

Effects of responsive stimulation and nutrition interventions on children's development and growth at age 4 years in a disadvantaged population in Pakistan: a longitudinal follow-up of a cluster-randomised factorial effectiveness trial



Aisha K Yousafzai, Jelena Obradović, Muneera A Rasheed, Arjumand Rizvi, Ximena A Portilla, Nicole Tirado-Strayer, Saima Siyal, Uzma Memon



Summary

Background A previous study in Pakistan assessed the effectiveness of delivering responsive stimulation and enhanced nutrition interventions to young children. Responsive stimulation significantly improved children's cognitive, language, and motor development at 2 years of age. Both interventions significantly improved parenting skills, with responsive stimulation showing larger effects. In this follow-up study, we investigated whether interventions had benefits on children's healthy development and care at 4 years of age.

Methods We implemented a follow-up study of the initial, community-based cluster-randomised effectiveness trial, which was conducted through the Lady Health Worker programme in Sindh, Pakistan. We re-enrolled 1302 mother-child dyads (87% of the 1489 dyads in the original enrolment) for assessment when the child was 4 years of age. The children were originally randomised in the following groups: nutrition education and multiple micronutrient powders (enhanced nutrition; n=311), responsive stimulation (n=345), combined responsive stimulation and enhanced nutrition (n=315), and routine health and nutrition services (control; n=331). The data collection team were masked to the allocated intervention. The original enrolment period included children born in the study area between April 1, 2009, and March 31, 2010, if they were up to 2.5 months old without signs of severe impairments. The primary endpoints for children were development and growth at 4 years of age. Interventions were given in monthly group sessions and in home visits. The primary endpoint for mothers was wellbeing and caregiving knowledge, practices, and skills when the child was 4 years of age. Analysis was by intention to treat. The original trial is registered with ClinicalTrials.gov, number NCT00715936.

Findings 1302 mother-child dyads were re-enrolled between Jan 1, 2013, and March 31, 2013, all of whom were followed up at 4 years of age. Children who received responsive stimulation (with or without enhanced nutrition) had significantly higher cognition, language, and motor skills at 4 years of age than children who did not receive responsive stimulation. For children who received responsive stimulation plus enhanced nutrition, effect sizes (Cohen's d) were 0.1 for IQ (mean difference from control 1.2, 95% CI -0.3 to 2.7), 0.3 for executive functioning (0.18, -0.07 to 0.29), 0.5 for pre-academic skills (7.53, 5.14 to 9.92) and 0.2 for pro-social behaviours (0.08, 0.03 to 0.13). For children who received responsive stimulation alone, effect sizes were 0.1 for IQ (mean difference with controls 1.7, -0.3 to 3.7), 0.3 for executive functioning (0.17, 0.07 to 0.27), 0.2 for pre-academic skills (3.86, 1.41 to 6.31), and 0.2 for pro-social behaviours (0.07, 0.02 to 0.12). Enhanced nutrition improved child motor development, with effect size of 0.2 for responsive stimulation plus enhanced nutrition (0.56, -0.03 to 1.15), and for enhanced nutrition alone (0.82, 0.18 to 1.46). Mothers who received responsive stimulation (with or without enhanced nutrition) had significantly better responsive caregiving behaviours at 4 years of child age than those who did not receive intervention. Effect size was 0.3 for responsive stimulation plus enhanced nutrition (1.95, 0.75 to 3.15) and 0.2 for responsive stimulation (2.01, 0.74 to 3.28). The caregiving environment had a medium effect size of 0.3 for all interventions (responsive stimulation plus enhanced nutrition 2.99, 1.50 to 4.48; responsive stimulation alone 2.82, 1.21 to 4.43; enhanced nutrition 3.52, 1.70 to 5.34).

Interpretation Responsive stimulation delivered in a community health service can improve child development and care, 2 years after the end of intervention. Future analyses of these data are needed to identify which children and families benefit more or less over time.

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Introduction

Stimulation and nutrition interventions delivered in the first 2 years of life in low-income and middle-income countries have demonstrated consistent short-term

benefits to children's early development and growth outcomes.¹⁻⁵ A meta-analysis¹ of early stimulation and nutrition interventions conducted between 2000 and 2013 in low-income and middle-income countries

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Department of Paediatrics and Child Health, Aga Khan University, Karachi, Pakistan (A K Yousafzai PhD, M A Rasheed MSc, A Rizvi MSc, S Siyal MA, U Memon MA); and Graduate School of Education, Stanford University, Stanford, CA, USA (J Obradović PhD, X A Portilla PhD, N Tirado-Strayer MSc)

Correspondence to: Department of Paediatrics and Child Health, Aga Khan University, Karachi 74800, Pakistan
aisha.yousafzai@aku.edu

Research in context

Evidence before this study

We conducted a review of recent systematic reviews for stimulation or nutrition interventions published since the last *Lancet* series on child development in developing countries in 2011 (Jan 1, 2011, to Nov 30, 2015). We searched for reviews on PubMed and PsycINFO. Key terms used were psychosocial stimulation, stimulation, parenting, responsive care, nutrition, supplementation, micronutrients, growth, child development, early, interventions, longitudinal, follow up. Inclusion criteria included studies conducted in low-and middle-income countries, stimulation or nutrition interventions for children younger than 2 years, and outcomes that included a measure of children's development. We identified three reviews with meta-analyses of intervention effect on children's development or growth. We found consistent medium-size effects on child development as a result of stimulation and small-size effects as a result of nutrition interventions. Nutrition interventions also improved growth and nutrition status. In the review that specifically analysed integrated stimulation and nutrition interventions, little evidence was available to determine additive or synergistic benefits on child outcomes. Only four studies from Jamaica and Colombia were identified that had followed up cohorts after the intervention had ended. The earliest age of follow-up began at 6 years. The two Colombian studies had high attrition rates (>25%). The Jamaican cohort showed stimulation intervention showed sustained benefits in to adulthood, while the effects of nutrition supplement were not observed after 7 years of age. In summary, there is limited information on the long-term effects of early stimulation (with or without nutrition intervention) on later child and adult outcomes.

Added value of this study

Our results show sustained improvement during the preschool period as a result of early responsive stimulation (with or

without enhanced nutrition) on child IQ, executive functions, pre-academic skills, and pro-social behaviours, while children who received early enhanced nutrition sustained significant benefits to motor development. Our study also contributes to the evidence by investigating sustained benefits to caregiving. Mothers who were exposed to early responsive stimulation (with or without enhanced nutrition) showed significant continued improvement in responsive caregiving behaviours and in the quality of the caregiving environment, while the enhanced nutrition exposure showed significant continued benefit to the quality of the caregiving environment. This longitudinal follow-up demonstrated that responsive stimulation delivered in a programme setting in a rural highly disadvantaged low-income and middle-income population can sustain benefits on children's development 2 years after the end of intervention. However, compared with the short-term effects at the end of the original intervention, the effect sizes are reduced.

Implications of all the available evidence

More studies are needed to investigate the independent and combined effects of early stimulation and nutrition interventions. These studies should be designed not only to provide insights into the effectiveness of these interventions, but also how to optimise integrated implementation. Further, in contexts such as Pakistan, in which access, retention, and attainment in future primary education remains extremely poor, the extent of development protection that early responsive stimulation might provide in the long term is likely to be small. Risks that threaten children's development will continue to accumulate; therefore strategies to bolster development along the life course should be explored.

reported that responsive stimulation had a medium effect ($n=21$ studies, Cohen's $d=0.42$; 95% CI 0.36–0.48) and nutrition supplementation with or without nutrition education had a small effect ($n=18$, 0.09; 0.04–0.14) on cognitive development at 2 years of age. A systematic review of combined stimulation and nutrition interventions reported that stimulation consistently benefited child development, while nutrition usually improved nutritional status and growth, and sometimes improved child development.⁴ The review found little evidence for additive benefits on children's development, although no significant loss of independent intervention benefits was reported. Increased attention to combining interventions is warranted in order to determine potential additive benefits to outcomes, evaluate cost-effectiveness, and identify optimal early childhood intervention bundles to affect many outcomes in children.

Evidence of the enduring effects of interventions that promote early child development on later life outcomes and the potential cost-benefits to society from low-income

and middle-income countries is scarce.^{2,3} Only four cohorts (from Colombia and Jamaica) have been followed up after the original stimulation interventions were implemented between 1978 and 2004.^{6–10} The Jamaican cohort is the most prominent example of a cohort tracked into adulthood following exposure to early stimulation and nutrition interventions.⁶ In the efficacy randomised controlled trial, undernourished infants from poor neighbourhoods of Kingston, Jamaica, were randomly assigned into four groups to receive stimulation, nutritional supplementation, combined interventions, or control (standard health care). After 24 months of intervention exposure, both interventions had independent and additive benefits on child development and the nutrition intervention improved early growth. The effects of the stimulation intervention on cognitive capacity and behaviour were sustained into adulthood, whereas the nutrition intervention sustained small cognitive benefits only up to 7 years of age. Neither intervention had long-term benefits on growth.¹¹

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