Effect of correcting for gestational age at birth on population prevalence of early childhood undernutrition
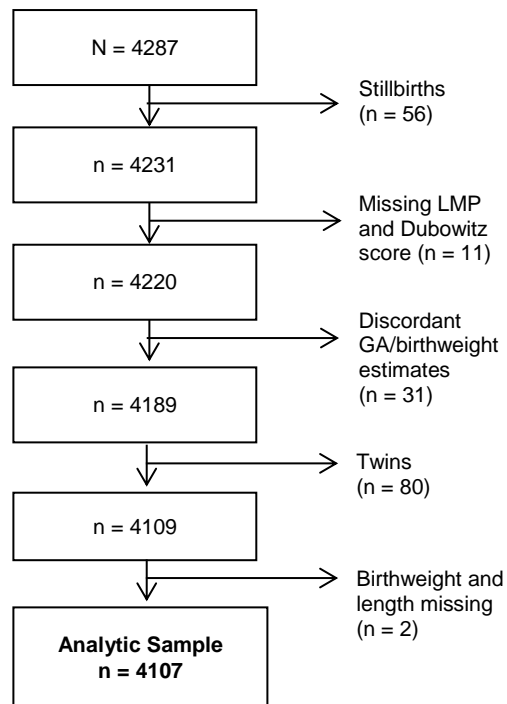
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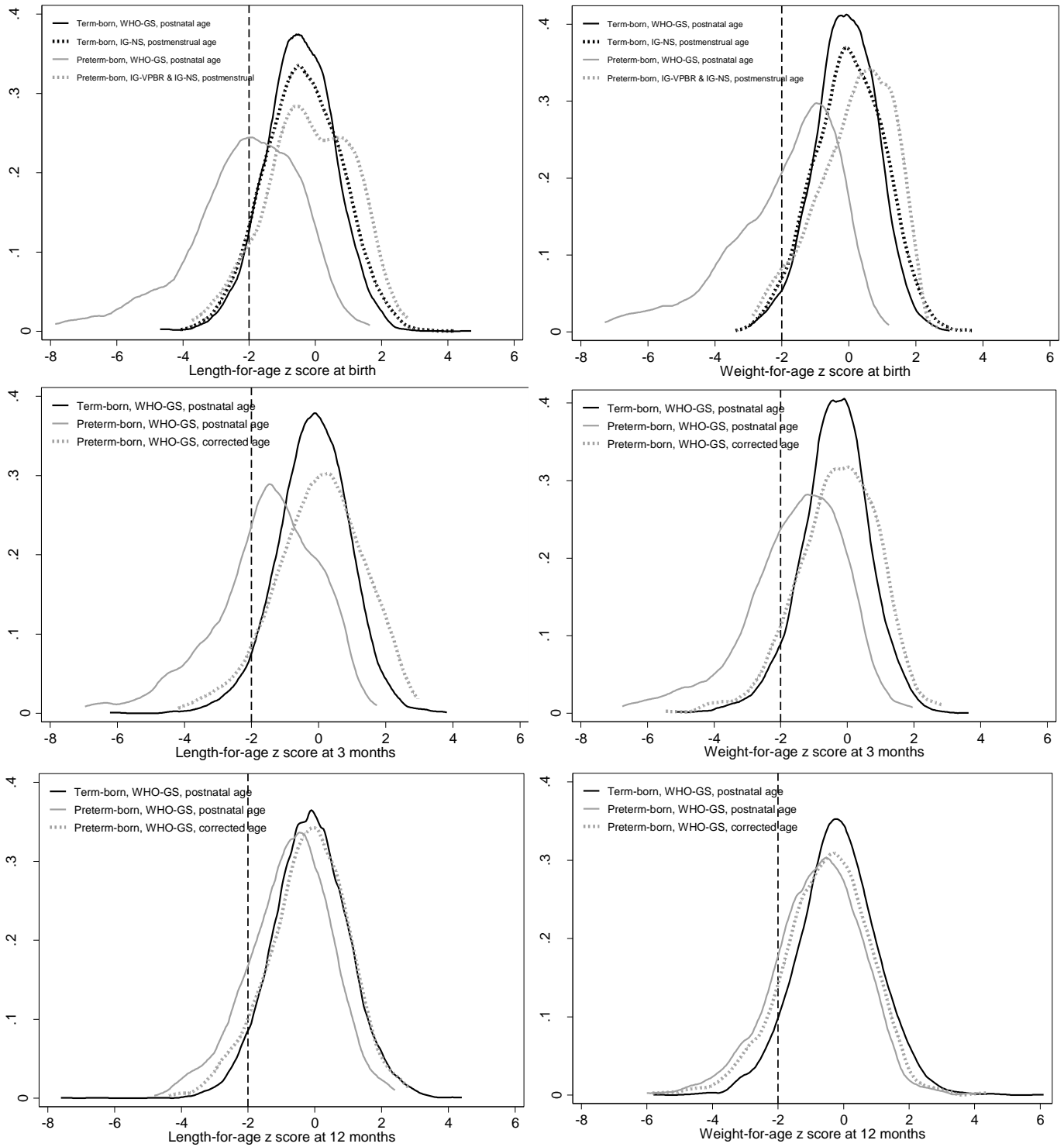
ADDITIONAL SUPPORTING MATERIAL

Emerging Themes in Epidemiology

Figure S1. Flowchart of analytical sample for this study.

Figure S2. Comparison of the distribution of length-for-age and weight-for-age *z* scores at birth (top row), 3 months (middle row), and 12 months (bottom row) among preterm- and term-born children using postnatal age and gestational age-corrected age in the application of World Health Organization child growth standards (WHO-GS). At birth, the INTERGROWTH newborn size standards (IG-NS) and the INTERGROWTH very preterm born size at birth references (IG-VPBR) were applied for all children using postmenstrual age.

Table S1. Length-for-age *z* scores at postnatal follow-up visits estimated using either postnatal age or gestational age-corrected age in the application of the World Health Organization growth child growth standards for all children.

Follow-up visit[a]	n	Excluded n		Flagged Obs[b]	Mean ± SD[c]	Median (1st, 99th)	Term-born children (≥37[0/7] wk)		Preterm-born children (<37[0/7] wk)		Mean difference in LAZ among term vs preterm-born	
		No data	Ineligible for analysis				n	Mean ± SD	n	Mean ± SD	Mean difference (95% CI)	*P* value[d]
3 mo[e]												
WHO-GS, postnatal age all	3859	4	2	10	-0.32 ± 1.23	-0.24 (-4.11, 2.24)	3444	-0.17 ± 1.08	415	-1.57 ± 1.61	1.41 (1.25, 1.57)	<0.001
WHO-GS, CA all	3859	4	2	0	-0.03 ± 1.14	0.01 (-3.05, 2.46)	3444	-0.04 ± 1.12	415	-0.002 ± 1.34	-0.03 (-0.17, 0.10)	0.618
12 mo												
WHO-GS, postnatal age all	3801	3	0	3	-0.20 ± 1.17	-0.20 (-3.09, 2.55)	3390	-0.13 ± 1.15	411	-0.76 ± 1.22	0.63 (0.50, 0.75)	<0.001
WHO-GS, CA all	3801	3	0	3	-0.10 ± 1.16	-0.10 (-2.84, 2.58)	3390	-0.09 ± 1.16	411	-0.21 ± 1.19	0.12 (0.001, 0.25)	0.048
24 mo												
WHO-GS, postnatal age all	3739	9	0	1	-0.10 ± 1.15	-0.09 (-2.89, 2.56)	3324	-0.04 ± 1.13	415	-0.55 ± 1.20	0.50 (0.39, 0.62)	<0.001
WHO-GS, CA all	3739	9	0	1	-0.03 ± 1.15	-0.02 (-2.82, 2.64)	3324	-0.004 ± 1.14	415	-0.28 ± 1.20	0.28 (0.16, 0.41)	<0.001
48 mo												
WHO-GS, postnatal age all	3609	4	0	1	-0.14 ± 1.08	-0.14 (-2.69, 2.42)	3214	-0.11 ± 1.07	395	-0.42 ± 1.11	0.31 (0.19, 0.42)	<0.001
WHO-GS, CA all	3609	4	0	1	-0.11 ± 1.08	-0.13 (-2.63, 2.43)	3214	-0.09 ± 1.07	395	-0.27 ± 1.11	0.18 (0.06, 0.29)	0.003

CA, gestational age-corrected age; CBP, children born preterm; GA, gestational age; IG-NS, INTERGROWTH-21st newborn size standards; IG-VPBR, INTERGROWTH 21st very preterm size at birth references; SD, standard deviation; TBC, term-born children; WHO-GS, World Health Organization child growth standards

[a] Child postnatal age during follow-up visits ranged from: 3 months (± 1 month); 12 months (± 2 months); 24 months (±2 months); 48 months (± 6 months)

[b] Length-for-age *z* scores <-6SD or >6SD were flagged as "biologically implausible" values by the World Health Organization child growth standards macro. These values were not excluded from summary estimates.

[c] P-values for difference in paired means at each visit estimated using paired sample t-test were p<0.001 at all follow-up visits.

[d] P-value for mean difference in length-for-age *z* scores among term versus preterm-born children was estimated using independent sample t-test with unequal variances.

[e] The WHO-GS could not be applied to two infants who had a corrected age of <0 at the 3-month visit and therefore were excluded from the 'WHO-GS, postnatal age all' strategy as well (inferences were unchanged when these two infants were included).

Table S2. Weight-for-age *z* scores at postnatal follow-up visits estimated using either postnatal age or gestational age-corrected age in the application of the World Health Organization growth child growth standards for all children.

Follow-up visit[a]	n	Excluded n		Flagged Obs[b]	Mean ± SD[c]	Median (1st, 99th)	Term-born children (≥37^{0/7} wk)		Preterm-born children (<37^{0/7} wk)		Mean difference in WAZ among term vs preterm-born	
		No data	Ineligible for analysis				n	Mean ± SD	n	Mean ± SD	Mean difference (95% CI)	*P* value[d]
3 mo[e]												
WHO-GS, postnatal age all	3855	8	2[f]	6	-0.50 ± 1.16	-0.40 (-3.97, 1.87)	3441	-0.38 ± 1.04	414	-1.56 ± 1.49	1.19 (1.04, 1.34)	<0.001
WHO-GS, CA all	3855	8	2[f]	0	-0.28 ± 1.08	0.24 (-3.23, 2.11)	3441	-0.28 ± 1.06	414	-0.29 ± 1.23	0.02 (-0.09, 0.13)	0.763
12 mo												
WHO-GS, postnatal age all	3779	25	0	1	-0.25 ± 1.23	-0.24 (-3.27, 2.61)	3368	-0.18 ± 1.20	411	-0.79 ± 1.35	0.61 (0.47, 0.74)	<0.001
WHO-GS, CA all	3779	25	0	1	-0.20 ± 1.22	-0.19 (-3.15, 2.72)	3368	-0.16 ± 1.21	411	-0.54 ± 1.32	0.38 (0.26, 0.51)	<0.001
24 mo												
WHO-GS, postnatal age all	3734	14	0	4	-0.11 ± 1.21	-0.13 (-3.06, 2.86)	3319	-0.06 ± 1.19	415	-0.57 ± 1.29	0.52 (0.39, 0.65)	<0.001
WHO-GS, CA all	3734	14	0	4	-0.08 ± 1.21	-0.10 (-2.98, 2.85)	3319	-0.04 ± 1.19	415	-0.41 ± 1.29	0.37 (0.25, 0.49)	<0.001
48 mo												
WHO-GS, postnatal age all	3612	1	0	11	0.43 ± 1.26	0.30 (-2.22, 4.21)	3216	0.47 ± 1.24	396	0.05 ± 1.28	0.42 (0.29, 0.55)	<0.001
WHO-GS, CA all	3612	1	0	13	0.44 ± 1.26	0.32 (-2.20, 4.25)	3216	0.48 ± 1.25	396	0.14 ± 1.29	0.34 (0.21, 0.47)	<0.001

CA, gestational age-corrected age; CBP, children born preterm; GA, gestational age; IG-NS, INTERGROWTH-21st newborn size standards; IG-VPBR, INTERGROWTH 21st very preterm size at birth references; SD, standard deviation; TBC, term-born children; WHO-GS, World Health Organization child growth standards

[a] Child postnatal age during follow-up visits ranged from: 3 months (± 1 month); 12 months (± 2 months); 24 months (±2 months); 48 months (± 6 months)

[b] Weight-for-age *z* scores <-6SD or >6SD were flagged as "biologically implausible" values by the World Health Organization child growth standards macro. These values were not excluded from summary estimates.

[c] P-values for difference in paired means at each visit estimated using paired sample t-test were p<0.001 at all follow-up visits.

[d] P-value for mean difference in length-for-age *z* scores among term versus preterm-born children was estimated using independent sample t-test with unequal variances.

[e] The WHO-GS could not be applied to two infants who had a corrected age of <0 at the 3-month visit and therefore were excluded from the 'WHO-GS, postnatal age all' strategy as well (inferences were unchanged when these two infants were included).

Table S3. Length/weight-for-age *z* scores at the 3-month visit estimated using postnatal age in the application of the World Health Organization child growth standards for all children (WHO-GS), or accounting for gestational age using the INTERGROWTH 21st postnatal standards for preterm born children in conjunction with WHO-GS for term-born children.

Anthropometric indices at 3 months	n	Mean (SD)[a]	Median (1st, 99th)	Term-born children (≥37[0/7] wks)		Preterm-born children (<37[0/7] wks)		*P* value[b]
				n	Mean ± SD	n	Mean ± SD	
Length-for-age z-score								
WHO-GS, postnatal age all	3861	-0.32 (1.24)	-0.24 (-4.11, 2.24)	3444	-0.17 (1.08)	417	-1.59 (1.63)	<0.001
IG-PPFS, postmenstrual age for CBP; WHO-GS postnatal age for TBC	3861	-0.11 (1.14)	-0.09 (-3.10, 2.45)	3444	-0.17 (1.08)	417	0.34 (1.43)	<0.001
Weight-for-age z-score								
WHO-GS, postnatal age all	3857	-0.51 (1.16)	-0.40 (-4.01, 1.87)	3441	-0.38 (1.04)	416	-1.58 (1.50)	<0.001
IG-PPFS, postmenstrual age for CBP; WHO-GS postnatal age for TBC	3857	-0.32 (1.08)	-0.27 (-3.29, 2.05)	3441	-0.38 (1.04)	416	0.16 (1.26)	<0.001

[a] P-value for difference in paired means (ref: WHO-GS, postnatal age all) estimated using paired t-test were p<0.001.
[b] P-value for mean difference among term versus preterm-born children using independent sample t-test with unequal variances.
CBP, children born preterm; IG-PPFS, INTERGROWTH 21st postnatal standards for preterm born children; SD, standard deviation; TBC, term-born children; WHO-GS, World Health Organization Child Growth Standards

Table S4. Prevalence, odds of stunting (length-for-age *z* score <-2) and underweight (weight-for-age *z* scores <-2) among preterm compared to term-born children, and the population attributable risk of stunting due to preterm birth, estimated using postnatal or postmenstrual age at 3 months in the 2004 Pelotas Birth Cohort.

Anthropometric indices at 3 months	n	Overall undernutrished[a]		Term-born children (≥37[0/7] wks)		Preterm-born children (<37[0/7] wks)		Odds of undernutrition among preterm vs term-born children	% PAR[c]
		n (%)	P value[b]	n	Undernourished n (%)	n	Undernourished n (%)	OR (95% CI)	
Length-for-age z-score									
WHO-GS, postnatal age all	3861	301 (7.80)	<0.001	3444	166 (4.82)	417	135 (32.4)	9.45 (7.31, 12.23)	38.2
IG-PPFS, postmenstrual age for CBP; WHO-GS postnatal age for TBC	3861	190 (4.92)		3444	166 (4.82)	417	24 (5.76)	1.21 (0.78, 1.87)	2.05
Weight-for-age z-score									
WHO-GS, postnatal age all	3857	361 (9.36)	<0.001	3441	220 (6.39)	416	141 (33.9)	7.51 (5.89, 9.59)	31.7
IG-PPFS, postmenstrual age for CBP; WHO-GS postnatal age for TBC	3857	240 (6.22)		3441	220 (6.39)	416	20 (4.81)	0.74 (0.47, 1.18)	-2.75

[a] Children with length-for-age z-scores <-2 SD (stunted) and/or weight-for-age z-scores <-2 SD (underweight) are collectively referred to as 'undernourished'.
[b] P-values from McNemar's test for difference in paired proportions (ref: WHO-GS, postnatal age all) were p<0.001.
[c] Proportion undernourished in the population due to preterm birth.
CA, gestational age-corrected age; CBP, children born preterm; CI, confidence interval; GA, gestational age; IG-NS, INTERGROWTH 21st newborn size standards; IG-PPFS, INTERGROWTH 21st postnatal standards for preterm born children; OR, odds ratio; PAR, population attributable risk; TBC, term-born children; WHO-GS, World Health Organization child growth standards

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Table S5. Prevalence, unadjusted odds of wasting (weight-for-length z score <-2) among children born preterm compared to term-born children using the World Health Organization child growth standards, and the population attributable risk of wasting due to preterm birth from birth to the 48-month follow-up visit in the 2004 Pelotas Birth Cohort.

Follow-up visit[a]	n	Overall wasted n (%)	Term-born children (≥37[0/7] wks)		Preterm-born children (<37[0/7] wks)		Odds of undernutrition among preterm vs term-born children		% PAR[b]
			n	Wasted n (%)	n	Wasted n (%)	OR (95% CI)	*P* value	
Birth	3764	44 (1.17)	3479	34 (0.98)	285	10 (3.51)	3.68 (1.80, 7.54)	<0.001	16.4
3 mo	3856	193 (5.01)	3441	165 (4.80)	415	28 (6.75)	1.44 (0.95, 2.17)	0.087	4.20
12 mo	3777	275 (7.28)	3366	228 (6.77)	411	47 (11.4)	1.78 (1.27, 2.48)	0.001	6.97
24 mo	3726	195 (5.23)	3312	159 (4.80)	414	36 (8.70)	1.89 (1.30, 2.75)	0.001	8.27
48 mo	3606	19 (0.53)	3211	12 (0.37)	395	7 (1.77)	4.81 (1.88, 12.29)	0.001	29.1

[a] Child postnatal age during follow-up visits ranged from: 3 months (± 1 month); 12 months (± 2 months); 24 months (±2 months); 48 months (± 6 months)
[b] Proportion of all wasting in the population that is attributable to preterm births.
CI, confidence interval; OR, odds ratio; PAR, population attributable risk.