HEALTH CARE COSTS ASSOCIATED WITH ELEVATED BODY MASS INDEX

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General Strategy For Identifying Costs Associated with Elevated Body Mass Index

- Grab a bunch of people with elevated body mass indices (BMI) and a bunch of people with average/"ideal" BMIs
- Assess the difference in the disease burden / health care cost between the two groups
- Attribute the difference to elevated BMI

What Can Go Wrong?

- The two groups may not differ in BMI alone, but also may differ in other factors that affect disease burden/cost
  - Age
  - Gender
  - Socioeconomic status
  - Genetics
  - Fitness
  - Medical conditions, obesity-related/unrelated
  - Other unmeasured/unmeasurable factors
- BMI might not be the cause of the disease/cost, but might be another expression of a common cause of both BMI and disease/cost

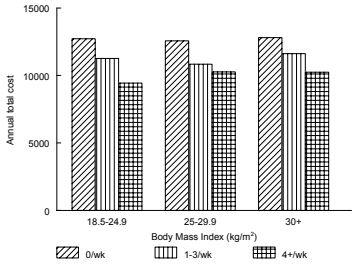
How Do We Address These Issues?

- To account for other differences between the groups:
  - Use statistical techniques that attempt to control for the differences
  - Often not possible to fully account for differences between groups in observational studies
- To sort out causal chain
  - Collect data that allow one to differentiate between the alternative, potential causes

Have We Sorted Out the Causal Chain?

- Do we know the independent effects of weight, physical activity, and fitness?
- Clinical judgment: What are health risks for an obese person who vigorously exercises an hour a day, 5 days a week, and -- where necessary -- maintains normal blood pressure, lipid, and blood sugar levels by taking niacin, statins, and metformin?
- Could our aesthetic judgments about overweight/ obesity be affecting our scientific judgments?

BMI & Physical Activity



$p<0.01$ for all pairwise comparisons of PA within each BMI level. Wang et al. Obesity Research. 2005; 13:1450-7

Swedish Obesity Study: Weight Loss

Variable	Surgery	Usual Care	P-value
2 years (%)	-23.4	0.1	<0.0001
% excess weight loss:	~58%		
10 years (%)	-16.1	1.6	<0.0001
% excess weight loss:	~40%		

Swedish Obesity Study: Other Outcomes

Variable	Surgery	Usual Care	P-value
Cumulative hospital days, 6 years			
Total	14.0	6.9	<0.0001
Nonsurgical	7.8	6.0	0.18
Cumulative inpatient costs ($), 6 years			
Total	9533	2540	<0.001
Nonsurgical	2747	2177	0.17
Annual Pharmacy costs (SEK)			
Total	1849	1905	NS
Years 2-6	1950	2048	NS

Flegel, "Excess Deaths...

- Relative to the normal weight category (BMI, 18.5 to <25), obesity (BMI≥30) was associated with 111 909 excess deaths and underweight with 33 746 excess deaths
- Overweight was not associated with excess mortality
- The impact of obesity on mortality may have decreased over time, perhaps because of improvements in public health and medical care

Flegel et al. Excess Deaths Associated With Underweight, Overweight, and Obesity. JAMA. 2005;293:1861-1867.

Study Designs for Quantifying Costs

- Cost-of-illness
  - Prevalence-based cost-of-illness studies (PBCOI)
    - Cohort studies
    - Attributable risk/cost studies
  - Incidence-based cost-of illness studies
- Treatment of obesity studies
  - Randomized trials
  - Decision analyses/simulation models

PBCOI: Cohort Studies

- Identify two groups of study participants
  - Those who have been exposed to the risk factor under study (e.g., elevated BMI)
  - Those who have not been exposed
- Estimate health care costs of study participants
- Predict (with varying degrees of technical sophistication) cost as a function of BMI
- The cost difference associated with BMI is taken to represent the cost difference due to the exposure

PBCOI: Attributable Risk Studies

- Obtain national estimates of the one-year cost of diseases associated with BMI (from various sources)
- Obtain estimates of the population-attributable risk% (PAR%) or obesity-attributable etiologic fractions (i.e., proportion of disease/cost that is due to obesity)
- Multiply cost times PAR% to obtain the cost-of-illness

Incidence-Based Cost of Illness Studies

- Identify two groups of study participants, those who have new onset of the condition under study (e.g., elevated BMI) and those who do not have the condition under study\
- Estimate health care costs of study participants over time
- Predict (with varying degrees of technical sophistication) cost as a function of onset of the condition
- The cost difference associated with new onset is taken to represent the cost difference due to the condition

Cost-Effectiveness Studies

- Even if we can prove that elevated BMI is associated with excess costs, does not necessarily mean that we can save money by having people reduce their BMI
- Should therefore evaluate the value for the cost of weight loss programs
- Cost-effectiveness studies compare the difference in costs and difference in outcomes between patients who "lose weight" with those who do not:

$$\Delta C / \Delta E$$

- Observed differences in costs and outcomes (assumed to be) caused by observed weight loss

Incremental Cost of Overweight and Obesity

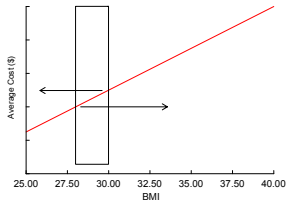
	Number of studies	Cost per person	National cost ($B)
Overweight	20	272	20.1
Men	8	276	
Women	9	445	
Obesity	23	1037	70.6
Men	8	1112	
Women	9	1693	

Sources of Heterogeneity

- Results in table may look very neat, but....
- Nationally representative sample vs less representative samples and attributable risk/models
  - In univariate analysis, nationally representative samples averaged $135 higher overweight costs and $500 higher obesity costs
- All adults vs specific age groups
  - In univariate analysis, samples with specific age groups tended to report higher overweight and obesity costs than samples comprised of all adults

Sources of Heterogeneity (2)

- Standard versus nonstandard definitions of overweight and obesity
  - In univariate analysis, studies with standard cut-offs reported higher overweight (+380) and obesity (+560) costs than those with nonstandard cut-offs



Sources of Heterogeneity (3)

- Year of study: Adjusted for in our calculation of the costs; affects:
  - Prevalence of obesity assumed in the different studies
  - CPI

Sources of Heterogeneity (4)

- Cost outcome
  - Per-person vs national estimates: Adjusted for in calculation
  - Stratified by category of obesity: Adjusted for in calculation
  - Gender-specific vs all
    - In univariate analysis, studies that reported gender-specific estimates tended to report higher overweight and obesity costs than those that did not report gender-specific estimates
  - Costs, charges, expenditures
    - In univariate analysis, studies that quantified expenditures yielded the highest estimates

Adjusted Cost Estimates

- Based on regression analysis that accounts for study design, BMI cut-offs used, and use of costs or charges, average overweight and obesity costs for nationally-representative samples, that used current definitions of overweight and obesity, and that quantified expenditures were:
  - Overweight: $353 (versus $272)
  - Obesity: $1370 (versus 1037)

Role of Chronic Medical Conditions

- Controlling for chronic medical conditions associated with obesity generally lowered the estimated cost of obesity, but also generally did not eliminate the "independent" effect of weight on cost
- Some studies controlled for variables that may be in the causal pathway of overweight/obesity (e.g., poor nutritional habits, hyperlipidemia, blood glucose, depression, etc.)
  - Truth probably lies somewhere between estimates that control for and do not control for chronic conditions (attributable risk)

Cost-Effectiveness Analysis

- Two main types of studies: trial-based evaluations vs decision analyses/simulation models
- Trial-based: Directly observe weight loss, costs, and outcomes
  - Strength: Direct observation
  - Weakness: Usually short term in duration
- Decision analyses/simulation models: Usually directly observe weight loss only; use epidemiologic models for relationships between weight loss and outcome and weight loss and cost
  - Strength: Can model life-time costs
  - Weakness: Assumption- rather than data-driven

Cost-Effectiveness Analysis (2)

- Studied interventions include:
  - Multidisciplinary lifestyle intervention
  - Weight loss medications
  - Bariatric surgery
- Outcomes vary across studies
  - lb/kg/BMI units lost
  - Cases of DM prevented
  - QALYs
- How should we compare results from studies with different outcomes?

CEA of Treatment for Obesity

Study	Intervention	Outcome measure	Result
Randomized controlled trials, nationally representative			
DPP	Lifestyle vs placebo	DM Prevented	$24,400
		QALY	$51,600
DPP	Metformin weakly dominated by lifestyle		
Randomized			
Wylie-Rosett	Computerized lifestyle	Lb lost	$6 - $18
Foxcroft	Orlistat	QALY	$76,667
Cohort Studies			
Martin	Medical vs surgical	$/LB lost	>$250 both arms, NS

CEA of Treatment for Obesity

Study	Intervention	Outcome measure	Result
Decision Analyses			
DPP (Herman)	Lifestyle vs placebo	QALY	1,100
DPP (Eddy)	Lifestyle vs. placebo	QALY	143,000
Craig, Fang	Bariatric surgery	QALY	$5,000 - 35,600
Lamotte	Orlisat	QALY	$4,415 - 25,500
Spielman	Commercial WL	Cost/lb lost	$2 - $26
Oster	Unspecified	% weight loss	Dominates

Summary of Findings

- Incremental cost of $275-$350 per overweight person and $1040-$1370 per obese person
- Costs of overweight/obesity greater for overweight/ obese women than for overweight/obese men
  - Occurs even though men are more likely to be overweight, and there is at most a tendency for more women than men to be obese

Summary of Findings (2)

- Cost of treating obesity
  - Few studies
  - Heterogeneous outcomes
  - The three studies that directly compared lifestyle intervention with medications found lifestyle to be more cost-effective (what does insurance cover?)
  - Only three published studies estimated lifetime benefits (vs. within-trial benefits)
  - The two long-term decision analyses of the DPP (Herman et al, Eddy et al) arrived at very different conclusions about the cost-effectiveness of treating obesity (why?)

So What?

- You perform a cost-of-illness study, and report that overweight is responsible for approximately $300 in health care costs per person per year in the U.S. (i.e., approximately $21 billion per year)
- What are these numbers supposed to be?
  - Actual measures of cost?
  - Warning signs?
  - Projections of what they will be?
- What incentives do investigators have to report higher or lower results?
- How do these numbers help us make decisions?
- What numbers would be better?

Conclusions

"Overweight/obesity is a major public health problem that costs society billions of dollars, and we should be doing everything we can to combat it."

- Reasons to agree with this statement
  - Consistent association between BMI, health, and cost
  - Biological plausibility
  - Quantitatively strong association
  - Dose response
  - Correct time sequence

Conclusions (2)

Reasons to question this statement

- We haven't performed a single trial that demonstrates the impact of weight loss on final health outcomes such as death, disease, and disability
  - When we had the chance (randomizing 5,000 patients and following them for 7 years), why did we decide to study weight loss in diabetics rather than weight loss in the general public?
- We haven't disaggregated the independent effects of weight, physical activity, and fitness
- Even if overweight/obesity is a health/economic problem, it is not clear we have cost-effective interventions for its treatment / prevention