PERSPECTIVE

Overcoming Challenges to Accelerating Linear Growth in Indian Children

HPS SACHDEV

Senior Consultant Pediatrics and Clinical Epidemiology, Sitaram Bhartia Institute of Science and Research, B-16 Qutab Institutional Area, New Delhi 110016, India. hpssachdev@gmail.com

This policy review highlights the need to focus on stunting as an indicator of under-five undernutrition and explores the major challenges and priority public health options for accelerating linear growth in children. Early childhood stunting predicts poor human capital including shorter adult height, lower attained schooling, reduced adult income, and decreased offspring birth weight. The current prevalence of stunting is disconcerting but there has been a relatively faster decline recently. It is imperative to intervene before birth to address stunting. Pertinent ongoing interventions (delaying early child birth, adequate antenatal care and maternal iron-folate supplementation) are beneficial but have sub-optimal coverage. There is only a narrow window of opportunity in early life – the first two years. Effective coverage of children below two years of age with a package of interventions (breastfeeding; immunization; appropriate complementary feeding; treatment of infections, especially diarrhea; safe water supply; and sanitation) merits urgent investigation for greater impact.

Undernutrition in children below five years of age is conventionally measured by three indices: *underweight* (low weight; weight for age below 2 standard deviations [SD] of World Health Organization [WHO] growth reference), *stunting* (short child; length or height for age below 2 SD of WHO growth reference), and *wasting* (thin child; weight for length or height below 2 SD of WHO growth reference). Weight for age represents a composite measure of height for age and weight for height. A low weight for height (wasting) is used to define *acute* undernutrition in populations, for example, severe acute malnutrition (weight for height below 3 SD of WHO growth reference; SAM), which necessitates immediate intervention to prevent mortality and severe morbidity. A low height for age or linear growth retardation (stunting) is however believed to represent a relatively longer lasting deprivation. It is important to realize that the three indicators reflect different biological facets of undernutrition and interventions aimed at reducing one may not necessarily ameliorate another.

NEED TO FOCUS ON STUNTING

Stakeholders invariably relate childhood undernutrition to underweight. Consequently all policy discussions revolve around underweight only, thereby eroding the public health importance of stunting and wasting. However, wasting has recently gained recognition for identification of SAM while stunting still remains neglected. Evidence indicates that height-for-age at 2 years is the best predictor of human capital in low and middle income countries (LMICs). Further, stunting in the first 2 years of life causes irreversible damage, including shorter adult height, lower attained schooling, reduced adult income, and decreased offspring birth weight [1]. In view of the increasing importance of human resource development, it is imperative that stunting be now viewed as a primary indicator of childhood undernutrition by policy and program stakeholders.

The ensuing sections explore the major challenges and priority public health options for accelerating linear growth in Indian children.

RECENT TRENDS AND CURRENT MAGNITUDE OF STUNTING

Epidemiological analyses of regional and national datasets document a sustained increase in mean height with a concomitant decline in stunting over the past four decades amongst children below five years of age [2], with some evidence of a faster decline during the past decade.

A comparison of undernutrition indices, defined as per the WHO growth reference, is possible between 1998-99 and 2005-6 from the National Family Health Surveys (NFHS) [3], only in children below three years age (***Fig.* 1**). There was a substantial decline in stunting (51% to 45%), a marginal reduction in underweight (43% to 40%), but a rise in wasting (20% to 23%). This trend was evident for both urban and under-privileged rural

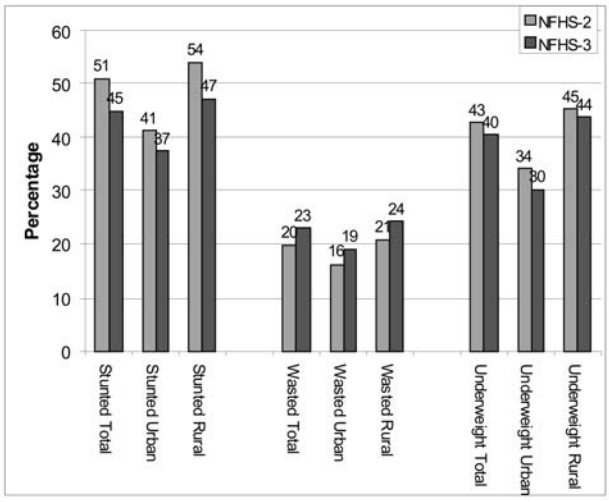

FIG. 1 *Comparison of undernutrition indices defined as per the WHO growth reference between 1998-99 and 2005-6 from the National Family Health Surveys [3] in children below three years age.*

regions; in fact, the greater decline in stunting in rural rather than urban areas (54% to 47% *vs* 41% to 37%) is inspiring. However, the marginal rise in wasting has often been misinterpreted as worsening of undernutrition.

Considering the biological perspective, linear growth (exemplified by an increase in length of a cylinder) and an increase in weight for height (exemplified by an increase in padding of the cylinder) are two distinct processes. The logical biological interpretation of the recent time trend is that the increase in length has outstripped the simultaneous growth in weight, resulting in taller but thinner (less padded) children with a consequential increase in wasting. This recent trend also reaffirms that over time (surrogate of invisible specific interventions), the changes in the three anthropometric indicators can vary both in direction and magnitude. However, generally in populations, linear growth acceleration has been more difficult to achieve than an increase in weight for height. This recent trend in national nutritional status should thus be viewed as an improvement rather than worsening of undernutrition. This inference is further substantiated by an increase in the *composite* anthropometric measure (weight for age) with a concomitant reduction of underweight prevalence (43% to 40%), albeit to a lesser extent. It is virtually impossible to dissect out the individual factors that facilitated preferential linear or weight growth from this data. Nevertheless, it is evident that measures to improve underweight may not improve linear growth and therefore specific interventions must be sought for and targeted to ameliorate stunting.

In summary, the current national estimate of stunting in children below five years of age is disconcerting (urban: 39.6% and rural: 50.7%) [3]. However, stunting has declined at a relatively greater pace during the past decade, even in the underprivileged rural areas. Further, linear growth, disproportionately greater than weight gain, is also feasible in India. The key issue pertains to consolidating and accelerating these gains at the population level.

Birth deficit persists

Longitudinal data from developing countries indicates that newborns with low birth weight (LBW; <2500 grams) are substantially predisposed to become undernourished children. In the New Delhi Birth Cohort (NDBC) longitudinal database [4], LBW increased the risk of being underweight (3 to 5 times), stunted (2.1 to 4.3 times), and wasting (2.2 to 2.9 times) in the first five years of life, and the risk generally decreased with increasing age [5]. A short newborn (12% in NDBC) is at a greater risk of developing stunting (2.5 to 8.1 times). In the NDBC, stunting attributable to LBW was 28% at 6 months and ranged between 8% and 16% from 1 to 5 years of age. With a LBW prevalence of 30% in India in comparison to 21% in the NDBC, these estimates increase to 37% at 6 months and between 13% and 22% from 1 to 5 years of age (***Fig.* 2**). It is therefore imperative to intervene before birth to address linear growth retardation in children.

INTERVENTIONS BEFORE CONCEPTION AND BIRTH

On the basis of current evidence [6], it would be pertinent to briefly examine the appropriateness of the ongoing major national initiatives for increasing birth size, and explore the need for incorporating any modifications or adopting novel approaches.

Early marriage and child-birth are important risk factors for delivering a LBW newborn. NFHS3 data indicates that infants born to mothers married before the age of 18 years are at 1.22 higher risk of stunting [7] and child birth before 20 years age increases the risk of

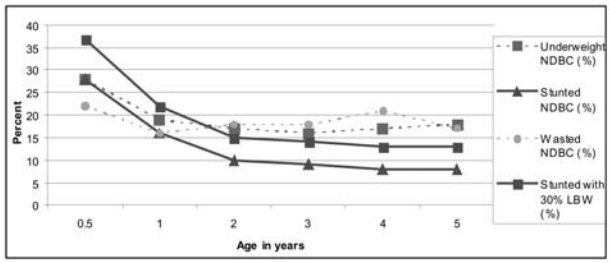

FIG. 2 *Proportion of undernutrition in children below five years of age attributable to being born low birth weight: data from the New Delhi Birth Cohort (NDBC)[4]. A similar projection has been done for stunting assuming a national low birth weight (LBW) prevalence of 30%.*

delivering a LBW newborn (1.5 times) and stunting [5]. Longitudinal unpublished data from NDBC documented that early child birth resulted in lower birth weight and length, and these deficits persisted till 6 months, 2 years, and 11 years of age and even into adulthood. This observation supports the possibility of an inter-generational handicap [1] for developing stunting. Indian law prohibits child marriage and some states also offer additional socio-economic incentives to delay early marriage and child birth. However, NFHS-3 data [3] indicates that 73% of births still occur to mothers married before age 18 years. The median age at first delivery is 19.9 years while 22% of all child-births occur before age 20 years It is evident that urgent efforts are required to provide appropriate socio-cultural interventions to effectively delay early marriage and child-birth, which could prove to be a sustainable remedy.

Provision of adequate antenatal care, including detection and treatment of illnesses, improves the birth size [6]. However, in the NFHS-3 survey, one-fifth pregnant women did not receive any antenatal care while one out of four women had only 1 or 2 antenatal care visits during pregnancy [3]. In this context, the recently introduced Janani Suraksha Yojana (JSY), a conditional cash transfer programme to increase births in health facilities, is a welcome initiative. It is hoped that increased institutionalization of births will improve the quantity and quality of routine antenatal care. A recent evaluation [8] documented that implementation of JSY in 2007-08 was highly variable by State - from less than 5% to 44% of women giving birth receiving cash payments. The poorest and least educated women did not always have the highest chance of receiving JSY payments. However, JSY had a significant effect on increasing antenatal care and in-facility births. The findings of this assessment are encouraging but do not provide any direct evidence of effects on birth size. The data emphasizes the need for improving targeting of the poorest women and quality of obstetric care in health facilities [8].

Evidence is convincing that maternal iron supplementation improves birth weight [9]. Iron-folic acid supplementation of pregnant women is being practiced as a national policy for several decades. However, the NFHS-3 data indicates that 65% pregnant women received (or bought) iron-folic acid supplements for their most recent birth, and only 23% took the supplements for at least 90 days, as recommended [3]. As multiple micronutrient deficiencies are common in developing countries, multiple micronutrient supplements are now being advocated in pregnant women to improve maternal and fetal outcomes. In a recent pooled analysis of 12 randomized controlled trials from developing countries [10], compared with control supplementation (mainly with iron-folic acid), multiple micronutrient supplementation was associated with a 22 grams increase in birth weight and 11% reduction in risk of LBW. However, there was an increased risk of excessively large babies prone to complications (13%), early neonatal mortality (23%) and perinatal mortality (11%) [11]. The current data are thus unconvincing for replacing supplementation of antenatal iron-folic acid with multiple micronutrients. It would therefore be prudent to focus on increasing the coverage of iron-folic acid supplementation rather than introducing multiple micronutrient supplements, which would also entail novel logistic and financial issues.

Food supplementation has been often advocated as an attractive social intervention for improving undernutrition. A 2010 update of Cochrane review on this subject [12] documented the following findings. In 5 trials (1135 women), nutritional advice to increase energy and protein intakes was successful in achieving those goals, but no consistent benefit was observed on pregnancy outcomes. In 13 trials (4665 women), balanced energy/protein supplementation was associated with modest increases in birth size (weight: 37.6 g, length: 0.1 cm) and a substantial reduction in risk of small-for-gestational-age (SGA) birth (32%). However, these effects did not appear greater in undernourished women. In 2 trials (529 women), high-protein supplementation was associated with a non-significant reduction in mean birth weight and a significantly increased risk of SGA birth. These data, mostly from developed country settings, suggest that food supplementation in all pregnant women is unlikely to reduce linear growth retardation. However, there may be a case to experiment with pilot programs of targeted food supplementation to pregnant women in extremely deprived settings through the Integrated Child Development Services or alternative infrastructure.

In summary, the ongoing interventions outlined above have proven benefit and no novel "magical" options appear on the horizon. It would therefore be pragmatic to primarily concentrate on improving the sub-optimal coverage of the existing programs and ensure equitable access for the poorer and unreached segments of society.

NARROW WINDOW OF OPPORTUNITY IN EARLY LIFE

In conformity with global observational evidence, in the cross-sectional NFHS-3 [3] and the longitudinal NDBC data too, the prevalence of stunting increased sharply between 6 and 23 months of age to nearly plateau thereafter (***Fig.* 3**). A recent pooled longitudinal analysis [13], from prospective cohorts in five transitioning

KEY MESSAGES

- Early childhood stunting predicts poor human capital. Stunting should be used as a primary indicator of childhood undernutrition.
- The current prevalence of stunting (urban: 39.6% and rural: 50.7%) is disconcerting but there has been a relatively faster decline recently, which needs to be accelerated.
- It is imperative to intervene before birth to address stunting. Pertinent ongoing interventions (delaying early child birth, adequate antenatal care and maternal iron-folate supplementation) are beneficial but have sub-optimal coverage.
- There is only a narrow window of opportunity in early life – the first two years. Maximizing coverage of under twos with the full package of interventions (breast feeding; immunization; appropriate complementary feeding; treatment of infections, especially diarrhea; safe water supply; and sanitation) may be pivotal for improving linear growth.
- Policy should primarily concentrate on improving the sub-optimal coverage of pertinent ongoing interventions and ensure equitable access for the poorer and unreached segments of society.

societies including NDBC in India, reaffirms the narrow window of opportunity in early life. Linear growth failure prior to age 12 months was strongly associated with shorter adult stature while linear growth in the periods 12–24 months and 24 months to mid-childhood were less so. These data emphasize the importance of initiating interventions within the first two years of life, and preferably within the first year of life. Unfortunately, the primary focus and coverage of most interventions to improve undernutrition is beyond the first two or five years of age (for example, the Integrated Child Development Services and Mid-Day Meal Programs).

In carefully conducted systematic reviews, several apparently "promising" interventions for improving growth have proved ineffective in increasing length in children in developing countries, particularly in the first two years of life. These include community-based supplementary feeding [14], growth monitoring [15], routine deworming [16], and individual micronutrient supplementation including iron, vitamin A and zinc [17,18]. Multiple micronutrient supplementation may increase linear growth [17], but the benefits are small (0.09 standard deviations) and need further substantiation in infants in our setting. This option may not be viable because of trivial expected benefit, and logistics and cost considerations of introducing a policy of daily supplementation; however, increasing the micronutrient content of complementary foods (including, through fortification) deserves exploration.

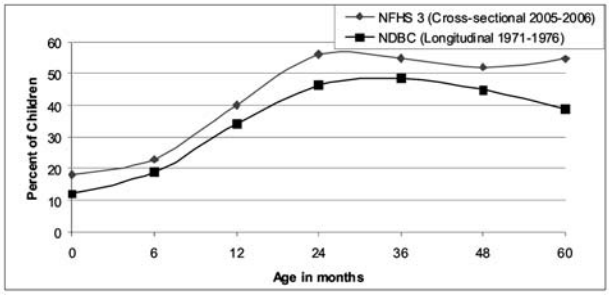

FIG. 3 *Prevalence of stunting in relation to age in the New Delhi Birth Cohort (NDBC) longitudinal study and the cross sectional National Family Health Survey (NFHS3) (3).*

Some of the ongoing initiatives in child health do have the potential to improve linear growth. These include educational interventions to promote appropriate complementary feeding practices [19,20]; treatment of infections, particularly diarrhea; and prevention of infections through breast feeding, immunization, and water supply, sanitation and hygiene interventions [21]. Observational data suggests that infections have a substantial effect on linear growth [22]; intervention trials to explore this hypothesis would be unethical. The coverage of most of these interventions is sub-optimal. Further, the responsiveness of length to these interventions in isolation is probably quite limited (0.1 to 0.2 standard deviations), which will not translate into sizeable reductions in stunting in the short term.

In summary, individual interventions received in isolation during the first two years of life have not demonstrated a substantial impact on linear growth in the short-term. Maximizing coverage of under twos with the full package of interventions (breast feeding; immunization; appropriate complementary feeding; treatment of infections, especially diarrhea; safe water supply; and sanitation) may be pivotal for improving linear growth.

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