

Appendix A. Review of Scholarship Regarding Health Risk and Medical Spending: Description of Review Process and Citations.

Appendix B. Review of Scholarship Regarding Financial Incentives and Health Improvement: Description of Review Process and Citations.

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Appendix A. Review of Scholarship Regarding Health Risk and Medical Spending: Description of Review Process and Citations

We searched several databases to find scholarly articles examining the relationship between various health risks and medical spending among the non-elderly, employed population in the United States. Although we investigated several databases in our initial research (CINAHL, Medline, ISI World of Knowledge, and PsycInfo), our final results relied only a search of the ISI Web of Knowledge Database because, despite using different searches in different databases with different search engines, the latter search alone produced the same results as earlier searches we performed on the combination of other databases. We performed the search on studies published from 1970 through 2012.

We used the following search terms: Topic=(MEDICAL* OR HEALTH OR PHARMA* OR “HEALTH CARE”) AND Topic=(COST* OR EXPENSE* OR EXPENDITURE* OR PAYMENT* OR SPEND* OR BILL*) AND Topic=('risk factor*' OR "health factor*" OR "health risk*" OR modifiable) AND Topic=(employee* OR employer* OR employee* OR INSURANCE OR INSURE* OR work*) AND Topic=(CHOLESTEROL OR CARDIOVASCULAR OR "BLOOD PRESSURE" OR LDL OR HDL OR CARDIAC OR SYSTOLIC OR DIASTOLIC OR HYPERTENSION OR NICOTINE OR SMOKING OR SMOKER OR TOBACCO OR BODY MASS INDEX OR bmi OR OVERWEIGHT OR OBESE OR HEMOGLOBIN* OR BLOOD SUGAR* OR ALCOHOL* OR DRINK* OR STRESS* OR ANXIETY OR EMOTION* OR DISTRESS OR DEPRESS* OR “MENTAL HEALTH” OR EXERCISE OR FITNESS OR AEROBIC OR CARDIO OR TRAINING)

This search produced 2,119 articles. We reviewed the titles to determine whether the articles were likely to provide information regarding the relationship between the health risks we wished to study and medical spending among the employed, non-elderly, U.S. population. We included studies of insurance plans that covered people under 65 years of age, assuming that the majority of enrollees were working adults, although that approach risked including some disabled adults, nonworking adults, dependents, and others.

After eliminating articles that were clearly irrelevant, such as those based on research regarding foreign populations, studies focused on outcomes other than medical spending, and studies of the elderly population, we reviewed the abstracts of 127 papers. Of those 127 abstracts, we selected 56 papers for a complete read to identify research based on statistical testing (i.e. studies that measured statistical significance with t-tests and research that attempted to identify the causal relationship between health risk conditions and spending rather than mere correlations). Of those 56 papers, 16 qualified. While reading the 16 papers, we reviewed their bibliographies applying the same process discussed above, and found an additional 13 papers that fit our criteria, for a total 29 papers. We also included one relevant paper from another source.

This process produced 30 papers, which we classified in Table 2 as demonstrating: 1) correlations between a health factor and increased medical spending, 2) correlations between a health factor and decreased medical care costs or 3) no significant effect on spending. We reproduce Exhibit 2 with full citations here.
There were some limitations to our approach. First, although two of the authors read the final set of 30 papers, Kelly identified the larger set of papers and culled them. However, she performed the research multiple times and in close collaboration with Horwitz. Second, the studies were not perfectly analogous. For example, they use different standards to identify a health risk (e.g., different BMI and cholesterol cutoffs), rely on different outcomes (average v. median, claims v. other measures of cost), and employ different control variables (age, sex, co-morbidities, socio-economic status). The studies are also based on different populations. For example, some included only active employees who completed a voluntary health assessment; others included all employees enrolled in a given health plan; others, such as those conducted on manufacturing employees, included a predominantly male population; and, others still included spouses and dependents. Third, published studies are biased towards showing significant results, although this bias makes it particularly striking that we found so few significant effects in the research and so many with insignificant results. Finally, the research we identified as statistically rigorous was heavily concentrated in two journals, the Journal of Occupation and Environmental Medicine and the American Journal of Health Promotion.

Studies on Health Risk and Medical Spending Supporting Exhibit 2 in Main Text

<table>
<thead>
<tr>
<th>Health Risk Factor</th>
<th>Higher Spending</th>
<th>Lower Spending</th>
<th>No Significant Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obesity / Body Mass Index</td>
<td>14\textsuperscript{a,f,g,h,i,l,m,p,q,u,w,v,y}</td>
<td>1\textsuperscript{v}</td>
<td>7\textsuperscript{b,c,e,o,s,x,bb}</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>8\textsuperscript{a,b,f,i,l,p,r,w}</td>
<td>9\textsuperscript{c,e,f,g,k,o,s,x,cc}</td>
<td></td>
</tr>
<tr>
<td>Cholesterol</td>
<td>4\textsuperscript{c*,l,g,w}</td>
<td>1\textsuperscript{a}</td>
<td>10\textsuperscript{b,e,f,g,i,k,o,s,x,cc}</td>
</tr>
<tr>
<td>Tobacco Use</td>
<td>7\textsuperscript{g*,i,r,v,v*,w,v,x}</td>
<td>1\textsuperscript{v}</td>
<td>11\textsuperscript{a,e,g,k,l,o,p,r,v,w,v*,cc}</td>
</tr>
<tr>
<td>Blood Glucose</td>
<td>4\textsuperscript{g,t,p}</td>
<td>2\textsuperscript{b,c}</td>
<td></td>
</tr>
<tr>
<td>Alcohol</td>
<td>1\textsuperscript{v}</td>
<td>2\textsuperscript{a,z}</td>
<td>8\textsuperscript{b,i,n,o,p,r,v,w,*}</td>
</tr>
<tr>
<td>Stress / Other Emotional</td>
<td>10\textsuperscript{a,e,g,i,j,k,m,x,a*,dd*}</td>
<td>5\textsuperscript{p,s,v,w,dd*}</td>
<td></td>
</tr>
<tr>
<td>Inadequate Exercise</td>
<td>8\textsuperscript{a,f,g*,h,i,r,v*,y*,}</td>
<td>1\textsuperscript{v*}</td>
<td>9\textsuperscript{d,e,g,k,m,o,p,y*,cc}</td>
</tr>
</tbody>
</table>

Note: *See parenthetical comments after full citations below for more explanation.


f. Pronk NP, Goodman MJ, O’Connor PJ, Martinson BC. Relationship between modifiable health risks and short-term health care charges. JAMA. 1999;282: 2235-2239. [f*: Blood pressure and cholesterol did not predict charges and were not useful in fit.]


w. Burton W, Chen C, Conti D, Schultz A, Edington D. Measuring the relationship between employees’ health risk factors and corporate pharmaceutical expenditures. J Occup Environ Med. 2003;45: 793-802. (w*: This study only concerns pharmaceutical expenditures. Additionally, pharmaceutical costs are statistically higher for ex-smokers only. Costs are not significant for non-smokers.)


y. Wang F, McDonald T, Champagne L, Edington D. Relationship of body mass index and physical activity to health care costs among employees. J Occup Environ Med. 2004;46: 428-436. (y*: For physical activity, drug costs are not statistically significant, but medical costs are statistically significant).


Appendix B: Review of Scholarship Regarding Financial Incentives and Health Improvement: Description of Review Process and Citations

We first searched ISI Web of Knowledge, the Cochrane Database of Systematic Reviews and the Cochrane Central Register of Controlled Trials (CENTRAL) to find scholarly articles regarding the effects of financial incentives on health behaviors and health improvement. We focused on literature reviews of articles studying non-elderly, majority-working populations in the United States. Although we investigated several databases in our initial research (CINAHL, ISI Web of Knowledge, and PsycInfo), our final results relied predominantly on the ISI Web of Knowledge Database and the Cochrane Database of Systematic Reviews because, despite using different searches in different databases with different search engines, the latter search produced the same results as earlier searches we performed on the combination of other databases. We performed the search on studies published from 1970 through 2012 inclusive.

In our initial research we found many papers, including several thorough literature reviews, concerning incentive use and weight loss and tobacco cessation. We found only one literature review that, in part, addressed incentives and blood pressure or cholesterol.1 However, we found four individual papers based on RCTs regarding the use of incentives in reducing cholesterol and blood pressure using the Cochrane CENTRAL database, include all the relevant papers cited in the one literature review. Therefore, we summarized the reviews for obesity and tobacco use, and summarized randomized controlled trials and other carefully controlled studies of incentives and cholesterol and blood pressure. We conducted the following searches on the ISI Web of Knowledge database:

\[
\text{TOPIC=} (\text{"CLINICAL TRIAL*" \text{OR} "RANDOMIZED CONTROLLED TRIAL*" \text{OR} "CLINICAL CONTROLLED TRIAL*" \text{OR} "RANDOMLY") AND TOPIC=} (\text{"LOTTERY" OR "PAYMENT*" OR "MONEY" OR "REWARD*" OR "INCENTIVE*"}) \text{ AND TOPIC=} ((\text{"CHOLESTEROL OR CARDIOVASCULAR OR "BLOOD PRESSURE" OR LDL OR HDL OR CARDIAC OR SYSTOLIC OR DIASTOLIC OR HYPERTENSION OR NICOTINE OR SMOKING OR SMOKER OR TOBACCO OR BODY MASS INDEX OR BMI OR OVERWEIGHT OR OBESE})]. \text{TIMESPAN=} 1970-2012.
\]

This search produced 849 results. We reviewed the titles and abstracts to determine whether the articles addressed the relevant health risks and population. In addition to studies of workplace programs, we included studies of participants enrolled through insurance plans because they were likely to include non-elderly workers even, although this decision meant that we were likely over-inclusive as the studies probably included some disabled adults, nonworking adults, dependents, and others. This left 89 relevant papers. At this point, since there were

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several relevant reviews for the obesity and smoking health risk factors, we selected 39 review papers that summarized individual studies. We excluded 29 reviews that did not contain data regarding the effect of incentives on health factors. Reviews that focused on studies that solely increased or otherwise influence participation rates in wellness programs were not included, but reviews where only a subset of studies reviewed concerned incentives’ effect on health risk factors were included. We also excluded one relevant paper because it contained only two qualifying RCTS, both of which were included in other reviews that we reported. In exhibit 3, we report the seven remaining individual reviews and three related reviews by Cahill.

For cholesterol and blood pressure, we went back to the 89 previously-identified papers that studied the effect of incentives on health factors and reviewed them again to eliminate studies that only concerned obesity or smoking or clearly did not measure cholesterol and blood pressure. This left 9 studies. We read these to find five that qualified. In this review we included foreign populations because there were so few results. Four were individual studies (Owen, Francisco, Gomel, and Bloch) and one review study (Kane) that reviewed several other irrelevant studies, as well as Owen and Francisco. Since Kane duplicated the individual studies already identified and included other irrelevant studies, we excluded it. Given the small number of studies assaying the effect of incentives on improving cholesterol and blood pressure values, we conducted the following search on the Cochrane Database of Systematic Reviews:

((cholesterol or obesity or weight or smoking or BP or blood pressure) and (incentive*)) .mp. [mp=title, short title, abstract, full text, keywords, caption text]. Although this search returned 134 results, it generated no relevant additional reviews.

We conducted the following search on the Cochrane CENTRAL database: ((blood pressure or cholesterol or LDL or HDL or diastolic or systolic) and (incentive* or financial)) .mp. [mp=title, original title, abstract, mesh headings, heading words, keyword]. This review returned 57 results. After reviewing these articles, we eliminated 53 studies based on their abstracts because they did not concern the effect of incentives on cholesterol or blood pressure. Because there were so few results, we included studies using accepted statistical methods on foreign populations. There were four remaining studies – identical to the ones identified in the first search – all included in Exhibit 4.

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4 We did, however, exclude a 1976 Canadian study from the final table because it was not well-designed and the incentive studied, $4 discounts on blood pressure cuffs, was dissimilar from incentives used in modern programs. Haynes RB, Gibson ES, Hackett BC, Sackett DL, Taylor DW, Roberts RS, et. al. Improvement of medication compliance in uncontrolled hypertension. Lancet. June 1976;1(7972): 1265-1268.
Because we found relatively few papers examining blood pressure and cholesterol, we conducted another search to find the effects of financial incentive programs on these two health conditions. We searched the Ovid, Medline, ProQuest, Ebscohost and Google Scholar databases for variations of the following search terms combined with “blood pressure” and “cholesterol”: “workplace wellness”, “wellness incentives”, “financial incentives”, “wellness program”, “monetary incentives”, “health promotion programs”, “worksite health promotion”. We did not find any additional relevant studies with this search.

There were some limitations to our approach. First, Kelly alone performed the article search and culling. However, she performed the research multiple times and in close collaboration with Horwitz, and Horwitz reviewed all of the included articles. Second, the studies are also based on different populations. For example, some included only active employees who completed a voluntary health assessment; others included all employees enrolled in a given health plan; others, such as those conducted on manufacturing employees, included a predominantly male population; and, others still included spouses and dependents. Third, published studies are biased towards showing significant results, although this bias makes it particularly striking that we found so few significant effects in the research and so many with insignificant results. Finally, some of the studies included both observational, unadjusted studies and randomized controlled trials. We reported the results based only on the randomized controlled trials.
**Appendix B, Exhibit 1. Employee Response to Financial Incentives: Summary of Research Reviews for Weight Loss and Smoking Cessation**

<table>
<thead>
<tr>
<th>Review</th>
<th># Papers on incentives</th>
<th>Scope of Review</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weight Loss</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paul-Ebhoimhen &amp; Avenell (2008)*</td>
<td>9</td>
<td>RCTs (1974-2008). Treatments for obesity and overweight using financial incentives with reported follow-up &gt;= 1 year.</td>
<td>No significant effect on weight loss or maintenance at 12 or 18 months.</td>
</tr>
<tr>
<td>Spahn (2010)*</td>
<td>9</td>
<td>RCTs (1986–2007). Included programs in which adult received nutrition counseling.</td>
<td>No effect on weight loss.</td>
</tr>
<tr>
<td>Kane (2004)*</td>
<td>7</td>
<td>RCTs (1966–2002). Effect of economic incentives on consumers’ preventative behaviors.</td>
<td>One study showed significant weight loss in incentive and no incentive calorie contract groups as compared to no intervention. One study showed significant weight change for incentive contracts as compared to control. Five studies on incentives showed no significant weight loss.</td>
</tr>
<tr>
<td><strong>Smoking Cessation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cahill (2008)*</td>
<td>19</td>
<td>RCTs or quasi-RCTs (1980–2010). Workplace smoking cessation interventions.</td>
<td>Of 2008, 2009 reviews (total 17 studies), none showed significantly higher quit rates for incentive compared to control group beyond 6-month follow-up. In 2011 update, incentives not shown to enhance long-term quit rates, except 1 study with significant higher quit rates for incentive group beyond 6 month assessment.</td>
</tr>
<tr>
<td>Kane (2004)*</td>
<td>6</td>
<td>RCTs (1966–2002). Effect of economic incentives on preventative health behaviors.</td>
<td>Studies showed short-term effects, but all four that addressed long-term effects were not significant.</td>
</tr>
<tr>
<td>Smedslund (2004)*</td>
<td>9</td>
<td>Control or comparison group (1989-2000). Smoking cessation interventions at workplace with &gt;= 6 mos. follow-up</td>
<td>Initial effectiveness decreased over time. No significant effect at 12 months post-intervention.</td>
</tr>
<tr>
<td>Cahill and Perera (2008)*</td>
<td>5</td>
<td>RCTs and controlled studies (1980–2010). Smoking quit and win contests with population, not individually-based incentives.</td>
<td>3 studies showed significantly higher quit rates for the quit and win group than the control group at 12 months.</td>
</tr>
</tbody>
</table>

*Note: *If the value was not significant to a p>0.10 level compared to the control group, it was considered to have no effect.*


f. Spahn J, Reeves R, Keim K, Laquatra I, Kellogg M, Jortberg B, et al. State of the evidence regarding behavior change theories and strategies in nutrition counseling to facilitate health and food behavior change. J Am Diet Assoc. 2010;110:879-891. (Note: Eight papers presented in this paper were already cited in the other included reviews: seven from Paul-Ebhohimhen and one from Wall.)

g. Kane R, Johnson P, Town R, Butler M. A structured review of the effect of economic incentives on consumers’ preventive behavior. Am J Prev Med. 2004;27(4):327-352. (Note: Four weight loss studies reviewed are unique to this review; three studies are reviewed in Paul-Ebhohimhen. Three of the included smoking studies were also reviewed in the Cahill reviews.)

h. Smedslund G, Fisher K, Boles S, Lichtenstein E. The effectiveness of workplace smoking cessation programmes: a meta-analysis of recent studies. Tob Control. 2004;13:197-204. (Note: Four of the reviewed papers were included in the Cahill reviews.)

i. Cahill K, Perera R. Quit and win contests for smoking cessation. Cochrane Database Syst Rev. 2008;(4). Art No.: CD004986. DOI: 10.1002/14651858.CD004986.pub3. (Note: this review focuses on population-based incentives, not individually-based incentives. These five studies are different from the 19 total identified in the other three Cahill papers.)
**Appendix B, Exhibit 2. Employee Response to Financial Incentives: Summary of RCTs on Blood Pressure and Cholesterol Levels**

<table>
<thead>
<tr>
<th>Health Risk Factor</th>
<th>Improvement</th>
<th>No improvement</th>
<th>Decline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood Pressure</td>
<td>1&lt;sup&gt;c*&lt;/sup&gt;</td>
<td></td>
<td>1&lt;sup&gt;c*&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>2&lt;sup&gt;a, b&lt;/sup&gt;</td>
<td>2&lt;sup&gt;c, d*&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:** *If the value was not significant to a p>0.10 level, it was considered to have no effect. **

a. Bloch MJ, Armstrong DS, Dettling L, Hardy A, Caterino K, Barrie S. Partners in lowering cholesterol: comparison of a multidisciplinary education program, monetary incentives, or usual care in the treatment of dyslipidemia identified among employees. J. Occup Environ Med. 2006;48:675-681. (Note: mean LDL-C reduced equally in both incentive groups – 11.3% with financial incentives, 11.5% with education, both more than control group 3.5%) financial incentive equal to other intervention. Only open to employees with high levels of LDL-C 100$ if reduced by 15% within 6 months.).

b. Francisco VT, Paine AL, Fawcett SB, Johnston J, Banks D. An experimental evaluation of an incentive program to reduce serum cholesterol levels among health fair participants. Arch Fam Med. 1994;3:246-251. (b*: compares health fair, health risk information, announcement of follow up screening v. these interventions plus 5 $100 lotteries.).

c. Gomel M, Oldenburg B, Simpson JM, Owen N. Work-site cardiovascular risk reduction: a randomized trial of health risk assessment, education, counseling, and incentives. Am J Public Health. 1993;83(9):1231-1238. (c*: conducted in Australia, blood pressure behavioral counseling plus lottery incentive showed improvement at 3 months and worse outcomes than at baseline at 12 months.)