

Flattening the (BMI) Curve: Timing of Child Obesity Onset and Cardiovascular Risk

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The worldwide prevalence and severity of childhood obesity has steadily risen over the last 50 years.¹ Although there have been some indicators of recent stabilization,² it has been suggested that we have simply reached our upper genetic limit.³ Whether this is true, the current prevalence is shockingly high; one-third of children aged 2 to 19 have a BMI >85th percentile, and 18.5% have a BMI >95th percentile,⁴ consequently affecting 13.7 million children in the United States and 340 million children worldwide.

It makes intuitive sense that childhood obesity is a serious health problem. However, at exactly what age obesity begins to predict future disease has proven an elusive question. The evidence is clear that (1) child obesity predicts adult obesity,⁵ (2) adult obesity predicts cardiometabolic disease and early mortality,⁶ and (3) obesity in late adolescence predicts early mortality, the majority of which is related to cardiovascular disease.⁷ But is obesity something to be concerned about in a 3-year-old?

Researchers in previous studies have demonstrated that single time-point measures of early obesity poorly predict adult outcomes. For example, in a 2016 meta-analysis of 37 studies that included child BMI data and adult endpoints, it was shown that although the association between high childhood BMI and adult disease was significant, only 31% of adults with diabetes and 22% with hypertension diagnoses were overweight as children.⁸ Researchers of

a 2012 systematic review of 39 studies found that the association between child BMI and adult outcomes was attenuated when adult BMI was considered.⁹ The inevitable conclusion is that child BMI is important through its impact on adult BMI rather than directly worsening health.

When repeatedly measured over time, however, other more-concerning patterns emerge. Geserick et al¹⁰ managed a cohort ($n = 51\,505$) from birth through age 18 and showed that 50% of adolescents with obesity had developed it by age 5; 90% of children who had obesity by age 3 remained obese at age 18. The Project Viva cohort demonstrated that BMI acceleration after age 1 predicts excess adiposity by age 6 to 10.¹¹ Smego et al¹² showed that obesity by age 4 to 6 months predicted obesity by age 6. Although these show the persistence of obesity, what they mean for later disease has been more difficult to study.

In this issue of *Pediatrics*, Lycett et al¹³ evaluate 5107 Australian children at repeated time points from infancy examining BMI and cardiometabolic markers up to age 11 to 12, with 1811 children retained throughout the time period. The growth data fell into 4 relatively distinct BMI trajectories: always low, always normal, always high, and normal to high. This important and comprehensive study has 2 important implications: first, high BMI by age 2 to 3 tends to stay high, and second, normal BMI occasionally increases to high BMI, but the reverse is rarely true.

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Simply put, infants and toddlers with obesity are unlikely to “grow out of it.”

The question remains, “is this a problem?” Lycett et al¹³ attempted to answer this question by collecting a cardiovascular risk assessment using metabolic syndrome, carotid-femoral pulse wave velocity, and carotid intima-media thickness at age 11 to 12. They found that obesity by age 3 and being overweight by age 6 predicted metabolic syndrome at age 11. Obesity by age 6 predicted subclinical atherosclerotic changes by age 11. Most strikingly, obesity that started at 3 and persisted appeared to accumulate risk over these early years of life, and those children demonstrated significant and detectable markers of silent atherosclerotic disease by 11 years of age. An important caveat is that although the relationships were significant, the amount of variance attributable directly to child BMI was small. Even small impacts are important on a population level, but this highlights the complexity of the relationship between obesity and health.

In this study, it is definitively established that obesity by age 3 is predictive of future obesity up to early adolescence, and evidence is added that risk for cardiovascular disease accumulates the earlier children develop their obesity. The point cannot be understated: early-onset obesity is unlikely to change and, if it persists, will lead to detectable precursors of atherosclerosis by the time a child enters middle school.

Parents¹⁴ and primary care physicians¹⁵ are less likely to

perceive obesity as a concern in younger children. Measuring and defining obesity in children <2 years of age is challenging. However, current predictions reveal that if we continue current patterns of watchful waiting, 57.3% of today’s children will have obesity by age 35.¹⁶

Our best chance to “flatten the curve” of cardiovascular disease may be to slow down BMI increases early in life, delaying (or preventing) the onset of obesity as long as possible to minimize accumulation of risk.

REFERENCES

1. Hales CM, Carroll MD, Fryar CD, Ogden CL. Prevalence of obesity among adults and youth: United States, 2015-2016. *NCHS Data Brief*. 2017;(288):1–8
2. Olds T, Maher C, Zumin S, et al. Evidence that the prevalence of childhood overweight is plateauing: data from nine countries. *Int J Pediatr Obes*. 2011; 6(5–6):342–360
3. Genné-Bacon EA. Thinking evolutionarily about obesity. *Yale J Biol Med*. 2014; 87(2):99–112
4. Skinner AC, Ravanbakht SN, Skelton JA, Perrin EM, Armstrong SC. Prevalence of obesity and severe obesity in US children, 1999-2016. *Pediatrics*. 2018; 141(3):e20173459
5. Simmonds M, Llewellyn A, Owen CG, Woolacott N. Predicting adult obesity from childhood obesity: a systematic review and meta-analysis. *Obes Rev*. 2016;17(2):95–107
6. Di Angelantonio E, Bhupathiraju SN, Wormser D, et al; Global BMI Mortality Collaboration. Body-mass index and all-cause mortality: individual-participant-data meta-analysis of 239 prospective studies in four continents. *Lancet*. 2016; 388(10046):776–786
7. Twig G, Yaniv G, Levine H, et al. Body-mass index in 2.3 million adolescents and cardiovascular death in adulthood. *N Engl J Med*. 2016;374(25):2430–2440
8. Llewellyn A, Simmonds M, Owen CG, Woolacott N. Childhood obesity as a predictor of morbidity in adulthood: a systematic review and meta-analysis. *Obes Rev*. 2016;17(1):56–67
9. Park MH, Falconer C, Viner RM, Kinra S. The impact of childhood obesity on morbidity and mortality in adulthood: a systematic review. *Obes Rev*. 2012; 13(11):985–1000
10. Geserick M, Vogel M, Gausche R, et al. Acceleration of BMI in early childhood and risk of sustained obesity. *N Engl J Med*. 2018;379(14):1303–1312
11. Perng W, Hajj H, Belfort MB, et al. Birth size, early life weight gain, and midchildhood cardiometabolic health. *J Pediatr*. 2016;173:122–130.e1
12. Smego A, Woo JG, Klein J, et al. High body mass index in infancy may predict severe obesity in early childhood. *J Pediatr*. 2017;183:87–93.e1
13. Lycett K, Juonala M, Magnussen C, et al. Body mass index from early to late childhood and cardiometabolic measurements at 11 to 12 years. *Pediatrics*. 2020;146(2):e20193666
14. Pesch MH, Meixner KA, Appugliese DP, Rosenblum KL, Miller AL, Lumeng JC. The evolution of mothers’ beliefs about overweight and obesity in their early school-age children. *Acad Pediatr*. 2016; 16(6):565–570
15. Turer CB, Barlow SE, Sarwer DB, et al. Association of clinician behaviors and weight change in school-aged children. *Am J Prev Med*. 2019;57(3):384–393
16. Ward ZJ, Long MW, Resch SC, Giles CM, Cradock AL, Gortmaker SL. Simulation of growth trajectories of childhood obesity into adulthood. *N Engl J Med*. 2017;377(22):2145–2153

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