SUPPLEMENTAL MATERIAL

We applied the Newton's Growth Models (NGMs), an extension of a semi-parametric stochastic velocity model (Zhu et al. 2011), to jointly model each infant's BMI growth trajectory, in conjunction with his/her BMI velocity (rate of change in BMI) and acceleration (speeding up or slowing down of BMI growth). Together, these three aspects of growth represent the components of Newton's Law of Motion, which govern physical properties, but may also be relevant to growth and development.

NGMs are described by each of the following equations, for each infant (*i*):

(1) Growth trajectory: $\mathrm{Y_i}(t) = U_i(t) + \epsilon_i(t)$;

(2) Growth velocity: $dU_i(t) = V_i(t)dt$;

(3) Growth acceleration: $dV_i(t) = -\rho_i(V_i(t) - \bar{v}_i)dt + \sigma_\xi dW_i(t)$,

Equation (1) describes a continuous smooth mean BMI trajectory $U_i(t)$ sampled at time *t* to obtain observed BMI $\mathrm{Y_i}(t)$, with normally-distributed measurement error $\epsilon_\mathrm{i}(t)$. Equation (2) is the velocity function $V_i(t)$ of the mean BMI trajectory. Equation (3), in turn, presents the model for BMI growth acceleration, which regularizes mean velocity ($dV_i(t)$) through the Ornstein-Uhlenbeck (OU) process. Within this equation, the rate parameter $\rho_i(> 0)$ describes the speed at which an equilibrium is achieved (e.g., the infancy BMI peak); $\bar{v}_i$ represents the child's long-term velocity trajectory (i.e., the child's BMI growth velocity across the entire birth-to-36-month observation period); and $W_i(t)$ represents the standard Wiener process with instantaneous variance σ_ξ^2 to capture short-term variability in BMI growth velocity observed between study visits.

To improve estimation of the BMI trajectory, we incorporated sex-specific World Health Organization (WHO) Multi-Center Growth Reference Study data (de Onis M et al. 2004) as a

prior probability distribution for Bayesian inference. Specifically, WHO data were used to inform the shape of the BMI trajectory $U_i(t)$, which was then used to derive the velocity $V_i(t)$ and acceleration $dV_i(t)$ trajectories. When specifying the prior initial distribution of ($U_i(t)$, $V_i(t)$), we performed extensive sensitivity analyses to increase power and minimize estimation bias. We then jointly modeled BMI trajectory, velocity, and acceleration to estimate age at the infancy BMI peak. Specifically, we defined age at BMI peak as the age at which a child's BMI velocity (which is essentially the derivative of the BMI trajectory) equals 0, *and* when acceleration switches from increasing to decreasing mode. Joint modeling of all three components of growth provides greater accuracy in identifying the infancy BMI peak than use of one or two of these components. For example, although the BMI peak is an inflection point that occurs when velocity = 0, this point could be a valley if acceleration switched from negative to positive mode, rather than positive to negative mode. Additionally, inclusion of the stochastic components of the acceleration trajectory – i.e., the long-term and short-term fluctuations to BMI growth velocity – enhance model flexibility by allowing for deviations from the population average curves, and improve realism of the models given that child growth is not a consistent, linear process.

We used the fitted BMI trajectories to estimate age at the BMI peak, and the magnitude of peak as the actual BMI at peak. These variables were subsequently evaluated as the independent variable in multivariable analyses.

Supplemental Table 1 Associations of mutually-adjusted age at BMI peak and peak BMI with adiposity and cardiometabolic risk during peripuberty (8-14 years) among 163 ELEMENT participants after adjustment for pubertal status.

	β (95% CI) in peripubertal outcomes[a]	
	per 1 mo age at BMI peak	**per 1 kg/m^2 of peak BMI**
Anthropometry		
BMI z-score[b]	**0.04 (0.02, 0.07)**	**0.31 (0.16, 0.47)**
Height z-score[b]	0.02 (-0.00, 0.04)	-0.04 (-0.17, 0.08)
Waist circumference (cm)	**0.34 (0.12, 0.56)**	**1.40 (0.13, 2.67)**
SS+TR (mm)	**0.40 (0.14, 0.66)**	1.49 (-0.03, 3.02)
Cardiometabolic biomarkers		
Fasting glucose (mg/dL)	**0.25 (0.04, 0.46)**	0.33 (-0.90, 1.57)
C-peptide (ng/mL)	**0.05 (0.02, 0.08)**	**0.05 (0.02, 0.08)**
CP-IR[c]	**0.01 (0.01, 0.02)**	0.04 (-0.01, 0.09)
Leptin (ng/mL)	**0.27 (0.09, 0.45)**	0.67 (-0.37, 1.71)
Total cholesterol (mg/dL)	0.28 (-0.33, 0.90)	0.84 (-2.74, 4.41)
HDL cholesterol (mg/dL)	-0.15 (-0.45, 0.16)	-0.76 (-2.54, 1.03)
LDL cholesterol (mg/dL)	0.22 (-0.29, 0.74)	1.72 (-1.27, 4.70)
Triglycerides (mg/dL)	1.05 (-0.06, 2.16)	-0.63 (-7.06, 5.81)
SBP (mmHg)	**0.36 (0.12, 0.60)**	0.68 (-0.69, 2.05)
DBP (mmHg)	0.13 (-0.04, 0.30)	0.54 (-0.44, 1.52)
MetRisk z-score[d]	**0.03 (0.02, 0.05)**	0.06 (-0.02, 0.15)

a Estimates are weighted for the number of anthropometric measurements during infancy, and adjusted for maternal calcium supplementation and age at enrollment; and child's sex, birthweight, age at the peripubertal visit, the other infant growth milestone, and pubertal status.

b According to the WHO growth reference for children 5-19 years.

c Calculated as [fasting serum C-peptide x fasting serum glucose]/405.

d Calculated as the average of 5 internally-standardized z-scores for waist circumference, fasting glucose, C-peptide, triglycerides/HDL-C ratio, and the average of SBP and DBP.