

# Why The World Is Fat




**Barry Popkin**

Department Of Nutrition

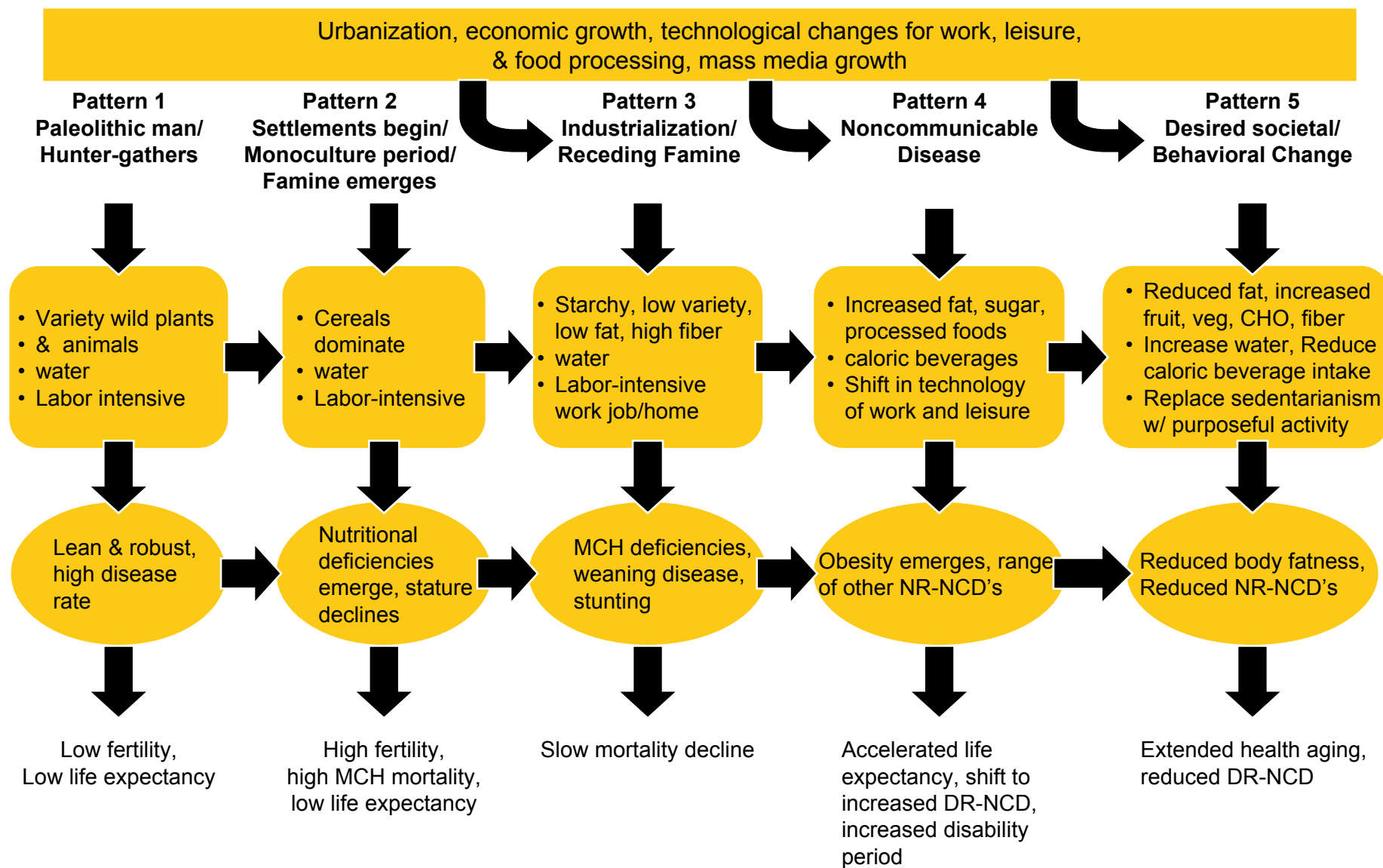
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*The University Of North Carolina At Chapel Hill*

THE  WORLD IS FAT *“Over 1.6 billion people in the world are overweight”*

# Figure 1. Stages of the Nutrition Transition



Source: Popkin 2002 revised 2006.

# Mismatch: Biology which has evolved over the millenia clashes with modern technology

Biology	Technology
Sweet preferences	cheap caloric sweeteners, food processing benefits
Thirst and hunger/satiety mechanisms not linked	Caloric beverage revolution
Fatty food preference	Edible oil revolution-high yield oilseeds, cheap removal of oils
Desire to eliminate exertion	Technology in all phases of movement/exertion

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# Role of our history

- **Core biochemical and physiologic processes have been preserved from those who appeared in Africa between 100,000 and 50,000 y ago.** Genetic evolution during subsequent millennia has continued, as shown by pigmentation changes (hair, eyes, skin), intestinal lactase retention beyond infancy, and adaptive defenses against microorganisms (eg, hemoglobinopathies and immune system adaptations).

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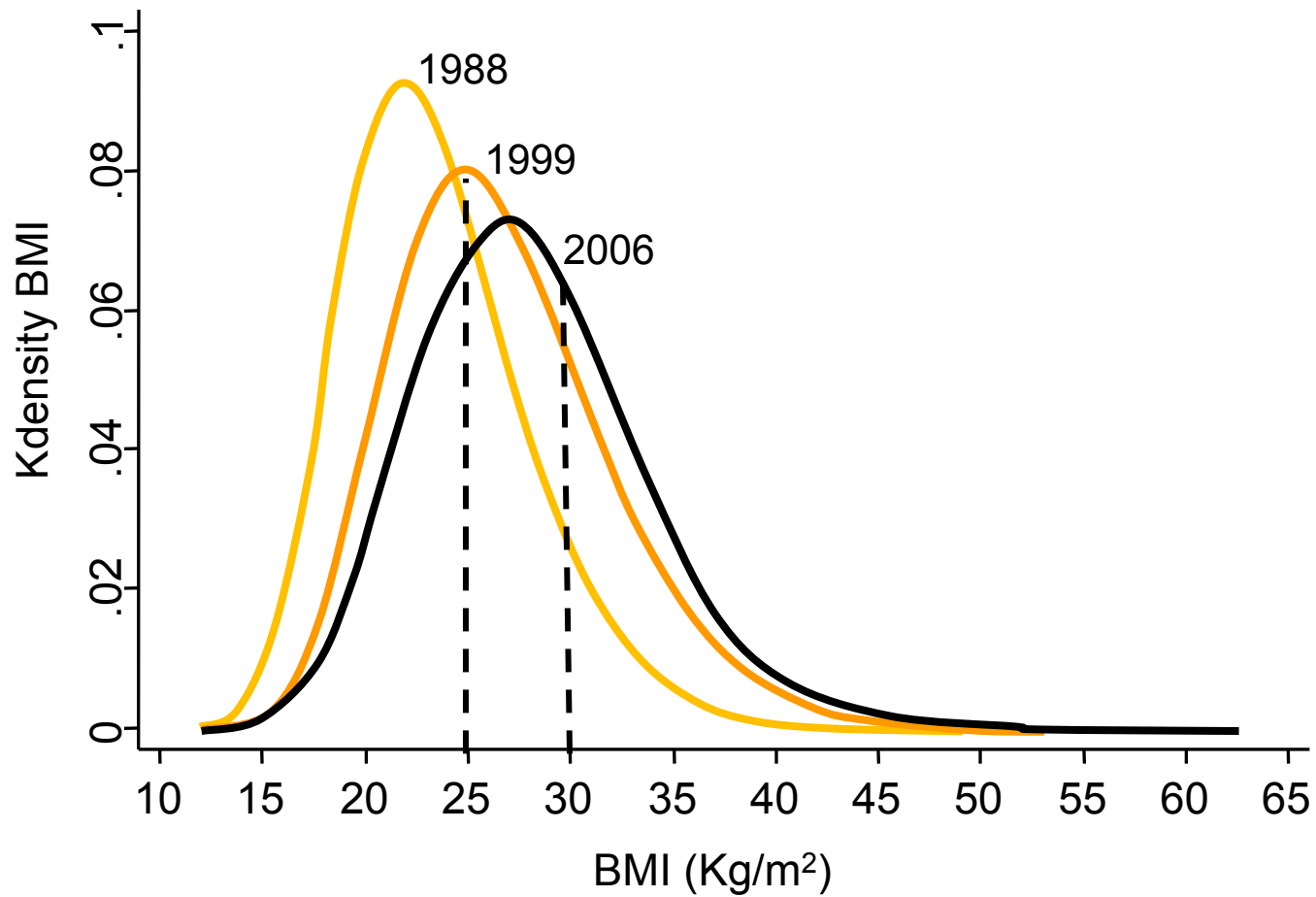


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El 54% de los uruguayos tiene sobrepeso u obesidad.

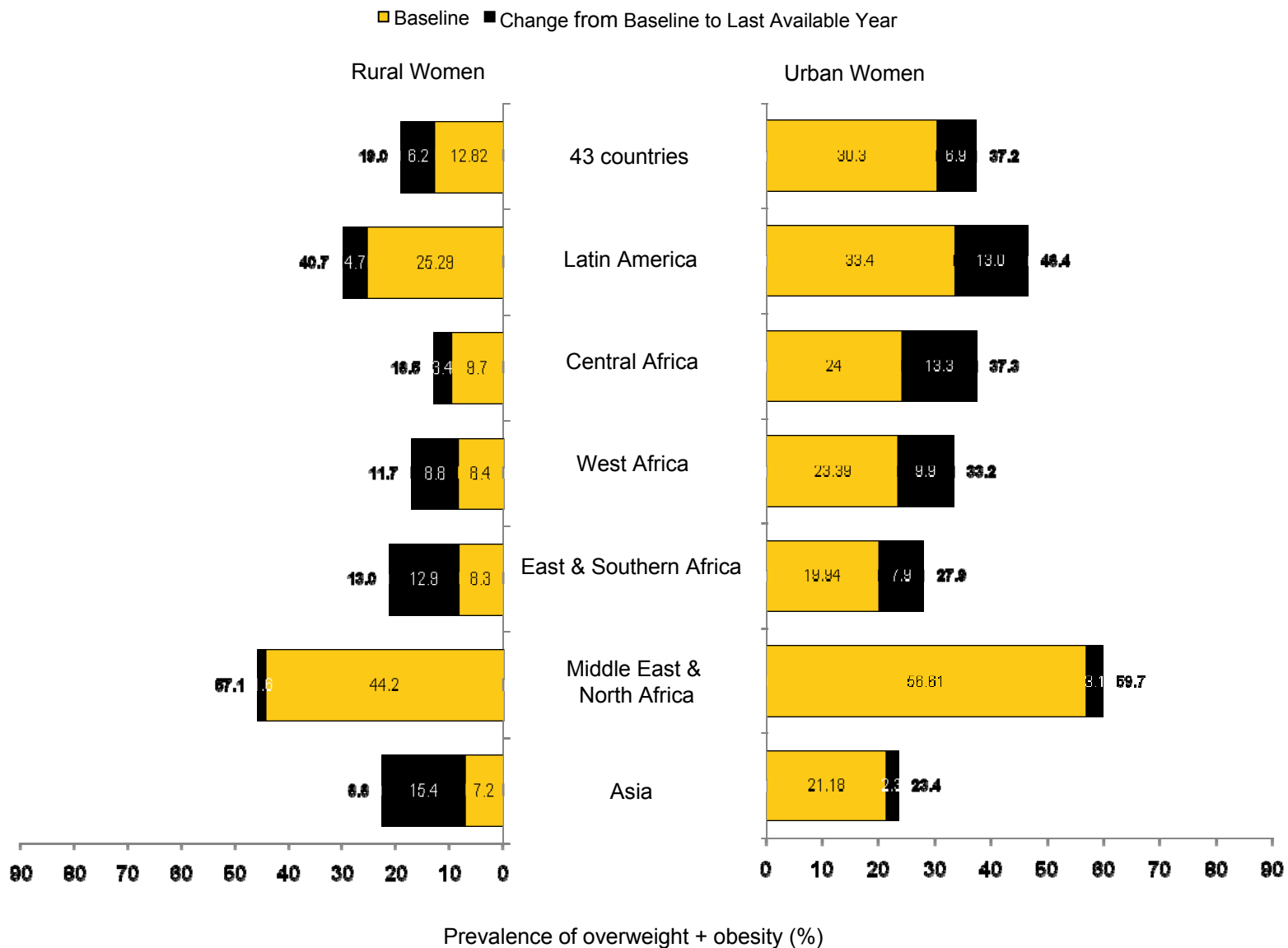
## BMI Distribution Shifts among Mexican women 18-49 y (National Surveys 1988, 1999 y 2006)



From Juan Rivera

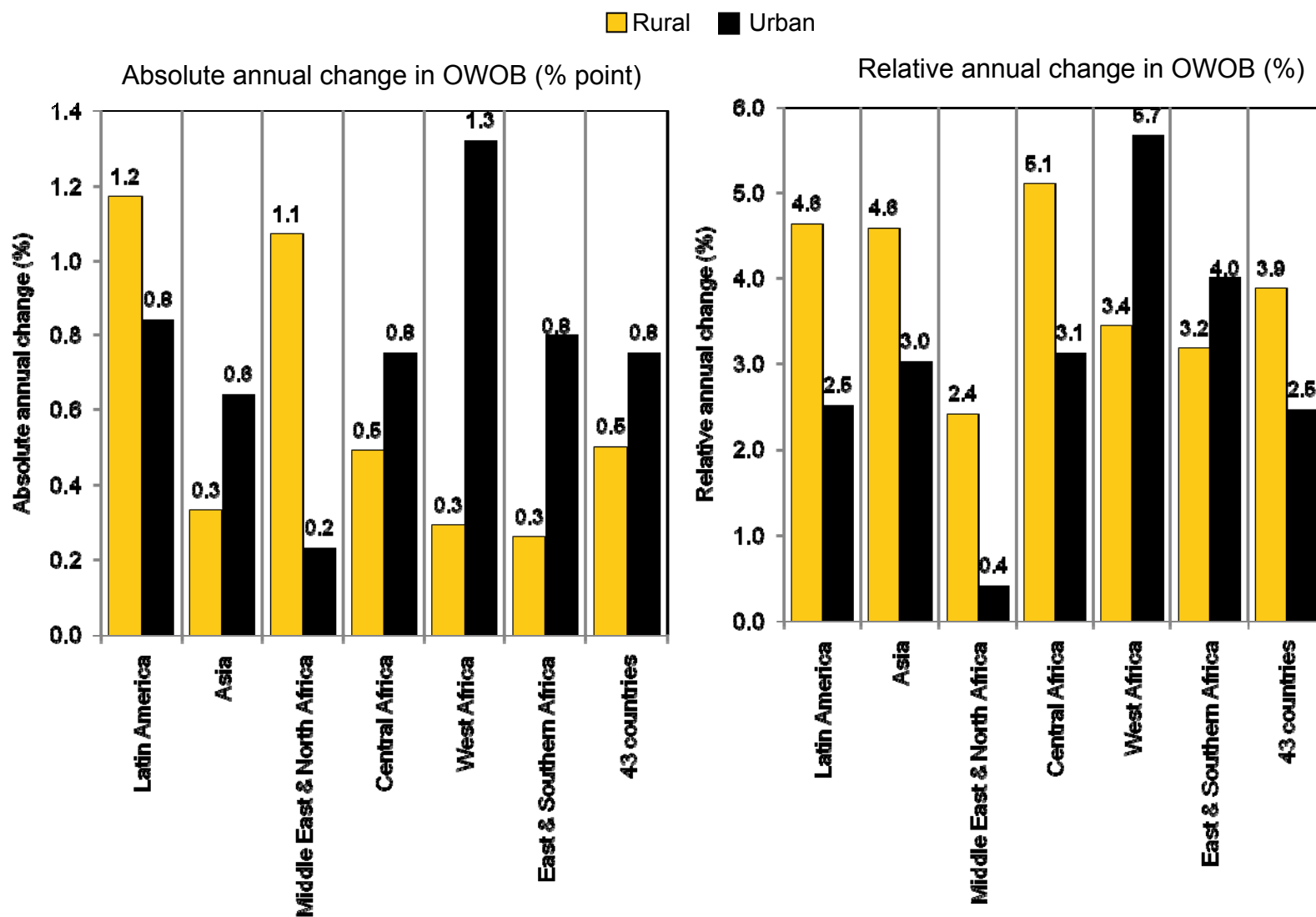
# Weighted prevalence of Overweight Plus Obesity among Women in Developing Countries

(based on repeated nationally representative surveys of 444,568 rural and 370,120 urban (814,688 total) adult women 18-49 )



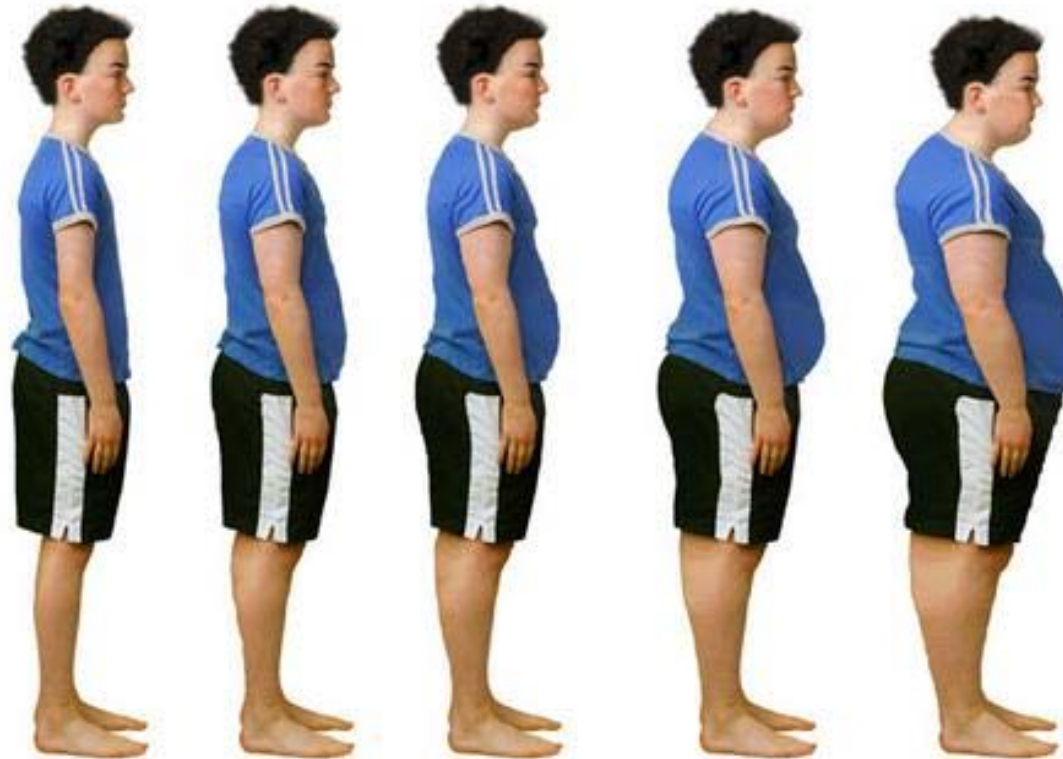
# Annual Change in Weighted Prevalence of Overweight plus Obesity (BMI $\geq$ 25) among Women in Developing Countries

(based on repeated nationally representative surveys of 444,568 rural and 370,120 urban (814,688 total) adult women 18-49)





# Australian Youth Gain Fat, Shift Body Shape



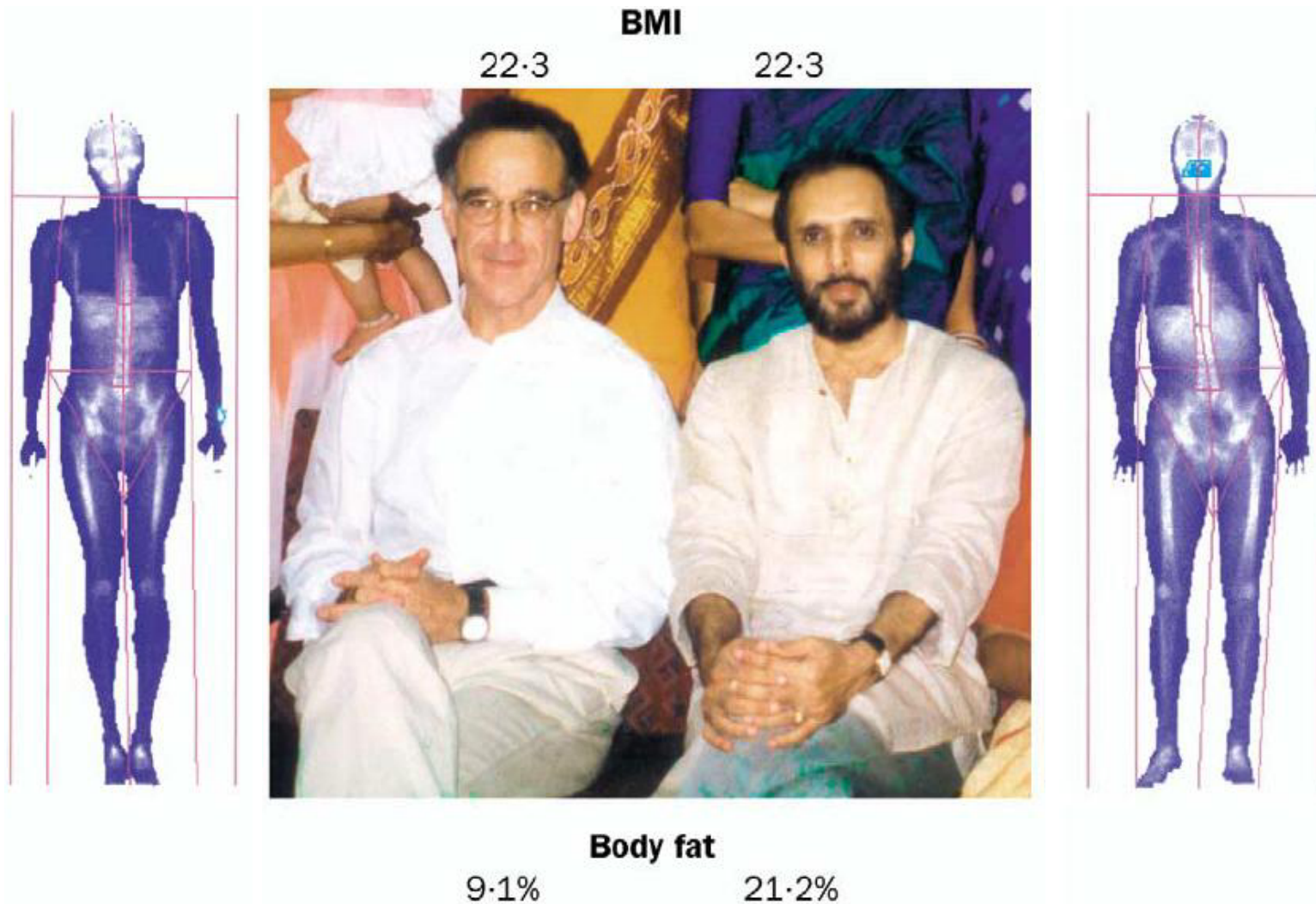
Based on the research of Olds (2009) EJCN 1-13.

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# The consequences vary by race-ethnicity: Body fat composition in the East vs the West



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# What drives caloric increases and leads to added energy imbalance?

- The only clear consensus is that caloric beverages are linked with increased total energy intake and weight gain
- We know that all total energy intake reductions and energy balance can occur with any diet: high/low protein, fat, or complex carbohydrates diets work
- But what is driving dietary change and keeping calories higher: that is much clearer

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# Sources of Major Global Dietary Shifts

- **Globally:** We see **increases** in:
  - Caloric sweetener use, especially in beverages
  - animal source foods
  - refined carbohydrates, ultra refined foods
  - snacking, away-from-home eating, precooked food
- **Globally:** We see **decreases** in:
  - legumes, vegetables, fruits in most countries
  - food preparation time
- **Low income world:** **increased** edible oil use

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# From Traditional to Modern Snacking



# From Traditional to Modern..... Marketing of Food



# Sweetness Preference

*Many think that we have inborn biological wisdom but how and why and what role this plays in our food preferences has not achieved consensus. Because sweet foods are naturally good and are safe sources of energy and nutrients, many believe adaptive evolutionary development has resulted in a preference for them. These early responses are modified by life experiences, producing tastes and preferences.*


***What about conditioning, issues of habituation: animal models do not help. We know little.***

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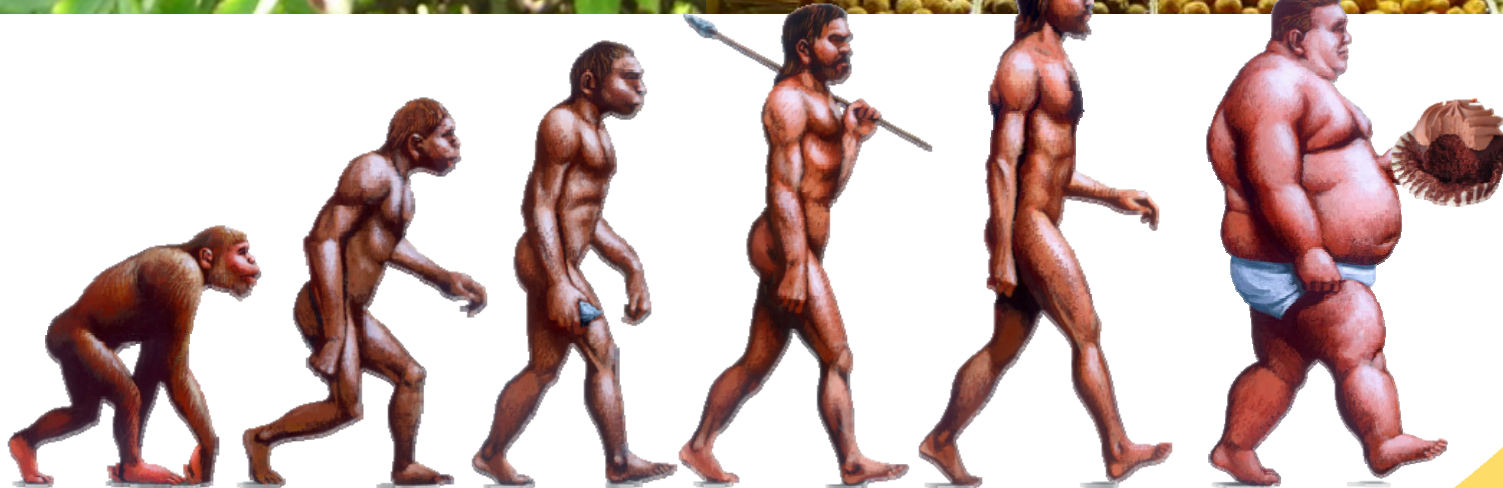


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**Sweetness Preference was Essential  
to Survive: Huge Shift in Amounts,  
Energy Density**



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## Increases in total calories from added sugar are greatest among top 20% of population\*

	Q1	Q2	Q3	Q4	Q5	Total
<b>1965</b>	60	161	262	396	701	316
<b>1977</b>	32	114	195	299	560	240
<b>1989-91</b>	29	113	206	324	616	258
<b>1999-00</b>	62	193	321	491	959	406
<b>2001-02</b>	59	176	300	464	882	376
<b>2003-04</b>	56	172	295	646	896	377

-8.3%

+27.7%

Source: Duffey & Popkin(2008) AJCN 88(suppl):1722S \* Underestimate, due to omission fruit juice concentrate

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# What are the implications of eating food and drinking water on energy balance?

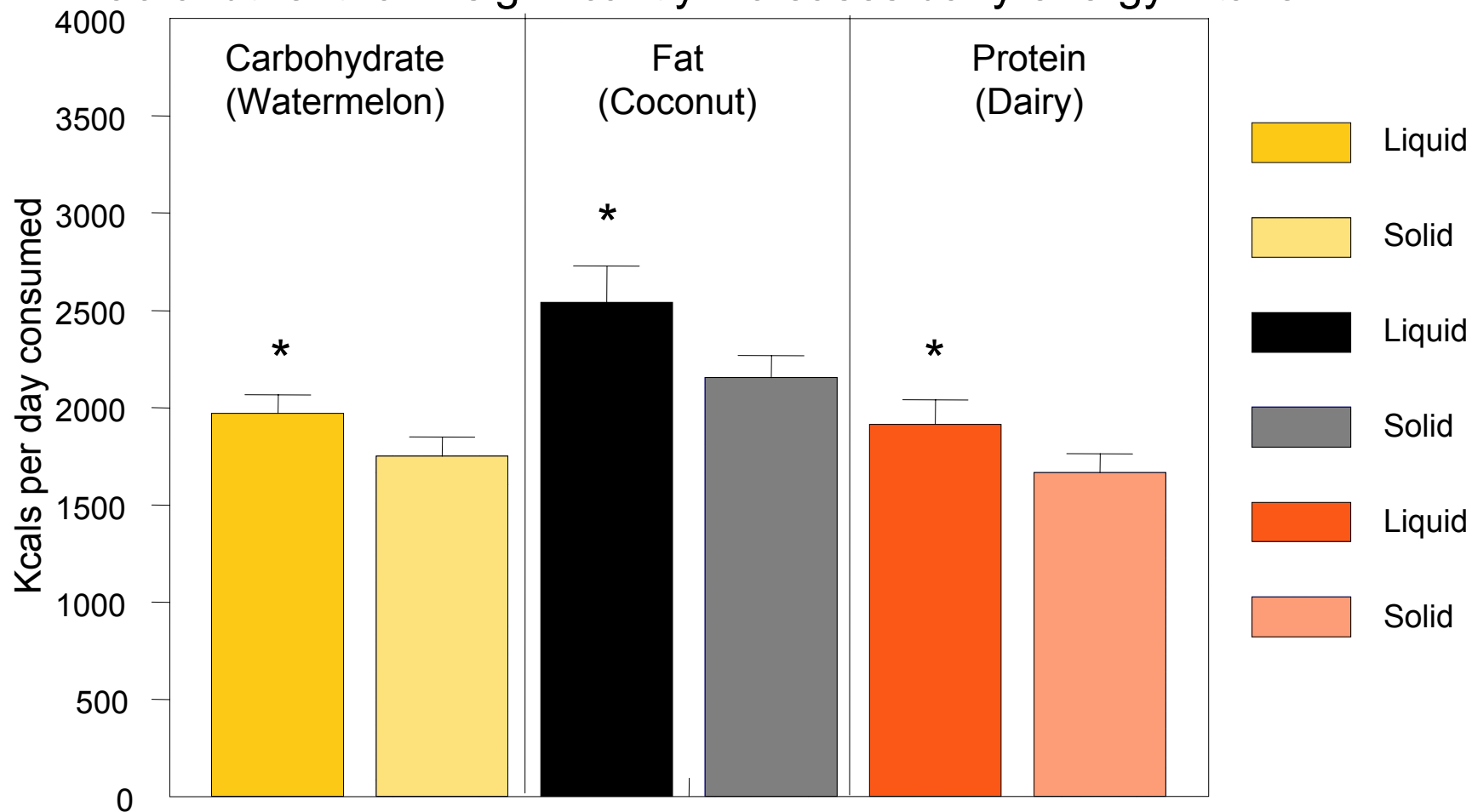
General Properties	
Food	Water
<b>Hunger – Feeding</b> Sensations that promote attainment of minimal food energy needs	<b>Thirst – Drinking</b> Sensations that promote attainment of minimal hydration needs
<b>Energy Excess</b> Stored	<b>Water Excess</b> Excreted
<b>Energy Deficit: Die in 1-2 months</b>	<b>Water Deficit : Die in 3-7 days</b>

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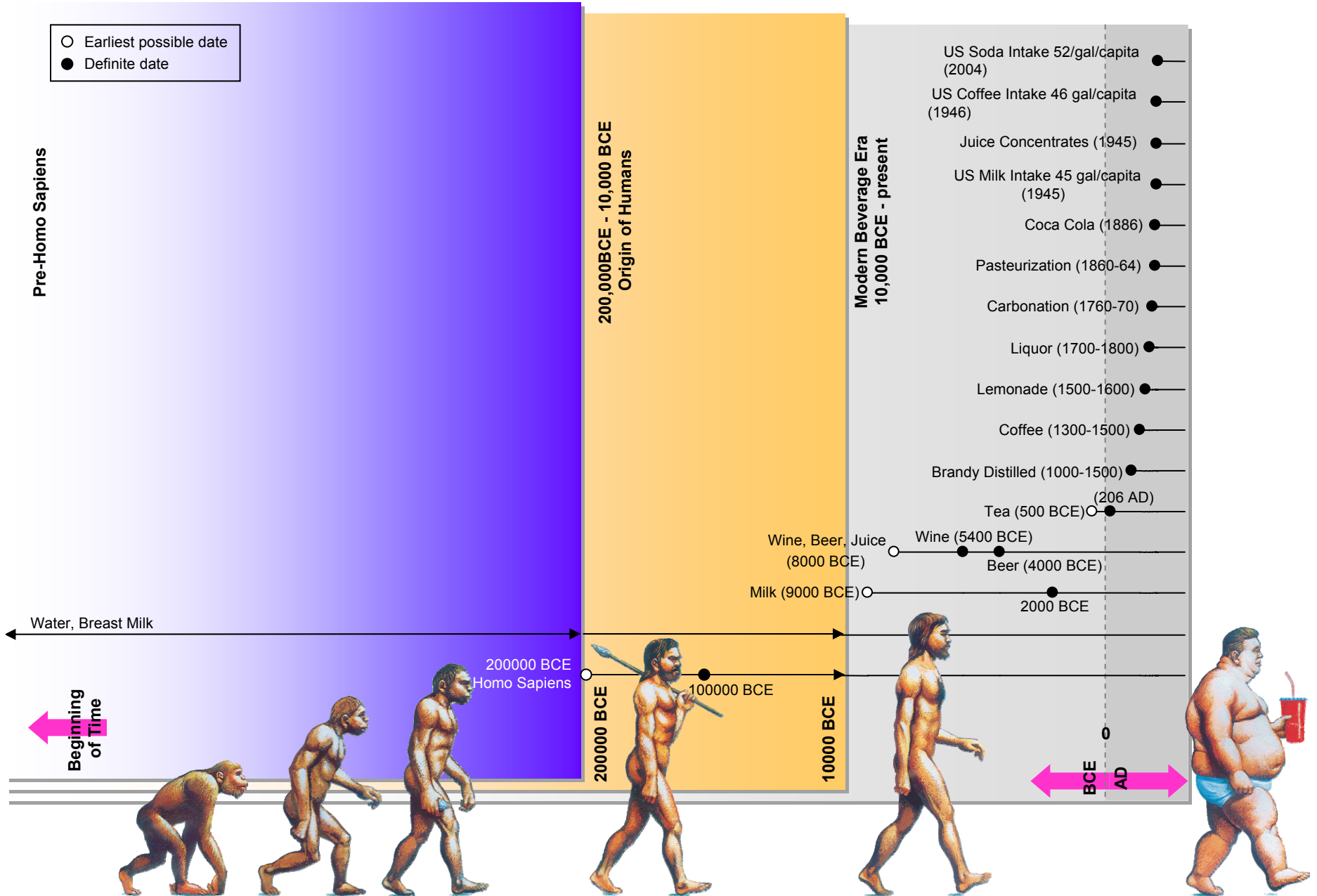


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Comparison of consumption of a beverage and a solid food on total Energy Intake shows beverage consumption in any macronutrient form significantly increases dairy energy intake



# Remarkably Short History for Caloric Beverages: Might the Absence of Compensation Relate to This Historical Evolution?



# Epidemiologic Evidence

- Weight gain and obesity\*\*\*
- Type 2 diabetes and metabolic syndrome\*\*\*
- Hypertension, inflammation, dyslipidemia\*\*
- CHD\*
- Hyperuricemia and gout\*\*\*
- Clearer understanding now of the added role of fructose

Malik, Popkin, Bray, Després, Willett, Hu (2010) Diabetes Care

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# Global Trends

- Mexico-see below.
- UK and all Western European adolescents—major consumers caloric beverages

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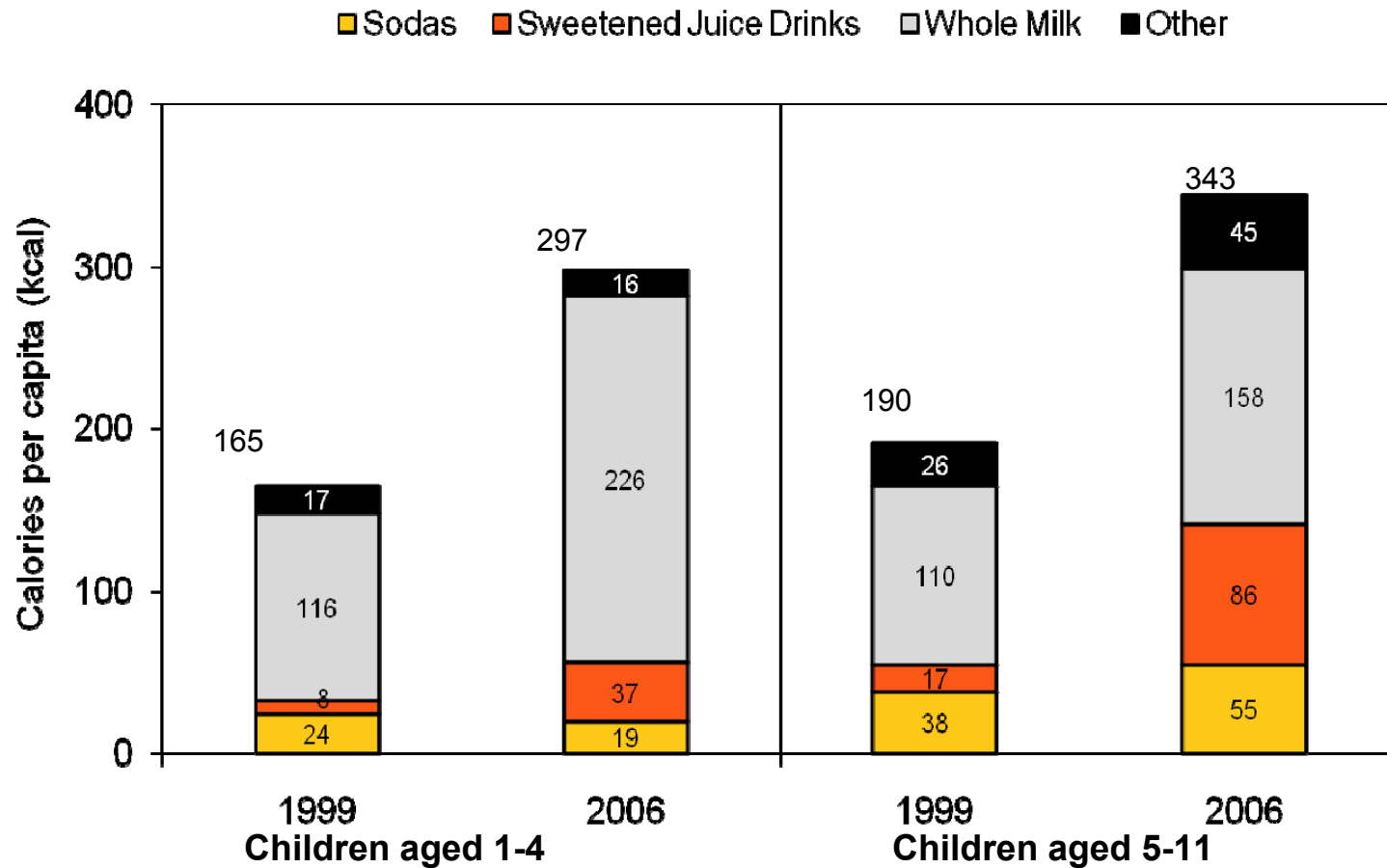


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per ≈250 ml serving



# Daily Beverage Consumption Trends Among Mexican Children, 1999-2006

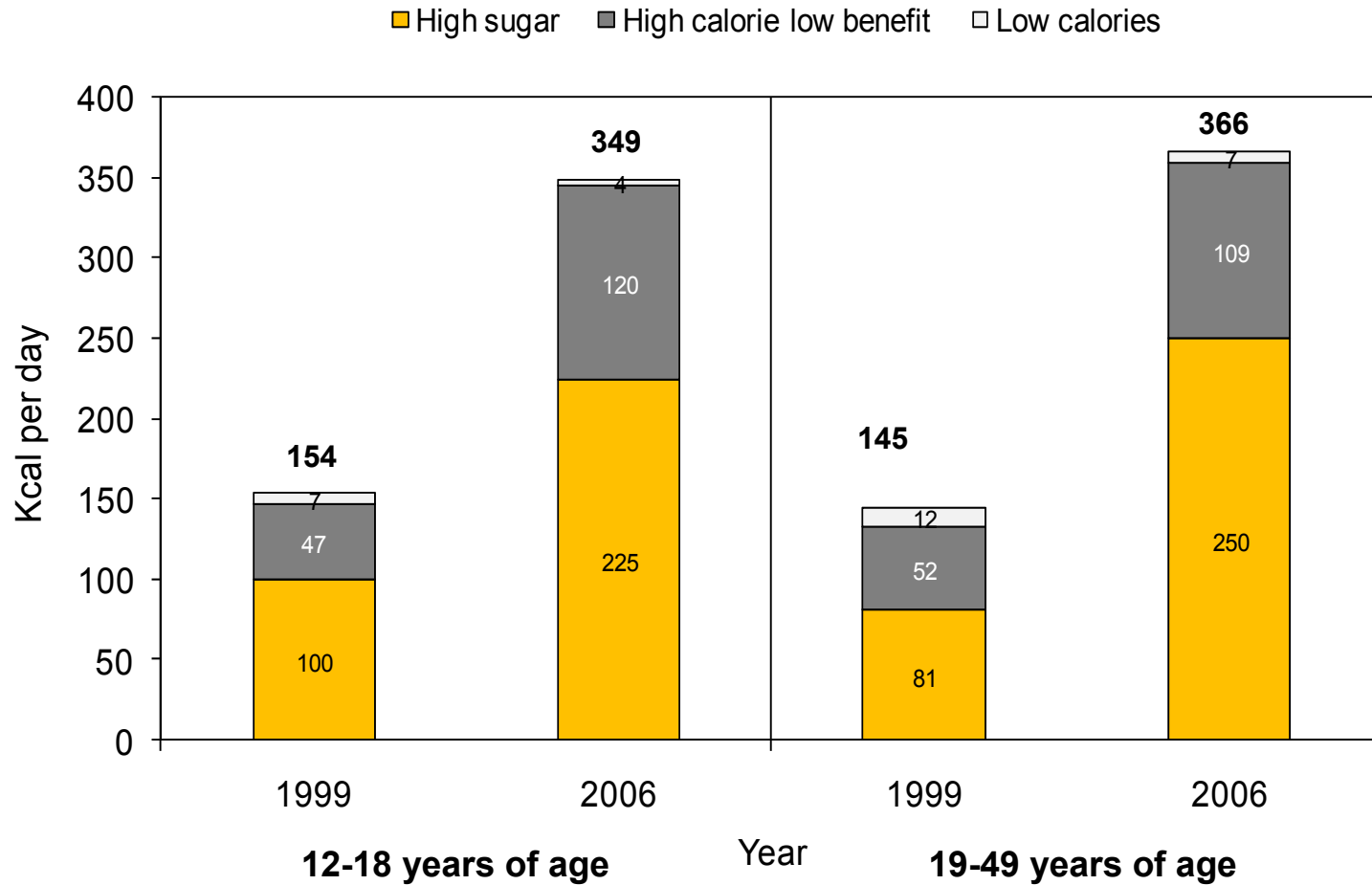


Note: Sweetened juice drinks include 100% fruit juice with sugar added and agua fresca (water, juice, sugar). Sodas include carbonated and noncarbonated sugar bottled beverages.

Source: Barquera et al (2008) J Nutr 138: 2454-61.



## Beverage consumption trends among Mexican adolescents and adult women, 1999 and 2006

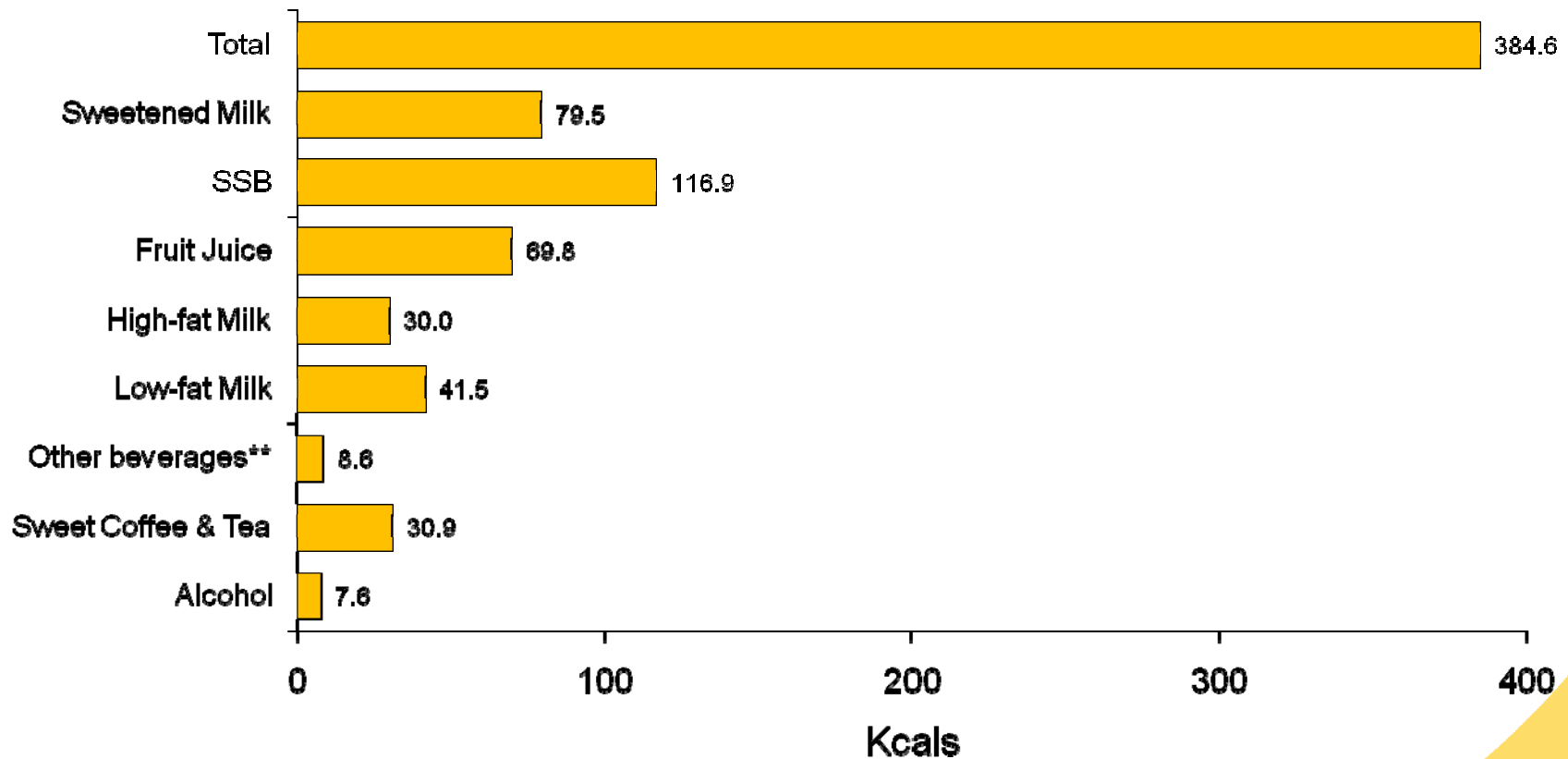


Note High sugar is composed of mainly soft drinks, sweetened juices, agua frescas and alcohol.

High calorie and low benefit is mainly whole milk. Low calories are slightly sweetened coffee and skim milk

Source: Barquera et al (2008)J Nutr 138: 2454-61.

## Helena: Total Beverage Consumption Patterns (kcal/person/day) European Adolescents 13-16.9 Years



\*\* Other beverages include vegetable juice, other sweet beverages, other beverages

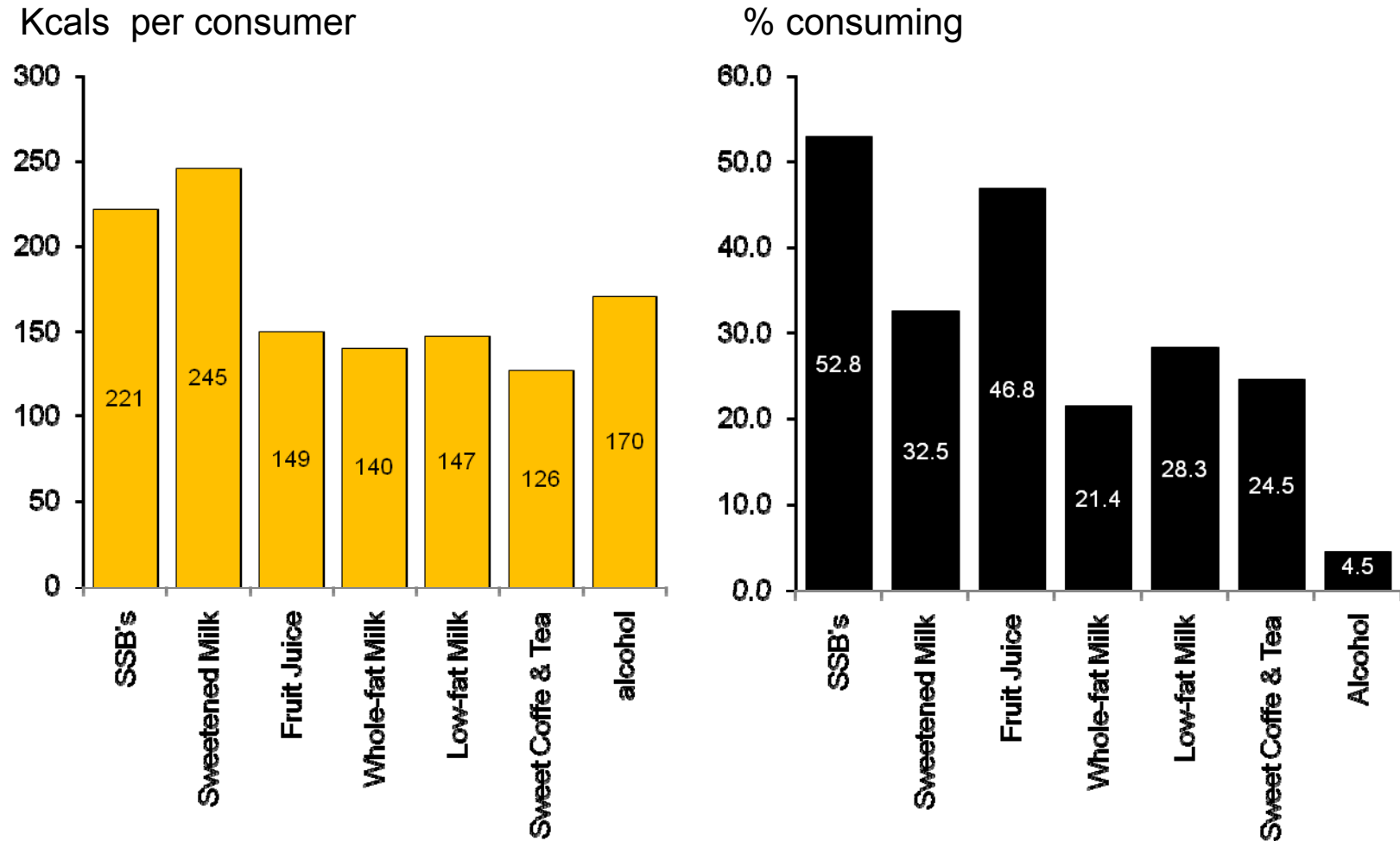
Source: Helena 24-hour recalls for Austria, Belgium, France, Germany, Greece, Italy, Spain, Sweden, Denmark, Norway, Portugal (2010) Beverage consumption among European adolescents in the HELENA Study

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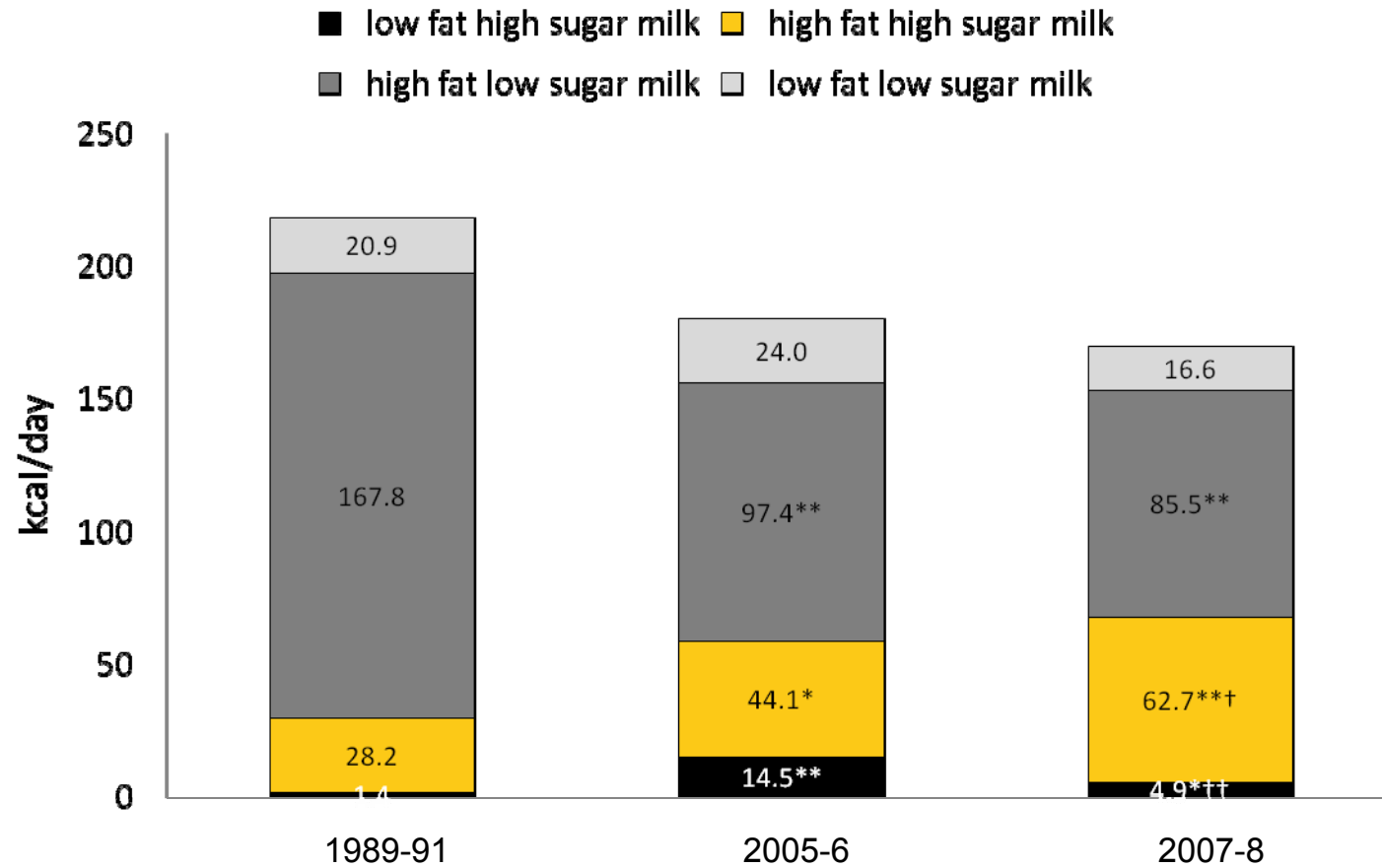
## Helena Beverage Consumption Patterns European Adolescents 13-16.9 years



\*\* Other beverages include vegetable juice, other sweet beverages, other beverages

Source: Helena 24-hour recalls for Austria, Belgium, France, Germany, Greece, Italy, Spain, Sweden  
Duffey, ..... Moreno, Popkin (2010) Beverage consumption among European adolescents in the HELENA Study

# Total Kcal Per Capita From Milk Groups US kids 6-11



Comparing with 1989: \* P<0.05 \*\*P<0.001

Comparing with 2005: † P<0.05 ††P<0.001

Popkin., unpublished, not for quotation or use

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# So what about noncaloric beverages?

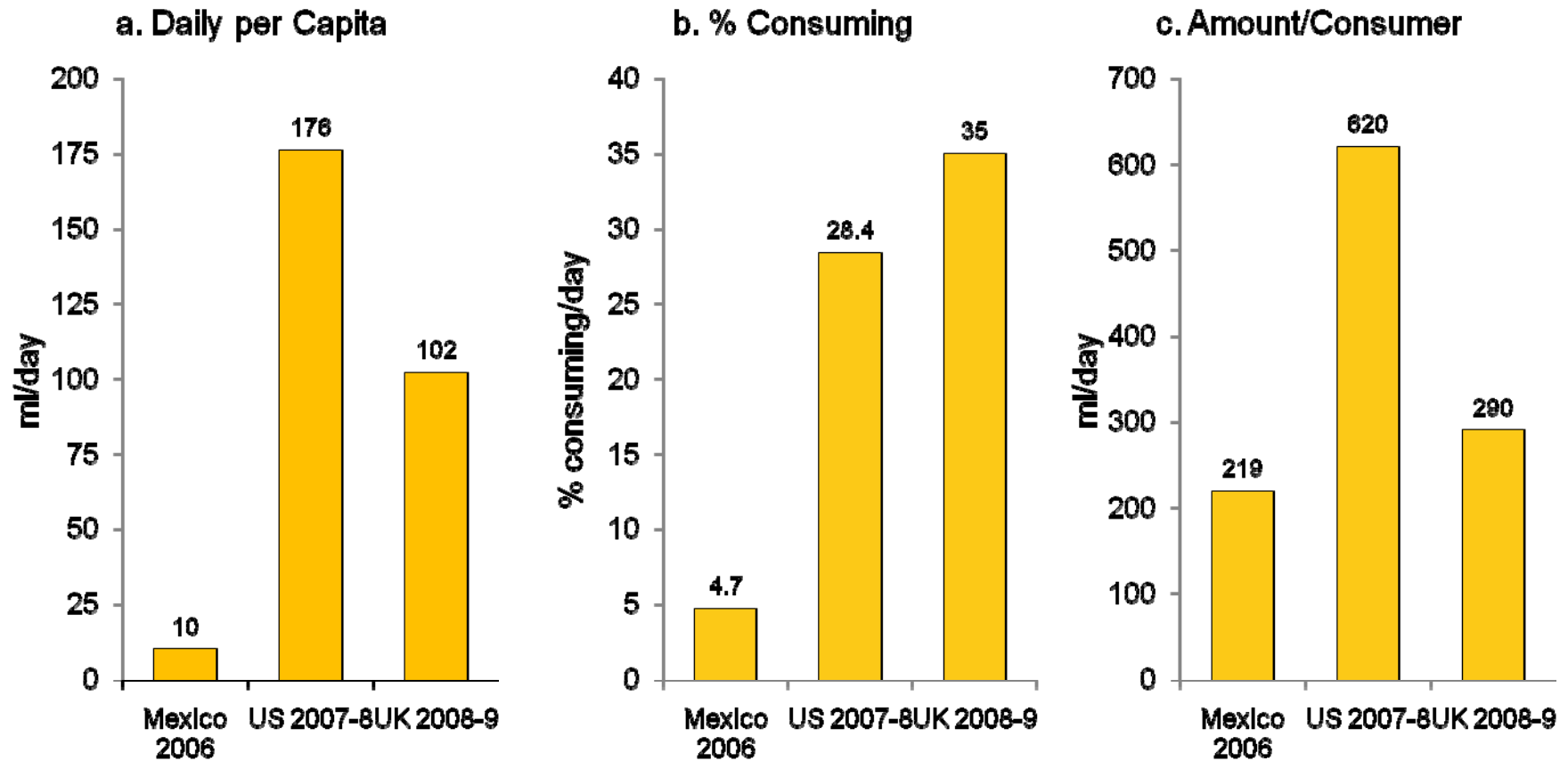
- Sweetened diet beverages: Complex. Our work in process suggests it is the diet linked with these beverages that determines the effect and not the diet beverages (see Mattes and Popkin, AJCN (2009) 84:)
- Diet sweeteners and health: two pictures. Healthy diet with diet sweeteners and those who use diet sweeteners to consume unhealthy foods.
- Expect huge increase in diet sweetener use in beverages in the next 2-4 years

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# Diet Beverage Intake: Daily Per Capita and Per Consumer Beverage Consumption among Adults (19-64y) in Mexico, United States and United Kingdom



# Water and Health

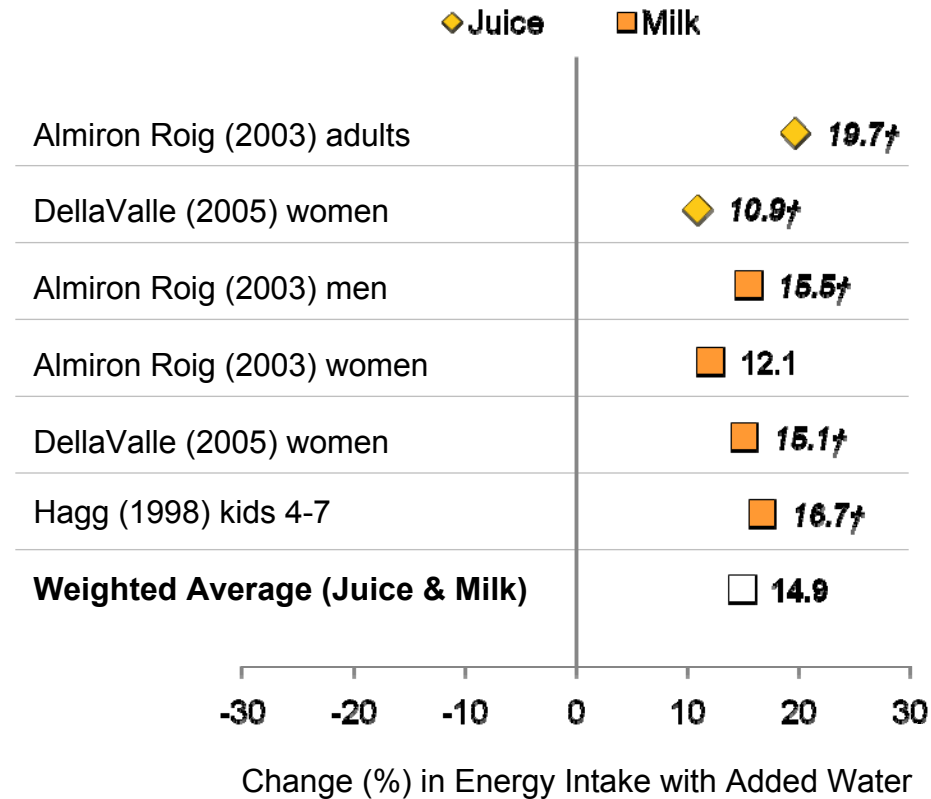
- Water research: very limited. Some studies beginning to suggest important direct calorie replacement and possibly added effects of water on energy intake, weight and metabolic functioning
- Review: adding water to the diet alone or to replace sugar-sweetened beverages, juice, milk and diet beverages
- Show effect on total daily intake of kcals

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## Difference in Total Energy Intake when Juice or Milk Displace Water



†P<0.05

Popkin, D'Anci, Rosenberg (2010) Nutr Rev 92; Daniels & Popkin (2010) Nutr Rev 92

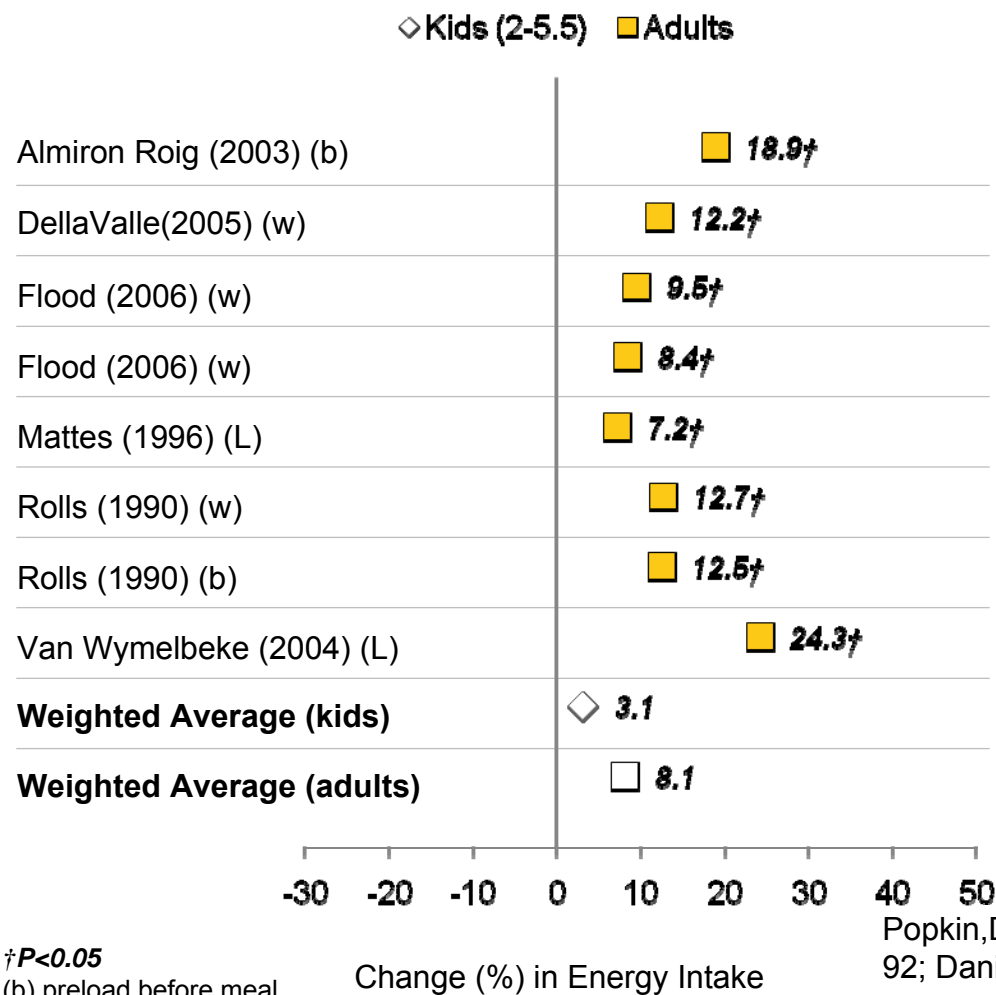
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## Differences in Total Energy Intake when HFCS or Sucrose Sweetened Beverages Displace Water (6 kids not shown; only sig adults shown out of 19 total)



†P<0.05

(b) preload before meal

(w) preload with meal

(L) long study (2+ meals)

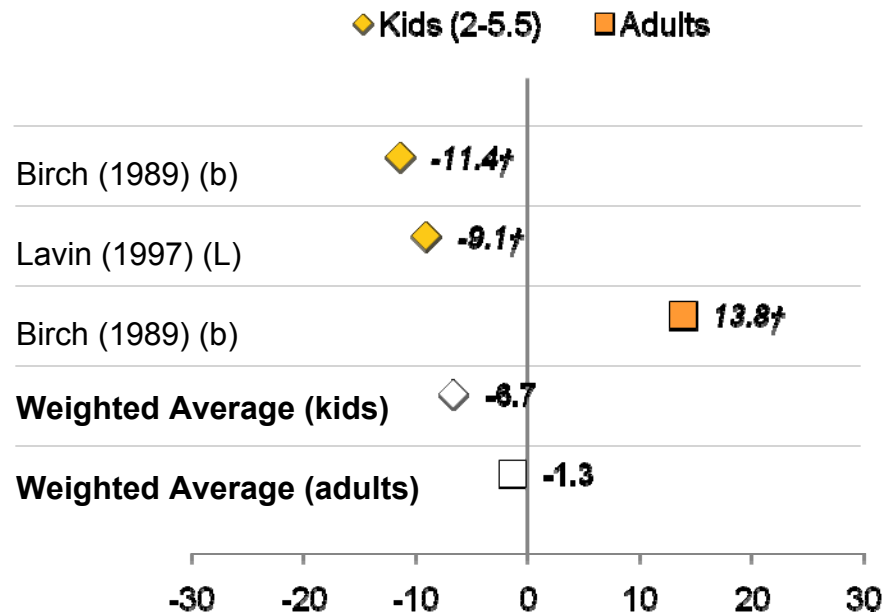
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Popkin, D’Anci, Rosenberg (2010) Nutr Rev 92; Daniels & Popkin (2010) Nutr Rev 92



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## Differences in Total Energy Intake When Diet Beverages Displace Water (6 kids; 19 adult comparisons; sig shown)



†  $P < 0.05$

(b) preload before meal

(w) preload with meal

(L) long study (2+meals)

Change (%) in Energy Intake

Popkin, D'Anci, Rosenberg (2010) Nutr Rev 92; Daniels & Popkin (2010) Nutr Rev 92

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# Water and Health

- 4 epidemiological studies suggest replacing SSB's with water might reduce kcals by about  $\geq 200$  kcals
- German controlled trial found that replacing vending machines and choices of any beverage with filtered water fountains plus water education reduced risk of overweight by 31%
- Absence of good random controlled trials. UNC one about to be submitted for publication. Strong positive results for both diet beverages and water vs normal beverages.

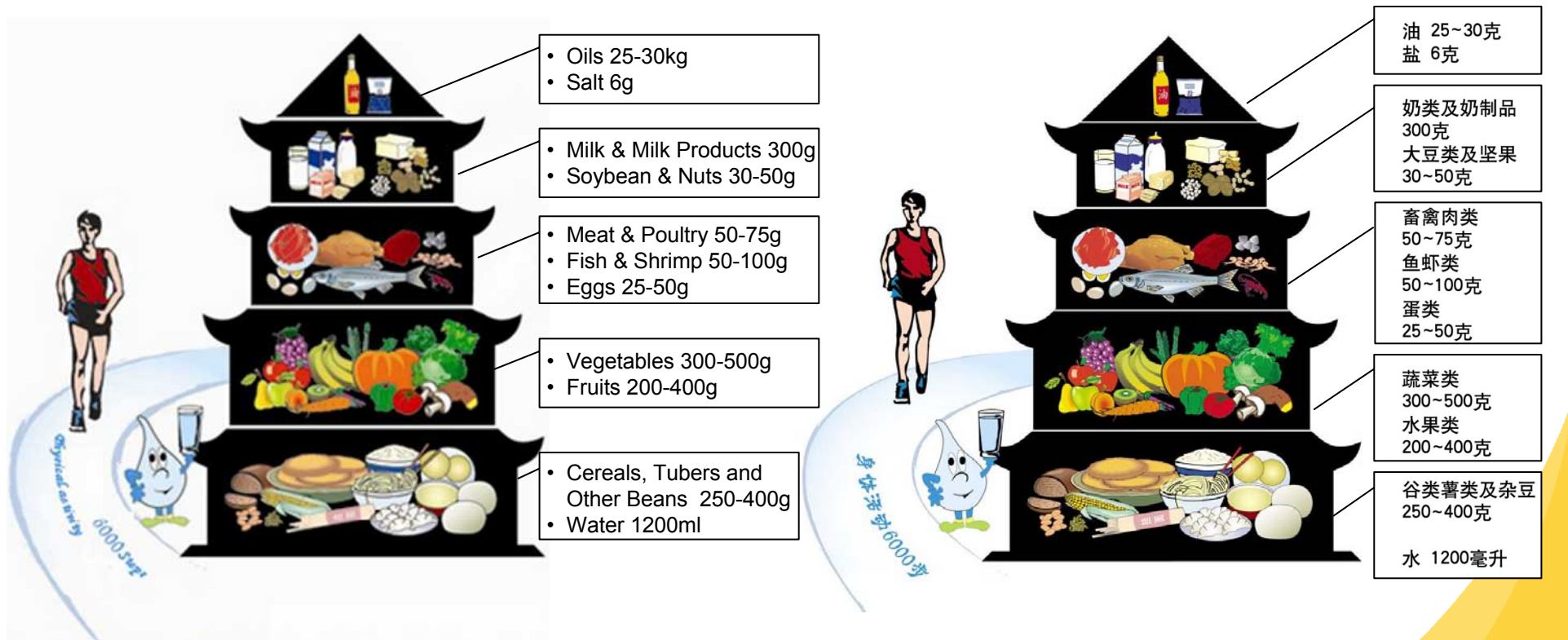
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# The Food Guide Pagoda for Chinese People

## 中国居民平衡膳食宝塔 (2007)



Chinese Nutrition Society

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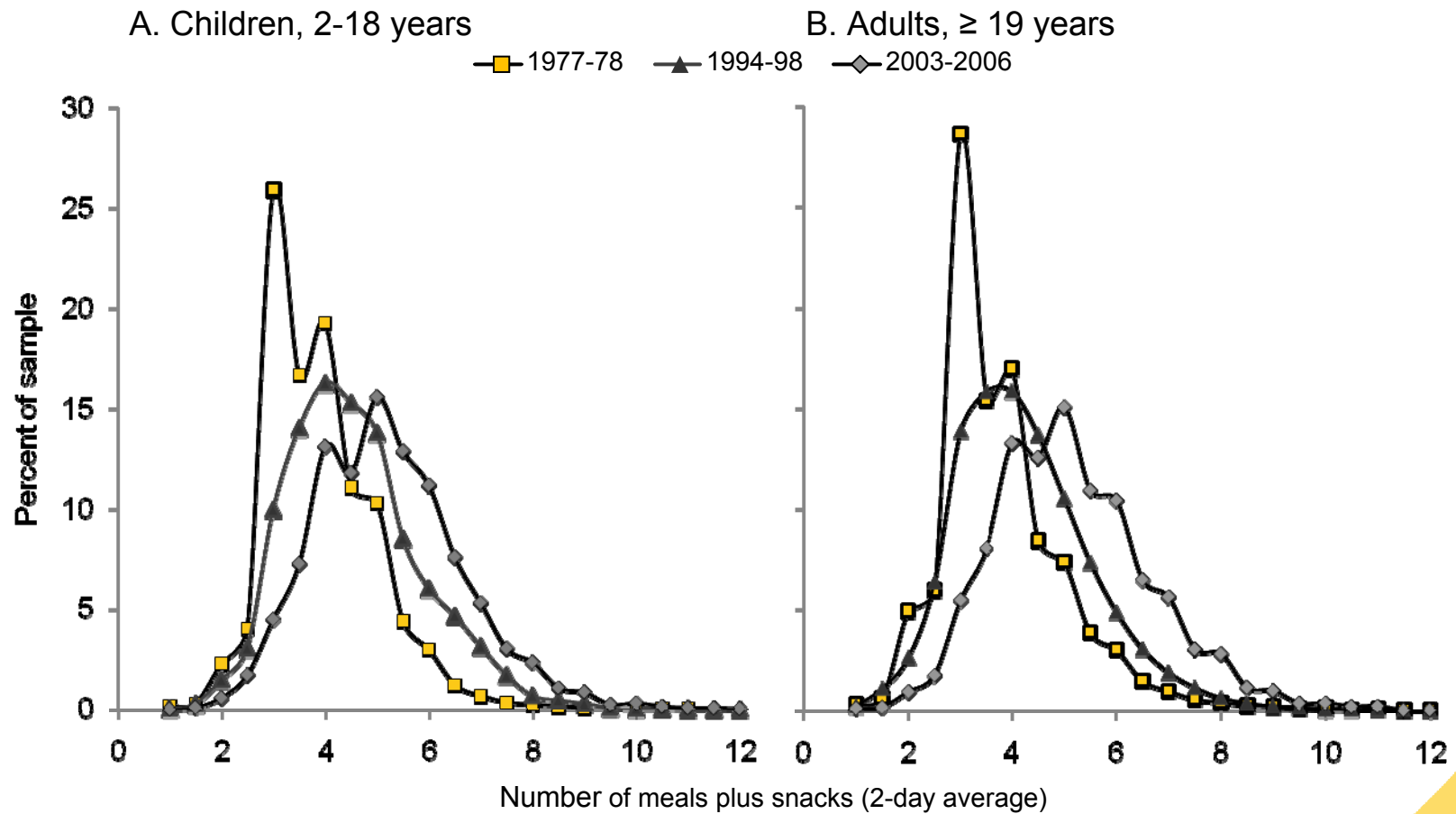
*Does the physiological basis for eating exist any more? Continuous caloric intake is becoming the norm.*

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## Daily Meal Frequency Among US Children, Ages 2-18 and US Adults Ages 19 and Older



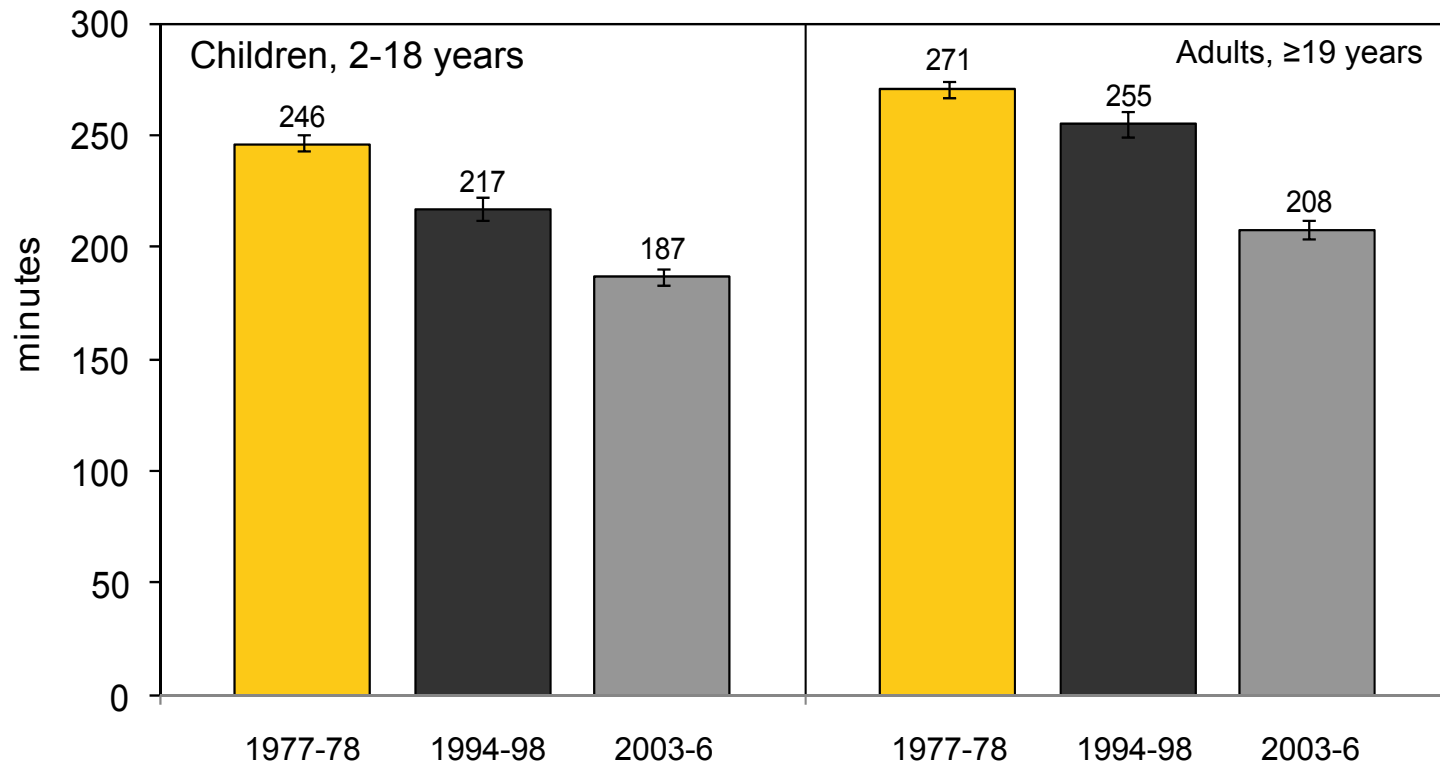
Source: Popkin, and Duffey American Journal of Clinical Nutrition (2010): 91

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## The Time Between Eating Occasions: US Adults and Children, 1977-78 to 2003-6



Source: Popkin, and Duffey American Journal of Clinical Nutrition (2010): 91

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# Location of eating

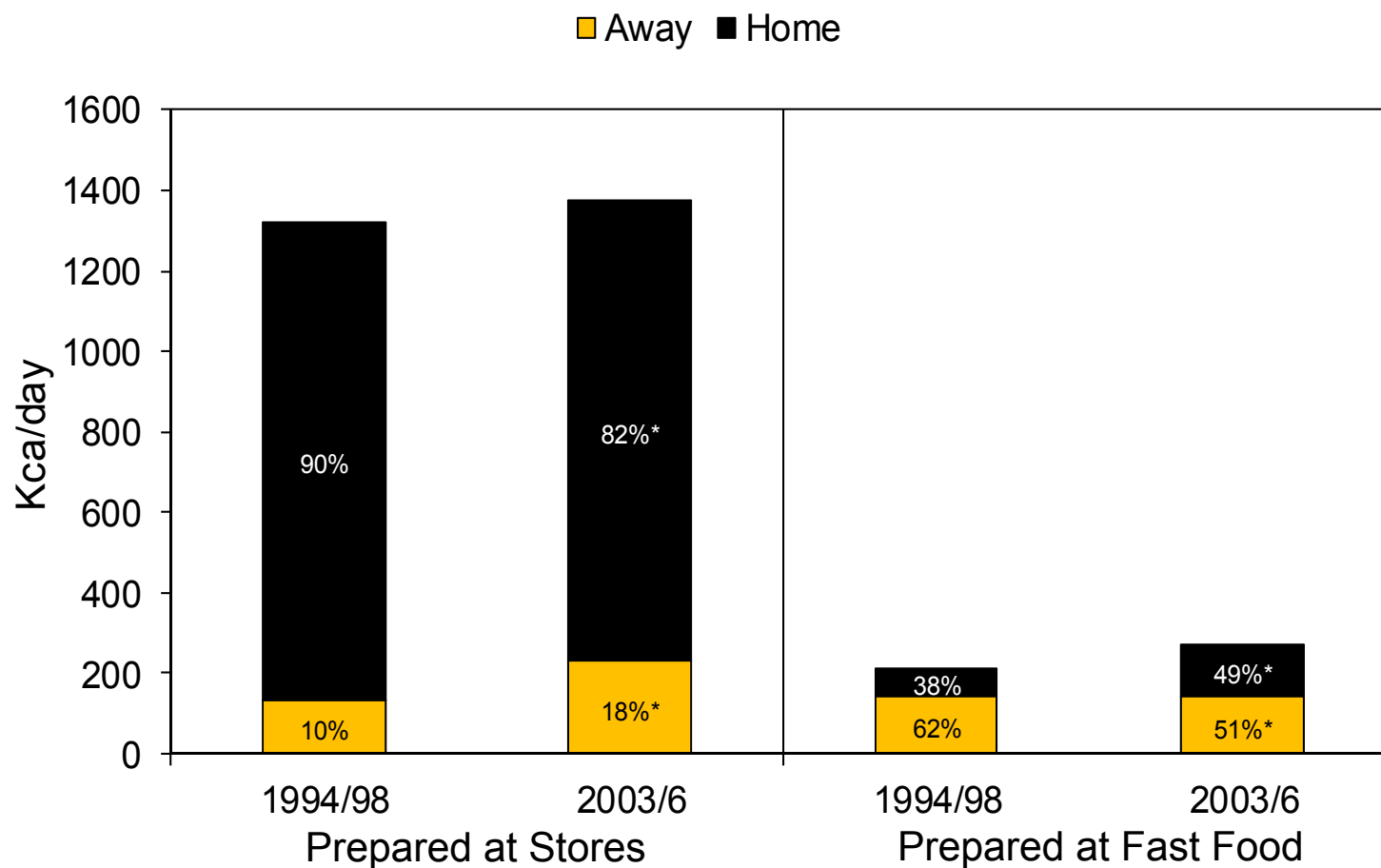
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# Location of Consumption and Purchases of Calories for US Children Aged 2-18 Kcal/day, 1994-98 to 2003-06<sup>a</sup>, from Stores and Fast Food



<sup>a</sup>Data were obtained from CSFII 1994-98 (n=7952) and NHANES 2003-06 (n=6644).

\* Percentage of energy was significantly different from 1994-98, P≤0.01 (t test)

**Fat Preference Key for Survival:  
Technology, Marketing have Utilized  
this Preference for Fatty Food**



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# Fatty Foods

- The term "sensory" as used here incorporates psychophysical, cognitive, and affective factors (usually analyzed separately by psychologists) that enter into taste discriminations and preferences in food selections.
- Fatty foods: smoother, affects taste in many ways

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## Edible Oil Consumption Still Rising in China (grams per day per capita)

Year	1989	1991	1997	2006	2009
Poorest (lowest income tertile)	11.8	19.4	26.5	30.8	37.6
Middle income tertile	15	22.4	29	35.4	43.5
Richest (highest income tertile)	17.4	26.9	32.2	33.9	37.7
Average for total adult population	14.8	22.9	29.2	33.4	39.6
% of all calories per capita from edible oil	4.9	7.8	11.3	13.2	14.4

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# How We Move

- Shifts in the composition of occupations and the activity within each occupation
- Shifts in production at home: new assets, reduced time in all activities
- Shifts in the ways we travel
- Shifts in leisure



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**The Struggle Over the Millenia to Eliminate Arduous Effort Could Not Foresee Modern Technology**



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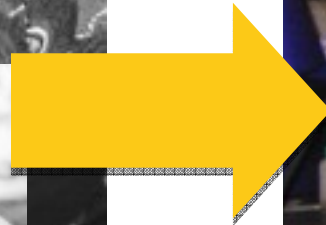
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# From Traditional to Modern Household Production





# From Traditional to Modern Economic Work at Home

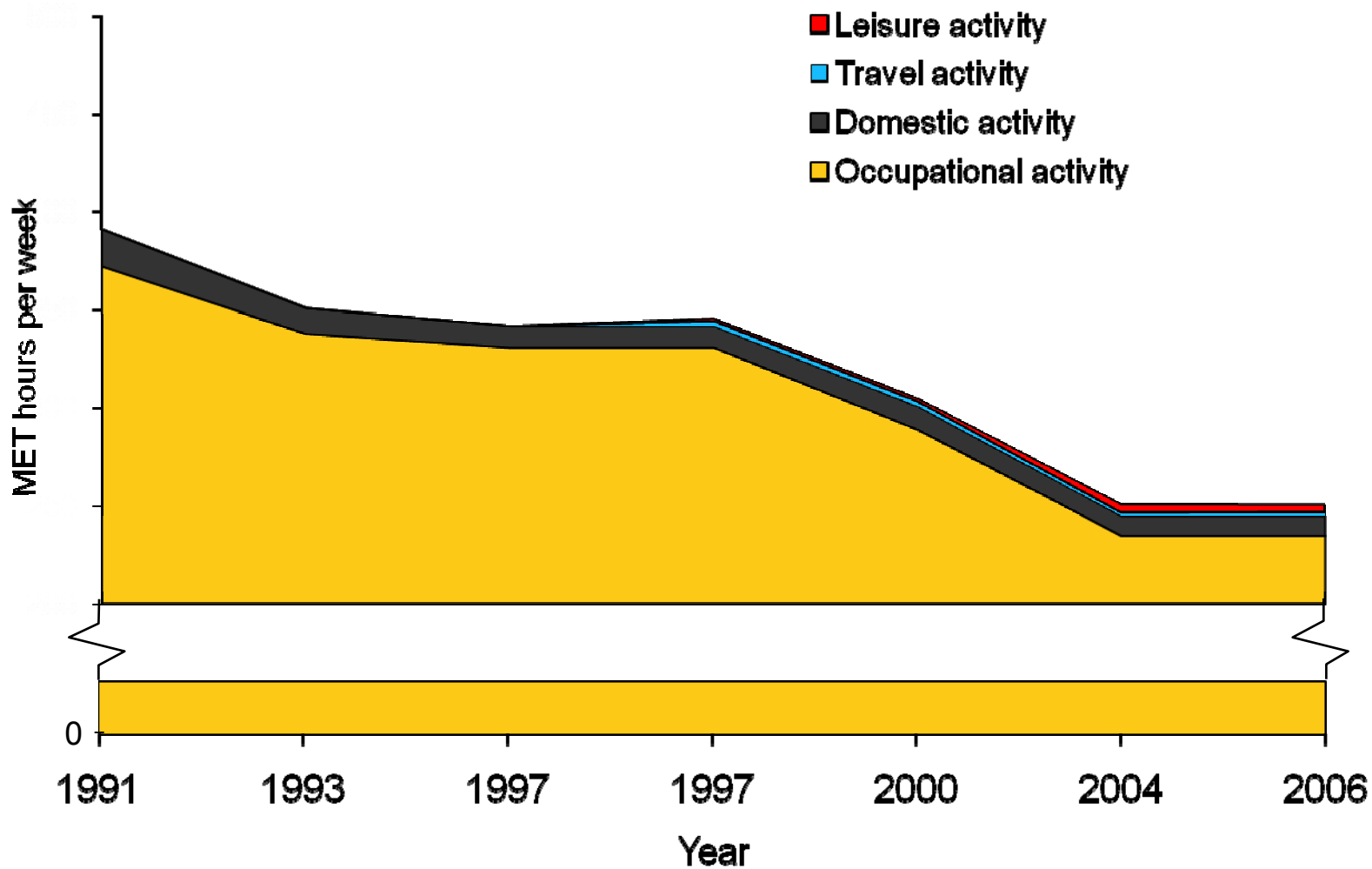




# From Traditional to Modern Leisure

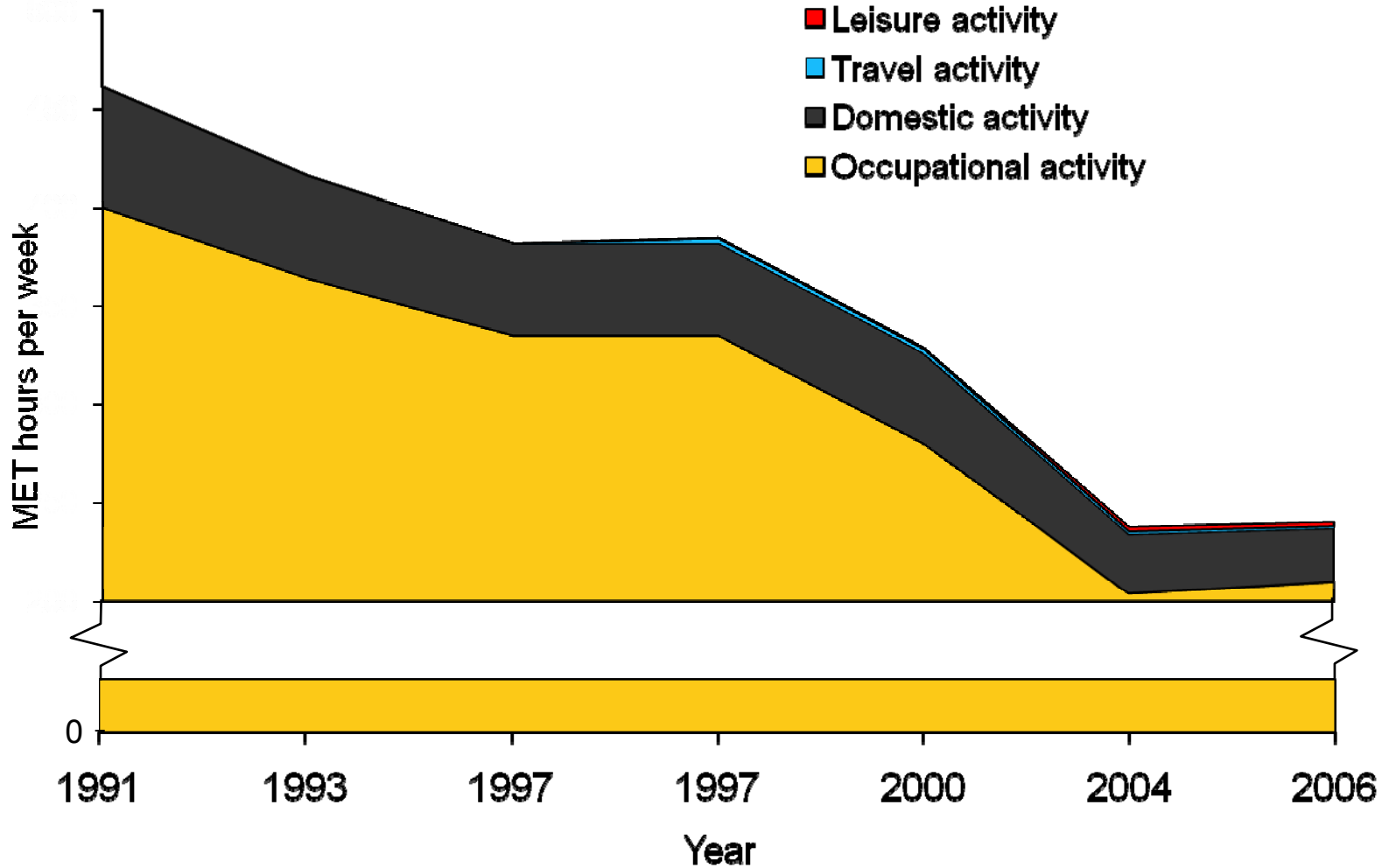


## Shift In MET Hours per Week by Activity Among Chinese Men (18-55 Years Old)



Source: Ng, Norton, Popkin (2009) SSM 68: 1305-14.

## Shift in MET Hours per Week by Type of Activity Among Chinese Women Aged 18-55



Source: Ng, Norton, Popkin (2009) SSM 68: 1305-14.

# Supermarkets: a new actor in the food system!

- In 1990 15-20% of food sold in supermarkets in Latin America. Now this is 60% of the average population share. They are becoming the main buyers in the supply chains for processed foods
- Even the poorest country, Nicaragua, has gone from 45 to 60 supermarkets in the last year
- Now 705 supermarkets in Central America. Replace small stores and plaza-markets. They do not replace street fairs and focused fruit & vegetable stores
- Top 5 chains control two-thirds of the supermarket sector in Latin America (Walmart, Carrefour, Ahold)
- Asia, urban Africa are next

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## How do we proceed?

- Clearly action needed at all levels; however I believe the only way to produce concerted change is to look to the models of tobacco use, seat belt, other major public health changes
- Regulations, taxation, mass education are key components
- Examples: UK Foresight Commission, Mexico Beverage campaign, US Farm Bill, Brazil and Singapore schools

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# The Policy Intervention Ladder

- Eliminate choice
- Restrict choice
- Guide choice through disincentives
- Guide choice through incentives
- Guide choices through changing the default policy
- Enable choice
- Provide information
- Do nothing or simply monitor the situation

Source Susan Jebb from the Nuffield Council Bioethics Public Health: Ethical Issues

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# Food Policy Options

- Clearly action needed at all levels; however I believe the only way to produce concerted change is to look to the models of tobacco use, seat belt, other major public health changes
- Regulations, taxation, mass education are key components
- The food and agricultural system is driven by historical concerns – examine this first.
- Price examples: show here from Mexico and US research on caloric beverages. Others on China and the UK show similar types of strong effects

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# Economic Policies Might Work

- Examples show the potential.
- However no examples exist for unhealthy foods taxed for healthy reasons with any linkage to diet or other measures of health.
- Tobacco is the prime example

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# Limitations to Current Studies of Food Price shifts on Dietary Intake in the US

- No studies examine the effects of food prices on individual dietary intake in the US except broad ecological relationships done cross-sectionally
- CARDIA cohort of adults followed over 20 years with clinical exams, fasting blood, detailed dietary data
- UNC team linked food price data longitudinally with each community.
- Focus on prices of beverages and fast foods here (Duffey et al, Archives of Internal Medicine, 2010)

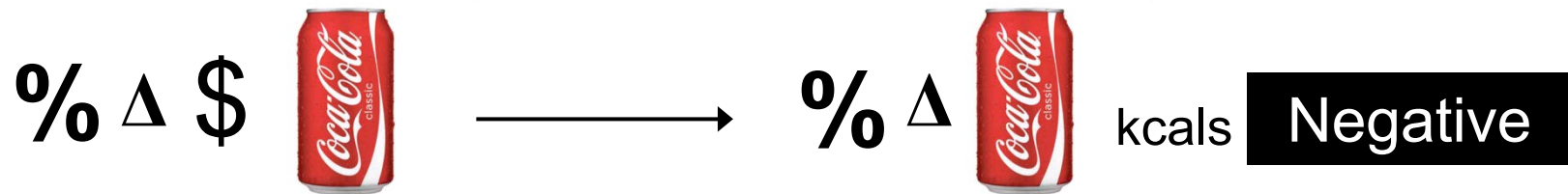
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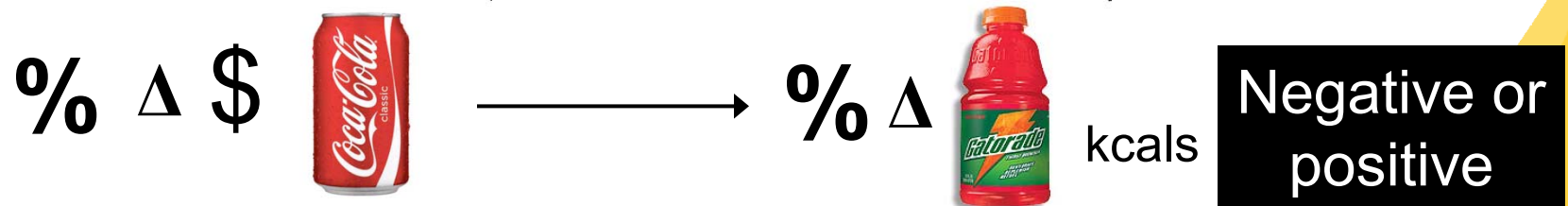
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# Methods: Price Elasticity of Demand

- Elasticity=  $\frac{\% \text{ change in demand}}{\% \text{ change in price}}$
- Own-price elasticity



- Cross-price elasticity

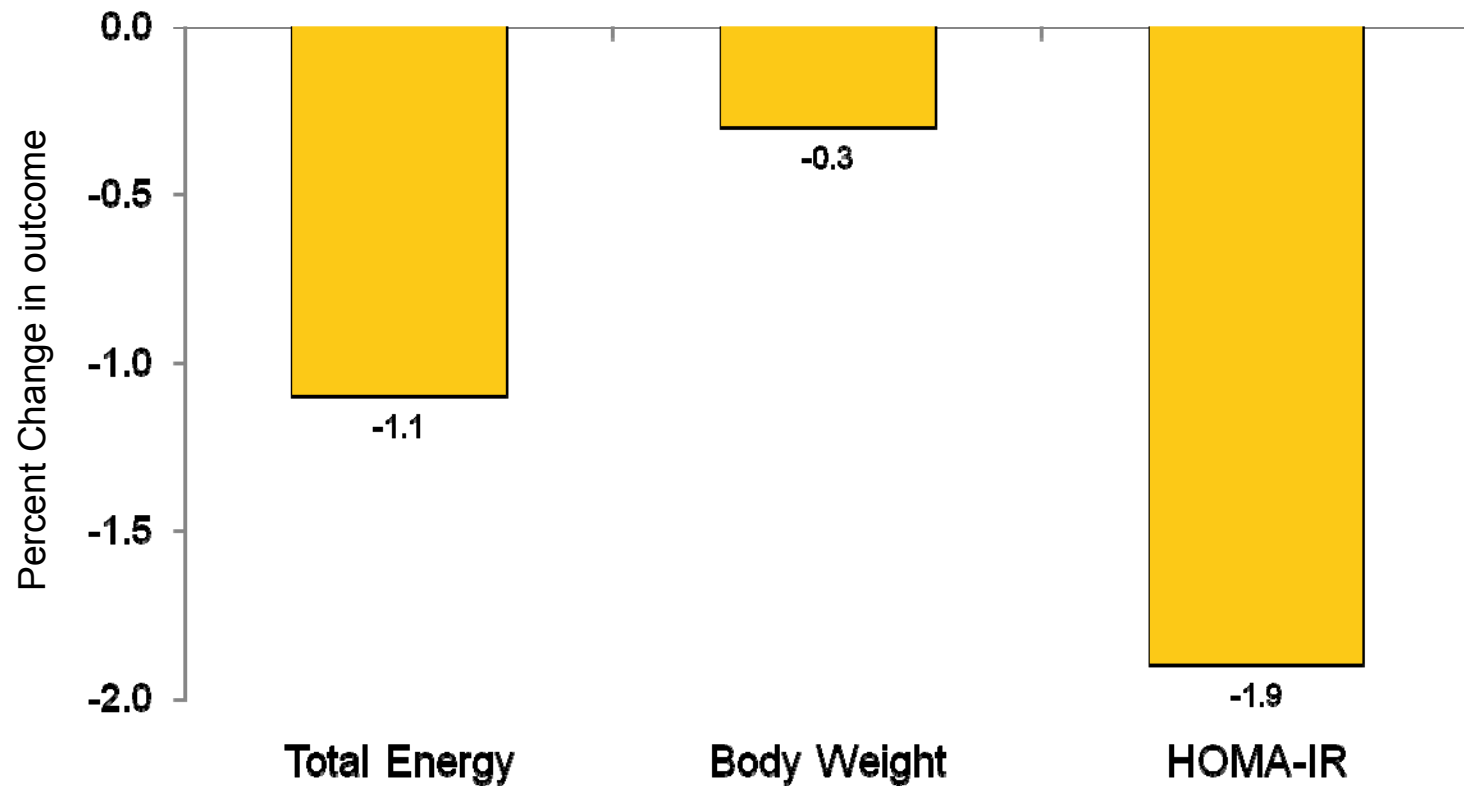


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US example: similar ones from Mexico and the UK now. Adult health significant improvement with a 10% change in the price of soda



Source: Duffey et al, Archives of Internal Medicine, 2010

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# Mexico's Initiative on Beverages

- In government programmes, Mexico has stopped using whole milk, uses only 1.5%-fat milk and will shift fully to skim milk
- In schools, sugar-sweetened beverages are banned, safe drinking water is provided and the sale of water and low-fat milk is allowed
- Mexico is considering taxing added sugars in beverages per gram and fat in milk
- Source: Rivera et al, *Salud Publica*, Mexico, 2008, 50:173-195

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# The Global Food Industry

- The global food industry is **NOT** as omnipresent as believed. In almost all countries, at least 50-60% of all processed foods are locally produced.
- **The good:** Global produces have great technology, are willing to make changes and have the means to do so. But, there have not yet been major reductions of kcal.
- **The bad:** Without government regulations, truly meaningful agreements are not possible.
- **The ugly:** The multitude of local unfettered manufacturers or small regional distributors

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# Summary

- Concern of major increases in potentially obesogenic eating behaviors
- Concern shift to even higher BMI's among upper centile levels
- Food policy. Many unanswered issues. Limited evidence of the effectiveness on food choice of taxation or price manipulation as it affects energy balance. Lot on shifting purchases but not the same
- Food industry: focus typically is on the global multinationals. Need more research on others

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# THE BOOK

“The most serious epidemic ever is insidiously engulfing the world. Barry Popkin draws upon his decades of research and experience to describe its origins—and a set of potential solutions. Those interested in the future of mankind should read this book.”

*Walter Willett, author of Eat, Drink, and Be Healthy, and chair, Department of Nutrition, Harvard University*

