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Hidden Undernutrition: How universal standards may bias estimates of childhood undernutrition around the world

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Height-for-Age (HAZ) and Childhood Malnutrition

International standards for tracking childhood malnutrition rely on a single reference growth curve – The WHO Growth Standards. Height is normalized to the growth curve to create height-for-age Zscores (HAZ).

- Stunting = HAZ < -2 SD
- Severe Stunting= HAZ > -3 SD

The WHO Standards assume that any population differences are a result of differences in resource inputs. Thus this growth curve applies to any child anywhere. However, a universal model of healthy growth may mask regional hotspots of stunting if populations differ in HAZ in ways that are independent of undernutrition.

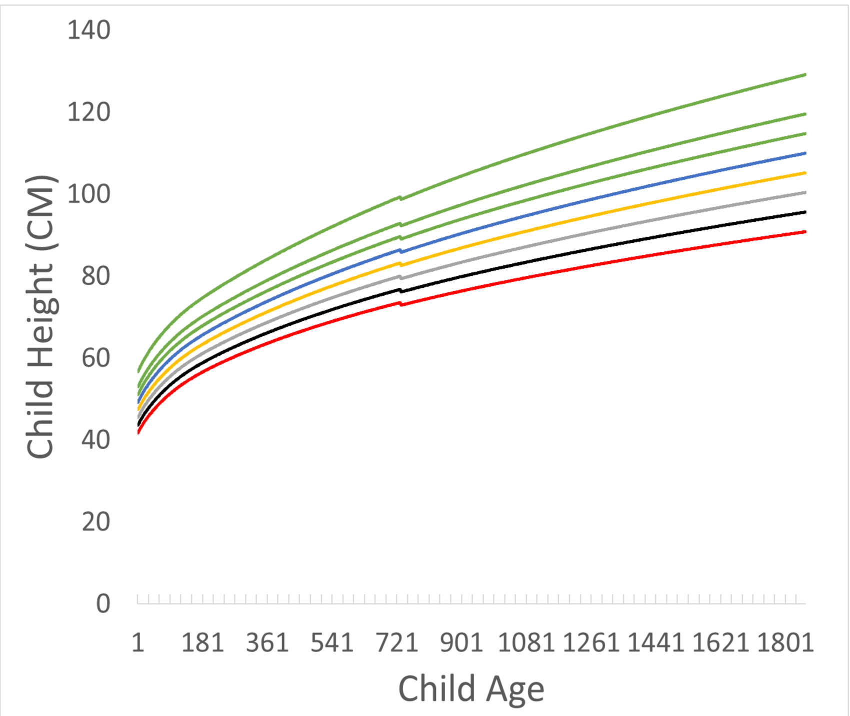


Fig.1: the WHO Growth Curve. Any child is considered stunted if its below the black line and severely stunted if its below the red line.

Research Questions

1. Do universal standards bias stunting estimates around the world?
2. Does HAZ vary independent of resources across populations?

Modeling Resource-Independent Variation in HAZ

Data:

≈190 harmonized Demographic and Health Surveys (DHS)

≈ 60 countries around the world

N=1,093,809 children (1-5yrs)

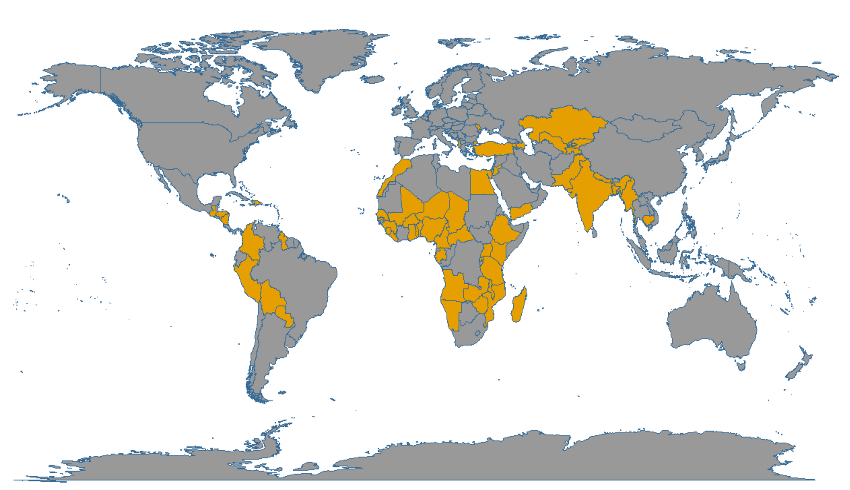


Fig. 2: Map of data sources

Model:

Nonlinear Multi-Level Model with random intercepts, controlling for known resource inputs to height:

- Absolute wealth
- Sanitation and disease
- Diet indicators
- Health care access
- Sex, urbanicity, sibling size, and maternal education.

Residual variation between populations cannot be attributed to differences in resource access, and. reflects the resource-independent variation in population HAZ.

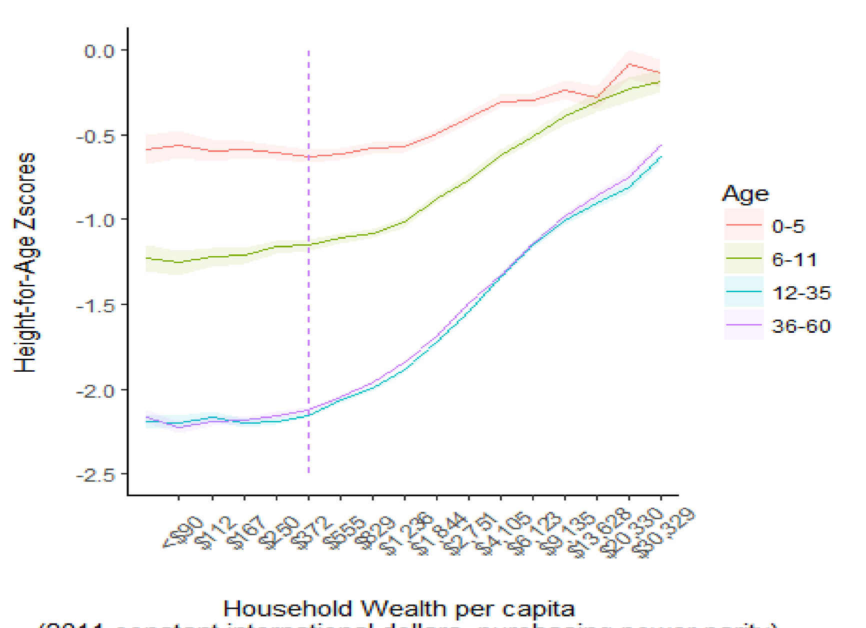
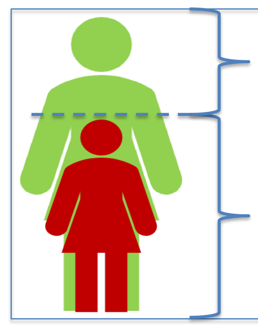


Fig. 3: HAZ by Household wealth. The bottoming out in extreme deprivation indicates a minimum HAZ. The model assess between population variation at this point

The Two Components of HAZ



- Accrued HAZ (aHAZ) – the component of HAZ that is sensitive to resource inputs.
- Basal HAZ (bHAZ) – the component of HAZ that is resource-independent.

The model gives country-specific estimates at the bottom of the resource curve (bHAZ). For any child we can measure the amount of resource-dependent growth (aHAZ) above the basal HAZ.

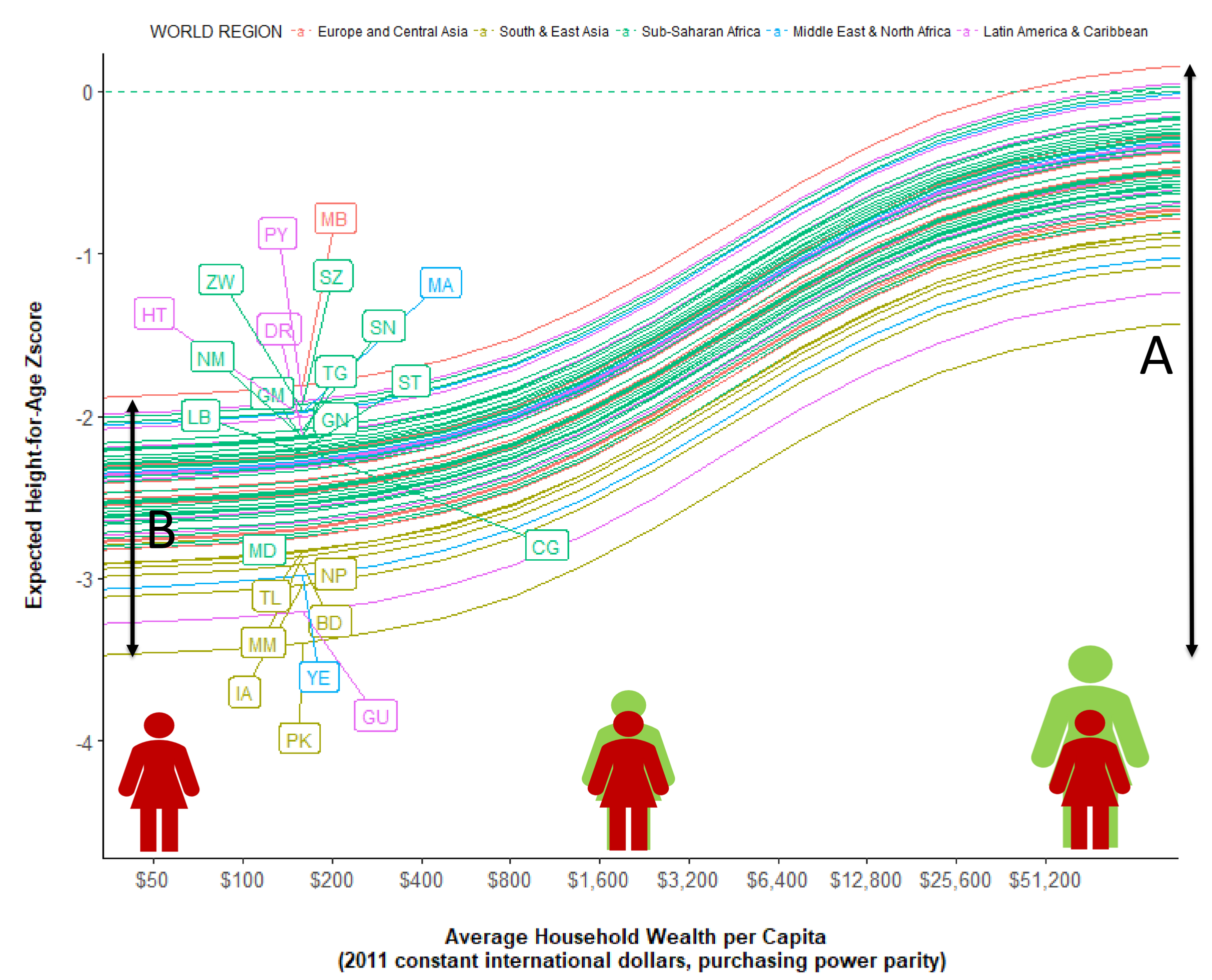
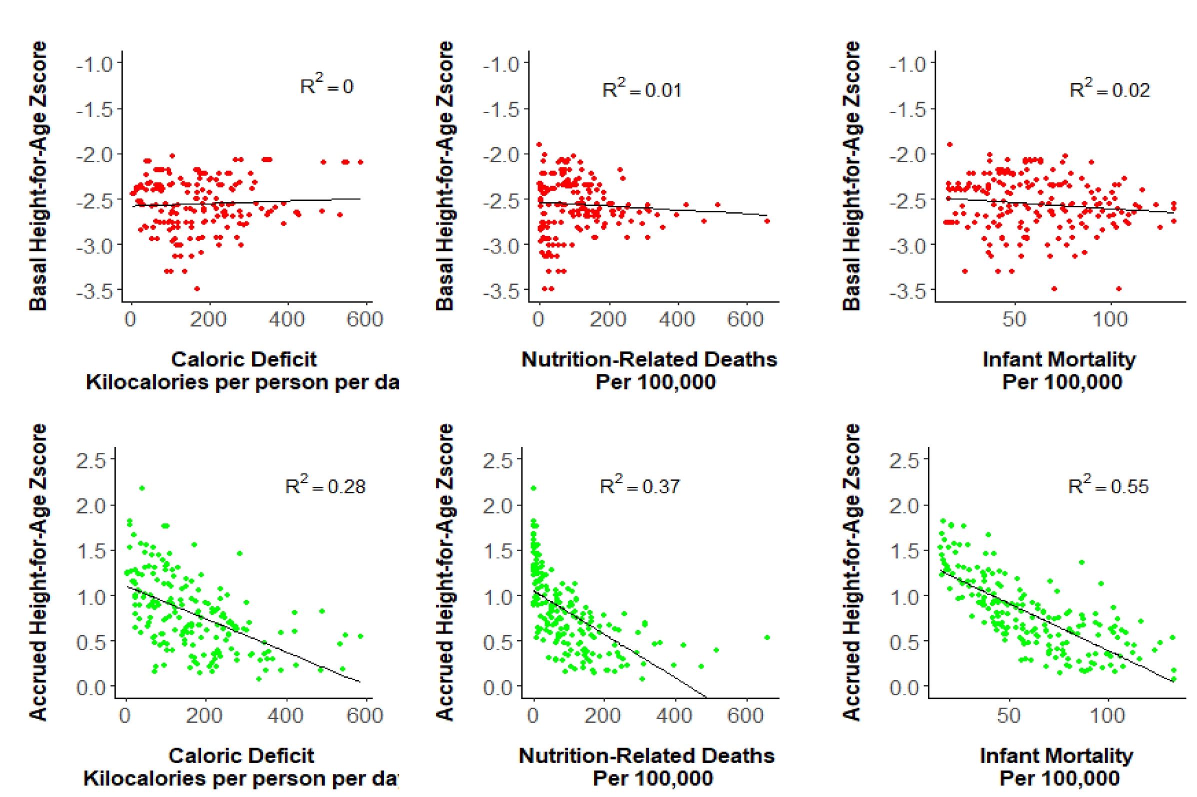


Fig. 4: Predicted HAZ for a given level of wealth. (A) effects of resources on HAZ (aHAZ). (B) amount of between population variation in contexts of extreme deprivation (bHAZ).

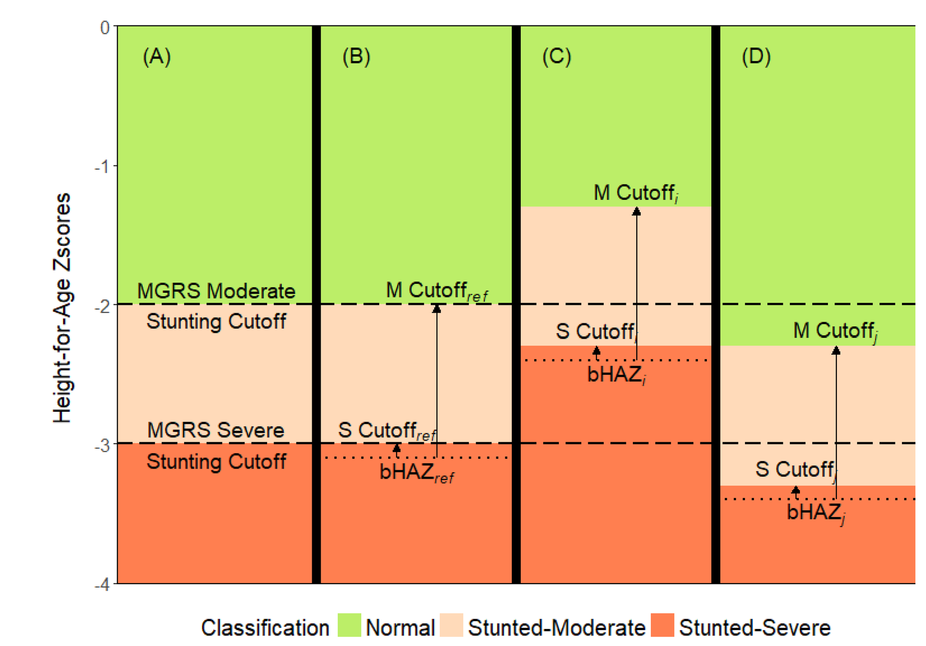
Validating the Two Components

Fig. 5: bHAZ is uncorrelated with indicators of resource deprivation, while mean aHAZ of a country shows strong associations with indicators of malnutrition. aHAZ is the component that tracks resource inputs and deprivation.



Stunting Cutoffs that Account for Both Components

Fig 6: Adjusting universal cutoffs (A) for population bHAZ. We measure the distance between the bHAZ and the WHO Standard cutoffs in a reference population (B). This converts the WHO Standard cutoffs into a specific amount of aHAZ. Any child that fails to accrue a minimum aHAZ will be considered stunted. For populations with larger bHAZ this will raise the cutoffs (C), for populations with smaller bHAZ it will lower the cutoffs (D).



Implications For Tracking Stunting in Tall Populations

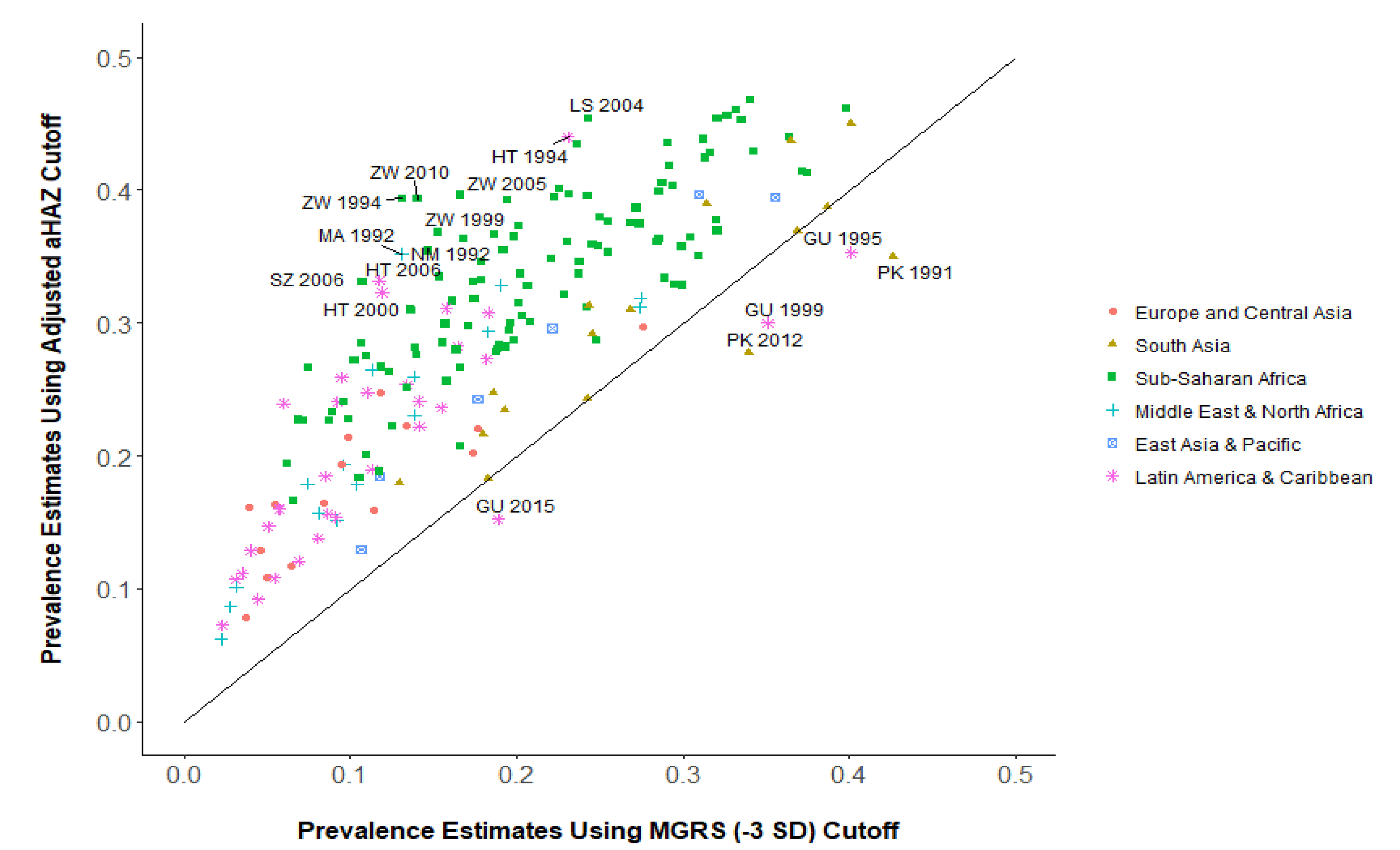


Fig. 7: Using India as our well established reference population, we find that the adjusted cutoffs leads to:

- Increases in estimates of stunting in all world regions.
- Largest increases were in populations with tall bHAZ – concentrated in Sub-Saharan Africa and parts of Latin America and Caribbean.
- 14% increase in severe stunting in Sub-Saharan Africa alone.
- Increases in severe stunting - Zimbabwe (25%), Swaziland (22%), Morocco (22%); Haiti (20%), Nicaragua (15%), Paraguay (18%), Bolivia (12%).

This approach could identify previously missed hotspots of child malnutrition and help resolve long-standing debates about differences in stunting in India and Africa.

Acknowledgements and References

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