The Impact of Prices and Availability on Adolescent Diet, Physical Activity and Weight

Frank J. Chaloupka
University of Illinois at Chicago
www.uic.edu/~fjc
www.impacteen.org

September 29, 2006, University of Colorado at Denver

Access to Fast Food and Food Prices: Relationship with Fruit and Vegetable Consumption and Overweight among Adolescents

Lisa M. Powell, M. Christopher Auld, Frank J. Chaloupka, Patrick M. O'Malley, and Lloyd D. Johnston

Forthcoming in *Advances in Health Economics and Health Services Research*

Associations between Access to Food Stores and Adolescent Body Mass Index

Lisa M. Powell, M. Christopher Auld, Frank J. Chaloupka, Patrick M. O'Malley, and Lloyd D. Johnston

Forthcoming in *American Journal of Preventive Medicine* supplement on Bridging the Gap Obesity Research

The Availability of Local Area Physical Activity-Related Facilities and Physical Activity Behavior and Overweight among Adolescents

Lisa M. Powell, Frank J. Chaloupka, Sandy Slater, Lloyd D. Johnston, and Patrick M. O'Malley

Forthcoming in *American Journal of Preventive Medicine* supplement on Bridging the Gap Obesity Research

Bridging the Gap: Research Informing Practice for Healthy Youth Behavior

impacTEEN

A Policy Research Partnership for Healthier Youth Behavior

YES! Youth, Education, & Society

Supported by
The Robert Wood Johnson Foundation

Related support provided by NIDA, NCI, USDA and CDC

Purposes of the Bridging the Gap Initiative:

- To evaluate the impact on youth of:
  Policies, Programs, Practices and Other Environmental Influences

- Simultaneously addressing various adolescent health behaviors/outcomes:
  Alcohol, Illicit Drug, and Tobacco Use
  Physical Activity, Diet, and Obesity

- At different levels of social organization:
  State, Community, School, and Individual

impacTEEN
A Policy Research Partnership to Reduce Youth Substance Use

YES! Youth, Education, & Society

Unique Aspects of Bridging the Gap

- It integrates across:
  - > Multiple behaviors
  - > Multiple disciplines
  - > Multiple centers and collaborators
  - > Multiple levels of social organization
  - > Multiple data sources

University of Michigan

Institute for Social Research

- **Monitoring the Future (MTF)**
- **Youth, Education and Society (YES!)**

University of Illinois at Chicago

Health Research and Policy Centers

- **ImpacTeen**
  - **Coordinating Center, Community Data Collections Polysubstance Use Research Alcohol Policy Research Healthy Eating/Physical Activity and Youth Obesity** UIC
  - **Illicit Drug Policy Research Team** Andrews U and RAND
  - **Tobacco Policy Research Team** U. of Buffalo Roswell Park,

ImpacTeen Obesity Research Team

- Lisa Powell
- Sandy Slater
- Jamie Chriqui
- M. Christopher Auld
- Shannon Zenk
- Sherry Emery
- Carol Braunschweig
- Glen Szyzpka
- Carol Bao
- Donka Mirtcheeva
- Deborah Harper

YES Obesity Research Collaborators

- Lloyd Johnston
- Patrick O’Malley
- Deborah Kloska
- Jorge Delva
- Jerald Bachman
- John Schulenberg

Obesity a growing problem in the US

- Results from energy imbalance: intake of calories exceeds expenditure of calories
- Defined by Body Mass Index:

$$BMI = \text{weight (kg)} / \text{height (m)}^2$$

- For adults:

  underweight: BMI < 18.5

  healthy weight: 18.5 = BMI = 24.9

  overweight: 25.0 = BMI = 29.9

  obese: BMI = 30.0

Body Mass Index

- For 5’9” adult:

  underweight: 124 pounds or less

  healthy weight: 125 to 168 pounds

  overweight: 169 to 202 pounds

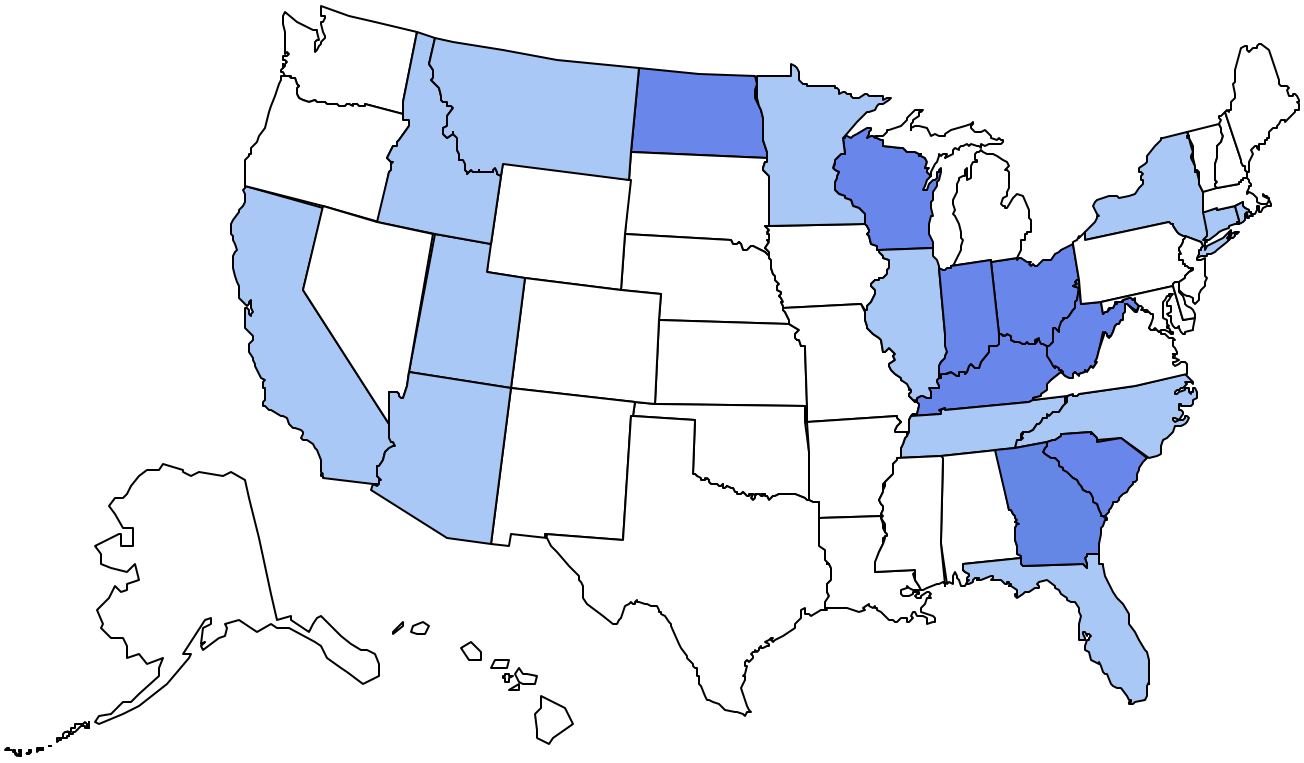
  obese: 203 pounds or more

- Highly correlated with body fat, but an imperfect measure
  - e.g. Athletes with significant muscle mass and low body fat likely to have high BMI

Obesity Trends* Among U.S. Adults

BRFSS, 1985

(*BMI =30, or ~ 30 lbs overweight for 5' 4" person)

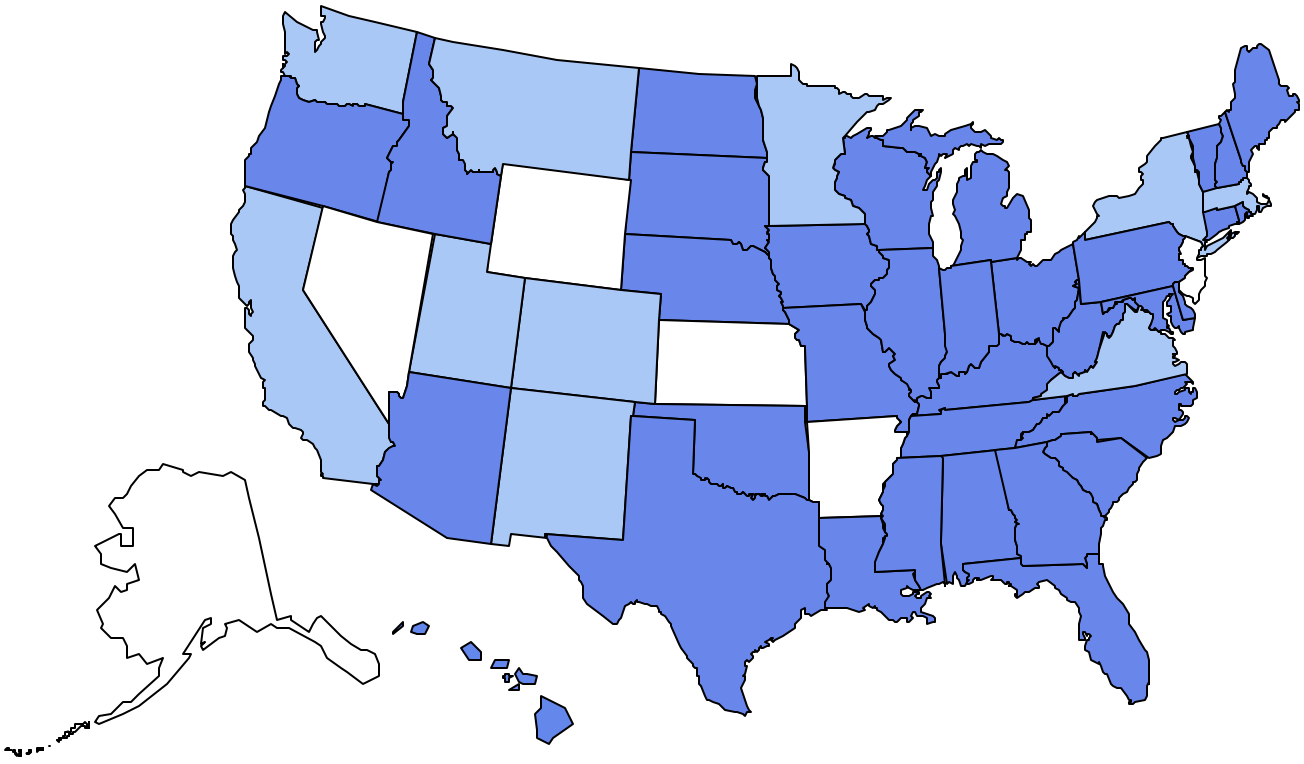


No Data | <10% | 10%–14%

Obesity Trends* Among U.S. Adults

BRFSS, 1990

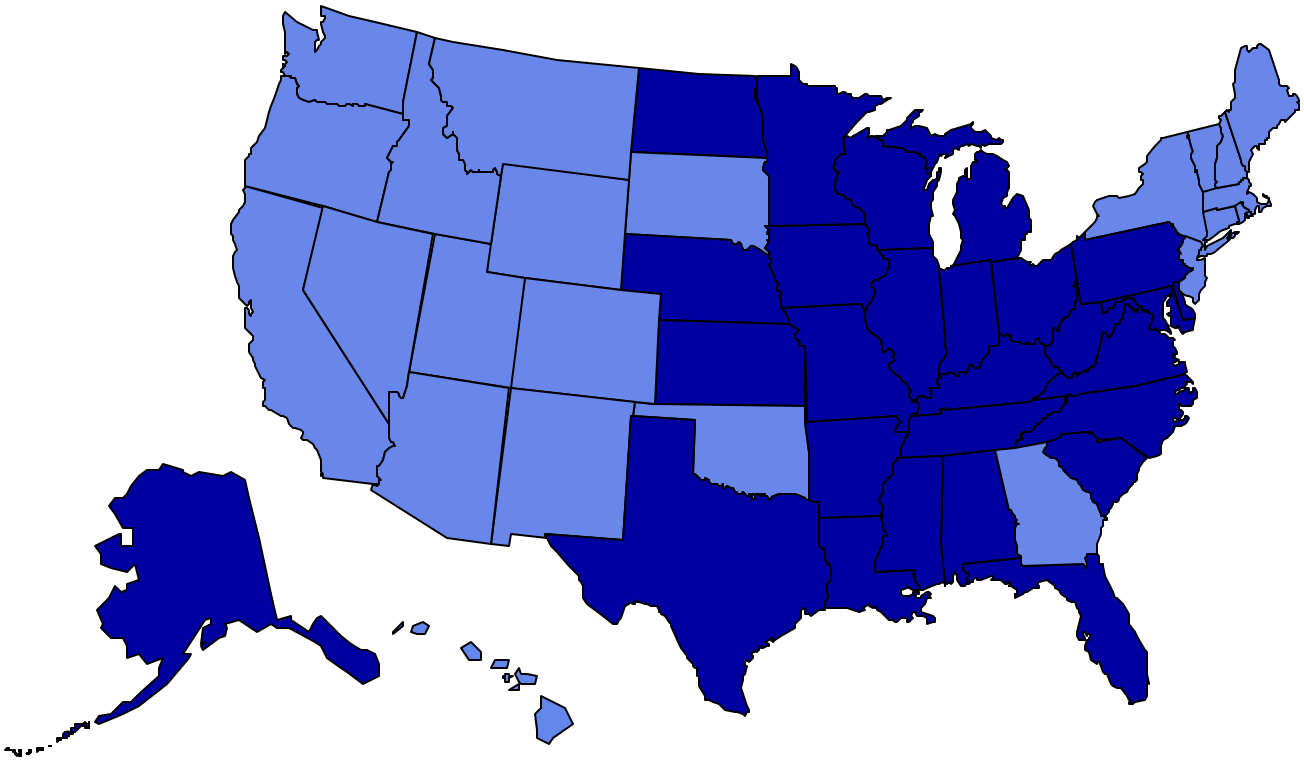
(*BMI =30, or ~ 30 lbs overweight for 5' 4" person)



Obesity Trends* Among U.S. Adults

BRFSS, 1995

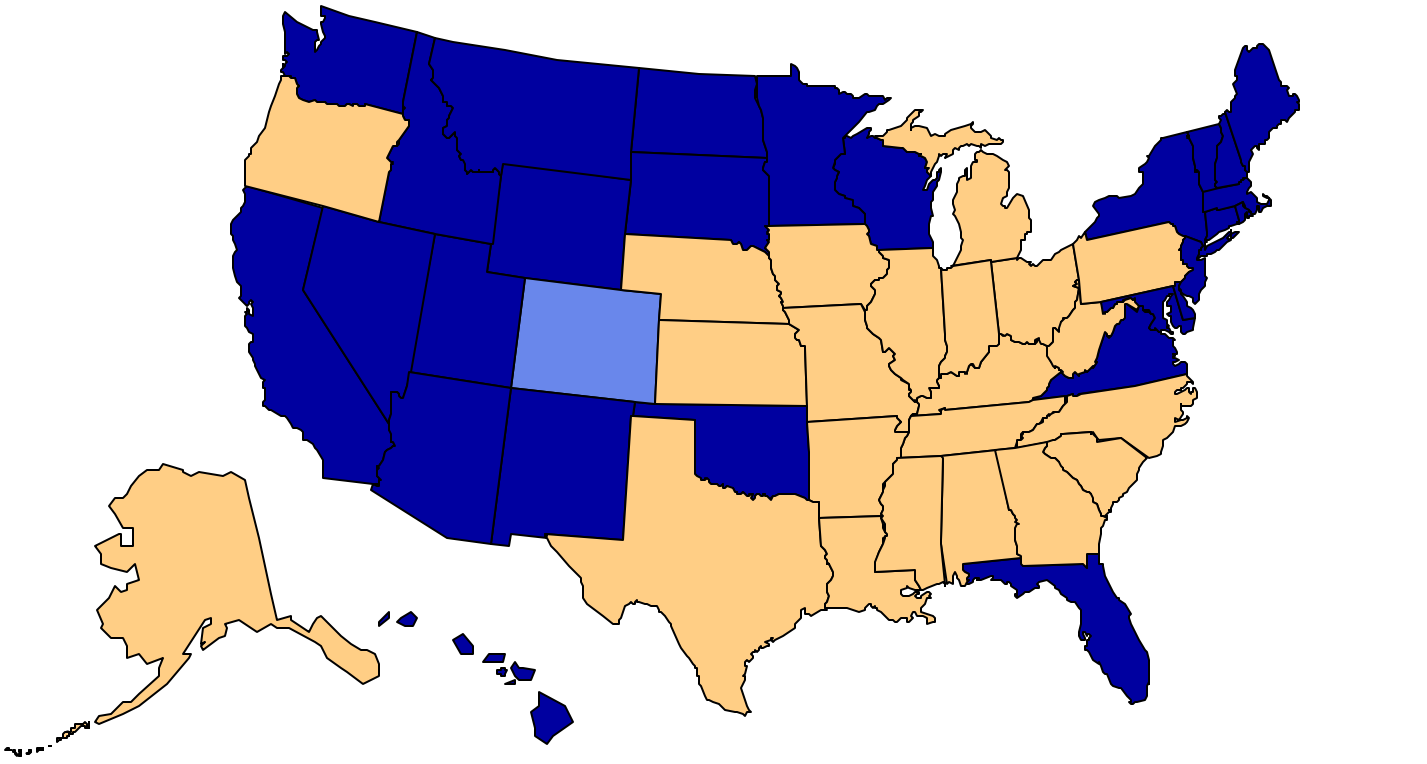
(*BMI =30, or ~ 30 lbs overweight for 5’ 4” person)



Obesity Trends* Among U.S. Adults

BRFSS, 2000

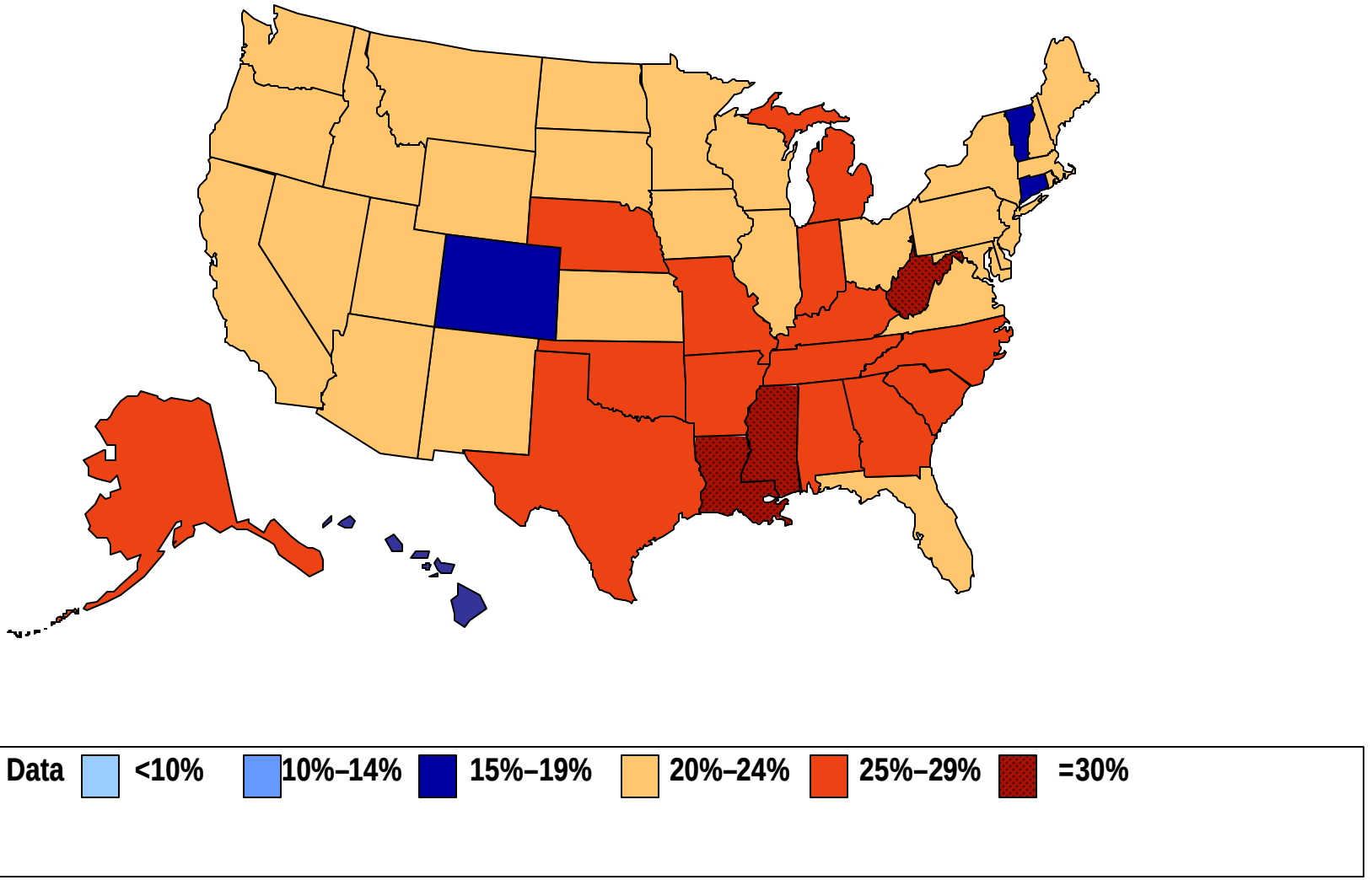
(*BMI =30, or ~ 30 lbs overweight for 5' 4" person)



Obesity Trends* Among U.S. Adults

BRFSS, 2005

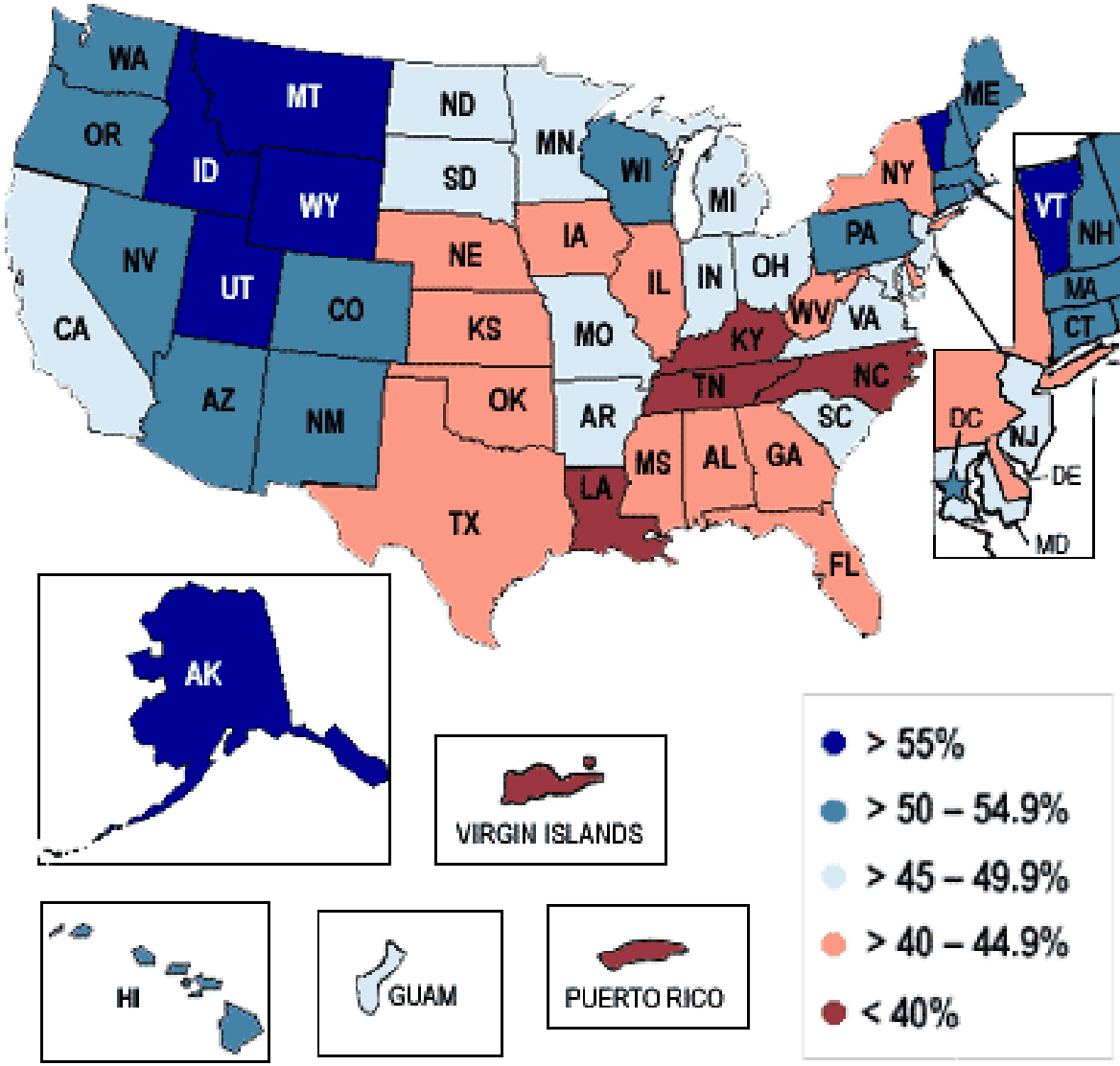
(*BMI =30, or ~ 30 lbs overweight for 5' 4" person)



Factors Contributing to Obesity

- Diet
  - Calorie consumption
  - Nutritional content
- Physical Activity
  - Occupational/household
  - Leisure time
- Genetics
- Environment
  - Prices, advertising and promotion, availability
  - Built environment
- Other Factors

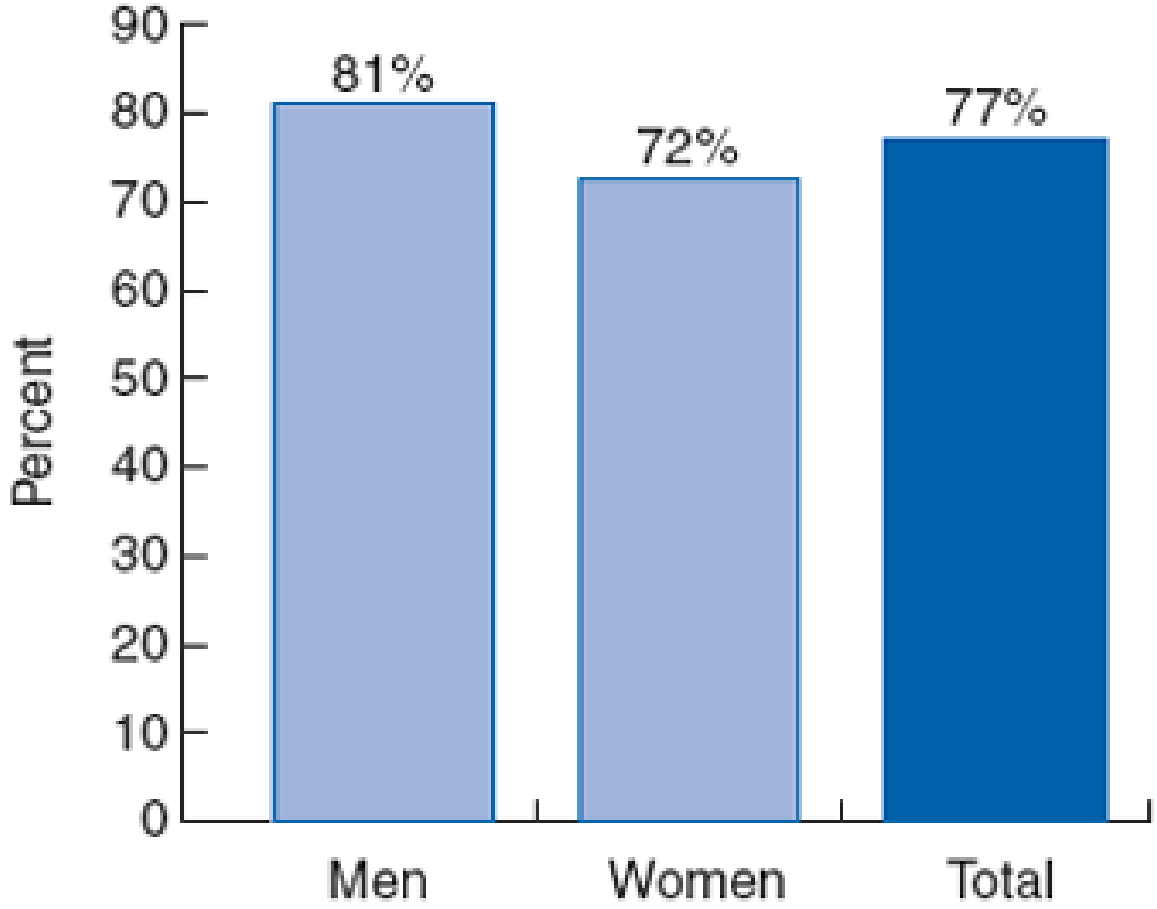
2003 Prevalence of Recommended Physical Activity



Recommended physical activity is defined as at least 5 days a week for 30 minutes a day of moderate intensity activity or at least 3 days a week for 20 minutes a day of vigorous intensity activity

Source: CDC - http://apps.nccd.cdc.gov/PASurveillance/StateSumV.asp

Percentage of Adults Who Ate Fewer Than 5 Servings of Fruits and Vegetables Each Day, by Sex, 2005



Source: CDC - http://www.cdc.gov/nccdphp/publications/aag/dnpa.htm

Childhood Obesity

- Also based on BMI:
  - based on CDC growth charts:
    - If age-sex specific BMI = 95th percentile, then "overweight" (obese)
    - If age-sex specific BMI = 85th percentile, but < 95th percentile, then "at risk for overweight" (overweight)
- Rising rapidly among children and adolescents
  - Tripled among 12-19 year olds to 16.1% in 1999-2002

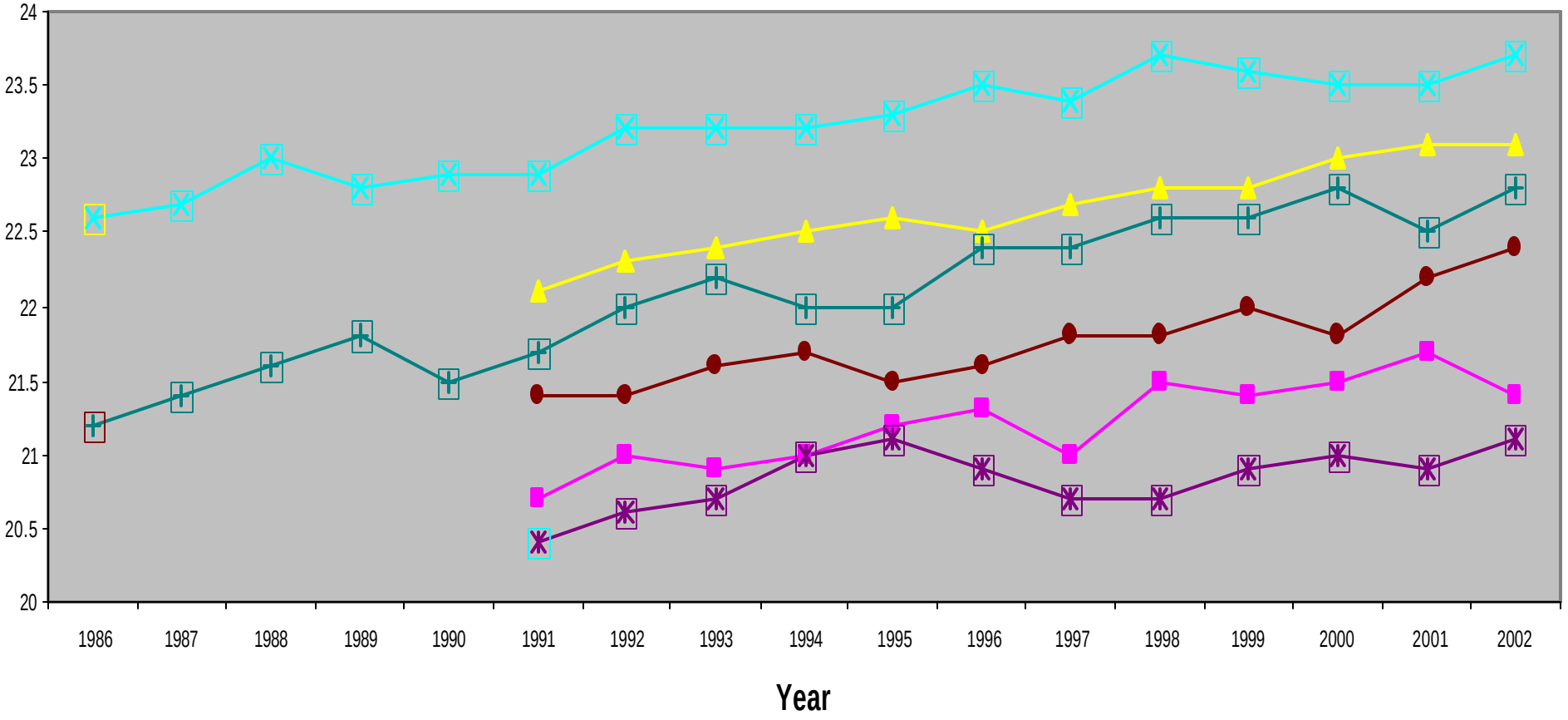
Monitoring the Future Study

- Annual school-based surveys of 8th, 10th and 12th grade students
  - Funded by National Institute on Drug Abuse
  - Conducted by Lloyd Johnston, Patrick O'Malley and colleagues
  - About 50,000 students per year since 1991
    - 17,000 12th graders 1975-1990
  - 400-425 schools per year
    - Rolling half-samples
  - Cohorts selected each year for longitudinal follow up
  - Focus on adolescent tobacco, alcohol, and illicit

Monitoring the Future

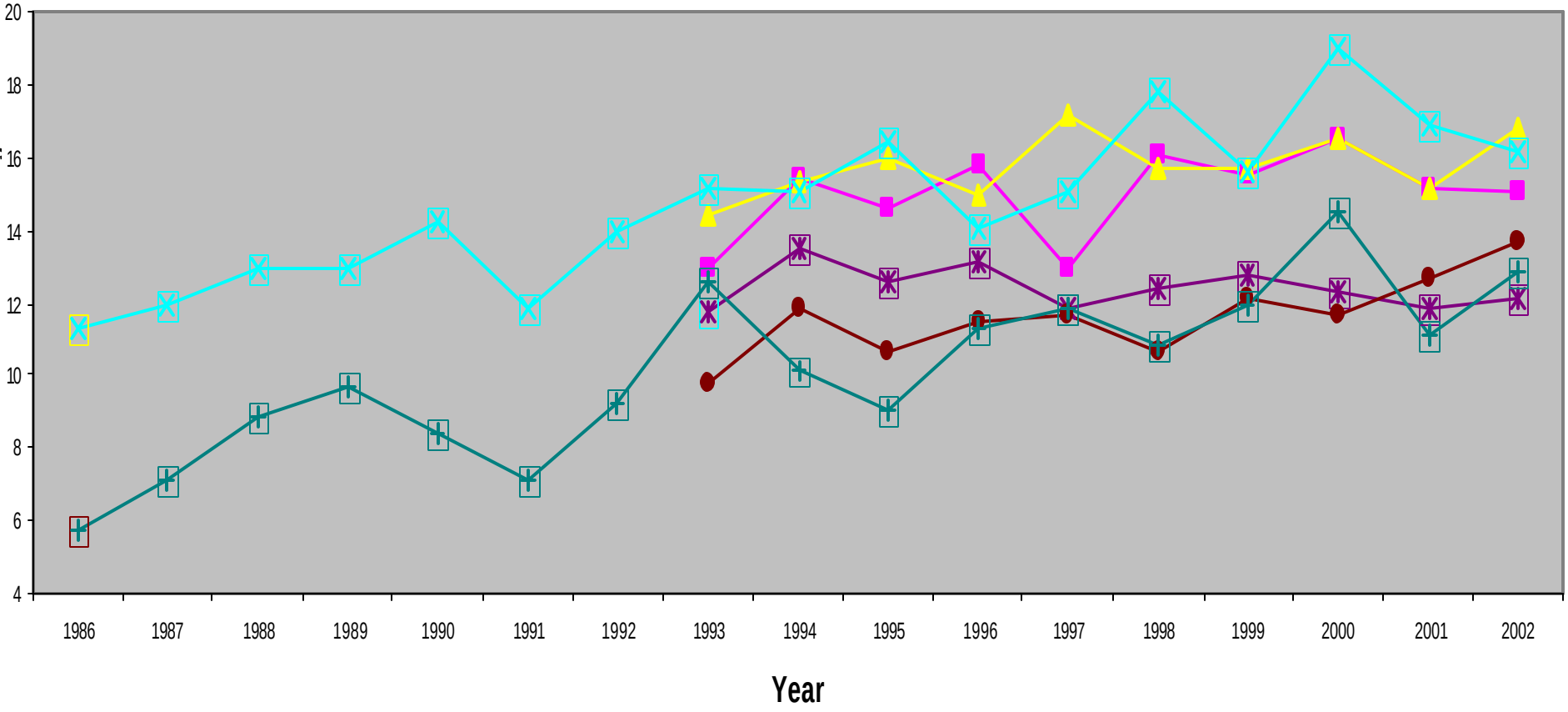
- Multiple forms employed
  - 6 for 12th graders; 4 for 8th/10th graders
- “core” component includes:
  - basic socioeconomic and demographic information
  - Basic smoking, drinking, drug use questions
- Specific forms include:
  - height and weight
    - » Some evidence that self-reports are valid
  - Physical activity
  - Diet
  - Variety of other information

Mean Body Mass Index



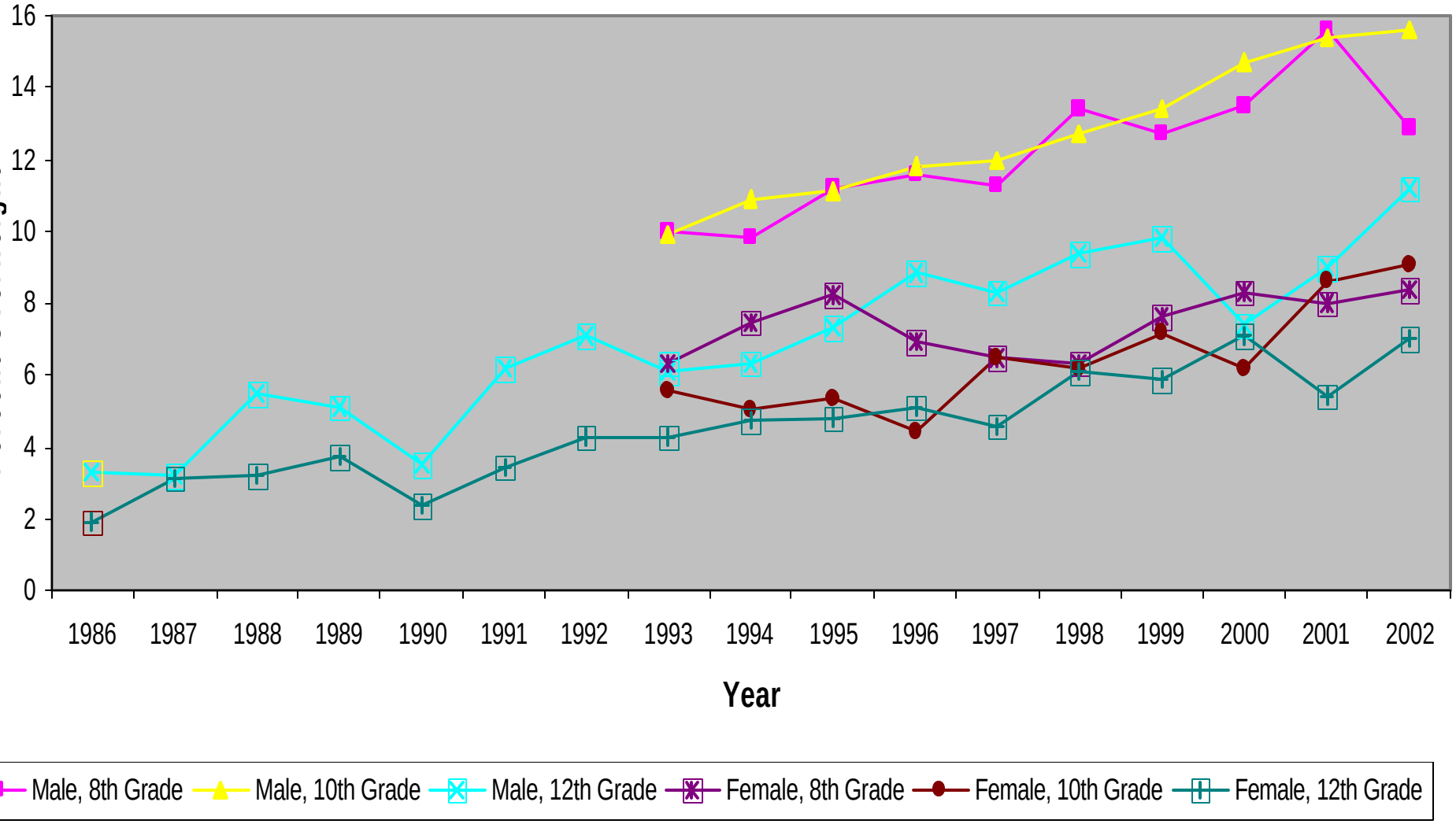
ource: Johnston, et al., 2003

Percent at Risk of Overweight



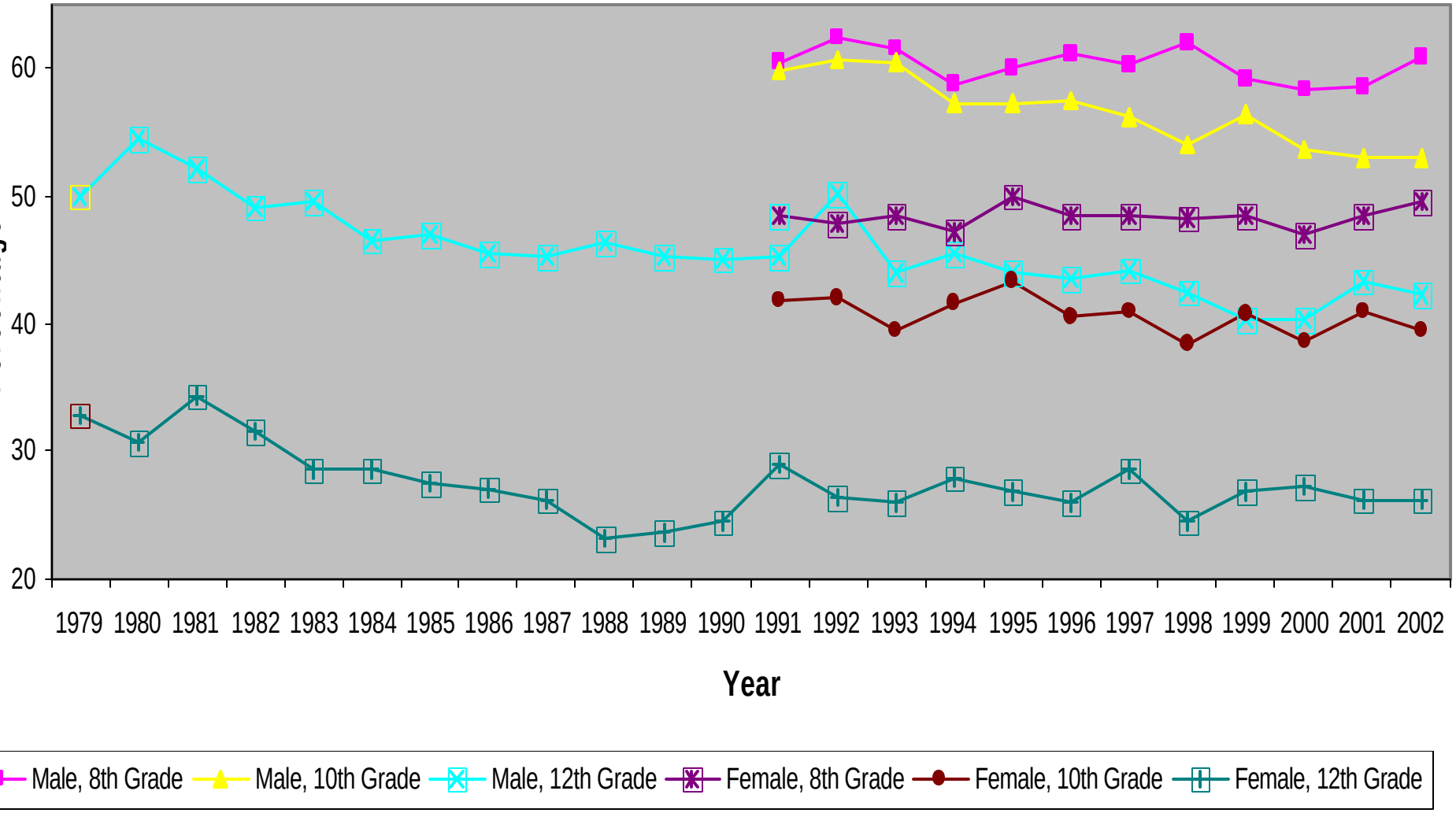
ource: Johnston, et al., 2003

Percent Overweight



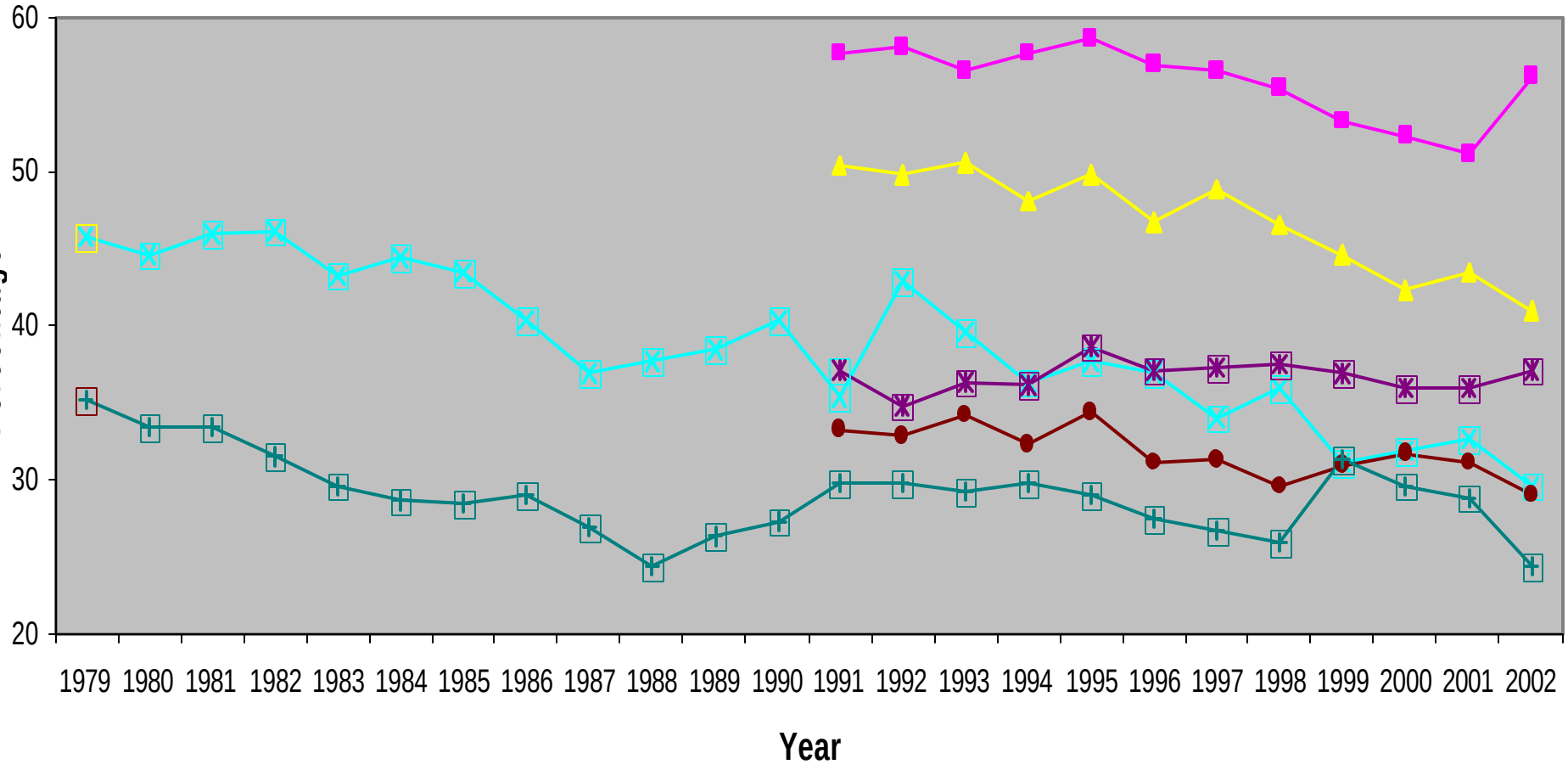
ource: Johnston, et al., 2003

Frequency of Vigourous Exercise, Nearly or Every Day



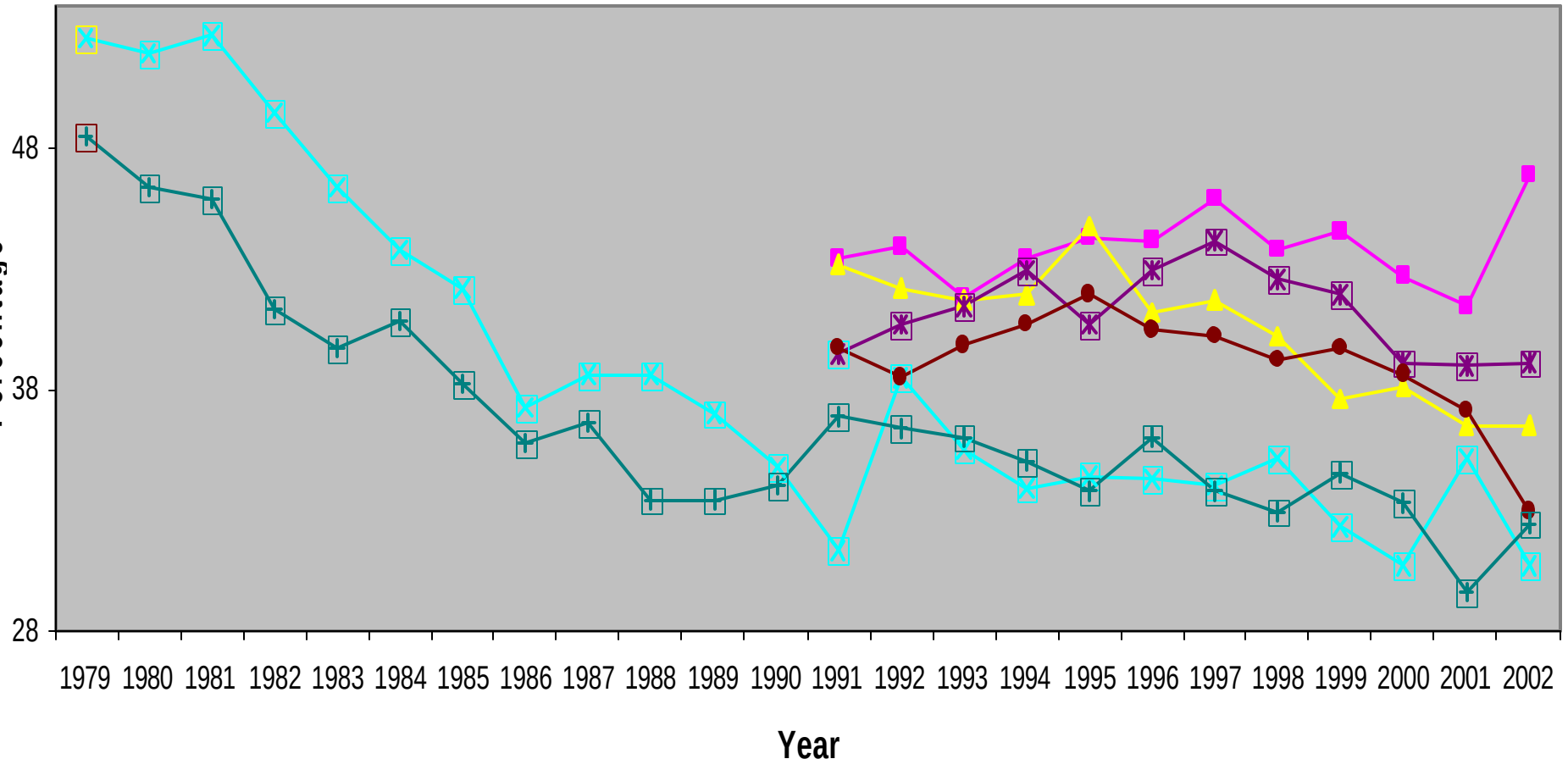
ource: Johnston, et al., 2003

Frequency of Eating Breakfast, Nearly or Every Day



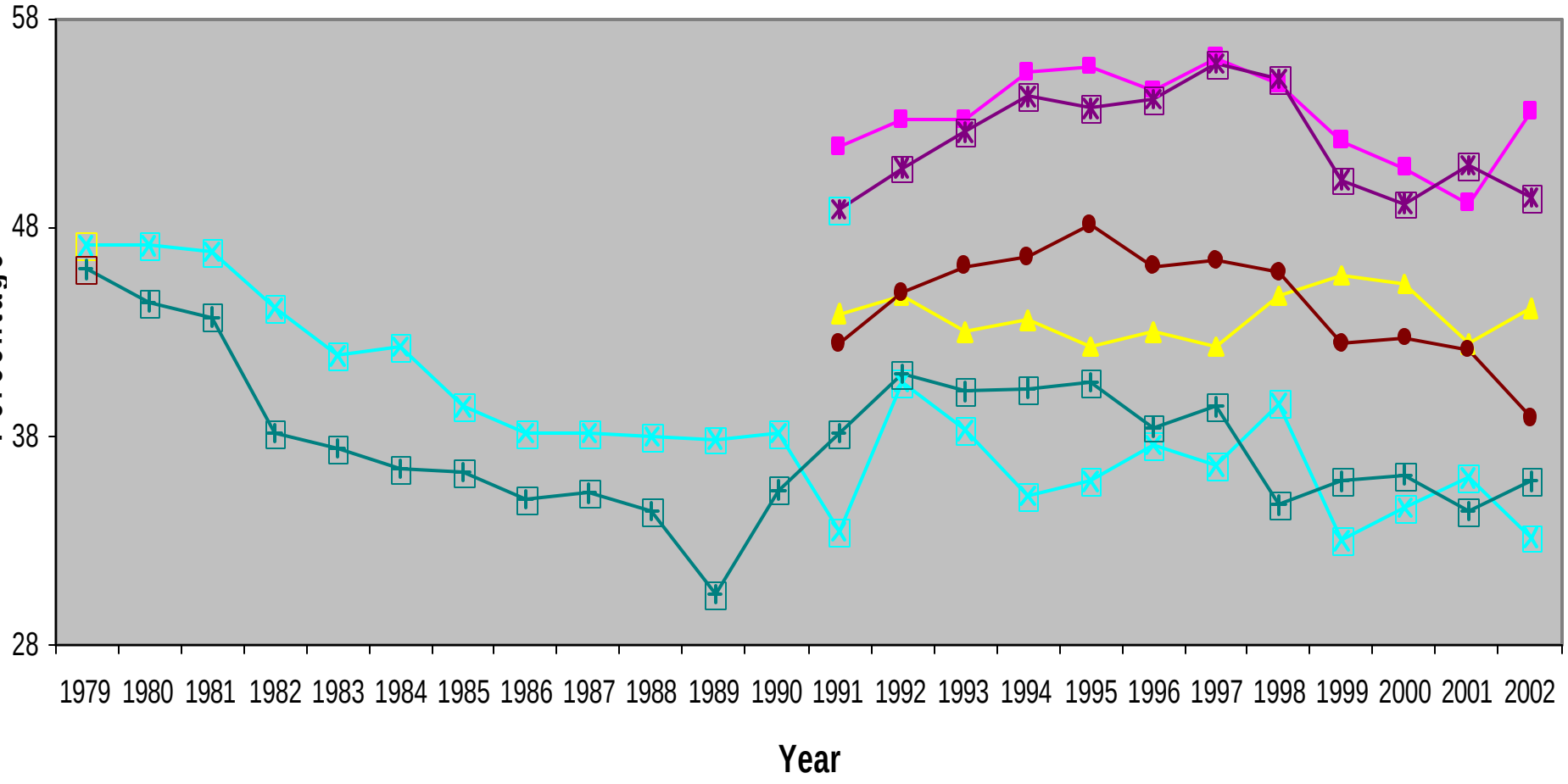
ource: Johnston, et al., 2003

Frequency of Eating Green Vegetables, Nearly or Every Day



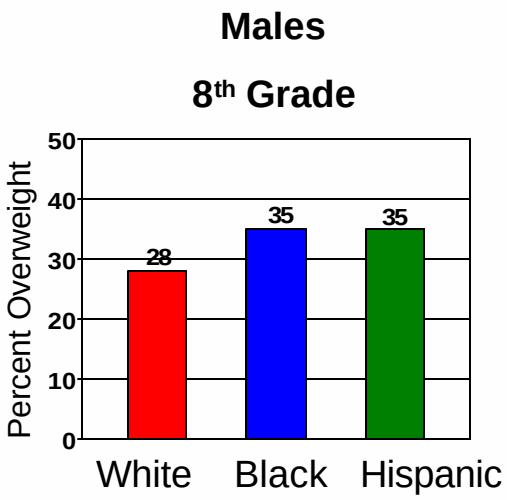
ource: Johnston, et al., 2003

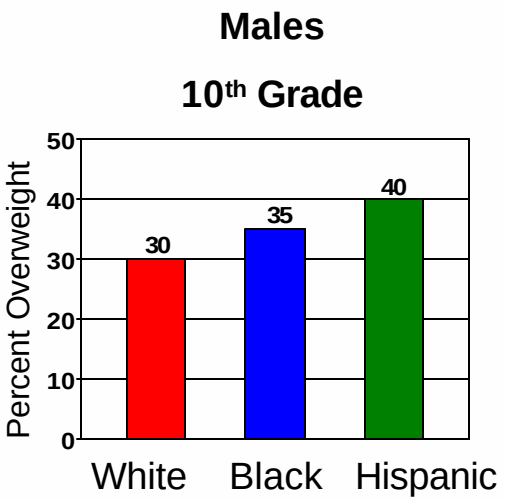
Frequency of Eating Fresh Fruit, Nearly or Every Day

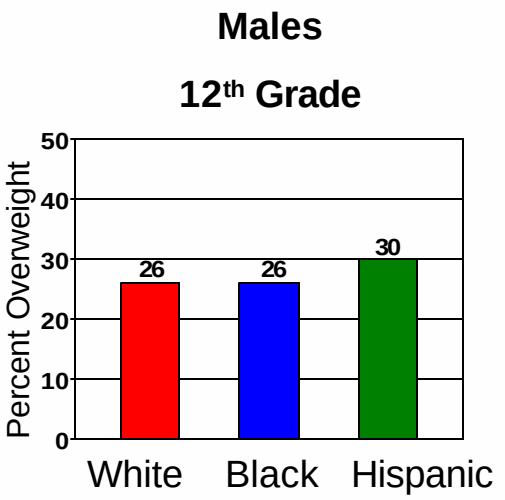


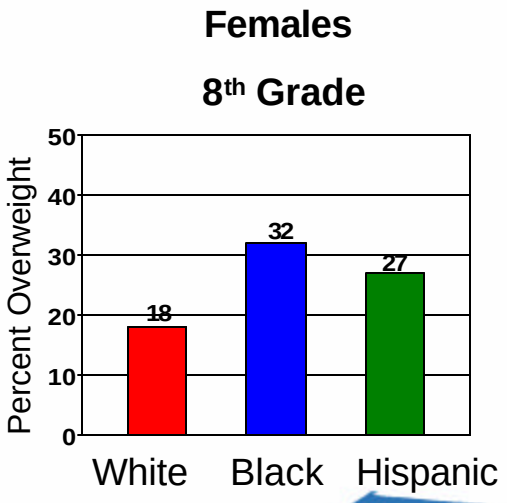
ource: Johnston, et al., 2003

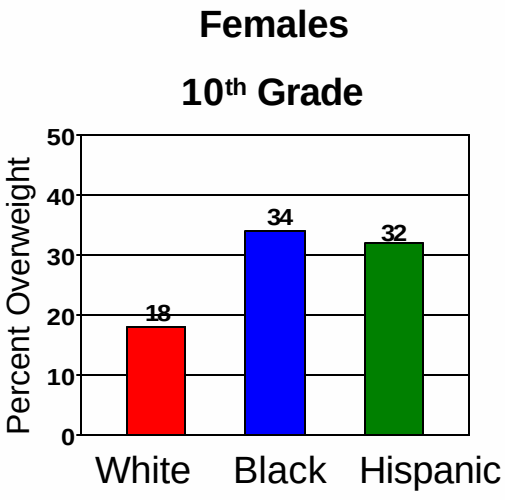
Prevalence of Overweight (BMI percentile = 85%) by Gender, Race/Ethnicity, and Grade: 2001-2003

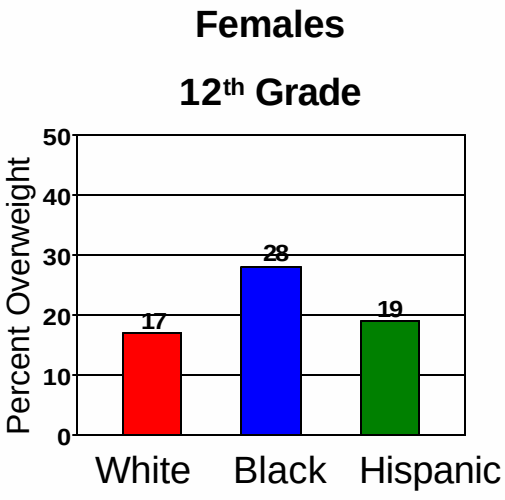






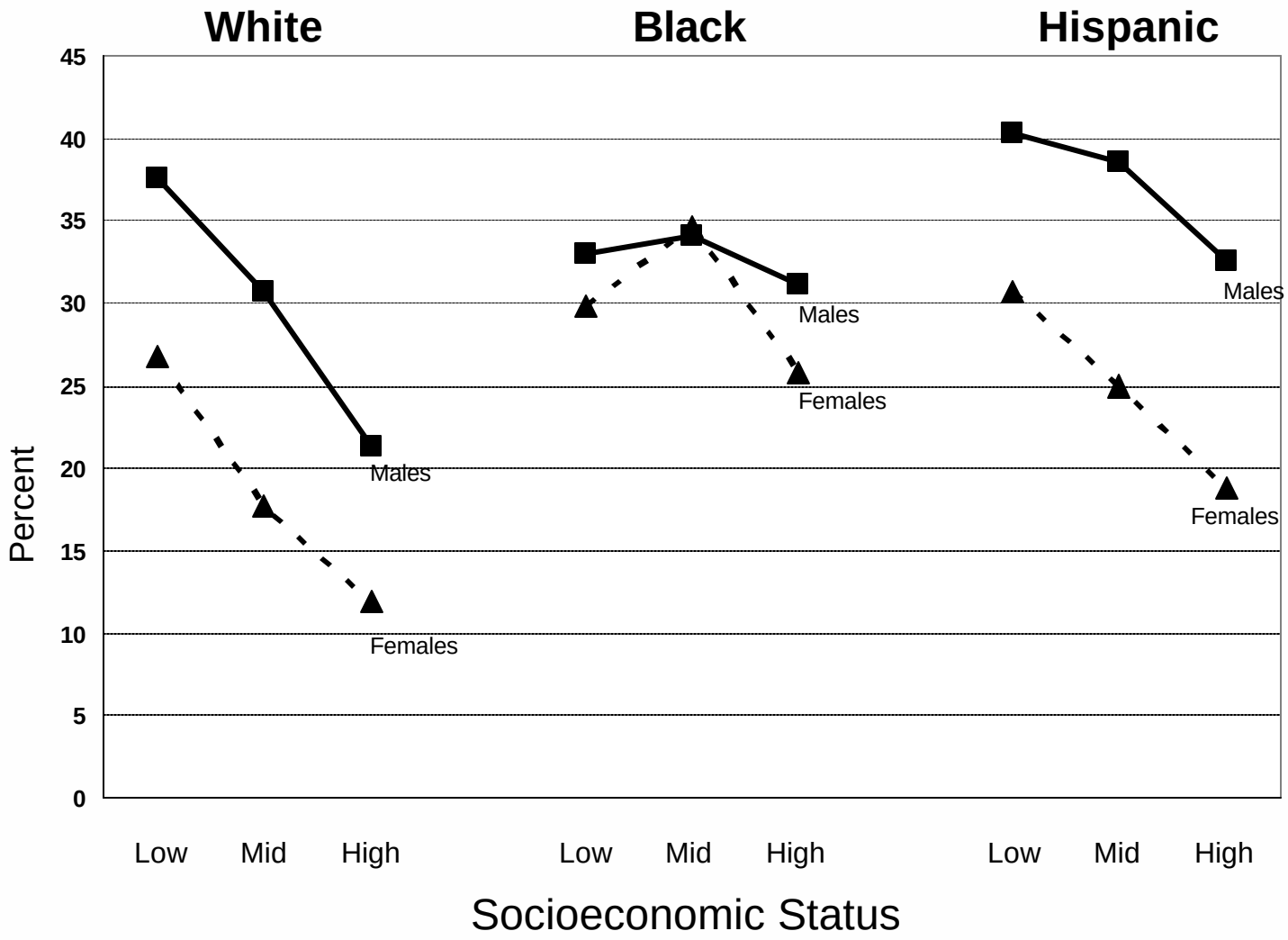






Source: Delva, Johnston and O'Malley, The Epidemiology of Overweight and Related Lifestyle Habits: Racial/Ethnic and Socioeconomic Status Differences Among Youths. *AJPM* supplement

Percent Overweight in 8th and 10th Grades by Gender, Socioeconomic Status and Race/Ethnicity



Source: Delva, Johnston and O'Malley, The Epidemiology of Overweight and Related Lifestyle Habits: Racial/Ethnic and Socioeconomic Status Differences Among Youths. *AJPM* supplement

Previous Research

- Relatively little economic research on the impact of environmental factors such as price and availablity on physical activity, diet, and weight among adolescents
  - Lakdawalla and Philipson (2002) argue that upward trend in obesity results from drop in relative price of calorie consumption and increase in opportunity cost of burning calories
  - Chou et al. (2004) conclude that increases in restaurant availability, lower real food prices, and higher real cigarette prices contribute to upward trend in obesity
  - Sturm and Datar (2005) find that lower fruit & veg. prices have small impact on BMI among children, but that other food prices and availability have little impact

Previous Research

- Non-economic research suggests importance of availability and pricing; for example:
  - French and colleagues, others find evidence that changes in relative prices of healthy/unhealthy foods changes youth consumption
  - Various studies find that children's and adolescents' physical activity is associated with availability of recreational facilities
- Few studies on environmental determinants of BMI and prevalence of overweight/obesity

Monitoring the Future

- Key Outcome variables
  - Body Mass Index
  - Indicator for “overweight”
  - Physical activity, from questions:
    - “how often do you actively participate in sports, athletics, or exercising?”
      - » Never
      - » A few times a year
      - » Once or twice a month
      - » At least once a week
      - » Almost every day
    - Dichotomous indicator for weekly or more

Monitoring the Future

- Key Outcome variables
  - Physical activity, from questions:
    - "how often do you exercise vigorously (jogging, swimming, calisthenics, or any other active sports?"
      - » Never
      - » Seldom
      - » sometimes
      - » Most days
      - » Nearly every day
      - » Every day
    - Dichotomous indicator for most days or more

Monitoring the Future

- Key Outcome variables
  - Food consumption, from questions:
    - "how often do you eat at least some green vegetables?" and
    - "how often do you eat at least some fruit?"
      - » Never
      - » Seldom
      - » sometimes
      - » Most days
      - » Nearly every day
      - » Every day
    - Dichotomous indicator for most days or more on both questions

Monitoring the Future

- Analyses use data from 1997-2003
  - Physical activity paper includes 8th/10th/12th graders; others 8th/10th only
    - BMI approximately 28 for sample
    - About 10 percent overweight
      - » rising over time
    - 73.4% of 8th/10th graders report frequent sports participation
    - 64.8% of 8th/10th graders report frequent vigorous exercise
    - 56.9% of 8th/10th graders report frequent fruit and green vegetable consumption

Monitoring the Future

- Other covariates from MTF include:
  - Age
  - Grade
  - Gender
  - Race/ethnicity
  - Parents' education
  - Family structure
  - Student work status
  - Mother work status
  - Student income
  - Rural residence

Monitoring the Future

- Sample sizes
  - Range from 47,675 to 195,702
    - Grades included
    - Form specific nature of questions
- Set of year indicators included in all models
    - 1997 excluded

MTF Descriptive Statistics

Male	0.4744
Age	15.0025
Age Squared	227.1899
8th Grade	0.4281
10th Grade	0.4511
12th Grade	0.1208
White	0.7010
Black	0.1056
Hispanic	0.0958
Other Race	0.0976

MTF Descriptive Statistics

Father Less Than High School	0.1296
Father Complete High School	0.2963
Father College or More	0.5741
Mother Less Than High School	0.1104
Mother Complete High School	0.2824
Mother College or More	0.6072
Live With Both Parents	0.7942

MTF Descriptive Statistics

Live In Rural Area	0.2355
Students' Weekly Real Income (in 100s)	0.2542
Hours Worked by Student	4.9628
Mother Works Part-Time	0.1855
Mother Works Full-Time	0.6408

Prices

- ACCRA (American Chamber of Commerce Researchers' Association)
  - Quarterly *Cost of Living Index* reports
    - about 300 cities/MSAs each quarter
    - Include data from most states
    - 62 different products sampled
      - » Fewer in most recent reports
    - Targeting 'mid-management' standard of living
    - Sample of establishments in each city
    - Specific brands identified for most products
      - » Lowest priced brand for some products

Prices

- Matched to the MTF schools based on the location of the school
  - Nearest ACCRA city to the MTF school zip code
    - Some sensitivity analyses based on quality of the match
      - » e.g. within same county, within specified distance, within same state, etc.
  - Data for 1st and 2nd quarters
    - MTF surveys conducted late-Feb. through May
  - Deflated by national CPI (82-84=1)
  - Not deflated by ACCRA local cost-of-living index

Prices

- 2 price indices created from ACCRA prices
  - "Fruit and vegetable price index" includes prices for:
    - Bananas
    - Peaches
    - Sweet peas
    - Tomatoes
    - Frozen corn
    - Lettuce
    - Potatoes
  - Weighted based on expenditure shares from BLS' Consumer Expenditure Survey as reported by ACCRA

Prices

- 2 price indices created from ACCRA prices
  - "Fast food price index" includes prices for:
    - McDonald's Quarter Pounder with Cheese
    - Pizza Hut or Pizza Inn thin crust regular size cheese pizza
    - Kentucky Fried Chicken or Church's Fried Chicken thigh and drumstick meal
  - Simple average of the three prices

Prices

- Fruit and Vegetable Prices:
  - Average of 72 cents
  - Rose by 17% in our sample
  - Considerable cross-sectional variation
- Fast Food Prices
  - Average $2.71
  - Fell by about 5% during sample period
  - Less, but some, cross-sectional variation

Availability

- Consider availability of a variety of different types of outlets:
  - Food stores
  - Fast food and other restaurants
  - Physical activity related outlets
- Builds on our earlier/ongoing research on differences in availability across communities based on socioeconomic and demographic population characteristics

Availability

- Dun & Bradstreet MarketPlace Database
  - List of more than 14 million US businesses
  - Updated quarterly
    - More than 1,300 D&B staff
    - Yellow page directories
    - News and media sources
    - Government registries
    - Websites
    - Verified with telephone interviews
    - Variety of quality control procedures to avoid duplication, minimize errors, etc.
  - Accessed through licensed D&B MarketPlace software

Availability

- Dun & Bradstreet MarketPlace Database
  - Multiple criteria included
    - Standard Industry Classification codes
      - » Primary and secondary codes reported
      - » Our analyses use primary codes
    - addresses
    - Contact information
    - Company size
    - More
  - Data matched to MTF surveys based on zip code of the MTF school and first quarter D&B data on outlets for that zip code

Availability

- Food store outlet density measures
  - Used 6 digit SIC codes to identify
    - Chain supermarkets
    - Non-chain supermarkets
    - Convenience stores
    - Grocery stores
- Differences largely based on:
  - availability of on-site services (e.g. meat counter, deli, bakery)
  - Size and sales volume

    -supermarkets have 7x more employees and 46x more sales volume than groceries; groceries have 2x more employees than convenience stores

Availability

- Presence of food stores (at least one):
  - 45.4% chain supermarket
  - 34.3% Non-chain supermarkets
  - 92.9% Convenience stores
  - 88.5% Grocery stores
- Density of food stores (per 10,000 pop.)
  - 0.30 chain supermarkets
  - 0.26 non-chain supermarkets
  - 2.2 convenience stores
  - 3.3 grocery stores
- Convenience and grocery rising over time; others relatively flat

Availability

- Restaurants:
  - Identified by 4 an 6 digit SIC codes
    - Any restaurants at 4 digit level
    - Fast food restaurants at 6 digit level
    - Full service restaurants are total – fast food
  - Nearly all zip codes had at least one fast food and full service restaurant
  - Density (per 10,000 pop.):
    - 2.4 fast food
    - 12.8 full service restaurants
  - Fast food rising during sample period (about 56% increase); full service mostly flat

Availability

- Physical activity related outlets
  - At 4 digit SIC level, identified:
    - Physical fitness facilities
      - » health clubs, spas and others featuring exercise and other physical fitness activities, both membership and non-membership
    - Membership sports and recreation clubs
      - » Ice, court, country, golf, tennis, amateur sports, yacht, and recreation clubs
    - Dance studios, schools, and public dance halls
  - Some analyses focus on just physical fitness facilities; others use all three
    - 0.55 fitness facilities per 10,000
    - 1.9 physical activity facilities per 10,000

Community Characteristics

- Recent/ongoing work shows associations between community characteristics and availability; for example:
  - Low income/high minority communities tend to be less likely to have:
    - Paid or free physical activity related outlets/opportunities
    - Chain supermarkets
    - Higher share of fast food restaurants among all restaurants
- Some analyses include per-capita income for zip code

Empirical Models

– Physical Activity:

$$PA_i = ß_0 + ß_1\, PAD_s + ß_2\, I_s + ß_3\, X_i + e_i$$

- Food Consumption:

$$FFV_i = ß_0 + ß_1\, OD_s + ß_2\, PFF_s + ß_3\, PFV_s + ß_4\, X_i + e_i$$

- Weight:

$$BMI/OW_i = ß_0 + ß_1\, OD_s + ß_2\, PFF_s + ß_3\, PFV_s + ß_4\, I_s + ß_5\, X_i + e_i$$

Empirical Models

- Models with and without year dummies
  Models with alternative sets of covariates
- Models for alternative subsamples:
  - Race/ethnicity
  - Maternal work status
- Probit methods for dichotomous outcomes
  - FVC, PA, Overweight
- OLS for continuous BMI measure
- Use MTF sampling weights and adjust for clustering of students in schools

Results: Physical Activity

- Frequent sports participation:
  - Small effect of fitness outlets or any PA outlets
  - Falls when community income included
    - One additional outlet raises prob. of participation by 0.25 percentage points

Physical Fitness Facilities	0.0068*** (0.0021)	0.0027 (0.0020)	-	-
Total Physical Activity Facilities	-	-	0.0046*** (0.0099)	0.0025** (0.0010)
Per Capita Income	-	0.0174*** (0.0023)	-	0.0167*** (0.0023)

Results: Physical Activity

- Frequent vigorous exercise:
  - Small effect of fitness outlets or any PA outlets
  - Falls when community income included
    - One additional outlet raises prob. of frequent vigorous exercise by 0.28 percentage points

Physical Fitness Facilities	0.0070** (0.0033)	0.0054 (0.0034)	-	-
Total Physical Activity Facilities	-	-	0.0036** (0.0017)	0.0028* (0.0017)
Per Capita Income	-	0.0070** (0.0029)	-	0.0067** (0.0029)

Results: Physical Activity

- BMI
  - Very small effects of fitness outlets or any PA outlets on BMI
  - Falls when community income included
    - One additional fitness facility lowers BMI by 0.04 units

Physical Fitness Facilities	-0.0770*** (0.0220)	-0.0388* (0.0231)	-	-
Total Physical Activity Facilities	-	-	-0.0150 (0.0107)	0.0063 (0.0109)
Per Capita Income	-	-0.1624*** (0.0211)	-	-0.1723*** (0.0218)

Results: Physical Activity

- Overweight
  - Again, small effects of fitness outlets or any PA outlets on probability of being overweight
  - Falls when community income included
  - One additional fitness facility reduces probability of overweight by 0.4 percentage points

Physical Fitness Facilities	-0.0073*** (0.0017)	-0.0041** (0.0017)	-	-
Total Physical Activity Facilities	-	-	-0.0026*** (0.0008)	-0.0010 (0.0007)
Per Capita Income	-	-0.0133*** (0.0019)	-	-0.0137*** (0.0019)

Results: Physical Activity

- Other covariates:
  - Males more likely to participate in sports, exercise
  - Minorities generally less likely to participate/exercise
  - High school students less likely to exercise, no differences in sports participation
  - Likelihood of participation/exercise rises sharply with parental education
  - Living with both parents raises participation and exercise by 4-5 percentage points
  - Student income has positive impact on both measures of physical activity

Results: Physical Activity

- Other covariates:
  - Teens who work more hours somewhat less likely to participate/exercise
  - Students with working mothers more likely to participate in sports; no significant effects on exercise
  - Living in rural areas has small negative impact on sports participation but not exercise
  - Time dummies:
    - significant downward trend in sports participation
    - Falling early for exercise, more recent leveling off
- Will come back to BMI/overweight later

Results: Fruit & Vegetable Consumption

- Small positive impact of full service restaurants
  - 1 more raises prob. of frequent FVC by 0.2 pct. points
- Negative but insignificant effect of fast food restaurants
- Estimates stable across various specifications

Per Capita Number of Full Service Restaurants	0.0019*** (0.0005)	0.0019*** (0.0005)
Per Capita Number of Fast Food Restaurants	-0.0028 (0.0018)	-0.0029 (0.0019)

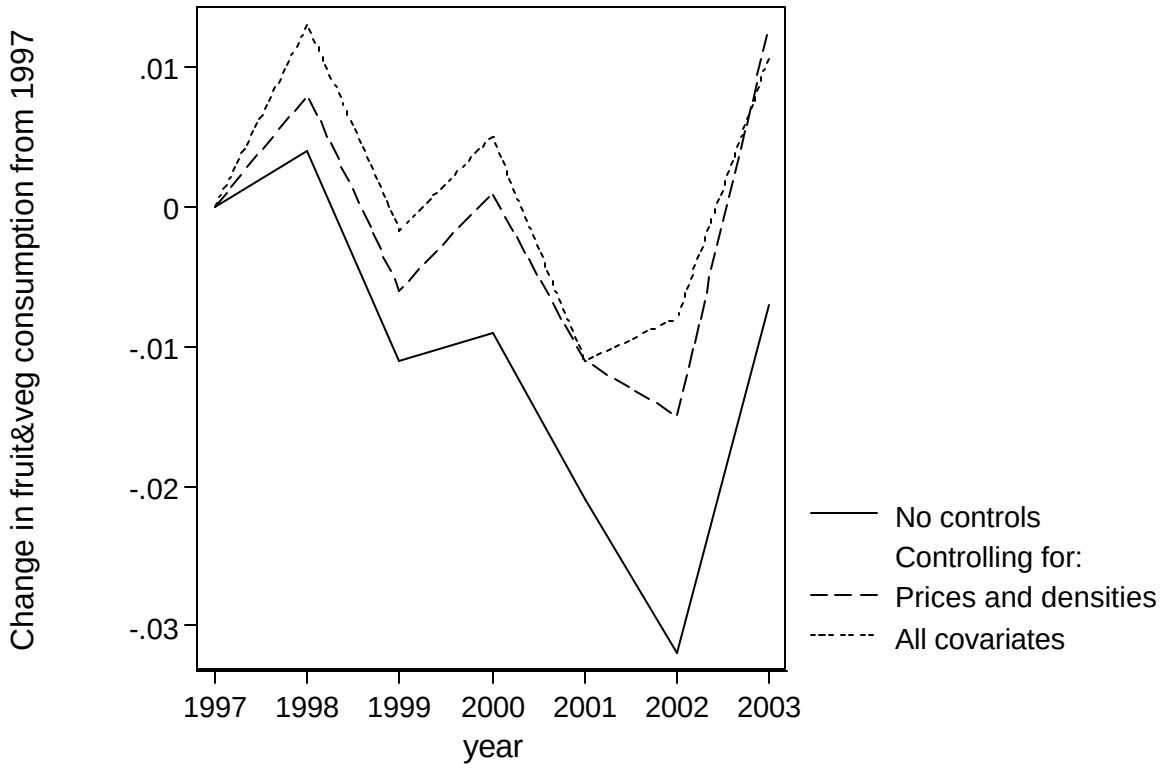
Results: Fruit & Vegetable Consumption

- Positively related to fast food prices
  - $1 increase in fast food prices would raise frequent fruit/veg consumption by about 7 pct. points
- Negatively related to fruit/veg prices
  - $1 rise in prices reduces fruit/veg consumption by 6.3 pct. Points
- Estimates stable across specifications

Price of Fast Food	0.0730*** (0.0197)	0.0669*** (0.0201)
Price of Fruit and Vegetables	-0.0633** (0.0308)	-0.0632* (0.0353)

Results: Fruit & Vegetable Consumption

- Prices and outlet density measures account for nearly all of the observed downward trend in raw data



Results: BMI

- No significant associations observed for full service or fast food restaurants and youth BMI

Per Capita Number of Full Service Restaurants	-0.0048 (0.0029)	-0.0039 (0.0029)
Per Capita Number of Fast Food Restaurants	0.0187 (0.0122)	0.0084 (0.0124)

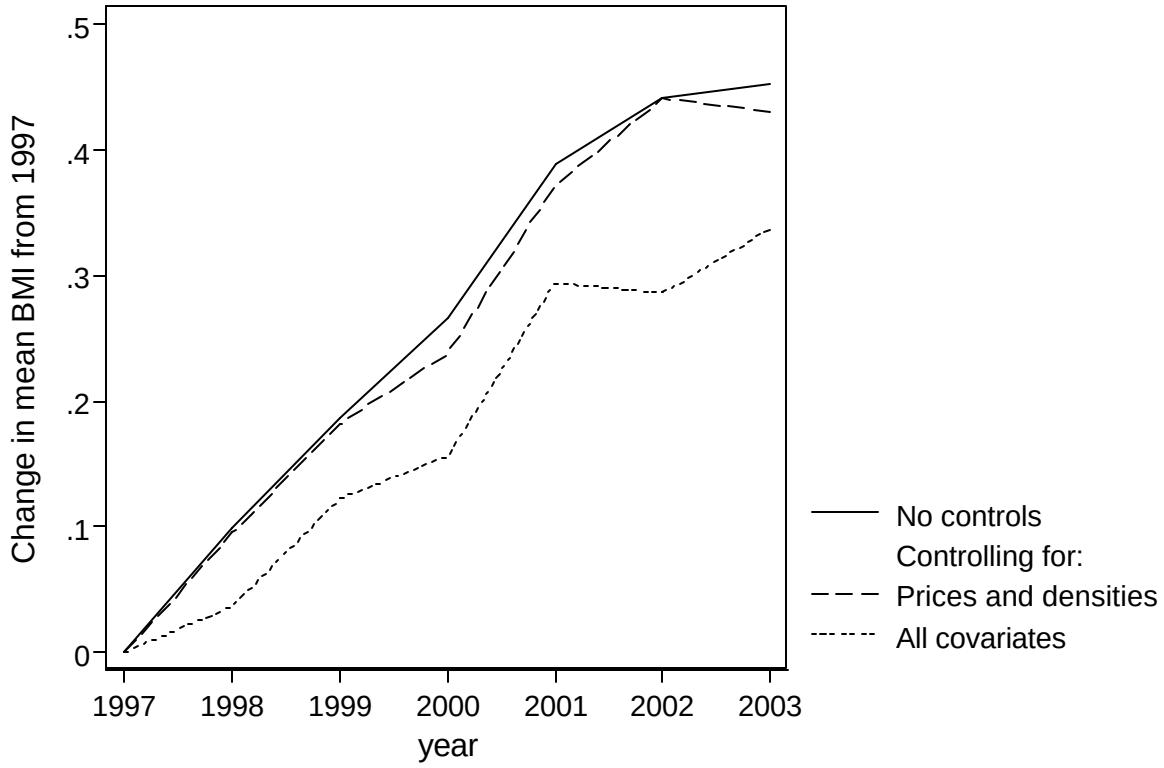
Results: BMI

- Significant negative impact of fast food prices
  - Falls when year dummies included
  - $1 rise in prices reduces BMI by 0.3 – 0.6 units
- Positive impact of fruit/veg prices
  - Loses significance, falls when year dummies included

Price of Fast Food	-0.5757*** (0.1321)	-0.3066** (0.1397)
Price of Fruit and Vegetables	0.6874*** (0.2027)	0.2688 (0.2392)

Results: BMI

- Prices and restaurant outlet density measures account for small part of change in BMI over sample period (about ¼)



Results: Probability of Overweight

- Negative but insignificant impact of full service restaurant availability
- Positive but insignificant impact of fast food restaurant availability

Per Capita Number of Full Service Restaurants	-0.0002 (0.0002)	-0.0002 (0.0002)
Per Capita Number of Fast Food Restaurants	0.0005 (0.0009)	0.00003 (0.0009)

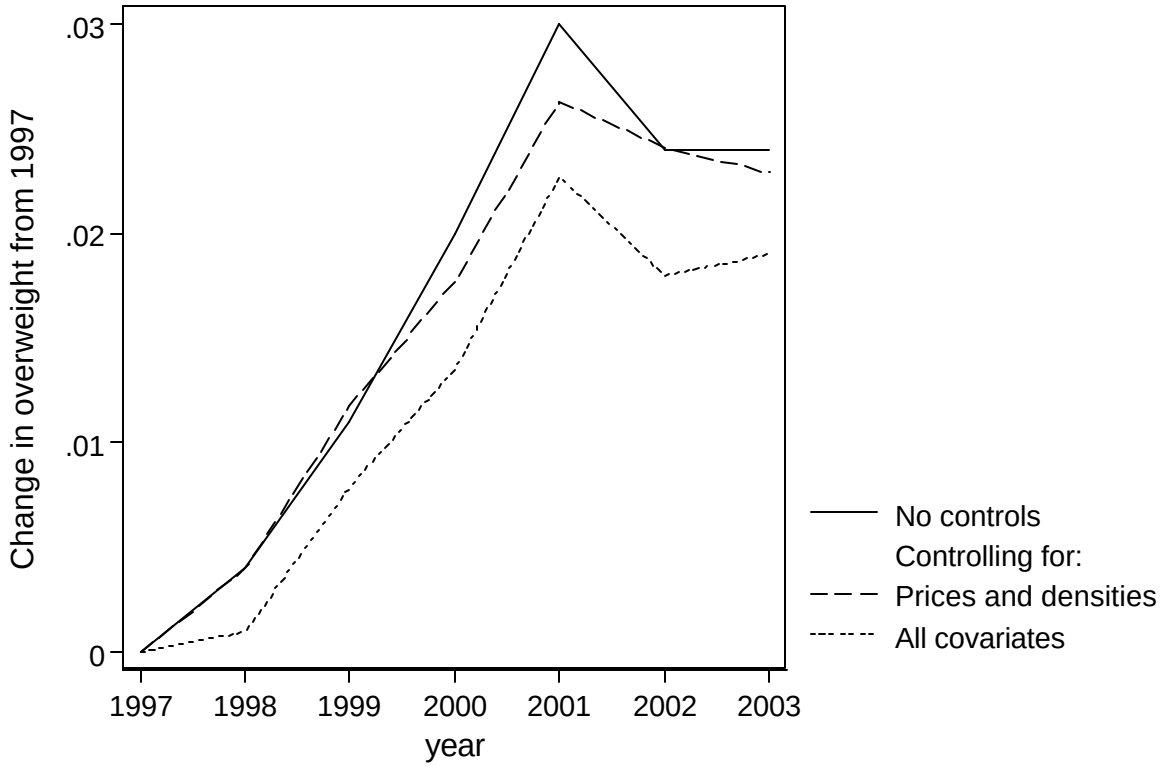
Results: Probability of Overweight

- Significant negative impact of fast food prices
  - Falls when year dummies included but still
  - $1 rise in prices reduces probability of overweight by 2-4 percentage points
    - Recall prevalence of overweight about 10 percent
- No impact of fruit and vegetable prices

Price of Fast Food	-0.0398*** (0.0088)	-0.0224** (0.0097)
Price of Fruit and Vegetables	0.0159 (0.0138)	-0.0049 (0.0153)

Results: Overweight

- Prices and outlet density measures account for little of the change in prevalence of overweight during sample period



Results: Fruit & Vegetable Consumption

- Other covariates:
  - No gender differences
  - Minorities generally less likely to consume F&V frequently
  - No differences by grade
  - Older students within grade less likely to consume
  - Strong positive associations between parental education and frequent F&V consumption
  - Living with both parents raises likelihood of frequent F&V consumption by about 7 percentage points

Results: Fruit & Vegetable Consumption

- Other covariates:
  - No associations with student income or hours of work
  - No association with living in rural area
  - Maternal work
    - No differences for youth with mothers who are not in labor force or who work part time
    - Significantly less likely to consume frequently if mother works full time (about 4 percentage points)
  - No clear time trend in F&V consumption after controlling for other factors

Results: Food Store Availability & Weight

- Significant negative impact of chain supermarket availability on weight outcomes
  - One more chain supermarket reduces BMI by 0.1 units and prevalence of overweight by 0.6 pct. Points
- No impact of non-chain supermarkets

Per Capita Number of Chain Supermarkets	-0.1164***	-0.1095***	-0.0060**
	(0.0301)	(0.0282)	(0.0025)
Per Capita Number of Non-Chain Supermarkets	0.0189	0.0184	0.0010
	(0.0398)	(0.0382)	(0.0028)
Zip code Per Capita Income	-	-0.1473***	-0.0123***
		(0.0230)	(0.0020)

Results: Food Store Availability & Weight

- BMI and probability of overweight positively associated with availability of grocery and convenience stores
  - Small impact on BMI
  - one more of each raises prob. of overweight by about 0.1 and 0.2 pct. points

Per Capita Number of Grocery Stores	0.0172**	0.0127	0.0009*
	(0.0087)	(0.0083)	(0.0005)
Per Capita Number of Convenience Stores	0.0434***	0.0299**	0.0017**
	(0.0127)	(0.0121)	(0.0007)
Zip code Per Capita Income	-	-0.1473***	-0.0123***
		(0.0230)	(0.0020)

Results: Food Store Availability & Weight

- Relatively larger impact of food store availability on weight outcomes among black youth and youth whose mothers work full time

BMI	White	Black	Hispanic
Per Capita Number of Chain Supermarkets	-0.0924***	-0.2958***	-0.0780**
	(0.0346)	(0.0966)	(0.0381)
Per Capita Number of Non-Chain Supermarkets	0.0482 (0.0482)	-0.052 (0.1598)	-0.0207 (0.1549)
Per Capita Number of Grocery Stores	0.0110	0.0127	0.0432
	(0.0080)	(0.0236)	(0.0326)
Per Capita Number of Convenience Stores	0.0165	0.0435	0.0711
	(0.0118)	(0.0336)	(0.0510)
Zip code per capita Income	-0.1677***	-0.0279	-0.1774**
	(0.0258)	(0.0909)	(0.0883)

Results: BMI and Overweight

- Other covariates:
  - BMI and prevalence of overweight higher among males
  - Minorities have higher BMI and greater prevalence of overweight
    - Highest among black youth
  - Generally positive associations between grade and BMI and prevalence of overweight
  - Older students within grade tend to have higher BMI but not significantly more likely to be overweight
  - Strong negative associations between parental education and weight outcomes

Results: BMI and Overweight

- Other covariates:
  - Youth living with both parents have lower BMI and are less likely to be overweight
  - No associations between student income and weight outcomes
  - Small positive association of hours worked with BMI but not with probability of overweight
  - Maternal work
    - Weak negative associations of part-time work with weight outcomes
    - Generally significant positive impact of full-time work on youth BMI, but not significant for probability of overweight
  - Significant upward trend in both after controlling for other factors

Limitations

- Potential measurement error in self-reported weight outcomes
  - Some evidence of under-reporting; other studies find mostly accurate
- Limited measures of physical activity and diet
- Measurement error in price and outlet density measures matched by school not student location
- Cross-sectional data can’t establish causality

Conclusions

- Availability of some types of outlets has a significant impact on youth behavior and weight outcomes
  - Effects generally small with some exceptions (e.g. chain supermarkets for black youth)
- Fast food prices have relatively strong impact on fruit & vegetable consumption, weight outcomes
  - Follow up analysis by Auld et al. finds greatest impact on the highest weight groups
- While statistically significant, availability and prices explain small part of observed trends in BMI and prevalence of overweight among youth

impacTEEN

A Policy Research Partnership for Healthier Youth Behavior

YES! Youth, Education, & Society

www.impacteen.org

www.yesresearch.org

www.monitoringthefuture.org