The Dynamic Effects of Obesity on the Wages of Young Workers

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University of Louisville

June, 2015
Prevalence of Obesity has Increased Dramatically

Obesity Trends* Among U.S. Adults

BRFSS, 1985

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

Source: Behavioral Risk Factor Surveillance System, CDC.
Introduction

Models of Obesity and Wages

Estimation

Data

Results

Conclusions

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**Obesity Trends* Among U.S. Adults**

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Source: Behavioral Risk Factor Surveillance System, CDC.
Prevalence of Obesity has Increased Dramatically

**Obesity Trends* Among U.S. Adults**

**BRFSS, 1988**

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

Source: Behavioral Risk Factor Surveillance System, CDC.
Prevalence of Obesity has Increased Dramatically

Obesity Trends* Among U.S. Adults
BRFSS, 1989
(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)

Source: Behavioral Risk Factor Surveillance System, CDC.
Prevalence of Obesity has Increased Dramatically

Obesity Trends* Among U.S. Adults

BRFSS, 1990

(*BMI \geq 30, or \sim 30 lbs. overweight for 5' 4'' person)

Source: Behavioral Risk Factor Surveillance System, CDC.
Prevalence of Obesity has Increased Dramatically

**Obesity Trends* Among U.S. Adults**

**BRFSS, 1992**

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

Source: Behavioral Risk Factor Surveillance System, CDC.
Prevalence of Obesity has Increased Dramatically

**Obesity Trends** Among U.S. Adults

*BMI ≥30, or ~30 lbs. overweight for 5’ 4” person*

*BRFSS, 1993*

Source: Behavioral Risk Factor Surveillance System, CDC.
Prevalence of Obesity has Increased Dramatically

Obesity Trends* Among U.S. Adults

BRFSS, 1994

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

Source: Behavioral Risk Factor Surveillance System, CDC.
Prevalence of Obesity has Increased Dramatically

**Obesity Trends* Among U.S. Adults**
**BRFSS, 1995**
(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person*)

Source: Behavioral Risk Factor Surveillance System, CDC.
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**Obesity Trends* Among U.S. Adults**

**BRFSS, 1996**

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

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**Obesity Trends* Among U.S. Adults**

**BRFSS, 1997**

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

Source: Behavioral Risk Factor Surveillance System, CDC.
Prevalence of Obesity has Increased Dramatically

Obesity Trends* Among U.S. Adults

BRFSS, 1998

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

Source: Behavioral Risk Factor Surveillance System, CDC.
Obesity Trends* Among U.S. Adults

BRFSS, 1999

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

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Obesity Trends* Among U.S. Adults

BRFSS, 2000

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

Source: Behavioral Risk Factor Surveillance System, CDC.
Prevalence of Obesity has Increased Dramatically

Obesity Trends* Among U.S. Adults
BRFSS, 2001
(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)

Source: Behavioral Risk Factor Surveillance System, CDC.
Prevalence of Obesity has Increased Dramatically

**Obesity Trends* Among U.S. Adults**
**BRFSS, 2002**

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

Source: Behavioral Risk Factor Surveillance System, CDC.
Prevalence of Obesity has Increased Dramatically

Obesity Trends* Among U.S. Adults

BRFSS, 2003

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

Source: Behavioral Risk Factor Surveillance System, CDC.
Prevalence of Obesity has Increased Dramatically

Obesity Trends* Among U.S. Adults
BRFSS, 2004
(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)

Source: Behavioral Risk Factor Surveillance System, CDC.
Prevalence of Obesity has Increased Dramatically

Obesity Trends* Among U.S. Adults
BRFSS, 2005
(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)

Source: Behavioral Risk Factor Surveillance System, CDC.
Prevalence of Obesity has Increased Dramatically

Obesity Trends* Among U.S. Adults
BRFSS, 2006

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

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Obesity Trends* Among U.S. Adults
BRFSS, 2008
(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)

Source: Behavioral Risk Factor Surveillance System, CDC.
Prevalence of Obesity has Increased Dramatically

**Obesity Trends* Among U.S. Adults**

**BRFSS, 2009**

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

Source: Behavioral Risk Factor Surveillance System, CDC.
Prevalence of Obesity has Increased Dramatically

Obesity Trends* Among U.S. Adults

BRFSS, 2010

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

Source: Behavioral Risk Factor Surveillance System, CDC.
Contributions

1. Focus on more recent cohort, NLSY97.
   - Industry mix, worker characteristics, etc. have varied over time.

2. Focus on young workers, shortly after labor market entry
   - More likely to observe discrimination as it unfolds.
   - Wage penalties less likely to reflect disability.
3. More realistic, dynamic model of wages:

- Current and past BMI affect wages.
- Past wages also affect current wages.
  \[ \Rightarrow \text{Effects of BMI can persist and accumulate.} \]

\[ \text{BMI} = \frac{\text{weight in kilograms}}{(\text{height in meters})^2} \]
Lagged body mass matters more than current.

- Lagged severe obesity lowers wages of white men by 17%.
- White women face 10% penalty for lagged BMI $\geq 24.5$, plus additional 10% for heaviest women.
- Current BMI only matters for severely obese women.

Dynamic models matter.

- Especially for women.
- Penalties do persist and accumulate.
Following Recent Literature

Start with a simple wage regression:

\[ w_{it} = X_{it} \beta + BM_{it} \phi + \nu_{it}, \]  

(1)
Start with a simple wage regression:

\[ w_{it} = X_{it}\beta + BMI_{it}\phi + \nu_{it}, \]  

(1)

**Problem**: \( BMI_{it} \) may be correlated with \( \nu_{it} \).

- Fixed effects related to genetics or upbringing.
- Time-varying unobservables, reverse causality, etc.
- Predetermined?
What Have Others Done?

- **Instrumental variables**
  - BMI of family member.
  - Problems: Only predicts time-invariant components of BMI. Correlated with time-invariant unobservables.
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- **Instrumental variables**
  - BMI of family member.
  - Problems: Only predicts time-invariant components of BMI. Correlated with time-invariant unobservables.

- **FE or Differencing**
  - Removes bias from fixed effects.
  - Problems: Time-varying unobservables, labor market history.
Only other paper to consider both current and lagged BMI.

- Uses NLSY79.
- Regresses wage in 30s on current BMI and BMI 10 years prior.
- Finds early BMI matters, especially for women.

Results for men appear biased by time-invariant unobservables.

- No mention of time-varying sources of bias.
- No control for past wages.
Including Effects of the Past

- Obvious first step: Add lagged BMI
- Should also add lagged wage.
- Adding one lag of each yields:

\[ w_{it} = \gamma w_{it-1} + X_{it} \beta + BMI_{it} \phi + BMI_{it-1} \phi_1 + \alpha_i + \epsilon_{it}. \]  

(2)

- Problems:
  - \( w_{it-1}, BMI_{it}, \) and \( BMI_{it-1} \) could be correlated with \( \alpha_i \).
  - \( BMI_{it} \) could be correlated with \( \epsilon_{it} \).
Difference GMM

Developed by Holtz-Eakin et al. (1988), Arellano & Bond (1991)

Basic Idea:

1. Difference to eliminate $\alpha_i$

$$
\Delta w_{it} = \gamma \Delta w_{it-1} + \Delta X_{it} \beta + \Delta BMI_{it} \phi + \Delta BMI_{it-1} \phi_1 + \Delta \epsilon_{it}.
$$

2. Use further lagged levels ($w_{it-2}, BMI_{it-2}$, etc.) as IVs.

Assumes:

- No serial correlation in $\epsilon_{it}$.
- $BMI_{it}$ uncorrelated with $\epsilon_{it+1}$. 

Testing for Potential Problems

- AB test for serial correlation in residuals
- Tests of overidentifying restrictions.
  - Hansen $J$-test.
  - "Difference-in-Hansen" tests.
- Less formal: Robustness to changes in health status.
NLSY97
1997-2009 waves.

- Respondents are 12-16 years old in 1996. 24-30 in 2009.
- Sample restrictions:
  - Only white men and women.
  - Only use jobs following full-time labor market entry.
    - First two consecutive years working full time for 75% of year.
    - Focus is on early careers, not summer jobs.
  - Never in military.
  - Drop women if pregnant since last interview.
### Summary Statistics

From Table 1

<table>
<thead>
<tr>
<th></th>
<th>White Men</th>
<th>White Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Dev.</td>
</tr>
<tr>
<td>Wage</td>
<td>19.89</td>
<td>356.12</td>
</tr>
<tr>
<td>Log Wage</td>
<td>2.33</td>
<td>0.62</td>
</tr>
<tr>
<td>BMI</td>
<td>26.72</td>
<td>5.52</td>
</tr>
<tr>
<td>Overweight</td>
<td>0.57</td>
<td>0.49</td>
</tr>
<tr>
<td>Obese</td>
<td>0.22</td>
<td>0.42</td>
</tr>
<tr>
<td>Severely Obese</td>
<td>0.08</td>
<td>0.27</td>
</tr>
<tr>
<td>Yrs since LM Entry</td>
<td>4.47</td>
<td>2.66</td>
</tr>
<tr>
<td>Yrs in 2009</td>
<td>7.01</td>
<td>2.56</td>
</tr>
<tr>
<td>Actual Experience</td>
<td>4.17</td>
<td>2.46</td>
</tr>
<tr>
<td>Exp in 2009</td>
<td>6.40</td>
<td>2.41</td>
</tr>
<tr>
<td>Observations</td>
<td>9,037</td>
<td></td>
</tr>
</tbody>
</table>
Self-Reported BMI
And what I (don’t) do about it

- Ongoing problem in this literature.
- Don’t use "validation" approach used by others in literature.
  - Assumptions required are likely violated across samples.
  - Do we care about actual BMI?
Self-Reported BMI
And what I (don’t) do about it

- Ongoing problem in this literature.
- Don’t use "validation" approach used by others in literature.
  - Assumptions required are likely violated across samples.
  - Do we care about actual BMI?
- Talking on phone = Miracle weight loss?
  - 10% of estimation sample from phone interviews.
  - Include controls for phone interview in $t$ and $t - 1$. 
Selecting Specifications of BMI

- No reason to assume penalties coincide with WHO categories.
- I consider alternative thresholds ranging from 23 to 38.
- Preferred specifications selected based on
  1. Robustness of coefficients to changes in specifications & estimation sample.
  2. Formal specification tests:
     - Bond et al. (2001) for nested specifications.
### Effects of Past & Current BMI on ln(wage) of White Men

#### WHO Categories (from Table 2)

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L.In(wage)</td>
<td>0.0722*</td>
<td>0.0605</td>
<td>0.0648</td>
<td>0.0769*</td>
<td>0.0720*</td>
<td>0.0768*</td>
</tr>
<tr>
<td></td>
<td>(0.0414)</td>
<td>(0.0410)</td>
<td>(0.0416)</td>
<td>(0.0420)</td>
<td>(0.0412)</td>
<td>(0.0421)</td>
</tr>
<tr>
<td>Overweight</td>
<td>-0.1187</td>
<td>-0.0977</td>
<td>...</td>
<td>-0.1190</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>(0.1198)</td>
<td>(0.1224)</td>
<td>...</td>
<td>(0.1207)</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>L.Overweight</td>
<td>0.0540</td>
<td>0.0477</td>
<td>...</td>
<td>0.0549</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>(0.0491)</td>
<td>(0.0456)</td>
<td>...</td>
<td>(0.0470)</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Obese</td>
<td>0.0112</td>
<td>...</td>
<td>0.0054</td>
<td>...</td>
<td>-0.0051</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>(0.0979)</td>
<td>...</td>
<td>(0.1021)</td>
<td>...</td>
<td>(0.1012)</td>
<td>...</td>
</tr>
<tr>
<td>L.Obese</td>
<td>0.0030</td>
<td>...</td>
<td>0.0175</td>
<td>...</td>
<td>0.0061</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>(0.0567)</td>
<td>...</td>
<td>(0.0576)</td>
<td>...</td>
<td>(0.0600)</td>
<td>...</td>
</tr>
<tr>
<td>Severely Obese</td>
<td>0.0465</td>
<td>...</td>
<td>...</td>
<td>0.0745</td>
<td>0.0557</td>
<td>0.0360</td>
</tr>
<tr>
<td></td>
<td>(0.0927)</td>
<td>...</td>
<td>...</td>
<td>(0.0938)</td>
<td>(0.0925)</td>
<td>(0.0951)</td>
</tr>
<tr>
<td>L.Severely Obese</td>
<td>-0.1699***</td>
<td>...</td>
<td>...</td>
<td>-0.1649***</td>
<td>-0.1722***</td>
<td>-0.1668**</td>
</tr>
<tr>
<td></td>
<td>(0.0632)</td>
<td>...</td>
<td>...</td>
<td>(0.0598)</td>
<td>(0.0594)</td>
<td>(0.0680)</td>
</tr>
</tbody>
</table>
## Effects of Past & Current BMI on $\ln(\text{wage})$ of Women

Alternative Categories (from Table 4)

<table>
<thead>
<tr>
<th></th>
<th>Lower Dummy Variable: BMI $\geq 24.5$</th>
<th></th>
<th>Lower Dummy Variable: BMI $\geq 25$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>$\ln(\text{wage})$</td>
<td>0.214***</td>
<td>0.221***</td>
<td>0.222***</td>
</tr>
<tr>
<td></td>
<td>(0.059)</td>
<td>(0.055)</td>
<td>(0.053)</td>
</tr>
<tr>
<td>Lower BMI Var.</td>
<td>0.050</td>
<td>0.067</td>
<td>0.018</td>
</tr>
<tr>
<td></td>
<td>(0.148)</td>
<td>(0.096)</td>
<td>(0.084)</td>
</tr>
<tr>
<td>L.(Lower BMI Var.)</td>
<td>-0.112***</td>
<td>-0.104**</td>
<td>-0.103**</td>
</tr>
<tr>
<td></td>
<td>(0.039)</td>
<td>(0.045)</td>
<td>(0.043)</td>
</tr>
<tr>
<td>BMI $\geq 36.5$</td>
<td>...</td>
<td>-0.101</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>...</td>
<td>(0.093)</td>
<td>...</td>
</tr>
<tr>
<td>L.(BMI $\geq 36.5$)</td>
<td>...</td>
<td>-0.048</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>...</td>
<td>(0.056)</td>
<td>...</td>
</tr>
<tr>
<td>BMI $\geq 37$</td>
<td>...</td>
<td>...</td>
<td>-0.126**</td>
</tr>
<tr>
<td></td>
<td>...</td>
<td>...</td>
<td>(0.054)</td>
</tr>
<tr>
<td>L.(BMI $\geq 37$)</td>
<td>...</td>
<td>...</td>
<td>-0.097*</td>
</tr>
<tr>
<td></td>
<td>...</td>
<td>...</td>
<td>(0.055)</td>
</tr>
<tr>
<td>BMI $\geq 37.5$</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td></td>
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<td>...</td>
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Differences Between the Results for Men & Women

Societal expectations, muscle mass & the beauty premium
The Importance of Dynamic Models

- Past body mass affects wages beyond the lags in the model.
  - $w_{it-1}$ is a function of $BMI_{it-2}$ and $w_{it-2}$.
  - $w_{it-2}$ is a function of $BMI_{it-3}$, etc.

- Penalty for high BMI is persistent & accumulates.

<table>
<thead>
<tr>
<th>Years in Market:</th>
<th>$t = 1$</th>
<th>$t = 2$</th>
<th>$t = 3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woman 1</td>
<td>BMI</td>
<td>38</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Penalty</td>
<td>13%</td>
<td>20%</td>
</tr>
<tr>
<td>Woman 2</td>
<td>BMI</td>
<td>23</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Penalty</td>
<td>0</td>
<td>0</td>
</tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>BMI</td>
<td>38</td>
<td>29</td>
<td>24</td>
</tr>
<tr>
<td>Penalty</td>
<td>13%</td>
<td>20%</td>
<td>15%</td>
</tr>
<tr>
<td>Woman 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI</td>
<td>23</td>
<td>29</td>
<td>24</td>
</tr>
<tr>
<td>Penalty</td>
<td>0</td>
<td>0</td>
<td>10%</td>
</tr>
<tr>
<td>Woman 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI</td>
<td>38</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>Penalty</td>
<td>13%</td>
<td>33%</td>
<td>37.5%</td>
</tr>
</tbody>
</table>
Robustness to Additional Control Variables

The results are robust to the inclusion of

- Self-reported health
  - Past or current
  - Implications for identification

- Employer-provided health insurance.

- Marital status, number & age of children.

- Hours worked.

- Tenure & training.
Robustness to Additional Control Variables

Occupation does matter, but it’s endogenous

<table>
<thead>
<tr>
<th></th>
<th>White Men</th>
<th>White Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preferred Model</td>
<td>Occupation Added</td>
</tr>
<tr>
<td>L.In(wage)</td>
<td>0.072*</td>
<td>0.072*</td>
</tr>
<tr>
<td></td>
<td>(0.041)</td>
<td>(0.041)</td>
</tr>
<tr>
<td>Overweight or BMI≥24.5</td>
<td>-0.119</td>
<td>-0.085</td>
</tr>
<tr>
<td></td>
<td>(0.121)</td>
<td>(0.113)</td>
</tr>
<tr>
<td>L.(Overweight or BMI≥24.5)</td>
<td>0.055</td>
<td>0.051</td>
</tr>
<tr>
<td></td>
<td>(0.047)</td>
<td>(0.046)</td>
</tr>
<tr>
<td>Obese or BMI≥37</td>
<td>0.056</td>
<td>0.065</td>
</tr>
<tr>
<td></td>
<td>(0.093)</td>
<td>(0.114)</td>
</tr>
<tr>
<td>L.(Obese or BMI≥37)</td>
<td>-0.172***</td>
<td>-0.214***</td>
</tr>
<tr>
<td></td>
<td>(0.059)</td>
<td>(0.079)</td>
</tr>
</tbody>
</table>
Lagged effects suggest something other than simple disutility-based penalty.

Already some work on indirect effects:

- Han et al. (2011): Effects of teen BMI on education and occupation.
- Lakdawalla & Philipson (2007), and Harris (2014) consider occupation.