Can Nutritional Label Use Influence Dietary and Body Weight Outcomes?

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(work with Andreas Drichoutis and Panagiotis Lazaridis)

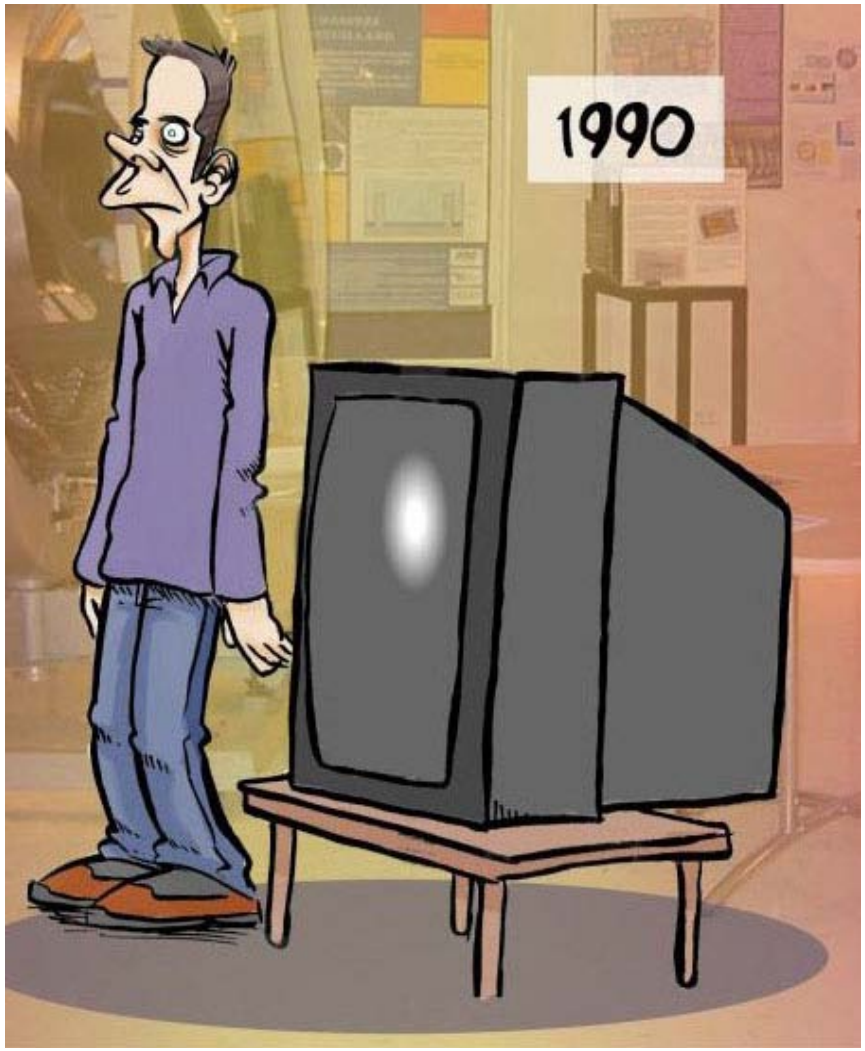
Introduction

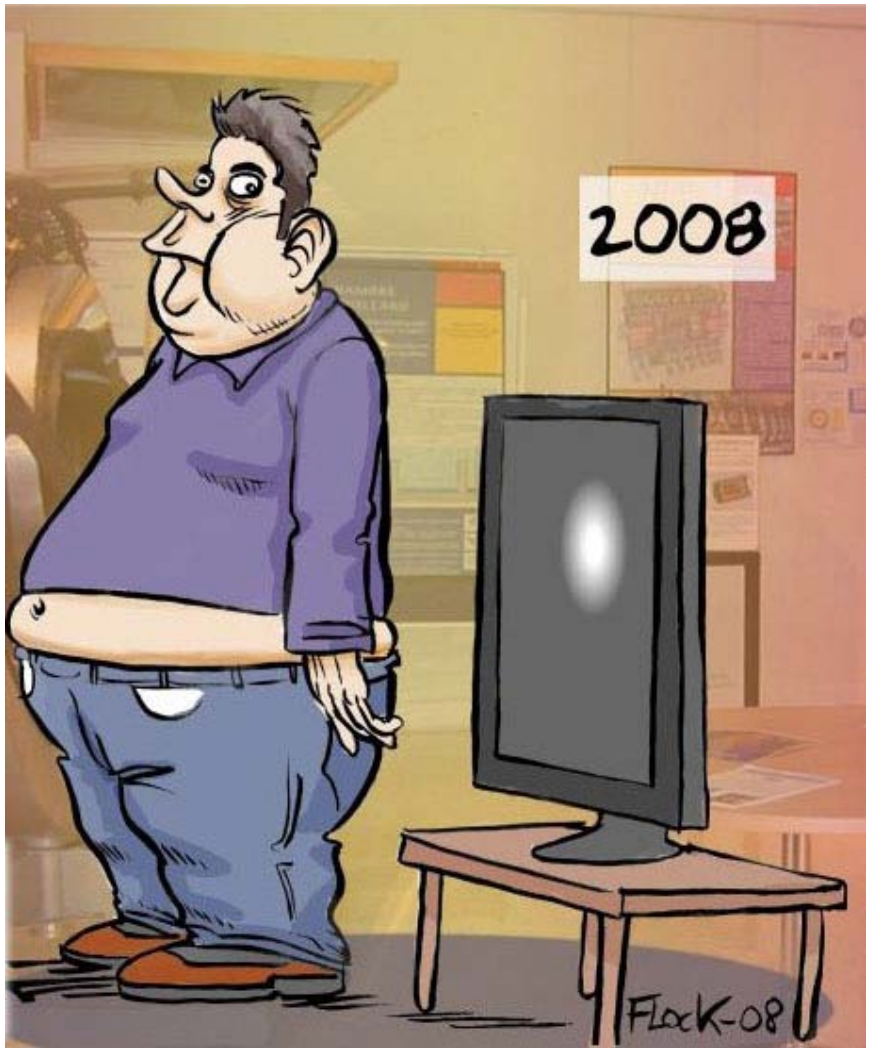
Obesity rates have reached epidemic proportions in the US and many other countries.

- Osteoarthritis
- Sleep apnea
- Asthma
- High blood pressure
- Gallbladder disease
- Cholesterol
- Type II diabetes
- Several forms of cancer
- Cardiovascular disease
- Stroke
- Social stigmatization
- Depression
- Low self esteem

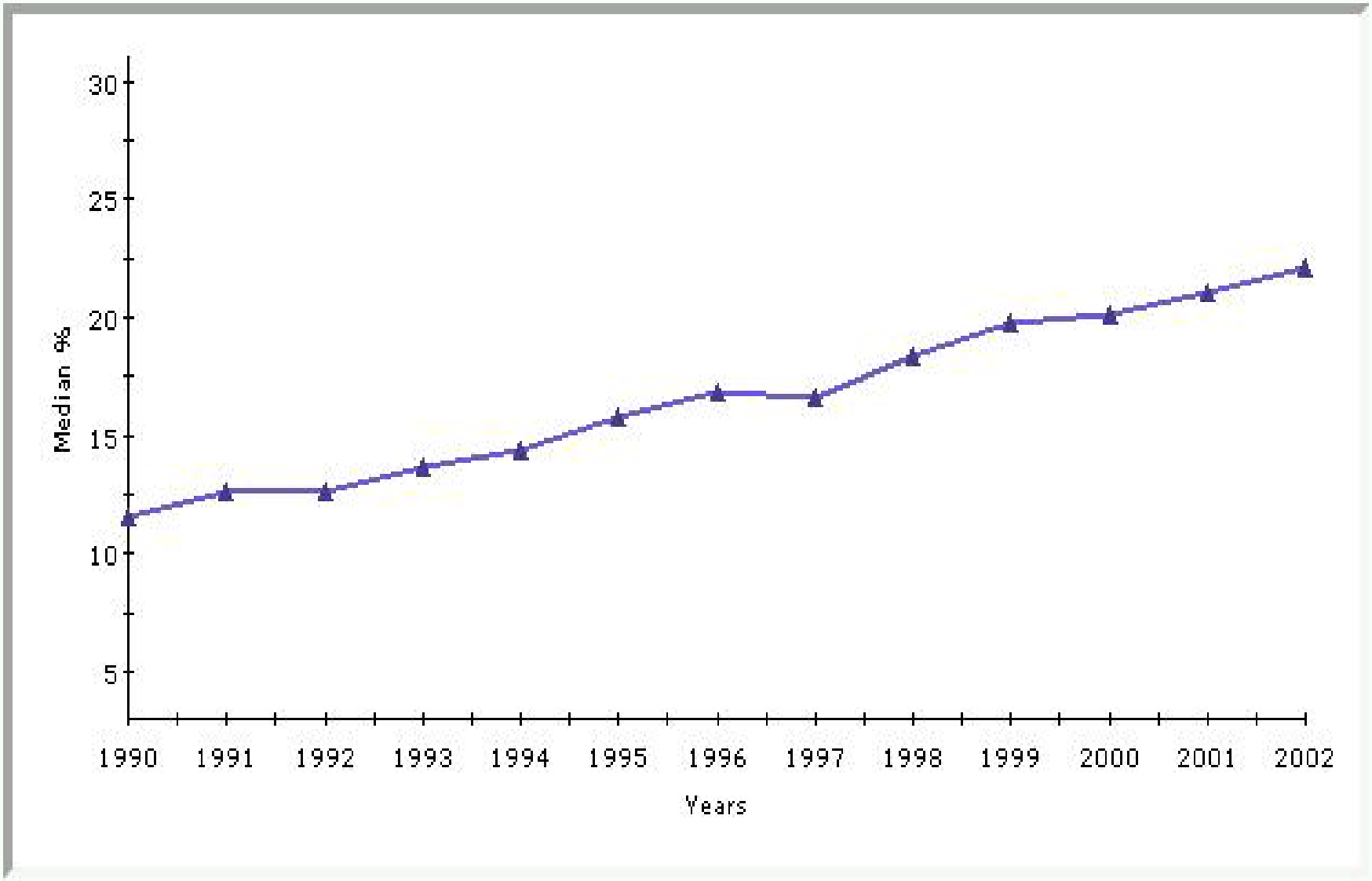
In the US obesity approaches tobacco as top preventable cause of death

Determinants of obesity: An economic view





Obesity: By Body Mass Index
Nationwide



Obesity and Economic Costs

Economic impacts on health care systems (medical costs)

- Direct
  - Preventive, diagnostic, treatment services
- Indirect
  - **Mortality costs**: the value of future income lost by premature death
  - **Morbidity costs**: the value of income lost from decreased productivity, restricted activity, absenteeism, and sick bed days

Obesity and Economic Costs

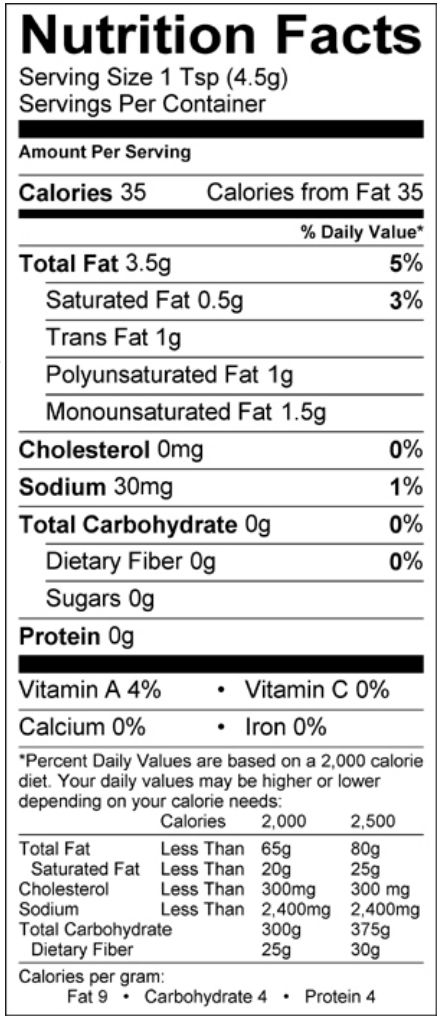
- Australia, Canada, England, France, New Zealand and USA: obesity accounts between **1%-8%** of national health expenditures.
- In USA health care costs associated with obesity top $100 billion annually.
- World Bank estimates that 12% of the US national health care budget is spent treating obesity.
- 7% of healthcare costs in EU, are linked to obesity and related illnesses

Tackling the problem

Healthy diets and healthier food choices are becoming the target of many public programs and policies.

e.g.

US : Nutritional Labeling and Educational Act



Nutrition Facts

Serving Size 1 Tsp (4.5g)
Servings Per Container

Amount Per Serving

Calories 35	Calories from Fat 35
	% Daily Value*
Total Fat 3.5g	**5%**
Saturated Fat 0.5g	**3%**
Trans Fat 1g	
Polyunsaturated Fat 1g	
Monounsaturated Fat 1.5g	
Cholesterol 0mg	**0%**
Sodium 30mg	**1%**
Total Carbohydrate 0g	**0%**
Dietary Fiber 0g	**0%**
Sugars 0g	
Protein 0g	

Vitamin A 4% • Vitamin C 0%

Calcium 0% • Iron 0%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories	2,000	2,500
Total Fat	Less Than	65g	80g
Saturated Fat	Less Than	20g	25g
Cholesterol	Less Than	300mg	300 mg
Sodium	Less Than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

NLEA

- update list of nutrient, ingredients
- standardize serving sizes
- define nutrient content claims
- define health claims


Häagen-Dazs
Chocolate
ICE CREAM

Nutrition Facts

Serving Size 1/2 cup (106g)
Servings Per Container 4

Amount Per Serving

Calories 270 Calories from Fat 160

	% Daily Value*
Total Fat 18g	**28%**
Saturated Fat 11g	**55%**
Cholesterol 115mg	**38%**
Sodium 60mg	**3%**
Total Carbohydrate 22g	**7%**
Dietary Fiber 1g	**4%**
Sugars 21g	

* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories: 2,000	2,500
Total Fat	Less than 65g	80g
Sat Fat	Less than 20g	25g
Cholesterol	Less than 300mg	300mg
Sodium	Less than 2,400mg	2,400mg
Total Carbohydrate	300g	375g
Dietary Fiber	25g	30g

INGREDIENTS: CREAM, [illegible], EGG YOLKS, COCOA [illegible]

DISTRIBUTED BY: [illegible]
12647 ALCOSTA BOULEVARD
SAN RAMON, CA 94583

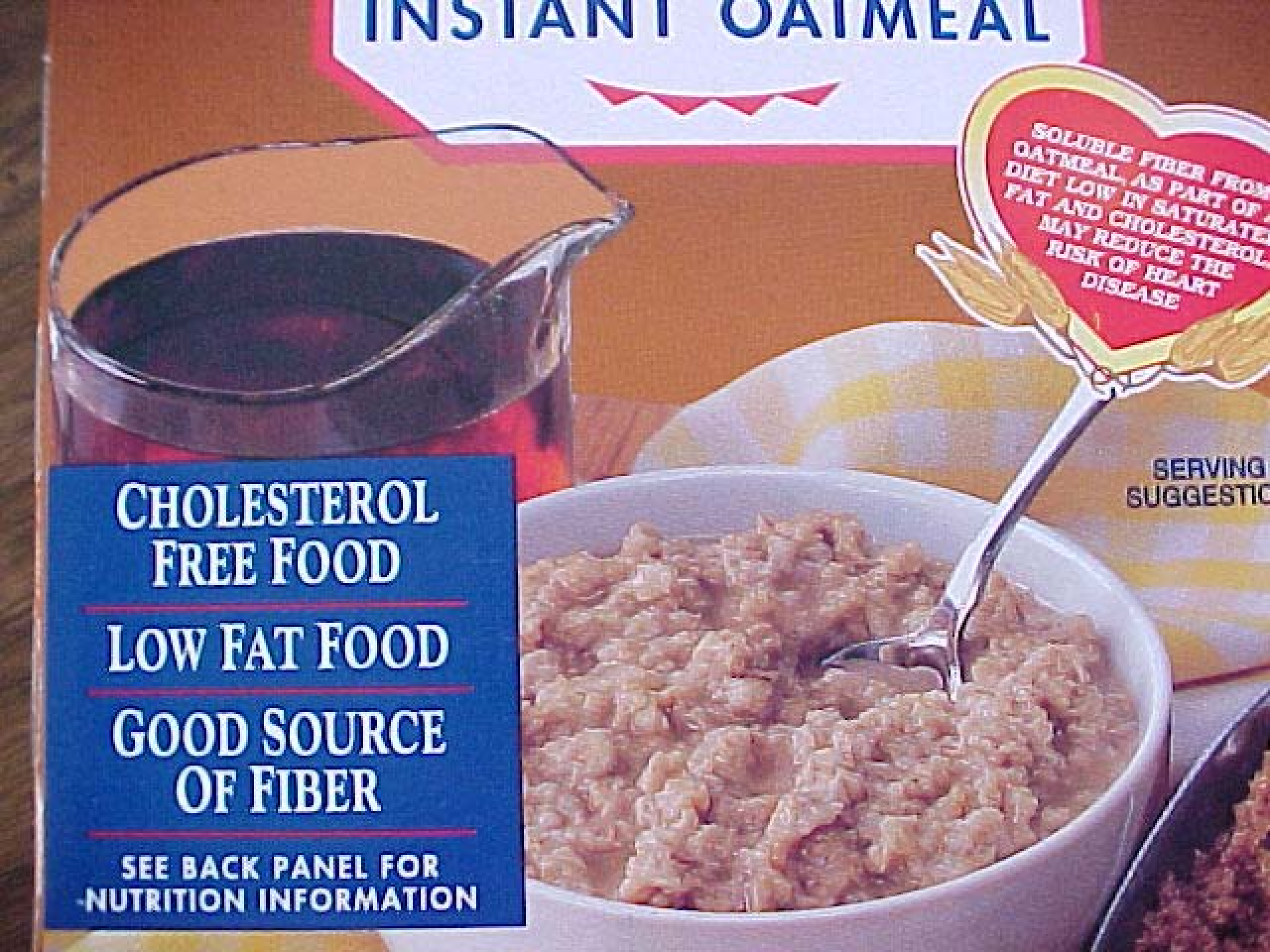
MADE IN U.S.A.

Häagen-Dazs [illegible] standards, and we [illegible] and comments of [illegible]

For best before [illegible]

Nutrient Content Claims: Example

- Light **- 33% fewer calories or 50% of the fat**
- low **- no more than 40 calories, 140mg sodium, 3g fat, 1 g saturated fat or 20 mg cholesterol per serving**
- free **- <5 calories, <5 mg sodium, <0.5 g fat, < 0.5 g saturated fat, <2 mg cholesterol, or < 0.5 g sugar per serving**
- good source **- contains 10-19% of the DV of a nutrient per serving**


INSTANT OATMEAL
SOLUBLE FIBER FROM
OATMEAL AS PART OF A
DIET LOW IN SATURATE
FAT AND CHOLESTEROL
MAY REDUCE THE
RISK OF HEART
DISEASE
SERVING
SUGGESTIO
CHOLESTEROL FREE FOOD
LOW FAT FOOD
GOOD SOURCE OF FIBER
SEE BACK PANEL FOR NUTRITION INFORMATION

Calories 110	Calories from Fat 0
	% Daily Value*
Total Fat 0 g	**0%**
Saturated Fat 0 g	**0%**
Cholesterol 0 mg	**0%**
Sodium 20 mg	**1%**
Potassium 450 mg	**13%**
Total Carbohydrate 27 g	**9%**
Sugars 24 g	
Protein 2 g Not a significant source of protein	
Vitamin C 120% • Calcium 35%	
Thiamin 10% • Niacin 2%	
Vitamin B6 4% • Folate 15%	
Magnesium 6%	

Not a significant source of dietary fiber, vitamin A and iron

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"Diets containing foods that are good sources of potassium and low in sodium may reduce the risk of high blood pressure and stroke."


LLY FLAVORED
T OATMEAL
SOLUBLE FIBER FROM OATMEAL, AS PART OF A DIET LOW IN SATURATED FAT AND CHOLESTEROL, MAY REDUCE THE RISK OF HEART DISEASE

Aims of NLEA

- promote consumer nutritional education
- enable consumers to make more healthful food choices
- provide incentive to agri-food industry to create innovative and healthier new products for consumers

Tackling the problem

Previous studies have evaluated effect of nutritional label use on dietary outcomes – generally found positive outcomes but magnitudes small!

- Coulson (2000)
- Guthrie et al. (1995)
- Russo et al. (1986)
- Kim, Nayga, and Capps (2000, 2001)
- Variyam (2004, 2008)

% Individuals Meeting the Dietary Guidelines: Calories from Total Fat

Calories from Total Fat	Non-Label Users	Label Users	Difference
30% or less	0.15	2.31	2.16
31-45%	**70.56**	**97.69**	**27.13**
>45%	**29.29**	**0.00**	**-29.29**

% Individuals Meeting the Dietary Guidelines: Calories from Saturated Fat

Calories from Saturated Fat	Non-Label Users	Label Users	Difference
<10%	0.29	8.82	8.53
10-15%	**83.21**	**91.13**	**7.92**
>15%	**16.50**	**0.05**	**-16.45**

- Assumption by policy-makers: nutritional labels can help reduce obesity rates?

- With the Health Care Reform Bill – nutritional labeling for restaurant chains

- Our research question: Can nutritional label use really influence body weight (Body Mass Index)?

Propensity score matching

Issue with IV - instruments

Matching methods represent either a semi-parametric or non-parametric alternative to linear regression

The propensity score was introduced by Rosenbaum and Rubin (1983) to provide an alternative method for estimating treatment effects when treatment assignment is not random.

Standard case: Binary treatment

Extensions: Multiple treatments

Propensity score matching: the binary treatment

The evaluation question

- Question which we want to answer is (counterfactual question): "What would have happened to those who, in fact, did receive treatment, if they had not received treatment (or the converse)?"

- Problem is that it is impossible to observe both outcomes of interest to get the true causal effect

- Randomized experiment – requires lots of money and effort

- PSM *mimics* a randomized experiment (like a quasi-experiment)

PSM

- **Idea – find a group of non-treated individuals that are similar to the treated individuals in all characteristics X**

- **Construct matching groups for label and non-label users**

Propensity score matching: the binary treatment

Formally, assume that there is a variable T_i indicating treatment, which equals 1 if individual i uses nutritional labels (treated case) and 0 if individual i does not use nutritional labels (control case).

Propensity score - the conditional probability of receiving a treatment (using nutritional labels) given pre-treatment (not using nutritional labels) characteristics X:

$$p(X) \equiv \Pr(T = 1 | X) = E(T | X)$$

Propensity score matching: the binary treatment

Conditional Independence Assumption (CIA) –

-assume that we have conditioned on all variables that influence both participation and outcome

- selection is solely based on observable characteristics

Propensity score matching: the binary treatment

Step by step:

1. Estimate binary probits (or logit).
2. Match based on propensity scores (probabilities).
3. Estimate the differences of the outcomes from the matched samples.

How about for multiple treatment levels?

Estimate a series of binomial models (Lechner, 2002, *RES*)

The data

National Health and Nutrition Examination Survey

Scope: Assess health and nutritional status of people in the US, combines interviews and physical examinations

Interview: demographic, socioeconomic, dietary, health-related

Examination: medical, dental, physiological, laboratory tests

measures how often consumers' read Nutrition Fact Panels on a five likert scale (never, rarely, sometimes, most of the time, always)

The data

BMI – measured, not self-reported

Label use – (1) never, (2) rarely, (3) sometimes, (4) most of the time, (5) always read nutrition facts panel

X vector uses variables that we group in five categories:

a) Socio-demographic: age, gender, race, education, household size, income

b) Risky behavior: alcohol consumption, drug use, smoking status, safe sexual behavior

c) Lifestyle: FAFH consumption, exercise frequency, perceived healthfulness of diet, households' food security

d) Knowledge: doctors advice (reduce weight, eat less fat), perceived knowledge of DG, FGP, 5aD and self-efficacy (some people are born to be fat; nothing you can do to change this)

e) Health situation: Pregnancy, diabetes, intake of diabetic medicine and chronic diseases status

Estimations: Plausibility of CIA

Have we conditioned on all variables that simultaneously influence participation decision and outcome?

<u>There is no test!</u>

We can only argue that: *Given that we have an extremely rich and informative dataset that allows us to control for a wide variety of socio-demographic variables, risky behavior, lifestyle, knowledge and current health situation, we argue that the CIA holds.*

Estimations: The matching procedure

We implement six matching algorithms:

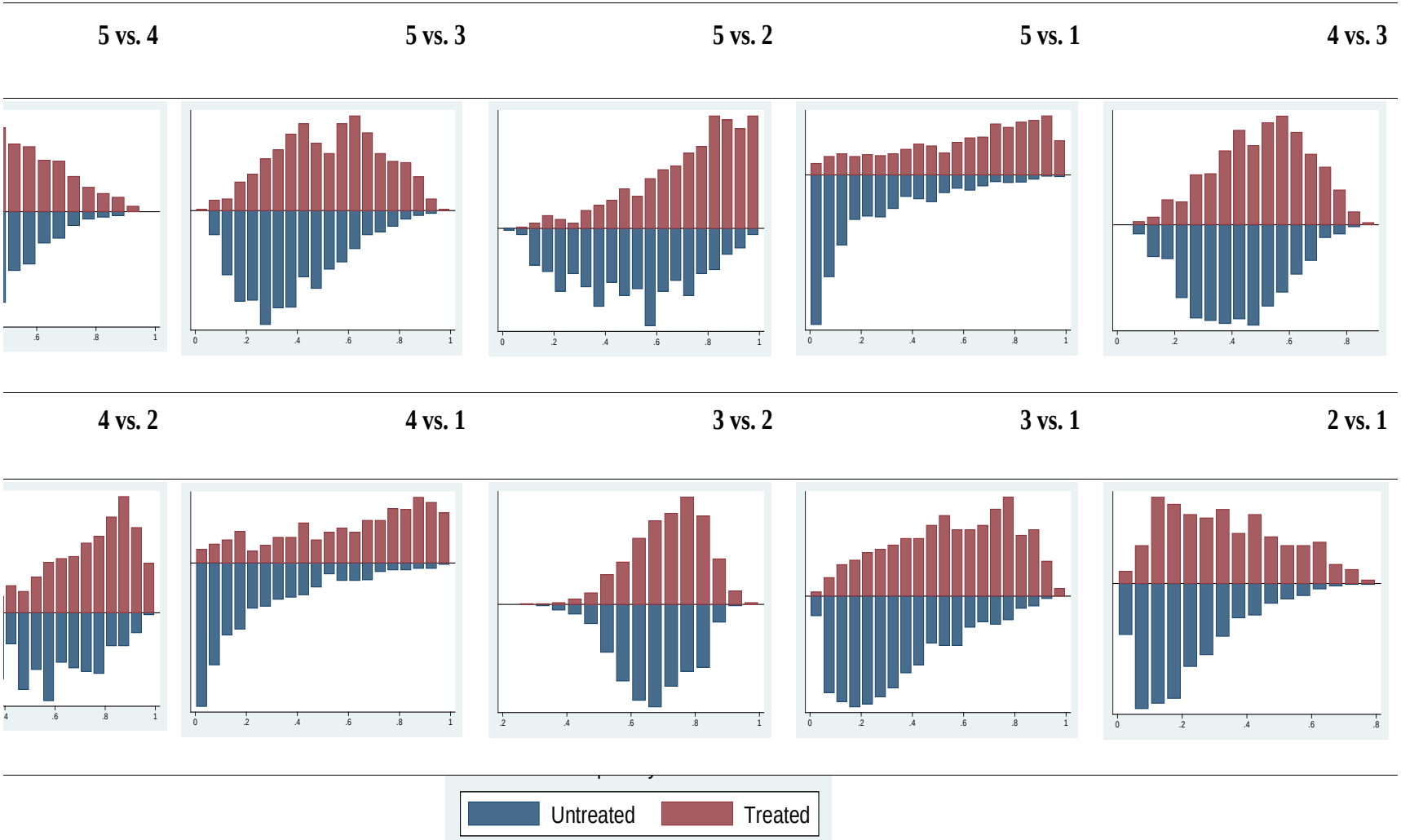
- One-to-one nearest neighbor
- Spline smoothing
- Local linear
- Kernel
- Radius matching with calipers (0.1, 0.01)

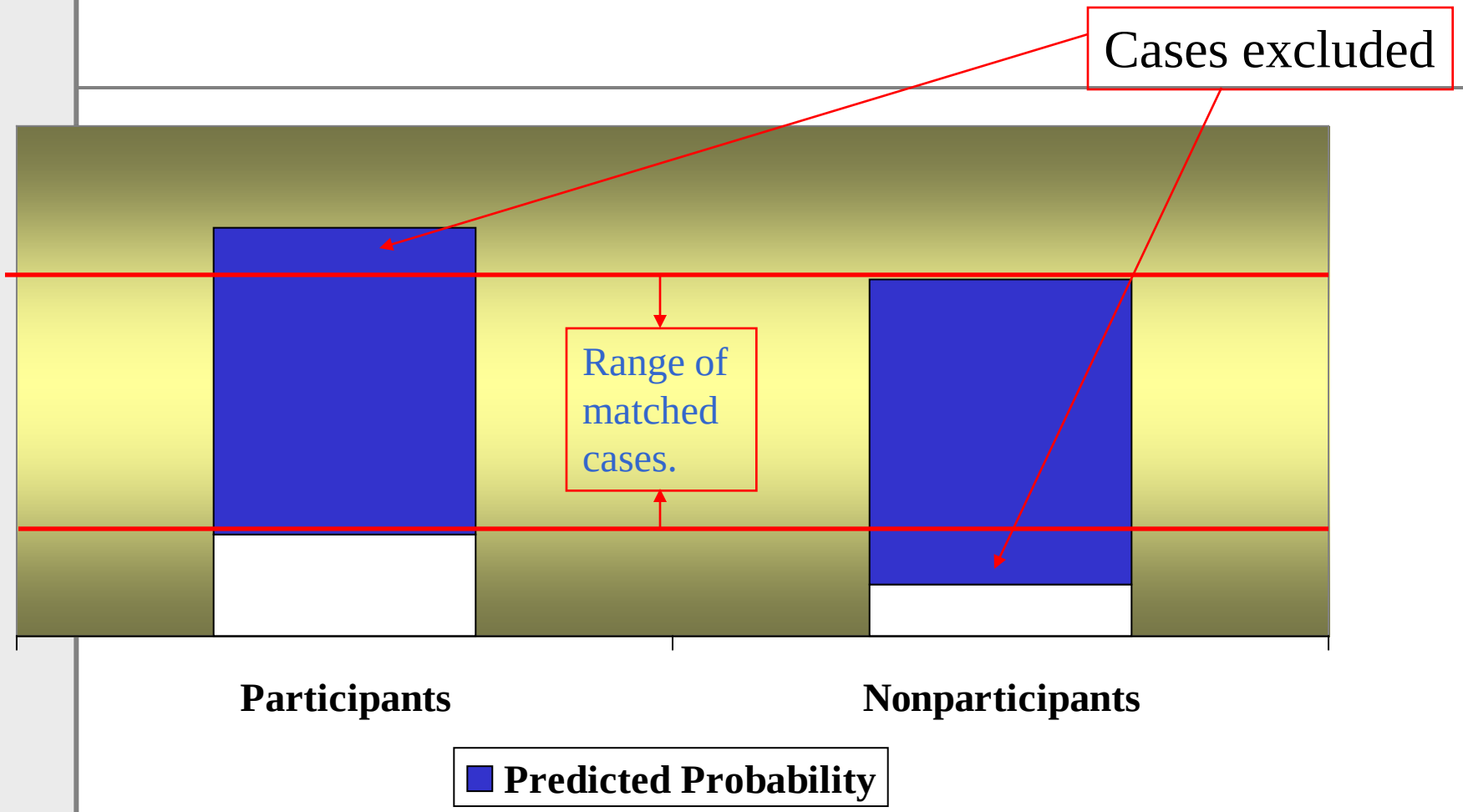
Use of the difference of the mean outcomes of the matched samples will yield the average treatment effect on the treated (ATT).

Computation of standard errors is not straightforward because the estimation steps that precede the matching process add variation. **BOOTSTRAP variance estimator**

Estimations: Common Support

Do density distributions of the propensity scores overlap?




Cases excluded
Range of matched cases.
Participants
Nonparticipants
Predicted Probability

Estimations: Common Support

Impose common support by "minima and maxima comparison": DELETE observations whose propensity score is smaller than the minimum and larger than the maximum in the opposite group.

Models	Before Matching	After Matching	% Lost	Probability scores Min	Max
5 vs. 4	1550	1544	0.39	0.155	0.900
5 vs. 3	1704	1698	0.35	0.056	0.932
5 vs. 2	1163	1144	1.63	0.031	0.984
5 vs. 1	2125	2122	0.14	0.006	0.986
4 vs. 3	1790	1781	0.50	0.076	0.814
4 vs. 2	1249	1209	3.20	0.057	0.960
4 vs. 1	2211	2168	1.94	0.003	0.965
3 vs. 2	1403	1399	0.29	0.328	0.946
3 vs. 1	2365	2335	1.27	0.021	0.917
2 vs. 1	1824	1823	0.05	0.008	0.772

Estimations: Results

	5 vs. 1	4 vs. 1	3 vs. 1	2 vs. 1
	ATT diff. (S.E.)	ATT diff. (S.E.)	ATT diff. (S.E.)	ATT diff. (S.E.)
Unmatched	0.933** (0.323)	0.725** (0.306)	0.933** (0.289)	0.701* (0.387)
One-to-One nearest neighbor	0.127 (0.647)	0.596 (0.537)	0.952** (0.472)	-0.041 (0.687)
Local linear regression	0.661 (0.657)	0.642 (0.505)	0.805** (0.367)	0.712* (0.429)
Spline-smoothing	0.671 (0.556)	0.671 (0.503)	0.785** (0.359)	0.648* (0.385)
Kernel (epanechnikov)	0.662 (0.642)	0.617 (0.466)	0.774** (0.356)	0.669 (0.431)
Radius, Caliper=0.1	0.654 (0.600)	0.676 (0.437)	0.803** (0.359)	0.680* (0.402)
Radius, Caliper=0.01	0.434 (0.642)	0.673 (0.472)	0.774** (0.372)	0.818* (0.431)

Estimations: Robustness check

We used another much older dataset: Continuing Survey of Food Intakes for Individuals (CSFII)

- Same results!

Estimations: Robustness checks

	4 vs. 1	3 vs. 1	2 vs. 1
	ATT diff. (S.E.)	ATT diff. (S.E.)	ATT diff. (S.E.)
Unmatched	0.934 (0.467)**	0.301 (0.409)	0.066 (0.511)
One-to-One nearest neighbor	0.746 (0.844)	0.706 (0.648)	0.794 (0.658)
Local linear regression	0.956 (0.826)	0.395 (0.658)	0.499 (0.512)
Spline-smoothing	1.047 (0.782)	0.497 (0.595)	0.410 (0.491)
Kernel (epanechnikov)	0.922 (0.786)	0.477 (0.657)	0.491 (0.511)
Radius, Caliper=0.1	0.987 (0.798)	0.719 (0.525)	0.441 (0.500)
Radius, Caliper=0.01	0.961 (0.690)	0.603 (0.524)	0.578 (0.489)

Sensitivity Analysis for Unobserved Heterogeneity

Rosenbaum bounds

- assess sensitivity of significance levels of treatment effects

- assumes that participation probability is not only determined by observable but also unobservable component u

$$\pi_i = \Pr(T_i = 1 | X_i) = F(\beta X_i + \gamma u_i)$$

- If no hidden bias, γ is zero

- varying this value allows us to assess sensitivity of results to hidden bias

- results suggest label use unlikely to have an effect on BMI even in presence of unobserved heterogeneity

Conclusions

Policy relevant question: Can nutritional label use reduce body weight?

Answer: NO! Not yet anyway based on our study.