RESEARCH PAPER

Dissimilar Associations Between Stunting and Low Ponderosity Defined Through Weight for Height (Wasting) or Body Mass Index for Age (Thinness) in Under-Five Children

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Background: Wasting and stunting commonly coexist, supposedly due to biological and social mechanisms. In under-five children, low-ponderosity is defined as <–2SD of WHO standards for either weight for height (wasted) or body mass index for age (thin) metrics. Unlike body mass index for age, weight for height ignores physiological changes in ponderosity with age, resulting in overestimation of wasting in comparison to thinness in under-5 populations with high stunting prevalence. This suggests a plausible statistical explanation for the wasting-stunting association.

Aim: To test the null hypothesis that wasting-stunting (WaSt) and thinness-stunting (ThSt) associations are similar.

Methods: Demographic Health Survey datasets (2010-2020) from South and South-East Asia (7 countries) and Sub-Saharan Africa (13 countries) were evaluated. WaSt and ThSt associations were estimated as odds ratio (OR) for individual datasets, which was pooled (random-effects meta-analysis). Stratified analyses were done for sex, age and region.

Results: Young infants (0-6 months) comprised 8-14% of under-five children, with equal representation of boys and girls. Participants, especially Asians, were mostly shorter with lower ponderosity than WHO standards. WaSt prevalence was higher than ThSt in the 6-59 months age group, but lower in young infants. Pooled WaSt estimates were not significant: Asia (OR 0.95; 95% CI 0.75-1.14), Africa (1.17; 0.95-1.40), and combined (1.09; 0.93-1.24). In contrast, pooled ThSt associations were significantly negative: Asia (0.63; 0.50-0.76), Africa (0.82; 0.68-0.96), and combined (0.75; 0.65-0.85). In girls, these associations were attenuated for WaSt (0.96; 0.8-1.1), but enhanced for ThSt (0.6; 0.5-0.7).

Conclusion: WaSt and ThSt associations are dissimilar. This suggests a primary statistical explanation for the reported wasting-stunting association, originating from ignoring physiological changes with age.

Keywords: Africa, Anthropometry, Asia, Underweight, Malnutrition.

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In the Sustainable Development Goal (SDG) 2 on Zero Hunger, stunting and wasting are listed as individual conditions. By 2025, India too is committed to achieve: *i*) a 40% reduction in the number of children under-5 who are stunted, and *ii*) reduce and maintain childhood wasting to less than 5% [1]. Recently, there has been a strong advocacy for integrated programmatic approaches for simultaneously addressing both wasting and stunting, instead of dealing with them as distinct entities. The underlying rationale is that both conditions have etiologic commonality and frequently co-exist, either simultaneously or at different periods in the same child. Also, concurrently stunted and wasted children have the highest risk of near-term mortality [2,3].

A recent analysis of cross-sectional survey datasets on 1.8 million children documented a robust positive association between wasting and stunting; the pooled odds ratio was 1.40 (95% CI: 1.32, 1.49) [4]. This study, providing fuel for the intensified advocacy efforts, also recommended extension of therapeutic feeding programs to concurrently wasted-stunted cases and routine reporting of wasting-stunting prevalence in surveys [4]. To guide future investments, the Wasting-Stunting Technical Interest Group has recommended priority research topics, which predominantly focus on biological and social mechanisms of this association and policy domains [5].

Scant attention has been directed towards a statistical explanation for the wasting-stunting association. In under-five children, low-ponderosity may be defined when either weight for height or body mass index for age (BMI) are below –2SD of the respective World Health Organization (WHO) standards [6,7]. Children with low ponderosity diagnosed by weight for height metric are also referred to as wasted. Weight for height ignores the physiological changes in ponderosity with age, whereas, by construct, BMI for age accounts for such alterations [7,8]. Notwithstanding the excellent correlation (r=0.97–0.99) between these metrics, the two definitions produce cut-offs, and hence estimates of low ponderosity, that differ with the age, sex and height of children [9]. Importantly, weight for height is associated with an overestimation of low ponderosity burden in comparison to BMI for age in under-5 populations with high stunting pre-valence, especially in children aged 6-59 months [9]. This suggests a plausible statistical explanation for the associa-tion between wasted and stunted children. For nomen-clature clarity, we subsequently refer to low ponderosity diagnosed by weight for height metric as wasted (or wasting) and that by BMI for age metric as thin (or thinness), and their co-occurrence with those stunted as wasted-stunted (WaSt) and thin-stunted (ThSt), respectively. We tested the null hypothesis that WaSt and ThSt associations are similar, to refute the statistical origin postulate. This was done in contemporary datasets from South and South-East Asia and Sub-Saharan Africa, both of which have a high prevalence of stunting.

METHODS

Ethical clearance was not required for these secondary analyses of datasets, for which informed consent of parents and ethical clearance from relevant authorities had been taken. Datasets were used from two settings: *i*) *Research*: The Meerut study was specifically designed to estimate the prevalence of severe acute malnutrition and identify midarm circumference surrogates for weight for height cutoffs. This community-based cross-sectional study was conducted between September, 2012 and October, 2013 in Meerut District, Uttar Pradesh, India [10]. This clinical research, conducted on 18,463 children between 6 and 59 months of age with quality assurance, was expected to have greater precision of measurements, *ii*) *National Surveys*: Demographic Health Survey (DHS) datasets from South- and South-East Asia and Sub-Saharan Africa, which had collected anthropometric measurements for children between 0-59 months in 2010 or later, were eligible for analysis [11]. A common set-up was constructed for the DHS datasets with the same variables, variable names, variable types, variable lengths, coding schemes, unit of measurement, and file format. These included case ID, age, sex, weight and length/height.

The WHO macro syntax for STATA was used to generate the four anthropometric indices *z*-scores from the absolute length/height, weight, age and sex, namely, length/ height for age (HAZ), weight for age (WAZ), weight for height (WHZ), and body mass index for age (BMIZ) [7]. WHO criteria were followed to set the missing values (*z*-scores): HAZ <-6 or >6; WAZ <-6 or >5; WHZ <-5 or >5; and BMIZ <-5 or >5 [7,12]. In the Meerut study, we considered missing values below -7 SD for all indices, because apparently abnormal measurements had been re-verified in the field. Children with low (<-2*z* of WHO standard) anthropometric indices were labelled as follows: underweight (for weight for age), stunted (for length/height for age), wasted (for weight for height), and thin (for BMI for age). Children who were both wasted and stunted were labelled as WaSt, while those who were both thin and stunted were defined as ThSt.

Statistical analysis: The concurrent WaSt and ThSt associations (strength and direction) were evaluated by calculating the Odds Ratios (OR) for each country dataset separately. This measure of association was symmetrical because the OR for being wasted (or thin) given stunting and the OR for being stunted given wasting (or thinness) were identical [4]. The ORs from the DHS datasets were pooled using a random-effects meta-analysis [13,14], because the clinical context of the surveys was heterogeneous. Stratified analyses were also conducted for sex and age groups (mainly in two broad age groups of 0-6 months and 6-59 months, and at 6-monthly intervals from 0-1 year, and yearly intervals thereafter, in pooled estimates to explore narrower age associations). WHZ (or BMIZ) and HAZ were compared in three categories, namely, wasted (or thin) only, stunted only and WaSt (or ThSt). As these indices were not normally distributed, being right truncated at -2 *z*-scores, the data was summarized as median (IQR) and compared by nonparametric Mann-Whitney test. A non-parametric effect size measure was used to capture the changes in central tendency and data distribution shape through a user defined package (ImpactEffectsize Version: 0.6.2) [15]. Pearson correlation coefficients were computed between weight for height and BMI for age *z*-scores, and between both these metrics individually and weight (kg) and height (cm). Coefficients were also computed for the log weight regressed on log height. STATA 16.0 version (StataCorp LLC) and R software 4.0.2 version (R Core Team, 2020; *www.R-project.org/*) were used to perform the analyses.

RESULTS

Among the available online DHS datasets, twenty countries (7 from South- and South-East Asia and 13 from Sub-Saharan Africa) fulfilled the inclusion criteria. The demographic and anthropometric characteristics of the analyzed datasets are summarized in **Web Table I**. The surveys had been conducted between 2011 and 2020. Except for India (*n*=207,364), the sample size in other DHS surveys ranged from 2,318 (Nepal) to 18,279 (Kenya). Young infants (0-6 months) comprised 8-14% of under-five children. There was almost equal represen-tation of boys and girls. The participants were mostly shorter and had lower ponderosity in comparison to the WHO standards. In individual countries, the ranges for HAZ means were -0.9 to -1.6 and for their SDs 1.1 to 1.7. In South and South East

Asia, the range for WHZ means was -0.2 to -0.9 and for BMIZ means was -0.1 to -0.8. These *z*-scores were higher for Sub-Saharan Africa, ranging from +0.4 to -0.5 and +0.5 to -0.5, respectively. Their SDs in both regions ranged from 1.0 to 1.4. The 6-59 months old participants (n=18452) in the Meerut study from India had the maximum left shift in means of HAZ (-1.9), WHZ (-1.1) and BMIZ (-0.9).

The prevalence of anthropometric deficits in DHS datasets is summarized in **Table I**. The overall prevalence (95% CI) of those stunted, wasted, thin, WaSt and ThSt were 31% (28%, 33.9%), 7.2% (3.6%, 10.7%), 6.4% (3.2%, 9.6%), 2.3% (1.3%, 3.4%) and 1.6% (0.9%, 2.3%), respectively. All these deficits were higher in the Asian regions. India had the highest prevalence, especially pronounced for those wasted (20.1%), thin (18.3%), WaSt (6.2%) and ThSt (4.4%). In all datasets, the prevalence of WaSt was significantly higher than that of ThSt. In comparison to the 0-6 months age group, the 6-59 months age group had a higher prevalence of those stunted (**Web Tables II** and **III**). WaSt prevalence was lower than ThSt prevalence in 0-6 months age group, but the converse was true for older children. Both WaSt and ThSt prevalence were higher in boys (**Web Table IV**). The male to female ratios in individual countries in 6-59 months age group ranged from 1.05 to 2.82, except for WaSt in Ghana (0.92) and Liberia (0.99). The ratios were comparable for WaSt and ThSt (overlapping confidence intervals).

Association between stunting and wasting or thinness: In the research dataset (Meerut study), there were significant positive associations for both WaSt [OR (95% CI) 1.91 (1.8, 2.1); P<0.001] and ThSt [OR (95% CI) 1.11 (1.0, 1.2); P=0.029]. **Fig. 1** summarizes the WaSt and ThSt associations in under-five children in DHS datasets. Significant positive WaSt associations were seen in six African countries, while significant negative associations were documented in one African and two Asian countries. The pooled estimates were not significant for Asia [OR (95% CI) 0.95 (0.75, 1.14); I^2=88%], Africa [1.17 (0.95, 1.40); I^2=92%], or the combined dataset [1.09 (0.93, 1.24); I^2=92%] with considerable heterogeneity. In contrast, for ThSt, significant negative associations were documented in six Asian and seven African countries and a positive

Table I Prevalence (%) of Anthropometric Deficits in 0-59 Months Age Group in Demographic Health Survey Datasets from South and South-East Asia and Sub-Saharan Africa

Country (year)	*Number*	*Stunting (95% CI)*	*Wasting (95% CI)*	*Thinness (95% CI)*	*Wasted-stunted (95% CI)*	*Thin-stunted (95% CI)*	*P value*[a]
Demographic Health Survey Datasets: South and South-East Asia							
Bangladesh (2017-18)	7,711	31.4 (30.4, 32.5)	8.5 (7.9, 9.1)	7.3 (6.7, 7.9)	3.0 (2.6, 3.4)	2.0 (1.7, 2.3)	<0.001
Cambodia (2014)	4,289	32.8 (31.4, 34.3)	9.7 (8.8, 10.6)	8.3 (7.5, 9.2)	3.3 (2.8, 3.9)	1.9 (1.5, 2.4)	<0.001
India (2015-16)	207,364	38.1 (37.9, 38.3)	20.1 (20.0, 20.3)	18.3 (18.1, 18.4)	6.2 (6.1, 6.3)	4.4 (4.3, 4.5)	<0.001
Maldives (2016-17)	2,342	15.1 (13.7, 16.6)	9.0 (7.9, 10.2)	8.0 (7.0, 9.2)	1.6 (1.2, 2.2)	1.2 (0.8, 1.7)	0.012
Myanmar (2015-16)	4,146	30.8 (29.4, 32.2)	6.6 (5.9, 7.4)	5.8 (5.1, 6.5)	1.7 (1.3, 2.1)	1.1 (0.8, 1.4)	<0.001
Nepal (2016)	2,318	36.6 (34.7, 38.6)	9.3 (8.2, 10.5)	8.1 (7.0, 9.2)	3.5 (2.8, 4.3)	2.3 (1.8, 3.0)	<0.001
Pakistan (2017-18)	4,079	38.6 (37.1, 40.1)	7.7 (6.9, 8.5)	7.2 (6.5, 8.0)	2.8 (2.3, 3.3)	2.3 (1.8, 2.8)	0.003
Pooled SSEA	232,249	31.9 (26.4, 37.4)	10.1 (4.1, 16.1)	9.0 (3.4, 14.6)	3.2 (1.3, 5.1)	2.2 (0.8, 3.5)	
Demographic Health Survey Datasets: Sub-Saharan Africa							
Angola (2015-16)	6,268	37.6 (36.4, 38.8)	5.0 (4.5, 5.6)	4.5 (4.3, 5.3)	1.9 (1.6, 2.3)	1.5 (1.2, 1.8)	<0.001
Benin (2017-18)	11,626	32.0 (31.2, 32.9)	5.2 (4.8, 5.6)	4.7 (4.3, 5.1)	2.0 (1.7, 2.2)	1.6 (1.4, 1.8)	<0.001
Cameroon (2018)	4,435	28.1 (26.8, 29.5)	3.9 (3.4, 4.5)	4.1 (3.5, 4.7)	1.1 (0.8, 1.4)	0.9 (0.6, 1.2)	0.072
Congo (2011-12)	4,464	26.9 (25.7, 28.3)	5.4 (4.8, 6.1)	5.2 (4.5, 5.8)	1.2 (0.9, 1.6)	0.9 (0.6, 1.2)	0.003
Ethiopia (2019)	5,055	35.9 (34.6, 37.3)	8.9 (8.2, 9.7)	6.9 (6.3, 7.7)	3.5 (3.1, 4.1)	2.1 (1.7, 2.5)	<0.001
Gambia (2019-20)	3,805	18.3 (17.1, 19.6)	5.1 (4.5, 5.9)	4.3 (3.7, 5.0)	1.4 (1.1, 1.8)	0.9 (0.7, 1.3)	<0.001
Ghana (2014)	2,682	19.0 (17.5, 20.5)	4.9 (4.2, 5.8)	4.4 (3.7, 5.2)	1.4 (1.0, 1.9)	1.0 (0.7, 1.5)	0.004
Kenya (2014)	18,279	27.3 (26.6, 27.9)	5.4 (5.1, 5.8)	4.8 (4.5, 5.1)	1.7 (1.5, 1.9)	1.0 (0.8, 1.1)	<0.001
Liberia (2019-20)	2,439	32.3 (30.5, 34.2)	4.2 (3.5, 5.1)	3.5 (2.8, 4.3)	1.6 (1.2, 2.2)	1.1 (0.7, 1.6)	0.005
Malawi (2015-16)	5,110	35.5 (34.2, 36.8)	3.1 (2.6, 3.6)	2.7 (2.3, 3.1)	1.0 (0.7, 1.3)	0.7 (0.5, 1.0)	0.003
Mali (2018)	8,202	26.8 (25.8, 27.7)	9.3 (8.7, 10.0)	9.0 (8.4, 9.6)	3.0 (2.7, 3.4)	2.4 (2.1, 2.8)	<0.001
Mozambique (2011)	9,251	39.6 (38.7, 40.7)	5.2 (4.8, 5.7)	5.0 (4.6, 5.5)	1.5 (1.2, 1.7)	1.2 (1.0, 1.5)	0.005
Nigeria (2018)	11,308	36.3 (35.4, 37.1)	6.6 (6.2, 7.1)	5.9 (5.5, 6.4)	3.1 (2.8, 3.4)	2.4 (2.1, 2.7)	<0.001
Pooled SSA	92,924	30.4 (27.0, 33.8)	5.6 (4.7, 6.4)	5.0 (4.2, 5.8)	1.9 (1.5, 2.3)	1.4 (1.1, 1.7)	
Grand Pool (a+b)	325,173	31.0 (28.0, 33.9)	7.2 (3.6, 10.7)	6.4 (3.2, 9.6)	2.3 (1.3, 3.4)	1.6 (0.9, 2.3)	

P-values for the difference in WaSt and ThSt prevalence using Mc-Nemar test. Pooled SSEA: pooled estimates for South and South-East Asia. Pooled SSA: pooled estimates for Sub-Saharan Africa. Grand pool: pooled data from all the Demographic Health Survey Datasets studied.

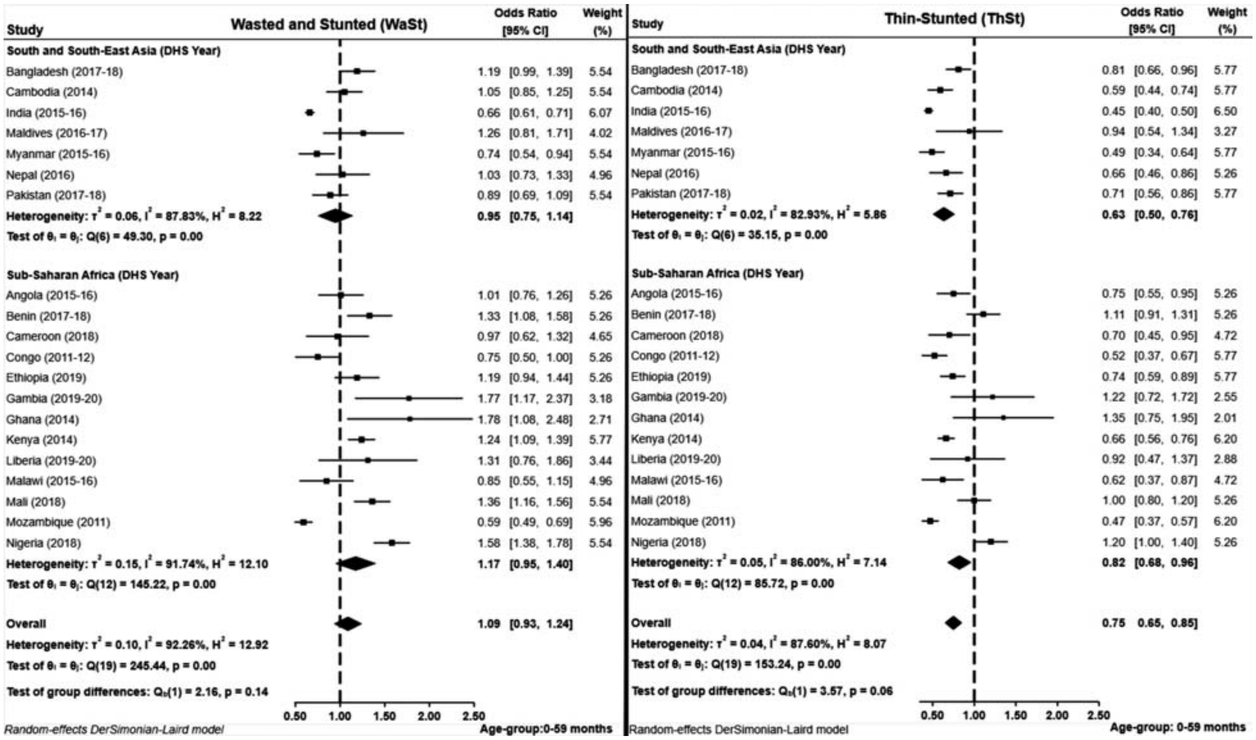

Fig. 1 Summary of wasting-stunting (WaSt) and thinness-stunting (ThSt) associations in the Demographic Health Survey datasets from South and South-East Asia and Sub-Saharan Africa for children aged 0-59 months.

association for one African country. The pooled estimates were significantly negative for Asia (0.63; 0.50, 0.76; I^2=83%), Africa (0.82; 0.68, 0.96; I^2=86%), and the combined dataset (0.75; 0.65, 0.85; I^2=88%) with considerable heterogeneity. In girls, these associations were attenuated for WaSt, but enhanced for ThSt (**Web Fig. 1**). In the combined dataset, the WaSt association for boys was 1.28 (1.09, 1.47) and for girls 0.96 (0.81, 1.10); the corresponding figures for ThSt were 0.74 (0.62, 0.85) and 0.57 (0.48, 0.67), respectively. In the combined dataset, in 0-6 months age group (**Web Fig. 2**), the WaSt association was negative (0.59; 0.40, 0.87), but the ThSt association was positive (2.0; 1.34, 3.0). The converse was documented in the 6-59 months age group (**Web Fig. 3**) for WaSt (1.18; 1.01, 1.35) and ThSt (0.69; 0.59, 0.79) associations. **Fig. 2** summarizes the comparison of WaSt and ThSt associations and their prevalence in the combined dataset in narrower age groups. The maximal contrast in these associations was evident in the 0-6 months and 12-24 months age groups.

Z-scores differences between single and combined anthropometric deficits: In 6-59 months age group, the WHZ (or BMIZ) impact difference among those only wasted (or thin) *versus* WaSt (or ThSt) was mostly null (**Web Table V**). Similarly, the HAZ impact difference (**Web Table VI**) was mostly null or small (≤0.2). However, there were large WHZ (or BMIZ) impact differences, ranging from 1.8 to 3.2, between stunted only *versus* WaSt (or ThSt). Similar findings, but of a lower magnitude, were documented for HAZ (impact differences 1.5 to 2.2). These patterns were broadly comparable for WHZ and BMIZ.

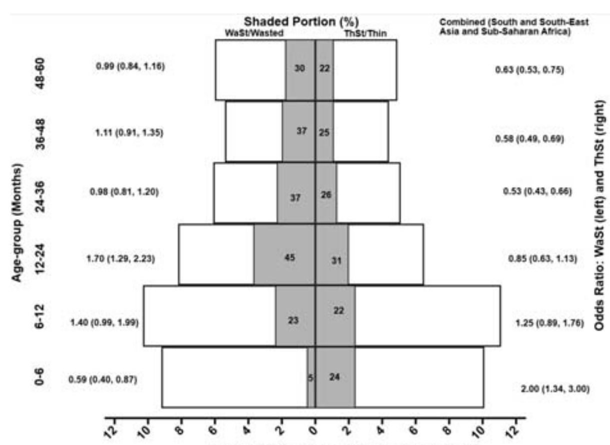

Fig. 2 Comparison of associations between wasting-stunting (WaSt) and thinness-stunting (ThSt) and their prevalence in the South and South-East Asia and Sub-Saharan Africa from the Demographic Health Survey combined datasets in stratified age groups.

Except for Nepal (r=0.92), there was almost perfect correlation (r=0.96 to 0.98) between WHZ and BMIZ in other datasets (**Web Table VII**). The beta-coefficients of log weight regressed on log height approximated 2 (1.81 to 1.95), except for Nepal (2.58). In general, both WHZ and BMIZ had comparable (non-overlapping confidence intervals) patterns of higher correlations with weight than with height.

DISCUSSION

In these analyses, the WaSt and ThSt associations were dissimilar and their directions varied with age. For the 0-59 months age group, the pooled estimates for Asia, Africa or the combined dataset were not significant for WaSt association, but were significantly negative for ThSt association. In the combined dataset, in 0-6 months age group, the WaSt association was significantly negative, but the ThSt association was significantly positive, whereas the converse was documented in 6-59 months old children. The comparison of WaSt and ThSt associations, and the descriptive epidemiology of ThSt association, from regions with high prevalence of stunting, is a novel contribution to the literature. Use of contemporary data-sets, concordance of observed patterns among various countries and regions, and alignment with earlier reports of higher WaSt prevalence in boys [4], and in comparison to ThSt [9], inspires confidence in the findings. Further, the flipover in the WaSt and ThSt associations after the age of 6 months is in consonance with the earlier findings on age differences [9].

Dissimilar, mostly opposing, associations between stunting and the two metrics of ponderosity (WHZ and BMIZ) indicate a primary statistical explanation for the reported WaSt association, which originates from ignoring physiological changes with age in the weight for height metric. Further support for this contention include: *i*) the flip-over of these associations around 6 months of age, as predicted by the curvature change in WHO BMI for age charts [7]; *ii*) almost perfect correlation between WHZ and BMIZ; *iii*) beta-coefficients of log weight regressed on log height approximated 2 (1.81 to 1.95) [16,17], providing validation for the use of BMI formula in under-five children; and *iv*) comparable patterns among both metrics of higher correlations with weight than with height.

The apparent differences from the robust positive WaSt association [OR (95% CI) 1.40 (1.32, 1.49)] in pooled analyses from 51 countries [4] merit closer scrutiny. First, these calculations excluded the 0-6 months age group, wherein the WaSt association is negative, thereby biasing the estimates upwards. Moreover, our 6-59 months pooled estimates were positive, but with a lower magnitude. Second, the earlier study's database included refugee settings and relatively dated surveys [4], with a higher probability of lower HAZ scores. In our research dataset from Meerut, with a fairly low mean (SD) HAZ of -1.9 (1.2), the WaSt association was markedly positive.

The near-term mortality in WaSt children is considerably higher than those who are either stunted only or wasted only [2-4]. In the earlier analysis [4], WaSt subjects were both more severely wasted than wasted only children, and more severely stunted than stunted only children. However, the effect sizes were small and it was hypothesised that these were probably insufficient to account for the heightened risk of mortality for WaSt and therefore, a multiplicative rather than an additive interaction between wasting and stunting is occurring. In contrast, in most datasets in this study, these effect sizes were null. But, by definition, there were large effect sizes (~2.0) in the paired anthropometric deficit; WaSt cases were both more severely stunted than wasted only children, and more severely wasted than stunted only children. Thus, the substantial conjoint effect of the two anthropometric deficits, acting either in an additive or multiplicative manner, could explain the considerably higher mortality risk in WaSt. Unfortunately, there seems to be no comparative data for the ThSt association, which merits exploration.

Governments, donors and other stakeholders should carefully examine the potential returns for investments in funding research focussing on biological and social mechanisms of WaSt association [5]. The recommended extension of routine therapeutic feeding programs to WaSt children [4] deserves careful consideration since this condition is largely a statistical phenomenon, primarily driven by severity and high prevalence of stunting. The WHO Guidelines on preventing overweight and obesity in the context of double burden of malnutrition state [18]: *"Routinely providing supplementary foods to moderately wasted infants and children presenting to primary health-care facilities is not recommended"* and *"The provision of supplementary foods for treating stunting among infants and children who present to primary health-care facilities is not recommended."* This recommendation resonates with the recent finding of 'metabolic obesity' (dysglycemia or dyslipidemia) in at least half of the children aged 5-19 years, including those who were thin or stunted, in the Comprehensive National Nutrition Survey from India [19].

The following limitations merit consideration. The DHS data across these countries were collected during different years, but within a decade. We could have analyzed all contemporary DHS datasets and also explored access to databases from refugee settings. However, their inclusion is unlikely to alter the main finding, since the analysis con-tains regions with high prevalence of stunting. A pooled analysis from exclusive research settings may have provided greater

WHAT IS ALREADY KNOWN?

- Wasting and stunting commonly coexist, supposedly due to biological and social mechanisms.
- Unlike body mass index for age, weight for height ignores physiological changes in ponderosity with age, resulting in overestimation of wasting in comparison to thinness.

WHAT THIS STUDY ADDS?

- Wasting-stunting and thinness-stunting associations are dissimilar, and mostly in opposing directions.
- This suggests a primary statistical explanation for the reported wasting-stunting association, which originates from ignoring physiological changes with age in the weight for height metric.

confidence and precision because of lower measurement errors. However, we included one such dataset, which confirmed the pattern, and also survey findings are invariably used for policy decisions.

In conclusion, WaSt and ThSt associations are dissimilar. This suggests a primary statistical explanation for the reported wasting-stunting association, which originates from ignoring physiological changes with age in weight for height metric.

Ethics clearance: Authors declare that the study procedures conform to the principles laid down in the Declaration of Helsinki.

Note: Additional matter related to this article is available with the web version at *www.indianpediatrics.net*

Contributors: HSS conceptualized the study. LNR did the primary analyses and interpretation under the supervision of MS and HSS. LNR and HSS drafted the initial manuscript. All authors provided critical inputs into revision of the article and are willing to be accountable for all aspects of the study.

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Web Table I Descriptive Characteristics of the Analysed Datasets

Country (Year)	*N (0-59 months)*	*0-6 months (% of total)*	*Boys (%)*	*HAZ: Mean (SD)*	*WHZ: Mean (SD)*	*BMIZ: Mean (SD)*
Research dataset: Meerut, Uttar Pradesh, India						
Meerut (2012-13), India[a]	18,452	NA	53.4	-1.9 (1.2)	-1.1 (0.9)	-0.9 (0.9)
Demographic Health Survey Datasets: South and South-East Asia (a)						
Bangladesh (2017-18)	7,711	11.9	52	-1.4 (1.3)	-0.5 (1.1)	-0.4 (1.1)
Cambodia (2014)	4,289	10.7	50.6	-1.4 (1.4)	-0.6 (1.2)	-0.5 (1.2)
India (2015-16)	207,364	9.9	51.7	-1.5 (1.7)	-0.9 (1.4)	-0.8 (1.4)
Maldives (2016-17)	2,342	7.6	50.9	-0.9 (1.2)	-0.4 (1.3)	-0.4 (1.3)
Myanmar (2015-16)	4,146	10.4	51.6	-1.4 (1.3)	-0.5 (1.1)	-0.3 (1.1)
Nepal (2016)	2,318	9.7	52.3	-1.6 (1.3)	-0.6 (1.1)	-0.5 (1.1)
Pakistan (2017-18)	4,079	10.4	50.5	-1.6 (1.7)	-0.2 (1.3)	-0.1 (1.3)
Pooled SSEA[b]	***232,249***	***10.0***	***51.4***	***-1.4 (1.7)***	***-0.9 (1.4)***	***-0.8 (1.4)***
Demographic Health Survey Datasets: Sub-Saharan Africa (b)						
Angola (2015-16)	6,268	12.2	49.9	-1.5 (1.5)	-0.1 (1.2)	0.0 (1.2)
Benin (2017-18)	11,626	11.6	50.5	-1.4 (1.3)	-0.3 (1.1)	-0.2 (1.1)
Cameroon (2018)	4,435	11.5	50.7	-1.1 (1.7)	0.4 (1.4)	0.5 (1.4)
Congo (2011-12)	4,464	11.9	51.0	-1.1 (1.5)	-0.2 (1.2)	-0.1 (1.2)
Ethiopia (2019)	5,055	11.0	51.2	-1.4 (1.5)	-0.5 (1.2)	-0.3 (1.2)
Gambia (2019-20)	3,805	13.8	52.4	-1.1 (1.1)	-0.4 (1.0)	-0.3 (1.0)
Ghana (2014)	2,682	12.4	51.7	-1.0 (1.3)	-0.3 (1.1)	-0.2 (1.1)
Kenya (2014)	18,279	10.2	50.6	-1.2 (1.4)	-0.1 (1.2)	0.0 (1.2)
Liberia (2019-20)	2,439	11.2	49.1	-1.4 (1.3)	0.0 (1.1)	0.2 (1.1)
Malawi (2015-16)	5,110	9.4	49.1	-1.5 (1.4)	0.1 (1.1)	0.2 (1.1)
Mali (2018)	8,202	11.4	50.8	-1.1 (1.6)	-0.5 (1.2)	-0.5 (1.2)
Mozambique (2011)	9,251	10.9	50.0	-1.6 (1.6)	0.2 (1.3)	0.4 (1.4)
Nigeria (2018)	11,308	10.4	50.7	-1.5 (1.6)	-0.3 (1.1)	-0.2 (1.2)
Pooled SSA[c]	***92,924***	***11.1***	***50.5***	***-1.3 (1.5)***	***-0.2 (1.2)***	***-0.1 (1.2)***
Grand Pool[d] (a+b)	***325,173***	***10.3***	***51.4***	***-1.4 (1.6)***	***-0.7 (1.4)***	***-0.6 (1.4)***

[a] The Meerut study was conducted in 6-59 months old children
[b] Pooled SSEA: Pooled South and South-East Asia
[c] Pooled SSA: Pooled Sub-Saharan Africa
[d] Grand pool: Pooled data from all the Demographic Health Survey Datasets studied

Web Table II Prevalence (%) of Anthropometric Deficits in 0-6 months in the Demographic Health Survey datasets

Country	*Number*	*Stunting (95% CI)*	*Wasting (95% CI)*	*Thinness (95% CI)*	*WaSt (95% CI)*	*ThSt (95% CI)*	*P-value*[a]
Demographic Health Survey Datasets: South and South-East Asia (a)							
Bangladesh	916	19.4 (17.0, 22.1)	10.0 (8.3, 12.2)	12.9 (10.9, 15.2)	1.1 (1.0, 2.0)	3.6 (2.6, 5.0)	<0.0001
Cambodia	458	16.2 (13.1, 19.8)	13.5 (10.7, 17.0)	14.4 (11.5, 17.9)	0.7 (0.2, 2.0)	2.0 (1.0, 3.7)	0.0143
India	20,582	20.3 (20.0, 20.9)	28.5 (27.9, 29.1)	29.7 (29.0, 30.3)	2.6 (2.4, 2.8)	5.4 (5.1, 5.8)	<0.0001
Maldives	177	20.9 (15.5, 27.6)	7.9 (4.7, 13.0)	8.5 (5.2, 13.6)	0.0 (0.0, 0.0)	2.3 (0.8, 5.9)	0.0455
Myanmar	430	7.2 (5.1, 10.1)	10.7 (8.1, 14.0)	10.5 (7.9, 13.7)	0.5 (0.1, 1.8)	1.4 (0.6, 3.1)	0.0455
Nepal	224	12.9 (9.1, 18.0)	13.4 (9.5, 18.5)	13.4 (9.5, 18.5)	0.9 (0.2, 3.5)	1.8 (0.7, 4.7)	0.1573
Pakistan	426	17.8 (14.5, 21.8)	11.0 (8.4, 14.4)	14.6 (11.5, 18.2)	1.6 (0.8, 3.4)	4.9 (3.2, 7.5)	0.0002
Pooled SSEA[b]	***23,213***	***16.3 (12.2, 20.4)***	***13.6 (4.7, 22.5)***	***14.9 (6.3, 23.5)***	***1.1 (0.2, 2.3)***	***3.1 (1.5, 4.7)***	
Demographic Health Survey Datasets: Sub-Saharan Africa (b)							
Angola	764	17.6 (15.1, 20.5)	5.2 (3.9, 7.1)	7.6 (5.9, 9.7)	0.3 (0.1, 1.0)	2.1 (1.3, 3.4)	0.0002
Benin	1,352	16.7 (14.8, 18.8)	6.9 (5.6, 8.4)	8.5 (7.1, 10.1)	1.3 (0.8, 2.0)	3.3 (2.5, 4.4)	<0.0001
Cameroon	509	16.5 (13.5, 20.0)	5.5 (3.8, 7.9)	6.3 (4.5, 8.8)	0.0 (0.0, 0.0)	1.6 (0.8, 3.1)	0.005
Congo	530	11.1 (8.7, 14.1)	7.0 (5.1, 9.5)	7.0 (5.1, 9.5)	0.0 (0.0, 0.0)	0.6 (0.2, 1.7)	0.0833
Ethiopia	556	16.0 (13.2, 19.3)	11.3 (8.9, 14.3)	8.6 (6.6, 11.3)	0.7 (0.3, 1.9)	1.4 (0.7, 2.9)	0.0455
Gambia	526	7.8 (5.8, 10.4)	4.2 (2.8, 6.3)	4.9 (3.4, 7.2)	0.4 (0.1, 1.5)	1.5 (0.8, 3.0)	0.0143
Ghana	332	5.7 (3.7, 8.8)	9.3 (6.6, 13)	7.8 (5.4, 11.3)	0.6 (0.2, 2.4)	0.6 (0.2, 2.4)	1.000
Kenya	1,858	11.4 (10.0, 12.9)	5.1 (4.2, 6.2)	4.7 (3.8, 5.7)	0.4 (0.2, 0.9)	0.8 (0.5, 1.3)	0.0082
Liberia	274	20.1 (15.7, 25.3)	4.4 (2.5, 7.6)	5.5 (3.3, 8.9)	0.7 (0.2, 2.9)	2.2 (1.0, 4.8)	0.0455
Malawi	482	20.9 (17.5, 24.8)	3.3 (2.0, 5.4)	3.7 (2.4, 5.9)	0.4 (0.1, 1.6)	1.5 (0.7, 3.0)	0.0253
Mali	932	12.6 (10.6, 14.8)	11.3 (9.4, 13.5)	13.5 (11.5, 15.9)	1.4 (0.8, 2.4)	3.2 (2.3, 4.6)	<0.0001
Mozambique	1,008	23.5 (21.0, 26.2)	8.4 (6.9, 10.3)	10.1 (8.4, 12.1)	1.4 (0.8, 2.3)	3.6 (2.6, 4.9)	<0.0001
Nigeria	1,174	18.0 (15.9, 20.3)	6.5 (5.2, 8.0)	9.5 (8.0, 11.4)	1.4 (0.8, 2.2)	4.1 (3.1, 5.4)	<0.0001
Pooled SSA[c]	***10,297***	***15.1 (12.4, 17.8)***	***6.7 (5.5, 7.9)***	***7.5 (6.0, 9.0)***	***0.1 (0.0, 0.1)***	***2.0 (1.3, 2.7)***	
Grand Pool (a + b)[d]	***33,510***	***15.5 (13.1, 17.9)***	***9.2 (4.1, 14.2)***	***10.1 (5.0, 15.2)***	***0.5 (0.4, 0.5)***	***2.4 (1.3, 3.3)***	

[a]P-values calculated between the prevalence of WaSt and ThSt using Mc-Nemar test
[b]Pooled SSEA: Pooled estimates for South and South-East Asia; [c]Pooled SSA: Pooled estimates for Sub-Saharan Africa
[d]Grand pool: Pooled data from all the Demographic Health Survey Datasets studied
Note: *There is no data available for 0-6 months in Meerut study*

Web Table III Prevalence (%) of Anthropometric Deficits in 6-59 Months for the Research Dataset (Meerut study) and the Demographic Health Survey datasets

Country	*Number*	*Stunting (95% CI)*	*Wasting (95% CI)*	*Thinness (95% CI)*	*WaSt (95% CI)*	*ThSt (95% CI)*	*P-value*[a]
Research dataset: Meerut district in Uttar Pradesh, India							
Meerut, India[b]	18,452	45.7 (45.0, 46.4)	16.2 (15.7, 16.8)	11.5 (11.1, 12.0)	9.6 (9.2, 10.0)	5.5 (5.2, 5.9)	<0.001
Demographic Health Survey Datasets: South and South-East Asia (a)							
Bangladesh	6,795	33.0 (31.9, 34.2)	8.3 (7.7, 9.0)	6.5 (5.9, 7.1)	3.2 (2.8, 3.7)	1.8 (1.5, 2.1)	<0.001
Cambodia	3,831	34.8 (33.3, 36.3)	9.2 (8.4, 10.2)	7.6 (6.8, 8.5)	3.6 (3.1, 4.2)	1.9 (1.5, 2.4)	<0.001
India	186,782	40.1 (39.9, 40.3)	19.2 (19.0, 19.4)	17.0 (16.8, 17.2)	6.6 (6.5, 6.7)	4.2 (4.2, 4.3)	<0.001
Maldives	2,165	14.6 (13.2, 16.2)	9.1 (8.0, 10.4)	7.9 (6.9, 9.2)	1.8 (1.3, 2.4)	1.1 (0.7, 1.6)	0.001
Myanmar	3,716	33.5 (32.0, 35.0)	6.1 (5.4, 6.9)	5.2 (4.5, 6.0)	1.8 (1.2, 2.3)	1.0 (0.7, 1.4)	<0.001
Nepal	2,094	39.2 (37.0, 41.3)	8.8 (7.7, 10.1)	7.5 (6.4, 8.7)	3.7 (3.0, 4.6)	2.3 (1.8, 3.1)	<0.001
Pakistan	3,653	41.0 (39.4, 42.6)	7.3 (6.5, 8.2)	6.4 (5.6, 7.2)	2.9 (2.4, 3.5)	1.9 (1.5, 2.4)	<0.001
Pooled SSEA[c]	***209,036***	***33.7 (27.7, 39.8)***	***9.7 (4.1, 15.3)***	***8.3 (3.2, 13.4)***	***3.4 (1.4, 5.3)***	***2.0 (0.7, 3.4)***	
Demographic Health Survey Datasets: Sub-Saharan Africa (b)							
Angola	5,504	40.4 (39.1, 41.2)	5.0 (4.5, 5.6)	4.4 (3.9, 5.0)	2.1 (1.8, 2.5)	1.4 (1.1, 1.8)	<0.001
Benin	10,274	34.0 (33.1, 35.0)	4.9 (4.5, 5.4)	4.2 (3.8, 4.6)	2.1 (1.8, 2.4)	1.4 (1.2, 1.6)	<0.001
Cameroon	3,926	29.6 (28.2, 31.1)	3.7 (3.2, 4.4)	3.8 (3.2, 4.4)	1.2 (0.9, 1.6)	0.8 (0.6, 1.1)	<0.001
Congo	3,934	29.1 (27.7, 30.1)	5.2 (4.6, 6.0)	4.9 (4.3, 5.6)	1.4 (1.0, 1.8)	0.9 (0.6, 1.2)	0.001
Ethiopia	4,499	38.4 (37.0, 39.8)	8.6 (7.8, 9.5)	6.7 (6.0, 7.5)	3.9 (3.4, 4.5)	2.1 (1.7, 2.6)	<0.001
Gambia	3,279	20.0 (18.6, 21.4)	5.3 (4.6, 6.1)	4.2 (3.6, 5.0)	1.6 (1.2, 2.1)	0.8 (0.6, 1.2)	<0.001
Ghana	2,350	20.9 (19.3, 22.5)	4.3 (3.5, 5.2)	3.9 (3.2, 4.8)	1.5 (1.1, 2.1)	1.1 (0.8, 1.6)	0.004
Kenya	16,421	29.1 (28.4, 29.8)	5.5 (5.1, 5.8)	4.8 (4.5, 5.1)	1.9 (1.7, 2.1)	1.0 (0.8, 1.1)	<0.001
Liberia	2,165	33.9 (31.9, 35.9)	4.2 (3.4, 5.1)	3.2 (3.1, 4.1)	1.7 (1.2, 2.4)	0.9 (0.6, 1.4)	<0.001
Malawi	4,628	37.0 (35.6, 38.4)	3.0 (2.6, 3.6)	2.6 (2.1, 3.0)	1.0 (0.8, 1.4)	0.6 (0.4, 0.9)	<0.001
Mali	7,270	28.6 (27.6, 29.6)	9.1 (8.4, 9.7)	8.4 (7.8, 9.1)	3.2 (2.9, 3.7)	2.3 (2.0, 2.7)	<0.001
Mozambique	8,243	41.6 (40.6, 42.7)	4.8 (4.4, 5.3)	4.4 (4.0, 4.9)	1.5 (1.2, 1.8)	0.9 (0.8, 1.2)	<0.001
Nigeria	10,134	38.4 (37.4, 39.3)	6.6 (6.1, 7.1)	5.5 (5.1, 6.0)	3.3 (2.9, 3.6)	2.2 (1.9, 2.5)	<0.001
Pooled SSA[d]	***82,627***	***32.4 (28.9, 35.3)***	***5.4 (4.6, 6.2)***	***4.7 (4.0, 5.4)***	***2.0 (1.6, 2.4)***	***1.3 (1.0, 1.5)***	
Grand Pool (a + b)[e]	***291,663***	***32.9 (29.8, 35.9)***	***6.9 (3.8, 10.0)***	***6.0 (3.3, 8.6)***	***2.5 (1.6, 3.7)***	***1.5 (0.7, 2.4)***	

[a] *P-values calculated between the prevalence of WaSt and ThSt using Mc-Nemar test*
[b] *The Meerut study was conducted in 6-59 months old children*
[c] *Pooled SSEA: Pooled estimates for South and South-East Asia*
[d] *Pooled SSA: Pooled estimates for Sub-Saharan Africa*
[e] *Grand pool: Pooled data from all the Demographic Health Survey Datasets studied*

Web Table IV Male to Female Wasting-Stunting (WaST) and Thinness-Stunting (ThSt) prevalence ratios in 6-59 months old children for Demographic Health Survey Datasets.

Country	*WaSt ratio (95% CI)*	*ThSt ratio (95% CI)*
Demographic Health Survey Datasets: South and South-East Asia		
Bangladesh	1.16 (0.9, 1.6)	1.09 (0.8, 1.6)
Cambodia	1.27 (0.9, 1.8)	1.06 (0.7, 1.7)
India	1.35 (1.3,1.4)	1.22 (1.2, 1.3)
Maldives	2.32 (1.2, 4.7)	2.68 (1.1, 6.8)
Myanmar	1.31 (0.8, 2.1)	1.17 (0.6, 2.2)
Nepal	1.29 (0.8, 2.0)	1.19 (0.7, 2.1)
Pakistan	1.52 (1.0, 2.2)	1.47 (0.9, 2.4)
Demographic Health Survey Datasets: Sub-Saharan Africa		
Angola	2.13 (1.4, 2.1)	1.86 (1.2, 3.0)
Benin	2.10 (1.6, 2.8)	1.82 (1.3, 2.6)
Cameroon	1.66 (0.9, 3.0)	1.81 (0.9, 3.8)
Congo	2.07 (1.2, 3.7)	2.82 (1.3, 6.0)
Ethiopia	2.28 (1.7, 3.1)	2.17 (1.4, 3.3)
Gambia	1.70 (1.0, 3.0)	1.13 (0.5, 2.4)
Ghana	0.92 (0.4, 1.8)	1.07 (0.5, 2.3)
Kenya	1.76 (1.4, 2.2)	1.50 (1.1, 2.1)
Liberia	0.99 (0.5, 1.9)	1.05 (0.4, 2.5)
Malawi	1.45 (0.8, 2.6)	1.38 (0.7, 2.9)
Mali	1.40 (1.1, 1.8)	1.29 (1.0, 1.7)
Mozambique	1.61 (1.1, 2.3)	1.73 (1.1, 2.8)
Nigeria	1.94 (1.5, 2.4)	2.09 (1.6, 2.8)

Web Table V Effect Size of Differences in Weight for height or BMI-for-age Z scores Between Combined and Single Anthropometric Deficits in 6-59 Months Age for Demographic Health Survey Datasets

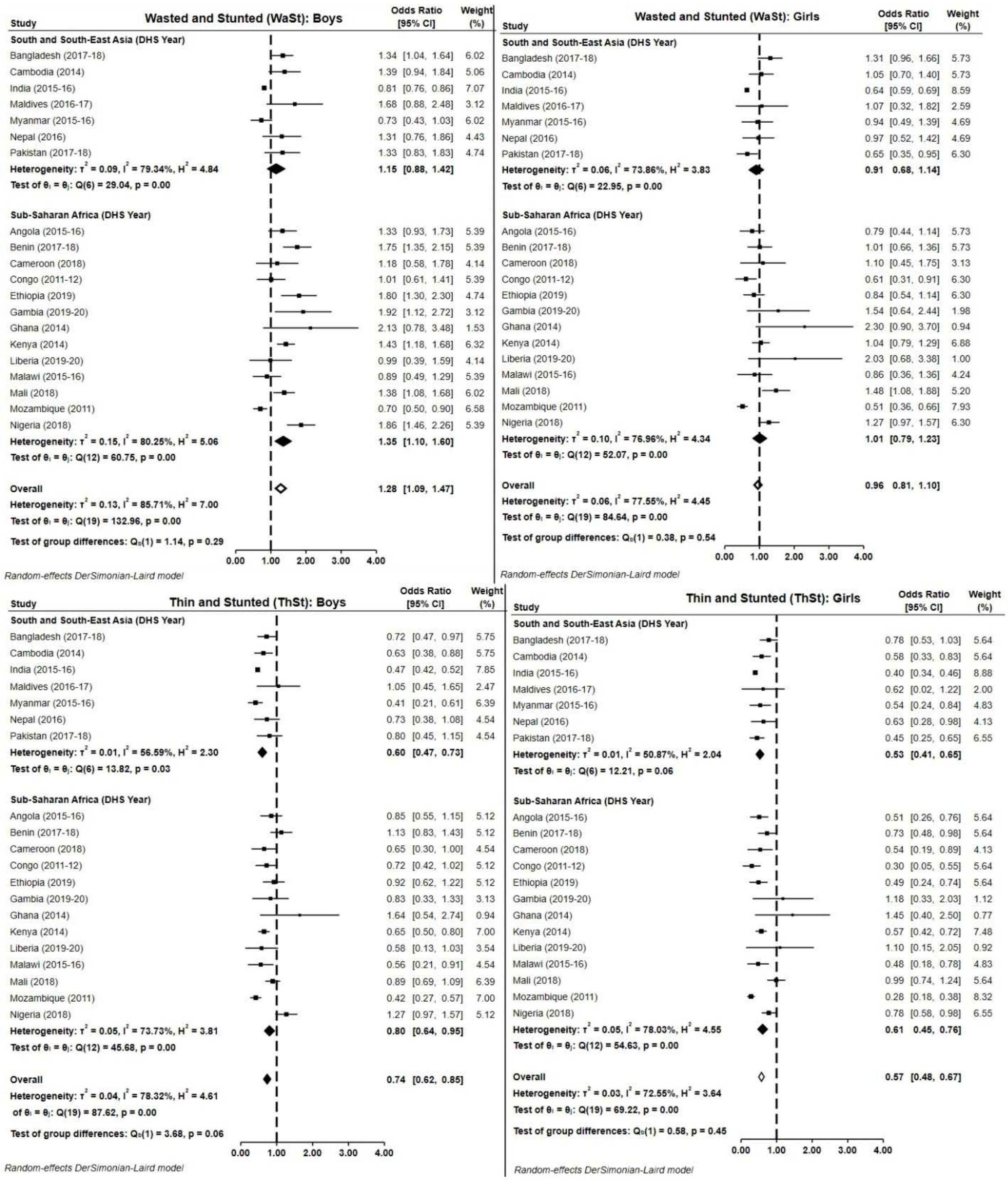
Country	*Weight for height Z-score*					*BMI-for-age Z-score*				
	Stunted only Median (Interquartile Range)	*Wasted only Median (Interquartile Range)*	*Wasted and Stunted (WaSt) Median (Interquartile Range)*	*Impact (WaSt vs Stunted only)*	*Impact (WaSt vs Wasted only)*	*Stunted only Median (Interquartile Range)*	*Thin only Median (Interquartile Range)*	*Thin and Stunted (ThSt)*	*Impact (ThSt vs Stunted only)*	*Impact (ThSt vs Thin only)*
Demographic Health Survey Datasets: South and South-East Asia										
Bangladesh	-0.6 (-1.2, 0.0)	-2.4 (-2.8, -2.2)	-2.4 (-2.6, -2.1)	2.2	0.0	-0.3 (-1.0, 0.3)	-2.4 (-2.9, -2.2)	-2.3 (-2.6, -2.1)	2.4	-0.3
Cambodia	-0.7 (-1.2, -0.1)	-2.5 (-3.3, -2.2)	-2.4 (-2.7, -2.2)	2.1	-0.4	-0.4 (-10, 0.2)	-2.5 (-3.5, -2.2)	-2.3 (-2.8, -2.1)	2.2	0.0
India	-0.6 (-1.2, 0.1)	-2.8 (-3.4, -2.3)	-2.6 (-3.1, -2.2)	-1.99	-0.24	-0.3 (-1.0, 0.4)	-2.8 (-4.3, -2.3)	-2.6 (-3.1, -2.2)	2.2	-0.3
Maldives	-0.6 (-1.3, 0.3)	-2.4 (-2.8, -2.2)	-2.4 (-2.7, -2.2)	1.8	0.0	-0.3 (-1.1, 0.5)	-2.5 (-3.0, -2.2)	-2.2 (-2.6, -2.1)	1.9	0.0
Myanmar	-0.5 (-1.0, 0.1)	-2.4 (-2.8, -2.2)	-2.4 (-2.7, -2.1)	2.4	0.0	-0.2 (-0.7, 0.5)	-2.4 (-2.9, -2.1)	-2.3 (-2.9, -2.1)	2.5	0.0
Nepal	-0.6 (-1.2, 0.0)	-2.5 (-2.8, -2.2)	-2.5 (-2.9, 2.2)	2.3	0.0	-0.3 (-0.9, 0.3)	-2.4 (-2.8, -2.2)	-2.5 (-2.8, -2.2)	2.5	0.0
Pakistan	-0.1 (-0.8, 0.6)	-2.8 (-3.3, -2.3)	-2.6 (-3.2, -2.2)	2.52	0.00	0.3 (-0.4, 1.0)	-2.9 (-3.5, -2.3)	-2.6 (-3.4, -2.3)	2.8	0.0
Demographic Health Survey Datasets: Sub-Saharan Africa										
Angola	-0.2 (-0.8, 0.5)	-2.5 (-2.8, -2.2)	-2.6 (-3.0, -2.2)	2.8	0.0	0.2 (-0.5, 0.9)	-2.5 (-3.0, -2.2)	-2.4 (-2.8, -2.2)	2.8	0.0
Benin	-0.3 (-0.9, 0.4)	-2.4 (-2.8, -2.2)	-2.5 (-2.9, -2.2)	2.6	0.0	0.1 (-0.6, 0.7)	-2.4 (-2.9, -2.2)	-2.5 (-2.8, -2.2)	2.9	0.0
Cameroon	0.5 (-0.4, 1.4)	-2.6 (-3.2, -2.2)	-2.7 (-3.1, -2.2)	2.7	0.0	0.8 (-0.1, 1.8)	-2.6 (-3.2, -2.2)	-2.8 (-3.5, -2.5)	3.0	0.0
Congo	-0.2 (-0.8, 0.5)	-2.5 (-3.0, -2.2)	-2.5 (-3.2, -2.3)	2.3	0.0	0.2 (-0.5, 0.8)	-2.6 (-3.2, -2.3)	-2.4 (-3.3, -2.1)	2.5	0.0
Ethiopia	-0.5 (-1.1, 0.2)	-2.4 (-2.8, -2.2)	-2.4 (-2.8, -2.2)	2.3	0.0	-0.2 (-0.8, 0.5)	-2.4 (-2.8, -2.2)	-2.4 (-3.0, -2.2)	2.4	0.0
Gambia	-0.6 (-1.1, 0.0)	-2.3 (-2.6, -2.1)	-2.5 (-2.9, -2.1)	2.3	0.0	-0.3 (-0.9, 0.3)	-2.3 (-2.6, -2.1)	-2.5 (-3.4, -2.4)	2.4	-0.4
Ghana	-0.3 (-0.9, 0.4)	-2.3 (-2.7, -2.1)	-2.5 (-2.9, -2.2)	2.2	0.0	0.0 (-0.6, 0.8)	-2.4 (-2.7, -2.2)	-2.5 (-2.9, -2.2)	2.5	0.0
Kenya	-0.2 (-0.9, 0.5)	-2.5 (-2.9, -2.2)	-2.4 (-2.9, -2.2)	2.5	0.0	0.2 (-0.6, 0.9)	-2.5 (-3.0, -2.2)	-2.5 (-2.9, -2.3)	2.8	0.0
Liberia	0.1 (-0.6, 0.7)	-2.4 (-2.9, -2.2)	-2.5 (-2.8, -2.2)	2.9	0.0	0.4 (-0.3, 1.0)	-2.6 (-3.3, -2.2)	-2.3 (-2.8, -2.2)	2.7	0.0
Malawi	0.1 (-0.5, 0.7)	-2.5 (-3.0, -2.2)	-2.4 (-2.7, -2.2)	2.8	0.0	0.4 (-0.3, 1.0)	-2.6 (-3.2, -2.3)	-2.4 (-2.7, -2.1)	3.2	0.0
Mali	-0.5 (-1.1, 0.3)	-2.5 (-3.0, -2.2)	-2.7 (-3.1, -2.3)	2.3	0.0	-0.1 (-0.8, 0.6)	-2.5 (-3.0, -2.2)	-2.5 (-2.9, -2.2)	2.4	0.0
Mozambique	0.4 (-0.3, 1.2)	-2.7 (-3.2, -2.3)	-2.7 (-3.2, -2.2)	2.9	0.0	0.8 (0.0, 1.6)	-2.8 (-3.4, -2.3)	-2.7 (-3.3, -2.3)	3.2	0.0
Nigeria	-0.2 (-0.9, 0.4)	-2.5 (-3.0, -2.2)	-2.5 (-3.1, -2.2)	2.6	0.0	0.2 (-0.6, 0.8)	-2.6 (-3.1, -2.3)	-2.5 (-3.0, -2.2)	2.9	0.0

Web Table VI Effect Size of Differences in Height-for-age Z scores Between Combined and Single Anthropometric Deficits in 6-59 Months Age for Demographic Health Survey Datasets

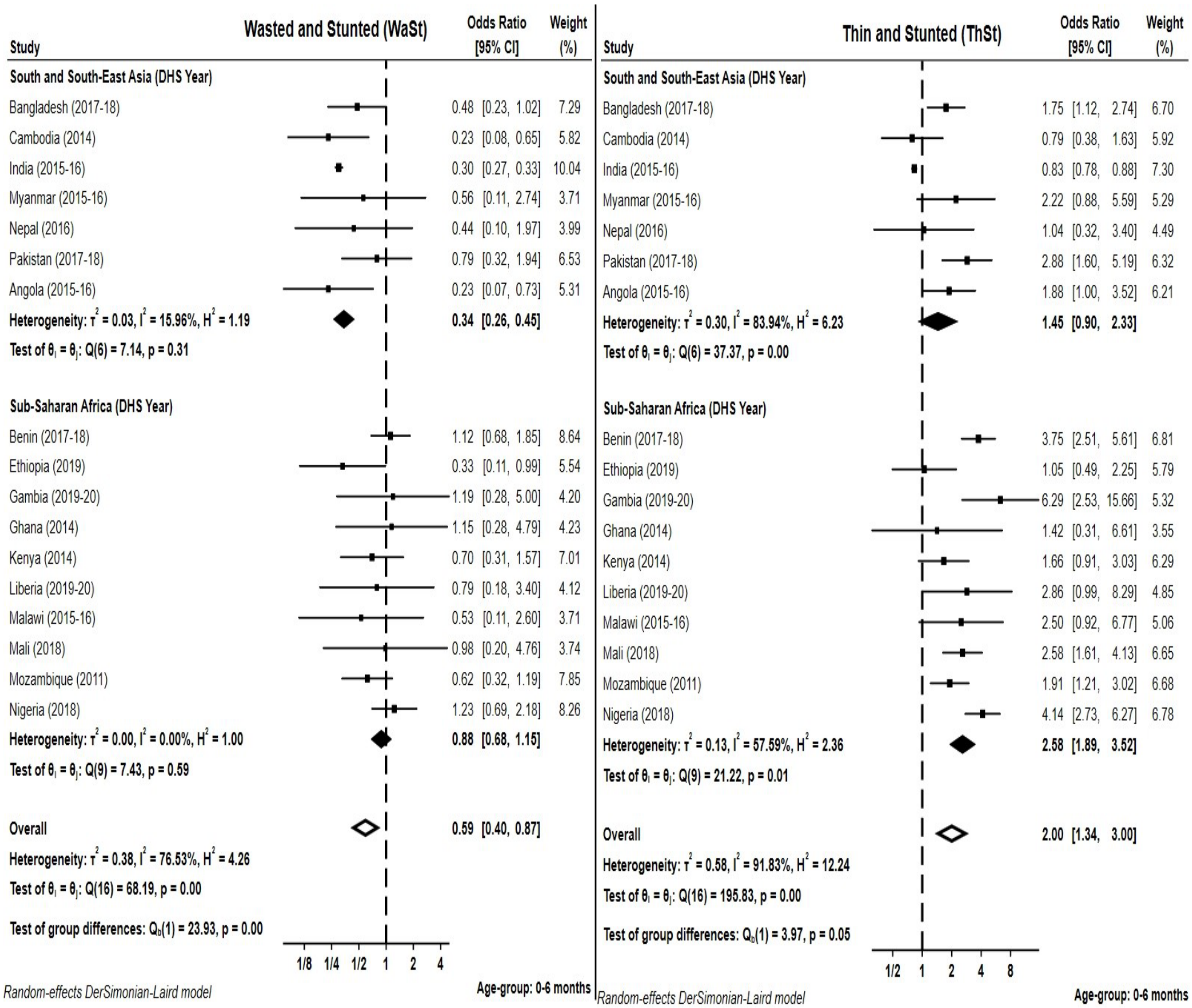
Country	*Height-for-age Z-score*								
	Stunted only Median (Interquartile Range)	*Wasted only Median (Interquartile Range)*	*Wasted and Stunted (WaSt) Median (Interquartile Range)*	*Impact (WaSt vs Stunted only)*	*Impact (WaSt vs Wasted only)*	*Thin only Median (Interquartile Range)*	*Thin and Stunted (ThSt) Median (Interquartile Range)*	*Impact (ThSt vs Stunted only)*	*Impact (ThSt vs Thin only)*
Demographic Health Survey Datasets: South and South-East Asia									
Bangladesh	-2.6 (-3.1, -2.3)	-0.9 (-1.5, -0.1)	-2.7 (-3.2, -2.4)	0.0	1.6	-0.7 (-1.4, 0.3)	-2.6 (-3.2, -2.3)	0.0	1.6
Cambodia	-2.6 (-3.1, -2.2)	-0.7 (-1.4, 0.7)	-2.7 (3.3, -2.3)	0.0	1.5	-0.4 (-1.2, 0.9)	-2.5 (-3.0, -2.2)	0.0	1.6
India	-2.8 (-3.5, -2.4)	-0.5 (-1.3, 0.7)	-2.9 (-3.5, -2.4)	0.0	1.8	-0.3 (-1.1, 0.9)	-2.8 (-3.4, -2.3)	-0.1	1.8
Maldives	-2.5 (-3.0, -2.2)	-0.9 (-1.4, 0.0)	-2.4 (-2.9, -2.1)	0.0	1.5	-0.6 (-1.3, 0.2)	-2.5 (-2.8, -2.1)	0.0	1.7
Myanmar	-2.6 (-3.1, -2.3)	-0.9 (-1.5, -0.3)	-2.6 (-3.0, -2.2)	0.0	1.5	-0.7 (-1.4, -0.1)	-2.5 (-3.1, -2.2)	0.0	1.6
Nepal	-2.7 (-3.2, -2.3)	-0.9 (-1.6, -0.2)	-2.8 (-3.2, -2.3)	0.0	2.0	-0.8 (-1.5, 0.0)	-2.8 (-3.2, -2.3)	0.0	2.1
Pakistan	-3.0 (-3.8, -2.4)	-0.6 (-1.3, 0.4)	-3.0 (-3.7, -2.4)	0.0	1.8	-0.4 (-1.2, 0.6)	-3.0 (-3.7, -2.4)	0.0	1.9
Demographic Health Survey Datasets: Sub-Saharan Africa									
Angola	-2.8 (-3.4, -2.4)	-0.7 (-1.4, 0.8)	-3.0 (-4.0, -2.3)	-0.2	1.6	-0.3 (-1.2, 1.1)	-3.0 (-3.8, -2.4)	0.0	1.7
Benin	-2.6 (-3.2, -2.3)	-1.0 (-1.5, -0.2)	-3.0 (-3.6, -2.5)	-0.2	1.7	-0.8 (-1.4, 0.0)	-2.9 (-3.6, -2.4)	-0.2	1.7
Cameroon	-2.9 (-3.6, -2.4)	-0.2 (-1.0, 0.7)	-2.8 (-3.7, -2.4)	0.0	1.8	0.0 (-0.8, 1.3)	-2.7 (-3.5, -2.4)	0.0	1.7
Congo	-2.7 (-3.3, -2.3)	-0.1 (-1.1, 1.0)	-2.9 (-3.6, -2.4)	0.0	2.0	0.2 (-0.7, 1.3)	-2.7 (-3.5, -2.3)	0.0	2.0
Ethiopia	-2.8 (-3.3, -2.3)	-0.9 (-1.4, 0.0)	-3.0 (-3.8, -2.4)	-0.2	1.8	-0.6 (-1.3, 0.5)	-2.8 (-3.3, -2.3)	0.0	1.9
Gambia	-2.5 (-2.9, -2.2)	-1.0 (-1.5, -0.5)	-2.5 (-2.9, -2.2)	0.0	2.0	-0.9 (-1.4, -0.4)	-2.5 (-3.4, -2.1)	0.0	1.1
Ghana	-2.5 (-3.0, -2.2)	-0.6 (-1.3, 0.0)	-2.8 (-3.4, -2.3)	0.0	1.8	-0.4 (-1.1, 0.3)	-2.6 (-3.5, -2.3)	0.0	1.8
Kenya	-2.6 (-3.1, -2.3)	-0.5 (-1.3, 0.5)	-2.8 (-3.4, -2.4)	-0.2	1.9	-0.3 (-1.2, 0.8)	-2.8 (-3.3, -2.4)	0.0	1.9
Liberia	-2.6 (-3.2, -2.3)	-0.5 (-1.2, 0.8)	-3.3 (-3.9, -2.8)	-0.1	1.9	-0.4 (-1.1, 0.9)	-3.2 (-3.9, -2.7)	0.0	2.0
Malawi	-2.6 (-3.1, -2.3)	-0.4 (-1.2, 1.1)	-3.0 (-3.8, -2.6)	-0.3	1.7	0.3 (-0.9, 1.3)	-2.8 (-3.5, -2.4)	0.0	2.2
Mali	-2.7 (-3.4, -2.3)	-0.6 (-1.2, 0.5)	-2.9 (-3.6, -2.4)	-0.2	1.8	-0.3 (-1.0, 0.9)	-2.9 (-3.5, -2.3)	0.0	1.9
Mozambique	-2.8 (-3.5, -2.4)	-0.1 (-1.1, 1.5)	-3.1 (-3.7, -2.5)	0.0	1.8	0.2 (-0.8, 1.6)	-3.1 (-3.7, -2.5)	0.0	2.1
Nigeria	-2.9 (-3.6, -2.4)	-0.9 (-1.5, 0.3)	-3.3 (-4.0, -2.6)	-0.2	1.8	-0.5 (-1.4, 0.8)	-3.2 (-3.9, -2.5)	-0.2	1.8

Web Table VII Correlation Coefficients for Weight for height and BMI-for-age in 0-59 Months Children for Demographic Health Survey Datasets

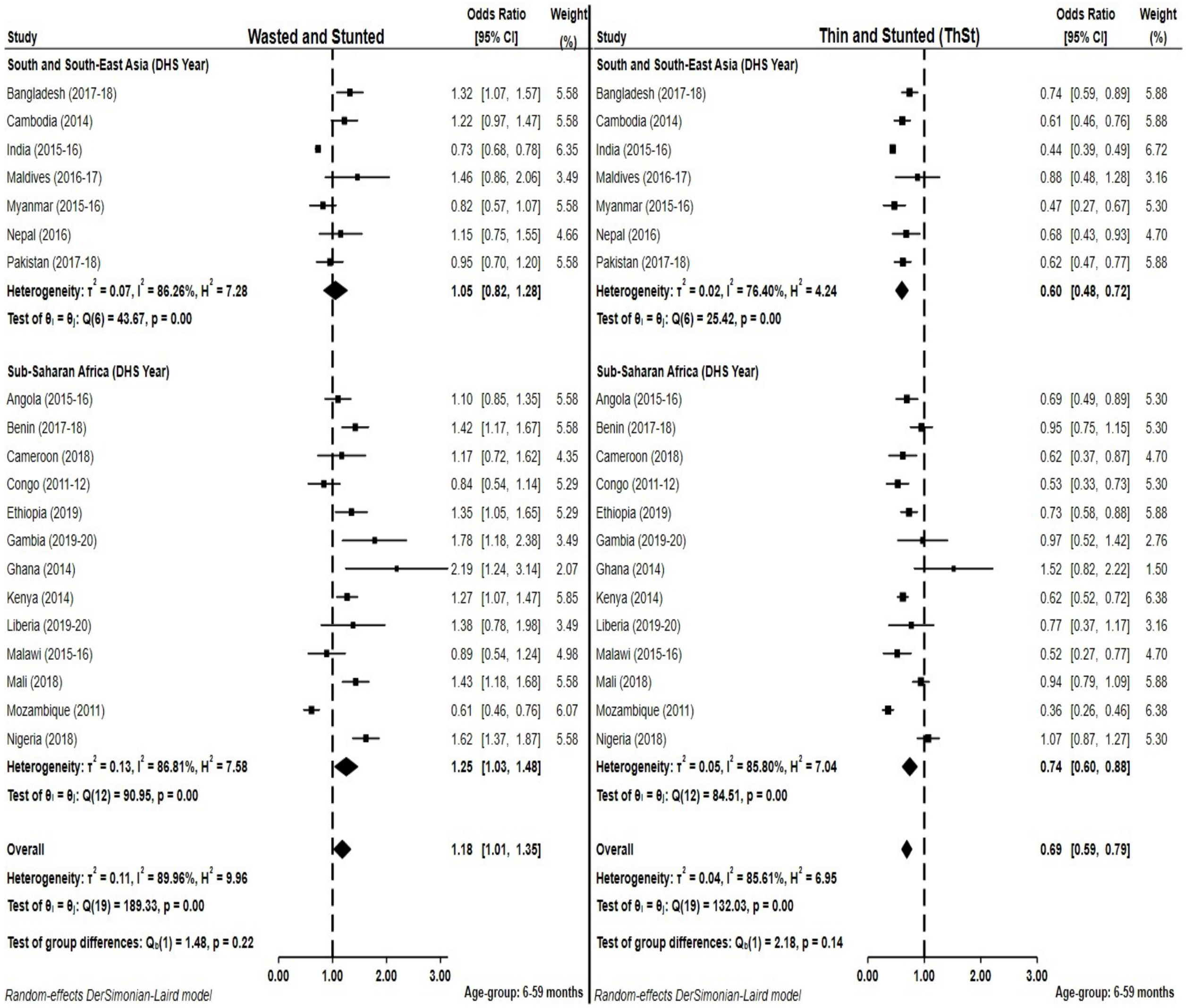
Country	*Correlation between Body mass index-for-age (z-scores) and Weight for height (z-scores) (95% CI); P*	*Coefficients of log weight regressed on log height (95% CI); P*	*Correlation between Body mass index-for-age (z-scores) and Weight (kg) (95% CI); P*	*Correlation between Weight for height (z-scores) and Weight (kg) (95% CI); P*	*Correlation between Body mass index-for-age (z-scores) and Height(cm) (95% CI); P*	*Correlation between Weight for height (z-scores) and Height (cm) (95% CI); P*
Demographic Health Survey Datasets: South and South-East Asia						
Bangladesh	0.97 (0.96, 0.97); <0.001	1.88 (1.86, 1.89); <0.001	0.23 (0.21, 0.25); <0.001	0.18 (0.16, 0.20); <0.001	-0.07 (-0.09, -0.04); <0.001	-0.12 (-0.15, -0.10); <0.001
Cambodia	0.97 (0.97, 0.97); <0.001	1.83 (1.82, 1.85); <0.001	0.23 (0.21, 0.26); <0.001	0.22 (0.17, 0.23); <0.001	-0.09 (-0.12, -0.06); <0.001	-0.12 (-0.15, -0.09); <0.001
India	0.97 (0.97, 0.97); <0.001	1.86 (1.85, 1.86); <0.001	0.33 (0.32, 0.33); <0.001	0.32 (0.31, 0.32); <0.001	-0.04 (-0.05, -0.03); <0.001	-0.06 (-0.07, -0.05); <0.001
Maldives	0.98 (0.98, 0.98); <0.001	1.81 (1.78, 1.82); <0.001	0.33 (0.28, 0.36); <0.001	0.31 (0.28, 0.35); <0.001	-0.08 (-0.12, -0.04); 0.001	-0.09 (-0.13, -0.05); <0.001
Myanmar	0.97 (0.97, 0.98); <0.001	1.82 (1.81, 1.84); <0.001	0.24 (0.21, 0.27); <0.001	0.22 (0.19, 0.25); <0.001	-0.06 (-0.09, -0.03); 0.001	-0.09 (-0.12, -0.06); <0.001
Nepal	0.92 (0.89, 0.93); <0.001	2.58 (2.4, 2.8); <0.001	0.41 (0.29, 0.51); <0.001	0.30 (0.18, 0.42); <0.001	-0.05 (-0.18, 0.08); 0.424	-0.19 (-0.31, -0.06); 0.005
Pakistan	0.97 (0.96, 0.97); <0.001	1.93 (1.91, 1.95); <0.001	0.35 (0.32, 0.38); <0.001	0.33 (0.29, 0.35); <0.001	0.04 (0.01, 0.07); 0.008	0.00 (-0.03, 0.03); 0.776
Demographic Health Survey Datasets: Sub-Saharan Africa						
Angola	0.96 (0.96, 0.96); <0.001	1.88 (1.87, 1.89); <0.001	0.27 (0.24, 0.29); <0.001	0.22 (0.20, 0.25); <0.001	-0.02 (-0.04, 0.01); 0.226	-0.07 (-0.09, -0.04); <0.001
Benin	0.96 (0.96, 0.96); <0.001	1.95 (1.94, 1.96); <0.001	0.34 (0.32, 0.35); <0.001	0.28 (0.27, 0.30); <0.001	0.09 (0.07, 0.11); <0.001	0.03 (0.01, 0.05); 0.003
Cameroon	0.97 (0.97, 0.97); <0.001	1.88 (1.86, 1.89); <0.001	0.31 (0.28, 0.33); <0.001	0.30 (0.27, 0.32); <0.001	-0.03 (-0.06, 0.0); 0.0867	-0.04 (-0.07, -0.01); 0.005
Congo	0.97 (0.97, 0.97); <0.001	1.88 (1.86, 1.90); <0.001	0.29 (0.27, 0.32); <0.001	0.27 (0.24, 0.30); <0.001	0.0 (-0.03, 0.03); 0.863	-0.03 (-0.06, 0.00); 0.052
Ethiopia	0.97 (0.96, 0.97); <0.001	1.85 (1.84, 1.87); <0.001	0.22 (0.19, 0.25); <0.001	0.21 (0.18, 0.24); <0.001	-0.08 (-0.11, -0.05); <0.001	-0.10 (-0.12, -0.07); <0.001
Gambia	0.97 (0.97, 0.97); <0.001	1.82 (1.80, 1.83); <0.001	0.09 (0.06, 0.12); <0.001	0.05 (0.02, 0.08); 0.004	-0.16 (-0.20, -0.13); <0.001	-0.21 (-0.24, -0.18); <0.001
Ghana	0.98 (0.97, 0.98); <0.001	1.94 (1.92, 1.96); <0.001	0.38 (0.34, 0.41); <0.001	0.37 (0.33, 0.40); <0.001	0.11 (0.08, 0.15); <0.001	0.10 (0.06, 0.14); <0.001
Kenya	0.98 (0.98, 0.98); <0.001	1.81 (1.80, 1.82); <0.001	0.19 (0.18, 0.21); <0.001	0.18 (0.17, 0.20); <0.001	-0.12 (-0.14, -0.11); <0.001	-0.14 (-0.15, -0.13); <0.001
Liberia	0.97 (0.96, 0.97); <0.001	1.88 (1.86, 1.91); <0.001	0.28 (0.24, 0.32); <0.001	0.23 (0.19, 0.27); <0.001	0.02 (-0.02, 0.06); 0.360	-0.04 (-0.08, 0.00); 0.064
Malawi	0.97 (0.97, 0.97); <0.001	1.81 (1.79, 1.83); <0.001	0.21 (0.18, 0.24); <0.001	0.18 (0.15, 0.20); <0.001	-0.09 (-0.12, -0.07); <0.001	-0.13 (-0.16, -0.11); <0.001
Mali	0.97 (0.97, 0.97); <0.001	1.91 (1.90, 1.92); <0.001	0.32 (0.30, 0.34); <0.001	0.31 (0.29, 0.33); <0.001	0.03 (0.01, 0.05); 0.006	0.02 (-0.01, 0.04); 0.142
Mozambique	0.97 (0.96, 0.97); <0.001	1.88 (1.87, 1.90); <0.001	0.31 (0.29, 0.32); <0.001	0.27 (0.25, 0.29); <0.001	-0.02 (-0.04, 0.00); 0.103	-0.06 (-0.08, -0.04); <0.001
Nigeria	0.96 (0.96, 0.96); <0.001	1.94 (1.93, 1.95); <0.001	0.35 (0.34, 0.37); <0.001	0.33 (0.32, 0.35); <0.001	0.10 (0.07, 0.12); <0.001	0.07 (0.05, 0.09); <0.001



Web Fig. 1 Sex differences in wasting-stunting (WaSt) and thinness-stunting (ThSt) associations in under-five children in Demographic Health Survey datasets.



Web Fig. 2 Summary of wasting-stunting (WaSt) and thinness-stunting (ThSt) associations in 0-6 months old infants in the Demographic Health Survey datasets.



Web Fig. 3 Summary of wasting-stunting (WaSt) and thinness-stunting (ThSt) associations in 6-59 months old children in the Demographic Health Survey datasets.