Epidemiology of Obesity

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Objectives of the lecture

- At the end of the session you should be able to:

- Describe the magnitude of the problem of obesity.
- Discuss attributes associated with obesity.
- List the factors leading to obesity.
- Recognize the consequences of obesity.
- Discuss the prevention of obesity.

Background

Definition and prevalence

Defining obesity

"Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health."

- World Health Organization

Measuring Obesity

Primary Screening Measure

Body Mass Index (BMI) = weight(kg) / height(m)^2

- Calculated from a person's weight and height.
- Reliable indicator of body fatness for most people.
- Inexpensive & easy-to-perform screening for weight categories that may lead to health problems.
- Does not measure body fat directly.

- BMI provides the most useful population-level measure of overweight and obesity as it is the same for both sexes and for all ages of adults. However, it should be considered a rough guide because it may not correspond to the same degree of fatness in different individuals.
- For children, age needs to be considered when defining overweight and obesity

International Classification of adult underweight, overweight and obesity according to BMI

Classification	**BMI(kg/m^2)**	
	Principal cut-off points	**Additional cut-off points**
Underweight	**<18.50**	**<18.50**
Severe thinness	<16.00	<16.00
Moderate thinness	16.00 – 16.99	16.00 – 16.99
Mild thinness	17.00 – 18.49	17.00 – 18.49
Normal range	**18.50 – 24.99**	**18.50 – 22.99**
		23.00 – 24.99
Overweight	**≥25.00**	**≥25.00**
Pre obese	25.00 – 29.99	25.00 – 27.49
		27.50 – 29.99
Obese	**≥30.00**	**≥30.00**
Obese class I	30.00 – 34.99	30.00 – 32.49
		32.50 – 34.99
Obese class II	35.00 – 39.99	35.00 – 37.49
		37.50 – 39.99
Obese class III	≥40.00	≥40.00

Defining obesity

Adults

- BMI ≥ 30.0 is obese
- 25.0-29.9 is overweight
- 18.5-24.9 is normal
- < 18.5 is underweight

Children/Adolescents

- Sex/age-specific BMI
- BMI ≥ 95th percentile is obese
- 85th to less than 95th percentile is overweight

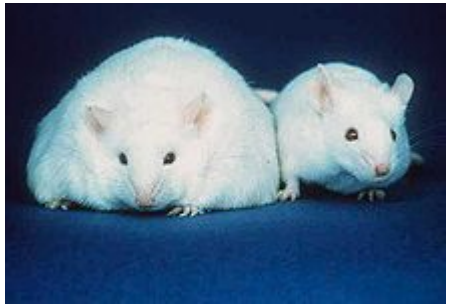
Defining obesity

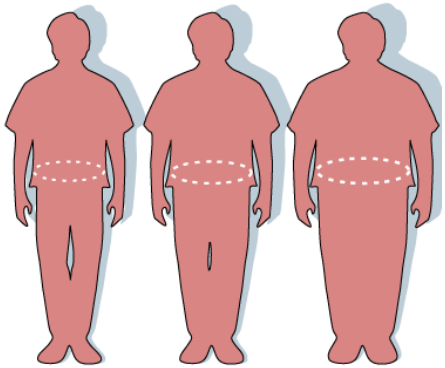
Subdivisions of obesity

- Grade 1 obesity: BMI 30.0-34.9
- Grade 2 obesity: BMI 35.0-39.9
- Grade 3 obesity: BMI 40.0+ (extreme obesity)

Other ways of estimating obesity

- Look
- Scale
- Waist circumference





Is obesity a disease or a condition/risk factor?

"…recognize obesity as a **disease state** with multiple pathophysiological aspects requiring a range of interventions to advance obesity treatment and prevention."

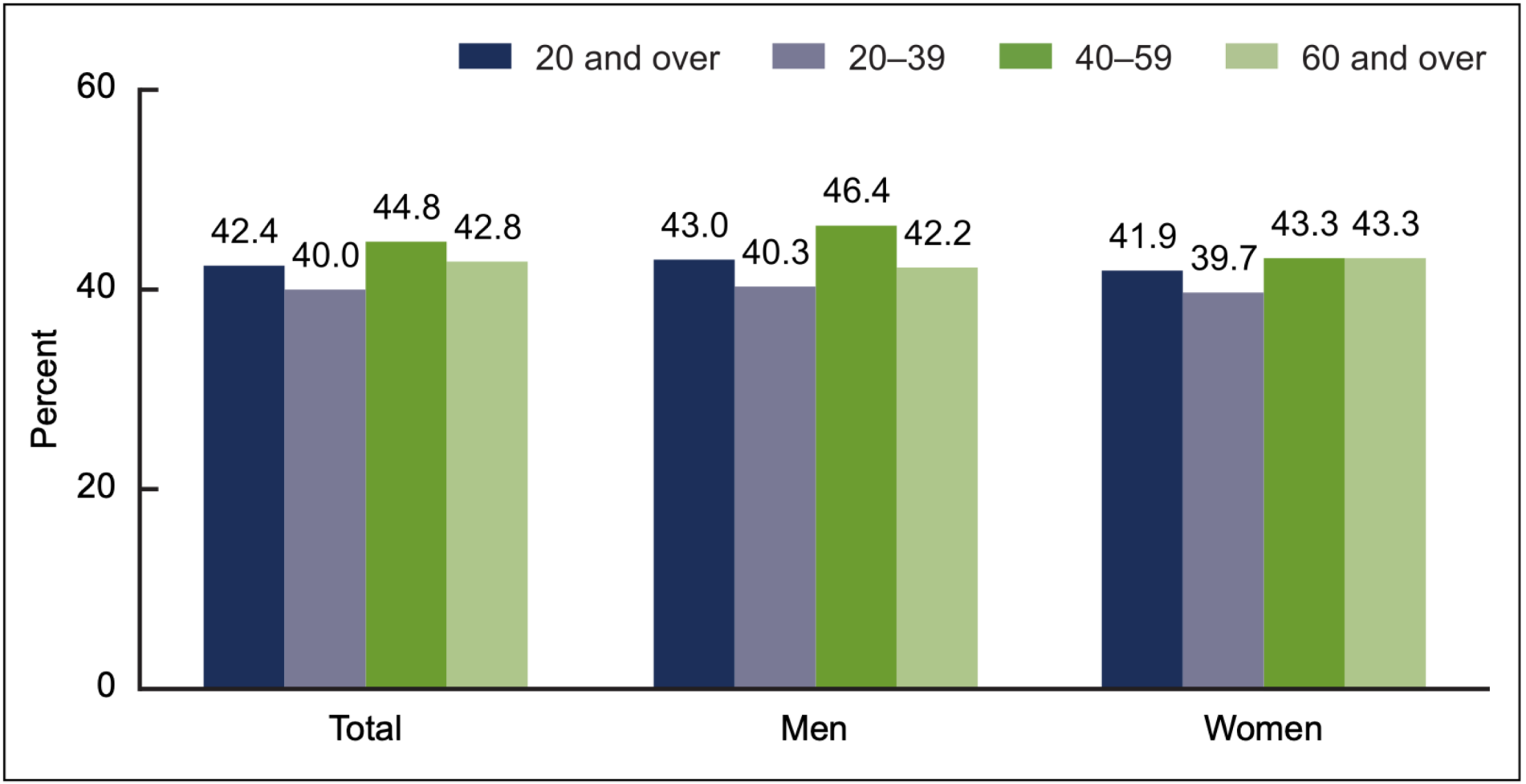
– American Medical Association

Prevalence of obesity globally

- Obesity worldwide prevalence
- 1995 200 million
- 2000 300 million
- 2008 857 million
- 2013 2.1 billion
- 2016 1.9 billion

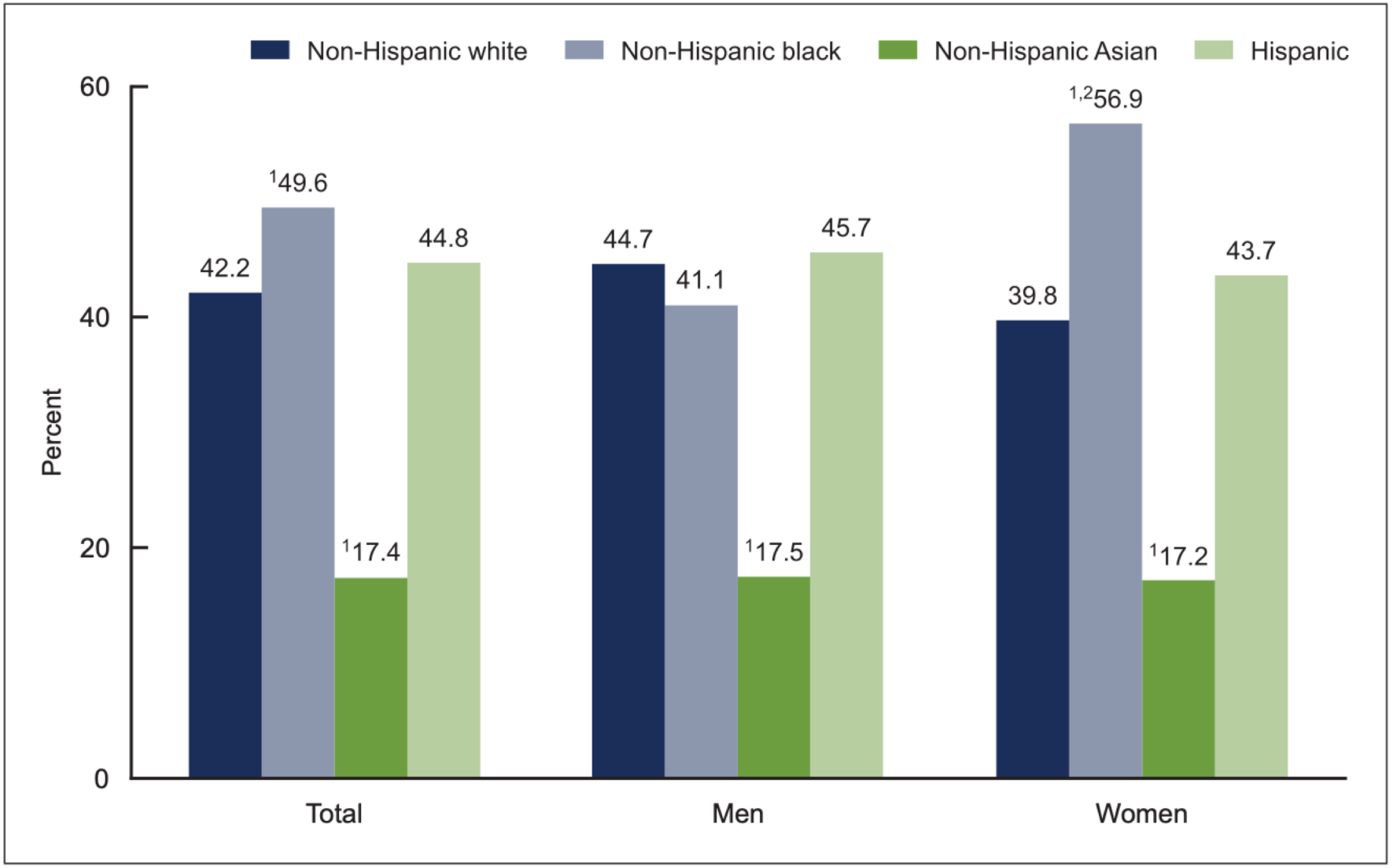
- 2021 WHO

Figure 1. Prevalence of obesity among adults aged 20 and over, by sex and age: United States, 2017–2018



NOTES: Estimates for adults aged 20 and over were age adjusted by the direct method to the 2000 U.S. Census population using the age groups 20–39, 40–59, and 60 and over. Crude estimates are 42.5% for total, 43.0% for men, and 42.1% for women.
Access data table for Figure 1 at: https://www.cdc.gov/nchs/data/databriefs/db360_tables-508.pdf#1.
SOURCE: NCHS, National Health and Nutrition Examination Survey, 2017–2018.

Figure 2. Age-adjusted prevalence of obesity among adults aged 20 and over, by sex and race and Hispanic origin: United States, 2017–2018



[1]Significantly different from all other race and Hispanic-origin groups.
[2]Significantly different from men for same race and Hispanic-origin group.
NOTES: Estimates were age adjusted by the direct method to the 2000 U.S. Census population using the age groups 20–39, 40–59, and 60 and over. Access data table for Figure 2 at: https://www.cdc.gov/nchs/data/databriefs/db360_tables-508.pdf#2.
SOURCE: NCHS, National Health and Nutrition Examination Survey, 2017–2018.

Prevalence of obesity in Saudi

Economist.com rankings

Highest obesity*

Men, % of total population

1	Lebanon	36.3
2	Qatar	34.6
3	Kuwait	32.8
4	Panama	27.9
5	United States	27.7
6	Cyprus	26.6
7	Saudi Arabia	26.4
8	West Bank and Gaza	23.9
9	Bahrain	23.3
10	Albania	22.8
11	England	22.7
12	Germany	22.5
13	Scotland	22.3
14	Ireland	20.1
15	Israel	19.9
16	Mexico	19.4
17	Australia	19.3
18	United Arab Emirates	17.1
19	Wales	17.0
20	Oman	16.7
21	Slovenia	16.5
	Turkey	16.5
23	Lithuania	16.2
24	Canada	16.0
	Peru	16.0
26	Luxembourg	15.3
27	Sweden	14.8
28	Portugal	14.5
29	Switzerland	14.1
30	Mongolia	13.8

Women, % of total population

1	Qatar	45.3
2	Saudi Arabia	44.0
3	West Bank and Gaza	42.5
4	Lebanon	38.3
5	Panama	36.1
6	Albania	35.6
7	Bahrain	34.1
8	United States	34.0
9	Egypt	32.4
10	United Arab Emirates	31.4
11	Iran	30.0
12	Kuwait	29.9
13	Turkey	29.4
14	Mexico	29.0
15	Scotland	26.0
16	Israel	25.7
17	Mongolia	24.6
18	Jamaica	23.9
19	England	23.8
20	Cyprus	23.7
21	Germany	23.3
22	Oman	23.1
23	Peru	23.0
24	Australia	22.2
25	Morocco	21.7
26	Russia	21.6
27	Trinidad & Tobago	21.1
28	Fiji	19.3
29	Mauritania	19.2
30	Wales	18.0

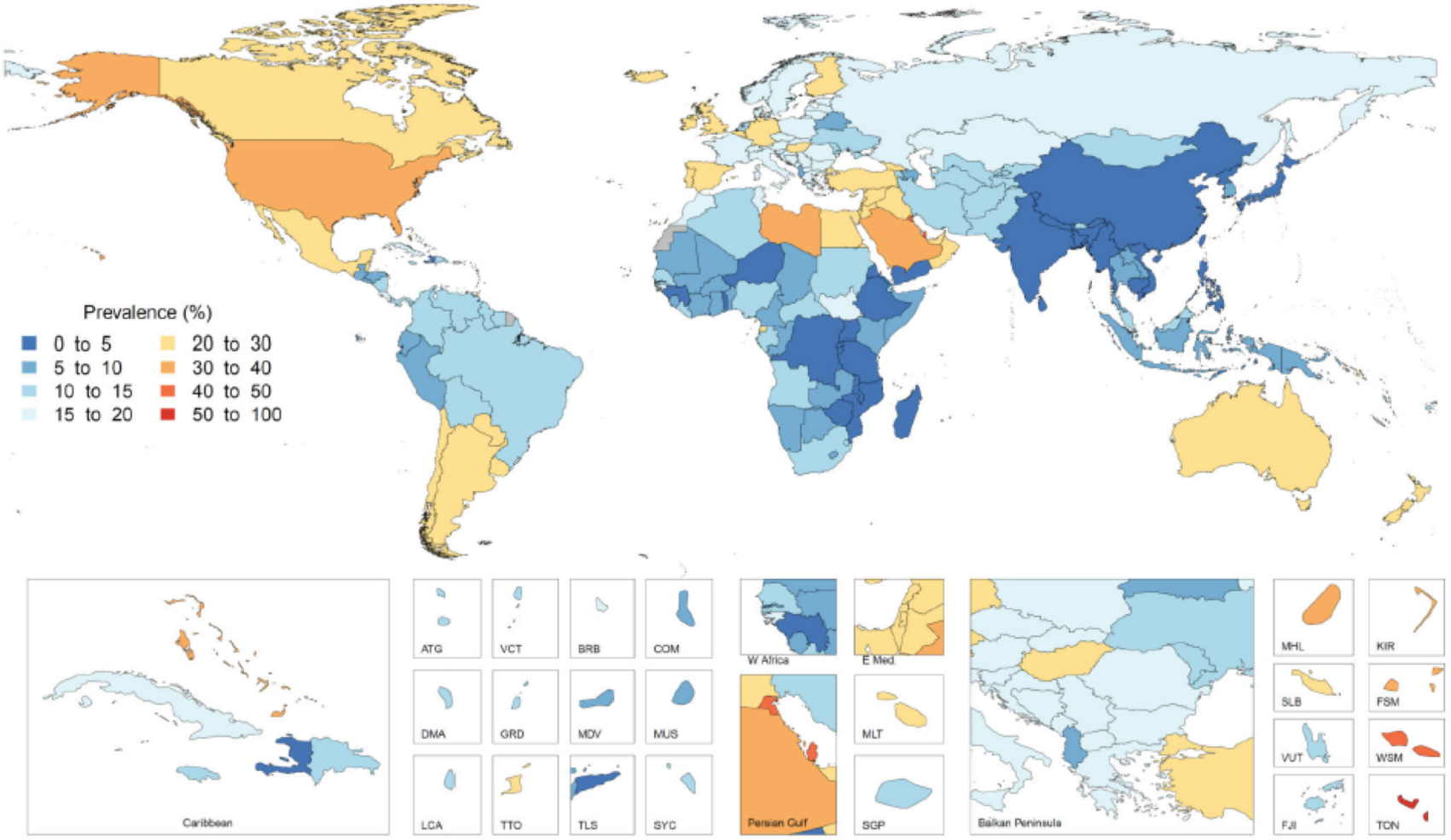
* Data for these health rankings refer to the latest year available, 1999-2003. Obesity is defined as body-mass index of 30 or more

Source: "Pocket World in Figures", based on data from the World Health Organisation

Country	Obesity Rate ▾	BMI	Population 2019
American Samoa	74.60%	34.9	55,312
Tokelau	74.40%		1,340
Nauru	61.00%	32.5	10,756
Cook Islands	55.90%	33	17,548
Palau	55.30%	29.4	18,008
Marshall Islands	52.90%	29.2	58,791
Tuvalu	51.60%	29.3	11,646
Niue	50.00%		1,615
Tonga	48.20%	31.9	104,494
Samoa	47.30%	31.7	197,097
Kiribati	46.00%	29.6	117,606
Micronesia	45.80%	29.4	113,815
Aruba	38.20%		106,314
Kuwait	37.90%	30	4,207,083
Cayman Islands	36.60%		64,948
United States	36.20%	28.8	329,064,917
British Virgin Islands	35.50%		30,030
Jordan	35.50%	28.9	10,101,694
Saudi Arabia	35.40%	28.5	34,268,528
Qatar	35.10%	29.2	2,832,067

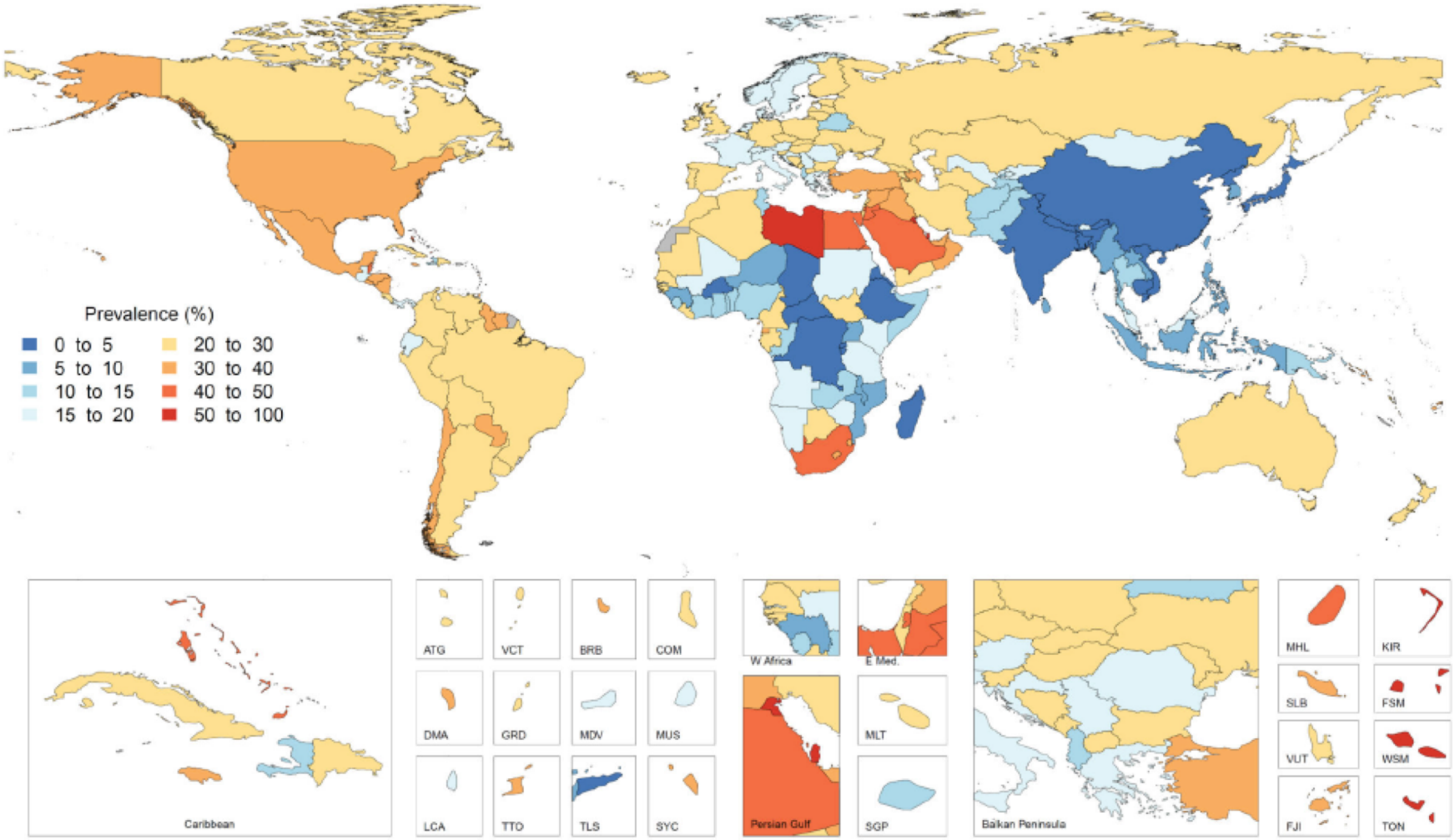
http://worldpopulationreview.com/countries/most-obese-countries/

Obesity Worldwide 2013 (Male Adults)



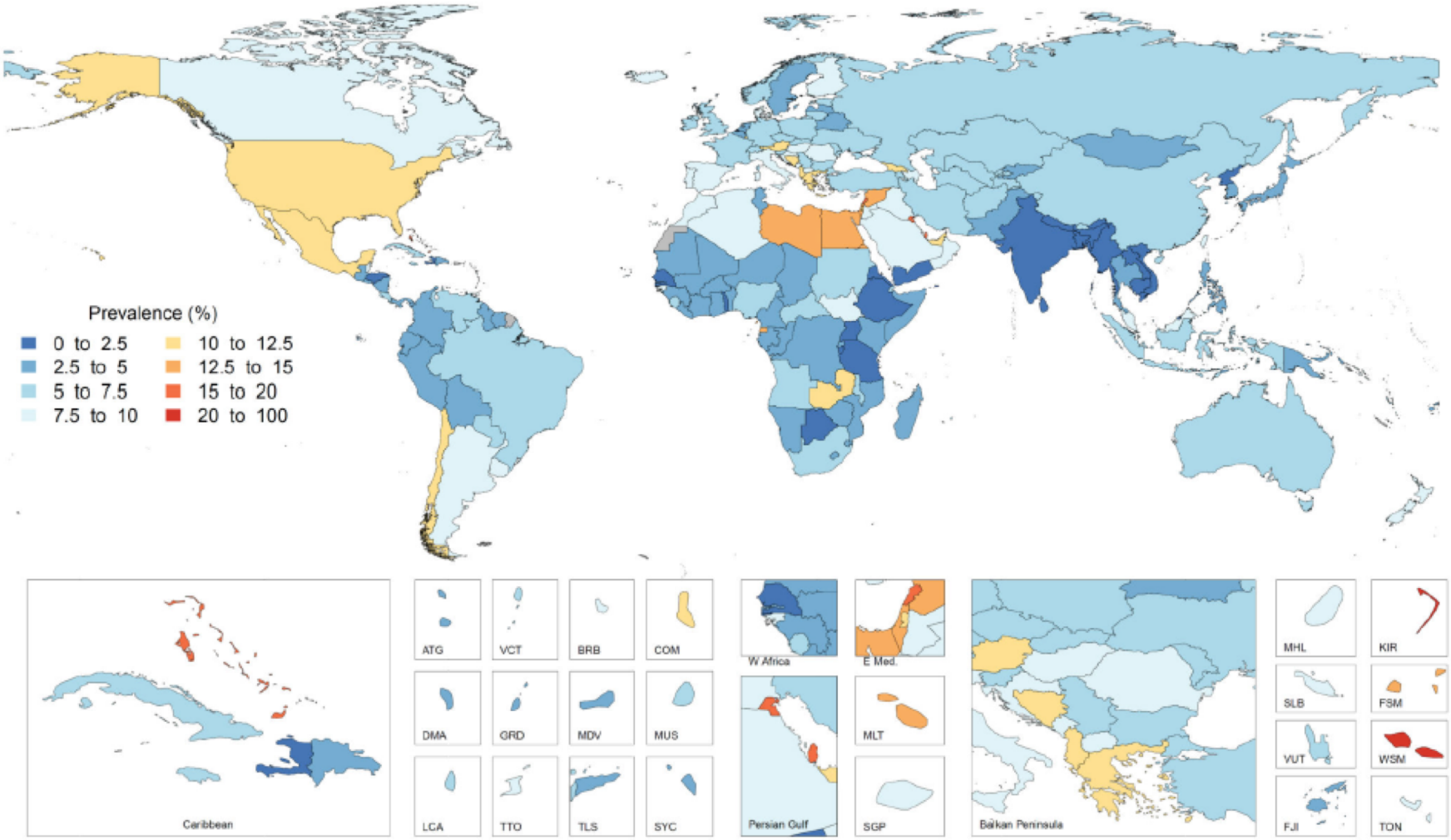
Source: The GBD 2013 Obesity Collaboration. Global regional and national prevalence of overweight and obesity in children and adults 1980-2013: A systematic analysis. Lancet 2014; 384(9945): 766-781.

Obesity Worldwide 2013 (Female Adults)



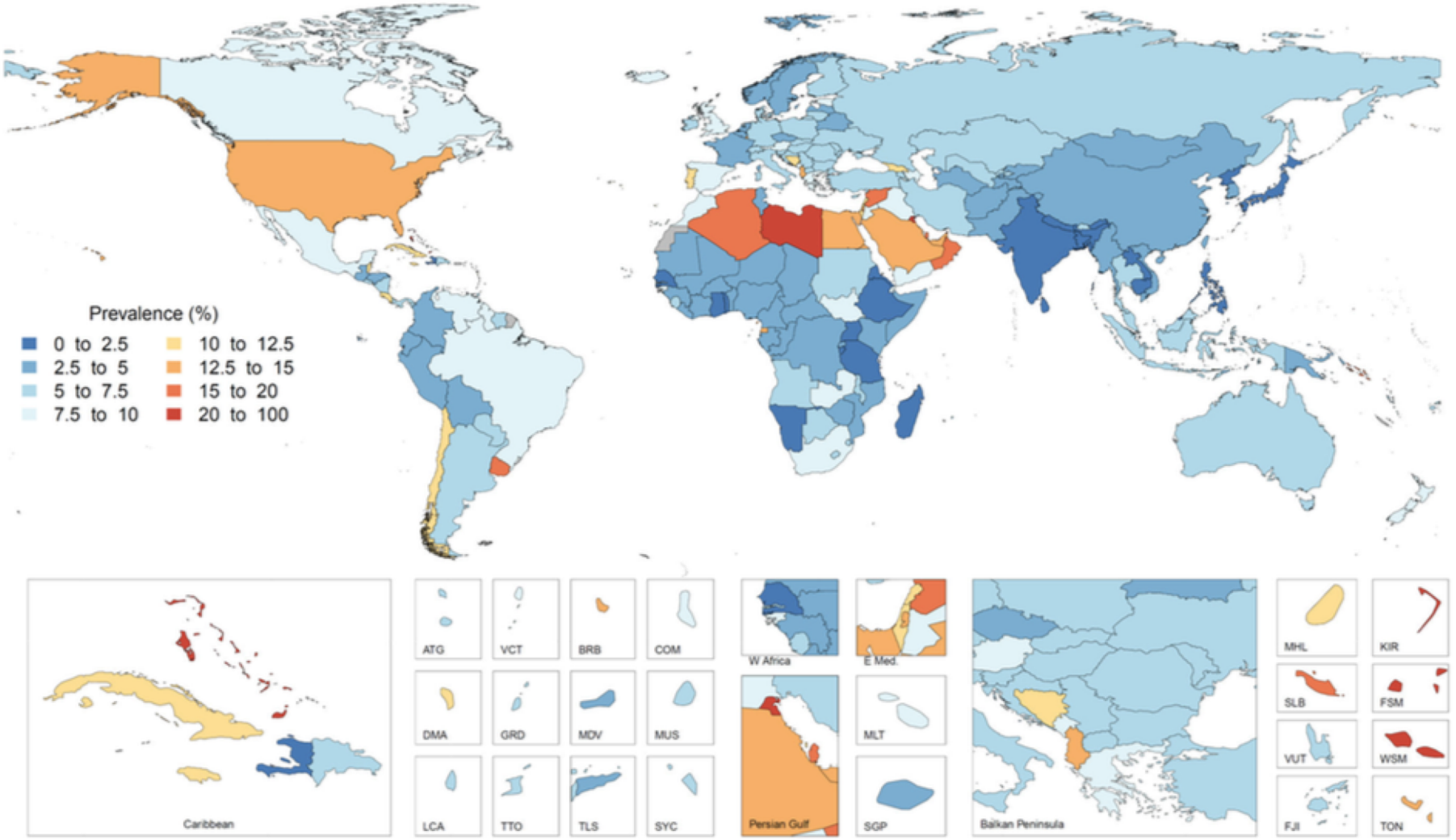
Source: The GBD 2013 Obesity Collaboration. Global regional and national prevalence of overweight and obesity in children and adults 1980-2013: A systematic analysis. Lancet 2014; 384(9945): 766-781.

Childhood Obesity (Boys), 2013



Source: The GBD 2013 Obesity Collaboration. Global regional and national prevalence of overweight and obesity in children and adults 1980-2013: A systematic analysis. Lancet 2014; 384(9945): 766-781.

Childhood Obesity (Girls), 2013



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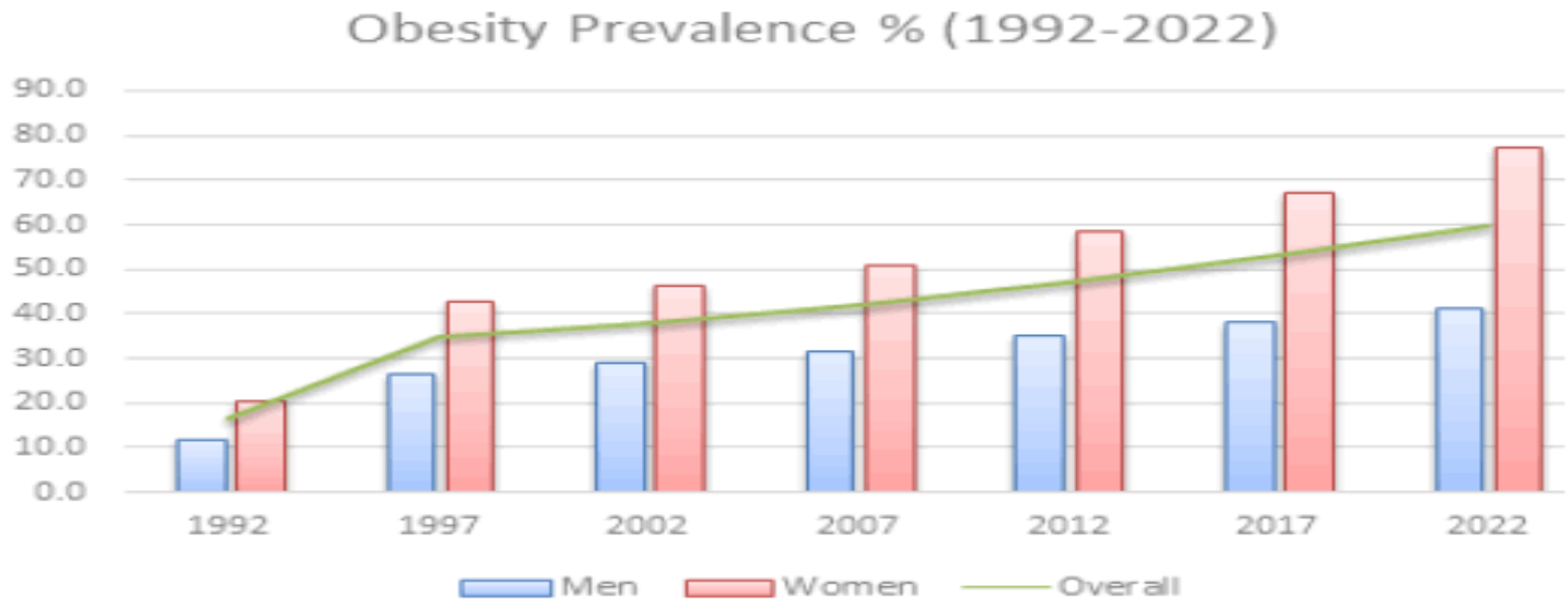
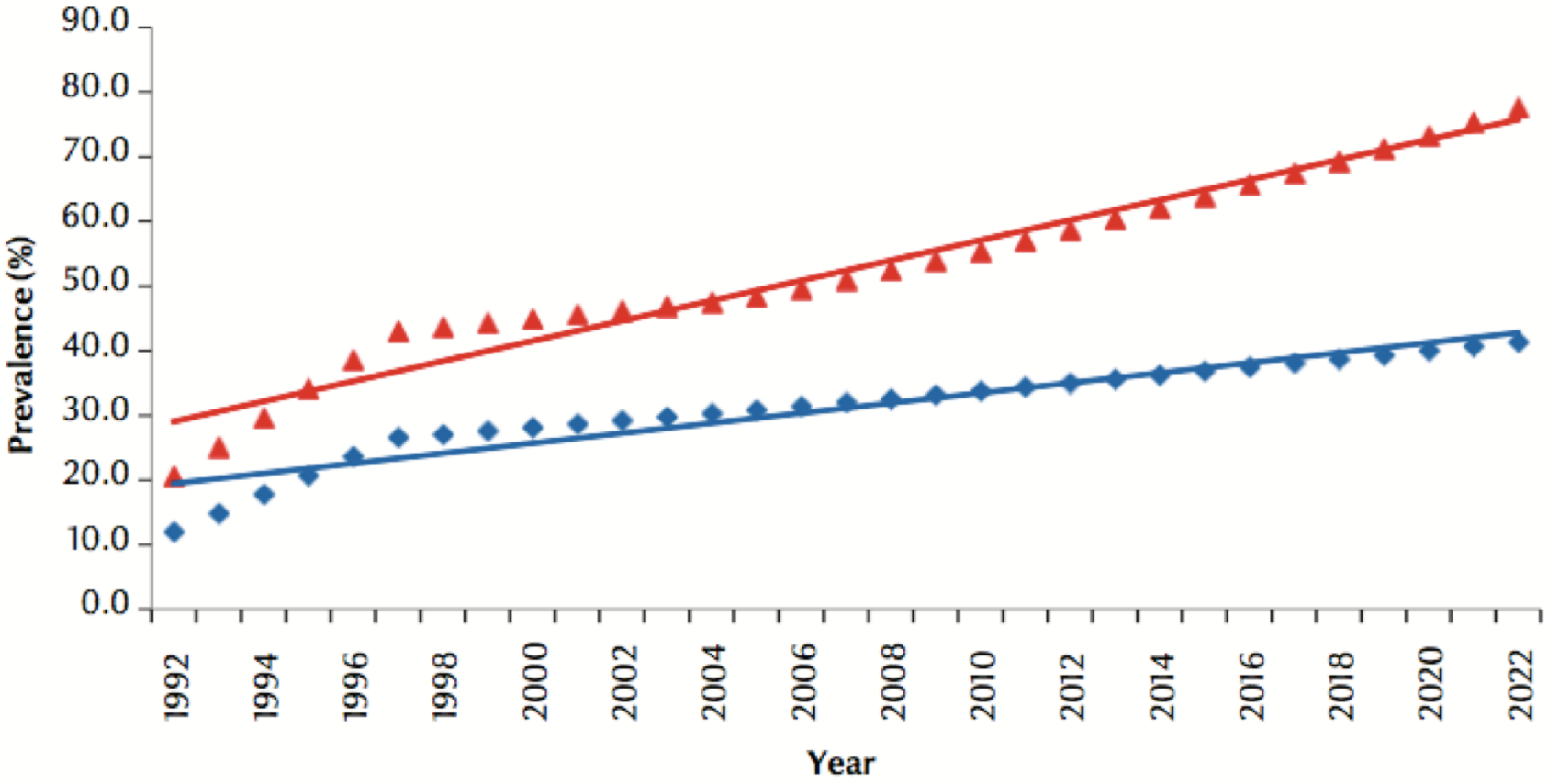


M Alqarni SS (2016) A Review of Prevalence of Obesity in Saudi Arabia. J Obes Eat Disord 2:2. doi: 10.21767/2471-8203.100025

Projections of obesity in Saudi Adults



Source: Al-Quwaidhi AJ, Pearce MS, Critchley JA, Sobngwi E, O'Flaherty M. Trends and future projections of the prevalence of adult obesity in Saudi Arabia, 1992-2022.

Incidence of obesity

- No official measures of Saudi obesity incidence currently
- Would require accurately identifying the **population at risk** (non-obese) at a given time, as well as **new cases**
- Potential for prospective cohort studies

Attributes associated with obesity

Who is most affected?

Race/ethnicity

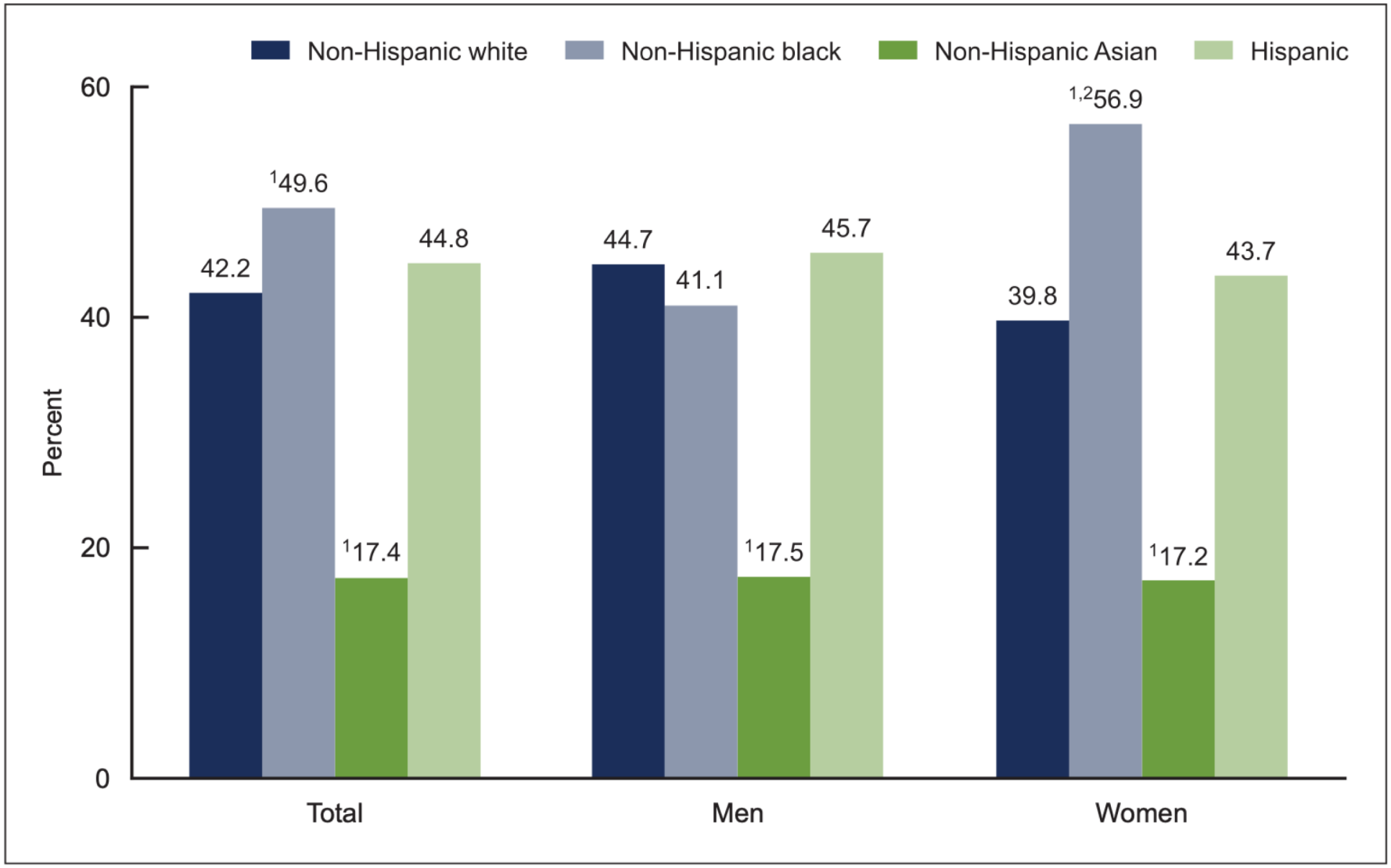
Adults

- 47% Hispanic
- 46.8% non-Hispanic black
- 37.9% non-Hispanic white
- 12.7% non-Hispanic Asian

Children/Adolescents

- 25.8% Hispanic
- 22% non-Hispanic black
- 14.1% non-Hispanic white
- 11% non-Hispanic Asian

Figure 2. Age-adjusted prevalence of obesity among adults aged 20 and over, by sex and race and Hispanic origin: United States, 2017–2018



[1]Significantly different from all other race and Hispanic-origin groups.
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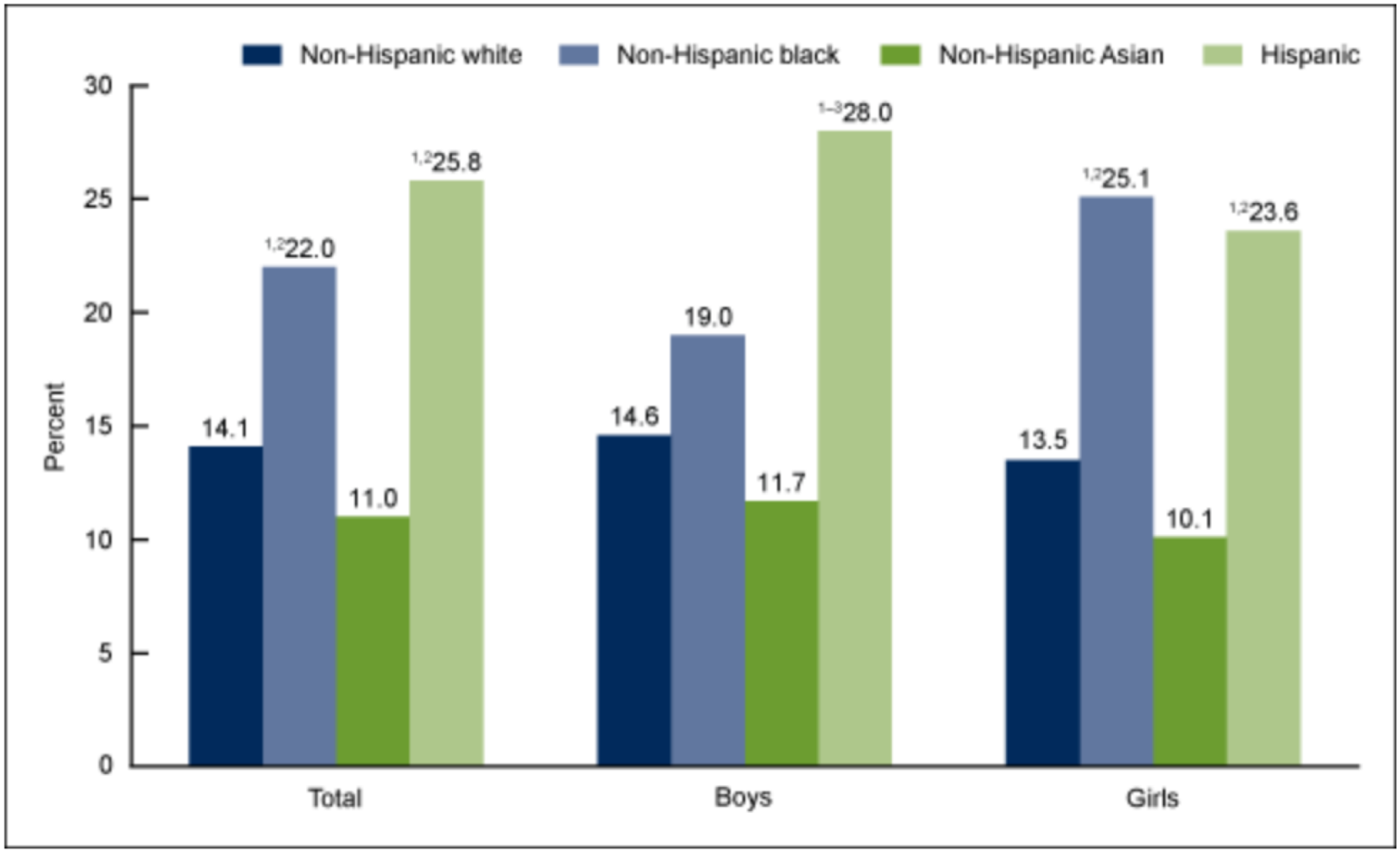
NOTES: Estimates were age adjusted by the direct method to the 2000 U.S. Census population using the age groups 20–39, 40–59, and 60 and over. Access data table for Figure 2 at: https://www.cdc.gov/nchs/data/databriefs/db360_tables-508.pdf#2.
SOURCE: NCHS, National Health and Nutrition Examination Survey, 2017–2018.

Figure 4. Prevalence of obesity among youth aged 2–19 years, by sex and race and Hispanic origin: United States, 2015–2016



Race/ethnicity

- The assumption that race reflects only biological distinctions is inaccurate.

- Suggestion from WHO Western Pacific Region that BMI cutoffs may need to be lower for some Asian populations due to increased risk for poor health outcomes

Age

Adults (20+)

- 42.8% ages 40-59
- 41% ages 60+
- 39.6% ages 20-39

Children/Adolescents

- 20.6% ages 12-19
- 18.4% ages 6-11
- 13.9% ages 2-5

Figure 1. Prevalence of obesity among adults aged 20 and over, by sex and age: United States, 2015–2016

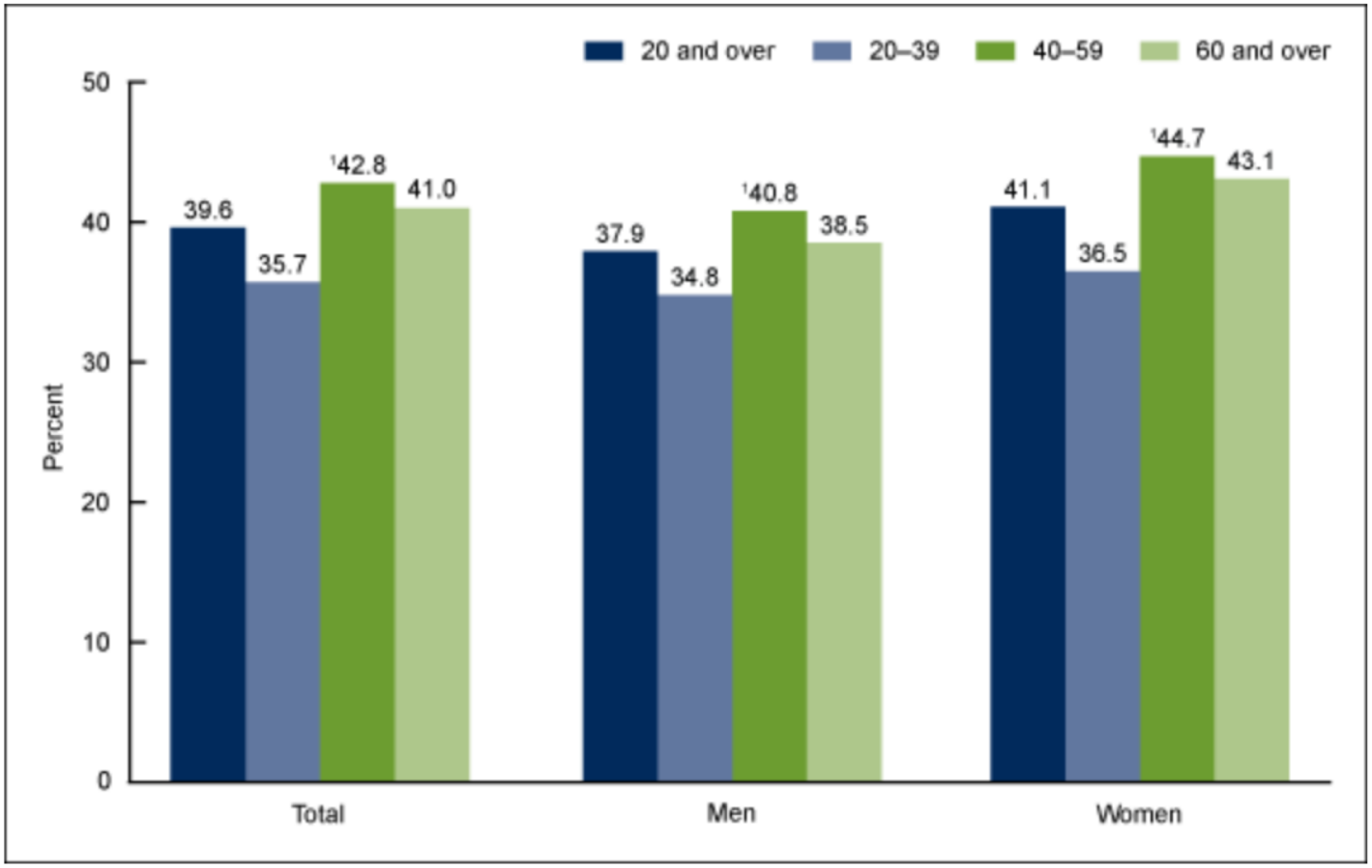


Figure 3. Prevalence of obesity among youth aged 2–19 years, by sex and age: United States, 2015–2016

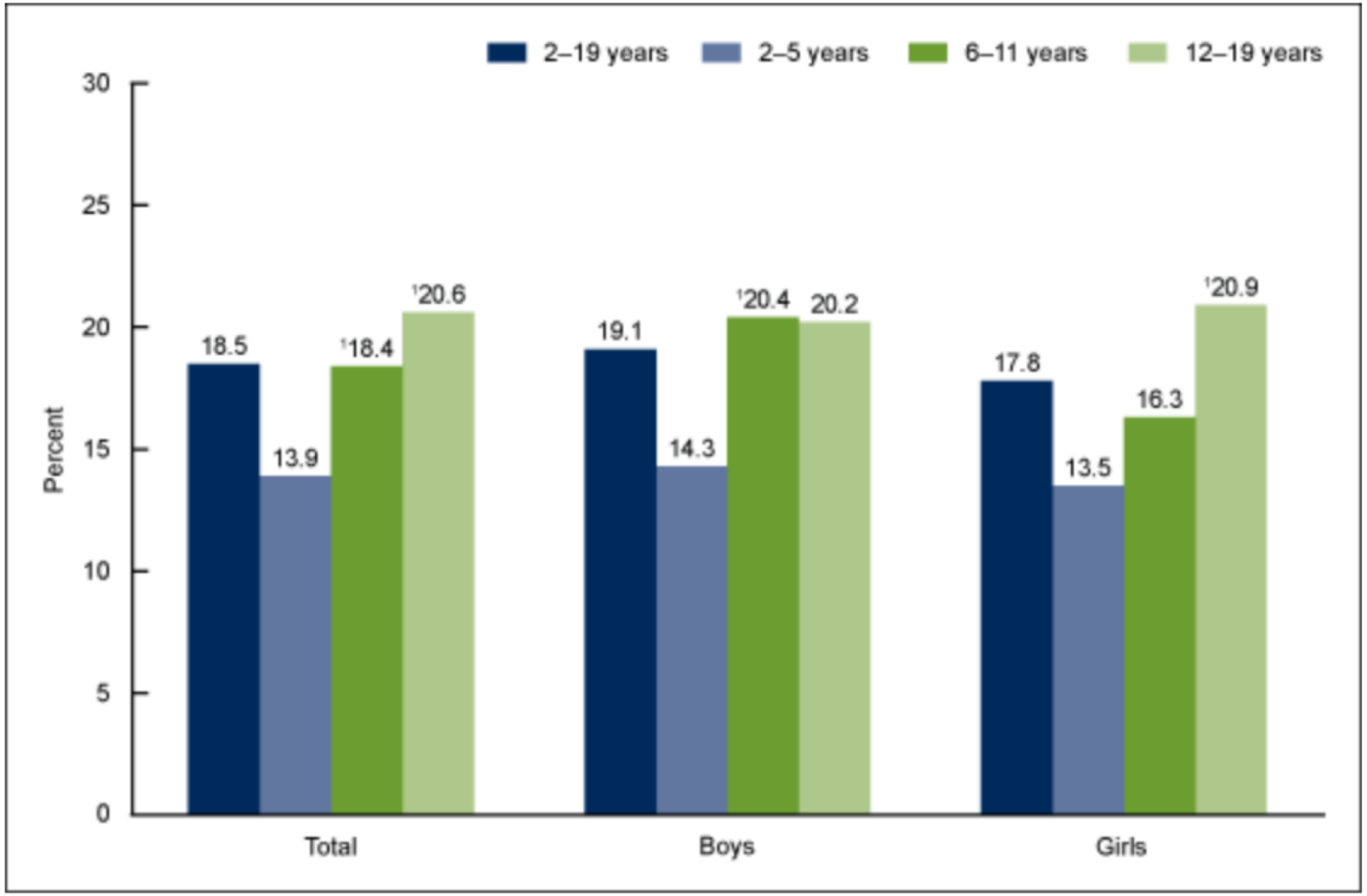
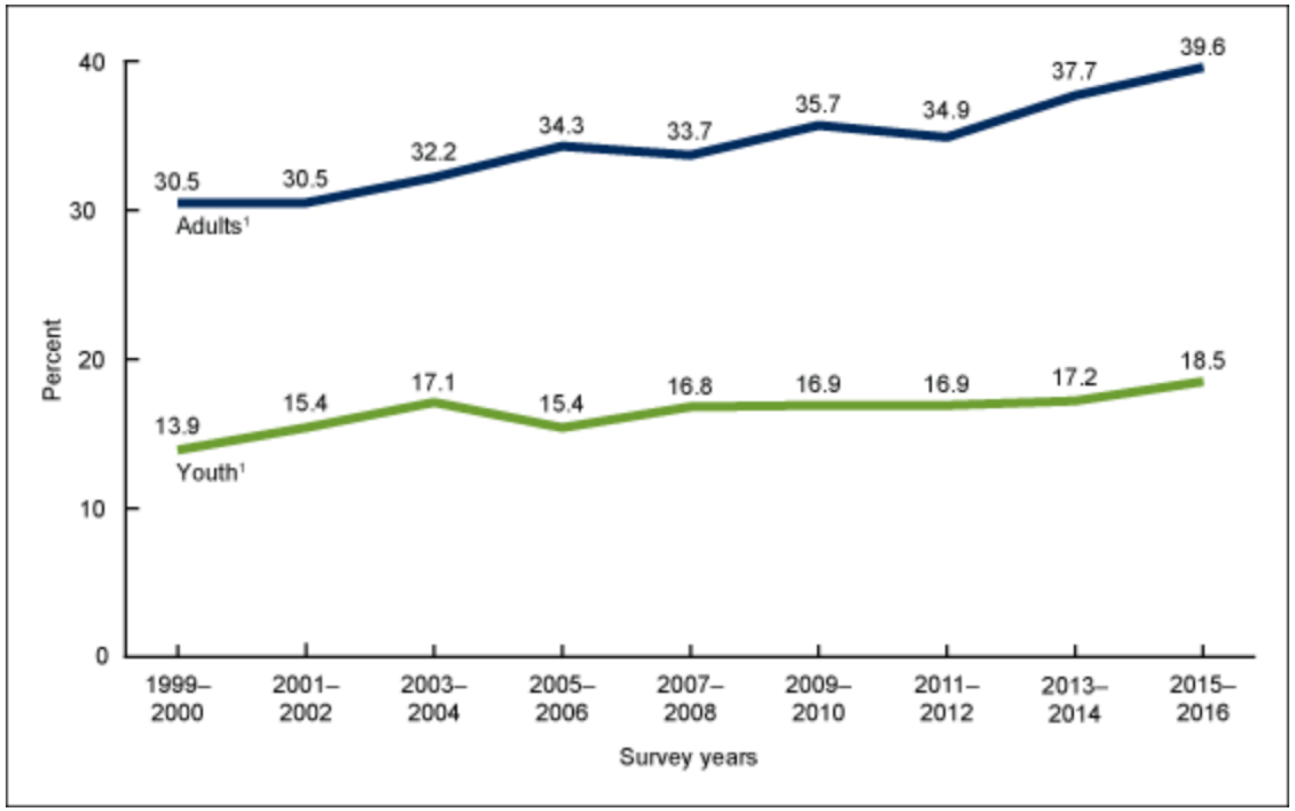
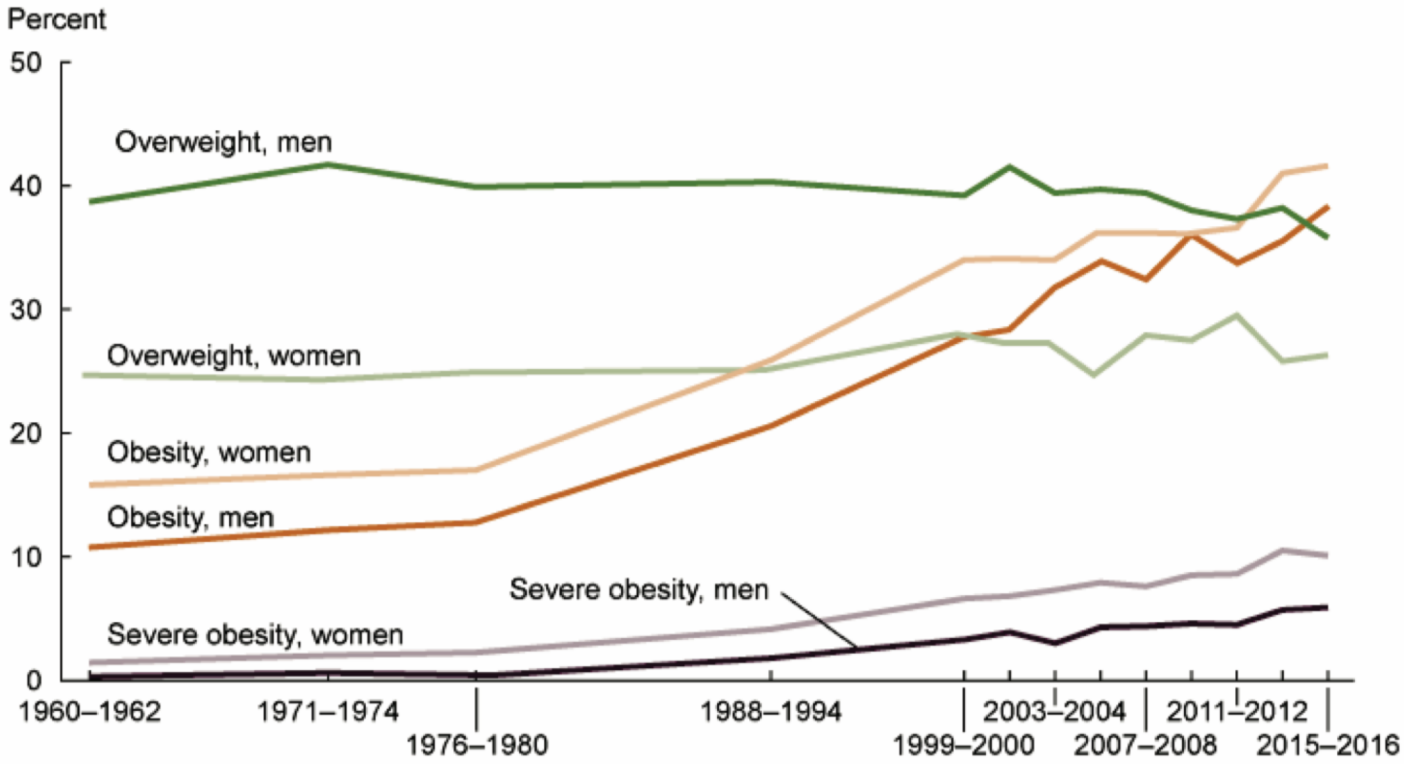


Figure 5. Trends in obesity prevalence among adults aged 20 and over (age adjusted) and youth aged 2–19 years: United States, 1999–2000 through 2015–2016



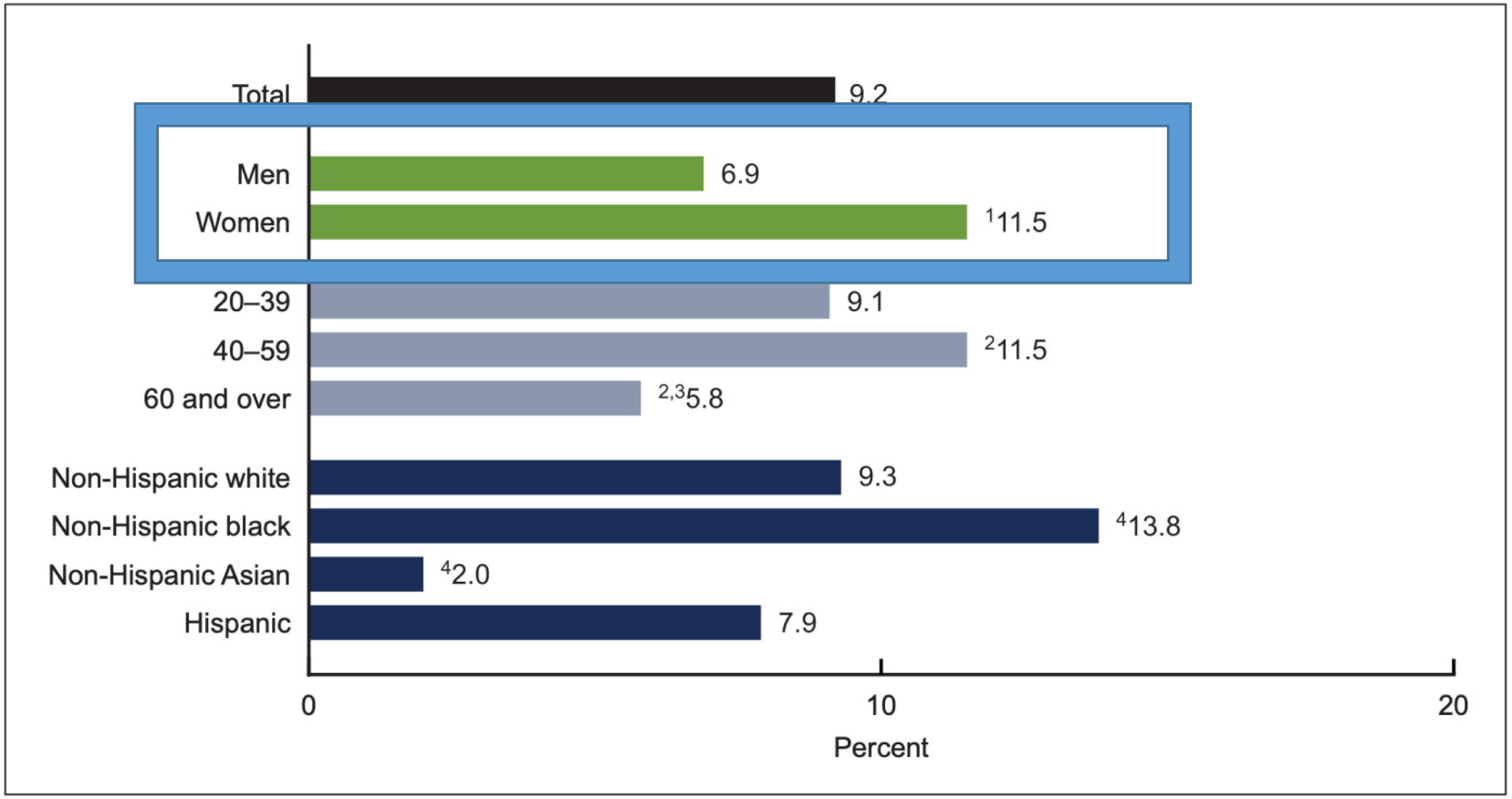
Sex

Figure. Trends in overweight, obesity, and severe obesity among men and women aged 20–74: United States, 1960–1962 through 2015–2016



NOTES: Data are age adjusted by the direct method to U.S. Census 2000 estimates using age groups 20–39, 40–59, and 60–74. Overweight is body mass index (BMI) of 25.0–29.9 kg/m^2; obesity is BMI at or above 30.0 kg/m^2; and severe obesity is BMI at or above 40.0 kg/m^2. Pregnant women are excluded from the analysis.
SOURCES: NCHS, National Health Examination Survey and National Health and Nutrition Examination Surveys.

Figure 3. Age-adjusted prevalence of severe obesity among adults aged 20 and over, by sex, age, and race and Hispanic origin: United States, 2017–2018

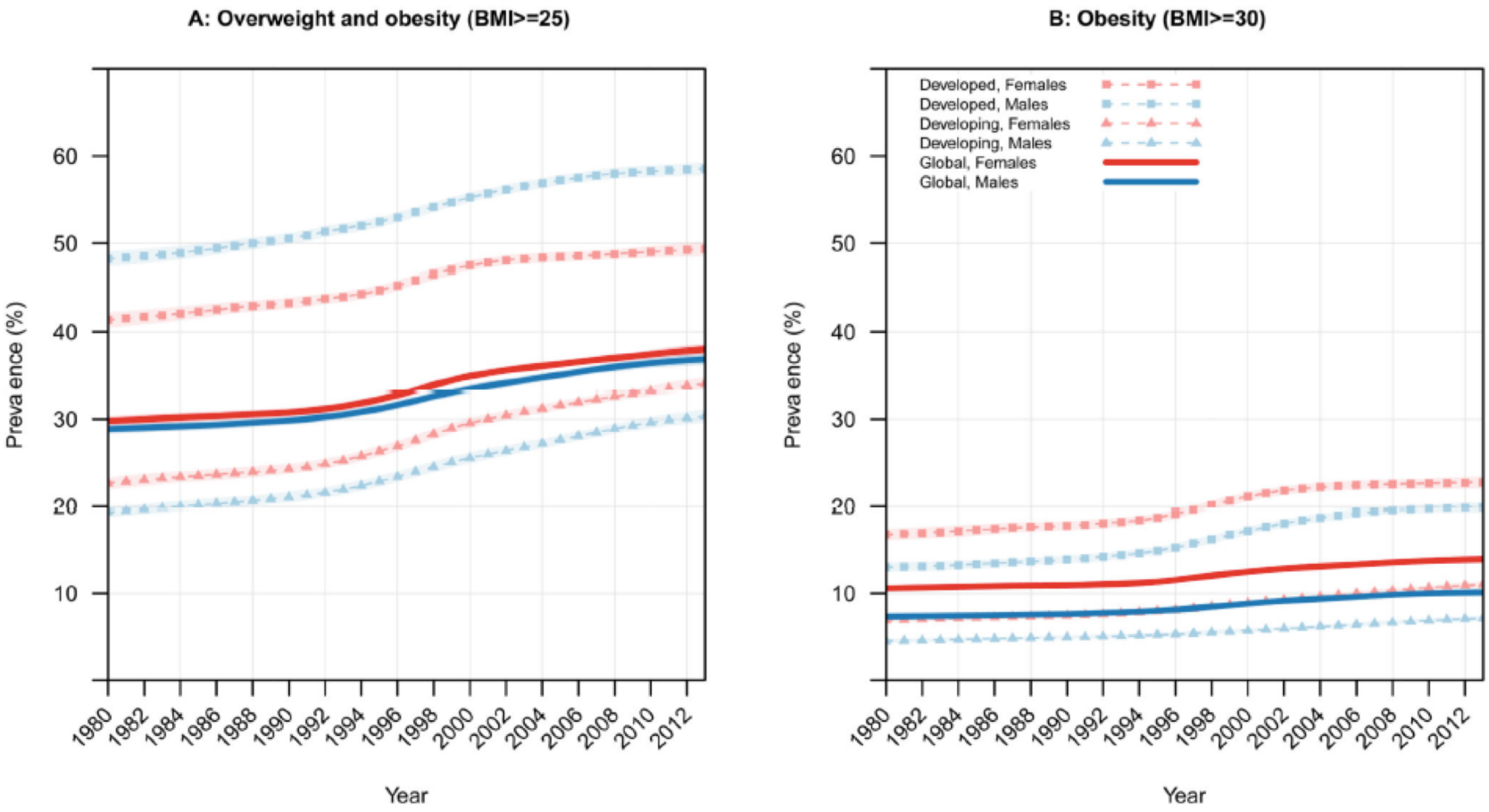


[1]Significantly different from men.
[2]Significantly different from adults aged 20–39.
[3]Significantly different from adults aged 40–59.
[4]Significantly different from all other race and Hispanic-origin groups.
NOTES: Estimates for adults aged 20 and over were age adjusted by the direct method to the 2000 U.S. Census population using the age groups 20–39, 40–59, and 60 and over. Crude estimates are 9.0% for total, 6.8% for men, and 11.1% for women. Access data table for Figure 3 at: https://www.cdc.gov/nchs/data/databriefs/db360_tables-508.pdf#3.
SOURCE: NCHS, National Health and Nutrition Examination Survey, 2017–2018.

Income

- Higher incomes associated with decreased risk of obesity in women, but increased risk in non-Hispanic black men and Mexican-American men
- Being at or below the poverty line is associated with higher rates of obesity among children
- 9 of 10 states with the highest obesity rates are among the poorest

Overweight and Obesity in Adults Globally 2013



Source: The GBD 2013 Obesity Collaboration. Global regional and national prevalence of overweight and obesity in children and adults 1980-2013: A systematic analysis. Lancet 2014; 384(9945): 766-781.

Many low- and middle-income countries are now facing a "double burden" of malnutrition.

- While these countries continue to deal with the problems of infectious diseases and undernutrition, they are also experiencing a rapid upsurge in noncommunicable disease risk factors such as obesity and overweight, particularly in urban settings.
- It is not uncommon to find undernutrition and obesity co-existing within the same country, the same community and the same household.

Education

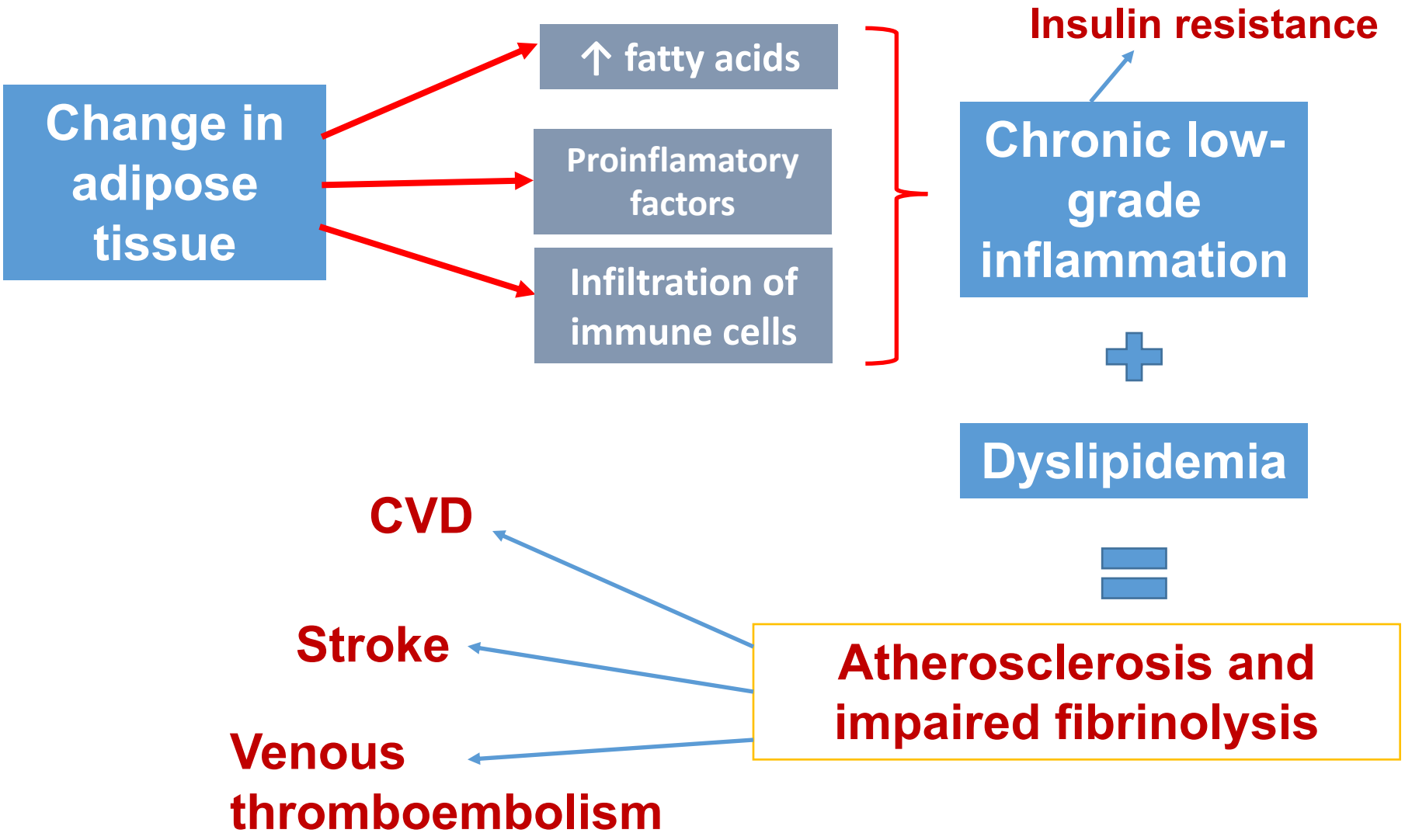
- Women with college degrees have lower risk of obesity compared to those with less education

- Generally, obesity rates are lower for children if head of household has college degree versus not finishing high school

Geography & culture

- Higher prevalence of obesity in rural areas
- States with highest rates of obesity also have lowest physical activity rates for adults
- Unhealthy food and physical activity environments
- Limited food access, availability, affordability

Pathophysiology of obesity



Risk Factors for Obesity

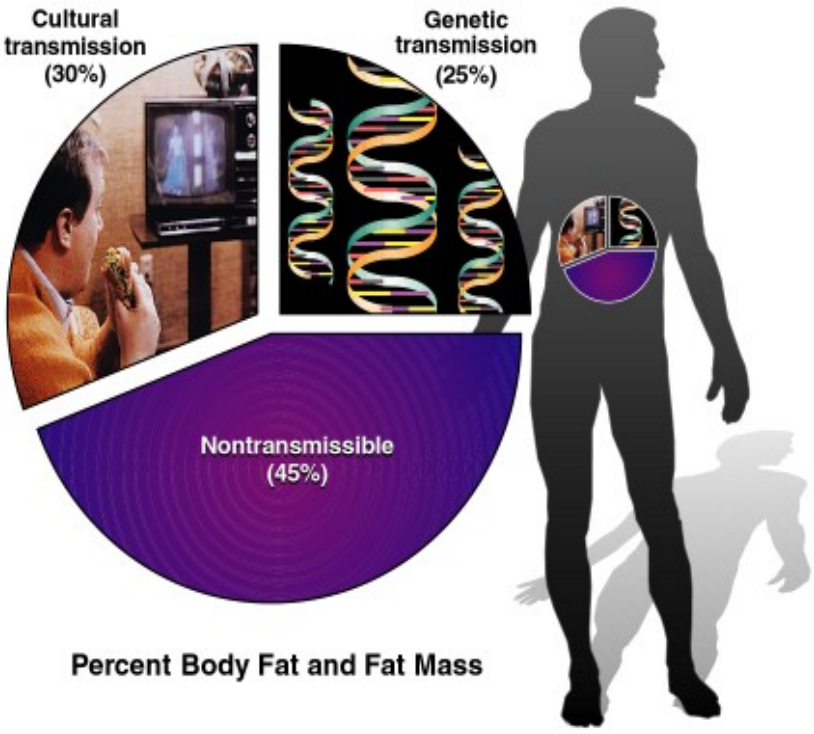
- Genetic factors
- Hormonal factors
- Environmental factors
- Behavioral factors

Genetics

- Family history of obesity
- Other conditions, such as Cushing's disease or polycystic ovary syndrome
- Potential gene variants affecting hunger or metabolism, interacting with environmental influences

- **Genetics plays a role**
  - How much variation in weight gain among individuals can be accounted for by genetic factors?
  - Largest transmissible variation is cultural.

19.1. Total transmissible variance for body fat.



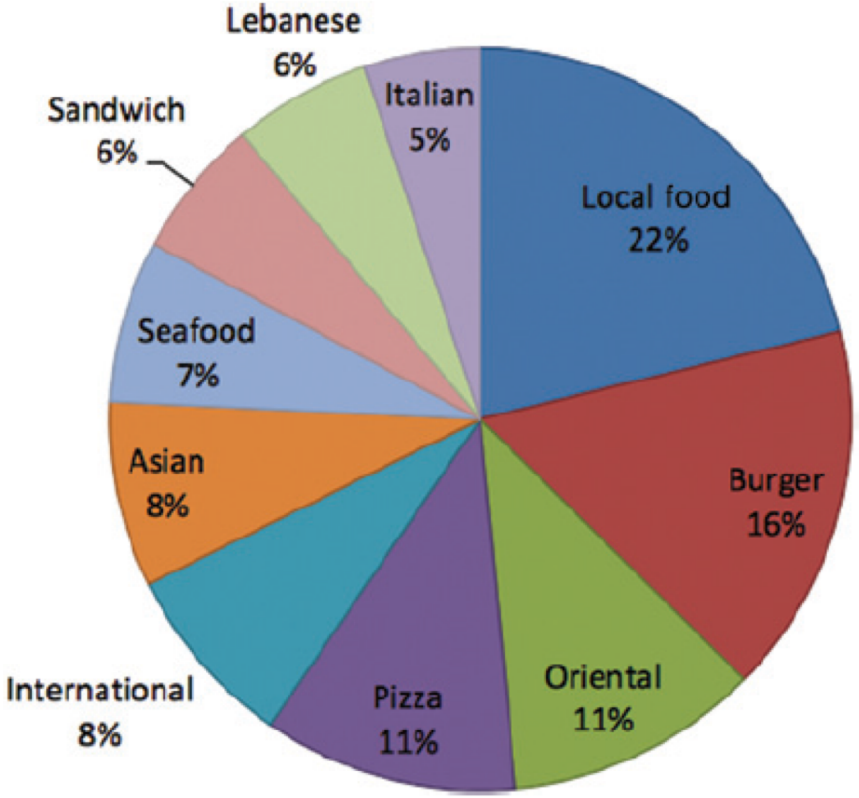
Hormonal risk factors for obesity

- Hypothyroidism
- Growth hormone deficiency
- Cushing syndrome
- Hypothalamic obesity
- Polycystic ovary syndrome (PCO)
- Hyperprolactinemia

Environmental/societal risk factors for obesity

- Low income
- Parents' bad habits for food and physical activity
- Difficulty accessing places with healthy food options (food desert)
- Living far away from parks
- Dangerous neighborhoods
- Food insecurity (no sufficient quantity of affordable healthy food)

Top ten restaurant types searched on phone-apps in 2013



Source: DeNicola E, Aburizaiza OS, Siddique A, Khawaja H, Carpenter DO. Obesity and public health in the Kingdom of Saudi Arabia. Rev Environ Health 2015; 30(3): 191-205.

Behavioral risk factors for obesity

- Nutrition and diet
- Physical activity
- Sleep
- Stress

Adverse behaviors

- Diets high in calories, added sugars, fast food
  - Average daily calorie intake for adults: 2,234
- Low physical activity
  - Only 19% of Americans meet minimum guidelines
  - Saudi Arabia is one of the countries with low physical activity
- Television or other media
  - Sedentary activity
  - Increased exposure to food/beverage marketing
  - Over 7.5 hours daily for older children/adolescents

Other risk factors

- Maternal smoking
- Extreme birthweight (low or high)
- Not being breastfed
- Disabilities
- Medications (steroids, antidepressants)

Morbidity/mortality

Effects on population health

"I would argue that [obesity] is the **most significant public health challenge we face** at this time, both because of the huge number of people it affects and because of the ripple effects it has and will have on the development of debilitating and costly chronic diseases."

- Daniel R. Glickman, Chair, Institute of Medicine's Committee on Accelerating Progress in Obesity Prevention, 2012

Morbidity associated with obesity

- **Degree of abdominal fat accumulation is correlated with increased risk of:**

- Type 2 Diabetes
- Cardiovascular Disease
- Stroke
- Hypertension
- Nonalcoholic fatty liver disease
- Osteoarthritis
- Some cancers

TABLE 2-1 Physical Health, Psychosocial, and Functional Consequences of Obesity Over the Life Course

Physical Health	Psychosocial	Functional
• Cardiovascular disease • Cancer • Glucose intolerance and insulin resistance • Type 2 diabetes • Hypertension • Dyslipidemia • Hepatic steatosis • Cholelitasis • Sleep apnea • Reduction of cerebral blood flow • Menstrual abnormalities • Orthopedic problems • Gallbladder disease • Hyperuricemia and gout	• Stigma • Negative stereotyping • Discrimination • Teasing and bullying • Social marginalization • Low self-esteem • Negative body image • Depression	• Unemployment • Mobility limitations • Disability • Low physical fitness • Absenteeism from school or work • Disqualification from active service in the military and fire/police services • Reduced productivity • Reduced academic performance

SOURCE: Adapted from IOM, 2010a.

Morbidity from childhood obesity

- Preschoolers who are overweight or obese are 5 times as likely to be overweight or obese as adults
- Obesity is a **long term** process.
- Obesity frequently begins in childhood.
- **Obese parents** likely have overweight children.
- Regardless of final body weight as adults, overweight children exhibit more illnesses as adults than normal kids.

Mortality

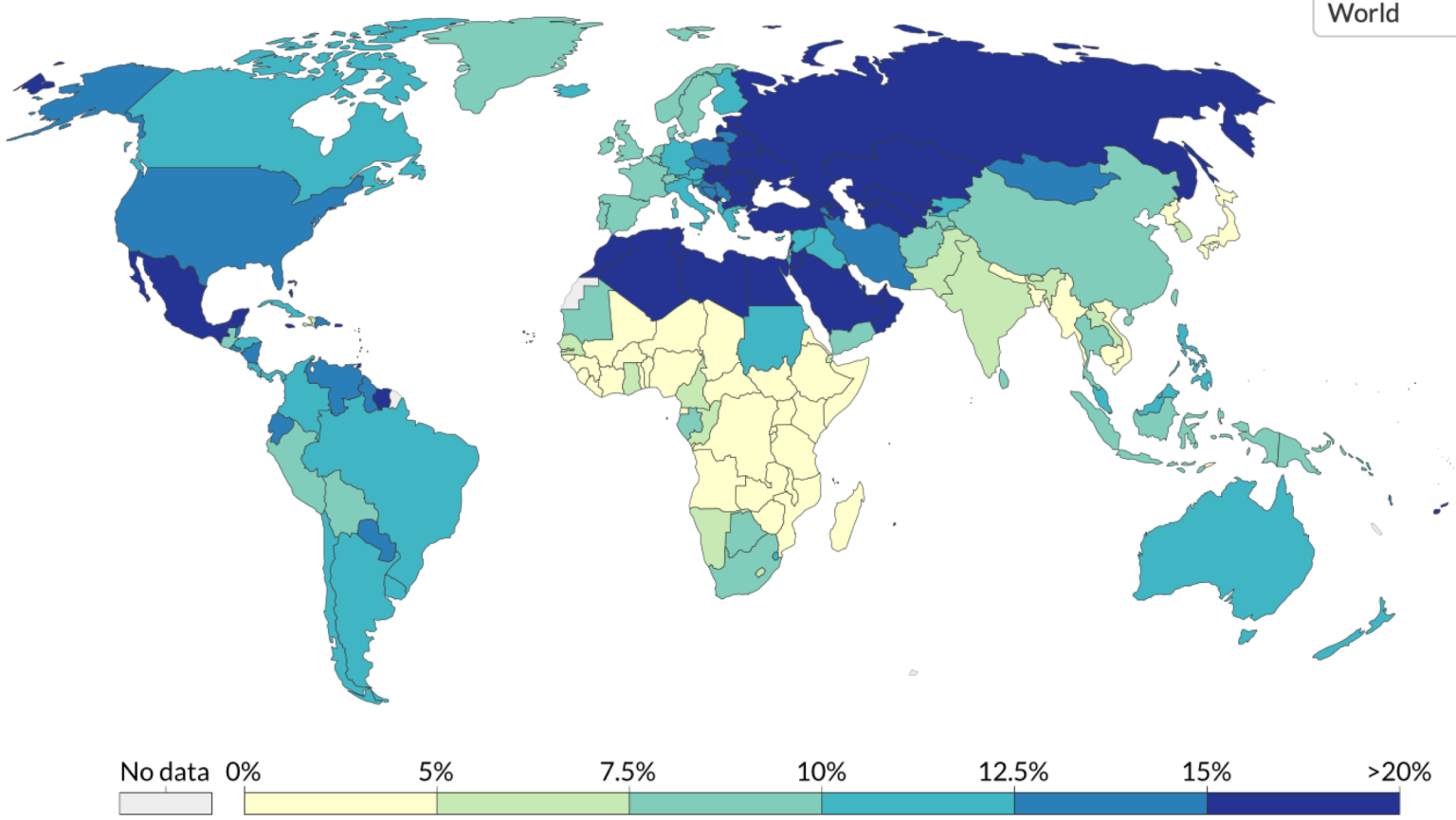
- More deaths globally associated with obesity/overweight than underweight
  - 2.8 million per year

Share of deaths attributed to obesity, 2017

Obesity is defined as having a body-mass index (BMI) equal to or greater than 30. BMI is a person's weight in kilograms
divided by his or her height in metres squared.

Our World in Data

World



Source: IHME, Global Burden of Disease

1990 2017

Screening

Limitations and Recommendations

Body Mass Index

- BMI was first used in 1835 as a way to estimate the proportion of body fat based on height and weight
- BMI has low sensitivity, especially below 30
- Cannot discern fat vs. muscle content or metabolic risk factors
- Validity?
- At the same BMI, women tend to have more body fat than men.
- At the same BMI, older people, on average, tend to have more body fat than younger adults.
- Highly trained athletes may have a high BMI because of increased muscularity rather than increased body fatness.

BMI + waist circumference

TABLE 1. National Heart Lung and Blood Institute Classifications of Overweight and Obesity by BMI and Waist Circumference in Adults[4]

Classification	BMI (kg/m^2)	Risk of type 2 diabetes, hypertension, and CVD *relative* to normal weight and waist circumference*	
		Men ≤ 40 in Women ≤ 35 in	Men ≥40 in Women ≥ 35 in
Underweight	< 18.5	---	---
Normal weight	18.5 – 24.9	---	---
Overweight	25.0 – 29.9	Increased	High
Obesity (Class I)	30.0 – 34.9	High	Very High
Obesity (Class II)	35.0 – 39.9	Very High	Very High
Extreme obesity (Class III)	≥ 40	Extremely High	Extremely High

*NHLBI guidelines note that increased waist circumference can indicate increased disease risk even in individuals considered normal weight.

Additional limitations

- Self-report of height & weight in surveys

Costs

Financial impacts on the health care system

Costs of obesity

- Medical care costs increasing over time mostly due to rise in obesity prevalence

- Socioeconomic costs also related to disability and premature death

Costs of obesity

$147 billion in health care costs in 2008

(10% of all medical spending)

Increases in spending from 1998-2006

- 8.5% ($34.3 billion) Medicare
- 11.8% ($27.6 billion) Medicaid
- 12.9% ($74.6 billion) Commercial insurance

http://www.commed.vcu.edu/Chronic_Disease/Obesity/2013/assessingobesityinterventions_0312.pdf

Interventions

Primary, secondary, tertiary, community-level

Primary prevention

Preventing obesity **before** it occurs

- Regulating caloric energy balance to prevent problematic weight gain
  - Diet
  - Physical activity
- Environmental factors

Address barriers to a healthy diet

- Access to healthy food
- Food advertising
- Large portion sizes
- Affordability of healthy food
- Time constraints
- Established behaviors

Address barriers to physical activity

- Zoning
- Safety
- Areas conducive to physical activity
- Time constraints
- Established behaviors

Physical activity guidelines

- 2.5 hours per week for adults
- 1 hour per day for children/adolescents
  - Physical activity tends to decline as children get older

Policy options

- Tax unhealthy foods/beverages
- Calorie labeling in food service facilities
- Food purchasing standards for hospitals/schools

Secondary prevention

- Recognize overweight or obese individuals early through screening in order to improve outcomes
  - Weight loss interventions
  - Challenges with sustaining weight loss over time
- Reduce risk factors associated with obesity
  - Secondary screening for potential comorbidities
- Need to understand different causes and responses to obesity in order to better target treatments

Tertiary prevention

Management of severe obesity to reduce complications

- Behavioral modifications
- Bariatric surgery
    - Type 2 diabetes, other comorbidities
- Medications, if shown to be effective

Community-level interventions

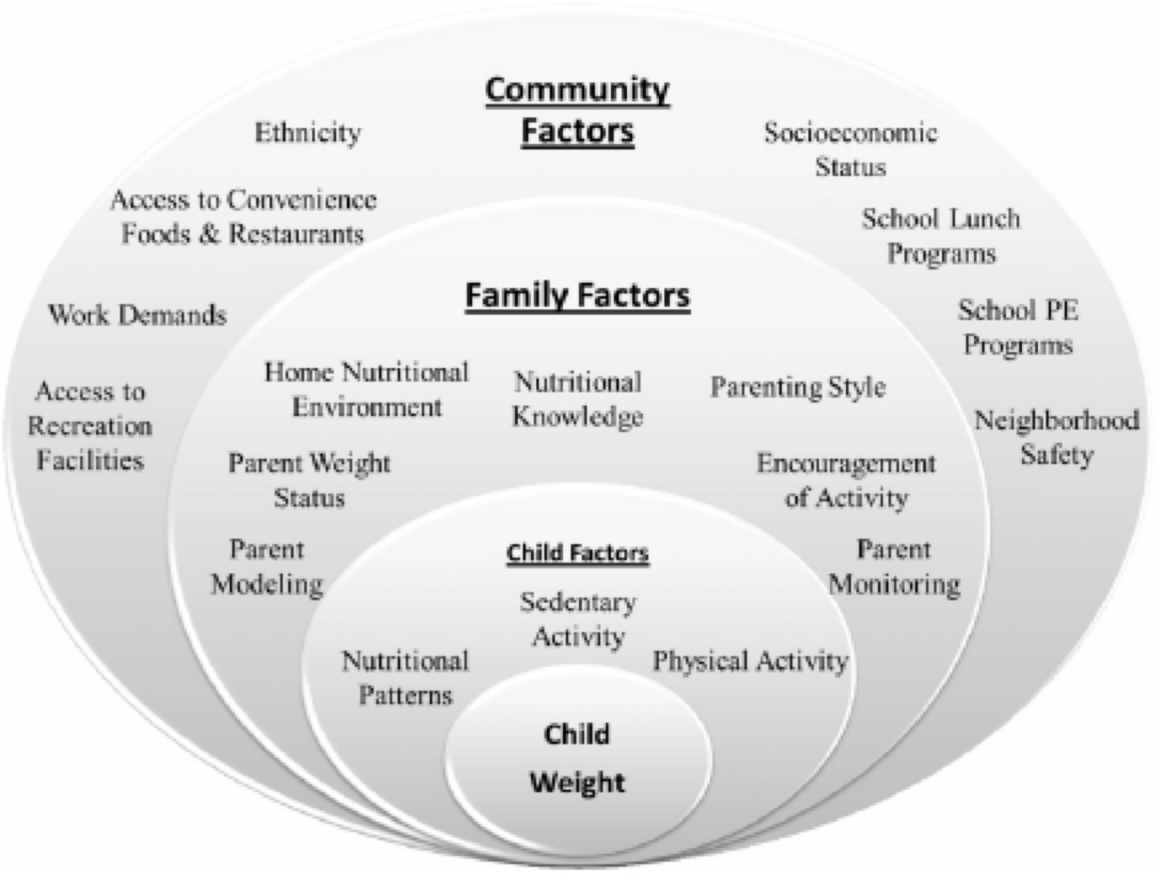
- Incentives for markets to locate to areas with limited food access
- Food and physical activity standards for childcare, schools, and hospitals
- Identifying viable/safe resources for promoting physical activity
- Partnerships for change, including healthy choices and behaviors
- Breastfeeding

Community-level interventions

Obesity Prevention Foundation

- Educational interventions in schools
- Focus on healthy diet/physical activity choices

Tackling factors affecting childhood obesity



(Adapted from Davison KK, Birch LL. Childhood overweight: a contextual model and

Source: Brown CL, Halvorson EE, Cohen GM, Lazorick S, Skelton JA. Addressing childhood obesity: opportunities for prevention. Pediatr Clin North Am 2015; 62(5): 1241-1261.

Summary

- Obesity is affected by a complex interaction between the environment, genetic predisposition, & human behavior.
- It has increased risk of numerous chronic diseases, from diabetes and cancers to many digestive diseases.
- The problem of overweight and obesity is one of the most pressing global issue with massive health care cost.
- Demands attention from the healthcare community, researchers, and policy makers.

Thank you

Questions?