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Post–1000 days growth trajectories and child cognitive development in low- and middle-income countries[1–3]

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There is no doubt that the first 1000 days of life are crucial for human physical and mental development (1, 2). However, a key question is if the developmental damage caused by poverty-related insults (including malnutrition) during this period of time can be reversed through interventions that start after 2 y of age, and if so, to what extent (3). The study by Crookston et al (4) sheds new light on this question through a well-designed, robust longitudinal study examining the relation between postinfancy linear growth (1–8 y of age) and child cognitive and schooling outcomes at 8 y of age. The ''Young Lives'' study followed up the growth trajectories of children recruited at 1 y of age in strikingly different socioeconomic and cultural contexts in Ethiopia, India, Peru, and Vietnam (average maternal education ranged from 3 grades in Ethiopia to 7.8 grades in Peru) and followed them up at ~5 and 8 y of age. As expected, height-for-age *z* score (HAZ) at 1 y was positively associated with child cognitive development (math, vocabulary, and reading) and schooling (age-for-grade) outcomes at 8 y confirming the fundamental importance of the first 1000 d for subsequent child development (5). The most innovative finding from this study, however, is that postinfancy linear growth, uncorrelated with HAZ at 1 y, was positively associated with child cognition and school performance. Specifically, *1*) linear growth between 1 and 8 y was positively associated with improved cognitive and schooling outcomes in early elementary school, independent of attained length at 1 y; *2*) preventing stunting during infancy and throughout the preelementary and early elementary school period (ie, never-stunted) was the growth trajectory most protective against poor cognitive and schooling outcomes at 8 y; and *3*) recovery from stunting after infancy (compared with persistent stunting) may have protected children's cognition and schooling performance, although protection was only partial when compared with never-stunted children.

The findings from Crookston et al (4) are in general agreement with previous empirical evidence suggesting that the brain is a highly plastic organ with remarkable ability to improve its function even when interventions start after exposure to nutritional insults during the first 1000 d of life (2). Strengths of this study include its well-standardized multicountry prospective design and the statistical modeling approach allowing for examination of the influence of the postinfancy linear growth on child development independent of HAZ at 1 y. Even though the directionality of the linear growth–child development associations was consistent, there was effect size heterogeneity across countries. This suggests that improving linear growth after 1 y of age may offer some child development benefits, but the extent to which this happens is expected to vary across contexts.

An important limitation of this study is that the linear growth period examined overlapped with the first 1000 d because it started at age 1 y. Future studies interested in examining post–1000 d nutrition recovery effects should also assess linear growth at 2 y and should also collect cognitive and other (sensory-motor and socioemotional) child development outcomes beginning at baseline and not only at the study's endpoint.

All countries experienced decreases in stunting (ranging from 9.3% in Vietnam to 26.1% in Ethiopia), indicating that stunting can be reversed in some children after the first year of life. Thus, it is important to understand why some children recover from stunting but others don't. Although the Young Lives study has also provided some insights into this complex question (6), much work remains to be done for understanding stunting reversal after 1000 d. Child development ecological life-course theory (3, 7) calls for answering questions such as What are the intrinsic characteristics of infants who recover from stunting after 2 y? What are the characteristics of the dynamic micro-, meso-, exosystems that end up determining the physical and psychosocial environments in which children grow, play, and learn that facilitate this recovery? Most important, how does the interaction between the children with their caregivers and their environments end up determining the linear growth trajectories that they follow after 2 y of age independent of linear growth before this age? Are these determinants context specific or are there common features across contexts? The Cali study, a randomized controlled trial conducted in Cali, Colombia, in the 1970s was designed to test a Head Start–like nutrition supplementation, education, and health day care center intervention beginning at 3.6 y of age. Key findings were as follows: *1*) linear growth and child cognitive development benefitted during the period of intervention that ended when children were 7 y old

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(8, 9) and *2*) 3 y after the end of the intervention, benefits in linear growth could no longer be detected but the cognitive development benefits remained (10). Thus, future studies should consider in their designs the possibility that transient linear growth improvement after 1000 d may also end up benefitting the child's cognition in the longer term. Answers to these questions are needed to design and test sound evidence-based child development interventions globally (11).

From a mechanistic point of view it is important to further understand the relation between pre– and post–1000 d linear growth and brain anatomy, physiology, and function taking advantage of recent scientific brain research advances (2, 3). These studies could help to find out if linear growth is simply a proxy for better brain development (ie, other factors are confounding the stunting–cognitive development relation) or if children who are not stunted (or who recover from stunting) are more likely than their persistently stunted counterparts to positively interact with and benefit from their environments and as a result experience better brain development and cognitive function.

In closing, the first 1000 d of life are crucial for future child physical and mental development. However the study by Crookston et al (4) confirms the possibility that improving linear growth during the preelementary and the early elementary school periods may still offer a window of opportunity to recover at least some of the cognitive development damage attributed to stunting.

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