



Addressing Cardiometabolic Risk in Children and Adolescents: CHALLENGES AND SOLUTIONS

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The Big Picture of Obesity and Metabolic Syndrome in the Pediatric Population

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Objectives

- Describe obesity and metabolic syndrome in children and adolescents.
- Define the prevalence of childhood obesity and metabolic syndrome.
- Define the burden of childhood obesity and metabolic syndrome.

Childhood and Adult Obesity Definitions

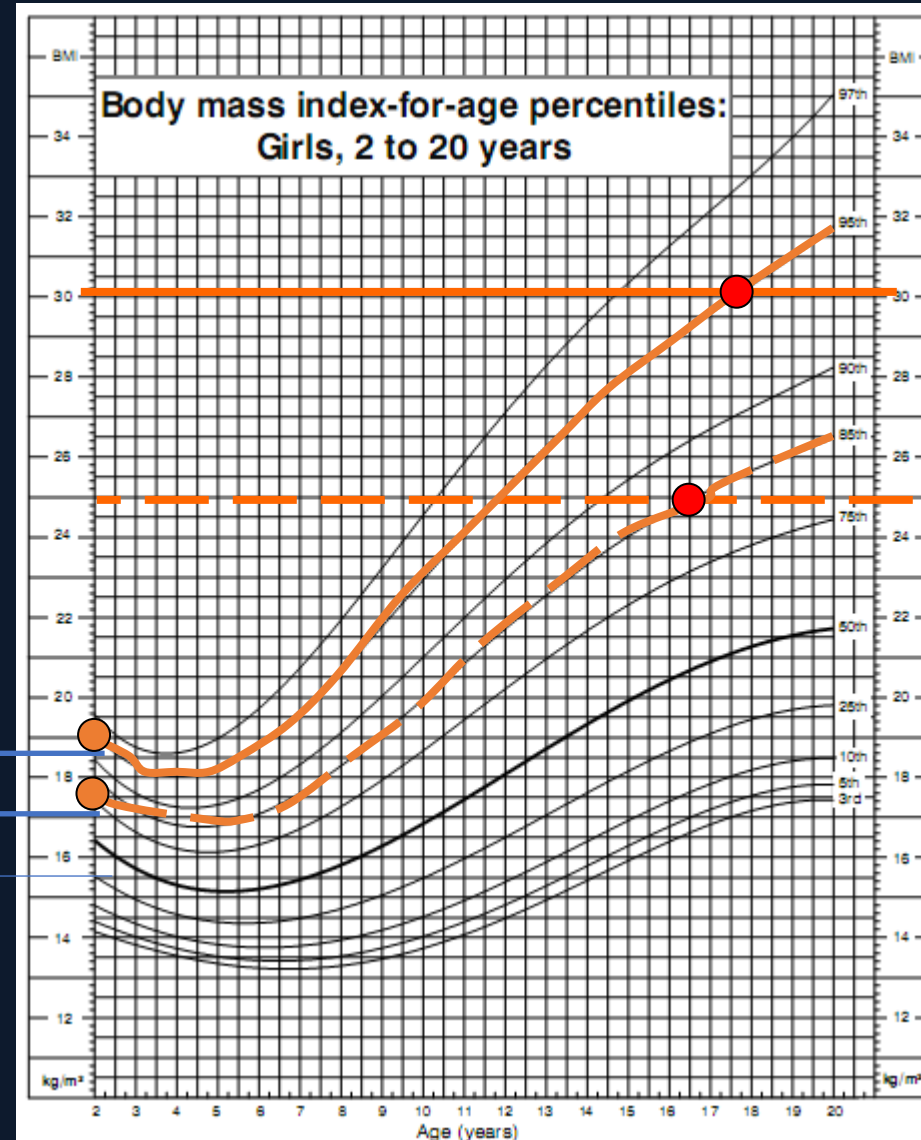
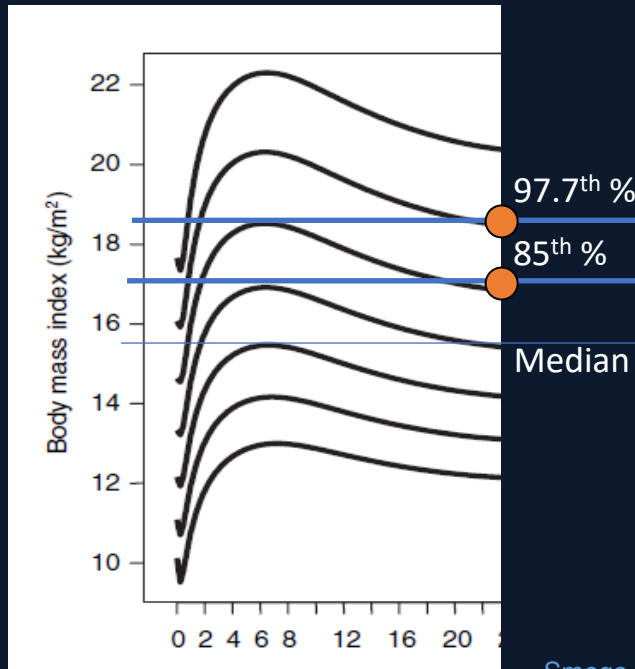
CDC growth chart

Body Mass Index (BMI) is calculated as weight (kg)/height (m)²

- Strongly but not perfectly related to “adiposity” or amount of fat tissue
- In children—age and sex percentiles

Obesity in children <2 remains undefined, but thresholds have been suggested at the 85th percentile (1.04 SD) and 95th or 97.7th percentiles (2 SD)

WHO growth chart



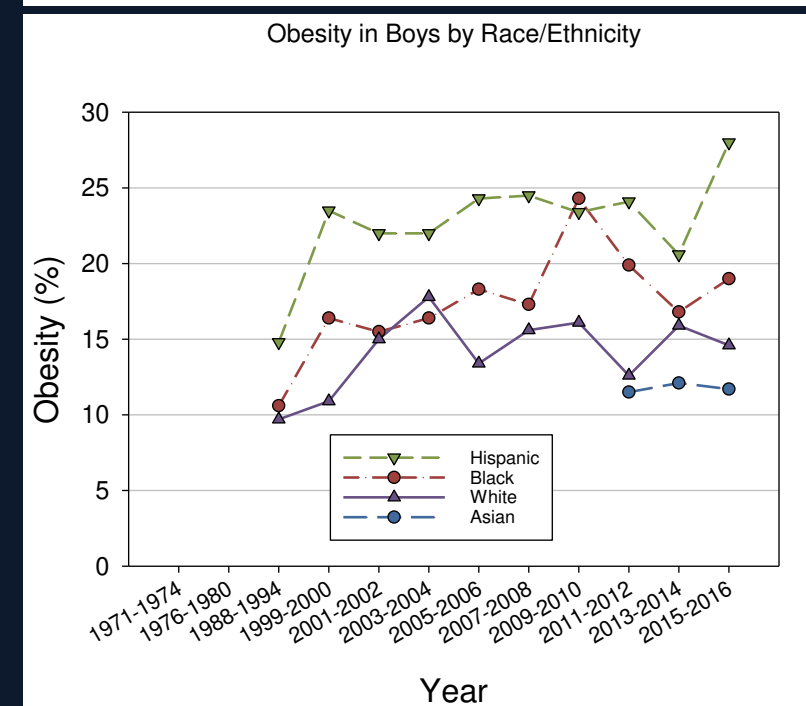
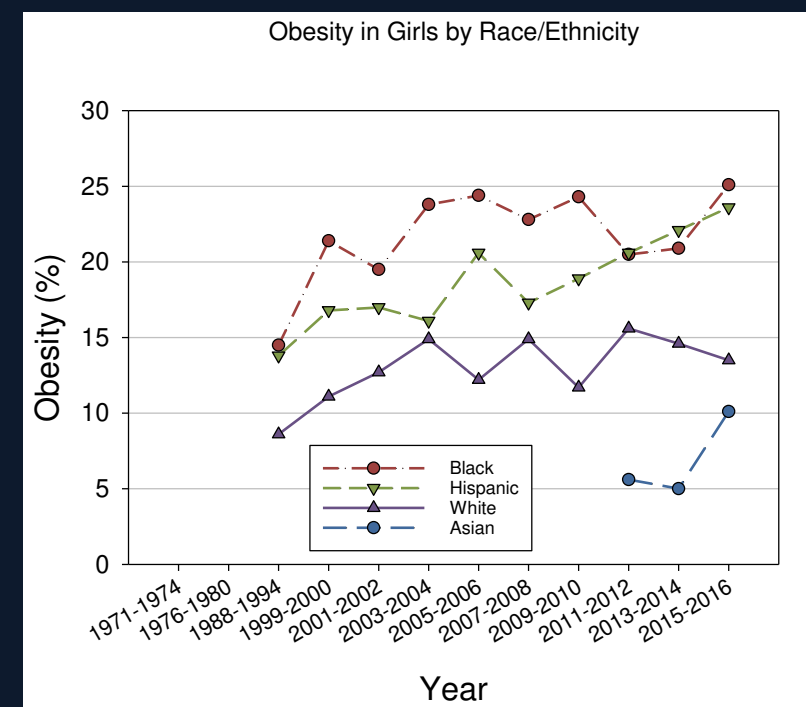
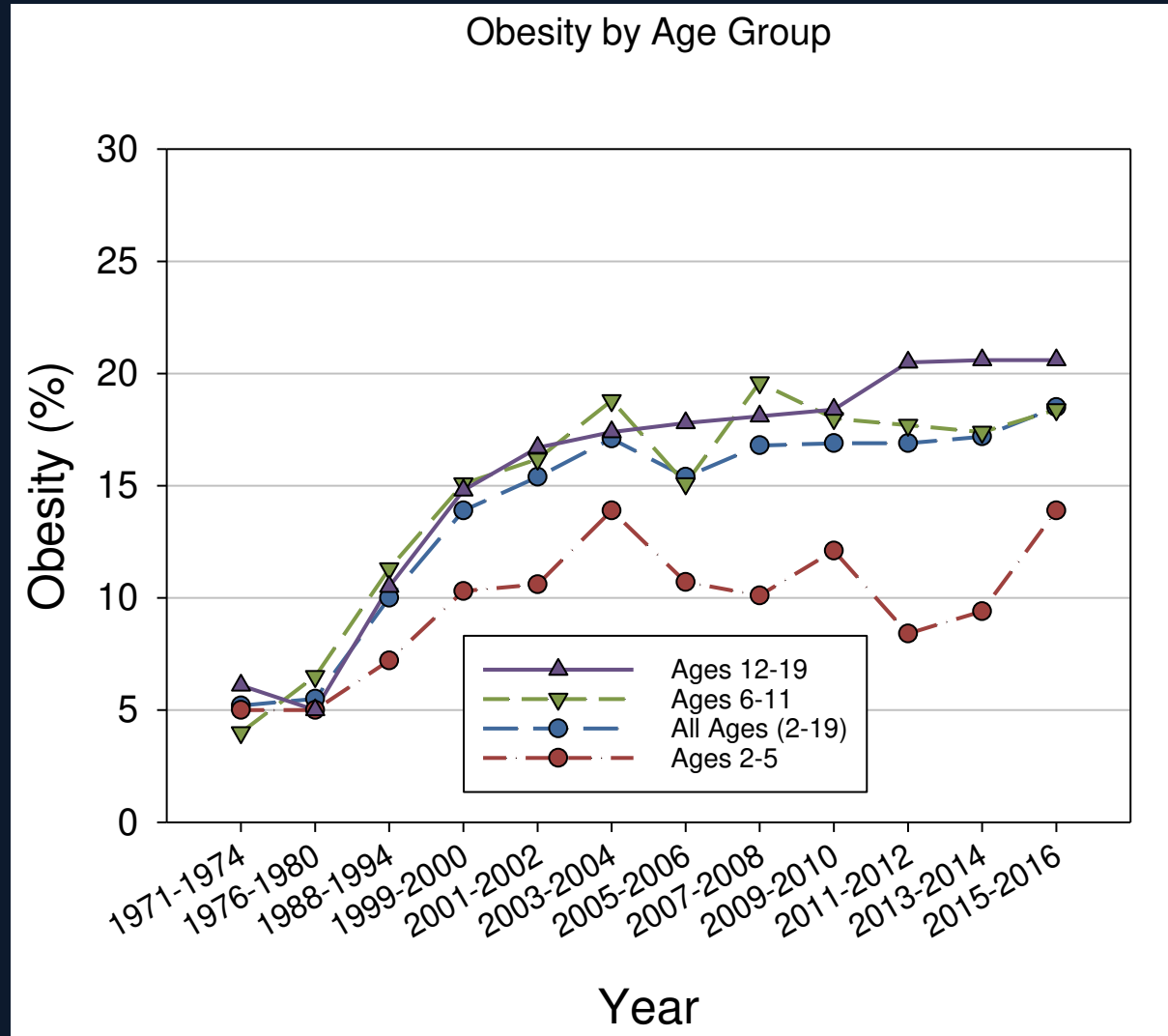
Childhood obesity (BMI≥95thile)

Adult obesity (BMI≥30)

Childhood overweight (BMI>85thile)

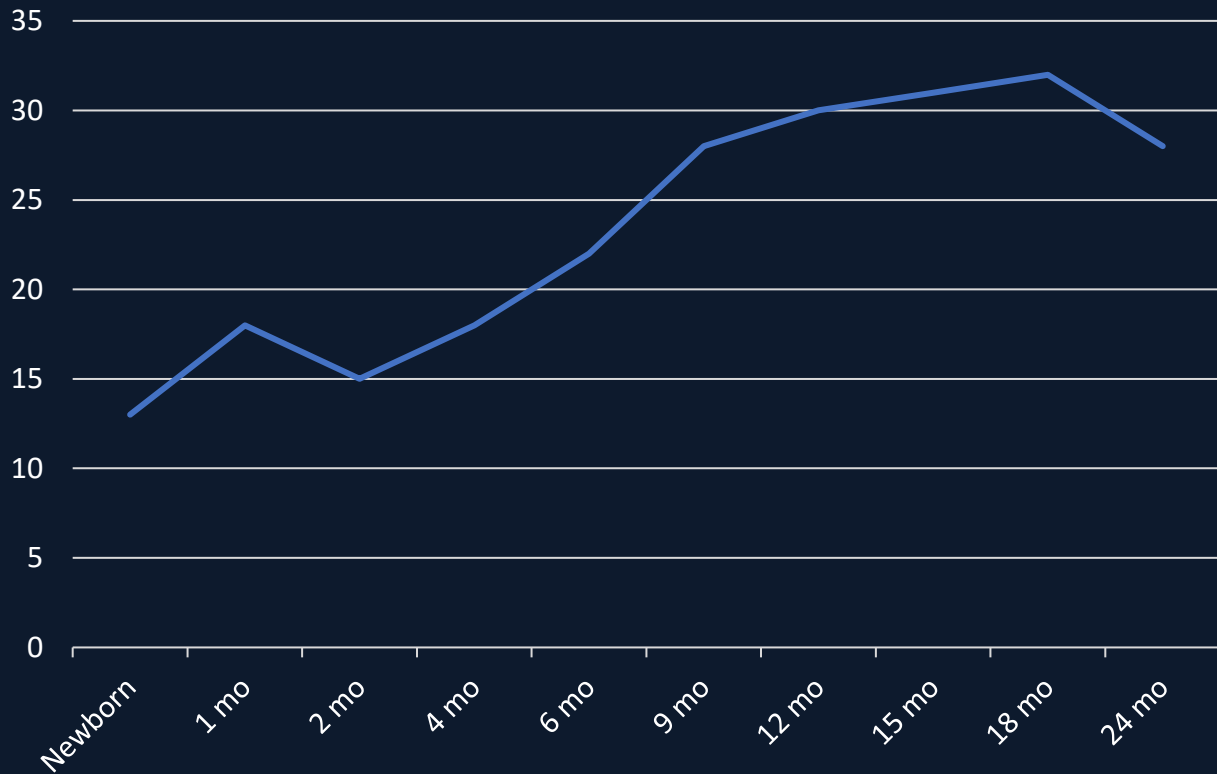
Adult overweight (BMI>25)

Overall obesity prevalence and trends



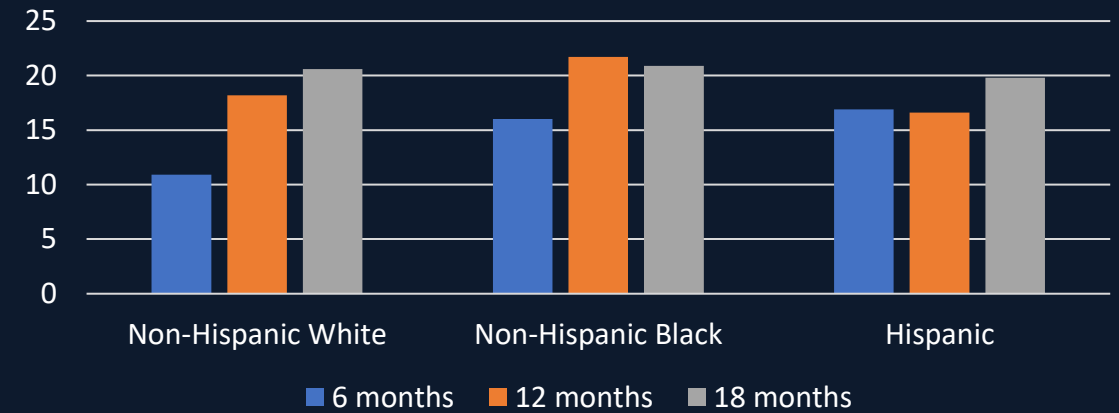
Prevalence of High Infant BMI (>85th Percentile)

BMI >85th Percentile by Infant Age

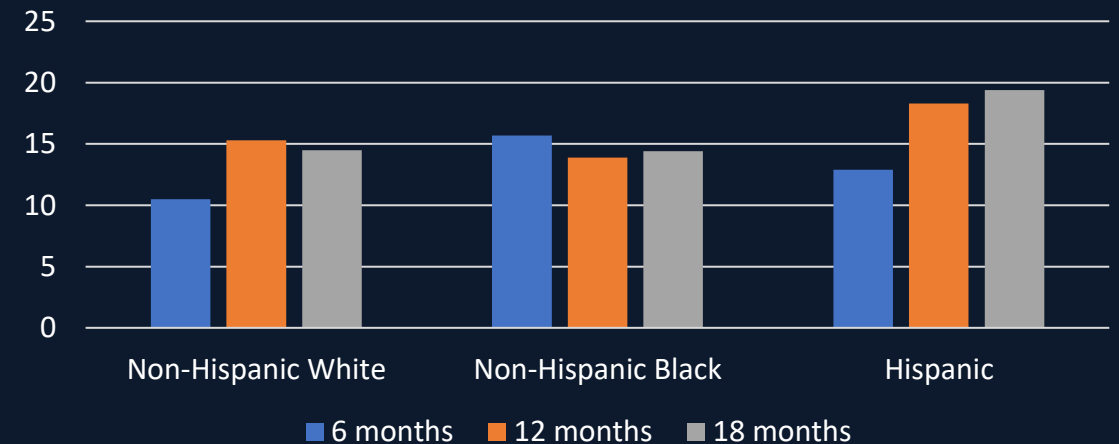


Roy SM, et al. *Pediatrics*. 2016;137(5):e20153492

BMI 85th to <95th Percentile

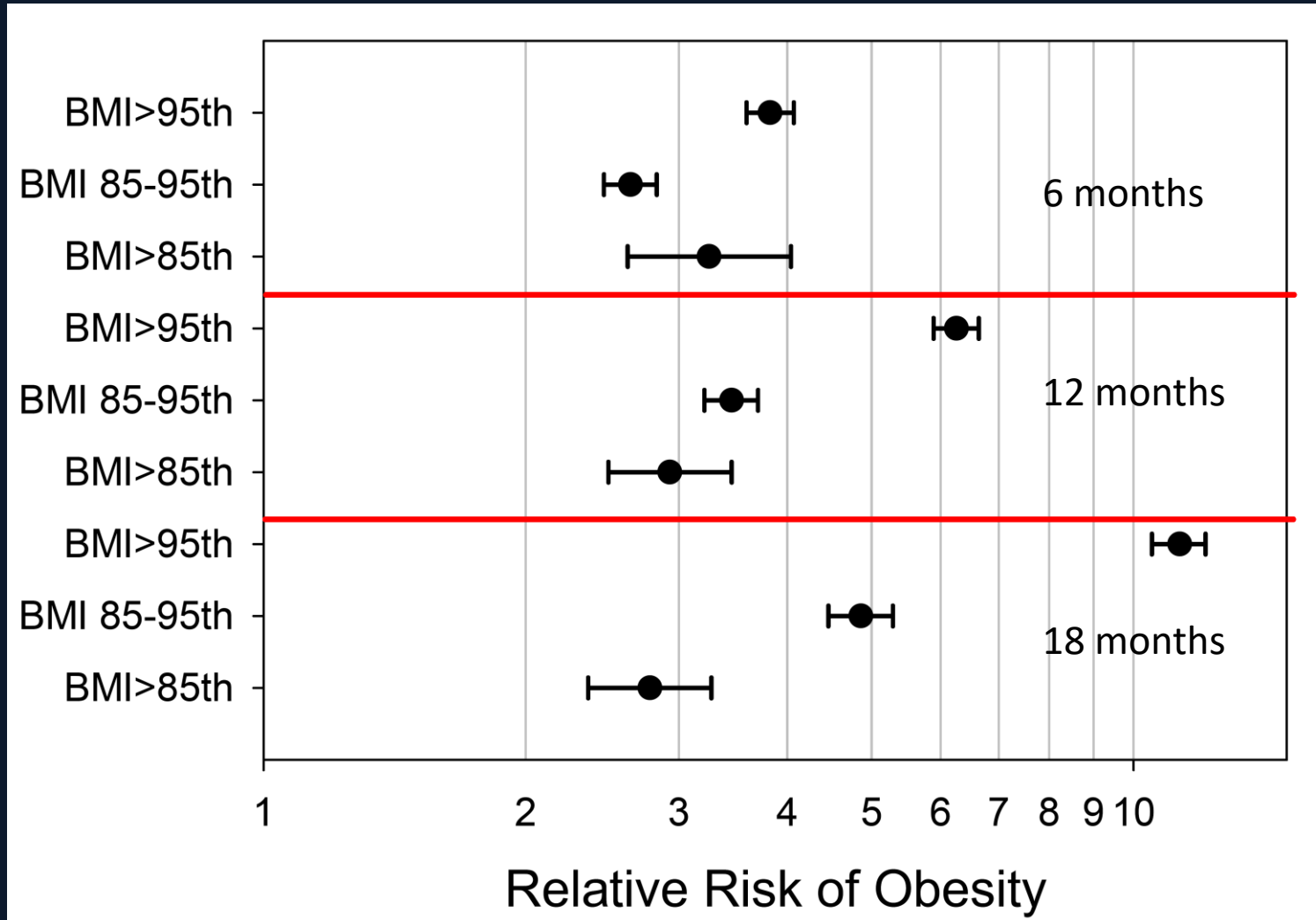


BMI 95th Percentile and above



Brown et al, *Academic Pediatrics* 2022; Mar 24 [ePub]:S1876-2859(22)00180-2

Infant BMI as risk for early childhood obesity



Infant BMI >85th percentile between 6 and 18 months of age carries a **2.5 to 11-fold risk of obesity** at ages 2 or 6

- Even at 2 months of age, BMI >85th percentile strongly predictive

Infant BMI more predictive of later obesity risk and better correlated with % body fat than weight-for-length (WFL)

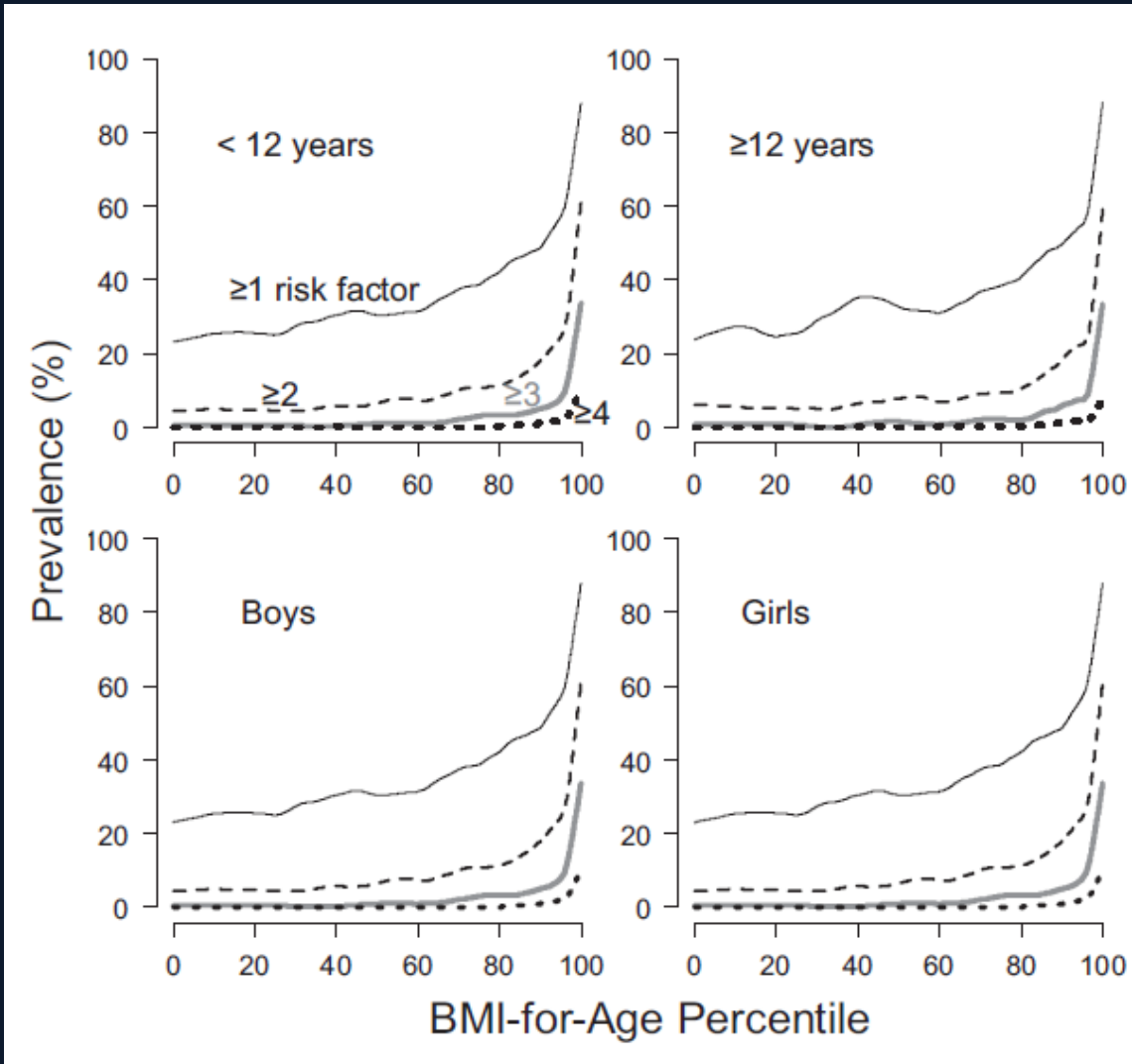
Rapid weight and BMI change in infants and young children

- Rapid changes in BMI or weight that “cross percentiles” are also risk factors for later obesity
 - Changes in weight >0.67 SD units in infancy are associated with a 4-fold increased risk of later obesity
 - Rapid infant weight gain is consistently associated with increases in both fat mass and fat-free (lean) mass later in life, with associations spanning up to 46 years of age

Once established, obesity is hard to reverse

- Childhood obesity demonstrates the highest tracking over time of all childhood risk factors
 - Over 50% of children with overweight and over 84% of children with obesity (mean age 13) were obese as adults (mean age 27)
 - A recent study of over 12,000 children followed to adulthood found that 29% and 59% of children with overweight or obesity, respectively, developed severe obesity in adulthood (BMI>35 kg/m²)
- Severe obesity in children may be particularly persistent
 - Longitudinal studies find that between 72% and 100% of children with severe obesity remain severely obese 2-19 years later

Consequences of Obesity in Children



Bogalusa Heart Study

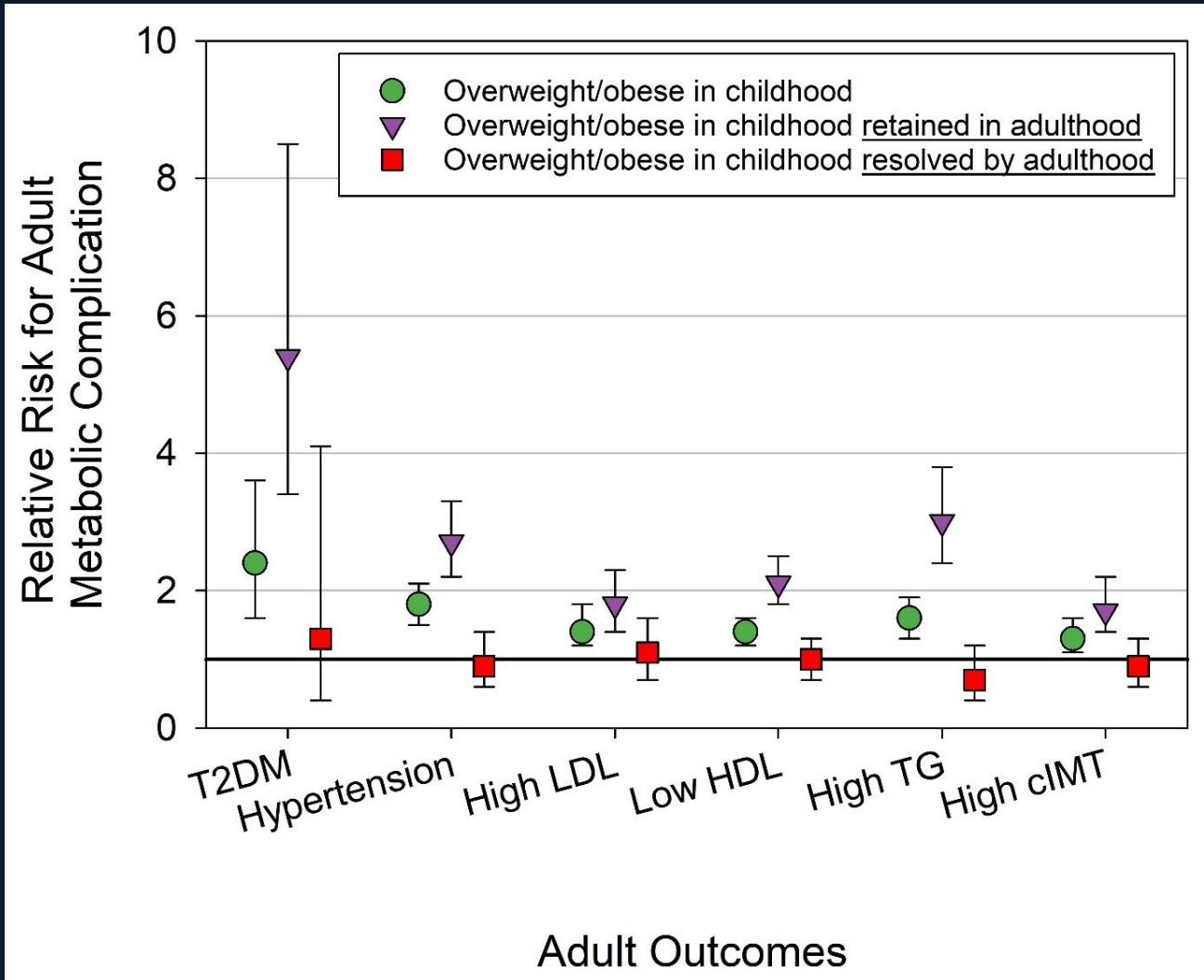
Risk factor clustering (LDL, HDL, TG, BP, insulin, excess adiposity) rises significantly with increasing BMI percentiles

3+ risk factors:

~18% of children with obesity

~33% of children with BMI > 99th percentile

Overweight or obesity in childhood is a risk for adult disease



- Childhood adiposity is associated with elevated risks of several cardiometabolic diseases or risk factors
 - Obesity retained from childhood to adulthood carries greater risks
 - Obesity that resolves by adulthood also resolves risk
- Prevention is important, but treatment or resolution is also key
 - Resolution doesn't often happen spontaneously

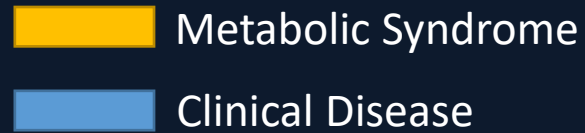
What is Metabolic Syndrome (MetS) in children?—many possible definitions

- Adult (and child) metabolic syndrome definition involves meeting 3 of 5 thresholds for: high blood pressure, low HDL-cholesterol, high triglycerides, high glucose, and high waist circumference
 - In childhood, most of these require adjustment for age and sex; some also require height or race adjustment
 - Standards for clinical thresholds for high blood pressure and glucose have changed over time
 - Lack of unified standards for lipids or waist circumference distributions in children by age and sex complicates definition

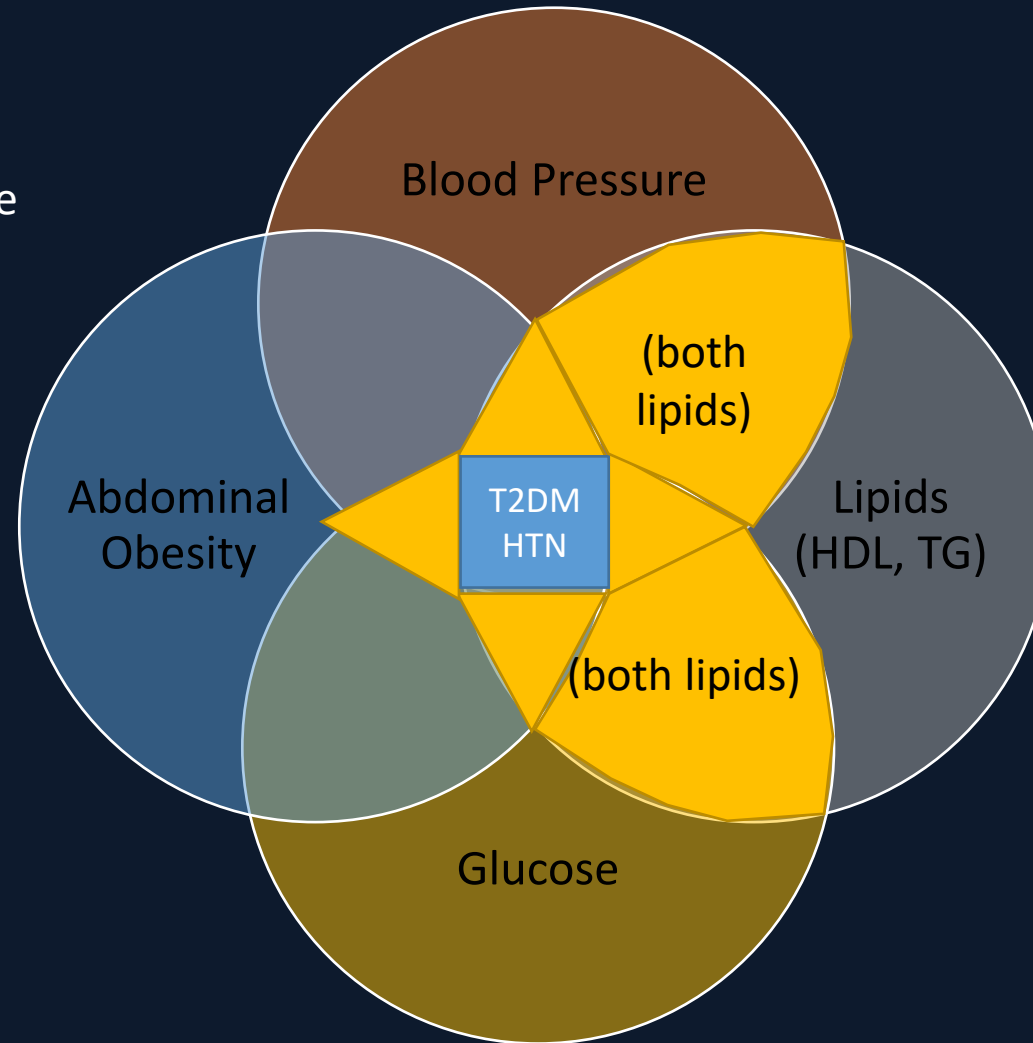
Table 1. Description of five regularly applied definitions of pediatric metabolic syndrome, with age- and sex-specific percentiles.

MetS definition	Conditions for MetS diagnosis	Risk factors				
		Blood pressure (systolic or diastolic)	Fasting glucose	HDL cholesterol	Triglycerides	Waist circumference
Cook	Presence of any of the three risk factors	≥90th percentile	≥6.1 mmol/L	≤1.03 mmol/L	≥1.24 mmol/L	≥90th percentile
de Ferranti	Presence of any of the three risk factors	>90th percentile	≥6.1 mmol/L	<1.3 mmol/L (<1.17 mmol/L for males aged 15–18 years)	≥1.1 mmol/L	>75th percentile
IDF (8–<16 years)	Presence of elevated waist circumference and two other risk factors	Systolic ≥130 mmHg or diastolic ≥85 mmHg	≥5.6 mmol/L	<1.03 mmol/L	≥1.7 mmol/L	≥90th percentile or adult cutoff, if lower
IDF (≥16 years)	Presence of elevated waist circumference and two other risk factors	Systolic ≥130 mmHg or diastolic ≥85 mmHg	≥5.6 mmol/L	Males: <1.03 mmol/L Females: <1.29 mmol/L	≥1.7 mmol/L	Males: ≥94 cm Females: ≥80 cm
IDFICS	Presence of any of the three risk factors	≥90th percentile	≥90th percentile	≤10th percentile	≥90th percentile	≥90th percentile

Metabolic Syndrome—the Warning Track



Metabolic syndrome is an accounting for risk clustering that may not meet clinical thresholds for high risk, but can be useful for identify higher-risk children



MetS Prevalence in Children and Adolescence

- Prevalence among adolescents between 2-9.4%, depending on definition (median ~6%)—basically stable from 1999-2006

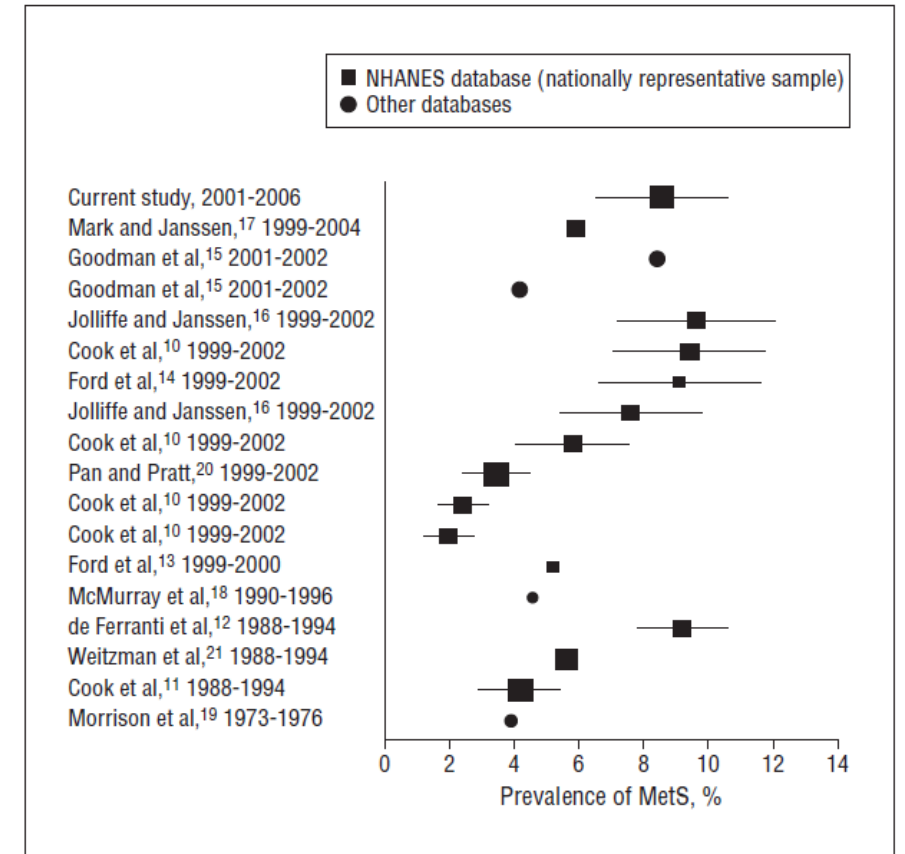
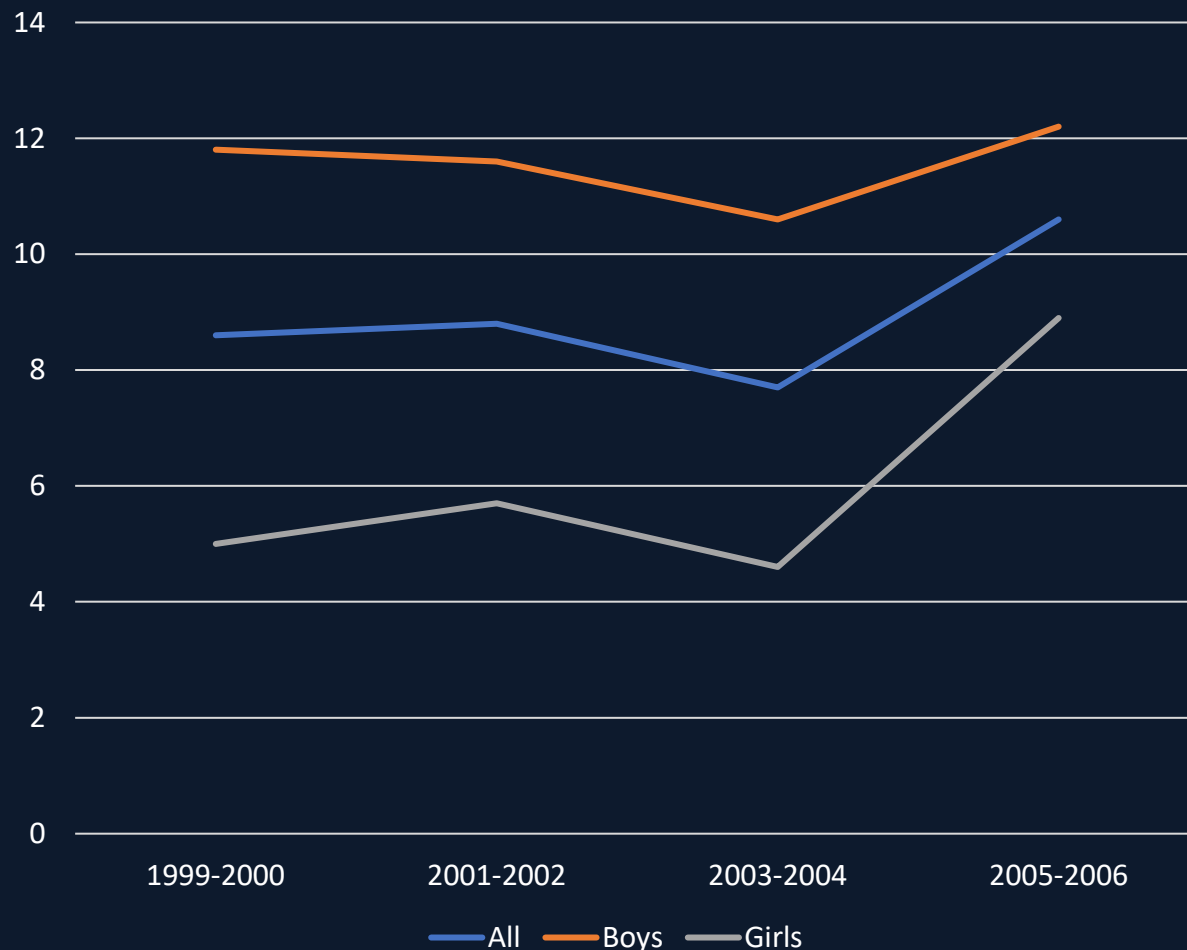
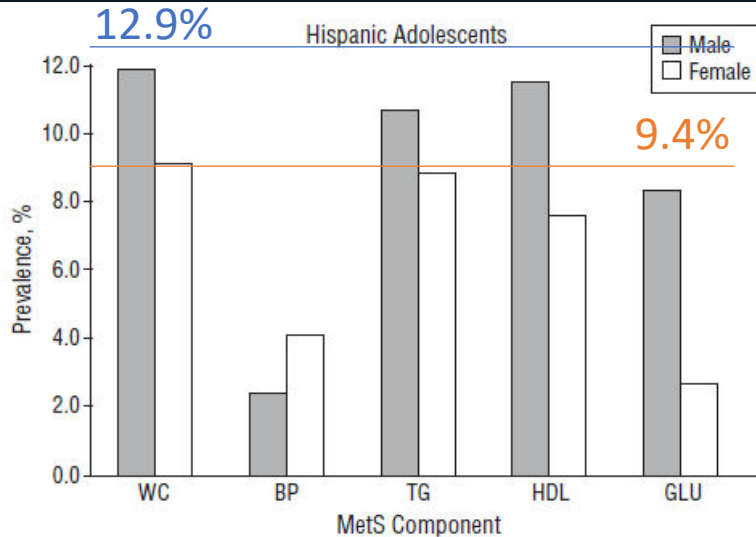


Figure 1. Prevalence (and 95% confidence intervals) of the metabolic syndrome (MetS) in US adolescents in various studies. NHANES indicates National Health and Nutrition Examination Survey.

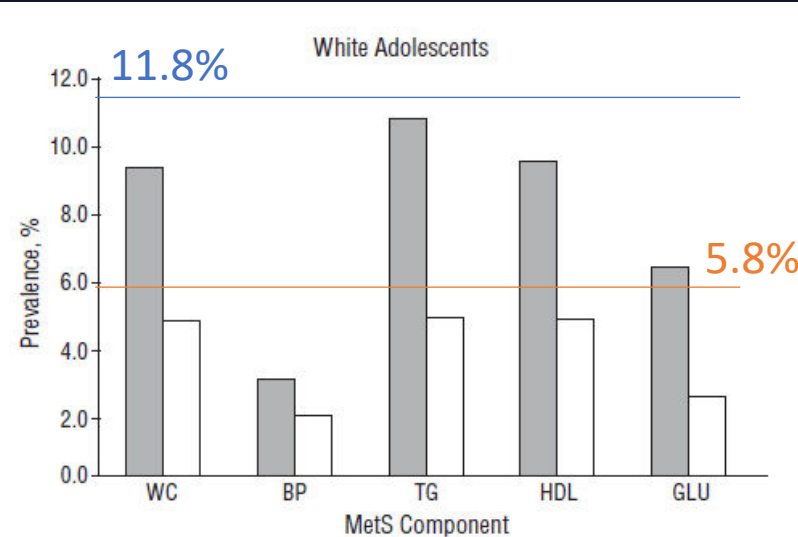
Distribution of MetS components differs by sex and race/ethnicity (among those with MetS)

Hispanic, age 12-19



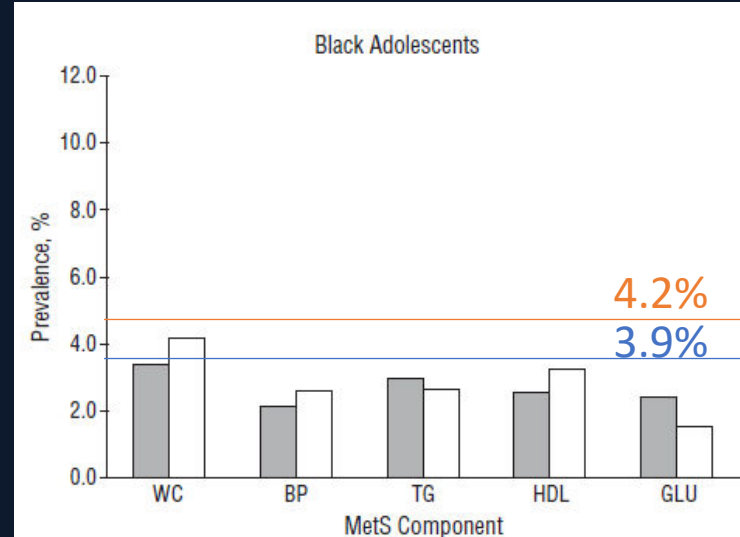
Male>Female
WC, TG, HDL predominant
Glu in males

White, age 12-19



Male>Female
WC, TG, HDL predominant
Glu in males

Black, age 12-19



Female>Male
No predominant factors

Male MetS Prevalence
Female MetS Prevalence

Relationships of childhood MetS with adult cardiovascular disease

- Risk factor clustering in childhood persists into adulthood
 - 68% of subjects with childhood MetS also had MetS 25 years later
 - Rates of change in metabolic risk factors also clustered between childhood and adulthood, especially for African-Americans
- Several lines of evidence point to childhood MetS as a risk factor for target organ damage and later CV events
 - Risk factor clustering in childhood is related to more common and severe atherosclerotic lesions
 - Greater risk factor clustering in adolescence is associated with higher carotid intima media thickness 21 years later, adjusting for concurrent risks
 - MetS in childhood is associated with 14-fold increased risk of cardiovascular disease 25 years later

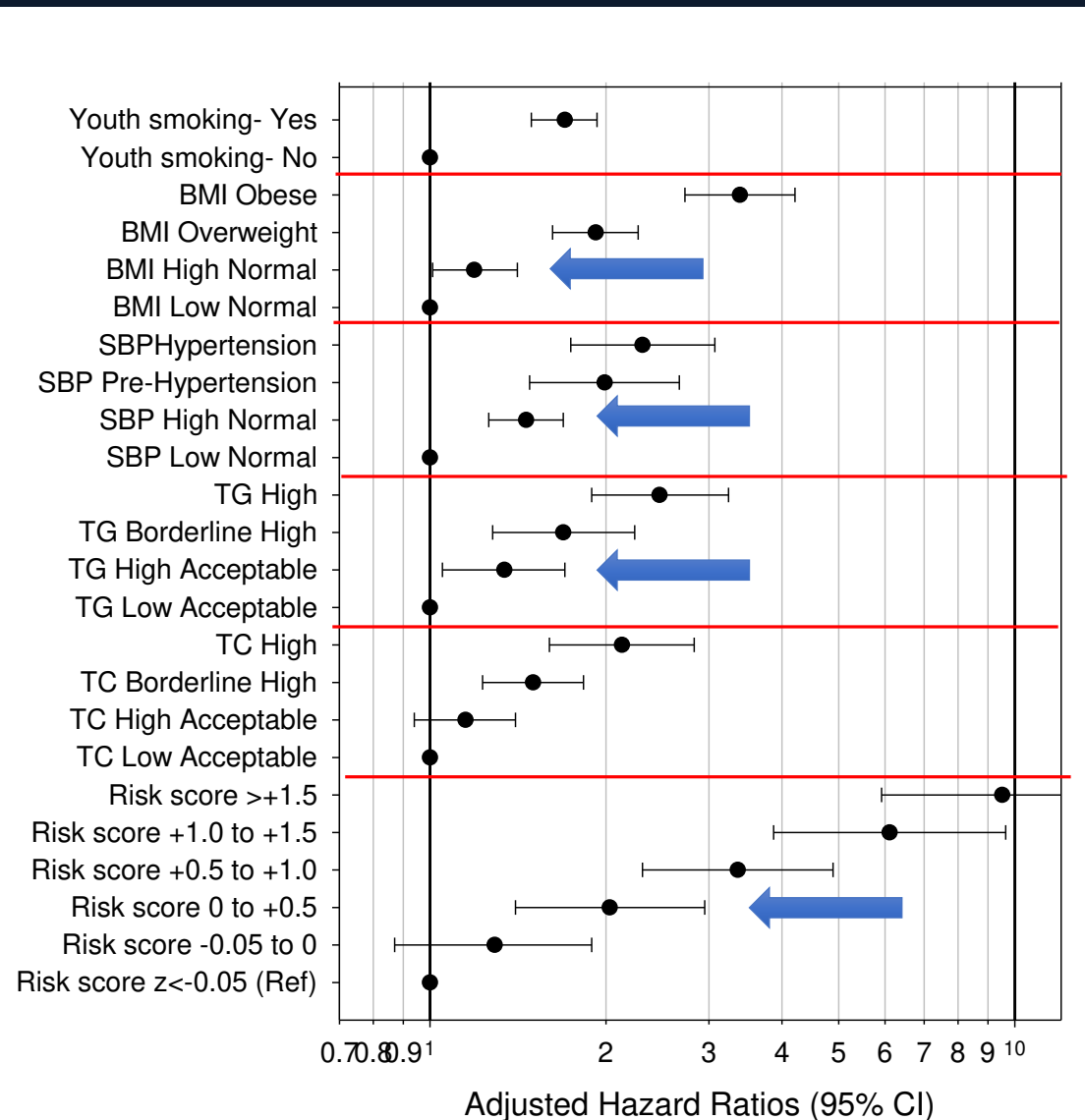
Morrison et al, *PEDIATRICS* 2007; 120(2)

Chen et al, *Am J Epidemiol* 2007;166:527–533

Tzou et al, *J Am Coll Cardiol* 2005;46:457– 63

Raitakari et al, *JAMA* 2003; 290(17)

Metabolic Risk Factors and Adult Cardiovascular Disease



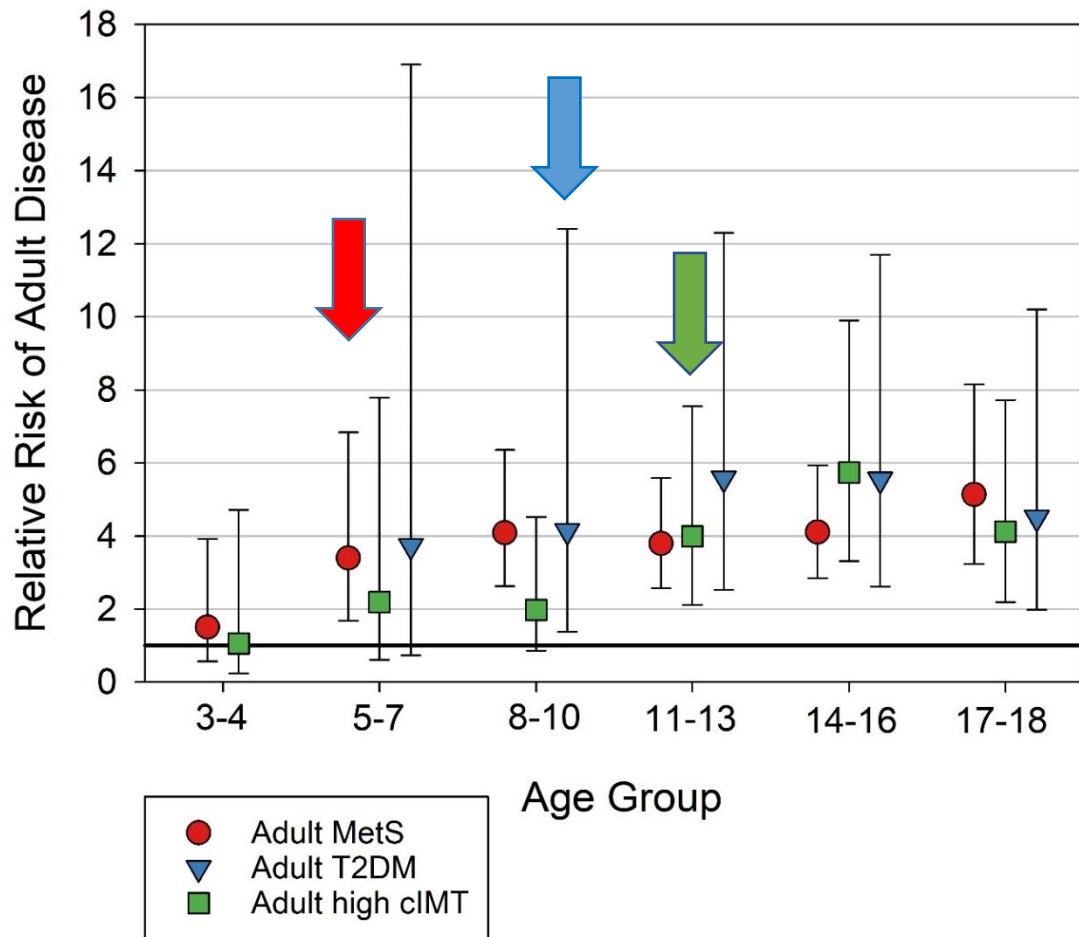
Each childhood risk factor associated with adult fatal/non-fatal CV events

- Most show increased risk in the clinical “high normal” range

Combined into a metabolic risk score, risk is much more steeply graded

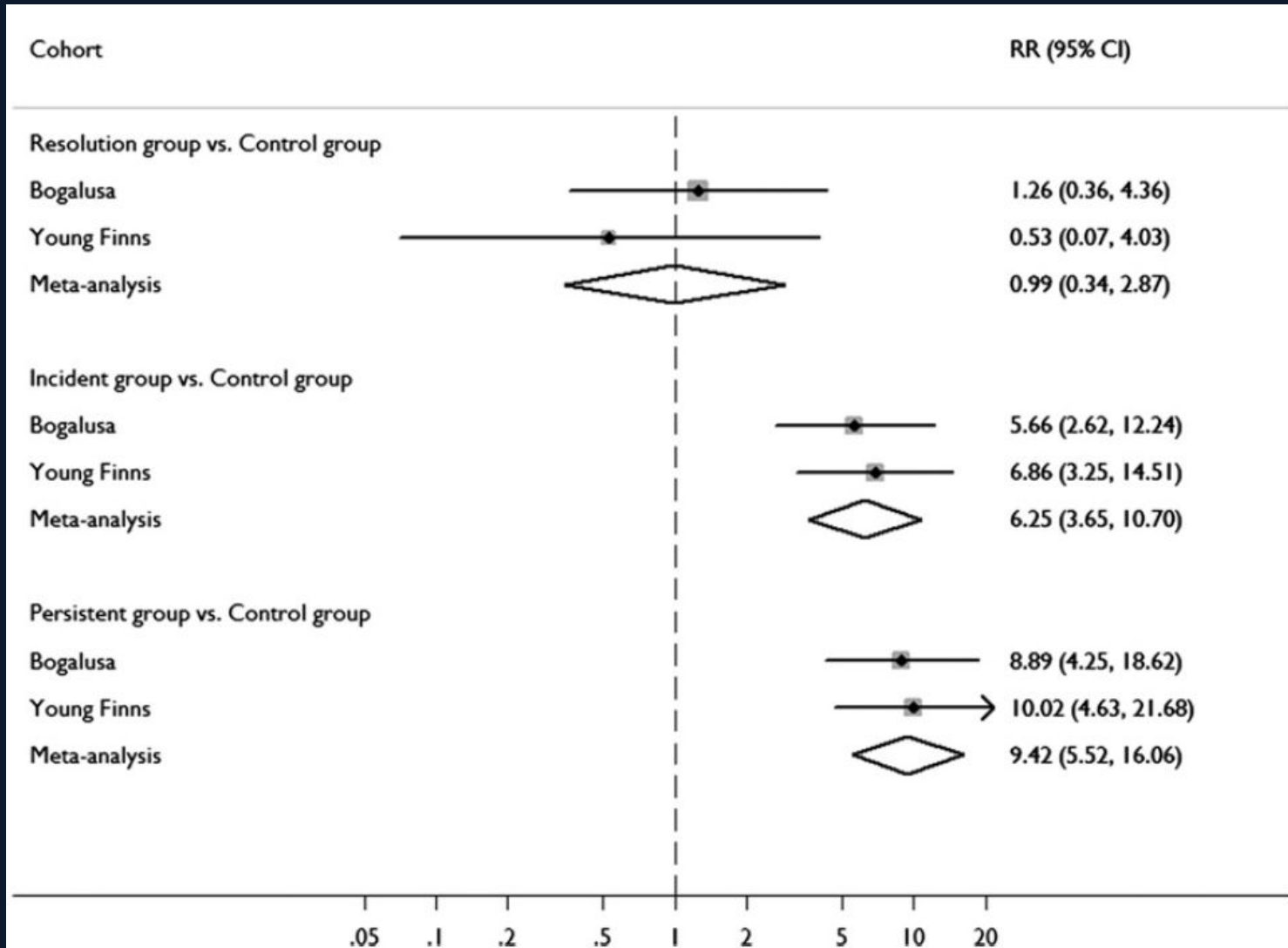
- Risk starts accumulating at the median risk score ($z=0$)

Does age at childhood MetS matter in prediction of adult disease?



- Childhood MetS associates with:
 - 3.5-fold risk of **adult MetS** by age 5-7
 - 4-fold risk of **adult T2DM** by age 8-10
 - 4-fold risk of **adult high cIMT** by age 11-13
- Mean age=33.2 [Range 19-57]
- Adjusted for sex, study cohort, year

Resolution of MetS by adulthood normalizes risk of high cIMT and cardiovascular events



- Compared with those without MetS at either childhood or adulthood:
 - Resolution of MetS by adulthood conferred no increased risk
 - Development of MetS in adulthood increased risk 6-fold
 - Persistence of MetS from childhood to adulthood increased risk 9-fold
- Both childhood risk score and change in risk score impact adult risk of cardiovascular events
- Secondary prevention by reducing MetS is impactful

Obesity and MetS screening guidance

- Obesity: Chart BMI against WHO or CDC growth charts at every child visit and be alert to increasing BMI percentile over time or high risk due to parental obesity
 - Blood pressure: take BP at each well child visit over 3 years of age
 - Replicate readings at multiple visits using an auscultatory device recommended
 - Fasting lipids: universal screening between ages 9-11 and between ages 17-21, earlier or continued screening for children with high family risk
 - Screen twice (2 wks to 3 mos apart) and average results
 - Fasting glucose: assess fasting glucose every 2 years in children over 10 who are overweight and have at least 2 other risks: family history of Type 2 diabetes, evidence of insulin resistance, or member of high-risk demographic groups
 - Waist circumference: No specific recommendations
-
- Expert Panel on Integrated Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents, *PEDIATRICS* Volume 128, Supplement 5, December 2011
 - Pediatric Obesity—Assessment, Treatment, and Prevention: An Endocrine Society Clinical Practice Guideline, *J Clin Endocrinol Metab*, March 2017, 102(3):709–757
 - Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents, *PEDIATRICS* Volume 140, number 3, September 2017:e20171904

Implications for treatment

- Childhood obesity has a limited medical arsenal for treatment—focus is on diet and physical activity and limiting sedentary or screen time
 - Focus on developing a healthy lifestyle, consistent with healthy growth
 - Evaluate for underlying issues, if appropriate—stressors, depression
 - Even small reductions in adiposity can have benefits for metabolism
- Despite focus on risk factor clustering in MetS, recommendations focus on treatment for individual risk factors
 - Often starts with a focus on lifestyle changes—diet and physical activity
 - Some pharmacological approaches are available for children and adolescents regarding blood pressure and lipid management

Conclusions

- Childhood obesity rates have leveled off (new higher “normal”), especially for boys
 - Childhood obesity is persistent, and strongly related to both childhood and adult cardiometabolic risk factors as young as 8 years old → Early obesity prevention is key!
- Metabolic syndrome in children can be used as an organizing concept to identify children who do not yet meet clinical treatment thresholds
 - Prevalence of 3-10%, higher in white and Hispanic children, lower in African-Americans → potential for under-recognition of metabolic risk in AA
 - Childhood risk clustering is more strongly related to adult cardiometabolic disease than obesity alone, but risk resolves with treatment
- Screening guidelines do not exist for metabolic syndrome—screening and treatment focused on each risk factor
 - First-line treatments for all risk factors are lifestyle change (diet, physical activity, screen time)
- Prevention of adult cardiometabolic disease should start in childhood
 - Resolution of obesity or metabolic syndrome by adulthood also resolves risk to never-obese levels, but that is rarely spontaneous



Thank you!