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

<table>
<thead>
<tr>
<th>Variable</th>
<th>Surgery</th>
<th>Usual Care</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 years (%)</td>
<td>-23.4</td>
<td>0.1</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>% excess weight loss</td>
<td>~58%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 years (%)</td>
<td>-16.1</td>
<td>1.6</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>% excess weight loss</td>
<td>~40%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Swedish Obesity Study: Other Outcomes

<table>
<thead>
<tr>
<th>Variable</th>
<th>Surgery</th>
<th>Usual Care</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative hospital days, 6 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>14.0</td>
<td>6.9</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Nonsurgical</td>
<td>7.8</td>
<td>6.0</td>
<td>0.18</td>
</tr>
<tr>
<td>Cumulative inpatient costs ($), 6 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>9533</td>
<td>2540</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Nonsurgical</td>
<td>2747</td>
<td>2177</td>
<td>0.17</td>
</tr>
<tr>
<td>Annual Pharmacy costs (SEK)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1849</td>
<td>1905</td>
<td>NS</td>
</tr>
<tr>
<td>Years 2-6</td>
<td>1950</td>
<td>2048</td>
<td>NS</td>
</tr>
</tbody>
</table>

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.

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:
  \[ \frac{\Delta C}{\Delta E} \]
- Observed differences in costs and outcomes (assumed to be) caused by observed weight loss.

Incremental Cost of Overweight and Obesity

<table>
<thead>
<tr>
<th></th>
<th>Number of studies</th>
<th>Cost per person</th>
<th>National cost ($B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overweight</td>
<td>20</td>
<td>272</td>
<td>20.1</td>
</tr>
<tr>
<td>Men</td>
<td>8</td>
<td>276</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>9</td>
<td>445</td>
<td></td>
</tr>
<tr>
<td>Obesity</td>
<td>23</td>
<td>1037</td>
<td>70.6</td>
</tr>
<tr>
<td>Men</td>
<td>8</td>
<td>1112</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>9</td>
<td>1693</td>
<td></td>
</tr>
</tbody>
</table>
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

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

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### CEA of Treatment for Obesity

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<th>Outcome measure</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPP (Herman)</td>
<td>Lifestyle vs placebo</td>
<td>QALY</td>
<td>1,100</td>
</tr>
<tr>
<td>DPP (Eddy)</td>
<td>Lifestyle vs placebo</td>
<td>QALY</td>
<td>143,000</td>
</tr>
<tr>
<td>Craig, Fang</td>
<td>Bariatric surgery</td>
<td>QALY</td>
<td>$5,000 - 35,600</td>
</tr>
<tr>
<td>Lamotte</td>
<td>Orlistat</td>
<td>QALY</td>
<td>$4,415 - 25,500</td>
</tr>
<tr>
<td>Spielman</td>
<td>Commercial WL</td>
<td>Cost/lb lost</td>
<td>$2 - $26</td>
</tr>
<tr>
<td>Oster</td>
<td>Unspecified % weight loss</td>
<td>Dominates</td>
<td></td>
</tr>
</tbody>
</table>
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