The double burden of malnutrition and the new nutrition reality

··

Barry Popkin

W. R. Kenan, Jr. Distinguished University Professor
Department of Nutrition
Gillings School of Global Public Health
School of Medicine
Department of Economics
The University of North Carolina at Chapel Hill

UNC
CAROLINA POPULATION CENTER

THE W●RLD IS FAT

GLOBAL FOOD RESEARCH PROGRAM
University of North Carolina at Chapel Hill

Key messages on DBM

- Measurement: I focus on the classical double burden—namely the linkage of stunting or low weight for age and obesity at the country level.

- Later WHO will discuss the triple burden with some measures of micronutrient malnutrition.

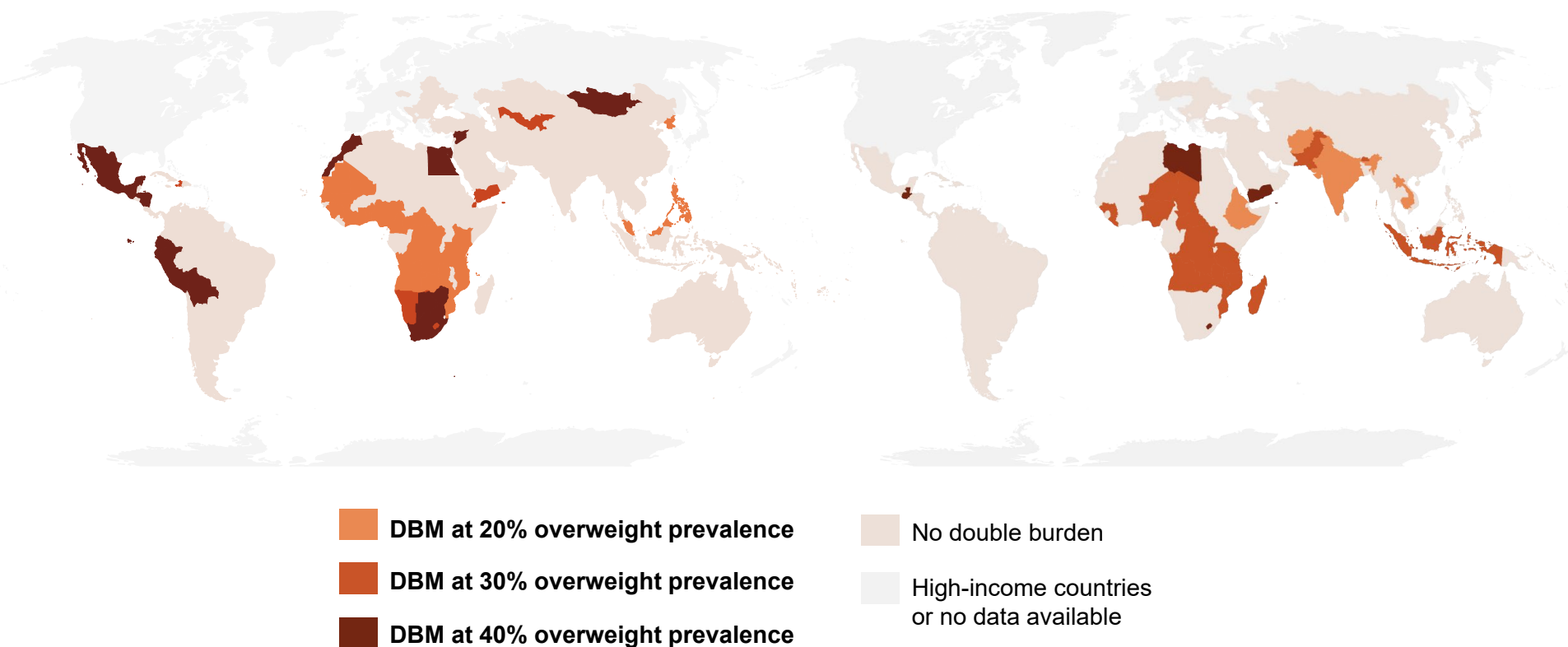- UNICEF, WHO and the World Bank created criteria for high levels of stunting that I use.

Popkin, B.M., C. Corvalan, and L.M. Grummer-Strawn. 2020. Dynamics of the Double Burden of Malnutrition and the Changing Nutrition Reality. Lancet. 395 (10217):65-74. https://doi.org/10.1016/S0140-6736(19)32497-3.

Global double burden of malnutrition in low- and middle-income countries based on 1990s and 2010–20s weight and height data*

(using UNICEF, WHO, World Bank, and NCD-RisC estimates, supplemented with selected DHS and other country direct measures)
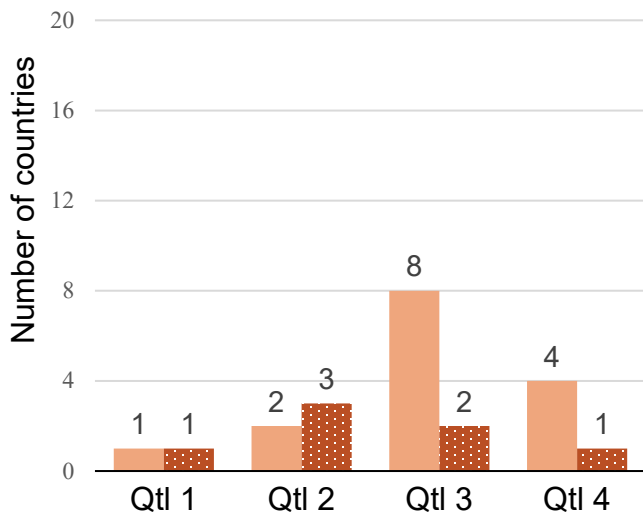
1990s double burden countries

2010s double burden countries

- DBM at 20% overweight prevalence
- DBM at 30% overweight prevalence
- DBM at 40% overweight prevalence

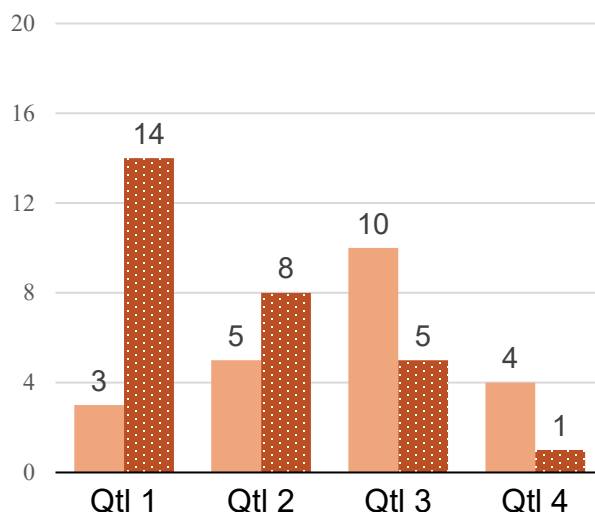- No double burden
- High-income countries or no data available

Double burden of malnutrition (DBM) = prevalence of child stunting exceeding threshold and prevalence of adult overweight exceeding threshold (shown at >20%, >30%, and >40% overweight prevalence)

Countries with high double burden of malnutrition* in 1990s and late 2010s/early 2020s, by time period and GDP/capita (PPP) quartile**
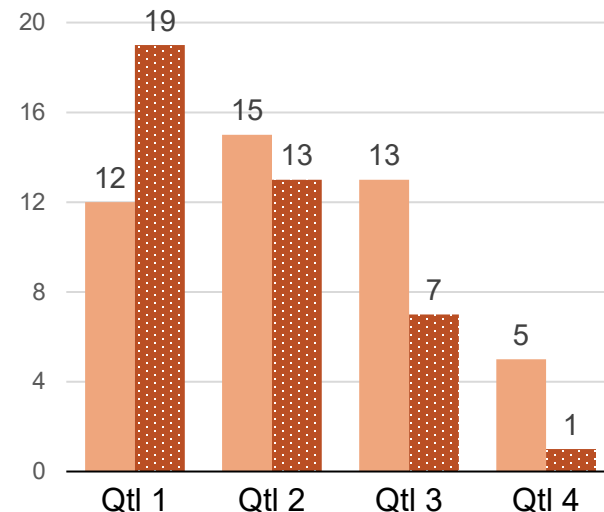
2a. DBM at 40% adult overweight prevalence

2b. DBM at 30% adult overweight prevalence

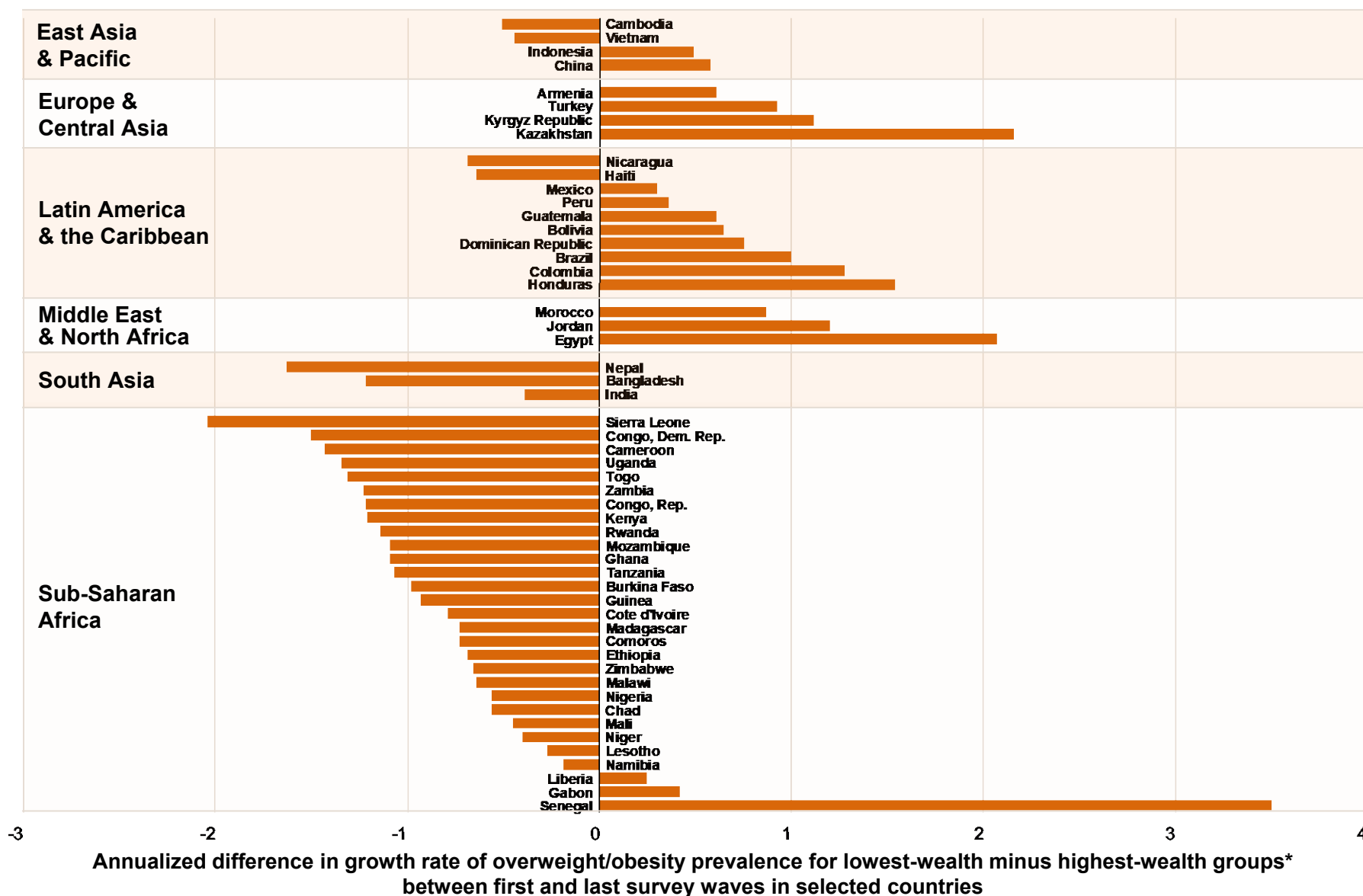### 2c. DBM at 20% adult overweight prevalence

Number of countries

1990s   2010s

UNC
CAROLINA
POPULATION
CENTER

GLOBAL FOOD
RESEARCH PROGRAM
University of North Carolina
at Chapel Hill

The shifting burden of overweight/obesity from higher- to lower-wealth populations

Annualized difference in growth rate of overweight/obesity prevalence for lowest-wealth minus highest-wealth groups* between first and last survey waves in selected countries

East Asia & Pacific: Cambodia, Vietnam, Indonesia, China

Europe & Central Asia: Armenia, Turkey, Kyrgyz Republic, Kazakhstan

Latin America & the Caribbean: Nicaragua, Haiti, Mexico, Peru, Guatemala, Bolivia, Dominican Republic, Brazil, Colombia, Honduras

Middle East & North Africa: Morocco, Jordan, Egypt

South Asia: Nepal, Bangladesh, India

Sub-Saharan Africa: Sierra Leone, Congo, Dem. Rep., Cameroon, Uganda, Togo, Zambia, Congo, Rep., Kenya, Rwanda, Mozambique, Ghana, Tanzania, Burkina Faso, Guinea, Cote d'Ivoire, Madagascar, Comoros, Ethiopia, Zimbabwe, Malawi, Nigeria, Chad, Mali, Niger, Lesotho, Namibia, Liberia, Gabon, Senegal

Key messages on DBM

- In LMIC's, undernutrition is declining while overweight is increasing much more rapidly.

- However, stunting was highly prevalent, so increases in overweight prevalence (20% or more in all countries) are leading to high DBM levels.

- Of 126 LMICs, 38% face a DBM prevalence that we define as very high or severe.

- The DBM is shifting toward countries in the poorest income quartile, particularly in South and Southeast Asia and sub-Saharan Africa.

The key increasing risk factor: Global obesity?

- For regions such as Asia: Overweight means very high risk and high likelihood of key NCDs.

- Focus on both overweight and obesity as major risk factors

  - Note: Adult obesity precedes child obesity by 10-15 years

- Rightward shift in BMI at all ages — age-period-cohort and other research suggests 8-10 kg increase over past 10-20 years *(e.g., Jaacks et al, IJE 42:828-837)*

- Waist circumference at each BMI level is increasing

- Remember much higher body fat proportion, visceral fat among many LMIC subpopulations. Also increased NCD susceptibility at lower BMI's

BMI increases across selected countries at the 95th centile in 30- and 40-year-old women: earlier year noted*
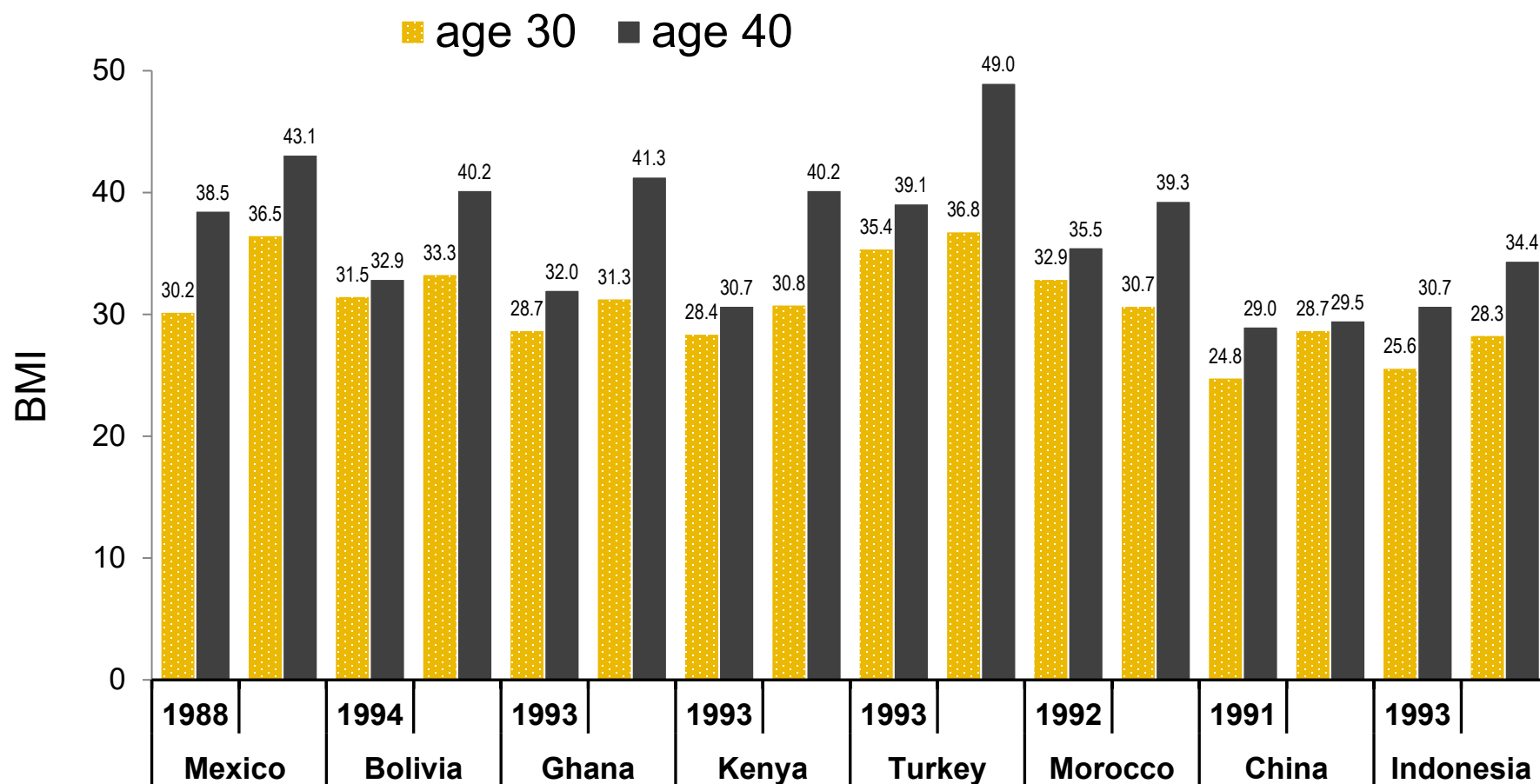
Based on quantile regression from nationally representative surveys of all countries except China Popkin, Amer J Clin Nutr: (2010 v 91)

Australian youth gain fat, shift body shape

Old's (2009) EJCN 1-13.

UNC
CAROLINA
POPULATION
CENTER

GLOBAL FOOD
RESEARCH PROGRAM
University of North Carolina
at Chapel Hill
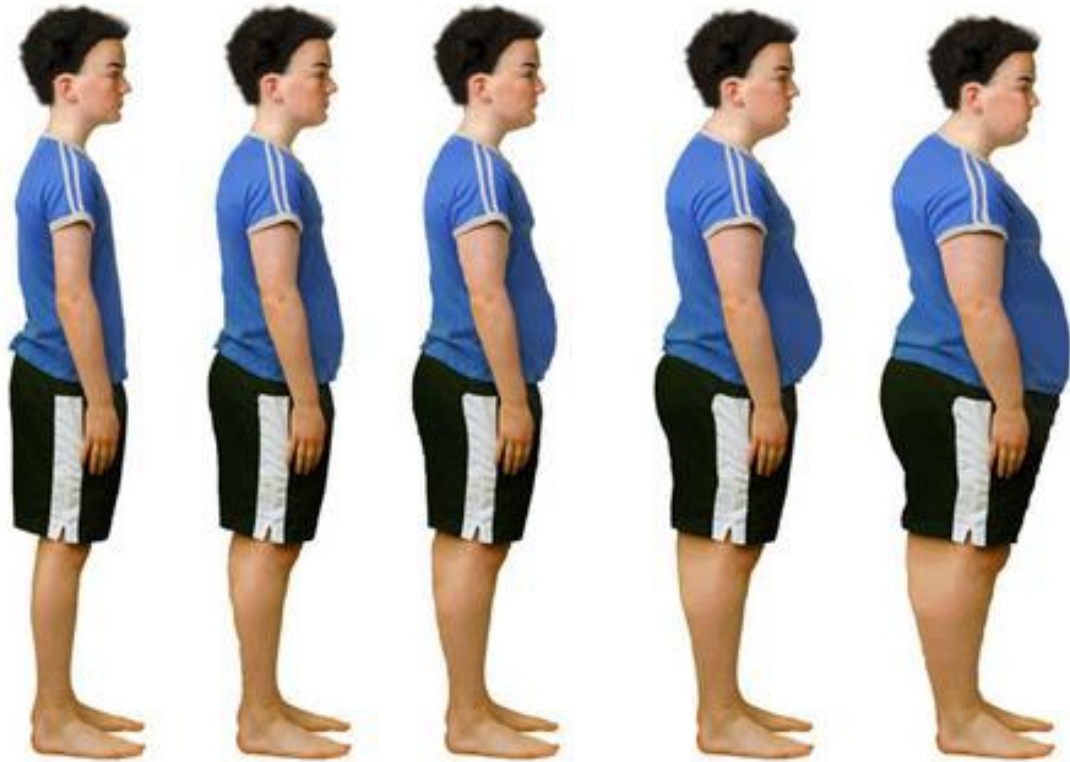
In most countries, waist circumferences are increasing at the same BMI
Example: Hispanic women, mean WC over time for females aged 20y and BMI=25 kg/m²
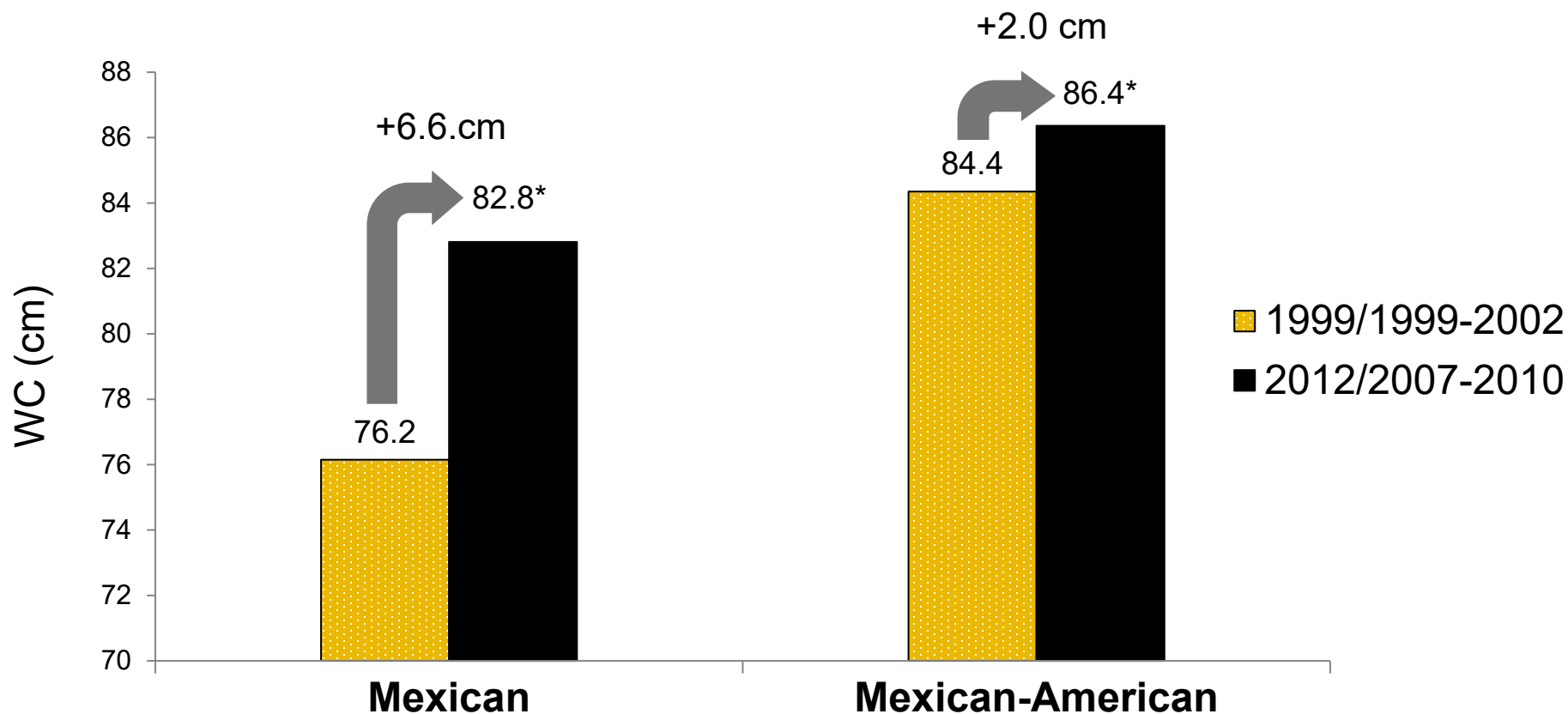
*p<0.0001, comparing predicted WC in most recent survey year to predicted WC in earlier survey year
** Mexican women and Mexican-American women.
All models adjusted for age, BMI, BMI-squared, and survey year in linear regression analyses.
Age centered to age 20 years and BMI centered to BMI=25 kg/m2

Source: Albrecht et al EJCN 2015; **69**: 1306-12.; Albrecht, et al AJHumBiol _26: 627–634

Predicted mean waist circumference (WC, cm) for BMI=25 kg/m2 in Year 2 compared to Year 1 for women aged 20-29 years in the United States (by race/ethnicity), England, Mexico, and China
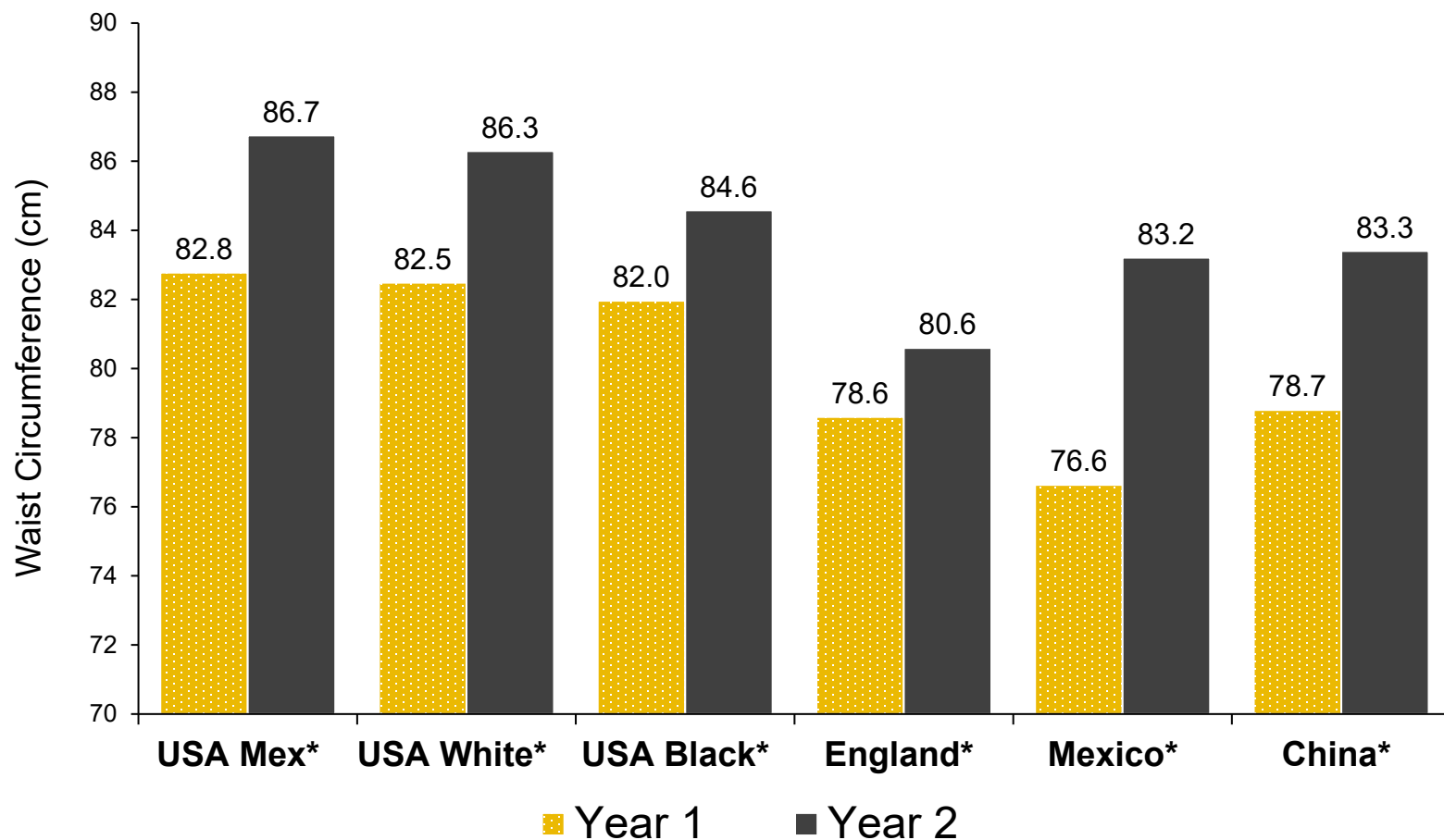
Bonferroni Corrected t-test significant at <.05 level.

Body fat in the East vs the West

BMI
22·3   22·3

Body fat
9·1%   21·2%

Yajnik & Yudkin 2004
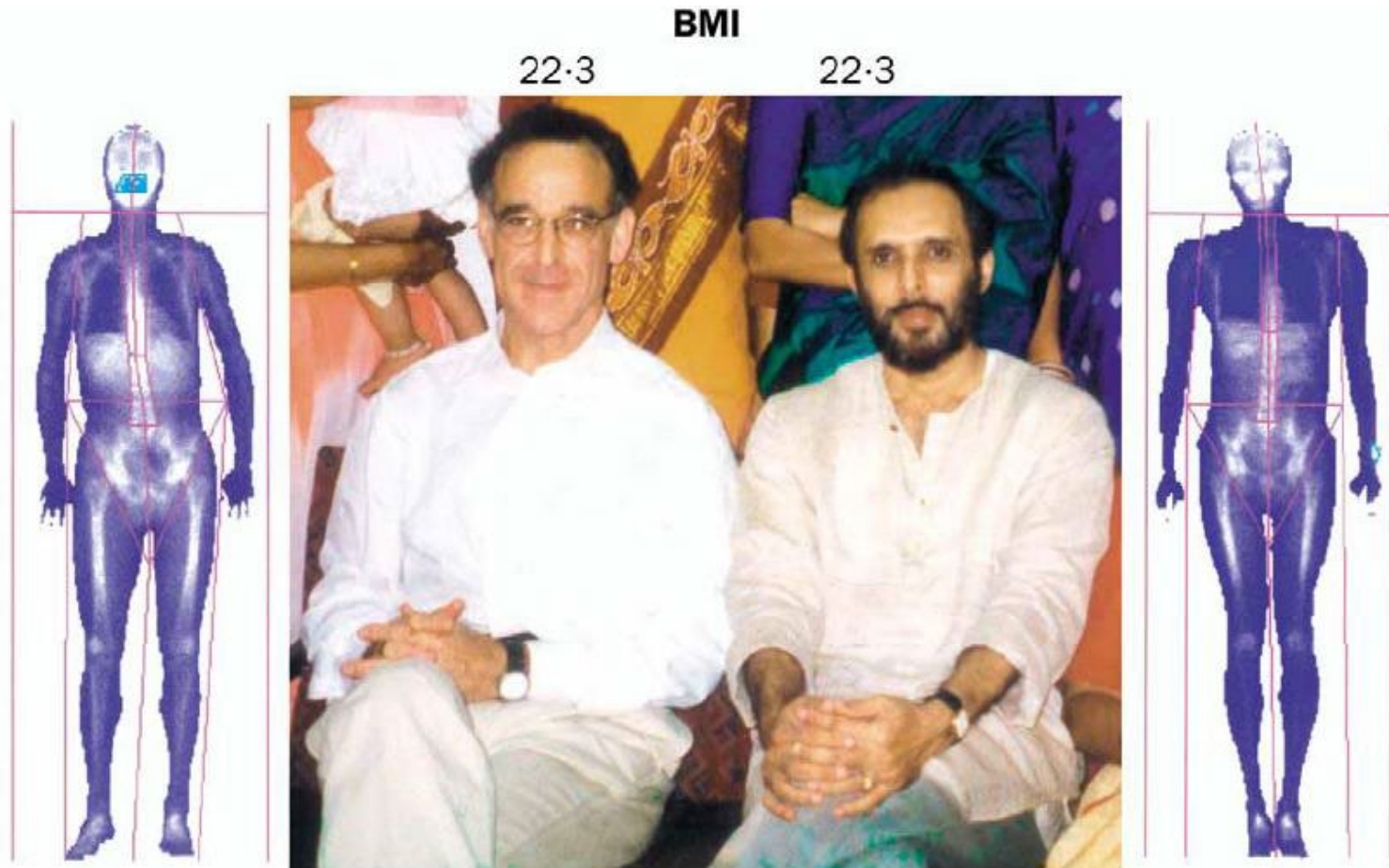
Overweight/obesity prevalence based on 1990s and 2020s weight and height data*

(using UNICEF, WHO, World Bank, and NCD-RisC estimates)

1990s

2020s

- 20–30% overweight/obesity prevalence
- 30–40% overweight/obesity prevalence
- >40% overweight/obesity prevalence
- <20% overweight/obesity prevalence
- No data
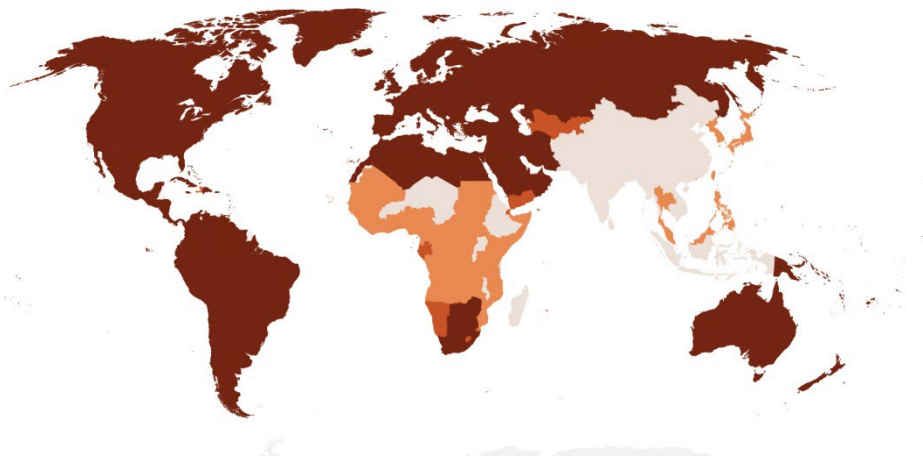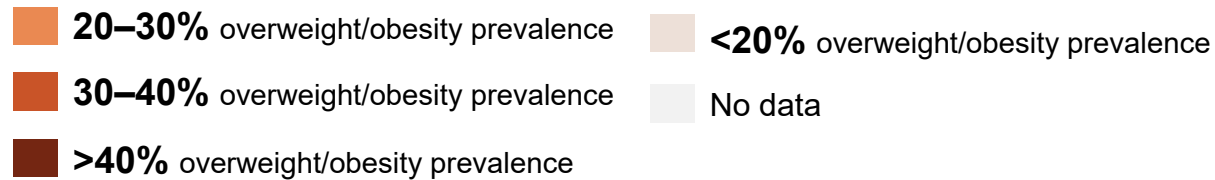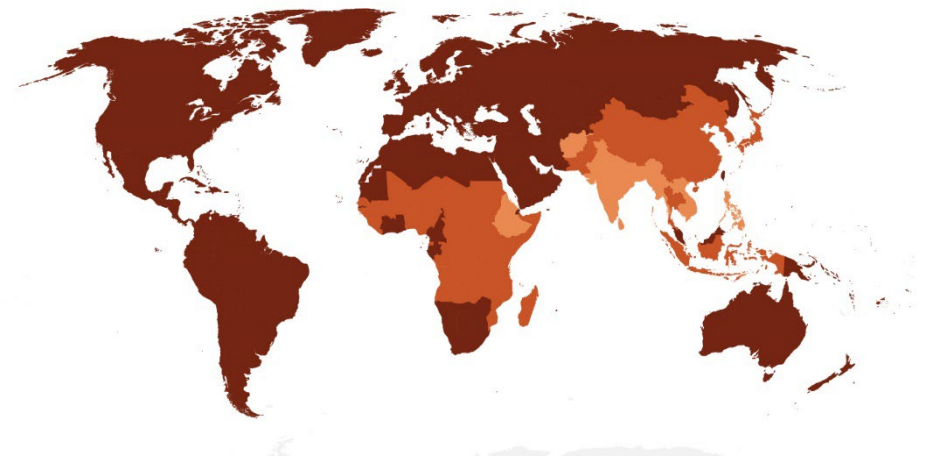
Countries colored according to highest overweight/obesity prevalence for either men or women.

Preschoolers (ages <5)**: Global stunting and overweight/obesity prevalence, 2000–2020**

STUNTING

OVERWEIGHT/OBESITY

33.1%
27.7%
22.0%

2000   2010   2020

5.4%   5.6%   5.7%

2000   2010   2020
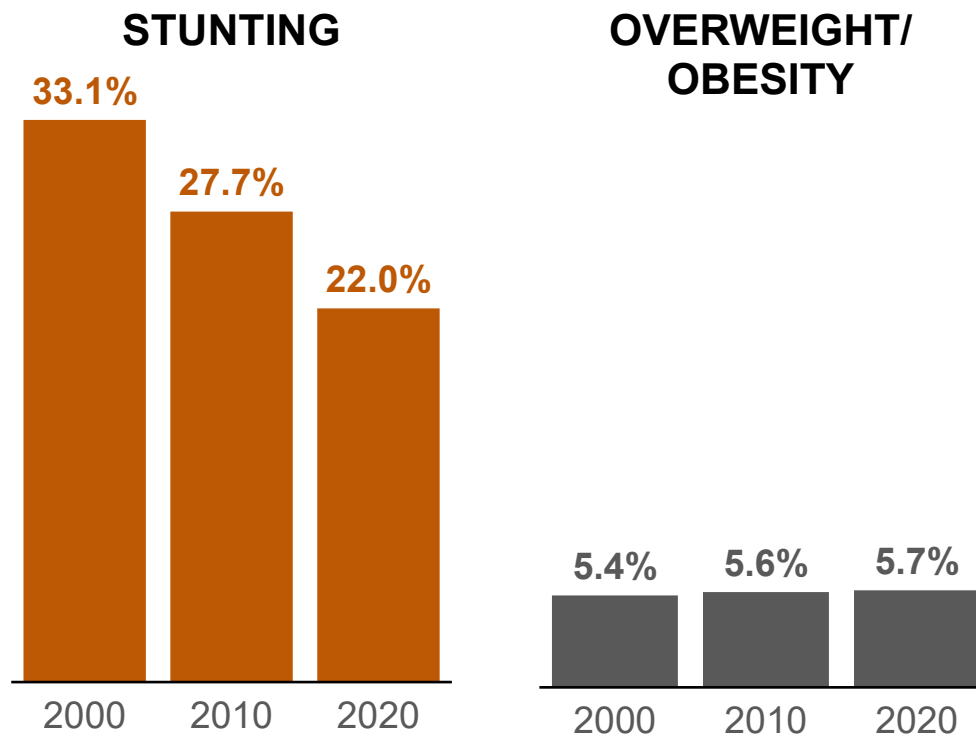
Data source: UNICEF

China: Prevalence of childhood overweight/obesity, 1991–2019

3–5-YEAR-OLDS

6–11-YEAR-OLDS

12–18-YEAR-OLDS

Data source: CHNS using IOTF cutoff points (equivalent to BMI ≥25.0 at age 18)
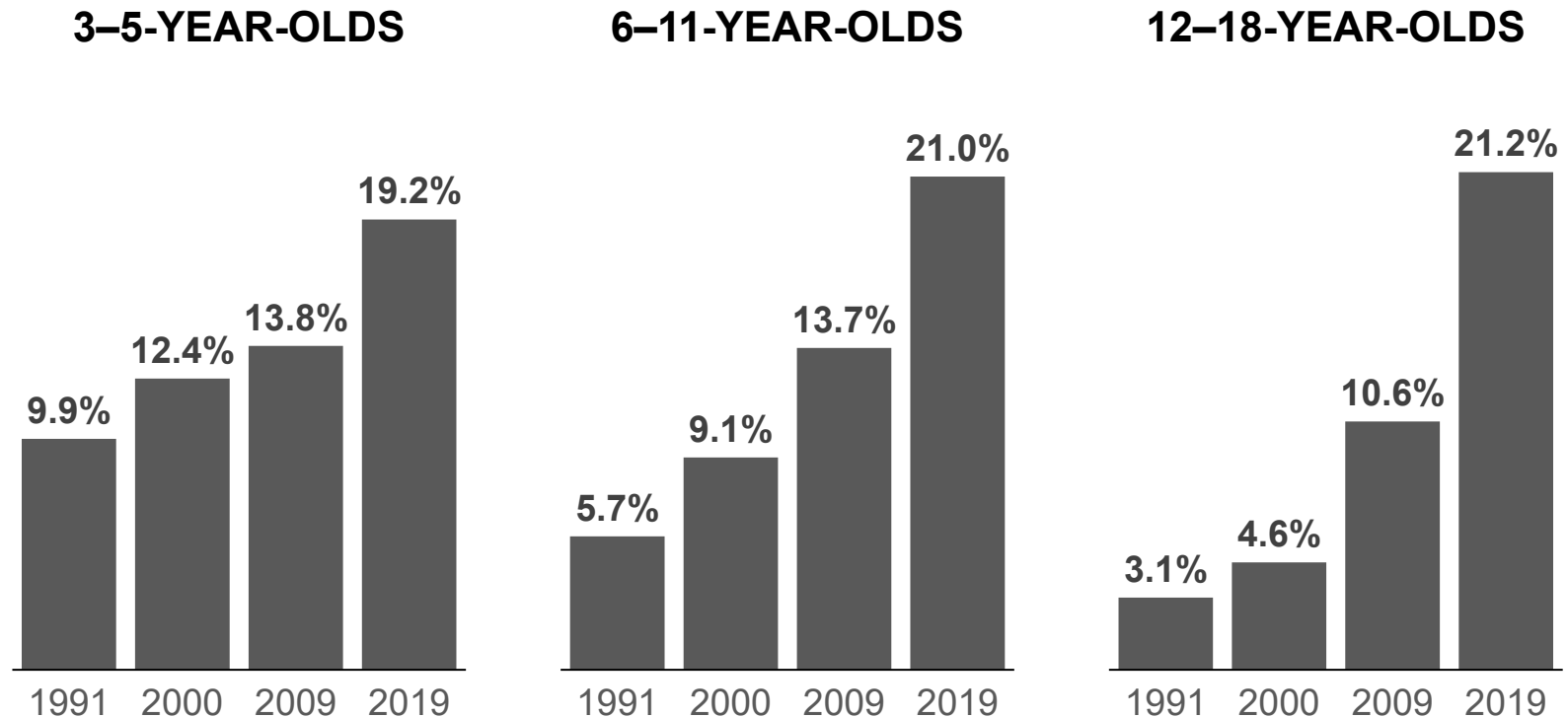
Preschoolers (ages <5): Stunting and overweight/obesity prevalence, 1980–2016

STUNTING

Legend:
- ■ Earliest Year
- ▦ Most Recent Year

Country	Earliest Year	Most Recent Year
Chile	14%	2%
China	32%	5%
Egypt	34%	22%
India	58%	36%
Indonesia	48%	31%
Kenya	40%	26%
Mexico	27%	14%
South Africa	29%	21%
Thailand	25%	13%

OVERWEIGHT/OBESITY

Legend:
- ■ Earliest Year
- ■ Most Recent Year

Country	Earliest Year	Most Recent Year
Chile	15%	9%
China	5%	9%
Egypt	7%	16%
India	3%	2%
Indonesia	7%	8%
Kenya	6%	4%
Mexico	6%	8%
South Africa	10%	12%
Thailand	1%	9%
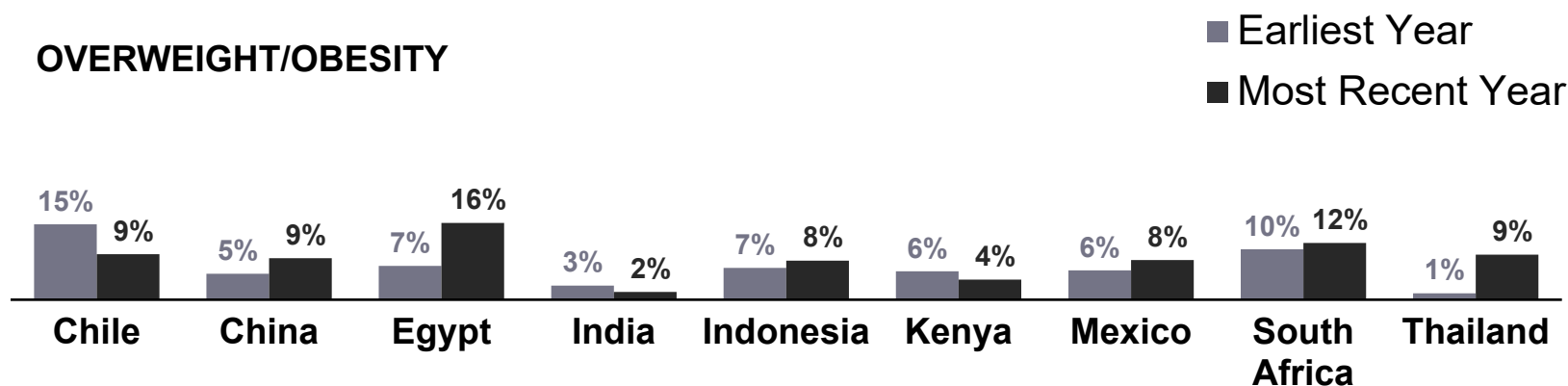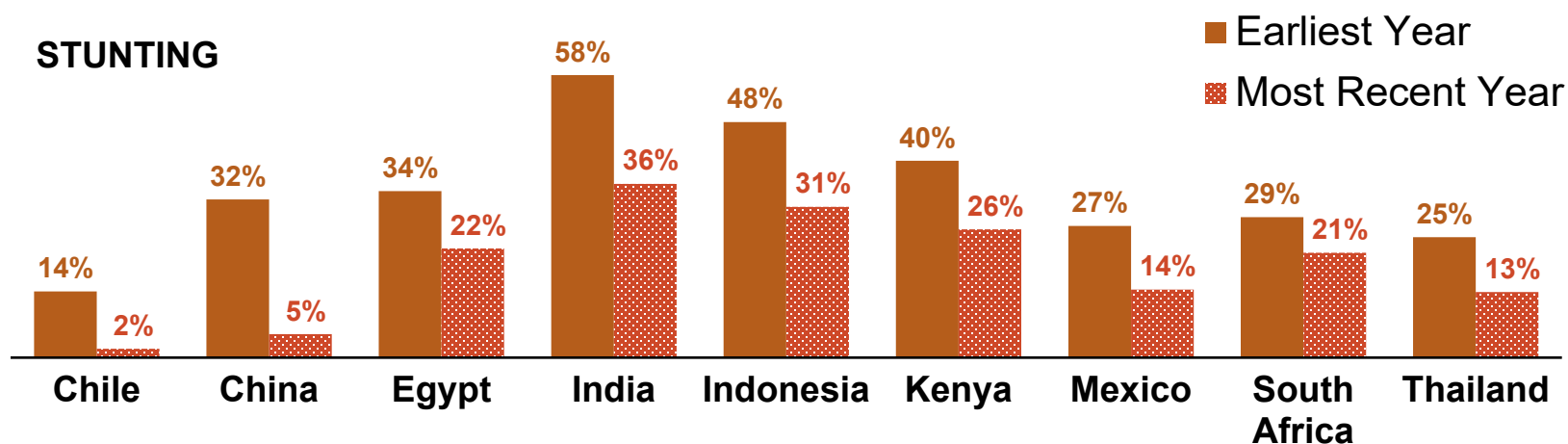
Data source: UNICEF for all except India (NFHS-5)

Children (ages 5–11): Global underweight and overweight/obesity prevalence, 1980–2016

UNDERWEIGHT

Year	Prevalence
1980	5%
1990	8%
2000	12%
2010	19%
2016	25%

OVERWEIGHT/OBESITY

Year	Prevalence
1980	5%
1990	8%
2000	12%
2010	18%
2016	23%
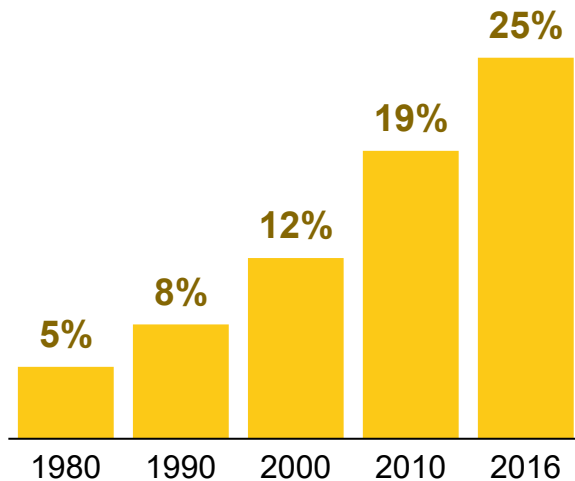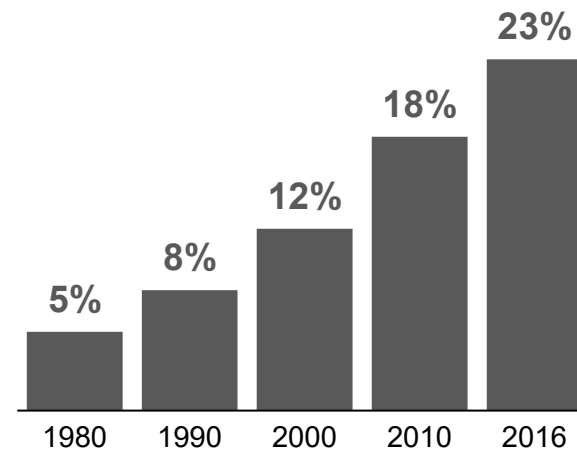
Children (ages 5–11)**: underweight and overweight/obesity prevalence, 1980–2016**

OVERWEIGHT / OBESITY

UNDERWEIGHT

Data source: NCD-RisC Risk Factor Collaboration
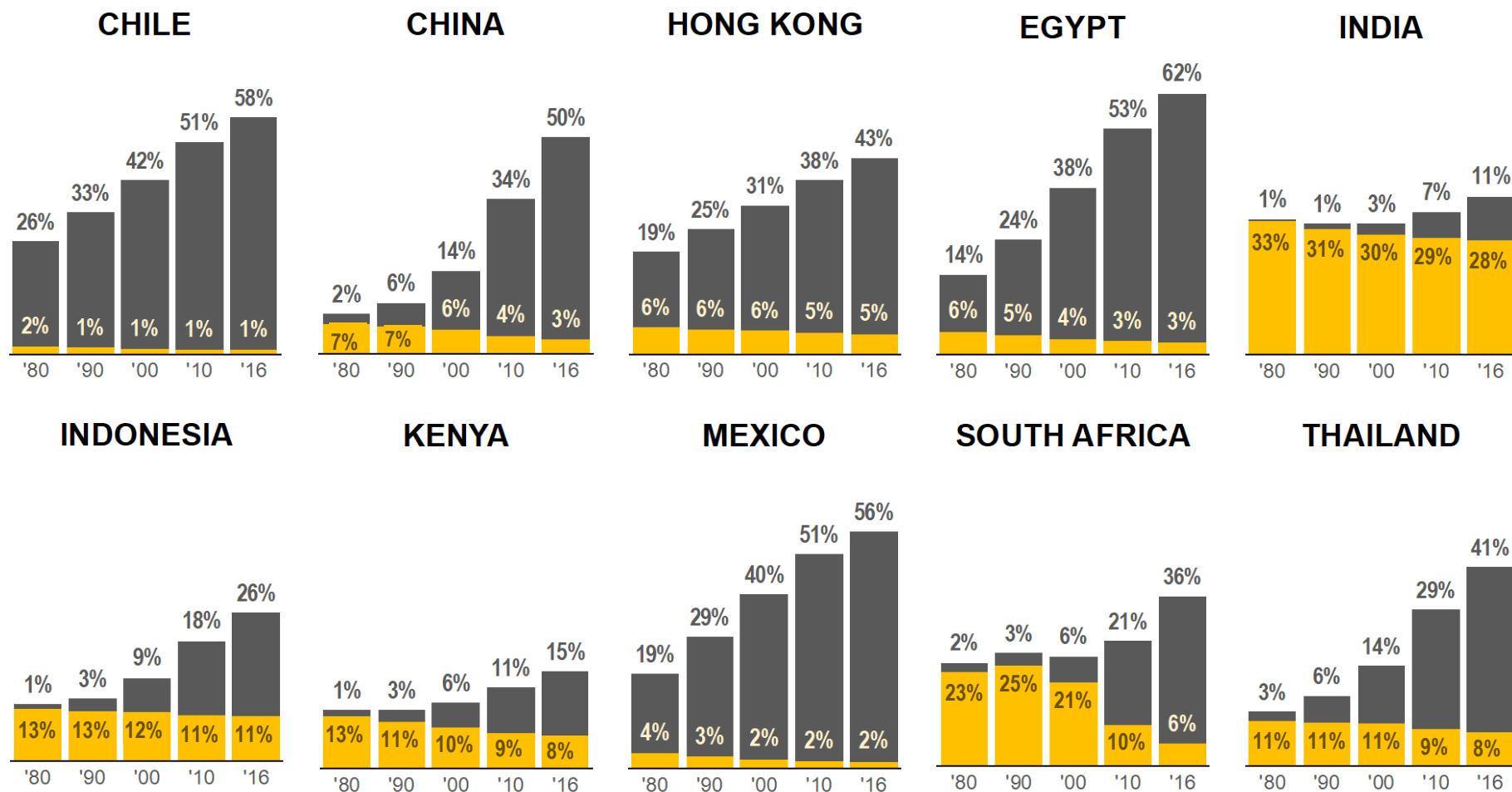
Adolescent girls (ages 12–18): Underweight and overweight/obesity prevalence, 1980–2016

OVERWEIGHT / OBESITY

UNDERWEIGHT

Data source: NCD-RisC Risk Factor Collaboration
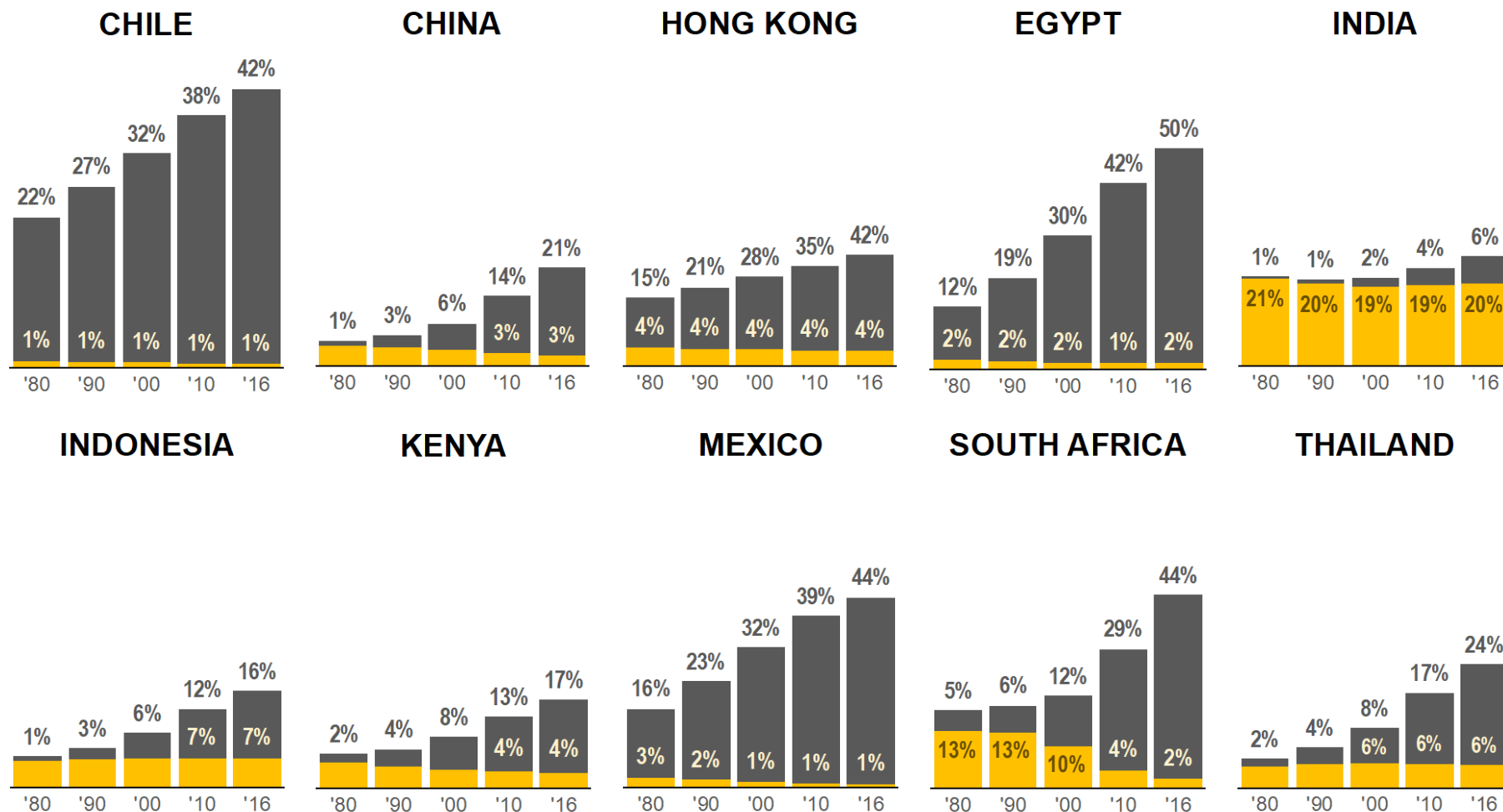
Adolescent boys (ages 12–18)**: Underweight and overweight/obesity prevalence, 1980–2016**

OVERWEIGHT / OBESITY

UNDERWEIGHT

CHILE

	'80	'90	'00	'10	'16
Overweight	17%	23%	31%	41%	48%
Underweight	2%	1%	1%	1%	1%

CHINA

	'80	'90	'00	'10	'16
Overweight	1%	3%	9%	24%	40%
Underweight	8%	8%	7%	5%	4%

HONG KONG

	'80	'90	'00	'10	'16
Overweight	15%	21%	28%	35%	42%
Underweight	7%	6%	6%	5%	5%

EGYPT

	'80	'90	'00	'10	'16
Overweight	7%	13%	23%	35%	43%
Underweight	7%	6%	5%	4%	4%

INDIA

	'80	'90	'00	'10	'16
Overweight	0%	1%	2%	4%	7%
Underweight	38%	35%	33%	32%	31%

INDONESIA

	'80	'90	'00	'10	'16
Overweight	1%	2%	5%	12%	18%
Underweight	16%	15%	14%	13%	12%

KENYA

	'80	'90	'00	'10	'16
Overweight	0%	1%	2%	4%	6%
Underweight	16%	14%	13%	11%	11%

MEXICO

	'80	'90	'00	'10	'16
Overweight	14%	22%	31%	41%	46%
Underweight	3%	3%	2%	2%	2%

SOUTH AFRICA

	'80	'90	'00	'10	'16
Overweight	1%	1%	3%	14%	27%
Underweight	23%	26%	22%	11%	6%

THAILAND

	'80	'90	'00	'10	'16
Overweight	1%	4%	9%	21%	32%
Underweight	13%	13%	12%	10%	9%

GLOBAL FOOD RESEARCH PROGRAM
University of North Carolina at Chapel Hill

UNC | CAROLINA POPULATION CENTER

Data source: NCD-RisC Risk Factor Collaboration

The COVID-19 pandemic has likely greatly exacerbated the DBM

- Both undernutrition and obesity are associated with **significant reductions in immune function and greatly increased susceptibility to Covid**.

- A recent metanalysis highlights this for COVID-19 and obesity *(Popkin et al, Obesity Reviews 2020, http://dx.doi.org/10.1111/obr.13128 PMCID: PMC7461480)* as many subsequent studies have shown.

- Globally, large decreases in physical activity both because of Covid control and also economic stress → reduction of active employment and production

- In most regions, we are seeing rapid increases in consumption of both ultra-processed food and less-nutritious, cheaper food from vendors, stalls, and home cooking. In a select few countries we are seeing increased healthy eating among the poor.

- The Global recession will increase risks for both stunting and overweight

- The result will be both increased overweight and undernutrition.

Figure 4. Role of our history

Mismatch: Biology which evolved over millennia clashes with modern technology
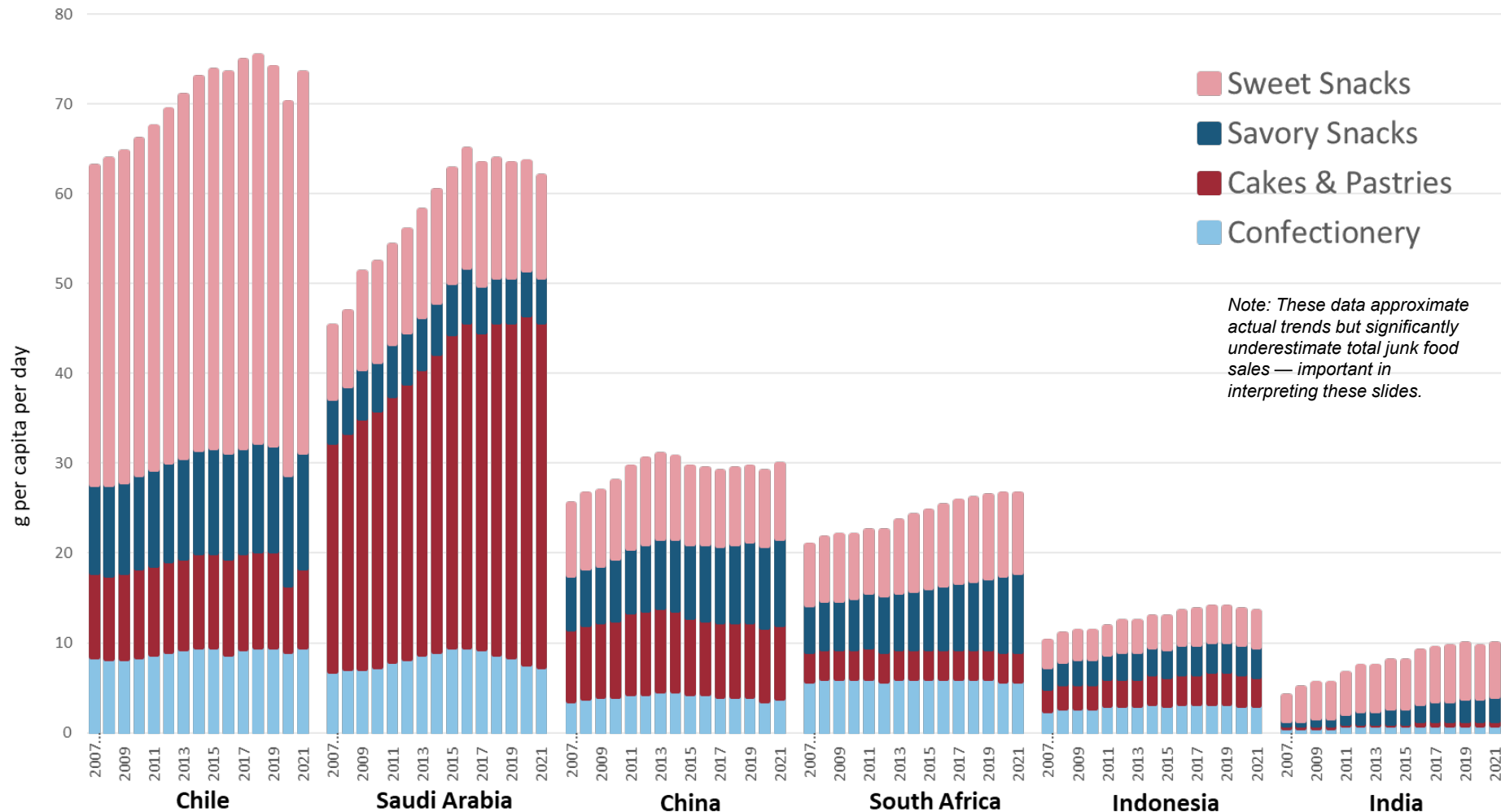
Core biochemical and physiologic processes have been preserved from those who appeared in Africa between 100,000 and 50,000 years ago.

Biology evolved over 100,000 Years	**Modern technology** has taken advantage of this biology
Sweet preferences	Cheap caloric sweeteners, food processing create habituation to sweetness
Thirst, hunger/satiety mechanisms not linked	Caloric beverage revolution
Fatty food preference	Edible oil revolution — high yield oilseeds, cheap removal of oils, modern processed food/vendor, stall & restaurant sector
Desire to eliminate exertion	Technology in all phases of work and movement reduce energy expenditure, enhance sedentarianism
Snacking Behavior	Modern food marketing; accessibility everywhere of unhealthy, nonessential, ready-to-eat snack foods
Real food with minimally processed ingredients *new*	**Ultra-processed foods**: more energy density, additives, smells, hyperpalatable; **Beverages**: many sweeteners used

Why we are seeing these increases in overweight status

- Technological shifts in the workplace, home, leisure, and transportation have greatly reduced physical activity, and we will never reverse this decline.

- **The global food system makes ultra-processed food and other less-nutritious food cheaper and more accessible. Large increases in intake now.**

- Effective policies that address the challenges of the double burden of malnutrition across the lifecycle are urgently needed

- Increasingly as studied we find 15-25% of infant calories come from ultra-processed food in the poorest countries.

Trends in packaged junk food sales by category among LMICs
(grams per capita per day, 2007–2021)

Legend:
- Sweet Snacks
- Savory Snacks
- Cakes & Pastries
- Confectionery

Note: These data approximate actual trends but significantly underestimate total junk food sales — important in interpreting these slides.

Countries shown: Chile, Saudi Arabia, China, South Africa, Indonesia, India (years 2007–2021)

Y-axis: g per capita per day

Confectionery includes chocolate and sugar confectioneries and gum;

Savory Snacks includes nuts, seeds, trail mixes, salty snacks (e.g., chips), savory biscuits, popcorn, pretzels, and other savory snacks;

Sweet Snacks includes fruit snacks, snack bars, sweet biscuits, chilled & shelf-stable desserts *(Chile, South Africa, and Saudi Arabia only)*, frozen desserts *(China only)*, and ice cream Source: Euromonitor International Limited 2021 © All rights reserved

Trends in packaged soft drink sales by category
(mL per capita per day, 2007–2021)

Legend:
- Sports & Energy Drinks
- RTD Coffee & Tea
- Fruit Drinks
- 100% Juice
- Liquid & Powder Concentrates
- Carbonated Drinks

y-axis: mL per capita per day

Country groups: Chile, Saudi Arabia, South Africa, China, Indonesia, India (2007–2021)
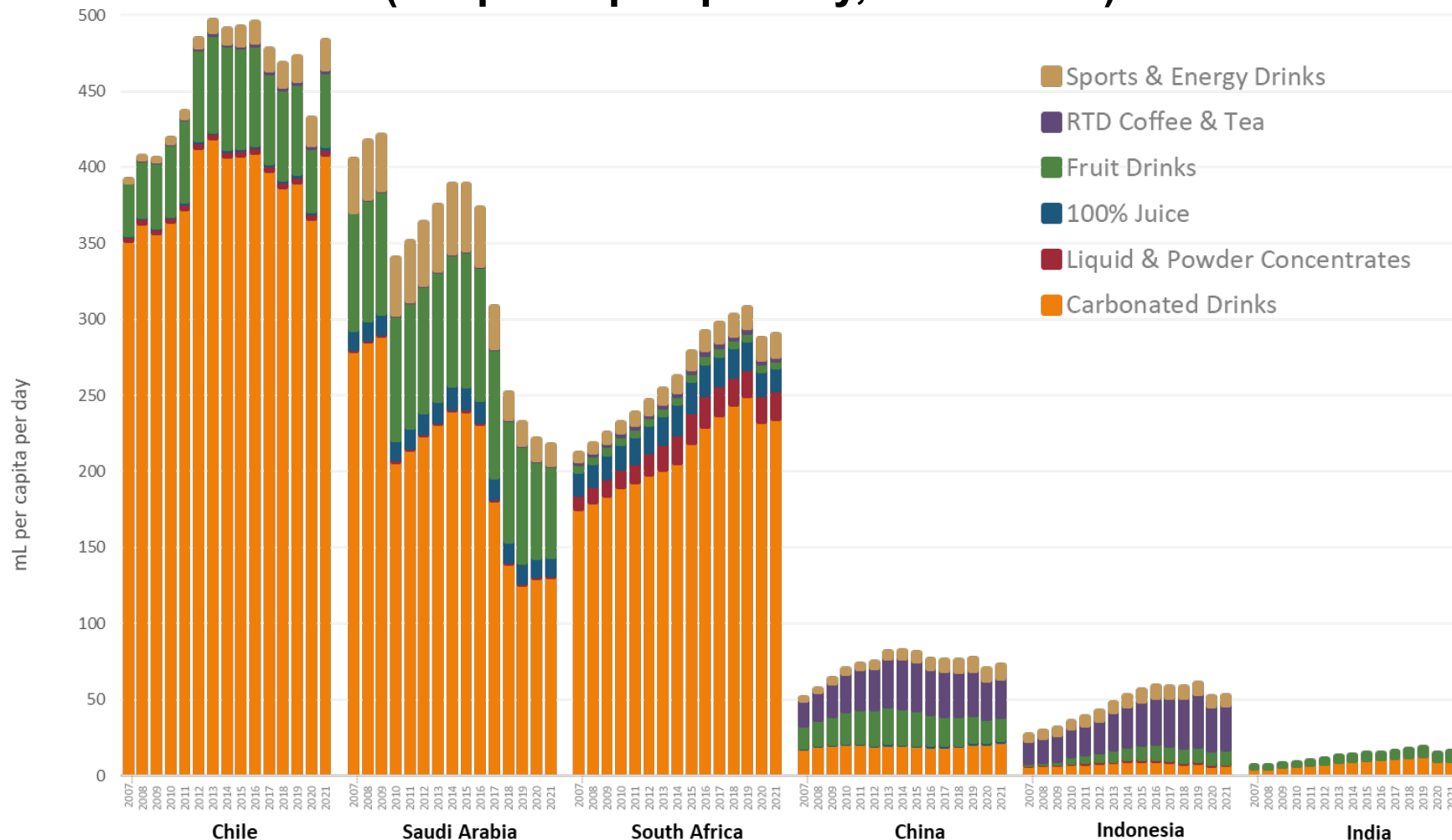
Note: Euromonitor does not separate data by full-sugar vs. "diet"/light
or non-caloric brands for most categories, so these data slightly overestimate total SSB sales.

Source: Euromonitor International Limited 2021 © All rights reserved

UNC
CAROLINA POPULATION CENTER

GLOBAL FOOD RESEARCH PROGRAM
University of North Carolina at Chapel Hill

2. Food system transformation in Latin America, Asia and Africa

Diet changes have occurred parallel to, and in two-way causality with, broad changes in the food system, driven by:

- Income increases
- Opportunity cost of women's time to shop & cook
- Employment featuring daily commuting away-from-home
- FDI and domestic investment in modern food industry, especially 1990s to present

→ Rapid rise of consumption of ready-to-eat and ready-to-heat convenience foods, a large subset of which are nonessential ultra-processed foods with major role for food marketing.

UNC
CAROLINA
POPULATION
CENTER

GLOBAL FOOD
RESEARCH PROGRAM
University of North Carolina
at Chapel Hill

Ultra-processed foods, US National Institutes Of Health RCT:

Sophisticated randomized controlled trial, compared a less-processed/"real" food diet with ultra-processed diet. This shows that the current diet trends in China must be turned around.

Unprocessed or minimally processed foods include **fresh, dried, or frozen vegetables, grains, legumes, fruits, meats, fish, eggs,** and **milk**. They are the basis of healthy dishes and meals.

UNC
CAROLINA
POPULATION
CENTER

GLOBAL FOOD
RESEARCH PROGRAM
University of North Carolina
at Chapel Hill

Ultra-processed foods

Ultra-processed foods include **fast food, sugary drinks, snacks, chips, candies, cookies, sweetened milk products, sweetened cereals, and sauce and dressings**. They are nutritionally poor.

Ultra-processed foods (UPF) typically have many additives that enhance our desire to eat more of them (e.g., added sugar, added saturated fats, added salt, added smells and flavors). Ultra-processed foods products designed to be:

- **Highly profitable** (low-cost ingredients, long shelf-life, emphatic branding)

- **Convenient** (ready-to-consume, ready-to-heat)

- **Hyper-palatable**

U.S. National Institutes of Health: Results

- Each person was his/her own control (crossover).

- **+500 kcal per day with UPF**
  - comprised mainly of additional carbohydrates and saturated fats
  - Similar protein with both diets
  - Major shift was UPF food, which is very energy dense.

- **In 2 weeks, +0.9 kg body weight with UPF**

- -0.9 kg body weight with unprocessed diet

- In just 2 weeks on UPF diet, significant negative shifts in:
  - lipids, HbA1c, inflammatory markers (key measures of CVD, type 2 diabetes, cancer risks)

This study points out two mechanisms: hyper-palatability and higher energy density

Hall, K. D.et al (2019). *"Ultra-processed diets cause excess calorie intake and weight gain: A one-month inpatient randomized controlled trial of ad libitum food intake."* Cell Metabolism *30: 1-10.*

UNC
CAROLINA
POPULATION
CENTER

GLOBAL FOOD
RESEARCH PROGRAM
University of North Carolina
at Chapel Hill

Results from additional major publications were only suggestive before this sophisticated clinical trial

- **Eminent Medical and Nutrition Journals:**
Total of >45 studies with US, European, Latin American and Asian cohorts show the same issue → large, significant, increasing risk of many noncommunicable disease biomarkers (e.g., diabetes, hypertension, other measures of heart disease and cancer) and obesity and mortality (total mortality, also heart disease and cancer mortality) among children (few studies) and mainly adults.

Gaps in knowledge

- How do we promote healthier eating for low and middle income countries, let alone the US?

- What are the best ways to regulate or reduce consumption of the most unhealthy ultra-processed foods?

- Can we even define precisely and simply these foods for policy purposes?

- Do we want these products to reformulate? Ie cut sodium, sugar, unhealthy saturated fats.

- What about refined carbohydrates and their powerful impact on our health?

Ultimate goal: Use multiple approaches to change BOTH supply and demand?
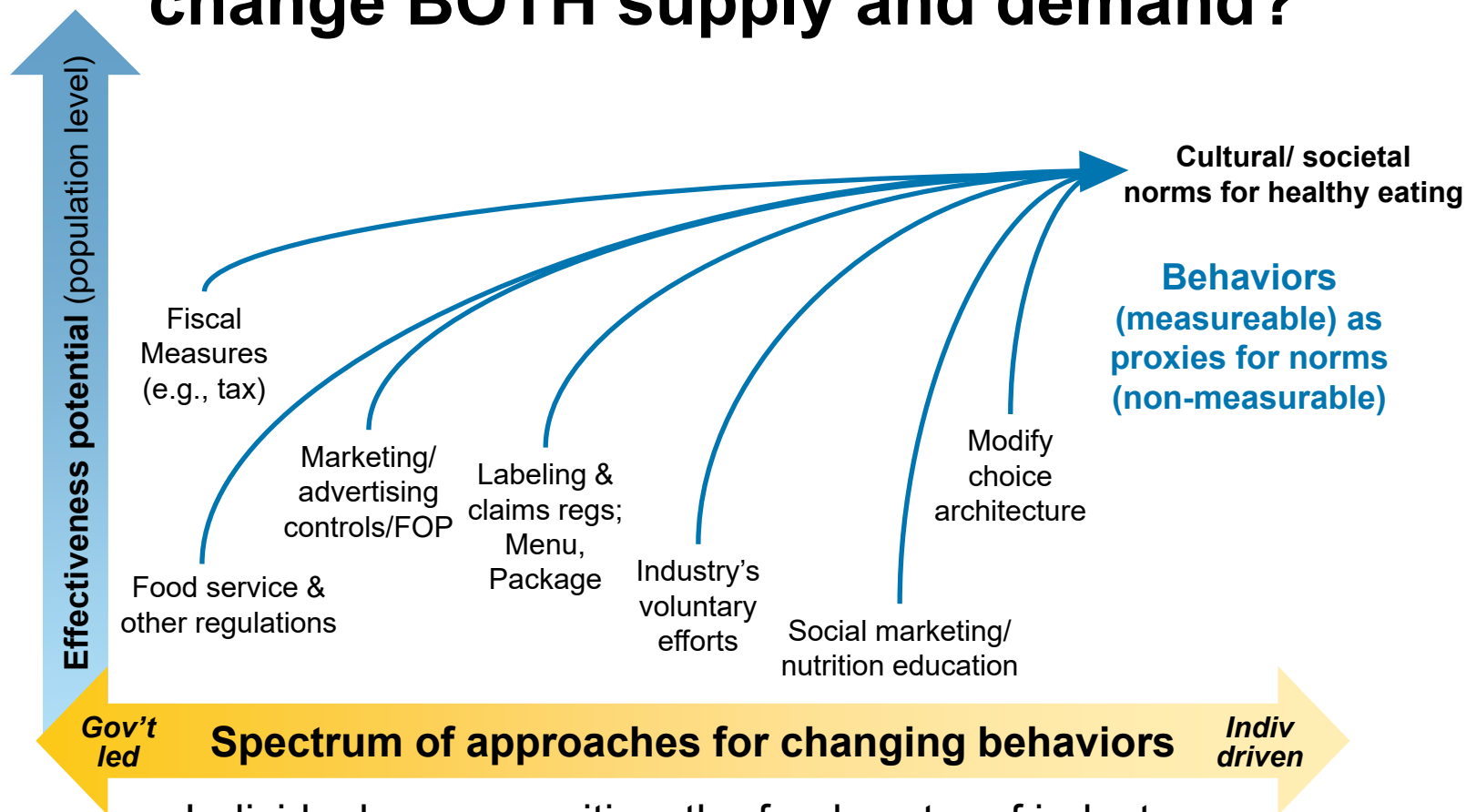
Individuals, communities, the food sector of industry, policymakers, regulatory agencies all have roles to play but to date little evidence the food industry will without legal changes.

Slide derived from Shu Wen Ng

The struggle over the millennia to eliminate arduous effort could not foresee modern technology