BMJ Paediatrics Open

Global relevance of MGRS growth standards: the case of India

Vandana Prasad [1], Dipa Sinha [2], Rohit James Joseph [3]

To cite: Prasad V, Sinha D, Joseph RJ. Global relevance of MGRS growth standards: the case of India. *BMJ Paediatrics Open* 2024;**8**:e002472. doi:10.1136/bmjpo-2023-002472

Received 6 February 2024
Accepted 3 March 2024

ABSTRACT

The most common measures of childhood undernutrition are based on anthropometric measures such as height-for-age (stunting/chronic undernutrition) and weight-for-height (wasting/acute undernutrition). It is well recognised that the determinants of undernutrition are multiple, including food intake, dietary diversity, health, sanitation and women's status. Currently, most countries across the world including India use the globally accepted WHO-Multicentre Growth Reference Study (MGRS) growth standards (2006) for the purposes of measurement as well as for evaluating progress on these metrics. However, there is some discussion on the universal relevance of these standards, and in the Indian context, whether these standards overestimate the prevalence of stunting, considering differences in genetic potential for growth. This is especially relevant in the context of increasing burden of obesity and non-communicable diseases in India. Based on a detailed review of literature, policy documents and expert inputs, this review paper discusses the relevance of the WHO growth standards for height/stunting, in the context of India. Issues discussed related to the MGRS methodology include pooling of data and intersite and intrasite variability, opting for standards as opposed to references, and external validity. Other issues related to plasticity of stunting and the influence of maternal heights are also discussed, in the context of analysing the appropriateness of using universal growth standards. Based on the review, it is recommended that the current standards may continue to be used until a newer global standard is established through a similar study.

KEY MESSAGES

⇒ WHO-Multicentre Growth Reference Study (MGRS) had a clearly stated objective of setting growth 'standards' and not growth 'references' for infants and young children; the study was designed accordingly.
⇒ Given diversity that exists even within a country, a universal standard is the only way to make credible international and subnational comparisons over time.
⇒ Using national large-scale sample surveys not designed for setting prescriptive standards is not appropriate to validate the MGRS.
⇒ Adjusting for maternal stature underestimates contribution of current deficient environment and ability of genetics of a population to adapt towards greater heights as conditions improve.
⇒ Poverty, gender and other distal determinants are intrinsic to understanding multifactorial nature of malnutrition and need not be teased out from direct nutritional interventions.

Anthropometric indicators such as height-for-age and weight-for-height are used to identify, quantify and track different forms of malnutrition. They are particularly useful as they are easy to collect and monitor in clinical as well as community settings. They are commonly used in public health programming and an integral part of public health statistics on health and well-being of children. In this context, the question of which references or standards are to be used to determine the extent of child malnutrition is crucial. Most countries have officially adopted the WHO growth standards.[1]

Growth *standards* represent a healthy pattern of growth based on a selected reference sample and show how children *ought* to grow rather than how they grow.[2] Growth *references*, however, describe *how* children grow and may be applied to other children to establish whether or not their growth is typical of the reference group. The Multicentre Growth Reference Study (MGRS) was conducted in six countries across the world to document growth patterns of children and towards developing a standard based on 'healthy children living under conditions likely to favour achievement of their full genetic growth potential.[3]' These standards were considered appropriate for use globally, as they included samples from select countries from different parts of the world and studies found that children across the world grow similarly when their health and care needs are met.[3]

Since the release of these standards, various attempts have been made at validating them in different country contexts (Sri Lanka, Indonesia, USA, etc) and some concerns have been raised about their universal applicability,[4–6] especially whether genetic factors are being sufficiently accounted for. India has been using these standards since 2008, both to determine

[1]Public Health Resource Society, New Delhi, India
[2]Dr BR Ambedkar University Delhi, New Delhi, India
[3]Ashoka University, Sonepat, India

Correspondence to
Dr Dipa Sinha; dipasinha@gmail.com

the prevalence of stunting, wasting and underweight as well as in its Integrated Child Development Scheme Programme for regular growth monitoring of individual children. However, there is now a renewed discussion in Indian policy and academic circles on whether these are the most appropriate growth standards to be used.[7] From a policy viewpoint, questions are raised on whether using global standards results in an overestimation of stunting prevalence in India and consequently, how useful they are for goal-setting as well as for designing interventions.[7 8] To investigate these concerns and their relevance to India, a purposive (non-systematic) review of the existing evidence was conducted based on technical consultations with a wide range of experts in February and October 2023 in New Delhi, India.

This paper presents a summary discussion of the relevant issues identified from the review related to representativeness of the MGRS, concerns on study design, plasticity of stunting and the influence of maternal heights (a detailed discussion of these issues may be found in our working paper available here[i]).

MGRS DESIGN AND RELATED ISSUES

The WHO-MGRS was a community-based, multicountry study to develop new growth standards for infants and young children with two arms: a longitudinal follow-up from birth to 24 months and a cross-sectional survey of children aged 18–71 months. Replacing the WHO-National Center for Health Statistics references based on children from a single country, the WHO-MGRS drew its sample from six diverse sites: Brazil (South America), Ghana (Africa), India (Asia), Norway (Europe), Oman (Middle East) and the USA (North America), and followed a strict inclusion criterion of 'populations lived under socioeconomic conditions favourable to growth'. The final MGRS sample included data from a total of 8440 affluent children. The India sample was drawn from children belonging to privileged households in South Delhi who met all the eligibility criteria including having a 'favourable' growth environment, being breastfed and having non-smoking mothers. Some concerns have been raised on the study methodology itself, especially with reference to final sample size and pooling of data from across the six countries. Most of these have been addressed rigorously and elaborately by the MGRS group in Acta Paediatrica[3] and are summarised and substantiated below.

There are concerns that the MGRS sample is biased,[9] for instance, by exclusion of non-compliant infants (due to violation of breastfeeding recommendations) and retention of higher number of breastfed infants, who tend to be larger in the first 6 months.[10] It would be fair to say that since the study set out to identify participants who met certain eligibility criteria, the exclusion of those not meeting these criteria must not be looked at as sample bias. The purposiveness was deliberate and in-built to the study design, which in turn, sought to create a standard for which breastfeeding was considered the norm. Further, the fall in sample size due to non-compliance and/or attrition has little to no effect on statistical power. 'Overall, 54% of the sample complied with the three feeding criteria, surpassing the expected compliance rate of 30% used to calculate the study's sample size. This result, coupled with a very low dropout rate, yielded a sample for the construction of the standards more than double the size required to ensure stable outer percentiles (ie, 882 vs 400).[11]'

Questions have also been raised on whether samples from the six sites are 'poolable', given the variability in heights of children across the sites in the study.[7 12] Limited variability is important to justify the study's conclusions that the resultant growth standards represent a universal, 'normal' underlying pattern of growth characterising all under-5 children.[13]

The MGRS group finds that no site-specific mean (9 ages×6 sites=54 site mean values) deviated by an absolute amount ≥0.5 SD of the corresponding overall sample mean. Moreover, 20 values (out of a total of 54) differed by >0.2 SD units and 10 differed by >0.3 SD units—both deemed less than 'medium' levels of difference, using the Cohen's rule of thumb on effect sizes.[14] Also, the standardised site effects (difference between the site-specific mean and the corresponding pooled mean, divided by the pooled SD) for India hardly cross 0.2 SD units (and deviate by −0.32 SD at the maximum for 60–62 months and −0.29 SD at birth) across all age groups and are not an outlier, even by a different cut-off.[15]

The MGRS group's discussion on pooling of data and variability is largely in the context of length/height-for-age. Length/height was selected as 'the most suitable measure to assess population differences of possible genetic or environmental origin among children of well-off families',[14] considering that it is normally distributed and resistant to skewing, in response to excessive energy intake. Since the MGRS data revealed that they needed to model for skewness for all standards other than stunting, complex modelling methods were tested and finally, the Box-Cox power exponential method was selected as the best approach to construct growth curves.[16] Thus, the present review also focuses largely on stunting.

MGRS: EXTERNAL VALIDITY

One of the major critiques of the MGRS has been that it does not stand the test of external validity as seen in a set of meta-analyses and studies attempting to validate the WHO-MGRS sample through large-scale national sample surveys.[6] In the context of India, external validation of the MGRS has been conducted by attempting

[i]https://www.researchgate.net/publication/375799563_WHO-MGRS_Review_Final_19_nov_2023

Table 1 Comparing baseline socioeconomic characteristics in MGRS India sample with top quintiles of NFHS 4 and 5

Baseline socioeconomic characteristics	MGRS India (2000–2001)—South Delhi	NFHS 4 top quintile (2015–2016)—India	NFHS 5 top quintile (2019–2021)—India
Females with ≥10 years of completed education (%)	100 (*mothers only*)	70.6 (*females aged 15–49*)	73.0 (*females aged 15–49*)
Males with ≥10 years of completed education (%)	100 (*fathers only*)	77.5 (*males aged 15–49*)	80.9 (*males aged 15–49*)
Households possessing a car (%)	90.4	26.5	31.2
Family income or consumption expenditure per month (Indian rupee)	45000 (*median family income*)	6530.48 (*mean household consumption expenditure in urban Delhi in 2001–2002, same year as MGRS, from National Sample Survey 57th round*)	

MGRS, Multicentre Growth Reference Study; NFHS, National Family Health Survey.

to identify a subsample from large-scale surveys such as the National Family Health Survey (NFHS) and Comprehensive National Nutrition Survey (CNNS) that might be close to the MGRS sample with regard to socioeconomic characteristics as well as feeding norms.

For instance, a recent study derived an 'analytical sample' of children approximating MGRS criteria from NFHS (2015–2016) and CNNS (2016–2018) to compare outcomes for children in these surveys with the MGRS growth standards.[17] Based on this analysis, it was argued that the MGRS growth standards for India overestimate the actual prevalence of undernutrition in the country.

However, comparisons with other large sample surveys would only be valid if these could provide subsamples that meet the MGRS criteria for a favourable/unconstrained growth environment. The MGRS sample is markedly different from average urban populace in India—a reflection of the high levels of income and wealth inequality in the country. There exist wide disparities between the MGRS India sample and top quintiles of nationally representative NFHS and CNNS on a variety of comparable indicators of socioeconomic development. Further, given that these large sample surveys under-represent very rich households and their asset holdings,[18–20] data on top quintiles cannot be assumed to approximate the MGRS India sample drawn from affluent neighbourhoods even on economic characteristics. The MGRS sample with stated criteria of 'no economic, environmental or biological constraints' on child growth,[3] representing a very small section of the Indian population, is almost impossible to replicate from available datasets collected for different purposes as evident from table 1.

Other studies have used synthetic Indian growth curves on NFHS data to derive revised prevalence rates.[21] However, synthetic growth charts such as the Indian Urban Middle Class (IUMC) chart[22 23] (see table 2) represent a completely different approach, in that they are growth references and not standards. They use pooled anthropometric data from various field studies of children from 'middle and upper-middle socioeconomic classes' in different parts of the country using modelling techniques to generate growth references. These studies did not follow the strict criteria of a 'favourable environment' as defined in the MGRS. Therefore, significant differences in stunting and wasting prevalence based on IUMC and WHO-MGRS 'cannot by itself provide an assessment of which one more accurately reflects the current extent of undernutrition'.[21]

Similarly, a higher disease burden, reflected in greater levels of stunting and wasting, under the MGRS standards (relative to national growth references) has prompted some scholars to suggest the use of regional growth charts in Spain,[24] Indonesia,[25] Pakistan[26] and Japan.[27] It needs

Table 2 Prevalence of stunting, wasting and underweight, as calculated by different measures/corrections

	Method used	Stunting (%)	Wasting (%)	Underweight (%)	Source data
NFHS 5	−2 SD units from the median of the WHO MGRS sample	35.5	19.3	32.1	
Ghosh *et al*[17]	Excess mean risk of growth faltering	15.5	15.0	7.1	Based on data from NFHS 5
Subramanian *et al*[21]	IUMC synthetic growth chart for India	24	9	29	Based on data from NFHS 5

IUMC, Indian Urban Middle Class; MGRS, Multicentre Growth Reference Study; NFHS, National Family Health Survey.

Table 3 Comparing awareness and adherence to feeding norms in MGRS India sample with top quintiles of NFHS 4 and 5

Breastfeeding norms	MGRS India (2000–2001)—South Delhi (n=269)	NFHS 4 top quintile (2015–2016)—India	NFHS 5 top quintile (2019–2021)—India
Baby breastfed within 1 hour of birth (%)	39.8	39.9	43.0
Mothers who were counselled/advised on breastfeeding (%)	100	80.4 (*women aged 15–49 with a live birth in the last 5 years*)	85.2 (*women aged 15–49 with a live birth in the last 5 years*)

MGRS, Multicentre Growth Reference Study; NFHS, National Family Health Survey.

Table 4 Comparing adherence to feeding norms in MGRS India sample with top quintile of CNNS 2016–2018

Feeding norms	MGRS India (n=269)	CNNS 2016–2018 top quintile (n=7612, weighted)
Baby breastfed within 1 hour of birth (%)	39.8	54.7
Exclusive/predominant breastfeeding at 4 months (%)	78.0	55.2
Continued breastfeeding at 12 months (%)	77.0	68.8
Initiation of complementary foods at 6 months (%)	99.0	68.0

CNNS, Comprehensive National Nutrition Survey; MGRS, Multicentre Growth Reference Study.

to be emphasised that their recommendations also relied on studies based on cross-sectional samples with little to no information on individual nutrition, health, infection status or socioeconomic background (unlike the MGRS), and thus suffer from the same limitations being discussed in this review.

While comparing with other prevalence studies or references, it must also be noted that mothers of the children in the MGRS India longitudinal sample received lactation counselling, regular advice on varied aspects of complementary feeding (timing, meal frequency, quantity and consistency of food, hygiene and nutrient supplementation) and complied accordingly. The resulting WHO growth standards therefore reflect the potential growth of children if all criteria, *including breastfeeding and infant and young child feeding counselling* as integral interventions, are met. The disparity in awareness and adherence to feeding norms between the top quintiles of NFHS/CNNS and the MGRS India sample is further indicative of the fact the two are fundamentally incomparable (see tables 3 and 4).

Further, it is also not appropriate to compare anthropometric data collected for the purposes of setting standards (as in the MGRS) with data collected in large-scale prevalence surveys (NFHS/CNNS) because of the difference in survey methodology and quality assurance protocols. The MGRS had very stringent protocols on the measurements of heights and weights,[28] which is impossible in nationally representative prevalence studies that are not designed for the purpose of creating standards.

In summary, once it is understood that the MGRS sample was designed for setting *prescriptive* standards, most of the concerns on sampling and study design are resolved.

RISK OF UNDERESTIMATING OVERWEIGHT/OBESITY

Concerns of overdiagnosis of underweight and wasting are also supplemented by a suspicion of underdiagnosis of overweight, considering that some evidence has arisen on the existence of metabolic obesity biomarkers in children with conventional anthropometric diagnoses of undernutrition,[29] with potential consequences for increased risk of non-communicable diseases (NCDs).

The MGRS methods do appear to have taken some care to avoid the risk of representing overweight and obesity as 'normal' in their sample by setting limits to exclude +3 SD of the longitudinal sample and +2 SD—given a rightward skewedness—for the cross-sectional sample for weights for length/height.[16] Similarly, term low birthweight babies were included in the sample to include small but normal children as would be expected in a normal distribution.

Another related concern that has been raised in technical consultations is whether intervention programmes might be encouraging overfeeding of individual children misclassified as stunted and/or wasted by using MGRS standards, resulting in increasing overweight/obesity and NCDs in adulthood.

However, in the Indian context, there exists little evidence to support concerns that nutritional interventions meant to combat undernutrition might contribute to overfeeding and/or subsequent metabolic risks. Notwithstanding the coexistence of undernutrition along with overweight, obesity or diet-related NCDs within individuals or households, gaps in intake, micronutrient deficiency and poor dietary diversity continue to be the norm among Indian children. According to NFHS 5, only about 11% of children (aged 6–24 months) receive the WHO-defined 'adequate diet', and CNNS data show poor dietary diversity across age groups.[30] Public feeding programmes for children also do not have

universal reach and are typically not used by the sections currently demonstrating overweight. Thus, fears of these programmes contributing to overweight seem unwarranted, while improving the nutritional content and diversity of cereal-heavy public feeding programmes[31 32] by using more local foods, millets, fruits, vegetables and animal proteins is certainly desirable and would break through all forms of undernutrition and allay some of these anxieties.

MATERNAL HEIGHTS, GENETICS AND PLASTICITY

It has been argued that child stunting being intergenerational and determined by mothers' heights that cannot be changed immediately, maternal height-adjusted references must be used for prevalence rates to better reflect what can be achieved in terms of improvements in the current generation.[33] Some studies have adjusted prevalence estimates by accounting for maternal stature, in order to more accurately capture 'current exposures to undernutrition and infections in children'. Stunting prevalence in India adjusted for maternal heights is estimated at 25.2%, compared with 38% using MGRS standards.[34]

While it is true that at an individual-level maternal height is a non-modifiable factor for the growth of her child, low average maternal heights are a reflection of the intergenerational transmission of socioeconomic status resulting in child growth failure.[35 36] Thus, adjusting for maternal height underestimates the role of a persistent deficient environment on child's stature[37] and misrepresents the goal of the WHO standards. Clearly, improving maternal heights and child-related factors both need simultaneous interventions for optimal child nutritional outcomes in the long term. What must be noted is that despite substantial parental height differences among the six study sites, the linear growth (from birth to 2 years) of children enrolled in the MGRS was similar.[38]

Mean maternal heights in India have seen a very sluggish growth between the last two rounds of NFHS and lag significantly behind (about 6 cm shorter than) the average maternal height of the MGRS India sample. There is a need to understand the low mean heights of women in India in the context of overall progress with respect to gender relations, nutrition and disease environments. While male and female adult heights in India have both been increasing, the increase is more among males.[39] India's slow progress in adult heights (0.5 cm/decade for men and 0.22 cm/decade for women)[40] may be compared with populations with similar genetics: China and one of its own states, Kerala, where men and women have both been gaining height of over 1 cm/decade,[40] or women in Bangladesh (0.24 cm/decade) and Nepal (0.59 cm/decade).[41]

A related and relevant discussion pertains to plasticity of stunting: how much progress or rate of change is possible in reducing stunting prevalence in the short term, given prevailing economic conditions and genetic factors. A cross-country comparison shows that countries such as Vietnam and Bangladesh, which have lower per capita incomes than India have had an impressive record in reducing child stunting rates. Compared with India's modest annual average rate of stunting reduction (0.39%), Indonesia (0.64%), Bangladesh (1.17%) and Vietnam (1.22%) recorded steep declines during the period 1995–2021 (see figure 1).

Joint child malnutrition estimates from WHO, UNICEF and the World Bank show that China was able to reduce its rates of childhood stunting from 38% in 1987 to under 5% by 2017.[42] Within Indian states too, there is a wide variation in average annual reduction in stunting rates among states (from −0.07% in Kerala to −1.14% in Chhattisgarh; see figure 2), which have been attributed to improvements in coverage of health and nutrition interventions, improvements in household living conditions, as well as positive changes in women's age at marriage, maternal education, maternal body mass index, among others.[43]

Since Indian states as well as various developing countries continue to experience stunting reductions while using the WHO-MGRS growth standards, it need not be considered too plastic an indicator, while acknowledging its multiple determinants and the need for further studies on the rates of improvement. A universal standard also helps to assess country-level compliance with the United Nations Convention on the Rights of the Child, which recognises that the right of every child to grow and be healthy cannot be achieved without attention to normal human development.[44]

CONCLUSION

Based on the review of evidence, it seems logical to stick to the aspirationally high but achievable standards suggested by the WHO-MGRS for use in the Indian context for stunting/linear growth. While acquiring newer and more precise information on child growth is a continuous process, this would allow the effective monitoring of trends, comparisons and interventions until a newer global standard is established through a similar study.

It needs to be foregrounded that unlike references, standards are, by nature, prescriptive in approach while indicating the full potential for growth. Policy must be based on the understanding that stunting, wasting and underweight are all population-level indicators and in a population with normal growth patterns for children, only about 2.3% of under-5 children would be 'expected' to be stunted/wasted/underweight and a significantly higher figures should be a cause of concern.

The use of a standard as a metric of comparison facilitates the examination of differences in the anthropometric (or nutritional) status between countries as well as of subgroups in a given population, and of changes in nutritional status over a period of time and is thus of great value. However, individual children grow uniquely,

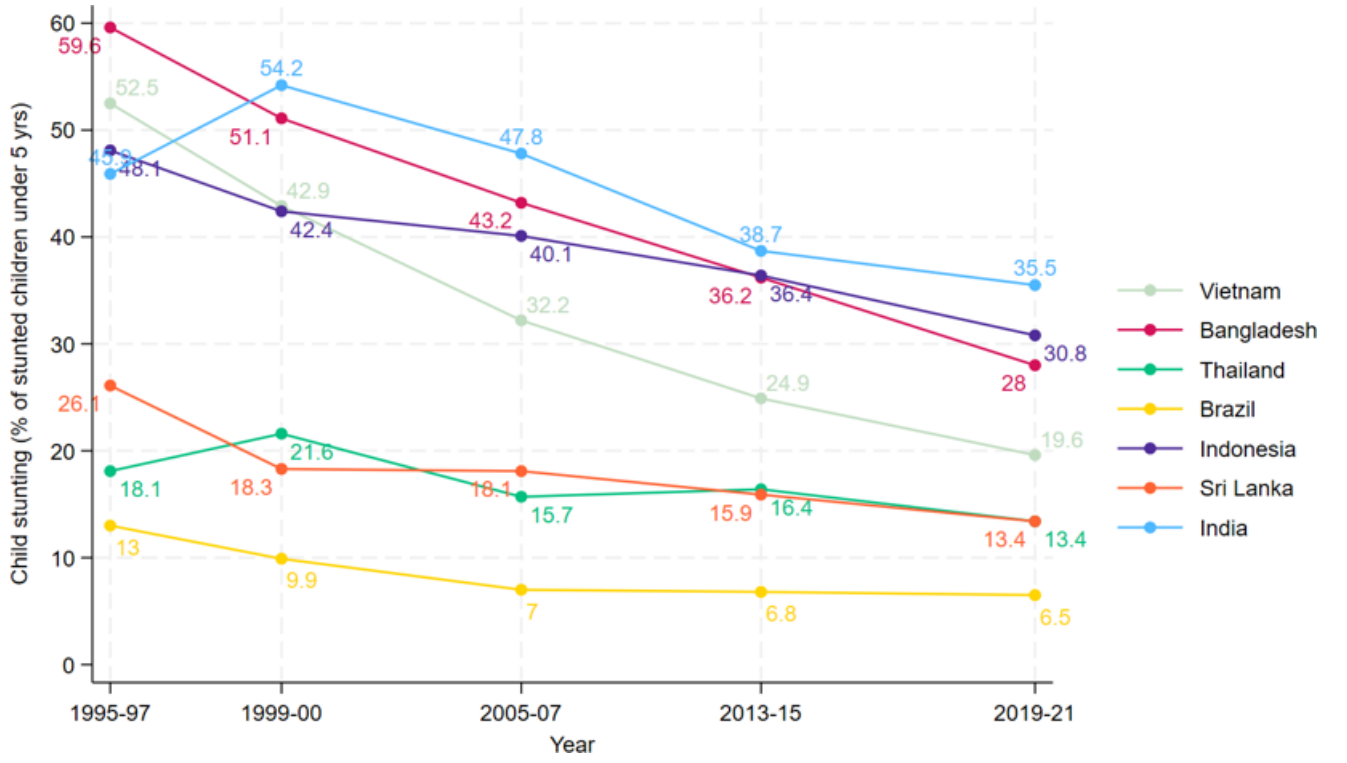

Figure 1 Trends in child stunting rates, in select developing countries. Source: Authors' calculations based on DHS, MICS and national survey data, where available.

and trained child health personnel such as treating physicians can apply judgement calls on the interpretation of growth charts in the context of children in their care.

As far as interventions are concerned, it is clear that there is a need to focus on the multiple proximal and distal determinants of undernutrition as given by well-established frameworks such as UNICEF framework on malnutrition and Lancet framework on nutritional-sensitive and nutrition-specific interventions. Stunting is a marker of deficient environments and hence does

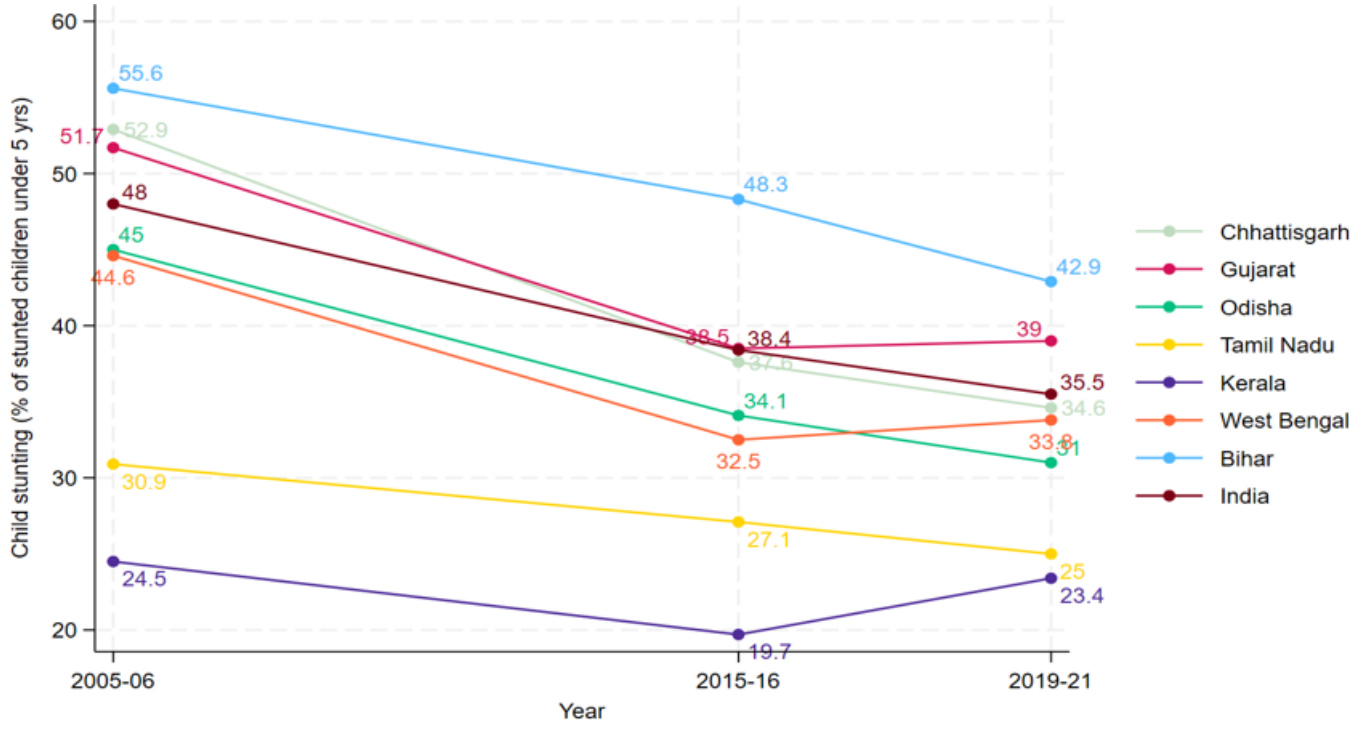

Figure 2 Trends in child stunting rates, in select Indian states. Source: Authors' calculations based on NFHS data (Rounds 3,4, and 5).

not only reflect poor diets but also poor economic conditions, unhealthy living conditions, lack of education, low status of women, lack of sanitation facilities and other such determinants. Addressing all of these would reflect in better improvements in stunting, but more importantly, the overall quality of life, of which stunting is only one marker.

X Dipa Sinha @sinhadipa

Acknowledgements We thank all the participants present in both rounds of the technical consultations for their valuable comments and suggestions which shaped the review of literature. The first technical consultation was held by two of the authors without any funding support. The WHO provided short-term funding for the detailed review and second consultation as one of the outcomes, culminating in a full report on which the paper is based (available here).[1]

Contributors VP and DS conceptualised and planned the project. VP, DS and RJJ reviewed the literature with inputs from experts in the technical consultations. VP, DS and RJJ cowrote the manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Disclaimer The authors are solely responsible for the views and opinions expressed here.

Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Commissioned; externally peer reviewed.

ORCID iDs
Vandana Prasad http://orcid.org/0000-0003-0640-4965
Dipa Sinha http://orcid.org/0000-0002-0306-219X
Rohit James Joseph http://orcid.org/0000-0002-2146-3835

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