belarus,[35] clinics were assigned to breastfeeding promotion or usual care. Intervention increased exclusive breastfeeding at 3 months and any breastfeeding up to 12 months. At age 6·5 years, intervention children had significantly higher scores on verbal and full-scale IQ and teacher ratings for reading and writing. No benefits were identified for child behaviour.[36] In Brazil, boys breastfed for at least 9 months attained 0·5–0·8 school grades more by 18 years than boys breastfed for less than 1 month. Regression of grade level attained on adult income in this population suggests this difference corresponds to a 10–15% difference in income.[37] These findings strengthen the evidence for benefits of breastfeeding to development and educational attainment.

In high-income countries, formula-fed infants given DHA supplemented formula had better visual acuity, with greater benefits for preterm infants. There is little information on essential fatty-acid intake or the developmental effect in infants and children from low-income and middle-income countries. In Turkey, improvements in brainstem auditory evoked potentials were noted in infants randomly assigned to receive DHA-supplemented formula compared with infants receiving non-supplemented formula.[38] Consumption of complementary foods fortified with micronutrients and essential fatty acids was associated with improved motor development in Ghana and China.[39,40] Although it is unclear which nutrients were responsible for the benefits, supplementation with essential fatty acids and micronutrients resulted in earlier walking compared with micronutrients alone;[39] however, the groups also differed in energy intake.

Linear growth retardation or stunting is estimated to affect 34% of children younger than 5 years in low-income and middle-income countries. Consistent with previous evidence, new longitudinal studies from Brazil, India, Peru, and Vietnam show associations between early height-for-age and cognitive or language ability at 5 years.

Height before 6 years was related to age at school enrolment and grades attained by late adolescence in Zimbabwe.[41] New information also extends the long-term outcomes associated with stunting, including reduced likelihood of formal employment at age 20–22 years in the Philippines[42] and poorer psychological functioning in Jamaican adolescents.[43]

Timing of growth faltering seems important. In Guatemala, growth and development were related up to age 24 months but not from 24 to 36 months.[28] Pooled analyses of five longitudinal studies identified that a 1 SD increase in weight gain from birth to 24 months was associated with increased schooling (0·43 years) and inversely related to grade failures, whereas growth from

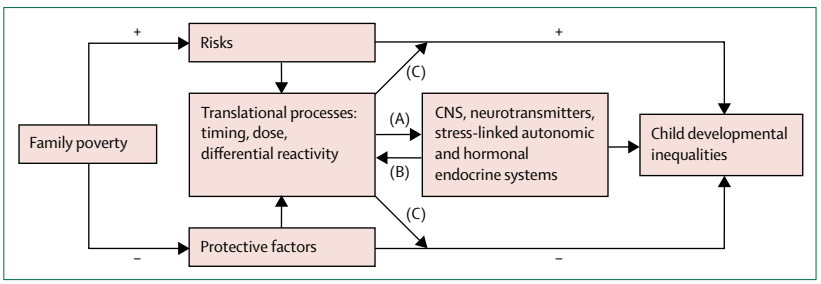

Figure 1: **Pathways linking poverty to developmental inequities**
(A) Timing, dose, and differential reactivity influence how individual exposure to risk and protective factors translate into individual differences in brain function and structure. (B) Brain structure and function influence the degree of differential reactivity shown. (C) Timing and dose of exposure, and differential reactivity moderate the effect of risk and protective factors upon child development.

	Examples*
Timing: extrinsic and environmental influences have maximum effect on brain and behavioural development during specific ages (sensitive periods)	The infant–caregiver relationship depends on the quality and availability of caregiving early in life, the same period that is sensitive to the effect of iron deficiency on myelination and density of dopamine receptors
Co-occurring or cumulative influences (dose): risk and protective factors that cumulate during a sensitive period or over time are potent adverse (risk) or facilitative (protective) influences on biological and behavioural development	When stress is cumulative or severe, the risk of adverse long-term physiological and behavioural consequences is substantially increased; early cumulative exposure to stress might compromise children's ability to benefit from supportive environments, or increase their susceptibility to later stressors
Differential reactivity: the effect of risk and protective factors on brain and behavioural development can be moderated by child and contextual characteristics	Reactivity to risks varies depending on the presence or absence of specific alleles, child characteristics such as temperament, and contextual characteristics such as social support

*References in the webappendix p 1.

Table 1: **Translational processes underlying the effect of risk exposure on brain and behavioural development**

2 to 4 years had little affect.[30] Duration might also change the effect because Peruvian children stunted at age 6–18 months, but not at 4·5–6 years, did not differ from children who were not stunted at either age in vocabulary and quantitative test scores at 4·5–6 years. Children stunted at both ages had significantly lower scores. The timing of catch-up growth is unknown and might have happened within the first 2 years of life.[44]

Previous randomised controlled trials of macronutrient supplementation to promote better growth consistently showed concurrent developmental benefits.[1] Follow-up of a cluster-randomised trial in Guatemala showed benefits to reading comprehension and reasoning at 25–42 years in participants supplemented from birth to 24 months, but not those supplemented later.[45] Men supplemented throughout the first 3 years earned higher hourly wages.[46] These findings highlight the importance of adequate nutrition early in life.

Several studies reported previously unrecognised behavioural or neurophysiological alterations with iron-deficiency anaemia in infancy (webappendix pp 9–28). Studies in Chile, India, and Mexico identified electrophysiological evidence of delayed brain maturation in infants with iron-deficiency anaemia. Sleep duration improved with iron plus folic acid or zinc supplementation, but not both, in trials in Zanzibar and Nepal.[47] However, sleep-state organisation was altered in Chilean children aged 4 years despite treatment for iron-deficiency anaemia in infancy.[48] Additional evidence from studies in Chile, India, Mexico, and Zanzibar showed poorer cognitive, motor, and social–emotional development associated with iron-deficiency anaemia in infancy, or the preschool period. Social–emotional development improved in Chilean infants with iron-deficiency anaemia who received home visitation to promote development, but remained lower than that of non-anaemic infants. Without home visitation social–emotional development declined in infants with iron-deficiency anaemia.[49]

Costa Rican adolescents who had chronic, severe iron deficiency with or without anaemia in infancy showed no catch-up in motor development despite iron therapy in infancy,[50] poorer executive functioning and recognition memory at age 19 years,[51] and more internalising and externalising behaviour problems in childhood and adolescence.[52] A study of fortification of complementary feeding in China noted infants whose anaemia did not correct within 6 months had lower IQ at age 6 years than those whose anaemia resolved.[40]

In addition to iron, many other micronutrients are deficient in children in low-income and middle-income countries including zinc, vitamins A, B12, D, E, riboflavin, and iodine in some regions. Six randomised and one non-randomised trial of supplementation with multiple micronutrients or fortification included three or more micronutrients and assessed development in children younger than 5 years (webappendix pp 29–37). Five of seven studies showed benefits to motor development. Studies from Bangladesh and India assessing mental development did not identify any benefits,[53,54] and one from China identified small benefits for mental development at 24 months and for IQ at 6 years.[40] There are insufficient data to establish whether supplementation with multiple micronutrients is more effective than iron alone in improving development.

Infectious diseases

Previous evidence of the effect of diarrhoea on child development was inconclusive. Additional studies in Brazil noted associations between the number of diarrhoea episodes before age 2 years, late school entry,[55] deficits in semantic fluency, and verbal learning,[56] adjusting for socioeconomic status and present nutritional status. Adjustment for stunting before age 2 attenuates the association between diarrhoea and intellectual performance.[29] A multicountry study showed that each episode of diarrhoea in the first 2 years of life contributes to stunting,[57] suggesting that associations between diarrhoea early in life and school-age performance might be through the same processes that cause stunting.

1·2 billion people are at risk of malaria, with children younger than 5 years at greatest risk. Cerebral or severe malaria can have serious neurological sequelae including seizures, and language and cognitive deficits.[1,58] In Uganda, cognitive training interventions improved the function of affected children.[59]

New evidence suggests that repeated uncomplicated attacks and asymptomatic parasitaemia (experienced by millions of children annually) also affect children's development. In a cross-country analysis controlling for education quality and other confounders, grade repetition and primary school completion rates were related to malaria exposure.[60] Longitudinal studies with school-aged children from Brazil and Mali have shown associations between attacks of clinical malaria or asymptomatic parasitaemia and poorer cognitive scores and academic performance. Randomised clinical trials of chemoprophylaxis in schoolchildren showed significant benefits to language, mathematics, and attendance in Sri Lanka,[61] and to attention in Kenya.[62]

There are fewer studies with children younger than 5 years. A history of malaria attacks was associated with poorer cognitive function at school entry in Sri Lanka,[63] and there were inconsistent associations between parasitaemia and activity and exploration in toddlers in Zanzibar.[64] Chemoprophylaxis in young children in The Gambia had later benefits for grades attained[65] but not cognitive function, although duration of intervention was related to cognitive function. Although most data come from studies of school-aged children, malaria attacks are more common and severe in younger children, and cognitive effects might be worse. Despite progress in control programmes, in 18 African countries surveyed only 23% of children younger than 5 years and

 Published online September 23, 2011 DOI:10.1016/S0140-6736(11)60555-2

27% of pregnant women were sleeping under insecticide-treated nets.

Most studies investigating other parasitic infections and child cognitive or social–emotional performance involve school-age children. The few studies with young children are inconclusive.[1] Although one additional study from Brazil[29] showed an association between the number of parasitic infections at 1–3 years and lower IQ at 5 years, findings were not significant after covariate control. Evidence is insufficient to establish if early parasitic infections affect child development.

An estimated 2·1 million children younger than 15 years are living with HIV; however, only 28% of children in low-income and middle-income countries who need antiretroviral drugs receive them. HIV infection affects brain development, leading to cognitive impairments.[66] Detrimental effects of HIV infection on neurocognitive development were identified in 36 of 43 studies from low-income, middle-income, and high-income countries.[67] We summarise in the webappendix (pp 33–37) studies of the development of children younger than 5 years infected with HIV from low-income and middle-income countries. Compared with uninfected children, children infected with HIV had significantly lower motor and mental development scores in most studies. Effects are accentuated by associated illnesses, poor nutritional status, and adverse living conditions, including caregiver stress, illness, and death (co-occurrence or cumulative influences).

In US studies, highly active antiretroviral therapy (HAART) has led to reduced rates of progressive HIV encephalopathy[68] and some benefits to development.[69] Cognitive function did not change after short-term treatment (6 months) in South African children;[70] however, benefits to motor and cognitive development were noted after 1 year in the Democratic Republic of the Congo with greater benefits in younger children.[71] There is an urgent need for increased access to treatment for infected children in low-income and middle-income countries and further assessment of the effect of early treatment on development.

Cognitive and motor deficits have been reported in HIV-exposed uninfected children in low-income and middle-income countries including the Democratic Republic of the Congo[72] and Thailand.[73] However, co-varying risks such as family poverty and non-parental caregivers were also increased and other studies have not identified deficits (webappendix pp 33–37). Many uninfected children are affected by parental HIV, which can increase exposure to developmental risks such as poverty,[74] disrupted caregiving,[75] and abandonment.[76] In South Africa, young children in affected households with caregiver illness or death were at risk for bullying, mental health problems,[77] and abuse,[74] and in Rwanda for emotional and behavioural problems.[78] The restricted financial and social support available to non-parental caregivers further challenges the wellbeing of orphans.[79]

Environmental toxins

Children might be exposed to environmental toxins prenatally—through maternal exposure—and post-natally—through breastmilk, food, water, house dust, or soil. We previously identified lead as a risk factor for young children from low-income and middle-income countries.[1] Recent evidence from Poland has shown that prenatal exposure to very low concentrations of lead (<5 µg/dL) can result in poor mental development in young children.[80]

Evidence from low-income and middle-income countries on the effect of other toxins on early child development is inconsistent or sparse (webappendix pp 38–39). Evidence from China shows that arsenic exposure can compromise cognition in older children;[81] however, studies from Bangladesh have not identified significant associations between arsenic exposure and mental development up to age 2 years.[17] Prenatal exposure to mercury has been linked to low cognitive performance in infancy and early childhood in Brazil,[82] but studies from the Seychelles report weak or inconsistent effects,[83] or no effects.[84] In Ecuador, prenatal exposure to pesticides was significantly associated with poor communication and motor skills;[85] however, associations with later development were weaker,[85] or non-significant in Mexico.[86] Prenatal exposure to polycyclic aromatic hydrocarbons was associated with slower language and cognitive development up to age 2 years in China[87] and intelligence at age 5 years in Poland.[88]

Comparison of findings is difficult because of variability in exposure duration, timing, and outcome measures.[83] Inconsistent findings might also relate to differential reactivity, in which effects are modified by risk factors, such as low birthweight or malnutrition.[85] Alternatively, the effect of toxins might be reduced when exposure is associated with protective influences, such as poly-unsaturated fatty acids in mercury contaminated fish, or better health care for children of mothers employed on farms. Further evidence is needed of the effects of toxins on early child development as well as further assessment of interactions with other exposures.

Disabilities

In a survey of disability in 18 low-income and middle-income countries, 23% of children aged 2–9 years had, or were at risk for, disabilities. Besides being a marker for compromised development, childhood disabilities can reduce access to school or health services, and increase risk of caregiver stress and depression[89,90] (webappendix p 40). Studies from south Asia suggest that learning and social integration is also limited by social stigma[89] and overprotection by parents.[90]

Although interventions can promote better function in children with disabilities, few have been assessed in low-income and middle-income countries. Randomised trials suggest more positive attitudes after interactive group therapy in parents of children with intellectual disabilities

in India,[91] and benefits from mother–child group intervention or parent training to child development and maternal adaptation for children with cerebral palsy in Bangladesh.[92] Quasiexperimental studies of parent-training programmes have shown some benefits to child development and maternal behaviour (webappendix p 40).

Evidence on availability of services is scarce but studies from Pakistan and South Africa report that few children receive adequate services.[89,93] Identifying barriers to accessing services is an important priority for children with disabilities. Community-based approaches to provision of services are discussed in the second paper in this Series.

Psychosocial factors

Early learning and caregiver–child interaction

Learning opportunities that facilitate early cognitive development include caregiver activities and materials that promote age-appropriate language and problem-solving skills. Caregiver–child interactions that facilitate early social–emotional development include caregiver positive emotionality, sensitivity, and responsiveness toward the child, and avoidance of harsh physical punishment. Lack of early learning opportunities and appropriate caregiver–child interactions contribute to loss of developmental potential.[1] We review new studies that assess the effect of interventions to increase learning opportunities and improve caregiver–child interaction (table 2 and webappendix pp 41–45). The second paper in the Series discusses the effectiveness of interventions that are, or could be, implemented at scale.

Studies from Bangladesh, China, India, and South Africa have shown that interventions to enhance mother–child interactions and increase developmentally facilitative activities benefit cognitive development when delivered through home visits,[98] individual parent

	Sample and intervention	Findings	Comments
Chile[49]	Children aged 6 and 12 months with iron-deficiency anaemia or who were non-anaemic were randomly assigned to intervention or surveillance groups for 1 year (n=277); infants were given oral iron for 1 year (6-month group) or 6 months (12-month group); surveillance groups received weekly visits to monitor feeding and health, intervention groups received weekly home visits by professional educators to promote development through improving the mother–child relationship	Significant benefit of intervention to cognitive and social–emotional scores of infants with iron-deficiency anaemia; intervention group of infants with iron-deficiency anaemia did not differ from non-anaemic infants in cognitive and motor trajectories, but their social–emotional development was delayed; in surveillance group infants with iron-deficiency anaemia social–emotional behaviour declined	No difference in cognitive and motor scores between infants with iron-deficiency anaemia and non-anaemic infants at baseline; infants with iron-deficiency anaemia had lower scores than non-anaemic infants on socio–emotional development; no intervention benefits to non-anaemic infants
South Africa[34]	Women recruited in late pregnancy from two periurban settlements; randomly assigned to intervention (n=220) or control group (n=229); caregivers were taught in a home stimulation programme to encourage sensitive, responsive interactions with infant, sensitise mother to her infant's abilities; 16 visits antenatal to 5 months	Intervention mothers more sensitive and less intrusive at 6 and 12 months (d=0·24–0·26); infants more securely attached at 18 months	Maternal sensitivity not significantly associated with infant attachment
China[94]	100 families with a child younger than 2 years from seven randomly selected villages; families randomly allocated to intervention (n=50) or control (n=50) groups; intervention was two 30–60 min counselling sessions with the WHO Care for Development guidelines, one on enrolment and one within 6 months; mothers were given a card with age-specific messages; counselling sessions included demonstration of play activities and practice, discussion of obstacles to implementation and problem solving	Significant benefits after 6 months to Gesell quotients in adaptive (d=0·49), language (d=0·52), and social (d=0·17) development; no benefits to motor development	Children's group not masked from tester; not clear where sessions were done but seems first was at health centre and second at home
India[95]	800 infants admitted to special-care nursery randomly assigned to intervention or control groups; 27% preterm, 50% LBW; 665 infants tested at 1 year, 735 at 2 years; mothers trained individually and in groups to give stimulation and to continue at home; compliance assessed at monthly home visits; intervention given for 1 year	Benefits to Bayley mental developmental index and psychomotor developmental index scores at 1 year (effect size mental developmental index 0·38, psychomotor developmental index 0·40); effect size at 2 about half that at 1 year; benefits for VLBW, LBW, and NBW infants	Number of training sessions for mothers not given; not clear if intervention was reinforced at home visits or only monitored compliance
South Africa[96]	122 HIV-positive children aged <30 months randomly assigned to intervention or control groups (institutionalised children excluded); caregivers taught through home stimulation programmes individualised for their child at usual clinic visit every 3 months; structured around daily activities and developmentally appropriate play; caregivers given a picture book and asked to spend time with child looking at and talking about pictures daily	Significant improvement after 12 months in intervention group compared with control in Bayley mental developmental index (d=0·27) and psychomotor developmental index (d=0·19)	Severe developmental delay in both groups; despite improvement, intervention group remained severely delayed
Jamaica[97]	Five inner-city preschools randomly assigned to intervention or control; children aged 3–5 years nominated by their teacher as having a behaviour difficulty were assessed (intervention n=69, control=66); intervention based on Incredible Years teacher training programme (seven full-day teacher workshops and monthly classroom consultations) and 14 child lessons on social and emotional skills in each class; control schools received educational materials only	Intervention children had reduced conduct problems (d=0·26), hyperactivity (d=0·36), and peer problems (d=0·71) by teacher report; no significant benefits to prosocial behaviour or emotional problems	Small sample size and small number of schools

d=effect size, Cohen's d. LBW=low birthweight. VLBW=very low birthweight. NBW=normal birthweight.

Table 2: **Effects of early interventions on cognitive and social–emotional development**

 Published online September 23, 2011 DOI:10.1016/S0140-6736(11)60555-2

counselling delivered at health centres,[94,96] or combined approaches.[95] Benefits have been shown in children with risk conditions such as severe malnutrition,[98] LBW,[95] iron-deficiency anaemia,[49] or HIV infection.[96] Group parenting education benefited mental development in one of three studies (webappendix p 41–45).

In Chile and South Africa, early interventions to improve mother–child interaction promoted attachment[14] and social–emotional development,[49] although gains were not identified in Bangladesh.[98] A preschool intervention in Jamaica to promote social–emotional development reduced child-behaviour problems.[97]

Sustained intervention benefits to cognitive function at age 18 years have previously been reported.[1] Studies from Jamaica and Turkey show benefits to college attendance,[99] psychological functioning,[100] and cognition and behaviour at age 6 years.[31]

Maternal depression

A recent study from Bangladesh provides further evidence of the high incidence of maternal depressive symptoms in many low-income and middle-income countries. Maternal depressive symptoms are negatively associated with early child development and quality of parenting across different cultures and socioeconomic groups.[101] In Bangladesh, maternal depressive symptoms were associated with infant stunting, perhaps related to unresponsive caregiving[13] (webappendix p 46). Risk factors for maternal depression, such as poverty, low education, high stress, lack of empowerment, and poor social support[101] are also risk factors for poor child development, suggesting that the relation between maternal depression and compromised early child development is multilevel and cumulative.

Availability of mental health care is restricted in many low-income and middle-income countries. In Pakistan and South Africa, interventions delivered by community health workers have reduced maternal depressive symptoms,[12,102] and improved maternal sensitivity and infant attachment,[14] infant health, and time spent playing with infants.[102] Evidence that symptoms of maternal depression can be effectively treated in low-income and middle-income countries, often with restricted resources and community health workers, emphasises the need for early identification and community programmes to reduce the risk of adverse consequences for mothers and children.

Exposure to violence

Estimates suggest that 300 million children younger than 5 years have been exposed to societal violence. New studies further show the adverse consequences of exposure to violence in young children (webappendix p 47). Although domestic violence and child abuse happen in countries of all incomes, we focus here on societal or community violence that might be particularly common in low-income and middle-income countries.

Young children exposed to societal violence show insecure attachments,[103] increased risk of behaviour problems,[104] reduced levels of prosocial behaviour, and increased aggressive behaviour.[105] The adverse consequences might result from disruptions to family structure and function[106] that compromise the adequacy of maternal childrearing skills,[103] and reduce children's ability to regulate their own emotions.[105]

Studies from Israel and Palestine identified intervention strategies that can reduce stress reactions for young children.[107,108] The effect of exposure to violence can be reduced by supportive parental reactions and positive family routines; however, violence can disrupt the quality of parenting, thereby reducing families' ability to protect young children exposed to violence.[107]

	Sample and method	Findings	Clinical implications
Metabolic function	Romanian children institutionalised early in life, adopted, and followed up at mean age of 8·8 years	PET scan revealed significantly reduced brain metabolism in the prefrontal cortex and temporal lobe, compared with non-institutionalised children	Reduced brain metabolism has several underlying causes; might be important to assess head growth after adoption
Brain structure	Romanian children institutionalised early in life, adopted, and followed up at adolescence	MRI scans showed significantly reduced grey-matter and white-matter volume and an enlarged amygdala, compared with non-institutionalised children	Although individuals vary, structural findings such as enlarged amygdala tend to correlate with reduced eye contact and perhaps emotional difficulties; screening for quasi-autism or anxiety symptoms might be indicated
Brain neurochemistry	Cohort of internationally adopted children	Children adopted from poor institutional care might exhibit raised cortisol concentrations years after adoption	Dysregulation of the hypothalamic–pituitary–adrenocortical axis might affect stress response and emotional regulation; it might be advisable to encourage or help parents, care providers, and teachers to teach skills in regulating emotions and strategies to manage stress
Brain electrophysiology	Bucharest Early Intervention Project, a randomised controlled trial of foster care as an intervention for early institutionalisation	Institutionalised children showed reduced amplitude in event related potential components, compared with non-institutionalised children	See metabolic function

References in the webappendix p 4.

Table 3: **Neural consequences of institutionalisation**

Panel 2: Protective mechanisms associated with more maternal education*

Less maternal depression

- Lower risk of maternal depression and non-depressed mothers provide a more optimum rearing environment for their children

Child nutritional status

- Infants and young children with better nutritional status

Quality of child-rearing environment

- Greater knowledge about child development
- More likely to use developmentally appropriate child-rearing strategies and provide more stimulating home environments
- Possess a wider variety of child-rearing strategies
- More sensitive to individual differences in children's developmental trajectories
- Have higher educational aspirations for their children

Ability to access and benefit from interventions

- More likely to make use of available intervention services; are more likely to be involved in and comply with intervention programmes
- Better able to comprehend intervention material (eg, growth charts)
- Have greater recall of intervention material

References in the webappendix pp 4–5. *Maternal education is a unique protective factor, even after adjusting for family economics.[123]

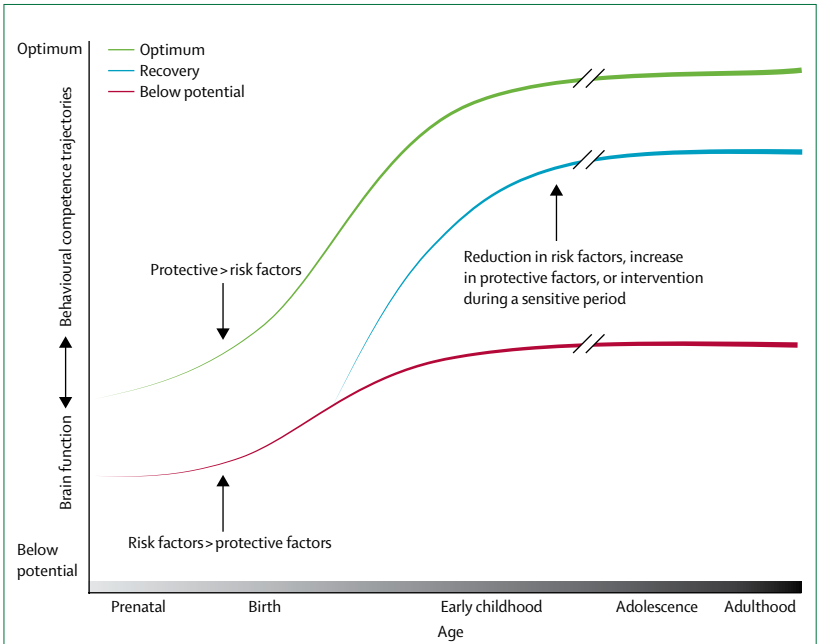

Figure 2: **Differing trajectories of brain and behavioural development as a function of exposure to risk and protective factors**
The cumulative effect is illustrated by the progressive strengthening (darker lines) of the trajectories over time.

Institutionalisation

At least 2 million children are institutionalised in non-parental-group residential care. This is probably an underestimate because of under-reporting and lack of information for some regions. Use of orphanages and other institutional care seems to be increasing. Although children's response to institutionalisation varies, many show long-term developmental deficits.[109] Institutional rearing starting early in life increases children's risk for adverse outcomes including poor growth, ill-health, attachment disorders, attention disorders, poor cognitive function, anxiety, and autistic-like behaviour[109,110] (webappendix p 48).

Recent studies of institutionalised children show the effect of early experiences on brain development. Institutional rearing has been associated with reduced metabolism in the temporal and frontal cortices, reductions in white-matter connectivity, reductions in brain electrical activity, dysregulation of the hypothalamic–pituitary–adrenocortical system, and changes in brain volume (particularly the amygdala; table 3 and webappendix p 48). Illustrating the translational processes of timing and cumulative exposure (table 1), children experiencing longer institutional placement show larger reductions in left amygdala volume[111] and greater dysregulation of the hypothalamic–pituitary–adrenocortical axis,[112] whereas children adopted from institutions before the second year of life have more normalised amygdala volume[113] and brain electrical activity.[114] Adverse neural consequences underlie the behavioural sequelae of early institutionalisation.[115]

Improving the institutional environment (eg, training staff in sensitive responsive caregiving; increasing caregiver stability and the caregiver-to-child ratio) results in significant benefits to child cognitive and social–emotional competence.[116] Foster placement and adoption are preferable alternatives to institutionalisation,[109,117] particularly if foster and adoptive families receive adequate support.

Protective influences

Protective factors attenuate adverse consequences of risk factors. Although risk and protective factors are conceptually distinct, many protective factors are the inverse of risk factors (eg, insecure attachment *vs* secure attachment). Studies in high-income countries have identified biological, psychosocial, and behavioural protective factors for young children, but there are few studies from low-income and middle-income countries. The protective effects of breastfeeding and early cognitive and social–emotional stimulation were reviewed in previous sections. Maternal education also can act as a protective factor, reducing child mortality and promoting early child development (webappendix pp 49–50).

Young children of educated mothers have higher levels of cognitive development than children of less educated mothers.[118–120] Similarly, high-risk infants[121] and young

 Published online September 23, 2011 DOI:10.1016/S0140-6736(11)60555-2

children[122] show better developmental trajectories when their mothers have higher levels of education.

In panel 2 we show the protective mechanisms linking maternal education and early child development. Children of less-educated mothers are likely to have greater exposure to developmental risks and less access to interventions than children of more-educated mothers, suggesting that low maternal education identifies families in need of intervention.[118] However, poorly educated women might benefit less from participation in parent-focused programmes than better-educated women[124] (differential reactivity), emphasising the need for strategies to increase their participation and learning in early child-development interventions.

Conclusions

Major advances in neuroscience show how exposure to biological and psychosocial risk factors, prenatally and during early childhood, affects brain structure and function and compromises children's development and subsequent developmental trajectory. We summarise in figure 2 how risk and protective factors encountered before age 5 years compromise children's development. The greater the exposure to cumulative risks the greater

	Recent evidence	Implications
Risk factors		
Inadequate stimulation and opportunities for learning	Increased evidence of intervention benefits for social–emotional outcomes (ES* 0·24–0·71) and further evidence of benefits to cognitive outcomes (ES 0·27–0·85; table 2 and webappendix pp 41–45)	Need for effective strategies for scaling up of programmes that promote early stimulation and learning opportunities and integration with health and nutrition services for young children
Stunting (linear growth retardation)	Evidence of effect on ability at age 5 years (ES 0·2 for stunting at age 1 year) and long-term outcomes such as educational attainment, increased formal employment (ES 0·2 for 1 SD change in height for age at age 2) and psychological functioning (ES 0·4–0·5 comparing stunted and non-stunted)	Results further emphasise the importance of adequate nutrition in the first 2 years; stimulation should be an integral part of intervention for stunted children
Iodine deficiency	We did not discuss this in view of previous conclusive findings;[3] for recent supporting studies see webappendix p 51	Need for continued attention to expanding and ensuring quality control of fortification programmes
Iron-deficiency anaemia	Evidence for neurophysiological changes and neural mechanisms leading to developmental deficits; ES medium to large; increased evidence of long-term cognitive and behavioural effects of early iron-deficiency anaemia; ES small to large (webappendix pp 9–28)	Results emphasise the importance of prevention of iron deficiency early in life
IUGR	Consistent evidence for lower developmental levels in early childhood; evidence for long-term effects mixed (ES 0·19–0·31)	IUGR infants likely to benefit from early interventions to promote development; need for increased strategies to reduce IUGR including better maternal nutrition
Malaria	Increased evidence for long-term deficits due to cerebral and severe malaria; less information for children younger than 5 years but longitudinal studies suggest uncomplicated attacks are associated with reduced ability at school entry (reading and language one to four attacks ES0·37–0·47; greater than four attacks 0·57–0·92) and fewer attacks with better subsequent educational achievement (ES 0·22–0·62)	Need for expansion of prevention programmes (eg, insecticide-treated bednets)
Lead exposure	Evidence for adverse effects of low concentrations of prenatal exposure for child development (ES 0·19–0·27)	Continued attention to prevention of exposure to lead (eg, through removal of lead in paint, gasoline)
Maternal depression	Further evidence for adverse effects of maternal depressive symptoms on early child development and quality of parenting; community-based interventions with para-professionals effective in reducing depressive symptoms (ES 0·21–0·62)	Increased emphasis on early identification of women who are depressed; programmes to reduce maternal depressive symptoms and reduce risks for depression will probably benefit early child development
Exposure to violence	Exposure to violence detrimentally affects social–emotional development of young children (ES medium to large) and compromises primary caregiver child-rearing capabilities; some evidence that interventions can reduce stress reactions in young children (ES 0·56–0·91)	Need for interventions that can strengthen families exposed to societal violence and help caregivers reduce effect of exposure on young children
HIV infection†	Substantial evidence that development of infected children is delayed (ES usually medium to large; webappendix pp 33–37); US studies show developmental benefits from HAART, less evidence from low-income and middle-income countries; affected children might also have cognitive deficits and mental health problems	Need for increased coverage with HAART starting children on treatment in the first year of life, and for assessment of effect of treatment on developmental outcomes
Institutionalisation†	Recent evidence has documented adverse neural, cognitive, and behavioural effects for institutionalised children (ES for IQ 1·10, compared with family reared); improving quality of caregiving in institutions benefits cognitive and social–emotional competence (ES 0·43–0·84)	Strategies are needed to support foster and adoptive families to prevent children being placed in institutions; where children are institutionalised, strategies shown to improve early child development should be implemented
Protective factors		
Breastfeeding†	Stronger evidence for beneficial effects of exclusively breastfed and longer duration of breastfeeding (ES for IQ 0·38; grades attained 0·22–0·35)	Benefits to development add to existing reasons for promotion of breastfeeding
Maternal education†	Growing evidence on mechanisms linking maternal education to children's development (ES medium Cohen's h=0·73 to large Cohen's h=0·82, d=1·59)	Increased emphasis on educating women as part of an overall intervention package; ensure interventions are appropriate for women with little education

IUGR=intrauterine growth restriction. ES=effect sizes. HAART=highly active antiretroviral therapy. IQ=intelligence quotient. *ES are for studies reviewed in this paper that reported them or with sufficient information to compute; where specific ES are given, these are Cohen's d unless otherwise specified (previously reported effect sizes from earlier studies are reported in Walker and colleagues[3]). †Not reported as a high priority risk or protective factor in the previous Series in *The Lancet*.

Table 4: **High priority developmental risk and protective factors**

Panel 3: **Priorities for future research to reduce developmental inequalities in infants and young children from low-income and middle-income countries**

Maternal nutrition
- Effect of food supplementation before and during pregnancy on development of infants and young children.
- Effect of prenatal iron deficiency on postnatal cognitive and social–emotional development.
- Effect of supplementation with multiple micronutrients in pregnancy on child development by comparison with iron and folic acid alone.
- Effect of maternal supplementation with ω3 fatty acids on infant development.
- Long-term effects of IUGR on cognitive and social–emotional outcomes.

Child nutrition
- Effect of improving infant intake of essential fatty acids on development.
- Effect of supplementation with multiple micronutrients on development and comparison with effects of iron only.
- How to integrate nutrition and psychosocial stimulation programmes at scale.

Infections
- Effect of malaria prevention strategies on early child development.
- Effect of antiretroviral treatment on cognitive and behavioural outcomes and effect of non-medical interventions to promote development in children infected with HIV.
- Extent of mental health problems for infants and young children orphaned because of AIDS. Assessment of interventions to support caregivers and promote development of children affected by HIV.

Toxins
- Evidence on effect of toxins is inconsistent possibly because of interactions with other exposures. Longitudinal studies are needed to assess potential moderating variables (eg, nutrition).

Disabilities
- Assessment of the effect of interventions for children with disability and their families.
- Identification of barriers to accessing general services (eg, primary health care) as well as specialist services.

Learning opportunities and stimulation
- Modification of interventions to facilitate expansion, and assessment of effectiveness of programmes at scale.
- More evidence on the effect of early interventions on social and emotional development.

Maternal depression
- Assessment of effect of interventions to reduce depressive symptoms on child development and identification of strategies to expand access.

Violence
- Evidence needed on the neural and developmental effect of violence exposure on children younger than 5 years and on effective treatment strategies for young children exposed to violence.

Protective factors
- Need to identify additional protective factors for outcomes related to early child development in low-income and middle-income countries.

the inequality, suggesting that early interventions that prevent inequality are more effective than later interventions, which attempt to remedy cumulative deficits. Risk factors are likely to co-occur, emphasising the importance of integrated interventions involving the simultaneous reduction of multiple risks. The second paper in the Series discusses integrated interventions.

Inequalities in low-income and middle-income countries are established in early childhood and contribute to lifetime differences. Accumulated developmental deficits in early childhood place children on a lower lifetime trajectory with negative implications for adult cognitive and psychological functioning, educational attainment, and subsequent income, thus contributing to continued inequalities in the next generation.

In table 4, we list the risk and protective factors with sufficient evidence to be priorities for intervention and summarise the evidence reviewed. Previously identified key risks (inadequate stimulation, stunting, iodine deficiency, iron-deficiency anaemia) remain in need of urgent intervention to prevent the loss of developmental potential in millions of young children. Although there has been recent attention to the effect of early nutrition on development and health,[125] substantial progress in improving development is unlikely to be made without also increasing early learning opportunities.[126] A meta-analysis of non-US intervention studies[127] showed that cognitive benefits were greater when interventions included stimulation or education components compared with those comprising nutrition or economic assistance only. This strengthens the case for integration of stimulation with economic, nutrition, and health interventions.

New research strengthens the evidence for prioritisation of interventions to reduce the levels of IUGR, malaria, maternal depression, institutionalisation, and exposure to societal violence and to promote development in affected children. New research also suggests the adverse consequences for children infected with HIV or whose parents are infected. We highlight the importance of protective factors such as breastfeeding and higher maternal education, which can reduce the effect of risks. Knowledge of risk and protective factors can inform priorities for programmes and funding to promote early child development. This knowledge, plus increased understanding of the neural consequences of risks, provides persuasive data for advocacy and the design of early intervention programmes to reduce developmental inequalities.

Although effective interventions exist for some identified risks, further research is needed to increase our ability to promote early child development in low-income and middle-income countries. We list research priorities in panel 3. There has been little progress in some previously identified research priorities (eg, supplementation with multiple micronutrients, prenatal iron deficiency, and exposure to toxins). Additional research questions include the effect of prenatal maternal nutrition and stress on development, assessment of the effect of interventions to reduce maternal depression on child development, and assessment of strategies to reduce the

www.thelancet.com Published online September 23, 2011 DOI:10.1016/S0140-6736(11)60555-2

developmental consequences for children affected by violence and for children in families affected by HIV. Research is also needed to develop strategies to include children with disabilities in early child development programmes and provide them with specialist services, and to identify additional protective factors in low-income and middle-income countries.

Without the threats of biological and psychosocial risks, and with a caregiving environment that supports cognitive and social–emotional development, children experience healthy brain development that enables them to reach toward their developmental potential. With this strong foundation, they build lifespan developmental trajectories that enable them to benefit from family, community, and educational opportunities (figure 2). Effective interventions to promote early child development in low-income and middle-income countries exist either at scale or are potentially scalable. Interventions to reduce risks and support early child development will yield lifetime gains that contribute to the achievement and sustainability of improved development in the next generation. By investing in early child development programmes, we have an opportunity to break the cycle of inequities that has dominated the lives of millions of children and families in low-income and middle-income countries.

Contributors

All authors participated in the review of published work, and drafting and review of the report. SPW and TDW are the lead authors of this report and were responsible for the final draft and the decision to submit for publication. SG-M and MMB provided critical revision of the text. Reviews and drafting of individual topics were as follows: Brain development CAN and TDW; maternal undernutrition SG-M; micronutrients SG-M and MMB; essential fatty acids SLH; IUGR SPW; breastfeeding CAP; stunting SG-M; iron deficiency BL; diarrhoea MMB; malaria SG-M; other parasitic infections TDW; HIV JMM and LR; toxins JDH; disabilities HB-H; early learning opportunities SPW, SMC, and HBH; maternal depression AR; violence JMM and TDW; institutionalisation CAN, SG-M, and LR; and protective factors TDW. The steering committee of the Global Child Development Group coordinated the writing of the report in this Series.

Conflicts of interest

We declare that we have no conflicts of interest.

Acknowledgments

We thank Amika Wright for assistance with referencing and Anna Quigg for assistance with figure 2. A meeting of all authors to discuss review findings and coordinate the report was held in Jamaica in December, 2009, with the support of the Global Alliance for Improved Nutrition (GAIN), UNICEF, the Bernard van Leer Foundation, and the University of the West Indies. A follow-up steering committee meeting was held in May, 2010, with the support of UNICEF, the Bernard van Leer Foundation, and the Child Health and Nutrition Research Initiative. The sponsors had no role in the design and conduct of the review, interpretation and writing or the decision to submit for publication. HBH was supported by a Wellcome Trust Fellowship (# 080534/Z/06/Z). We thank the Global Child Development Group Secretariat for coordinating the meetings.

References

1 Walker SP, Wachs TD, Gardner JM, et al. Child development: risk factors for adverse outcomes in developing countries. *Lancet* 2007; **369:** 145–57.

2 Grantham-McGregor S, Cheung YB, Cueto S, Glewwe P, Richter L, Strupp B. Developmental potential in the first 5 years for children in developing countries. *Lancet* 2007; **369:** 60–70.

3 Friedman J, Sturdy J. The influence of economic crisis on early childhood development: a review of pathways and measured impact. In: Alderman H, ed. No small matter: the impact of poverty, shocks and human capital investments in early childhood development. Washington, DC: The World Bank, 2011: 51–83.

4 Sheffield P, Landrigan P. Global climate change and children's health: threats and strategies for prevention. *Environ Health Perspect* 2011; **119:** 291–98.

5 Engle PL, Black MM, Behrman JR, et al. Strategies to avoid the loss of developmental potential in more than 200 million children in the developing world. *Lancet* 2007; **369:** 229–42.

6 Hertzman C, Boyce T. How experience gets under the skin to create gradients in developmental health. *Annu Rev Public Health* 2010; **31:** 329–47.

7 Dawson G, Ashman SB, Carver LJ. The role of early experience in shaping behavioral and brain development and its implications for social policy. *Dev Psychopathol* 2000; **12:** 695–712.

8 Stiles J. The fundamentals of brain development: integrating nature and nurture. Cambridge, MA: Harvard University Press, 2008.

9 Fernald LC, Gunnar MR. Poverty-alleviation program participation and salivary cortisol in very low-income children. *Soc Sci Med* 2009; **68:** 2180–89.

10 Hackman DA, Farah MJ. Socioeconomic status and the developing brain. *Trends Cogn Sci* 2009; **13:** 65–73.

11 Talge NM, Neal C, Glover V. Antenatal maternal stress and long-term effects on child neurodevelopment: how and why? *J Child Psychol Psychiatry* 2007; **48:** 245–61.

12 Dowd JB, Simanek AM, Aiello AE. Socio-economic status, cortisol and allostatic load: a review of the literature. *Int J Epidemiol* 2009; **38:** 1297–309.

13 Black MM, Baqui AH, Zaman K, El Arifeen S, Black RE. Maternal depressive symptoms and infant growth in rural Bangladesh. *Am J Clin Nutr* 2009; **89:** 951S–7S.

14 Cooper PJ, Tomlinson M, Swartz L, et al. Improving quality of mother-infant relationship and infant attachment in socioeconomically deprived community in South Africa: randomised controlled trial. *BMJ* 2009; **338:** b974.

15 Walker SP, Thame MM, Chang SM, Bennett F, Forrester TE. Association of growth in utero with cognitive function at age 6–8 years. *Early Hum Dev* 2007; **83:** 355–60.

16 Tofail F, Persson LA, El Arifeen S, et al. Effects of prenatal food and micronutrient supplementation on infant development: a randomized trial from the Maternal and Infant Nutrition Interventions, Matlab (MINIMat) study. *Am J Clin Nutr* 2008; **87:** 704–11.

17 Hamadani JD, Grantham-McGregor SM, Tofail F, et al. Pre- and postnatal arsenic exposure and child development at 18 months of age: a cohort study in rural Bangladesh. *Int J Epidemiol* 2010; **39:** 1206–16.

18 Wachs TD, Kanashiro HC, Gurkas P. Intra-individual variability in infancy: structure, stability, and nutritional correlates. *Dev Psychobiol* 2008; **50:** 217–31.

19 Murray-Kolb LE, Beard JL. Iron deficiency and child and maternal health. *Am J Clin Nutr* 2009; **89:** 946S–50S.

20 Perez EM, Hendricks MK, Beard JL, et al. Mother-infant interactions and infant development are altered by maternal iron deficiency anemia. *J Nutr* 2005; **135:** 850–55.

21 McGrath N, Bellinger D, Robins J, Msamanga GI, Tronick E, Fawzi WW. Effect of maternal multivitamin supplementation on the mental and psychomotor development of children who are born to HIV-1-infected mothers in Tanzania. *Pediatrics* 2006; **117:** e216–25.

22 Li Q, Yan H, Zeng L, et al. Effects of maternal multimicronutrient supplementation on the mental development of infants in rural western China: follow-up evaluation of a double-blind, randomized, controlled trial. *Pediatrics* 2009; **123:** e685–92.

23 Caulfield LE, Putnick DL, Zavaleta N, et al. Maternal gestational zinc supplementation does not influence multiple aspects of child development at 54 mo of age in Peru. *Am J Clin Nutr* 2010; **92:** 130–36.

24 Christian P, Murray-Kolb LE, Khatry SK, et al. Prenatal micronutrient supplementation and intellectual and motor function in early school-aged children in Nepal. *JAMA* 2010; **304:** 2716–23.

For more on the **Global Child Development Group** see http://www.globalchilddevelopment.org

25 Innis SM, Friesen RW. Essential n-3 fatty acids in pregnant women and early visual acuity maturation in term infants. *Am J Clin Nutr* 2008; **87:** 548–57.

26 Colombo J, Kannass KN, Shaddy DJ, et al. Maternal DHA and the development of attention in infancy and toddlerhood. *Child Dev* 2004; **75:** 1254–67.

27 Judge MP, Harel O, Lammi-Keefe CJ. Maternal consumption of a docosahexaenoic acid-containing functional food during pregnancy: benefit for infant performance on problem-solving but not on recognition memory tasks at age 9 mo. *Am J Clin Nutr* 2007; **85:** 1572–77.

28 Kuklina EV, Ramakrishnan U, Stein AD, Barnhart HH, Martorell R. Early childhood growth and development in rural Guatemala. *Early Hum Dev* 2006; **82:** 425–33.

29 Santos DN, Assis AM, Bastos AC, et al. Determinants of cognitive function in childhood: a cohort study in a middle income context. *BMC Public Health* 2008; **8:** 202.

30 Martorell R, Horta BL, Adair LS, et al. Weight gain in the first two years of life is an important predictor of schooling outcomes in pooled analyses from five birth cohorts from low- and middle-income countries. *J Nutr* 2010; **140:** 348–54.

31 Walker SP, Chang SM, Younger N, Grantham-McGregor SM. The effect of psychosocial stimulation on cognition and behaviour at 6 years in a cohort of term, low-birthweight Jamaican children. *Dev Med Child Neurol* 2010; **52:** e148–54.

32 Emond AM, Lira PI, Lima MC, Grantham-McGregor SM, Ashworth A. Development and behaviour of low-birthweight term infants at 8 years in northeast Brazil: a longitudinal study. *Acta Paediatr* 2006; **95:** 1249–57.

33 Sabet F, Richter LM, Ramchandani PG, Stein A, Quigley MA, Norris SA. Low birthweight and subsequent emotional and behavioural outcomes in 12-year-old children in Soweto, South Africa: findings from Birth to Twenty. *Int J Epidemiol* 2009; **38:** 944–54.

34 Wang WL, Sung YT, Sung FC, Lu TH, Kuo SC, Li CY. Low birth weight, prematurity, and paternal social status: impact on the basic competence test in Taiwanese adolescents. *J Pediatr* 2008; **153:** 333–38.

35 Kramer MS, Aboud F, Mironova E, et al. Breastfeeding and child cognitive development: new evidence from a large randomized trial. *Arch Gen Psychiatry* 2008; **65:** 578–84.

36 Kramer MS, Fombonne E, Igumnov S, et al. Effects of prolonged and exclusive breastfeeding on child behavior and maternal adjustment: evidence from a large, randomized trial. *Pediatrics* 2008; **121:** e435–40.

37 Victora CG, Barros FC, Horta BL, Lima RC. Breastfeeding and school achievement in Brazilian adolescents. *Acta Paediatr* 2005; **94:** 1656–60.

38 Unay B, Sarici SU, Ulas UH, Akin R, Alpay F, Gokcay E. Nutritional effects on auditory brainstem maturation in healthy term infants. *Arch Dis Child Fetal Neonatal Ed* 2004; **89:** F177–79.

39 Adu-Afarwuah S, Lartey A, Brown KH, Zlotkin S, Briend A, Dewey KG. Randomized comparison of 3 types of micronutrient supplements for home fortification of complementary foods in Ghana: effects on growth and motor development. *Am J Clin Nutr* 2007; **86:** 412–20.

40 Chen CM, Wang YY, Chang SY. Effect of in-home fortification of complementary feeding on intellectual development of Chinese children. *Biomed Environ Sci* 2010; **23:** 83–91.

41 Alderman H, Hoddinott J, Kinsey B. Long term consequences of early childhood malnutrition. *Oxf Econ Pap* 2006; **58:** 450–74.

42 Carba DB, Tan VL, Adair LS. Early childhood length-for-age is associated with the work status of Filipino young adults. *Econ Hum Biol* 2009; **7:** 7–17.

43 Walker SP, Chang SM, Powell CA, Simonoff E, Grantham-McGregor SM. Early childhood stunting is associated with poor psychological functioning in late adolescence and effects are reduced by psychosocial stimulation. *J Nutr* 2007; **137:** 2464–69.

44 Crookston BT, Penny ME, Alder SC, et al. Children who recover from early stunting and children who are not stunted demonstrate similar levels of cognition. *J Nutr* 2010; **140:** 1996–2001.

45 Stein AD, Wang M, DiGirolamo A, et al. Nutritional supplementation in early childhood, schooling, and intellectual functioning in adulthood: a prospective study in Guatemala. *Arch Pediatr Adolesc Med* 2008; **162:** 612–18.

46 Hoddinott J, Maluccio JA, Behrman JR, Flores R, Martorell R. Effect of a nutrition intervention during early childhood on economic productivity in Guatemalan adults. *Lancet* 2008; **371:** 411–16.

47 Kordas K, Siegel EH, Olney DK, et al. The effects of iron and/or zinc supplementation on maternal reports of sleep in infants from Nepal and Zanzibar. *J Dev Behav Pediatr* 2009; **30:** 131–39.

48 Peirano PD, Algarin CR, Garrido MI, Lozoff B. Iron deficiency anemia in infancy is associated with altered temporal organization of sleep states in childhood. *Pediatr Res* 2007; **62:** 715–19.

49 Lozoff B, Smith JB, Clark KM, Perales CG, Rivera F, Castillo M. Home intervention improves cognitive and social–emotional scores in iron-deficient anemic infants. *Pediatrics* 2010; **126:** e884–94.

50 Shafir T, Angulo-Barroso R, Calatroni A, Jimenez E, Lozoff B. Effects of iron deficiency in infancy on patterns of motor development over time. *Hum Mov Sci* 2006; **25:** 821–38.

51 Lukowski AF, Koss M, Burden MJ, et al. Iron deficiency in infancy and neurocognitive functioning at 19 years: evidence of long-term deficits in executive function and recognition memory. *Nutr Neurosci* 2010; **13:** 54–70.

52 Corapci F, Calatroni A, Kaciroti N, Jimenez E, Lozoff B. Longitudinal evaluation of externalizing and internalizing behavior problems following iron deficiency in infancy. *J Pediatr Psychol* 2010; **35:** 296–305.

53 Black MM, Baqui AH, Zaman K, et al. Iron and zinc supplementation promote motor development and exploratory behavior among Bangladeshi infants. *Am J Clin Nutr* 2004; **80:** 903–10.

54 Dhingra P, Menon VP, Sazawal S, et al. Effect of fortification of milk with zinc and iron along with vitamins C, E, A and selenium on growth, iron status and devlopment in preschool children—a community based double-masked randomized trial. 2nd World congress of Pediatric Gastroenterology, Hepatology and Nutrition; Paris, France; July 3–7, 2004.

55 Lorntz B, Soares AM, Moore SR, et al. Early childhood diarrhea predicts impaired school performance. *Pediatr Infect Dis J* 2006; **25:** 513–20.

56 Patrick PD, Oria RB, Madhavan V, et al. Limitations in verbal fluency following heavy burdens of early childhood diarrhea in Brazilian shantytown children. *Child Neuropsychol* 2005; **11:** 233–44.

57 Checkley W, Buckley G, Gilman RH, et al. Multi-country analysis of the effects of diarrhoea on childhood stunting. *Int J Epidemiol* 2008; **37:** 816–30.

58 Kihara M, Carter JA, Newton CRJC. The effect of *Plasmodium falciparum* on cognition: a systematic review. *Trop Med Int Health* 2006; **11:** 386–97.

59 Bangirana P, Giordani B, John CC, Page C, Opoka RO, Boivin MJ. Immediate neuropsychological and behavioral benefits of computerized cognitive rehabilitation in Ugandan pediatric cerebral malaria survivors. *J Dev Behav Pediatr* 2009; **30:** 310–18.

60 Thuilliez J. Malaria and primary education: a cross-country analysis on repetition and completion rates. *Revue d'économie du développement* 2009; **2:** 127–57.

61 Fernando D, De Silva D, Carter R, Mendis KN, Wickremasinghe R. A randomized, double-blind, placebo-controlled, clinical trial of the impact of malaria prevention on the educational attainment of school children. *Am J Trop Med Hyg* 2006; **74:** 386–93.

62 Clarke SE, Jukes MC, Njagi JK, et al. Effect of intermittent preventive treatment of malaria on health and education in schoolchildren: a cluster-randomised, double-blind, placebo-controlled trial. *Lancet* 2008; **372:** 127–38.

63 Fernando D, Wickremasinghe R, Mendis KN, Wickremasinghe AR. Cognitive performance at school entry of children living in malaria-endemic areas of Sri Lanka. *Trans R Soc Trop Med Hyg* 2003; **97:** 161–65.

64 Olney DK, Pollitt E, Kariger PK, et al. Young Zanzibari children with iron deficiency, iron deficiency anemia, stunting, or malaria have lower motor activity scores and spend less time in locomotion. *J Nutr* 2007; **137:** 2756–62.

65 Jukes MC, Pinder M, Grigorenko EL, et al. Long-term impact of malaria chemoprophylaxis on cognitive abilities and educational attainment: follow-up of a controlled trial. *PLoS Clin Trials* 2006; **1:** e19.

66 Van Rie A, Harrington PR, Dow A, Robertson K. Neurologic and neurodevelopmental manifestations of pediatric HIV/AIDS: a global perspective. *Eur J Paediatr Neurol* 2007; **11:** 1–9.

67 Sherr L, Mueller J, Varrall R. A systematic review of cognitive development and child human immunodeficiency virus infection. *Psychol Health Med* 2009; **14:** 387–404.

68 Chiriboga CA, Fleishman S, Champion S, Gaye-Robinson L, Abrams EJ. Incidence and prevalence of HIV encephalopathy in children with HIV infection receiving highly active anti-retroviral therapy (HAART). *J Pediatr* 2005; **146:** 402–07.

69 Lindsey JC, Malee KM, Brouwers P, Hughes MD. Neurodevelopmental functioning in HIV-infected infants and young children before and after the introduction of protease inhibitor-based highly active antiretroviral therapy. *Pediatrics* 2007; **119:** e681–93.

70 Smith L, Adnams C, Eley B. Neurological and neurocognitive function of HIV infected children commenced on antiretroviral therapy. *S Afr J Child Health* 2008; **2:** 108–13.

71 Van Rie A, Dow A, Mupuala A, Stewart P. Neurodevelopmental trajectory of HIV-infected children accessing care in Kinshasa, Democratic Republic of Congo. *J Acquir Immune Defic Syndr* 2009; **52:** 636–42.

72 Van Rie A, Mupuala A, Dow A. Impact of the HIV/AIDS epidemic on the neurodevelopment of preschool-aged children in Kinshasa, Democratic Republic of the Congo. *Pediatrics* 2008; **122:** e123–28.

73 Sanmaneechai O, Puthanakit T, Louthrenoo O, Sirisanthana V. Growth, developmental, and behavioral outcomes of HIV-affected preschool children in Thailand. *J Med Assoc Thai* 2005; **88:** 1873–79.

74 Gray GE, Van Niekerk R, Struthers H, et al. The effects of adult morbidity and mortality on household welfare and the well-being of children in Soweto. *Vulnerable Children Youth Studies* 2006; **1:** 15–28.

75 Floyd S, Crampin AC, Glynn JR, et al. The social and economic impact of parental HIV on children in northern Malawi: retrospective population-based cohort study. *AIDS Care* 2007; **19:** 781–90.

76 Zabina H, Kissin D, Pervysheva E, et al. Abandonment of infants by HIV-positive women in Russia and prevention measures. *Reprod Health Matters* 2009; **17:** 162–70.

77 Cluver L, Gardner F. The mental health of children orphaned by AIDS: a review of international and southern African research. *J Child Adolesc Mental Health* 2007; **19:** 1–17.

78 Boris N, Thurman T, Snider L, Spencer E, Brown L. Infants and young children living in youth-headed households in Rwanda: implications of emerging data. *Infant Mental Health Journal* 2006; **27:** 584–602.

79 Lusk D, Mararu J, O'Gara C, et al. Community care for orphans and AIDS affected children. Kakamega: The Academy for Educational Development/Speak for the Child, 2003.

80 Jedrychowski W, Perera FP, Jankowski J, et al. Very low prenatal exposure to lead and mental development of children in infancy and early childhood: Krakow prospective cohort study. *Neuroepidemiology* 2009; **32:** 270–78.

81 Wang SX, Wang ZH, Cheng XT, et al. Arsenic and fluoride exposure in drinking water: children's IQ and growth in Shanyin county, Shanxi province, China. *Environ Health Perspect* 2007; **115:** 643–47.

82 Marques RC, Dorea JG, Bernardi JV, Bastos WR, Malm O. Prenatal and postnatal mercury exposure, breastfeeding and neurodevelopment during the first 5 years. *Cogn Behav Neurol* 2009; **22:** 134–41.

83 Myers GJ, Thurston SW, Pearson AT, et al. Postnatal exposure to methyl mercury from fish consumption: a review and new data from the Seychelles Child Development Study. *Neurotoxicology* 2009; **30:** 338–49.

84 Davidson PW, Jean SR, Myers GJ, et al. Association between prenatal exposure to methylmercury and visuospatial ability at 10·7 years in the Seychelles Child Development Study. *Neurotoxicology* 2008; **29:** 453–59.

85 Handal AJ, Lozoff B, Breilh J, Harlow SD. Effect of community of residence on neurobehavioral development in infants and young children in a flower-growing region of Ecuador. *Environ Health Perspect* 2007; **115:** 128–33.

86 Torres-Sanchez L, Schnaas L, Cebrian ME, et al. Prenatal dichlorodiphenyldichloroethylene (DDE) exposure and neurodevelopment: a follow-up from 12 to 30 months of age. *Neurotoxicology* 2009; **30:** 1162–65.

87 Tang D, Li TY, Liu JJ, et al. Effects of prenatal exposure to coal-burning pollutants on children's development in China. *Environ Health Perspect* 2008; **116:** 674–79.

88 Edwards SC, Jedrychowski W, Butscher M, et al. Prenatal exposure to airborne polycyclic aromatic hydrocarbons and children's intelligence at 5 years of age in a prospective cohort study in Poland. *Environ Health Perspect* 2010; **118:** 1326–31.

89 Mirza I, Tareen A, Davidson LL, Rahman A. Community management of intellectual disabilities in Pakistan: a mixed methods study. *J Intellect Disabil Res* 2009; **53:** 559–70.

90 Pal DK, Chaudhury G, Sengupta S, Das T. Social integration of children with epilepsy in rural India. *Soc Sci Med* 2002; **54:** 1867–74.

91 Russell PS, al John JK, Lakshmanan JL. Family intervention for intellectually disabled children: randomised controlled trial. *Br J Psychiatry* 1999; **174:** 254–58.

92 McConachie H, Huq S, Munir S, Ferdous S, Zaman S, Khan NZ. A randomized controlled trial of alternative modes of service provision to young children with cerebral palsy in Bangladesh. *J Pediatr* 2000; **137:** 769–76.

93 Saloojee G, Phohole M, Saloojee H, IJsselmuiden C. Unmet health, welfare and educational needs of disabled children in an impoverished South African peri-urban township. *Child Care Health Dev* 2007; **33:** 230–35.

94 Jin X, Sun Y, Jiang F, Ma J, Morgan C, Shen X. "Care for Development" intervention in rural China: a prospective follow-up study. *J Dev Behav Pediatr* 2007; **28:** 213–18.

95 Nair MK, Philip E, Jeyaseelan L, George B, Mathews S, Padma K. Effect of Child Development Centre model early stimulation among at risk babies—a randomized controlled trial. *Indian Pediatr* 2009; **46** (suppl)**:** s20–26.

96 Potterton J, Stewart A, Cooper P, Becker P. The effect of a basic home stimulation programme on the development of young children infected with HIV. *Dev Med Child Neurol* 2010; **52:** 547–51.

97 Baker-Henningham H, Walker SP, Powell C, Gardner JM. Preventing behaviour problems through a universal intervention in Jamaican basic schools: a pilot study. *West Indian Med J* 2009; **58:** 460–64.

98 Nahar B, Hamadani JD, Ahmed T, et al. Effects of psychosocial stimulation on growth and development of severely malnourished children in a nutrition unit in Bangladesh. *Eur J Clin Nutr* 2009; **63:** 725–31.

99 Kagitcibasi C, Sunar D, Bekman S, Baydar N, Cemalcilar Z. Continuing effects of early enrichment in adult life: The Turkish Early Enrichment Project 22 years later. *J Appl Dev Psychol* 2009; **30:** 764–79.

100 Walker SP, Chang SM, Powell CA, Simonoff E, Grantham-McGregor SM. Effects of psychosocial stimulation and dietary supplementation in early childhood on psychosocial functioning in late adolescence: follow-up of randomised controlled trial. *BMJ* 2006; **333:** 472.

101 Wachs TD, Black MM, Engle PL. Maternal depression: a global threat to children's health, development, and behavior and to human rights. *Child Development Perspectives* 2009; **3:** 51–59.

102 Rahman A, Malik A, Sikander S, Roberts C, Creed F. Cognitive behaviour therapy-based intervention by community health workers for mothers with depression and their infants in rural Pakistan: a cluster-randomised controlled trial. *Lancet* 2008; **372:** 902–09.

103 Almqvist K, Broberg AG. Young children traumatized by organized violence together with their mothers—the critical effects of damaged internal representations. *Attach Hum Dev* 2003; **5:** 367–80.

104 Thabet AA, Karim K, Vostanis P. Trauma exposure in pre-school children in a war zone. *Br J Psychiatry* 2006; **188:** 154–58.

105 Kithakye M, Morris AS, Terranova AM, Myers SS. The Kenyan political conflict and children's adjustment. *Child Dev* 2010; **81:** 1114–28.

106 Lustig S. An ecological framework for the refugee experience: what is the impact on child development? In: Evans GW, Wachs TD, eds. Chaos and its influence on children's development: an ecological perpective, 1st ed. Washington, DC: American Psychological Association, 2010: 239–52.

107 Qouta S, Punamaki RL, El Sarraj E. Child development and family mental health in war and military violence: the Palestinian experience. *Int J Behav Dev* 2008; **32:** 310–21.

108 Sadeh A, Hen-Gal S, Tikotzky L. Young children's reactions to war-related stress: a survey and assessment of an innovative intervention. *Pediatrics* 2008; **121:** 46–53.

109 Rutter M, Sonuga-Barke EJ, Beckett C, et al. Deprivation-specific psychological patterns: effects of institutional deprivation. *Monogr Soc Res Child Dev* 2010; **75:** 1–252.

110 van IJzendoorn MH, Lujik M, Juffer F. IQ of children growing up in children's homes a meta-analysis on IQ delays in orphanages. *Merrill-Palmer Quarterly* 2008; **54:** 341–66.

111 Mehta MA, Golembo NI, Nosarti C, et al. Amygdala, hippocampal and corpus callosum size following severe early institutional deprivation: the English and Romanian Adoptees study pilot. *J Child Psychol Psychiatry* 2009; **50:** 943–51.

112 Fries AB, Shirtcliff EA, Pollak SD. Neuroendocrine dysregulation following early social deprivation in children. *Dev Psychobiol* 2008; **50:** 588–99.

113 Tottenham N, Hare TA, Quinn BT, et al. Prolonged institutional rearing is associated with atypically large amygdala volume and difficulties in emotion regulation. *Dev Sci* 2010; **13:** 46–61.

114 Marshall PJ, Reeb BC, Fox NA, Nelson CA III, Zeanah CH. Effects of early intervention on EEG power and coherence in previously institutionalized children in Romania. *Dev Psychopathol* 2008; **20:** 861–80.

115 Nelson CA, Furtado EA, Fox NA, Zeanah CH. The deprived human brain. *Am Sci* 2009; **97:** 222–29.

116 The St Petersburg–USA Orphanage Research Team. The effects of early social-emotional and relationship experience on the development of young orphanage children. *Monogr Soc Res Child Dev* 2008; **73:** 1–297.

117 van IJzendoorn MH, Juffer F. The Emanuel Miller Memorial Lecture 2006—adoption as intervention: meta-analytic evidence for massive catch-up and plasticity in physical, socio-emotional, and cognitive development. *J Child Psychol Psychiatry* 2006; **47:** 1228–45.

118 Barros AJ, Matijasevich A, Santos IS, Halpern R. Child development in a birth cohort: effect of child stimulation is stronger in less educated mothers. *Int J Epidemiol* 2010; **39:** 285–94.

119 Castro DC, Lubker BB, Bryant DM, Skinner M. Oral language and reading abilities of first-grade Peruvian children: associations with child and family factors. *Int J Behav Dev* 2002; **26:** 334–44.

120 Paxson C, Schady N. Cognitive development among young children in Ecuador: the roles of wealth, health, and parenting. *J Hum Resour* 2007; **42:** 49–84.

121 Wang LW, Wang ST, Huang CC. Preterm infants of educated mothers have better outcome. *Acta Paediatr* 2008; **97:** 568–73.

122 Stith AY, Gorman KS, Choudhury N. The effects of psychosocial risk and gender on school attainment in Guatemala. *Applied Psychology* 2003; **52:** 614–29.

123 Boyle MH, Racine Y, Georgiades K, et al. The influence of economic development level, household wealth and maternal education on child health in the developing world. *Soc Sci Med* 2006; **63:** 2242–54.

124 Shin JY, Nhan NV, Lee SB, Crittenden KS, Flory M, Hong HT. The effects of a home-based intervention for young children with intellectual disabilities in Vietnam. *J Intellect Disabil Res* 2009; **53:** 339–52.

125 Victora CG, Adair L, Fall C, et al. Maternal and child undernutrition: consequences for adult health and human capital. *Lancet* 2008; **371:** 340–57.

126 Black MM, Walker SP, Wachs TD, et al. Policies to reduce undernutrition include child development. *Lancet* 2008; **371:** 454–55.

127 Nores M, Barnett WS. Benefits of early childhood interventions across the world: (under) investing in the very young. *Economics of Education Review* 2009; **29:** 271–82.

Child Development 2

Strategies for reducing inequalities and improving developmental outcomes for young children in low-income and middle-income countries

Patrice L Engle, Lia C H Fernald, Harold Alderman, Jere Behrman, Chloe O'Gara, Aisha Yousafzai, Meena Cabral de Mello, Melissa Hidrobo, Nurper Ulkuer, Ilgi Ertem, Selim Iltus, and the Global Child Development Steering Group

This report is the second in a Series on early child development in low-income and middle-income countries and assesses the effectiveness of early child development interventions, such as parenting support and preschool enrolment. The evidence reviewed suggests that early child development can be improved through these interventions, with effects greater for programmes of higher quality and for the most vulnerable children. Other promising interventions for the promotion of early child development include children's educational media, interventions with children at high risk, and combining the promotion of early child development with conditional cash transfer programmes. Effective investments in early child development have the potential to reduce inequalities perpetuated by poverty, poor nutrition, and restricted learning opportunities. A simulation model of the potential long-term economic effects of increasing preschool enrolment to 25% or 50% in every low-income and middle-income country showed a benefit-to-cost ratio ranging from 6·4 to 17·6, depending on preschool enrolment rate and discount rate.

Published **Online** September 23, 2011 DOI:10.1016/S0140-6736(11)60889-1

See **Online/Comment** DOI:10.1016/S0140-6736(11)61450-5

This is the second in a **Series** of two reports about child development

Psychology, California Polytechnic State University, San Luis Obispo, CA, USA (Prof P L Engle PhD); **School of Public Health, University of California at Berkeley, Berkeley, CA, USA** (L C H Fernald PhD); **Development Research Group, The World Bank, Washington, DC, USA** (H Alderman PhD); **Department of Economics and Department of Sociology, University of Pennsylvania, Philadelphia, PA, USA** (Prof J Behrman PhD); **The William and Flora Hewlett Foundation, Menlo Park, CA, USA** (C O'Gara PhD); **Department of Paediatrics and Health, Division of Women and Child Health, Aga Khan University, Karachi, Pakistan** (A Yousafzai PhD); **World Health Organization, Geneva, Switzerland** (M Cabral de Mello PsyD); **International Food Policy Research Institute, Washington, DC, USA** (M Hidrobo PhD); **United Nations Children's Fund, New York, NY, USA** (N Ulkuer PhD); **Department of Pediatrics, Faculty of Medicine, University of Ankara, Ankara, Turkey** (Prof I Ertem PhD); **and Bernard van Leer Foundation, The Hague, Netherlands** (S Iltus PhD)

Correspondence to:
Prof Patrice L Engle, California Polytechnic State University, Psychology, 1 Grand Avenue, San Luis Obispo, CA 93407, USA
pengle@calpoly.edu

Introduction

This report, the second in a Series, assesses the effectiveness of early child development intervention programmes in low-income and middle-income countries, calculates the cost of not investing in early child development, and builds on the 2007 Series in *The Lancet* on child development.[1–3] The first report[4] of the present Series identified social–cultural, psychosocial, and biological risk and protective factors that affect child development. The theoretical framework used in both reports, presented in the first figure of the first report, illustrates how children's developmental trajectories are affected by biological systems and by positive and negative risk and protective factors. The intensity of these effects relates to the developmental periods in which the risk factors happen (timing), the dose or extent of the risks (exposure), and the child's individual reactivity (temperament) to the risk and protective factors. Effective programmes, policies, and other interventions can protect children from the negative consequences of living in poverty.

Inequalities between and within countries

Social and economic differences, both between and within countries, contribute to inequalities in children's development. The WHO Commission on the Social Determinants of Health, in a World Health Assembly report,[5] highlighted the social injustice of "avoidable health inequalities" and concluded that social and economic policies addressing early child development can affect whether children develop to their potential or experience a constrained life-course trajectory. Not only are there major differences between countries in preschool attendance by gross national income (GNI), but also within countries. Children in the highest income quintile in a particular country are more than twice as likely to attend preschool (figure 1) as those in the lowest quintile in the same country, and are also more likely to have higher quality stimulation in the home (figure 2), as measured by Family Care Indicators (methods for both figures described in panel 1). Similarly, children aged 5 years in the highest-income

Key messages

- Early childhood is the most effective and cost-efficient time to ensure that all children develop their full potential. The returns on investment in early child development are substantial.
- Reducing inequalities requires integrated interventions early in life that target the many risks to which vulnerable children are exposed.
- Parenting interventions and centre-based programmes can improve children's cognitive and social–emotional development and school readiness.
- Quality in early child development programmes can be maximised through design, curriculum, practise for parents, training for childcare workers, monitoring and assessment, governance, and supervision.
- Increasing preschool enrolment to 25% or 50% in each low-income and middle-income country would result in a benefit-to-cost ratio ranging from 6·4 to 17·6 depending on preschool enrolment rate and discount rate.
- Unless governments allocate more resources to quality early child development programmes for the poorest people in the population, economic disparities will continue and widen.

Search strategy and selection criteria

In our systematic review, we searched databases including Psychinfo, PubMed, Google Scholar, Global Health, Econ Lit, ISI Web of Science, Academic Search Elite, the World Bank website, the UNICEF Evaluation Database, and the Brookings Institution website, and we used personal contacts to identify unpublished work in both English and Spanish. Our primary search was done between September, 2009, and December, 2010, and we limited our search to papers that had been published since July, 2006, when the previous review was completed. We also included earlier papers that had not been included in the 2007 review. Our goal was to identify assessments of effectiveness interventions and programmes that included psychosocial components such as child stimulation, responsive interaction, early education, or other social investments, usually in combination with health, nutritional, social safety net, or parent educational interventions. Except for the informal searches, the search for published work was done in English, and the terms used in the review for intervention type were "parenting", "preschool", "pre-primary", "early learning", "stimulation", "conditional cash transfer", "media", "television", "Sesame Street", "social investment", and "educational intervention", and the terms for outcome measures were "early child development", "cognition", "language", "behaviour", or "socio-emotional development". We only included studies that focused on children aged 0–5 years that were undertaken in low-income or middle-income countries.

We defined selection criteria separately for effectiveness studies and for programme assessments. For effectiveness studies, we included only those with a comparison group that met the criteria for "moderate or strong quality" of design according to the McMaster University Effective Public Health Practice Project Quality Assessment Tool For Quantitative Studies. These quality ratings were made by at least two of the authors. All studies included in the review had to have either a randomised controlled design at the individual or cluster level, or a cohort analytic design, defined as an observational study design where groups are assembled according to whether or not exposure to the intervention has happened and study groups might be non-equivalent or not comparable on some feature that affects outcome. For a moderate rating, there should have been either initial equivalence of the two groups or statistical controls for at least 80% of potential confounders. Econometric methods acceptable for assessing causality were accepted here also. For programme assessments, the assessments of quality related primarily to meeting accuracy standards, and included reporting valid and reliable data, sound analytic designs and analyses, and explicit and justifiable interpretations and conclusions.

42 efficacy or effectiveness studies and programme assessments met these criteria for all interventions. Studies that were eliminated had small sample sizes (defined as n<50), did not include a psychosocial intervention, focused on children outside of the 0–5 year age group, had been reviewed in the previous analysis, did not meet the moderate or accurate quality standard for research design, or used outcome measures that were not valid. To be included in our review, studies were required to have been published in a peer-reviewed journal, or be available online as a working paper—student theses were not included. Although the period of early child development is often defined as lasting until the transition to school (age 8 years) we focus on children aged 0–5 years, which includes most children in learning programmes before school attendance.

See Online for webappendix

quintile had language performance between 0·5 and 1·5 SDs higher than those in the lowest-income quintile (figure 3) in Ethiopia, India, Peru, and Vietnam (Young Lives Longitudinal Study; panel 1).[8]

Early child development programmes

The challenge of sustainable improvement

Despite evidence of the potential effectiveness of interventions in early childhood, policy makers and planners are challenged by designing interventions that sustainably improve early child development at scale.[9] In our previous review[3] we reported that 18 of 20 early child development programmes in low-income and middle-income countries substantially affected early child development, with the largest effects in comprehensive programmes. Other recent reviews,[10,11] which included high-income countries, identified benefits from early child development interventions, particularly those incorporating educational or stimulation components.

Our present systematic review (see search strategy) included 42 effectiveness trials and programme assessments of parenting support and education, pre-primary or preschool centres, conditional cash transfer programmes, educational media for children, and interventions for children at high risk (panel 2 provides a summary of the main findings). The effectiveness trials met the public health standards of experimental design[12] and content criteria. Programme assessments were measured with reference to programme evaluation standards.[13] These assessments often used quasi-experimental or matched designs, post-test only designs, or controlled for confounding factors with statistical and econometric methods. The programme assessments are included because they provide unique information about programmes at scale when the standards of a high quality effectiveness trial might not be possible.

Parenting and education support

Parenting interventions promote parent–child interactions to improve responsiveness in feeding infants and young children;[14,15] increase attachment;[16,17] and encourage learning, book reading, play activities,[15,18] positive discipline,[19] and problem-solving related to children's development, care, and feeding.[20] Parenting education and support are often delivered through home visits, community groups, regular clinic visits, media or in combination with other components.

15 assessments (11 effectiveness trials and four scaled-up programmes) of parenting interventions met our criteria (table 1 and webappendix pp 1–6). Parenting interventions used home visits, primary health care visits,[18,20,25,26] group sessions with caregivers, and a combination of group sessions, home visits, community activities, and primary health care and nutritional services. Seven interventions worked primarily with parents or caregivers[15,20,24–28] and eight worked with parents or caregivers and children together.[14,16–19,21–23] All 15 interventions had defined curricula or key messages.

Substantial positive effects on child development were identified in all 11 effectiveness studies; nine on cognitive or social–emotional development, and two on parent knowledge, home stimulation, and learning activities with children,[20,24] which are associated with child development.[29] Effect sizes were larger for interventions that included both parent and child programmes (median 0·46, range 0·04–0·97) than for parent-only

programmes (0·12, 0·03–0·34). In some cases, effects were greater for younger children compared with older children,[22] and for poorer children compared with richer children.[25] Effects for some information-based, parent-only interventions were small.[24] The most effective programmes were those with systematic training methods for the workers, a structured and evidence-based curriculum, and opportunities for parental practice with children with feedback. The total number of contacts with parents in these studies varied from two to more than 100, but number of contacts was not clearly related to the size of the effect. However, a recent review of home visiting programmes reported that higher frequency of contact (at least fortnightly) was related to effectiveness.[30]

Of the four assessments of scaled-up programmes, in Uzbekistan small effects on parent activities but not child milestones were identified,[27] and in The Gambia no effects were identified.[27,28] Both assessments used community volunteers and incorporated early child development messages into pre-existing health and nutrition programmes. In Ecuador and central Asia moderate but consistent effects on child development were identified.[23,26] In Ecuador, the programme *Educa tu Hijo* (Educate your Child) was adapted from Cuba's model, which combines health care with a carefully structured parenting programme coordinated by the health sector and community committees. Children in the programme had higher cognitive scores than those not in the programme.[23]

In central Asia, the assessment of the implementation of the Care for Development module of Integrated Management of Childhood Illness noted that children's developmental scores were substantially higher in intervention districts than in similar control districts. There were also improvements in parents' activities with children and in health-worker recommendations.[26] The Care for Development module, developed by WHO and UNICEF, trains health workers to provide specific behavioural recommendations to caregivers about play, communication, and responsive feeding.[31] Two effectiveness studies (reported above) also assessed the Care for Development module and identified substantial effects on home stimulation[20] and child development.[18] In general, parenting programmes that were more effective had a well developed parenting curriculum, adequate training of workers, a balance of health, nutrition, and early child development components, and both community and governmental (local or national) support.[23]

In high-income countries,[32] three meta-analyses of parenting and home visiting programmes[32–34] identified similar factors contributing to programme effectiveness: systematic curricula, training for workers and parent educators, and active strategies to promote caregiver behaviour change, such as feedback, coaching, roleplay, and videotaped interactions. They also noted that the quality of the relationship between parent and worker was positively correlated with effectiveness.[32,33,34] Long duration did not necessarily result in better outcomes. A meta-analysis of US programmes, for example, identified that an intervention including only 16 effective, high-quality sessions showed substantial effects on parent–child interactions.[35]

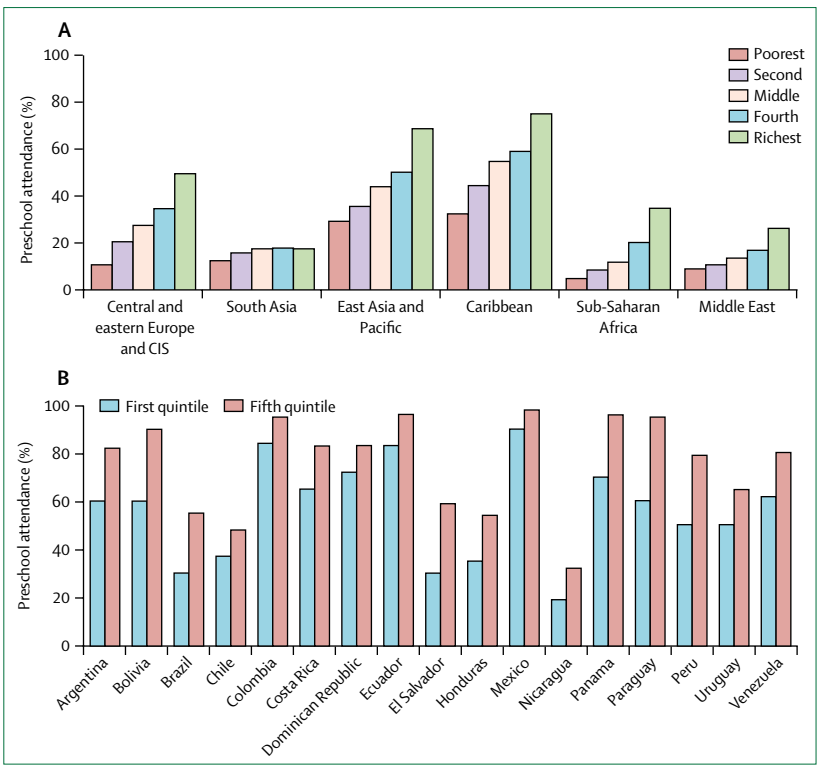

Figure 1: **Proportion of young children attending preschool in 58 low-income and middle-income countries by income quintile within country summed across sample countries by region (A) and by country in Latin America (B)**

(A) Data are from the UNICEF's 2005 Multiple Indicator Cluster Survey 3 for children aged 3 and 4 years. Countries included in each region are Albania, Belarus, Bosnia and Herzegovina, Georgia, Kazakhstan, Kyrgyzstan, Macedonia, Serbia, Tajikistan, Ukraine, Uzbekistan (central and eastern Europe, CIS, and Baltic states); Bangladesh (south Asia); Laos, Mongolia, Thailand, Vanuatu, Vietnam (east Asia and Pacific); Belize, Guyana, Jamaica, Suriname, Trinidad and Tobago (Caribbean); Burkina Faso, Burundi, Cameroon, Central African Republic, Côte d'Ivoire, Djibouti, Gambia, Ghana, Guinea-Bissau, Malawi, Mauritania, Nigeria, Sierra Leone, Somalia, Togo (sub-Saharan Africa); Iraq, Lebanon, Syria, Yemen (Middle East). (B) Adapted from Vegas and Santibanez,[6] with permission. The rates in Argentina, El Salvador, Honduras, Peru, and Venezuela are for children aged 3–6 years; in Bolivia, Colombia, Costa Rica, Mexico, Panama, and Paraguay for children aged 5–6 years; and in the Dominican Republic and Nicaragua are for children aged 4–6 years. In all other countries the rates are for children aged 0–6 years. Income quintiles are calculated within country and summed across regional areas. CIS=Commonwealth of Independent States.

For the **data from the Multiple Indicator Cluster Survey** see http://www.childinfo.org

Although many low-income and middle-income countries have put child development messages on child health cards, growth charts, and so-called baby passports, there were few assessments of their effectiveness in low-income and middle-income countries. In one study in India, literate parents who kept a card with Care for Development messages for 2 months increased their recall, understanding, and reported appreciation of these messages.[36]

Preschool, childcare centres, and daycare

We also assessed effects of two preschool models: formal pre-primary or preschool programmes—generally linked

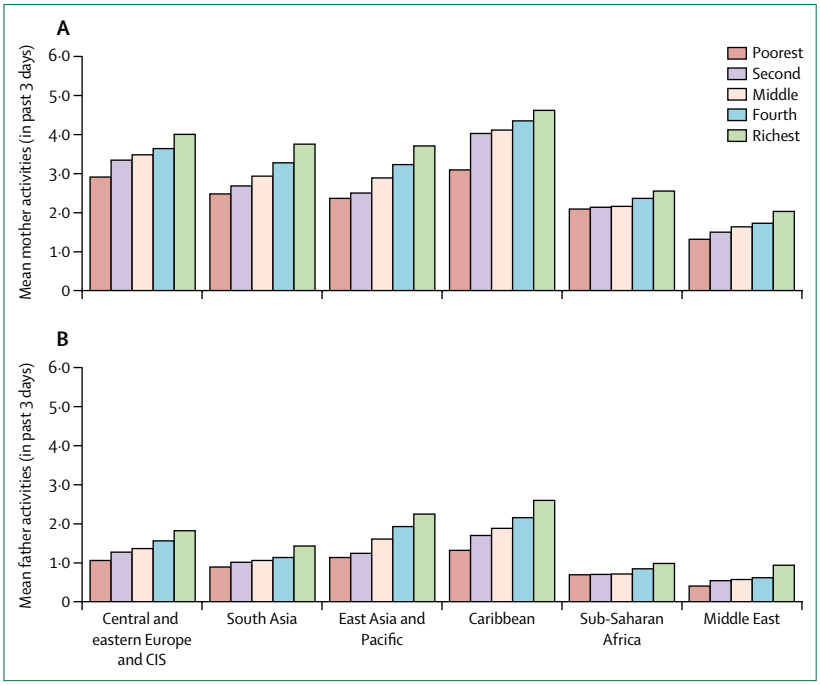

Figure 2: **Mother's (A) and father's (B) total activities in the past 3 days by sampled countries within region and within-country wealth quintile for 38 countries**

Data are from the UNICEF's 2005 Multiple Indicator Cluster Survey 3. Countries included in each region are Albania, Belarus, Bosnia and Herzegovina, Georgia, Kazakhstan, Kyrgyzstan, Macedonia, Montenegro, Serbia, Tajikistan, Uzbekistan (central and eastern Europe, CIS, and Baltic states); Bangladesh (south Asia); Laos, Mongolia, Thailand, Vanuatu, Vietnam (east Asia and Pacific); Belize, Guyana, Jamaica, Suriname, Trinidad and Tobago (Caribbean); Burkina Faso, Burundi, Cameroon, Central African Republic, Côte d'Ivoire, Djibouti, Gambia, Ghana, Guinea-Bissau, Mauritania, Nigeria, Sierra Leone, Somalia, Togo (sub-Saharan Africa); Iraq, Lebanon, Syria, Yemen (Middle East). CIS=Commonwealth of Independent States.

Panel 1: Methods used for within-country analysis

For the data based on UNICEF's Multiple Indicator Cluster Survey (MICS) presented in figure 1 and figure 2, income quintiles were calculated by UNICEF for each country on the basis of estimates of income and assets, and were summed across countries. For the data from the Young Lives study in figure 3, expenditures were calculated for all sample households in each country (about 2000) and included food, transport, security, telephone, electricity, water supply, housing, clothes, footwear, and other items. Quintiles of expenditure were then created separately for each country on the basis of the aggregation of all sampled households in that country. Language scores for children were assessed with the Peabody Picture Vocabulary Test,[7] and the mean was set at 0 with an SD of 1. The mean language scores for each expenditure quintile are presented for each country in terms of SDs.

to schools or offered by private providers, with curricula, learning materials, paid and trained teaching staff, and a fixed classroom site—and non-formal or community-based preschools, which tend not to have professionally trained teachers and might have locally adapted sites. We divided the preschool studies into those comparing preschool attendance with no attendance, and others comparing attendance at improved preschools with attendance at non-improved preschools. Unfortunately, no studies were identified that assessed the effect of daycare—the provision of full daycare for infants and young children of employed caregivers, which vary from offering only custodial care to educational care.

15 assessments (10 effectiveness studies and five programme assessments) met the relevant inclusion criteria (table 2 and webappendix pp 7–15). Nine studies,[37–50] including five programme assessments, compared preschool attendees with non-attendees, controlling for initial differences. In eight, attendees had higher scores on one or more measures of child development, such as literacy, vocabulary, mathematics, quantitative reasoning, and teacher assessments of performance at the end of the year. In one programme assessment, attendees had lower cognitive scores than non-attendees.[42] However, children who attended for more than 16 months scored higher on cognitive tests than age-matched children who had attended for 2 months or less.[42] Only two of four studies that assessed the effects of preschools on social and behavioural development reported positive effects.[39,52] Although the effects of non-formal preschools on child outcomes were typically weaker than the effects of formal preschools, some non-formal preschool programmes resulted in better early child development outcomes compared with non-participants.[37,49,50]

Similar to the parenting intervention findings, studies of children in preschools showed greater benefits for higher-risk[39] or more disadvantaged[41] children compared with lower-risk or less disadvantaged children. Often the longer-term benefits of preschool attendance decreased during primary school,[43] but some studies identified longer-term effects. Preschool attendance was associated with improved school performance through second and third grades in some reports,[41,43,52] and effects were even larger in adolescence.[52]

Being enrolled in higher quality or improved preschool programmes compared with standard programmes was associated with better learning outcomes in all studies and programme assessments that compared them.[43–51,53] Effective innovations included structured pre-reading programmes in Bangladesh[48] and Costa Rica,[51] formal rather than informal preschools in China and Cambodia,[49,50] a teacher training programme in Jamaica,[44] child-centred methods or interactive teacher–child methods of instruction in Bangladesh[46] and east Africa,[38,45] and interactive radio or audio instruction to guide classes for teachers in Zanzibar.[47] Two studies identified that social and behavioural interventions led to improved behaviour, school success, and persistence.[44,52] Interactive radio instruction has also been used in Bolivia, Honduras, Indonesia, and El Salvador at scale to improve the quality of the preschool experience, although it has not been assessed.[54]

The median effect sizes for preschool interventions, when they could be calculated, were moderate and

 Published online September 23, 2011 DOI:10.1016/S0140-6736(11)60889-1

similar for preschool attendance (median 0·24, range –0·14 to 1·68) and for quality improvements (0·28, –0·23 to 0·69; table 2).

Promising directions for programming

Since poverty is a root cause of poor child development, some approaches to improving early child development are aimed at making those improvements through poverty alleviation. Cash transfer programmes are a popular approach to long-term poverty alleviation;[55,56] the expectation of conditional cash transfer programmes is that families use cash transfers both to help parents provide for their children's needs and as an incentive for parents to invest in their children's health and education.[57–59]

Many conditional cash transfer programmes distribute benefits conditional on mandatory attendance at preventive health-care services and health and nutrition education sessions designed to promote positive behavioural changes, and some programmes also require school attendance for children of school age. Whether conditionality makes a difference in the outcomes of cash transfer programmes is a crucial research question. We are aware of only three evaluations of cash transfer programmes in Latin America that have included assessments of cognitive or language function in preschool children (Mexico,[60,61] Nicaragua,[62] and Ecuador[63,64]) and programme effects on cognition and language development are generally positive, but small. Some cash transfer programmes (eg, Mexico's *Oportunidades*) are at present experimenting with the inclusion of programme requirements that involve the promotion of child development (eg, parents must participate in weekly classes on parenting).

As television and radio ownership increases in low-income and middle-income countries, educational programming (content that is educational, non-violent, and designed for young children) might be a viable option for improving early child development (webappendix pp 16–17). Sesame Street, for example, is available in more than 120 countries.[65] Research from the USA shows benefits of educational programming on the cognitive development and social understanding[65] of children older than 2 years,[66] but non-educational television has been linked with outcomes such as child obesity and violent behaviour.[65]

Two effectiveness studies in low-income and middle-income countries have shown positive effects of educational television (a Bangladeshi Sesame Street [Sisimpur] and a Turkish experimental children's programme) on child mathematics and literacy scores.[67,68] Bangladeshi families reported doing more to support their children's learning after viewing the programme,[69] and in a longitudinal study poorer children benefited more.[70] Children's television can also increase young children's acceptance of negatively perceived groups (eg, Israelis and Palestinians).[71] In poor families in high-income countries, providing books for young children through primary health services has been shown to increase how often parents read to their children and to improve child language.[11]

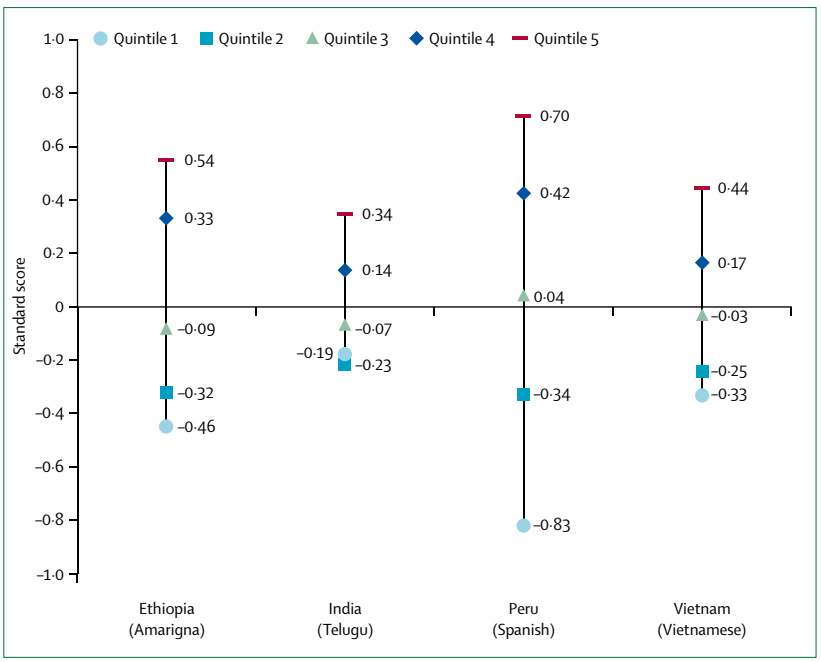

Figure 3: **Peabody Picture Vocabulary Test[7] standard scores by country and quintile of expenditure**
Data for children (aged 5–6 years) speaking the majority language of the region or country (in parentheses).

Panel 2: **Conclusions from the analysis of intervention effects**

- Parenting education and support can improve children's cognitive and psychosocial development
  - Effects are larger in more disadvantaged populations
  - Effects are larger when there are systematic curricula and training opportunities for childcare workers and parents
  - Effects are larger when there are active strategies to show and promote caregiving behaviours—eg, practice, role play, or coaching to improve parent–child interactions
- Centre-based early learning programmes usually improve children's cognitive functioning, readiness for school, and school performance
  - Effects are larger for children from disadvantaged circumstances
  - Effects are larger as a result of higher quality programmes, whether formal or informal
- Promising directions for interventions include expanding educational media for children, and linking conditional cash transfers and nutrition with early child development interventions
- Although there are some reports attesting to the effectiveness of interventions for high-risk children in low-income and middle-income countries, evidence is not yet sufficient to establish best approaches

Children at risk of not reaching their potential

Substantial numbers of children experience risks to their development, in addition to poverty and malnutrition. These risks include physical and developmental

	Country	Intervention and number of visits	Outcome	Results	Effect size
Focused primarily on both parent and child					
Aboud and Akhter 2011[14]	Bangladesh	Six parent group sessions of coaching on responsive feeding and stimulation	HOME score (A), responsive talk (B), Bayley III language score (C)	Intervention groups had significantly higher scores than controls at follow-up (A, B, and C)	Reported as d 0·38 (A), 0·40 (B), and 0·35 (C)
Cooper et al 2009[16]	South Africa	Home Visit Parenting intervention (16 visits)	Quality of mother–infant interaction at 6 and 12 months (A) and infant attachment (B)	Treatment mothers were significantly more sensitive and less intrusive at 6 and 12 months (A) and significantly higher rates of infant attachment (B)	Reported as d 0·24 to 0·86 (A), and unavailable (B)
Jin et al 2007[18]	China	Care for Development Intervention with primary health care (two visits)	Gesell Developmental Schedules	No substantial differences between treatment and control in motor scale, but treatment children had significantly higher scores in language, social, and adaptive scales	Calculated from pretest and post-test changes as d 0·28–0·66
Kagitcibasi 2009[21]	Turkey	Three (educational centre, custodial centre, or control) by two (mother training or control) design for 4–6 year children (mother training intervention: 60 weeks of home visit and monthly groups)	19 year follow-up in early adulthood compared mother training or not (1), early childcare or not (2), and any enrichment or not (3) for cognitive composite (A) and social composite and subscales (B)	No effects on cognitive or social composite (1); no effect for cognitive outcome, but significant difference on social composite at each age (2); higher proportion of enriched went to college, had higher educational attainment (significant for males), had higher status occupations, and were more likely to own a computer (3)	Reported d 0·20 (1A), unavailable (1B), unavailable (2A), unavailable (2B), unavailable (3A), calculated 0·35 (3B)
Klein and Rye 2004[17]	Ethiopia	Meditational Interaction for Sensitive Caregiving video tapes with feedback and awareness raising (five home visits and five groups)	Development checklist (A), MacArthur Communicative Development Inventory (B), Rutter's Scale of Social and Emotional development (C), school achievement 6 years later (D)	No significant differences (A), treatment had higher vocabulary scores (B), no significant differences (C), and significant differences in school attendance and achievement (D)	Unavailable
Leung et al 2003[19]	China	Group sessions with Triple P methods for parents of children with behaviour difficulties (four groups and follow-up)	Parent daily report of problems (A), Eyberg Child Behaviour Inventory subscales (B), and Strengths and Difficulty Scale subscales (C)	Treatment children had significantly better scores on all outcomes (A, B, and C)	Calculated, no covariates d 0·56 (A), reported 0·9 to 0·97 (B), and calculated, no covariates 0·48 to 0·77 (C)
Janssens and Rosemberg 2011[22]	St Lucia	Roving Caregivers Programme—home visits two times per week (about 104 visits)	Cognitive scales (Mullen Scales of Early Development)	Significant effect on youngest birth cohort in treatment group compared to control group (aged 6–18 months at programme start; A) and no significant affect for oldest birth (aged 18–30 months at programme start; B)	d 0·45 (A) and 0·04 (B)
Tinajero 2010 (Asociación Velnec-RH 2004)[23]	Ecuador (scaled up)	Comprehensive parenting, health, nutrition, and community	Abbreviated development scale	Treatment children had significantly higher scores on all subscales than control children	Unavailable
Focused primarily on parent and family					
Al-Hassan and Lansford 2010[24]	Jordan	Better Parenting Program: parent groups (16 hours in parent group, over 1–2 months)	Parent report of cognitive and social activities with children, discipline, knowledge (43 questions)	Intervention group improved significantly and control did not on two of 12 activities (play and read), two of 15 discipline questions, four of 16 knowledge questions	Unavailable
Bentley et al 2010[15]	India	Home visits to improve complementary food (1); complementary food, responsive feeding, and play (2); (ICDS; 30–40 home visits)	Bayley Scales (Mental and Motor scales; A) and HOME score (B)	Scores were significantly greater in both treatment groups for mental development scale but not motor (A) and HOME total scores were significantly larger for treatment group at 15 months but not at earlier months (B)	Calculated effect size, no covariates d 0·03 to 0·11 (1A), 0·06 to 32 (1B), 0·12 to 30 (2A), and 0·11 to 0·32 (2B)
Ertem et al 2006[20]	Turkey	Care for Development Intervention with primary health care (two visits)	HOME scores	No significant differences in mean HOME score between treatment and control but treatment families were significantly more likely to have optimum HOME scores	Unavailable
Palti et al 1982[25]	Israel (not low or middle income but disadvantaged in 1982)	Parenting intervention through primary health care (1 year of visits)	Developmental Quotient	No significant difference in Developmental Quotient scores between treatment and control group; however, there were significant differences for treatment group that received "good stimulation"	Calculated, no covariates d 0·11

(Continues on next page)

	Country	Intervention and number of visits	Outcome	Results	Effect size
(Continued from previous page)					
Engle et al 2010[26]	Kyrgyzstan, Tajikistan (scaled up)	Care for Development Intervention in Tajikistan (1) and Kyrgyzstan with primary health care (2; number of sessions not known, recommended to be monthly for first year)	Early Learning and Development Standards (A) and Ages and Stages Questionnaire subscales (B)	Children's score was significantly higher in intervention areas than control areas (1A); children's score was significantly higher in intervention areas for communication, gross motor, and personal social but not fine motor or problem solving (1B); and children's score was significantly higher in intervention areas for communication and personal social but not fine motor, gross motor, or problem solving (2B)	Calculated effect size, no covariates d 0·34 (1A), unavailable (1B), and range 0·06 to 0·29 (2B)
Nodira et al 2009[27]	Uzbekistan (scaled up)	Family empowerment programme—large-scale community-based health and nutrition programme (number of contacts not specified)	Child milestones of development, parent activities with children, parent knowledge	χ^2 analysis of child milestones by parent report, and parent behaviours by parent report between intervention and non-intervention areas showed some significant differences in parent skills and parent knowledge	Unavailable
Sidibeh 2009[28]	The Gambia (scaled up)	Parenting intervention through community actions as part of breastfeeding programme (number of contacts not specified)	Parent knowledge, beliefs, and reported activities with children	No difference in parent beliefs and practices in child-rearing	Unavailable

Design details in webappendix pp 1–6. If effect sizes were not reported we calculated a Cohen's d (d) effect sizes from either post-test means, differences from pretest to post-test means, or from ordinary least squares regression results. We focused on main effects and not subgroups, unless results were only presented by subgroups. If results were only presented by subgroups, then we reported the range of the effect size. We also reported the range for tests that had subscales. If studies did not report Cohen's d effect sizes, and we did not have the information to calculate them, then we reported unavailable. HOME=Home Observation for Measurement of the Environment.[29]

Table 1: **Summary of interventions and effect sizes for 15 studies of parenting education programmes, support programmes, or both, comparing interventions with standard of care**

disabilities, severe acute malnutrition, being small for gestational age and low birthweight (LBW), and being infected with HIV/AIDS (webappendix pp 18–20).

Children with developmental disabilities

Few studies have assessed intervention models for children with disabilities in low-income and middle-income countries. One randomised clinical trial in Bangladesh reported that rural children with disabilities whose caregivers received a parenting training package progressed more on adaptive skills and that the mothers improved in their support for their children, compared with a minimal intervention.[72] Community-based rehabilitation, a strategy advocated by WHO, is widely used but not well assessed—a review of 128 published studies identified few robust assessments.[73] Studies recommend broader community awareness and more evidence, more screening and referral services, and caregiver support.[72,74]

Children with severe acute malnutrition

WHO recommends incorporating stimulation into management strategies for children with malnutrition, in addition to food supplementation and health care,[75] but we identified few studies testing the effects of such integrated programmes. One study in Bangladesh[76] and one in Uganda[77] showed positive effects of stimulation on early child development for severely malnourished children.

Children small for gestational age or LBW

Early interventions for LBW infants in high-income countries improve cognitive and social–emotional development with effects lasting into childhood and adult years.[78–81] In Jamaica, weekly home visits for LBW term infants resulted in higher development quotients at 6 years.[82] In India, mothers of at-risk infants (75% LBW, premature, or both) were randomly assigned to receive training to provide stimulation at home over 12 months. At both 12 months and 2 years, intervention children's cognitive development was greater.[83] Ongoing work in India, Pakistan, and Zambia will provide more data on early stimulation for at-risk infants in community-based settings.[84]

Children affected and infected by HIV/AIDS

Young children in communities affected by the AIDS pandemic are exposed to many threats. Even though fewer young children are becoming infected because of the increase in programmes for the prevention of mother-to-child transmission, the overall number of vulnerable and infected children, particularly in sub-Saharan Africa, is high.[85] Interventions to improve early child development for these children include supporting caregivers' capacity through home visits, cash transfer systems (eg, so-called child grants in South Africa), preschool programmes, and legal protection strategies.[70,86] In a randomised controlled trial, a home stimulation programme provided to caregivers of infants infected with HIV at clinic visits every 3 months resulted in substantially higher cognitive scores at 12 months.[87]

Many qualitative or pre-test and post-test design studies have shown benefits of these programmes on the child-rearing behaviours of caregivers, and on

	Country	Intervention and child age	Outcome	Results	Effect size
Preschool attendance *vs* none					
Aboud et al 2008[37]	Bangladesh	Preschool attendance *vs* none (children aged 5 years)	First grade reading (A) and first grade mathematics (B)	Preschool graduates scored higher than non-attendees in reading and writing (A) and preschool graduates scored higher than non-attendees in oral but not written mathematics (B)	Effect sizes unavailable; reported as "small" by the authors
Mwaura et al 2008[38]	Kenya, Uganda, and Zanzibar	Madrasa preschool (1), non-Madrasa preschool (2), and none (3); children aged 3–5 years	British Ability Scales (A; subscales) and African Child Intelligence Test (B; subscales)	Significant improvements in scores for treatment children *vs* children with no preschool on both outcomes (1A, 1B) and significant improvements in scores for treatment children *vs* non-Madrasa on all African Child Intelligence Test outcomes and verbal comprehension and number concept subscales (British Ability Scales; 2A, 2B)	Calculated from regressions with covariates d 0·50 to 0·79 (1A), 0·86 to 0·95 (1B), 0·08 to 0·46 (2A), and 0·27 to 0·59 (2B)
Raine et al 2003[39]	Mauritius	Enriched Preschool programme *vs* none for children aged 3–5 years	Behaviour problems (A) and schizotypal personality (B)	Treatment group had significantly better scores than control (A) and treatment group had significantly better scores than control at age 17 years but not 23 (B)	Reported range d 0·31 to 0·44 (A) and 0·34 (17 years; B)
Urzua and Veramendi 2010[40]	Chile	Preschool *vs* none (children aged 2–5 years)	TESPI (Spanish IQ test 2–5 years; A), Peabody Picture Vocabulary Test (B), child behaviour checklist (C), and child behaviour questionnaire (D)	Children who attended had significantly higher scores than those who did not attend (A); no significant difference between children attending daycare and those not attending (B, C, and D)	Unavailable (A, B, C, and D)
Berlinkski et al 2008[41]	Uruguay (scaled up)	Pre-primary education *vs* none (children aged 3–5 years)	Years of education (A) and school attendance (B)	Treatment children older than 8 years have significantly more years of education (A) and treatment children older than 11 years are significantly more likely to be in school (B)	Calculated from regressions with covariates d 0·02 to 0·19 (A), and 0·01 to 0·12 (B)
Bernal et al 2009[42]	Colombia (scaled up)	Community childcare centres *vs* none (children aged 2–5 years)	Early Development Inventory (EDI) psychosocial (A), EDI cognitive (B), TVIP (Spanish vocabulary test; C), Woodcock Munoz scales (D), and fifth grade achievement test (E)	No significant difference between treatment and control (A); treatment children had significantly lower scores; however, treatment children with more than 15 months of exposure had significantly higher scores (B, C, and D); and treated children had significantly higher test scores (E)	Calculated, no covariates d 0·02 (A), –0·1 (B), –0·14 (C), and –0·05 to 0·08 (D); and calculated from instrument variable regression with covariates d 0·11 (E)
Improvements in preschool compared with non-improved preschools					
Aboud and Hossain 2011[43]	Bangladesh (scaled up)	Preschool with three levels of quality *vs* no preschool (all children aged 5 years)	First grade mathematics (A), first grade language (B), second grade mathematics (C), and second grade language (D)	Graduates of highest quality preschool scored significantly higher than graduates of lower 2 groups, preschool children (highest quality programme) perform significantly better than non-preschool children on all first grade outcomes (A, B), and preschool children (highest quality programme) perform significantly better than non-preschool children on all but reading second grade outcomes (C, D)	Reported differences between preschool graduates from highest quality programme and comparisons controlling for confounding variables d 0·36 to 0·59 (A), 0·53 to 0·67 (B), 0·19 to 0·36 (C), and 0·58 (D)
Baker-Henningham et al 2009[44]	Jamaica	"Incredible years" teacher training programme *vs* standard preschool (children aged 3–5 years)	Child behaviour	Significant improvements in child behaviour for children in treatment group	Unavailable
Malmberg et al 2011[45]	Kenya, Uganda, and Zanzibar	Madrasa Resource Centre *vs* other preschools (children aged 3–5 years)	Cognitive score	Treatment group had significantly higher cognitive scores	Calculated from regressions with fixed effects d 0·4
Moore et al 2008[46]	Bangladesh	Improved preschool *vs* standard (children aged 4–5 years)	Wechsler Preschool and Primary Scale of Intelligence subsets (A) and play observation scale (B)	Significant increases in scores for treatment children (A) and no significant increases in scores (B)	Reported d 0·04 to 0·08 (A) and unavailable (B)
Morris et al 2009[47]	Zanzibar	Radio instruction in preschools *vs* standard preschools (children aged 3–5 years)	Mathematics test (A), English test (B), and Kiswahili test (C)	Treatment children had significantly higher scores on all outcomes (A, B, and C)	Reported d 0·47 (A), 0·29 (B), and 0·69 (C)
Opel et al 2009[48]	Bangladesh	Dialogic reading *vs* standard preschool (children aged 5 years)	Vocabulary test	Significant increases in vocabulary scores for treatment children	Reported d 0·2
Rao et al 2011[49]	Cambodia (scaled up)	Formal preschool (1), community preschool (2), home based (3), and no preschool (3–5 years; 4)	Locally developed test	All three groups had significantly higher scores on post-test controlling for pretest and confounding factors than controls; home based did not differ from the other two, but children in formal preschools scored higher than those in community preschools	Calculated d 1·68 (1 *vs* 4), 1·01 (2 *vs* 4), 1·00 (3 *vs* 4), 0·68 (1 *vs* 3), 0·02 (2 *vs* 3), and 0·66 (1 *vs* 2)

(Continues on next page)

	Country	Intervention and child age	Outcome	Results	Effect size
(Continued from previous page)					
Rao et al 2011[50]	China (scaled up)	Kindergarten—child centred (1), separate preschool (2), children sit in regular first grade classroom (mixed; 3), and no preschool (children aged 5 years; 4)	First grade school preparedness (A), literacy (B), and mathematics (C)	Treatment children had significantly higher scores on all outcomes than no preschool (1), treatment children had higher scores on all outcomes than no preschool (2), and treatment children were not significantly different than control children for any outcomes (3)	Calculated, no covariates d 1·63 (1A), 0·86 (1B), 1·07 (1C), 0·28 (2A), 0·23 (2B), 0·57 (2C), –0·43 (3A), –0·23 (3B), and 0·15 (3C)
Rolla et al 2006[51]	Costa Rica	Quality interventions: classroom activities (1), work with families (2), tutoring (3), combination (4), and controls (children aged 4–5 years; 5)	Print composite (A) and language composite (B)	No significant differences between treatment and control children (1), no significant differences between treatment and control children (2), significant differences between treatment and control children (3), and significant differences between treatment and control children in print composite (4)	Calculated, no covariates d –0·04 (1A), –0·08 (1B), –0·05 (2A), –0·23 (2B), 0·28 (3A), 0·13 (3B), 0·47 (4A), and –0·02 (4B)

Design details in webappendix pp 7–15. If effect sizes were not reported we calculated a Cohen's d (d) effect sizes from either post-test means, differences from pretest to post-test means, or from ordinary least squares regression results. We focused on main effects and not subgroups, unless results were only presented by subgroups. If results were only presented by subgroups, then we reported the range of the effect size. We also reported the range for tests that had subscales. If studies did not report Cohen's d effect sizes, and we did not have the information to calculate them, then we reported unavailable.

Table 2: **Summary of interventions and effect sizes for 15 studies with preschool programmes, preschool-improvement programmes, or both**

preschool attendance[88,89] and early child development,[87,89] but there is a need for more robust assessments.[86]

Programmatic implications

Most effectiveness studies that we have reviewed reported substantial and positive effects on child development, but results from assessments of scaled-up programmes were more variable. In panel 3 we list our conclusions and recommendations for the scale-up of early child development programmes. The Wolfensohn Center at Brookings Institution assessed issues in taking early child development to scale from 2005 to 2011.[23,90,91] Expanding coverage while maintaining quality is a major issue for every programme, and needs a system of capacity development.[92] Scale-up efforts in Mexico and South Africa have identified that existing systems, including private ones, might be undermined when public coverage expands.[91,92] Scale-up to universal provision should include systems of governance, provisioning, and capacity building for implementation, and must include ongoing and continual advocacy.[91] Monitoring methods are needed to track progress and facilitate advocacy.

Co-occurring risk factors such as stunting and lack of stimulation should be addressed together for maximum effect, such as combining nutrition, responsive child feeding, and child-stimulation interventions.[14,15] Few studies have assessed which combinations work best, although several combinations exist. Combinations tend to be more effective if addressing risks that co-occur, and if the programme can coordinate interventions to minimise extra work. Adding early child development might be motivating for parents and childcare workers. Research is urgently needed on how to effectively integrate psychosocial interventions with programmes to address the risks identified in the first report of this Series.[4]

Reaching the poorest, a key goal for many programmes, is also a challenge. In the Philippines for example, publicly funded childcare centres exist in 86% of villages, but coverage reaches only 39% of the age-eligible population.[90] A recent estimate of the cost of scaling up nutrition services noted that the unit costs were constant for 80% of the population, but were 3–4-times higher for the next 10%.[93,94] Yet to reduce inequality, investments must be targeted at the poorest. Our review suggests that effects might be greater for these children, possibly resulting in a more favourable benefit-to-cost ratio.

Countries might have difficulty creating a mechanism for integrated or coordinated interventions for early child development across sectors.[90] A programme is often run by one ministry and coordination with others can be limited, even if the effects could be synergistic. Community involvement and the demand for services as well as a legal policy structure have facilitated implementation.[23,90–92] In the Philippines, for example, a legal mandate combined several delivery systems with local government control to create an integrated programme.[90] Under a controlled political system, Cuba's *Educa Tu Hijo* programme effectively scaled up an integrated approach and achieved virtually universal coverage of young children in early child development by 2000.[23] Community involvement and ownership were important for its successful scale-up.

For most programmes, early child development components for younger children (aged 0–3 years) were less common than for older children. Incorporating early child development activities into the health system—through prenatal care, breastfeeding promotion programmes, wellchild visits, consultations for mild illnesses, parenting education, and early intervention for at-risk children—might provide the best opportunities for reaching children younger than 3 years.

Estimating potential benefits of preschool

Preschool is only one component of a comprehensive early child development agenda, but can serve as a proxy in an analysis of potential economic benefits of increasing

Panel 3: Recommendations for development and expansion of national programmes to support early child development

Maximise quality of early child development programmes

- Maximise quality in all early child development programmes, in programme design, curriculum, childcare-provider development, monitoring and assessment, and governance and supervision
- Adapt programmes to children and families from ethnically or economically vulnerable groups
- Incorporate families and communities as active partners in the development of early child development programmes to integrate relevant child-rearing practices and cultural beliefs

Promote multisectoral integration

- Mainstream early child development into health programmes such as maternal and child health; nutrition; HIV/AIDS, malaria, and tuberculosis; mental health; violence; and injury
- Develop effective coordination mechanisms in sectors for early child development
- Develop and assess integrated strategies, packages, and approaches to early child development that are suitable for scale-up

Prioritise monitoring and assessment

- Systematically assess effectiveness of early child development interventions to establish the most effective approaches to improve quality and outcomes particularly for the most disadvantaged
- Assess relative effectiveness of various quality improvements for preschools (eg, adding more years of preschool, increasing teacher training)
- Develop and assess cost-effectiveness of new approaches for early child development promotion such as conditional cash transfer programmes with an early child development component, educational media, or other information technologies for children and families and integrated programmes
- Assess the relative effectiveness of early child development interventions for children at risk because of malnutrition, low birthweight, HIV, or disabilities

Emphasise policy action

- Use the existing theory and evidence to inform policy and decision makers at all levels that early child development is fundamental to the promotion of social justice and equity
- Build a sustainable funding mechanism for early child development services and interventions
- Acknowledge and support interventions that protect and support children and families in the first 5 years of life

Panel 4: Methods for our gap analysis

We estimated the association between the schooling gap (gap in median years of schooling between the wealthiest quintile and each of the other quintiles) and preschool enrolment by regressing the gap on the preschool gross enrolment rate 8–12 years earlier for each country with ordinary least squares in Stata 10, controlling for per head gross domestic product (GDP) in constant dollars adjusted for purchasing power and income inequality (by use of the Gini coefficient). We then calculated the projected economic gain from decreasing the schooling gap through increasing preschool enrolment as the present discounted value of added wage productivity. We estimated added wage productivity for each country using a weighted average of 8·3% for urban areas and 7·5% for rural areas for the returns to an additional year of schooling,[93] and average wages were based on a 40% wage share of GDP. We used discount rates of 3% and 6% to adjust (to the time at which investments in preschool enrolments are assumed to be made) future wage earnings starting 12 years after preschool enrolment and lasting 45 years. We estimated the economic benefits from increasing preschool programmes under three scenarios: moving countries with less than 25% pre-primary enrolment to 25%, moving countries with less than 35% pre-primary enrolment to 35%, and moving countries with less than 50% pre-primary enrolment to 50%.

In table 3 we summarise these estimates for one cohort of children in 2008 US$. Changes in preschool enrolments are simulated to induce reductions in schooling gaps based on the regression analysis discussed.

investments. We estimated the effect of preschool enrolment on the gap between schooling attainment of the wealthiest quintile of youth (aged 15–19 years) compared with youth in the other wealth quintiles for 73 low-income and middle-income countries with a total population of 2·69 billion people (panel 4).[98] Our estimates show that for every percentage point increase in preschool enrolment, the schooling gap for those aged 15–19 years declines 0·026 grades (95% CI –0·14 to –0·38; figure 4). This result, which controls for a country's gross domestic product (GDP) and inequality rates (as measured by the Gini index) is robust to the use of country fixed-effects for countries where two or more observations were available, and to the inclusion of child mortality in the fixed-effects regressions. The use of country fixed-effects and inclusion of child mortality rate as a control provide some assurance that the results are attributable to preschool enrolment, rather than the access or quality of the school and health systems.

We calculated the loss in dollars from the schooling gap and identified that the gaps between the richest quintile and the poorer quintiles within low-income and middle-income countries resulted in an estimated total loss of $196 billion in present annual productivity due to fewer years of schooling (panel 4). Using estimates from the regression of the schooling gap on preschool enrolment, we then simulated reductions in schooling gaps due to increasing preschool enrolment rates and calculated the economic benefits of reducing the schooling gap for one cohort of children.

With a 3% discount rate, the benefits from reducing the schooling gap range from $10·6 billion with an increase of all children in each country to 25% enrolment for 1 year of preschool, to $33·7 billion with an increase to 50% preschool enrolment (table 3). With a 6% discount rate the benefits were $4·7 billion (for 25%) to $14·9 billion (for 50%). These benefits, compared with the costs based on the number of additional children enrolled and the median cost of preschool per student,[99] imply benefit-to-

cost ratios respectively from 6·4 to 17·6, and are similar to programme-specific estimates[100] for the USA,[101] Turkey,[102] and Uruguay (panel 5).[41]

Our estimates, based on several assumptions, suggest substantial potential gains from increasing preschool attendance with very satisfactory benefit-to-cost ratios. The estimates are most likely conservative because they include only direct wage productivity benefits and many studies suggest that there would be additional benefits due to increased schooling, such as reduced crime and improved parenting. Additionally, the estimates include only preschool enrolment, and do not include parenting, nutrition and health programmes, which are also known to improve the child's school performance and therefore have economic benefits. Increased earnings are calculated assuming that GDP is not growing over time with technological change or increased capital investment; the resulting benefits would be larger if these were included.

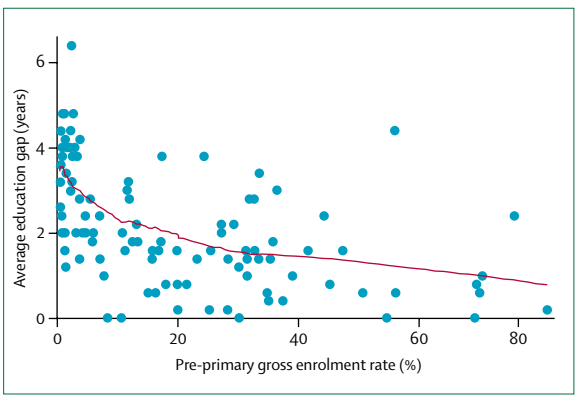

Figure 4: **Association of preschool enrolment and the schooling gap for 73 low-income and middle-income countries**
Schooling gap defined as the gap between schooling attainment of the wealthiest quintile of youth compared with youth in other wealth quinites. Average education gap is for those aged 15–19 years. Pre-primary gross enrolment rate is from 8–12 years earlier. Bandwidth=0·8.

Trends in policies and funding

In the 2007 Series, there was a call for expanded early child development programmes, policies, and coordinating mechanisms at the national level. According to UNICEF annual reports, more than 40 countries are developing or have developed and received parliamentary approval for early child development policies, and several UN bodies have publicly supported early child development. WHO's Commission on the Social Determinants of Health made child development one of its key focus areas,[5] the Organization for American States issued a "hemispheric commitment" to early child development in November, 2007,[103] and the Secretary General of the UN's report highlighted the rights of the child in early childhood.[104]

Progress has also been made on the 2007 recommendation to develop a core set of globally accepted measurements and indicators for child development that could be adapted across countries for monitoring, planning, and assessment. UNICEF supported 53 countries to prepare their own standards for what preschool children should know and be able to do.

	Actual values	Projected values with minimum preschool enrolment of 25%	Projected values with minimum preschool enrolment of 35%	Projected values with minimum preschool enrolment of 50%
Mean preschool enrolment, 8–12 years before data for schooling gap	17·6%	30·6%	38·3%	51·1%
Total number of children aged 5 years enrolled, 8–12 years before data for schooling gap (millions)	11·4	19·8	24·8	33·1
Mean estimated average gap of schooling (years)	1·9	1·7	1·5	1·2
Benefits due to increasing preschool enrolment				
PDV of lifetime earnings (3% discount rate) for one cohort (2008 US$ billions)	..	$10·64	$18·73	$33·72
PDV of lifetime earnings (6% discount rate) for one cohort ($ billions)	..	$4·73	$8·32	$14·97
Total costs due to increasing preschool enrolment ($ billions)	..	$0·74	$1·18	$1·92
Benefit-to-cost ratios				
3% discount rate	..	14·3	15·8	17·6
6% discount rate	..	6·4	7·0	7·8

Our sample consists of 73 countries with a population of about 3 billion with preschool data from 1998–2007. We dropped Bangladesh, Namibia, and Tanzania from our sample because of inconsistent statistics in the preschool enrolment rates. The schooling gap is the gap in median years of schooling between the wealthiest quintile and each of the other quintiles for individuals 15–19 years old.[95] The benefits due to increasing enrolment were calculated with estimates from an ordinary least squares (OLS) regression of average schooling gap on preschool enrolment from 8 to 12 years before the schooling gap statistic,[96] gross domestic product per capita, and Gini.[97] Estimates from OLS regression were used to simulate the schooling gap under three scenarios with preschool enrolment floors of 25%, 35%, and 50%. The economic benefit from decreasing the schooling gap through increasing preschool enrolment was calculated as the present discounted value (PDV) of added wage productivity under the assumption that earnings are zero for first 12 years after preschool and then are equal to yearly average earnings incremented by the average rates of return to schooling for the subsequent 45 years. For the benefit-to-cost ratio, we used the median cost per preschool student in 2004 from UNESCO data on 38 low-income and middle-income countries (US$77·50) adjusted to show the 2008 values ($88·34).

Table 3: **Analysis of benefits and costs of increasing preschool enrolments**

Panel 5: Conclusions from our gap analysis

A conservative estimate of the returns to investment in early child development is illustrated by the effects of improving one component, preschool attendance. Achieving enrolment rates of 25% per country in 1 year would result in a benefit of US$10·6 billion and achieving 50% preschool enrolment could have a benefit of more than $33 billion (in terms of the present discounted value of future labour market productivity) with a benefit-to-cost ratio of 17·6. Incorporating improved nutrition and parenting programmes would result in a larger gain.

The 2010 UNICEF Multiple Indicator Cluster Survey includes both the Family Care Indicators and an assessment of child development for children aged 3–4 years. Several regional child development assessments are also being developed.

Policies and indicators are effective only if funding is available. Because of increased awareness of neurological, economic, and behavioural science findings in recent years, donor interest is increasing but the results for funding are mixed. Organisations such as Save the Children, UNICEF, The World Bank, and the Interamerican Development Bank are providing funds. Corporations are new entrants, sponsoring modest programmes, principally in regions where they have business interests. Centre-based and school-based preschool programming continues to predominate, and interest in the 0–3 years age-group is growing. The complexity, cost, and need for multisectoral ownership of early child development programmes continues to be a constraint and the role of early child development in future global agendas such as new Millennium Development Goals needs to be strengthened.

Governments are not allocating enough funds to early child development programmes. A report from the Organisation for Economic Co-operation and Development (OECD) estimated that a public investment of 1% of GNP is the minimum required to ensure provision of quality early child development services.[105,106] Average government spending for children aged 0–6 years across OECD countries was 2·36% of GNP.[106] Public spending on preschool is at least 0·4% in some central and eastern European and Latin American countries (Belarus, Chile, Costa Rica, Croatia, Guyana, Mexico, and Mongolia,) whereas governments of Kenya, Nepal, and Tajikistan spend just 0·1% of GNP and Nicaragua and Senegal spend less than 0·02% of GNP on preschool education (data were not available on any other early child development services).[105] In most countries, less than 10% of the education budget is allocated to preschool education.[106] Unless governments allocate more resources to quality early child development programmes for the poorest segment of the population, economic disparities will continue to exist and to widen.

Conclusions and future work

We have presented evidence for factors contributing to the effectiveness of interventions to promote early child development in low-income and middle-income countries (panel 2), recommendations for how programmes and policies can support early child development (panel 3), and we pose several future research questions (panel 6). The review from the previous Series[3] reported that the most effective early child development programmes are those that provide direct learning experiences for children and their families, are high intensity, targeted towards younger and more disadvantaged children, are integrated with other systems such as nutrition or family support, and are of long duration. These conclusions are supported by our present review, although we have also identified some beneficial effects with more moderate-length interventions. We have also highlighted the importance of programme quality on effectiveness.

In this review, all parenting education effectiveness trials positively affected parenting behaviour, children's development, or both, but only half of the scaled-up programmes showed similar effects. The most effective interventions were those with systematic training of workers, a structured and evidence-based curriculum, and

Panel 6: Future research questions

- What factors increase effectiveness of parenting programmes?
  - How can pregnant women be included in parenting interventions in preparation for raising children?
  - How can maternal mental health interventions effectively incorporate child development?
- How can preschool be made most effective in low-income and middle-income countries?
  - What is the optimum timing, duration, and exposure to preschool?
  - How can preschools be integrated with other services—eg, by offering age-appropriate health services and nutrition programmes?
  - What are the additional effects of improving the transition to primary school, and primary school quality, on child development outcomes?
- What are the most effective approaches for combining nutrition and psychosocial programmes at scale, and for which children?
- What interventions are most effective for children with disabilities or children at risk in low-resource settings?
- How can conditional cash transfer programmes be most effectively combined with programmes to support a young child's development and nutrition?
- What possibilities exist for increasing use of media, such as television, radio, and mobile telephones for improving parenting and child outcomes?
- What strategies can be used to increase funding for young children's growth and development?

 Published online September 23, 2011 DOI:10.1016/S0140-6736(11)60889-1

opportunities for parental practice with children with feedback. Community and family involvement was also effective. Preschool attendance in most cases had a positive effect on learning, but improvements in preschool quality were more consistently effective. Promising interventions include linking early child development services to conditional cash transfer programmes and developing educational media for children and parents. There is suggestive, but restricted, evidence that psychosocial interventions can improve the wellbeing of children at risk because of physical disabilities, severe malnutrition, low birthweight, and HIV infection. To illustrate the economic effect of early child development interventions, we developed a simulation showing a benefit of $10·6 billion for increasing preschool enrolment to 25% in all countries, and $33·7 billion for increasing to 50%, with a benefit-to-cost ratio as large as 17·6 to 1. Based on our review and economic simulation, we conclude that early child development interventions are a good investment for reducing inequalities in the development of children's potential perpetuated by poverty, poor health, poor nutrition, and restricted learning opportunities.

Contributors

All authors participated in the review of published work, and drafting and review of the report. PLE and LCHF are the lead authors. All authors reviewed and provided commentary on the text. Reviews and drafting of individual topics were as follows: economic issues HA, JB, and MH; parenting PLE and LCHF; preschool CO'G, LCHF, and PLE; media PLE; conditional cash transfers LCHF; disabilities and high-risk AY and IE; political and social context MCdeM, NU, and SI. The steering committee of the Global Child Development Group coordinated the writing of the report in this Series.

Conflicts of interest

We declare that we have no conflicts of interest.

Acknowledgments

We thank Kallista Bley for help in document preparation, Santiago Cueto for Young Lives data, Ivelina Borisova for document searches and reviews, and Giorgio Tamburlini for a critical review of the report. Members of the Steering Committee (Sally Gratham-McGregor, Susan Walker, Ted Wachs, Maureen Black) have reviewed all drafts extensively. A meeting of all authors to discuss review findings and coordinate the report was held in Jamaica in December, 2009, with the support of the Global Alliance for Improved Nutrition (GAIN), UNICEF, the Bernard van Leer Foundation, and the University of the West Indies. A follow-up steering committee meeting was held in May, 2010, with the support of UNICEF, the Bernard van Leer Foundation, and the Child Health and Nutrition Research Initiative. The sponsors had no role in the design and conduct of the review, interpretation and writing, or the decision to submit for publication. We thank the Global Child Development Group Secretariat for coordinating the meetings.

References

1 Grantham-McGregor S, Cheung YB, Cueto S, et al. Developmental potential in the first 5 years for children in developing countries. *Lancet* 2007; **369:** 60–70.

2 Walker SP, Wachs TD, Gardner JM, et al. Child development: risk factors for adverse outcomes in developing countries. *Lancet* 2007; **369:** 145–57.

3 Engle PL, Black MM, Behrman JR, et al. Strategies to avoid the loss of developmental potential in more than 200 million children in the developing world. *Lancet* 2007; **369:** 229–42.

4 Walker SP, Wachs TD, Grantham-McGregor SM, et al. Inequality in early childhood: risk and protective factors for early child development. *Lancet* 2011; published online Sept 23. DOI:10.1016/S0140-6736(11)60555-2.

5 Commission on Social Determinants of Health. Closing the gap in a generation: health equity through action on the social determinants of health—final report of the Commission on Social Determinants of Health. Geneva: World Health Organization, 2008.

6 Vegas E, Santibanez L. The promise of early child development in Latin America and the Caribbean. Washington, DC: The World Bank, 2010.

7 Dunn LM, Padilla ER, Lugo DE, Dunn LM. Test de Vocabulario en Imágenes Peabody (Peabody Picture Vocabulary Test): Adaptación Hispanoamericana (Hispanic-American Adaptation). Circle Pines, MN: American Guidance Service (Dunn Educational Services), 1986.

8 Cueto S, Leon J, Guerrero G, Muñoz I. Psychometric characteristics of cognitive development and achievement instruments in Round 2 of Young Lives—Technical Note 15. Oxford: Department of International Development, 2009.

9 Bhutta ZA, Ahmed T, Black RE, et al. What works? Interventions for maternal and child undernutrition and survival. *Lancet* 2008; **371:** 417–40.

10 Nores M, Barnett WS. Benefits of early childhood interventions across the world: (under) investing in the very young. *Econ Educ Rev* 2010; **29:** 271–82.

11 Maulik PK, Darmstadt GL. Community-based interventions to optimize early childhood development in low resource settings. *J Perinatol* 2009; **29:** 531–42.

12 McMaster University School of Nursing. Effective public health practice project: quality assessment tool for quantitative studies. http://www.hamilton.ca/NR/rdonlyres/6b3670ac-8134-4f76-a64c-9c39dbc0f768/0/qatool.pdf (accessed March 16, 2011).

13 Yarbrough DB, Shulha LM, Hopson RK, Caruthers FA. The program evaluation standards: a guide for evaluators and evaluation users, 3rd edn. Thousand Oaks, CA: Sage, 2011.

14 Aboud FE, Akhter S. A cluster-randomized evaluation of a responsive stimulation and feeding intervention in Bangladesh. *Pediatrics* 2011; **127:** e1191–97.

15 Bentley ME, Vazir S, Engle PL, et al. A home-based educational intervention to caregivers in south India to improve complementary feeding and responsive feeding, and psychosocial stimulation increases dietary intake, growth and development of infants. *FASEB J* 2010; **24** (suppl)**:** 564.14.

16 Cooper PJ, Tomlinson M, Swartz L, et al. Improving quality of mother-infant relationship and infant attachment in socioeconomically deprived community in South Africa: randomised controlled trial. *BMJ* 2009; **338:** b974.

17 Klein PS, Rye H. Interaction-oriented early intervention in Ethiopia: the MISC approach. *Infants and Young Children* 2004; **17:** 340–54.

18 Jin X, Sun Y, Jiang F, Ma J, Morgan C, Shen X. "Care for Development" intervention in rural China: a prospective follow-up study. *J Dev Behav Pediatr* 2007; **28:** 213–18.

19 Leung C, Sanders MR, Leung Sl, Mak R, Lau J. An outcome evaluation of the implementation of the Triple P-Positive Parenting Program in Hong Kong. *Fam Process* 2003; **42:** 531–44.

20 Ertem IO, Atay G, Bingoler BE, Dogan DG, Bayhan A, Sarica D. Promoting child development at sick-child visits: a controlled trial. *Pediatrics* 2006; **118:** e124–31.

21 Kagitcibasi C, Sunar D, Bekman S, Baydar N, Cemalcilar Z. Continuing effects of early enrichment in adult life: the Turkish Early Enrichment Project 22 years later. *J Appl Dev Psychol* 2009; **30:** 764–79.

22 Janssens W, Rosemberg C. The impact of a home-visiting Early Childhood intervention in the Caribbean on cognitive and socio-emotional child development. Amsterdam: Amsterdam Institute for International Development, 2011.

23 Tinajero A. Scaling-up early child development in Cuba—Cuba's Educate Your Child Program: strategies and lessons from the expansion process. Washington, DC: The Brookings Institution, 2010. http://www.brookings.edu/papers/2010/04_child_development_cuba_tinajero.aspx (accessed Aug 29, 2011).

24 Al-Hassan S, Lansford J. Evaluation of the Better Parenting Program in Jordan. *Early Child Dev Care* 2011; **181:** 587–98.

25 Palti H, Zilber N, Kark SL. A community-orientated early intervention programme integrated in a primary preventive child health service—evaluation of activities and effectiveness. *Community Med* 1982; **4:** 302–14.

For more on the **Global Child Development Group** see http://www.globalchilddevelopment.org

26 Engle PL, Smeby A, Grover D. Care for development in three central Asian countries: report of process evaluation in Tajikistan, Kyrgyzstan, and Kazakhstan. http://globalchilddevelopment.com/sites/default/files/Status%20of%20Care%20for%20Development%20in%20three%20Central%20Asian%20Countries%20Oct%2031%202010.doc (accessed Aug 29, 2011).

27 Nodira A, Yakupov S, Yakupov T. Impact Assessment Family Education Project. Tashkent: Sharh va Tavsiya Sociology Centre, 2009.

28 Sidibeh L. Evaluation of the parental education programme at LRR, CRR & URR, The Gambia. http://globalchilddevelopment.com/sites/default/files/Gambia%20ECD%20PARENTAL%20EDUCATION%20PROGRAMME%20EVALUATION%20final%20final.doc (accessed Aug 29, 2011).

29 Bradley RH, Corwyn RF. Caring for children around the world: a view from HOME. *Int J Behav Dev* 2005; **29:** 468–78.

30 Walker S. Promoting equity through early child development interventions for children from birth through three years of age. In: Alderman H, ed. No small matter. Washington, DC: The World Bank, 2011: 115–54.

31 WHO. Documents on integrated management of childhood illness listed by year of publication. Geneva: World Health Organization, 2010. http://www.who.int/child_adolescent_health/documents/imci/en/index.html (accessed Aug 29, 2011).

32 Nowak C, Heinrichs N. A comprehensive meta-analysis of triple P-positive parenting program using hierarchical linear modeling: effectiveness and moderating variables. *Clin Child Fam Psychol Rev* 2008; **11:** 114–44.

33 Moran P, Ghate D. The effectiveness of parenting support. *Children and Society* 2005; **19:** 329–36.

34 Korfmacher J, Green B, Spellman M, Thornberg KR. The helping relationship and program participation in early childhood home visiting. *Infant Ment Health J* 2007; **28:** 459–80.

35 Bakermans-Kranenburg MJ, van IJzendoorn MH, Juffer F. Less is more: meta-analyses of sensitivity and attachment interventions in early childhood. *Psychol Bull* 2003; **129:** 195–215.

36 Paul D, Bhatia N, Priscilla S, Siwach S. Report of the pre-test study: Mother and Child Protection Card. New Delhi: National Institute of Public Cooperation and Child Development, 2005.

37 Aboud FE, Hossain K, O'Gara C. The Succeed Project: challenging early school failure in Bangladesh. *Rese Comp Int Educ* 2008; **3:** 295–307.

38 Mwaura PAM, Sylva K, Malmberg L-E. Evaluating the Madrasa preschool programme in east Africa: a quasi-experimental study. *Int J Early Years Educ* 2008; **16:** 237–55.

39 Raine A, Mellingen K, Liu J, Venables P, Mednick SA. Effects of environmental enrichment at ages 3–5 years on schizotypal personality and antisocial behavior at ages 17 and 23 years. *Am J Psychiatry* 2003; **160:** 1627–35.

40 Urzua S, Veramendi G. The impact of out-of-home childcare centers on early childhood development. Washington, DC: Inter-American Development Bank, 2010.

41 Berlinski S, Galiani S, Manacorda M. Giving children a better start: preschool attendance and school-age profiles. *J Public Econ* 2008; **92:** 1416–40.

42 Bernal R, Fernandez C, Flores CE, et al. Evaluación de impacto del Programa Hogares Comunitarios de Bienestar del ICBF (evaluation of the impact of the program of community homes of well-being of ICBF). Bogota: Centro de Estudios sobre Desarrollo Económico Universidad de los Andes, 2009.

43 Aboud FE, Hossain K. The impact of preprimary school on primary school achievement in Bangladesh. *Early Child Res Q* 2011; **26:** 237–46.

44 Baker-Henningham H, Walker S, Powell C, Gardner JM. A pilot study of the Incredible Years Teacher Training programme and a curriculum unit on social and emotional skills in community pre-schools in Jamaica. *Child Care Health Dev* 2009; **35:** 624–31.

45 Malmberg L-E, Mwaura P, Sylva K. Effects of a preschool intervention on cognitive development among East-African preschool children: a flexibly time-coded growth model. *Early Child Res Q* 2011; **26:** 124–33.

46 Moore AC, Akhter S, Aboud FE. Evaluating an improved quality preschool program in rural Bangladesh. *Int J Educ Dev* 2008; **28:** 118–31.

47 Morris E, Philip M, Othman AF, Mitchell J. Radio Instruction to Strengthen Education (RISE) in Zanzibar: impact study. Boston: Education Development Center, Inc, and USAID, 2009.

48 Opel A, Ameer SS, Aboud FE. The effect of preschool dialogic reading on vocabulary among rural Bangladeshi children. *Int J Educ Res* 2009; **48:** 12–20.

49 Rao N, Pearson V, Sun J, Pearson E, Constas M, Engle PL. Is something better than nothing? An evaluation of early childhood programs in Cambodia. *Child Dev* (in press).

50 Rao N, Sun J, Zhou J, Zhang L. Early achievement in rural China: the role of preschool experience. *Early Child Res Q* (in press).

51 Rolla San Francisco A, Arias M, Villers R, Snow C. Evaluating the impact of different early literacy interventions on low-income Costa Rican kindergarteners. *Int J Educ Res* 2006; **45:** 188–201.

52 Berlinski S, Galiani S, Gertler P. The effect of pre-primary education on primary school performance. *J Public Econ* 2009; **93:** 219–34.

53 Mwaura PAM, Sylva K, Malmberg L. Evaluating the Madrasa preschool programme in east Africa: a quasi-experimental study. *Int J Early Years Educ* 2008; **16:** 237–55.

54 Ho J, Thukral H. Tuned in to student success: assessing the impact of interactive radio instruction for the hardest-to-reach. *J Educ Int Dev* 2009; **4:** 34–51.

55 Handa S, Davis B. The experience of conditional cash transfers in Latin America and the Caribbean. *Dev Policy Rev* 2006; **24:** 513–36.

56 Fiszbein A, Schady N, Ferreira FHG, et al. Conditional cash transfers: reducing present and future poverty. Washington DC: The World Bank, 2009.

57 Das J, Do Q-T, Özler B. Reassessing conditional cash transfer programs. *World Bank Res Obs* 2005; **20:** 57–80.

58 de Janvry A, Sadoulet E. Making conditional cash transfer programs more efficient: designing for maximum effect of the conditionality. *World Bank Econ Rev* 2006; **20:** 1–29.

59 Rawlings LB, Rubio GM. Evaluating the impact of conditional cash transfer programs. *World Bank Res Obs* 2005; **20:** 29–55.

60 Fernald LCH, Gertler PJ, Neufeld LM. 10-year effect of Oportunidades, Mexico's conditional cash transfer programme, on child growth, cognition, language, and behaviour: a longitudinal follow-up study. *Lancet* 2009; **374:** 1997–2005.

61 Fernald LCH, Gertler PJ, Neufeld LM. Role of cash in conditional cash transfer programmes for child health, growth, and development: an analysis of Mexico's Oportunidades. *Lancet* 2008; **371:** 828–37.

62 Macours K, Schady N, Vakis R. Cash transfers, behavioral changes, and the cognitive development in early childhood: evidence from a randomized experiment. *Am Econ J Appl Econ* (in press).

63 Fernald LCH, Hidrobo M. Ecuador's cash transfer program (Bono de Desarollo Humnano) and child development in infants and toddlers: a randomized effectiveness trial. *Soc Sci Med* 2011; **72:** 1437–46.

64 Paxson C, Schady N. Does money matter? The effects of cash transfers on child health and development in rural Ecuador. *Econ Dev Cult Change* 2010; **59:** 187–229.

65 Fisch SM. Children's learning from educational television: Sesame Street and beyond. Mahwah, NJ: Lawrence Erlbaum Associates Inc, 2004.

66 Anderson DR, Pempek TA. Television and very young children. *Am Behav Sci* 2005; **48:** 505–22.

67 Baydar N, Kagitçibasi Ç, Küntay AC, Göksen F. Effects of an educational television program on preschoolers: variability in benefits. *J Appl Dev Psychol* 2008; **29:** 349–60.

68 Lee J. The educational impact of Sisimpur: results of an experimental study of children's learning. http://comminit.com/early-child/node/70718 (accessed Aug 24, 2011).

69 Jain S, Kibria N. Sisimpur, Sesame Street in Bangladesh: exploring the challenges in early childhood development. *J Child Media* 2009; **3:** 95–100.

70 King E, De Silva M, Stein A, Patel V. Interventions for improving the psychosocial well-being of children affected by HIV and AIDS. *Cochrane Database Syst Rev* 2009; **2:** CD006733.

71 Cole C, Labin D, del Rocio Galarza M. Begin with the children: what research on Sesame Street's international co-productions reveals about using media to promote a new more peaceful world. *Int J Behav Dev* 2008; **32:** 359–65.

72 McConachie H, Huq S, Munir S, Ferdous S, Zaman S, Khan NZ. A randomized controlled trial of alternative modes of service provision to young children with cerebral palsy in Bangladesh. *J Pediatr* 2000; **137:** 769–76.

73 Finkenflügel H, Wolffers I, Huijsman R. The evidence base for community-based rehabilitation: a literature review. *Int J Rehabil Res* 2005; **28:** 187–201.

74 Mirza I, Tareen A, Davidson LL, Rahman A. Community management of intellectual disabilities in Pakistan: a mixed methods study. *J Intellect Disabil Res* 2009; **53:** 559–70.

75 Ashworth A, Khanum S, Jackson A, Schofield C. Guidelines for the inpatient treatment of severely malnourished children. Geneva: World Health Organization, 2003.

76 Nahar B, Hamadani JD, Ahmed T, et al. Effects of psychosocial stimulation on growth and development of severely malnourished children in a nutrition unit in Bangladesh. *Eur J Clin Nutr* 2009; **63:** 725–31.

77 Jones L, Morris J, Berrino A, Crow C, Jordans M, Okema L. Does combining infant stimulation with emergency feeding improve psychosocial outcomes for displaced mothers and babies? A controlled evaluation from Northern Uganda. *Am J Orthopsychiatry* (in press).

78 Ramey CT, Bryant DM, Wasik BH, Sparling JJ, Fendt KH, La Vange LM. Infant health and development program for low birth weight, premature infants: program elements, family participation, and child intelligence. *Pediatrics* 1992; **89:** 454–65.

79 Klebanov P, Brooks-Gunn J. Cumulative, human capital, and psychological risk in the context of early intervention: links with IQ at ages 3, 5, and 8. *Ann NY Acad Sci* 2006; **1094:** 63–82.

80 Spittle A, Orton J, Doyle LW, Boyd R. Early developmental intervention programs post hospital discharge to prevent motor and cognitive impairments in preterm infants. *Cochrane Database Syst Rev* 2007; **2:** CD005495.

81 Moster D, Lie RT, Markestad T. Long-term medical and social consequences of preterm birth. *N Engl J Med* 2008; **359:** 262–73.

82 Walker SP, Chang SM, Younger N, Grantham-McGregor SM. The effect of psychosocial stimulation on cognition and behaviour at 6 years in a cohort of term, low-birthweight Jamaican children. *Dev Med Child Neurol* 2010; **52:** e148–54.

83 Nair MK, Philip E, Jeyaseelan L, George B, Mathews S, Padma K. Effect of Child Development Centre model early stimulation among at risk babies—a randomized controlled trial. *Indian Pediatr* 2009; **46** (suppl)**:** s20–26.

84 Wallander JL, McClure E, Biasini F, et al. Brain research to ameliorate impaired neurodevelopment--home-based intervention trial (BRAIN-HIT). *BMC Pediatr* 2010; **10:** 27.

85 UNAIDS. Global report: UNAIDS report on the global AIDS epidemic 2010. Geneva: Joint United Nations Programme on HIV/AIDS, 2010. http://www.unaids.org/en/media/unaids/contentassets/documents/unaidspublication/2010/20101123_globalreport_en.pdf (accessed March 13, 2011).

86 Schenk K. Community interventions providing care and support to orphans and vulnerable children: a review of evaluation evidence. *AIDS Care* 2009; **21:** 918–42.

87 Potterton J, Stewart A, Cooper P, Becker P. The effect of a basic home stimulation programme on the development of young children infected with HIV. *Dev Med Child Neurol* 2010; **52:** 547–51.

88 Nyesigomwe L. Strengthening the capacity of grandmothers in providing care to young children affected by HIV/AIDS. *J Intergener Relatsh* 2006; **4:** 55–63.

89 Lusk D. Bungoma and Vihiga annual assessments: key results. Washington, DC: Academy for Educational Development, 2005.

90 Wolfensohn Center for Development at Brookings. Scaling up early child development in the developing world: event summary. Washington, DC: Wolfensohn Center for Development at Brookings, 2009. http://www.brookings.edu/~/media/Files/events/2009/0505_early_child_development/20090505_early_child_development_summary.pdf (accessed Aug 24, 2011).

91 Biersteker L. Scaling-up early child development in South Africa: introducing a reception year (grade R) for children aged five years as the first year of schooling. Washington, DC: The Brookings Institution, 2010. http://www.brookings.edu/papers/2010/04_child_development_south_africa_biersteker.aspx (accessed Aug 29, 2011).

92 Yosikawa H, McCartney K, Myers R, et al. Early childhood education in Mexico: expansion, quality improvement, and curricular reform. Florence: Innocenti Research Center, 2007.

93 Orazem P, Glewwe P, Patrinos H. Copenhagen Consensus 2008 Challenge Paper: education. http://www.copenhagenconsensus.com/The%2010%20challenges/Education-1.aspx (accessed Aug 24, 2011).

94 Horton S, Shekar M, McDonald CM, Mahal A, Brooks JK. Scaling up nutrition: what will it cost? Washington, DC: The World Bank, 2009.

95 Filmer D. Education attainment and enrollment around the world. http://econ.worldbank.org/projects/edattain (accessed Aug 5, 2010).

96 Filmer, D. Education attainment and enrollment around the world: an international database. Washington, DC: The World Bank, 2010. http://econ.worldbank.org/projects/edattain (accessed Aug 24, 2011).

97 The World Bank. Education statistics. http://go.worldbank.org/ITABCOGIV1 (accessed Aug 24, 2011).

98 The World Bank. World development indicators. http://data.worldbank.org/indicator (accessed Aug 24, 2011).

99 UNESCO. Education for all global monitoring report 2007: strong foundations, early childhood care and education. Paris: UNESCO Publishing, 2006.

100 Kilburn MR, Karoly LA. The economics of early childhood policy: what the dismal science has to say about investing in children. Santa Monica, CA: RAND Corporation, 2008. http://www.rand.org/pubs/occasional_papers/2008/RAND_OP227.pdf (accessed Nov 15, 2011).

101 Reynolds AJ, Temple JA. Cost-effective early childhood development programs from preschool to third grade. *Annu Rev Clin Psychol* 2008; **4:** 109–39.

102 Kaytaz M. A cost benefit analysis of preschool education in Turkey. http://www.acev.org/arastirmalarimiz.php?id=24&lang=en&page=3 (accessed Aug 24, 2011).

103 Organization of American States, Inter-American Council for Integral Development. Draft "hemispheric commitment to early childhood education and joint agenda of work (2007–2009)". Fifth Meeting of Ministers of Education; Cartagena de Indias, Colombia; Nov 15–16, 2007.

104 UN Secretary-General. Status of the Convention on the Rights of the Child—A/65/206. New York, NY: United Nations, 2010: 2–17.

105 Nadeau S, Kataoka N, Valerio A, Neumann MJ, Elder LK. Investing in young children: an early childhood development guide for policy dialogue and project preparation. Washington, DC: The World Bank; 2010. http://siteresources.worldbank.org/INTCY/Resources/395766-1187899515414/Note-Investing_Countrys_CY_Aug_2010.pdf (accessed Nov 15, 2010).

106 Tayler C, Bennett J. Starting strong II: early childhood education and care. Paris: Education Directorate of the Organisation of Economic Co-operation and Development, 2006.

Early childhood development—global action is overdue

Published Online
September 23, 2011
DOI:10.1016/S0140-6736(11)61450-5

See Online/Series
DOI:10.1016/S0140-6736(11)60555-2 and
DOI:10.1016/S0140-6736(11)60889-1

In 2007, *The Lancet* declared that early childhood development was a global challenge of the greatest urgency.[1-4] 4 years later, we have made progress, but still have far to go in making early childhood development the global priority it must be.

The importance of early childhood development remains profound. As the accompanying papers[5,6] in *The Lancet* show so clearly, the prenatal and postnatal periods are the most critical time in a child's development, laying the foundation for physical, emotional, and intellectual wellbeing. Dietary deficiencies, inadequate feeding practices, chronic infections, and low levels of stimulation during this period jeopardise a child's chance to reach his or her full potential and increase the risk that poor health and poverty will follow that child into adulthood. Exposure to multiple deprivations increases these terrible consequences.

Not surprisingly, children in the most disadvantaged quintiles of their societies are at the greatest risk of being deprived during this crucial early period. As the *Lancet* papers show, interventions directed at the poorest children can provide enormous returns on investment.[5,6] For example, home and community-based parenting and family support programmes significantly benefit the youngest children by promoting physical, cognitive, and emotional development, especially when they are integrated with other health, nutrition, and child-protection interventions. For children aged 3–6 years, organised early childhood learning centres not only improve school readiness but also school attainment. In turn, children who remain—and succeed—in school are more likely to earn higher incomes as adults, and to provide better nutrition, health care, stimulation, and educational opportunities to their own children. Furthermore, early childhood development interventions have a substantial impact on children affected by violence, disability, and developmental delays.[5]

That is why it is so alarming that the poorest and most vulnerable children who are most likely to benefit from early childhood development programmes are also least likely to have access to them. According to the World Bank, the Organisation for Economic Co-operation and Development countries spend an estimated 1·6% of their gross domestic product (GDP) on family services and preschool for children aged 0–6 years, and 0·43% of GDP on preschools alone. By comparison, low-income countries such as Nepal, Kenya, and Tajikistan spend just 0·1% of GDP on preschools, while Nicaragua and Senegal spend less than 0·02%.[6,7]

Neglect of young children most in need is an outrage—and a huge strategic mistake. Focusing on reaching these children is not only the right thing to do, it is a highly cost-effective investment that countries can and must make for their long-term growth. To cite just one example raised in the *Lancet* papers, increasing preschool enrolment rates to 25% could yield an estimated US$10·6 billion through higher educational achievement, while a 50% increase could generate $33·7 billion.[6] Such investments in centre-based early childhood development yield even greater dividends when they are coupled with community-based nutrition and parenting programmes.

The two *Lancet* papers present new evidence on the causes and consequences of developmental inequities in early childhood—and the exceptional opportunity we have to redress them. We must not ignore this evidence. Instead, we must act on it, working together to make safe and supportive early childhood development a reality for the world's poorest and most vulnerable children. Increased investment is needed in quality parenting programmes and organised early learning centres for the most disadvantaged children. These services should also be better integrated into existing community-based programmes across a broad range

Corbis

of sectors, including health, nutrition, education, water and sanitation, and protection. And we need to mobilise the political support of all stakeholders, including governments, UN agencies, and civil society groups. While the challenges ahead are steep, the imperative for universal early childhood development is clear: every child has the right to develop her or his fullest potential and to contribute fully to society. Our responsibility to pursue this goal is just as clear.

Anthony Lake
UNICEF, New York, NY 10017, USA
alake@unicef.org

I declare that I have no conflicts of interest.

1 Jolly R. Early childhood development: the global challenge. *Lancet* 2007; **369:** 8–9.
2 Grantham-McGregor S, Cheung YB, Cueto S, et al, for the International Child Development Steering Group. Developmental potential in the first 5 years for children in developing countries. *Lancet* 2007; **369:** 60–70.
3 Walker SP, Wachs TD, Gardner JM, et al, for the International Child Development Steering Group. Child development: risk factors for adverse outcomes in developing countries. *Lancet* 2007; **369:** 145–57.
4 Engle PL, Black MM, Behrman JR, et al, for the International Child Development Steering Group. Strategies to avoid the loss of developmental potential in more than 200 million children in the developing world. *Lancet* 2007; **369:** 229–42.
5 Walker SP, Wachs TD, Grantham-McGregor S, et al. Inequality in early childhood: risk and protective factors for early child development. *Lancet* 2011; published online Sept 23. DOI:10.1016/S0140-6736(11)60555-2.
6 Engle PL, Fernald LCH, Alderman H, et al, and the Global Child Development Steering Group. Strategies for reducing inequalities and improving developmental outcomes for young children in low-income and middle-income countries. *Lancet* 2011; published online Sept 23. DOI:10.1016/S0140-6736(11)60889-1.
7 Naudeau S, Kataoka N, Valerio A, Neuman MJ, Elder LK. Investing in young children: an early childhood development guide for policy dialogue and project preparation. Washington, DC: International Bank for Reconstruction and Development/World Bank, 2011. 179–82.