High-frequency repeated measures of over 5,000 infants aged 6-27 months reveals pattern of growth faltering in rural Burkina Faso

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OBJECTIVE

- To test whether low attained height is due to episodes of faltering and interrupted growth trajectories, as opposed to continuously slower growth every month, among at-risk children in rural Burkina Faso.

METHODS

- We collected monthly length data from 5,039 children aged 6-27 months during a food aid trial from August 2014 to December 2016.
- We estimated the smoothness of each child's growth along their own individual trajectory using the R^2 of a spline regression of length on age.
- We examined the significance of smoothness for attained height by regressing height at 27 months on the R^2 of each child's trajectory, then adding in growth curve parameters of child's initial length and velocity in each age range up to 27 months.

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RESULTS

Fig 1. (A) Length (cm) and (B) Length velocity (cm/month) by age among children from selected centiles of attained length. Children who end short start shorter and grow slower

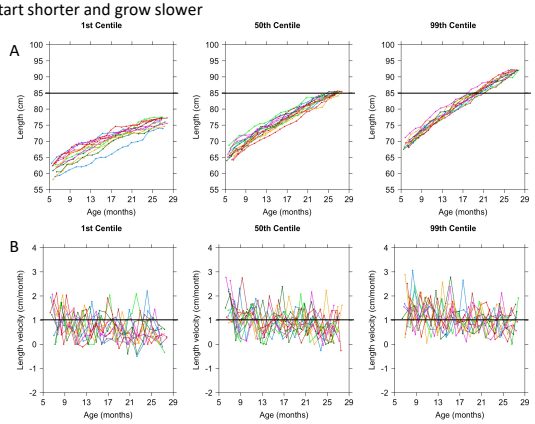

Fig 2. A) Length-for-age z-scores and (B) Length-for-age difference by age among children from selected centiles of attained length. Children experience both episodic and continuous faltering below the height-for-age of a healthy population

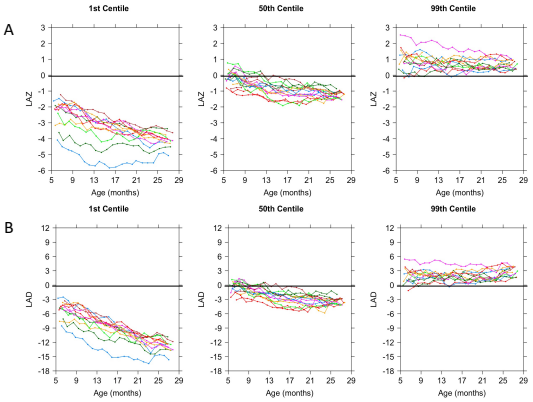

Fig 3. Distribution of lengths at 6, 12, 18 and 24 months for children in each quintile of attained height at 27 months (Q1 lowest, Q5 highest). Most sample children experience growth faltering by 24 months of age

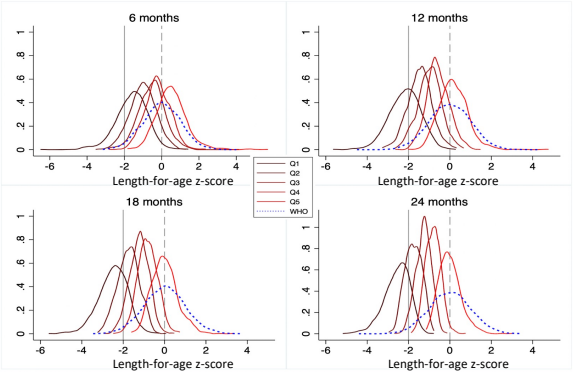

Table 1. Contribution of uninterrupted growth and age-specific velocities to attained height of children at 28 months. Attained height is associated with smoother growth as well as growth velocity at each age group, especially 9-11 months

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
R^2 (Smoothness)	3·104***	3·370***	3·300***	2·656***	2·092***	1·735***	1·168***	0·567***	0·412***
	(2·796, 3·411)	*(3·113, 3·628)*	*(3·058, 3·543)*	*(2·473, 2·839)*	*(1·938, 2·246)*	*(1·584, 1·886)*	*(1·025, 1·311)*	*(0·442, 0·692)*	*(0·295, 0·529)*
Initial length		0·610***	0·671***	0·946***	0·979***	0·957***	0·943***	0·956***	0·958***
		(0·584, 0·636)	*(0·646, 0·696)*	*(0·926, 0·967)*	*(0·962, 0·996)*	*(0·941, 0·974)*	*(0·928, 0·958)*	*(0·943, 0·969)*	*(0·946, 0·970)*
Velocity 6-8 months			2·260***	3·706***	3·677***	3·590***	3·473***	3·441***	3·433***
			(2·085, 2·435)	*(3·567, 3·845)*	*(3·561, 3·792)*	*(3·479, 3·701)*	*(3·371, 3·575)*	*(3·354, 3·529)*	*(3·352, 3·514)*
Velocity 9-11 months				6·296***	7·180***	7·015***	6·841***	6·755***	6·713***
				(6·098, 6·493)	*(7·011, 7·348)*	*(6·853, 7·177)*	*(6·693, 6·990)*	*(6·627, 6·882)*	*(6·595, 6·831)*
Velocity 12-14 months					3·860***	4·153***	4·062***	3·938***	3·906***
					(3·700, 4·020)	*(3·997, 4·308)*	*(3·919, 4·204)*	*(3·816, 4·060)*	*(3·792, 4·019)*
Velocity 15-17 months						1·760***	2·262***	2·213***	2·203***
						(1·600, 1·920)	*(2·112, 2·412)*	*(2·084, 2·341)*	*(2·084, 2·322)*
Velocity 18-20 months							2·383***	2·910***	2·900***
							(2·234, 2·533)	*(2·780, 3·041)*	*(2·779, 3·021)*
Velocity 21-23 months								2·786***	3·056***
								(2·658, 2·914)	*(2·936, 3·176)*
Velocity 24-28 months									0·852***
									(0·793, 0·911)
R-squared	0·072	0·350	0·423	0·675	0·775	0·794	0·828	0·873	0·891

95% Confidence Interval in parentheses
*** p<0·01, ** p<0·05, * p<0·1
Sensitivity analyses using alternative functional forms for the individual regression models (linear polynomial model with cubic term for age, restricted cubic splines, linear splines with four knots) give a range of 2·44-2·83 for R^2, when attained length is regressed on R^2, with 95% confidence intervals spanning 2·39-3·09. N=5,039 in each model.

CONCLUSIONS

- Growth faltering manifests as both episodes of interrupted growth and also continuously lower growth velocity.
- Attained height at 27 months is most sensitive to velocity in the 9–11 month period, but initial length at 6 months and velocity in all periods are significant, as is the smoothness of growth from month to month.
- Low attained height in this setting is only partly due to episodic growth; as such intervention must target underlying conditions that reduce growth velocity continuously in every month.