Appendices – Supplemental material

Appendix A: Definition of explanatory variables used in regressions (Eq. 2)

Table S1. Definition of explanatory variables used in regressions, children 2 ≤ age ≤ 7 in 2002, but age ≤ 11 by 2010

Category	Variable definition	Variable name
I. Child:	Birth order	Pseudo birth order; 1 = youngest, 2 = next youngest, etc. Birth order determined by child's age in household, not by asking mother about the exact birth order of the child. This variable only includes children living in the household at the time of the survey
	Lagged weight	Weight of subject during previous year
	Age	Best estimate of child's age in whole years
	Male	Child's sex: 1 = male, 0 = female
	Dry-season birth	Subject was born during the dry season (May - July); 1 = yes, 0 = no
	Survival	Number of times child appears in the panel
II. Mother:	Baseline age	Best estimate of mother's age in whole years at baseline
	Schooling	Mother's maximum school grade attained
	Current height	Measured standing physical height of child's mother (cm)
	Current weight	Mother's weight in kg
III. Household	No. of children	Number of children in the household
	Current income	Natural log of household monetary income earned during the 2 weeks before the day of the interview. Income sources include money from sales and wage labor
	Current wealth	Natural log of the monetary value of sum of stock of domesticated animals + asset wealth in goods produced locally (e.g., canoes), and commercial goods owned by the entire household
	Forest clearance	Natural logarithm of old-growth and fallow forest cleared by the household during the year before the interview. Raw variable measured in *tareas* (10 *tareas* = 1 hectare). Proxies for annual household income
Community	Village fixed attributes	Full set of dummy variables for villages (n = 13 - 1 = 12)

Appendix B: Standing height and annual height increments during the panel study

Table S2. Pairwise correlations between heights during 2002 through 2010 for Tsimane' children $2 \leq \text{age} \leq 7$ at baseline (2002) but no more than 11 years old by 2010.

Age	2	3	4	5	6	7	8	9	10	11
2	1									
3	0.85	1								
4	0.79	0.81	1							
5	0.77	0.85	0.91	1						
6	0.74	0.78	0.88	0.89	1					
7	0.67	0.75	0.84	0.89	0.89	1				
8	0.40	0.58	0.72	0.77	0.83	0.88	1			
9	0.58	0.66	0.84	0.83	0.86	0.89	0.88	1		
10	0.62	0.60	0.70	0.79	0.76	0.78	0.79	0.88	1	
11	-	0.57	0.73	0.71	0.75	0.77	0.84	0.88	0.83	1

Notes: The results in the table show higher correlations between measurements at older ages and shorter measurement intervals, consistent with Cole (1997).

Table S3. Standing height and annual height increments in cm during 2002 - 2010 for Tsimane' children, 2 ≤ age ≤ 7 at baseline (2002) but no more than 11 years old by 2010

Age in 2002	Sex	Standing height in cm during: 2002 N	2002 M	2002 SD	2003 N	2003 M	2003 SD	2004 N	2004 M	2004 SD	2005 N	2005 M	2005 SD	2006 N	2006 M	2006 SD
2	Girls	37	80.8	4.3	26	86.9	3.6	30	93.4	3.9	31	99.5	3.7	29	106.1	3.3
	Boys	33	81.4	5.0	22	87.2	5.7	30	94.6	4.8	29	101.3	4.9	28	106.8	5.1
3	Girls	29	89.4	4.6	21	93.1	4.4	24	100.4	3.2	24	106.6	3.5	21	111.8	2.9
	Boys	34	89.0	5.6	28	93.6	5.3	23	100.7	5.6	24	105.9	4.6	23	111.9	6.1
4	Girls	29	95.4	5.6	21	100.5	5.6	25	105.0	6.2	25	111.4	5.3	25	115.8	6.8
	Boys	32	97.9	4.4	23	101.7	5.6	25	107.8	4.0	27	113.1	4.6	25	118.5	4.3
5	Girls	31	103.6	5.4	25	107.5	4.6	25	113.7	5.0	26	117.5	5.3	25	123.3	6.1
	Boys	25	103.7	6.0	22	107.4	5.2	24	112.4	4.9	23	117.2	5.2	23	122.3	4.7
6	Girls	48	112.5	8.2	38	115.8	7.8	39	120.3	6.1	40	126.9	7.1	39	133.9	7.8
	Boys	55	111.8	7.3	44	115.0	6.5	44	120.6	6.5	48	125.3	6.9	46	130.4	8.2
Total	Girls	174	97.5	13.3	131	102.4	12.3	143	107.5	11.3	146	113.4	11.4	139	119.6	12.0
	Boys	179	98.2	12.8	139	102.9	11.8	146	108.6	11.2	151	114.2	10.7	145	119.6	10.9

Notes: N = number of observations. M = mean; SD = standard deviation. Sample includes all children in the 13 villages of TAPS. Height measured following the protocol of Lohman et al. (1988), using a Seca 213 portable stadiometer. Blank cells means that the child's age >11. We found no significant differences ($p<0.05$) in average change in standing height among cohorts when adjusting for age and sex composition.

222 **Table S3**. Continued

Age in 2002	Sex	Standing height in cm during: 2007 N	2007 M	2007 SD	2008 N	2008 M	2008 SD	2009 N	2009 M	2009 SD	2010 N	2010 M	2010 SD	Average change in height, 2002 - 2010: Annual change in: cm M	cm SD	% M	% SD
2	Girls	28	112.2	3.1	27	117.8	4.4	22	122.7	4.8	24	129.4	6.3	5.9	0.6	5.7	0.5
	Boys	25	112.4	5.6	26	119.0	8.5	23	123.4	5.1	25	127.4	5.8	5.7	0.6	5.6	0.6
3	Girls	19	117.8	3.5	22	122.9	3.8	16	132.6	8.2	18	137.0	5.4	6.0	0.7	5.4	0.7
	Boys	24	117.0	4.6	21	120.9	4.9	21	126.5	4.6	22	132.1	6.3	5.3	0.5	4.8	0.5
4	Girls	20	121.7	8.0	21	128.4	9.1	20	134.6	9.6				5.6	0.7	4.9	0.5
	Boys	23	123.8	4.8	22	128.9	4.8	17	133.3	4.8				5.2	0.5	4.5	0.4
5	Girls	22	130.0	6.7	21	135.8	6.8							5.5	0.6	4.6	0.5
	Boys	21	127.5	4.7	21	132.8	5.0							4.9	0.6	4.2	0.6
6	Girls	12	136.6	7.0										5.8	1.0	4.7	0.7
	Boys	22	132.4	6.0										4.6	0.8	3.7	0.7
Total	Girls	101	121.9	10.1	91	125.7	9.2	58	129.5	9.3	42	132.7	7.0	5.8	0.8	5.0	0.7
	Boys	115	122.2	8.9	90	125.1	8.3	61	127.2	6.3	47	129.6	6.4	5.0	0.7	4.4	0.9

223 **Notes**: N = number of observations. M = mean; SD = standard deviation. Sample includes all children in the 13 villages of TAPS. Height
224 measured following the protocol of Lohman et al. (1988) , using a Seca 213 portable stadiometer. Blank cells means that the child's age >11. We
225 estimated the average change in height within individuals and present the mean and SD for each age group. We found no significant differences
226 ($p<0.05$) in average change in standing height among cohorts when adjusting for age and sex composition.

Appendix C: Linear growth and height deficits from WHO reference growth tables for selected middle-income countries and the Tsimane'.

Table S4. Measurements of linear growth, in cm and HAZ, and height deficits from WHO reference growth tables at 2 and 4 years of age for middle-income countries from the Consortium of Health-orientated Research in Transitioning Societies (COHORTS) and the Tsimane'

	Brazil	Guatemala	India	South Africa	Tsimane'
Two years of age					
Height (cm)	84.6 ± 3.8	78.1 ± 3.0	80.6 ± 3.5	83.2 ± 3.2	81.1 ± 4.6
HAZ	-0.6 ± 1.2	-2.9 ± 0.9	-1.9 ± 1.1	-1.2 ± 1.0	-2.4 ± 1.4
Height deficit from WHO standards (cm)*	-1.5 ± 3.7	-8.9 ± 2.9	-6.6 ± 3.4	-3.8 ± 3.1	-5.3 ± 4.6
Four years of age					
Height (cm)	100.0 ± 4.7	93.4 ± 3.7	94.9 ± 4.1	99.0 ± 4.0	94.8 ± 5.0
HAZ	-0.6 ± 1.1	-2.4 ± 0.9	-1.9 ± 1.0	-0.9 ± 0.9	-2.1 ± 1.1
Height deficit from WHO standards (cm)	-2.2 ± 4.5	-9.6 ± 3.6	-8.1 ± 4.1	-3.6 ± 3.9	-7.2 ± 5.1

Notes: HAZ denotes height-for-age z score. Values shown in the table correspond to mean ± standard deviations. Data for Brazil, Guatemala, India, and South Africa correspond to the COHORT study; data were obtained from Lundeen et al. (2014b), Table 1. We excluded the Philippines from the comparison because of missing data for 4 years of age. * Deficit corresponds to the difference with the 50th percentile for age- and sex-specific height. The number shown corresponds to the mean and standard deviation of the difference between each individual and the WHO standard.

Appendix D: Mean HAZ and annual change in HAZ during the panel study

Table S5. Mean height-for-age z score (HAZ) and annual change in HAZ during 2002 - 2010 for Tsimane' children, 2 ≤ age ≤ 7 at baseline but no more than age 11 by 2010, measured annually during 2002 - 2010: Stunted (HAZ < -2) and non-stunted (HAZ ≥ -2) children compared

		Mean height-for-age z score (HAZ) during:														
		2002			2003			2004			2005			2006		
Age in 2002	Sex	T	S	NS	T	S	NS	T	S	NS	T	S	NS	T	S	NS
2	Girls	-2.3	-3.0	-1.0	-2.2	-2.7	-1.5	-2.2	-2.6	-1.5	-2.1	-2.4	-1.6	-1.8	-2.1	-1.5
	Boys	-2.5	-3.4	-0.9	-2.5	-3.2	-1.2	-2.1	-2.5	-1.2	-1.8	-2.3	-1.1	-1.9	-2.3	-1.2
3	Girls	-2.0	-3.1	-1.1	-2.2	-2.9	-1.5	-1.8	-2.3	-1.4	-1.6	-2.0	-1.3	-1.7	-2.0	-1.4
	Boys	-2.4	-3.4	-0.9	-2.3	-3.0	-1.4	-2.0	-2.7	-1.1	-2.0	-2.5	-1.3	-1.9	-2.5	-1.0
4	Girls	-2.1	-2.8	-1.0	-1.9	-2.5	-0.8	-2.0	-2.6	-1.0	-1.7	-2.2	-1.0	-1.9	-2.6	-0.9
	Boys	-1.8	-2.9	-1.2	-1.9	-3.1	-1.2	-1.8	-2.5	-1.3	-1.7	-2.4	-1.3	-1.6	-2.3	-1.3
5	Girls	-1.4	-2.6	-0.8	-1.4	-2.3	-1.0	-1.3	-2.1	-0.9	-1.5	-2.3	-1.0	-1.5	-2.3	-0.9
	Boys	-1.6	-2.8	-0.7	-1.8	-2.6	-1.0	-1.8	-2.6	-1.1	-1.8	-2.6	-1.1	-1.8	-2.4	-1.2
6	Girls	-1.5	-2.7	-0.8	-1.6	-2.6	-1.0	-1.8	-2.7	-1.3	-1.6	-2.7	-1.1	-1.5	-2.5	-0.9
	Boys	-1.6	-3.0	-0.9	-1.8	-2.7	-1.3	-1.6	-2.8	-1.2	-1.7	-2.8	-1.2	-1.6	-2.7	-1.2
Total	Girls	-1.8	-2.9	-0.9	-1.8	-2.6	-1.1	-1.8	-2.5	-1.2	-1.7	-2.3	-1.2	-1.7	-2.3	-1.1
	Boys	-2.0	-3.2	-0.9	-2.0	-2.9	-1.2	-1.8	-2.6	-1.2	-1.8	-2.5	-1.2	-1.7	-2.4	-1.2

Notes: T = total; S = stunted (HAZ < -2 SD); NS = not stunted (HAZ ≥ -2 SD).

Table S5. Continued

Age in 2002	Sex	Mean height-for-age z score (HAZ) during: 2007 T	2007 S	2007 NS	2008 T	2008 S	2008 NS	2009 T	2009 S	2009 NS	2010 T	2010 S	2010 NS	Change in mean HAZ, 2002-2010 End-line – 2002 T	End-line – 2002 S	End-line – 2002 NS	% stunted at baseline, but not at end-line
2	Girls	-1.7	-1.9	-1.4	-1.6	-1.7	-1.4	-1.7	-1.9	-1.4	-1.6	-1.9	-1.1	0.7	1.1	-0.1	75
	Boys	-1.8	-2.2	-1.1	-1.5	-1.7	-1.1	-1.5	-1.7	-1.1	-1.7	-2.0	-1.0	0.9	1.4	-0.1	77
3	Girls	-1.6	-2.0	-1.3	-1.6	-2.0	-1.3	-1.0	-1.7	-0.4	-1.3	-1.7	-0.9	0.7	1.4	0.2	69
	Boys	-1.9	-2.3	-1.3	-2.0	-2.3	-1.5	-1.8	-2.1	-1.3	-1.7	-2.1	-1.1	0.7	1.2	-0.2	70
4	Girls	-1.9	-2.5	-0.9	-1.7	-2.5	-0.7	-1.6	-2.3	-0.6				0.5	0.5	0.4	59
	Boys	-1.6	-2.3	-1.1	-1.5	-2.1	-1.1	-1.6	-2.0	-1.3				0.2	0.9	-0.2	73
5	Girls	-1.5	-2.1	-0.8	-1.3	-2.1	-0.8							0.0	0.5	0.0	30
	Boys	-1.7	-2.3	-1.2	-1.6	-2.2	-1.0							0.0	0.6	-0.3	36
6	Girls	-1.4	-2.5	-0.6										0.1	0.2	0.1	24
	Boys	-1.8	-2.7	-1.2										-0.1	0.3	-0.3	42
Total	Girls	-1.6	-2.2	-1.0	-1.6	-2.0	-1.0	-1.5	-2.0	-0.7	-1.4	-1.8	-1.0	0.4	1.0	-0.1	54
	Boys	-1.7	-2.3	-1.2	-1.6	-2.0	-1.2	-1.6	-1.9	-1.3	-1.7	-2.0	-1.1	0.3	1.1	-0.1	61

Notes: T = total; S = stunted (HAZ < -2 SD); NS = not stunted (HAZ ≥ -2 SD).

Appendix E: Comparison of annual growth rates in the three height categories, stunted, marginally-stunted, and not-stunted

To compare the annual growth rates of children in the three height categories, we ran one regression with two dummy variables, one for stunted children and one for marginally-stunted children, using not-stunted children as the excluded category while controlling for all the variables indicated in Table 1. These results are shown in Table X, below. We found that stunted children grew by 0.03 cm/year less or 0.16 HAZ units/year more than not-stunted children, while marginally-stunted children grew by 0.13 cm/year less or 0.07 HAZ units/year more than not-stunted children; except for the growth of stunted children expressed as changes in HAZ, none of the other results were statistically significant at the 5% level or lower. Columns A2 and B2 suggest that, on average, stunted children were 11.5 cm or 1.6 HAZ units shorter than not-stunted children, and that marginally-stunted children were 5.4 cm or 0.8 HAZ units shorter than not-stunted children, with all results significant at the 1% level.

Table S6. OLS regression results for height growth rates during 2002 - 2010 in relation to baseline (2002) stunting among Tsimane' children $2 \leq$ age ≤ 7 at baseline but no more than 11 years old by 2010.

Explanatory variables	Dependent variable is standing height in 2010 or at age 11 when exiting the panel; height expressed in:			
	[A] Centimeters (cm)		[B] HAZ	
I. Baseline stunting	[1] Change cm/year	[2] Height at the end of the study	[1] Change HAZ/year	[2] HAZ at the end of the study
Stunted	-0.03 (0.26)	-11.54 (0.32)**	0.16 (0.05)**	-1.62 (0.05)**
Marginally- stunted	-0.13 (0.27)	-5.42 (0.34)**	0.07 (0.05)	-0.82 (0.05)**
II. Child				
Age	0.03 (0.04)	0.19 (0.05)**	0.004 (0.01)	-0.01 (0.01)*
Male	-0.78 (0.15)**	-3.24 (0.26)**	-0.05 (0.03)	-0.29 (0.03)**
Survival	0.04 (0.06)	-0.57 (0.12)**	-0.002 (0.01)	-0.07 (0.02)**
III. Constant	4.88 (0.94)**	147.55 (1.27)**	-0.15 (0.20)	0.63 (0.18)**
R^2	0.02	0.49	0.02	0.50
N	1,619	1,728	1,619	1,728

Notes: For definition of variables see Appendix E. OLS regressions include a child's age, sex, and survival (number of times the child was measured in the panel), village fixed effects, constant, and robust standard errors. * and ** significant at < 5% and < 1%.

Appendix F: Changes in height category among Tsimane' children at baseline and end-line

Table S7. Changes in height category among Tsimane' children 2 ≤ age ≤ 7 at baseline (2002) and end-line (2010) or age 11, whichever came first

Height at the end of the study:	Baseline height			Total
	Not-stunted	Marginally-stunted	Stunted	
Not-stunted	39	28	9	76
Marginally-stunted	11	50	39	100
Stunted	0	9	68	77
Total	50	87	116	253

Notes: Kendall's tau-b = 0.6 and ASE (asymptotic standard error) = 0.03. Children who dropped out of the panel before reaching age 11 are excluded.